The Mesoamerican codex re-entangled : production, use, and re-use of precolonial documents

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Production, Use, and Re-use of Precolonial Documents

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Summary

THE MESOAMERICAN CODEX RE-ENTANGLED

Production, use and re-use of precolonial documents

This work is an attempt to piece together the cultural biography of the precolonial Mesoamerican codices. It will be shown that modern technology is capable of elucidating even the earliest episodes of this biography. The less than twenty manuscripts that still exist today are all that remains of the Mesoamerican book-making tradition. Past studies of these pictographic and hieroglyphic manuscripts have focussed mostly on their content. The lack of a focus on their physical characteristics has meant that not enough is known about the production, use and re-use of these books.

As with any object, the biography of the codices begins with the creation process. Much about this process is unclear, as its study is made difficult by a number of factors. The first of these factors is the understandably protective policy of the institutes that have these books in their care. Any investigation of the originals has to be done in a fully non-invasive manner. The methods currently available for non-invasive investigation of materials all use spectral analysis at different wavelengths. These methods are able to identify inorganic materials such as mineral pigments, but have limited applicability to organic materials. Earlier studies have shown that these codices are made on strips of either leather or paper, which was folded like an accordion to make pages and then covered with a chalk or gypsum gesso. On this bright white surface the scribes painted their figures using mostly organic dye-based paints. What the source of these dyes was is often impossible to ascertain using the non-invasive methods. Next to these modern investigations, there is however also a number of early colonial Spanish documents that provide information on the materials that were used by precolonial Mesoamerican peoples to make colours. These two sources of information provide a list of possible ingredients for the making of a codex. Within the context of this study experiments have been performed with the ingredients on this list to: better understand how to work with this material; what previously unidentified secondary materials may need to be included; and also what techniques, skills and tools are needed to successfully make a full scale codex. During this reconstruction process it becomes clear that these books are the result of intensive interaction between many people. First of all, some of the materials identified in these books come from sources with a wide geographical spread. The wide range of skills needed to extract the resources and make all the components for each codex furthermore suggests a complex interaction between different craft specialists.

When an object is finished, it enters into a new phase of its biography: a period of actual use. There is very little securely known about the use of these books, though it is clear that these books were sacred texts rather than everyday objects. Some texts contain information that can be considered more historical in nature, though these books were also not objects for simple everyday use. A basic distinction that can be made is private versus communal use of a text. This distinction is important when considering the location of use, as well as all the other objects and people involved in its use.

When the remaining codices are studied closely, it becomes clear that these books are fragile. Danger comes from fire, water, light and simple handling. Thus throughout their use they are in constant danger of deterioration and will eventually need to be either repaired, or disposed of in a proper manner. From Spanish descriptions as well as some very rare archaeological finds it can be seen that one way of disposing of an old codex was by putting it in a

burial, either in a cave or in the ground. Both of these leave very little archaeological remains. This helps explain why so few codices exist today.

The second big reason for the disappearance of entire libraries is to be found in the encounter between the Mesoamerican and the European worldviews. In Europe centuries of war against internal and external "Others" had associated non-Christians with the realm of evil. In the European imagination there was a whole realm of evil, subjected to the devil, where demons were worshipped. In European art devils and demons were depicted as hybrid creatures, exhibiting both human and animal characteristics. In the Mesoamerican writing traditions, humans are often depicted with animal features in their dress. This was originally meant to be related to the name of the character, but was reinterpreted by Europeans to show that these were evil books used for demon worship. As a result the Europeans destroyed them. The codex Iya Nacuaa (Colombino-Becker) shows an indigenous reaction to the threat of destruction levelled at the Mesoamerican writing systems as a result of this imaginary demonology. This document is one of the most damaged documents, but the damage is intentional and can paradoxically be seen to be directed towards a goal of preserving the document.

Almost all books that have survived the colonial period did so within the walls of European institutions. For many of these books it is not well known how they got there, or where they came from. For some it was even forgotten that they came from the Americas. In these institutes the books lost their meaning and the workings of the writings system were forgotten. It was only with their reproduction that they could be studied and started to regain some of their meaning. The strategies of reproduction can be considered as a new chapter in the cultural biography of these codices. The different ways of reproduction transformed the objects in fundamental ways. Inaccurate reproduction is one obvious transformation, but even photographic reproduction, with its two-dimensionality, changes the codex. A second aspect of transformation is the creation of access to these books through reproduction. Whom they are reproduced for is as important as how they are reproduced. Reproduction of these books has given more access to scholars, but has due to the costs of many of the reproductions had a limited impact on the general public. As with any rare and thus valuable object, these codices have attracted the attention of forgers, which again transforms the meaning of these objects. Modern digital technology is on the rise as one of the ways of creating access to cultural heritage, though it has not yet been applied extensively on these manuscripts. The new possibilities that these techniques offer, as well as the pitfalls that need to be avoided, are important aspects to consider for the future of these books.

Modern technology has been the main tool for the investigation of the earliest phase of one of the Mesoamerican codices. During the 1950s it was discovered that one of the codices had lived a life before the use of the known text: the Codex Añute (Selden) is a palimpsest. Hidden underneath the gesso layer, and older layer of images can be found. When it was first discovered, technology had not advanced far enough to allow the investigation of these images without removing the gesso. Within the project here presented researchers from Leiden University, Delft University of Technology, and the Bodleian Libraries of the University of Oxford, have recently teamed up to recover these images in a non-invasive manner. A whole range of techniques was applied to obtain as much information as possible on the images that were already exposed – due to natural wear and the invasive investigation of the 1950s - as well as previously invisible images on pages still completely covered with gesso. This opened up a whole series of new questions which may now be asked of this object: why was it reused? Was this normal? What can the hidden text tell us about Mesoamerican history?

All these new questions indicate that the cultural biographies of these manuscripts are not yet finished. One possible future chapter may be to use these books to reconnect present-day Mexican indigenous peoples with their cultural heritage. One medium for this may be the internet. The final part of this work contains a brief discussion of the possibilities and the pitfalls that this would bring.

Nederlandse Samenvatting

DE MESO-AMERIKAANSE CODEX OPNIEUW VERWARD

Productie, gebruik en hergebruik van pre-koloniale documenten

Deze studie beoogt de culturele biografie van de pre-koloniale Meso-Amerikaanse codices te reconstrueren. Met deze studie wordt duidelijk gemaakt dat moderne technieken het onderzoek naar zelfs de vroegste fases van de biografie van codices een belangrijke stap vooruit kunnen helpen.

Slechts twintig boeken vanuit de pre-koloniale Meso-Amerikaanse literaire traditie zijn overgeleverd. De teksten in deze boeken, in pictografisch schrift en in hiërogliefen, zijn in het verleden vooral inhoudelijk bestudeerd. Doordat weinig of geen onderzoek is gedaan naar de fysieke kenmerken van de codices, is nog onvoldoende bekend over productie, gebruik en hergebruik ervan.

Net als bij andere objecten begint de biografie van de codices met het productieproces. Een groot deel van dit proces is nog onduidelijk, omdat de studie hiernaar word bemoeilijkt door een aantal factoren. Ten eerste hebben de instituten die deze boeken in hun collectie beheren een begrijpelijk beschermend beleid. Hierdoor moet al het huidige onderzoek op een niet-invasieve manier gebeuren. De technieken die hier tegenwoordig beschikbaar voor zijn, maken alle gebruik van een vorm van spectrale analyse bij verschillende golflengtes. Deze technieken kunnen anorganische materialen, zoals minerale pigmenten, effectief identificeren, maar zijn minder effectief waar het gaat om organische stoffen. Eerdere studies hebben uitgewezen dat voor de codices gebruikgemaakt is van stroken leer of boombastpapier. Dit basismateriaal werd als een accordeon opgevouwen om pagina's te creëren, die vervolgens werden bedekt met een gesso laag van gips of kalk. Dit zorgde voor een heldere witte ondergrond waar de Meso-Amerikaanse auteurs op konden schrijven met voornamelijk organische kleurstoffen. Waar deze kleurstoffen van gemaakt zijn, is in veel gevallen niet te achterhalen met de niet-invasieve technieken. Naast deze moderne technieken zijn er echter ook vroeg-koloniale bronnen die informatie geven over welke materialen gebruikt werden door de Meso-Amerikaanse bevolking voor het maken van kleur. Deze twee bronnen van informatie vormen samen een lijst met mogelijke basisingrediënten die nodig zijn voor het maken van een codex.

Met de ingrediënten op deze lijst zijn voor dit onderzoek experimenten uitgevoerd om te achterhalen hoe met deze materialen gewerkt kan worden, welke overige materialen hierbij nodig zijn en welke technieken, vaardigheden en gereedschappen vereist zijn voor het maken van een volledige codex. De experimenten laten zien dat deze codices tot stand komen in een interactie tussen veel verschillende mensen. Ten eerste is duidelijk dat de gebruikte materialen van geografisch wijd verspreide bronnen komen. De vaardigheden die nodig zijn voor het verkrijgen van de ruwe materialen en voor het vervaardigen van de verschillende onderdelen van deze codices getuigen van een hoge mate van interactie tussen specialisten van verschillende ambachten.

Zodra een object klaar is, begint het aan een nieuwe fase van de biografie: het gebruik. Er is zeer weinig met zekerheid te zeggen over het daadwerkelijk gebruik van de codices, hoewel wel duidelijk is dat de teksten erin een veelal sacraal karakter hebben. Dat maakt dat de codices geen alledaagse gebruiksvoorwerpen waren. In sommige teksten kan een iets meer historisch dan sacraal karakter worden herkend, maar ook de handschriften met die teksten zullen geen alledaagse gebruiksvoorwerpen zijn geweest. Een eerste scheiding kan wel gemaakt worden tussen het privégebruik en het publieke

gebruik. Dat verschil is belangrijk omdat het ook implicaties heeft voor de locatie van het gebruik én ook voor de betrokken personen en andere objecten. Wanneer de overgeleverde codices in detail bestudeerd worden, wordt duidelijk dat ze zeer fragiel zijn. Ze waren en zijn zeer gevoelig voor vuur, water, licht en zelfs het bedoelde gebruik. In de omgang met de codices moest altijd rekening gehouden worden met de dreiging van verval. Uiteindelijk moest een manuscript ofwel gerepareerd, ofwel op een manier afgevoerd worden die aansloot bij het sacrale karakter van de teksten. Vanuit een aantal Spaanse bronnen en zeldzame archeologische vondsten, weten we dat het plaatsen van een codex in een graf gezien werd als een verantwoorde manier om deze af te voeren. Daarbij kwam de codex in een grot of in de grond terecht; beide methoden laten in het algemeen weinig archeologische resten achter. Dit verklaart voor een deel waarom er nog maar zo weinig van dit soort codices over zijn.

Een tweede belangrijke reden voor het verdwijnen van hele bibliotheken aan boeken is de botsing tussen de Meso-Amerikaanse en de Europese wereldvisies. Vanuit het christelijk wereldbeeld was in Europa een strijd ontstaan tegen interne en externe 'anderen'. Daardoor werden niet-christenen vrijwel gelijkgesteld aan 'het kwaad'. In de Europese verbeelding was een wereld van het kwaad ontstaan, waar mensen leefden onder invloed van de duivel en waar demonen aanbeden werden. In Europese kunst werden demonen en duivels afgebeeld als hybride wezens, met menselijke en dierlijke karakteristieken. In de Meso-Amerikaanse schriftvormen worden vaak mensen afgebeeld met dierlijke elementen als onderdeel van hun kleding. Dit heeft over het algemeen te maken met de namen van deze personen, maar dit werd door de Europeanen geïnterpreteerd als bewijs dat dit kwade boeken waren, bedoeld voor duivelsaanbidding. In de Codex Iya-Nacuaa (Colombino-Becker) is een inheemse aanpassing te zien als reactie op de bedreiging die voortkwam uit de ingebeelde demonologie van de Europeanen. Dit document is een van de meest beschadigde boeken, maar de beschadigingen zijn intentioneel en kunnen paradoxaal genoeg gezien worden als onderdeel van een strategie die als doel had het document te beschermen.

Vrijwel alle codices die de koloniale periode hebben overleefd waren in het bezit van Europese instellingen. Van veel daarvan is het niet duidelijk hoe ze daar terecht zijn gekomen, noch waar ze precies vandaan kwamen. Van sommige werd zelfs vergeten dat ze uit de Amerika's kwamen. De betekenis van de handschriften en de manier waarop ze gelezen moesten worden was in deze Europese bewaarplaatsen al helemaal onbekend. Pas toen reproducties van de manuscripten gemaakt werden, kon de studie beginnen en kregen ze weer nieuwe betekenis. De strategie van reproductie kan gezien worden als een nieuwe fase in de culturele biografie van deze boeken. De reproducties veranderden de boeken fundamenteel. Onjuiste reproducties zijn een duidelijk voorbeeld van een dergelijke verandering, maar zelfs fotografische reproducties, door hun tweedimensionaliteit, zorgen voor verandering.

Een tweede transformatie werd veroorzaakt door de toegankelijkheid van de reproducties van de teksten. Voor welk publiek de reproducties gemaakt werden is even belangrijk als hoe ze zijn gemaakt. De reproducties hebben wetenschappers toegang gegeven tot deze boeken, maar door de hoge kosten van de reproducties hebben ze relatief weinig invloed gehad op een breder publiek. Net als andere zeldzame en daarmee potentieel waardevolle objecten, hebben de codices de aandacht getrokken van vervalsers, die ook weer voor een andere transformatie in de betekenis van deze boeken zorgden.

Moderne digitale technieken zijn in opkomst als een van de manieren om cultureel erfgoed toegankelijk te maken. Deze technieken zijn nog niet veelvuldig toegepast op de codices. Het is echter belangrijk om de mogelijkheden alsook de gevaren van deze technieken in beeld te brengen voor de toekomst van deze handschriften.

Moderne technieken zijn de belangrijkste middelen voor het bestuderen van een van de vroegste fases van een van de codices. In de jaren vijftig van de 20ste eeuw werd ontdekt dat een van de codices een eerder leven had gehad voor het gebruik van de reeds bekende tekst; de Codex Añute (Selden) is een palimpsest. Verborgen onder de gesso laag werden oudere tekeningen gevonden. Ten tijde van deze

eerste ontdekking waren er nog geen technieken in staat om de verborgen tekst zichtbaar te maken zonder de gesso laag te verwijderen. Binnen het hier gepresenteerde onderzoeksproject hebben onderzoekers uit Delft, Leiden en de Bodleian Library van de Universiteit van Oxford samengewerkt om deze afbeeldingen op niet-invasieve manieren zichtbaar te maken. Een scala aan technieken werd toegepast om zoveel mogelijk informatie te verkrijgen over alle afbeeldingen. Daarbij ging het zowel om de afbeeldingen die door natuurlijk verval of door onderzoek uit de jaren vijftig al zichtbaar waren gemaakt, als om de voorheen onzichtbare afbeeldingen die nog volledig bedekt zijn met gesso. Dit alles roept een nieuwe serie aan vragen op: Waarom is dit document hergebruikt? Was dit hergebruik normaal? Wat leert deze verborgen tekst ons over de Meso-Amerikaanse geschiedenis?

Het is duidelijk dat de codices nog steeds nieuwe betekenissen krijgen en dat hun biografieën nog niet afgerond zijn. Een mogelijkheid voor de toekomst is dat deze manuscripten een brug slaan tussen huidige Mexicaanse inheemse bevolkingsgroepen en hun cultureel erfgoed. Het internet zou hier een mogelijk medium voor kunnen zijn. In het laatste deel van dit werk worden de voordelen en de valkuilen hiervan besproken.

Propositions

1. Making a precolonial Mesoamerican codex was a complex cross-craft process, involving a set of raw materials that only became available through complex regional interaction.

2. The pattern of wear on codex Iya Nacuaa (Colombino-Becker) can be explained as an indigenous tactic to protect the document in the new colonial situation.

3. High-quality digital reproduction, including 3D-technology, is a next logical step for the dissemination of the precolonial Mesoamerican codices.

4. The Añute palimpsest contains sections of the Mixtec historical narrative which are not found in the other known codices.

5. Although non-invasive investigation is generally preferable, the present day state of the codices and the technological capabilities would warrant the taking of micro-samples to answer pressing research questions.

6. Based on the current knowledge of the material composition of the codices, a unified handling, conservation, and display guideline can and needs to be established.

7. Experimental replication is a research strategy which needs to be used to complement non-invasive investigation of materials, as it reveals more material properties and interactions than those recovered with chemical or physical investigation alone.

8. The Cultural Biography approach should be applied more in research focussing on Postclassic and early colonial Mesoamerican archaeology, as it allows for a better understanding of both parties involved in the transformations that took place during colonisation.

9. In order to address the moral obligation of reconnecting indigenous heritage with descendant communities, which is felt by a growing number of researchers and guardians of that heritage, the creation of an online platform is in the present economic climate the best option.

10. The increased specialisation needed to investigate the (material) properties of artefacts requires researchers to engage in a modern scientific version of cross-craft interaction.

11. Advanced computational techniques such as pattern recognition and machine learning need to be developed for hyperspectral imaging scans of cultural heritage objects, in order to fully utilize the information they contain and to establish a measure of scientific control over reconstructions made based on this information.

12. Medieval European demonology has even today a large impact on the interpretation of precolonial Mesoamerican cultures.

Introduction

Less than twenty books remain of the entire bibliographic tradition of precolonial Mesoamerica and, with that, of the entire American continent. All of these manuscripts, generally called codices, are screenfold books, meaning they are made on long strips of material, folded like an accordion into pages. After the conquest of Mesoamerica by the Spanish conquerors, virtually all remaining codices were transported to Europe where they eventually became part of the collections of museums and libraries. As isolated oddities in this European context, their meaning was quickly forgotten. However, in the time since multiple generations of researchers have focused on reinterpreting these books, which has led to the current situation where the content of these texts is relatively well understood. Because they are such rich sources of information, these books are usually approached as sources for the interpretation of precolonial culture. While this is a valuable pursuit in-itself and one that has certainly yielded a wealth of information, it often skips over the fact that these books were not made to inform present day Western scholars. These books were meant to be useful material objects that played an active role in society. This work is an attempt at reconstructing the cultural biography of these objects (Gosden & Marshall, 1999; see also Kopytoff, 1986) following them from production, original use, re-use, up to eventual discard and present day (re-)interpretation.

The remaining precolonial codices are not all the same. There are three Maya codices which were made in the Yucatan peninsula, and are written with hieroglyphs. The rest of these books are made using a pictographic script. Only for the five remaining Mixtec codices can it be determined exactly where they were made. This is due to their content, as these books recount the history of identifiable towns in the Mixtec area in present day state of Oaxaca (see Boone, 2000; B.E. Byland & Pohl, 1994; Jansen & Pérez Jiménez, 2011; Kowalewski et al., 2009). The rest of the pictographic codices cannot be precisely sourced as they do not contain clear markers of origin, although their style and content suggest they were made somewhere in the central area of what is today Mexico. They are filled with information about religion, the calendar, and also contain mantic or divinatory texts (see Anders, Jansen, & Reyes García, 1993a, 1993b; Boone, 2013). This group of codices is often called the Borgia group, after the old name of one of the most iconic examples of this group. The content of the Maya codices is in many respects similar to these religious pictographic texts, with the addition of many tables containing astronomical information (Grube & Bürger, 2012; Vail & Aveni, 2004). Despite the differences, there are two reasons why all the remaining codices are included in this research. Both of these reasons are related to the fact that these codices represent only a small fraction of the total corpus that must have existed. Because of this it would also be unwise to exclude a group of documents because it deviates, either in content or in composition, from the majority of the corpus: the corpus is simply too small to justify treating any group of documents as real outliers. This does mean, however, that care must be taken not to over-generalise the information gained from the codices.

It was decided to include in this research only the precolonial documents. This is because the corpus of colonial document is too large and because the Europeans introduced their own material culture and traditions which were incorporated in the writing process (see Wolf, Connors, & Waldman, 2011). Both these factors would greatly increase the complexity of this research. The exception to this is the inclusion of the codex Añute (Selden), which is technically colonial, as it was made between 1556 and 1560 A.D. (Jansen & Pérez Jiménez, 2007b, p. 31). It is, however, completely precolonial in style, content, and, as will be shown in chapter 1, material composition. Throughout this work, the names used for these codices are the ones given to them by Jansen and Pérez Jiménez (2004). They decided to rename the Mixtec codices and those of the Borgia group so that their names better reflect their Mesoamerican origin. For indigenous peoples today, these names are more recognisable than their counterpart European names. Since the old names are still in use in much scholarly literature, in some cases the old names are

Manuscript name	Alternative name[1]	Currently held at
Mixtec group		
Codex Bodley	Codex Ñuu Tnoo-Ndisi Nuu	Bodleian Library, Oxford
Codex Selden	Codex Añute	Bodleian Library, Oxford
Codex Becker I	Codex Iya Nacuaa[2]	Museum fur Völkerkunde, Vienna
Codex Colombino	Codex Iya Nacuaa	MNAH, Mexico City
Codex Nuttall	Codex Tonindeye	British Museum, London
C. Vindobonensis Mexicanus 1	Codex Yuta Tnoho	ONB, Vienna
Maya Group		
Codex Dresden		SLUB, Dresden
Paris Codex		BNF, Paris
Madrid Codex		Museo de América, Madrid
Grolier Codex[3]		Mexico City
Borgia-Group		
Codex Borgia	Codex Yoalli Ehecatl	BAV, Vatican
Codex Vaticanus B	Codex Tonalpouhqui	BAV, Vatican
Codex Cospi	Codex Tlamanalli	Biblioteca Universitaria, Bologna
Codex Fejérvàry-Mayer	Codex Tezcatlipoca	World Museum, Liverpool
Codex Laud	Codex Mictlan	Bodleian Library, Oxford
Important Fragments		
Codex Yauhtepec		San Bartolo Yauhtepec
Codex Porfirio Díaz	Codex Yada	BNA, Mexico D.F.
Nochixtlan-Fragment[4]	Nuu Naa Fragment	Museum für Völkerkunde in Hamburg

Table 1. Names and locations of the remaining pre-colonial Mesoamerican manuscripts

1.The alternative names reproduced in this table were originally proposed by Jansen and Pérez Jiménez (2004) (see also Jansen & Pérez Jiménez, 2011, pp. 42-95) to replace the colonial nomenclature used in the studies of these books. In this work, the alternative, more dignified names will be used. However since scientific literature is permeated with these names, on occasion the older names will be given in brackets.

2.The codices Becker I and Colombino are parts of the same document, which is reflected in the alternative name.

3.The Grolier Codex is thought by many to be a fake. As such, it is not taken up in the discussion of the materials. It does feature in chapter 5 where its possibly deceptive nature is discussed.

4.This fragment is the beginning of the Codex Cochi (see Jansen, 1994).

also given in brackets. Table 1 shows both of these names, as well as the institutes that currently have these books as a part of their collections.

Although the term object is used in this work to refer to the codices, it must be understood that these books were not always passive, but that they had a definite effect in society. This is not because of some "magical mind dust" as Ingold (2007, p. 11) calls the agency that is often attributed to objects in materiality theory. It can be much better explained by using the definition of materiality given by Rebay-Salisbury, Brysbaert, and Foxhall (2014, p. 1) as "the properties, affordances, functions and styles of different materials". In other words, what gives these books agency is that they enable humans to do things with them, which they could not do in the same way without them. This goes beyond simplistic structural functionalism, as these books clearly contain complex layers of symbolism. Interpretation of this symbolism may change the affordances and perceived functions of the object. Hodder (2012) distinguishes two types of relations between objects and between objects and humans. One relation is the enabling affordance that is also incorporated in the definition of materiality given above. The second relation is one of dependence; i.e. all the "things" that are needed to construct and maintain an object. These "things" can be material – in the sense of raw materials, tools, and the artists' hands, immaterial – in the sense of knowledge, skill, and desire, or both material and immaterial. The total set of affordances and dependencies creates a web of entanglement that each object is caught up in.

To give all these aspects a place, the cultural biographical approach as proposed by Gosden and Marshall (1999) is ideal. With this approach, the codices can be studied in such a way that they remain the centre of attention without losing the social context in which they appear. This context is crucial to understand the changes that occur in the set of affordances and dependencies of these codices. There are, for example, massive changes in context that occur with the coming of the Spanish Conquerors, which severely transform the meaning of these books. The changes that occur in the book-making tradition in the Americas as a whole are obvious, with the introduction of alphabetic writing and the use of European materials such as paper, though more subtle changes can be seen in the already existing precolonial documents as well.

What makes the biographical approach so applicable to the codices is the fact that it allows for the consideration of the whole life of an object. In this way, the biographical approach includes the chaîne opératoire and use-life analysis approaches, and may even go beyond these approaches to account for present day interactions with these objects as well as considering future developments (Joy, 2009, p. 542). Especially for such significant objects as these codices, which remain important artefacts or even tools for present day scientific and social issues, the biography continues to aggregate meaning. The biographical approach is, however, not without its issues. On a basic level the objects under scrutiny in this work, by their very nature, are not prehistoric. At the same time, some problems plaguing prehistoric artefact biographies (see Joyce et al., 2004, p. 543) also need to be addressed for this study. As with prehistoric artefacts, there is little in the way of recorded information about the life of this class of objects, let alone about the specific lives of individual codices. At the same time, as texts they are clearly objects inscribed with meaning from their very creation (Marshall, 2008, p. 64). An understanding of this inscribed meaning forms the basis for an exploration of the ways in which they can acquire more meaning, particularly, as Gosden and Marshall (1999, p. 174) suggest, through performance.

With the approach taken in this dissertation, a first attempt is made to understand the place of the precolonial codices in society through time. Often this means transcending the analysis of the biography of individual codices and looking at idealised biographies of the entire class of object (see Jones, 2001, p. 85). In the case of the colonial encounter where Spanish views clashed with these books, all the remaining codices deviate from the ideal path, as they are the ones that escaped the idealised destruction. Luckily, here the colonial Spanish documents, as well as medieval European practice, do give contextual information which helps to reconstruct the preferred way of dealing with these books.

Each chapter of this work focusses on a specific section of the cultural biography of these codices. The first two chapters look at the dependencies of the codices in a material sense. From the cultural biographical perspective, these two chapters simultaneously analyse the very beginning as well as a very late part of the story of these books. This is because the understanding of the material composition of these books and the process by which they were made is only now being understood with the help of very modern technology. The information used in chapter 1 on material composition comes from a number of investigations involving different types of precolonial documents, both historical and religious, and from different cultural areas, which were aimed at understanding the physical and chemical composition of these books using high-tech (mostly) non-invasive investigative techniques. Because of the rarity of these books and with that the understandably protective policies of the institutes holding them, all current investigation needs to be fully non-invasive. These non-invasive technique are, however, not always capable of fully identifying the materials. Thus, secondary sources of information often needed to be consulted; in this case, a number of early colonial sources which give information about plants and other natural materials that, at least as far as their writers understood the matter, could have been used in the production of these books. Most notable amongst these secondary sources are the Historia general de las cosas de nueva España also known as the Florentine Codex by Fray Bernardino de Sahagún (1577c), the Quatro libros de la naturaleza by Dr. Francisco Hernandez (1615), and the so-called Badiano Codex or the Libellus de Medicinalibus Indorum Herbis written by Martin de la Cruz and translated into Latin by Juan Badiano (1991).

The list of identified materials can then be used to do experiments in order to understand the process of creation through replication. The results of this are incorporated in chapter 2. While the high-tech investigation allows for the recovery of the main components used in the creation of these books, the experimental replication shows the production process to be rather more complex. Experimental replication yields a fuller understanding of the materials, skills, and specialist skills needed to complete a codex. Working with the materials also helps one to explain why certain materials are chosen, and how all these materials work together to form a book. Furthermore, the full scale replicas help one to appreciate the original aesthetics of these books, before use and the passage of time took their toll. A theoretical issue needs to be raised here. If the definition of experimental archaeology, in which this process of replication can be situated, is followed (Mathieu, 2002, p. 1), then there is a difficulty with these experiments in terms of controllability and in the creation of analogies to archaeological remains. The problem here is not so much with the experimental replication itself, but rather with the ability to check the replicated object against the archaeological original, because of the restrictions placed on the research of the originals. Thus, these experiments can only show how a codex could be made using the available materials and technology, but they do not provide us with any certainty about how such documents would have to have been made. Being such complex objects, the precolonial codices also give an interesting window into the multiplicity of precolonial crafts. Many of these crafts did not leave much in the way of material remains in archaeology and are thus very difficult to study. The codices are one of the few examples of objects that have survived which are the result of this complex interaction of different crafts.

The affordances of these books – i.e. their possible uses – are central to the discussion in chapters 3 and 4. The first of these chapters focusses on the original intended context of use. Because none of the codices is encountered in a primary context, this use has to be completely reconstructed, based upon the types of content (the inscribed meaning) of these texts. As will be shown, none of these books were used in isolation, so their use invariably implies further entanglement with objects and people. Because of the relative fragility of these books, continued use also implies decay. Close observation of the remaining codices, combined with some very fragmented archaeological and historical data, allows for an understanding of the strategies of repair, reuse, and also disposal of these books. Chapter 3 can thus be considered as a discussion of the complete use-life

of a codex as it was intended by their creators, thus finishing the object's intended chaîne opératoire.

Chapter 4 turns the tables and is an attempt to understand the affordances of these codices within a completely new set of entanglements caused by Spanish colonialism. As Gosden and Marshall (1999, p. 176) already note, colonial encounters are moments in cultural biographies where sharp breaks may occur in the meaning of objects. In the case of the precolonial codices, it may be more appropriate to consider this as a reinterpretation of the books within the already existing cultural framework with which the Spaniards entered Mesoamerica. This is the world of an essentially Medieval Spain that, through its own turbulent socio-political and religious past, created a whole new set of conditions within which the codices had a set of specific negative affordances. It also introduced a new set of "Things" (as defined in Hodder, 2012, pp. 7-9) which could connect to and disrupt part of the old set of relations, potentially unsettling the dependences that the creation and maintenance of the codices had relied upon. One codex, the Codex Iya Nacuaa, is shown to contain a strategy to deal with this new perception of precolonial writing.

Ironically, the move of the codices to Europe may have been the "salvation" of the physical objects, though for a large part of the 17th and 18th century they lay forgotten in libraries or private collections. It is not until the late 18th and early 19th century that renewed interest in these books began. Spread out as they are over multiple institutes throughout Europe, it was quickly understood that no study of these books could be attempted without proper reproduction (M. D. Coe, 1992, p. 90). These reproductions are central to chapter 5. They can be seen as creating new entanglements between these codices and people, affording study and extensive reinterpretation. At the same time, the technologies used remove the texts ever further from the object itself. Today it is possible to study the contents of a Mesoamerican codex without ever laying eyes on one. New technology, such as the internet, creates new possibilities for connecting with these books, though not all of these new relations are without problems. Two examples of modern re-creations, fake codices which came to light during this investigation, exemplify the issues that such limitless access may bring.

The final chapter of this dissertation reports on the recent research done by the author and my colleague Tim Zaman of the Technical University of Delft on one specific codex held at the Bodleian Library: the codex Añute (Selden 3135 A.2). The Añute document is unique as it is a palimpsest, having been painted over an older manuscript. During the period of this project, Zaman developed a new technique with the purpose of looking through this document. This and other techniques applied to the document are discussed and the results are presented. In the final chapter the need for understanding the physical object is made clear, as the recovery of the palimpsest is severely limited by the material composition of the book. It also shows a new type of relation that firmly binds these codices with the most modern of techniques. The previously unknown codex which with this research is being revealed only becomes visible in the virtual world.

It is clear that these books are continuing to add to their biography, which becomes increasingly entangled with modern technology. A different type of connection that has thus far been explored only seldom is the connection of these books with present-day indigenous peoples. Although this connection is in many cases heavily distorted if not lost completely, perhaps modern technology can in the future reconnect these books with the descendants of their creators. In the conclusion these and other possible future connections that these books can engage in are reflected upon.

1. Materials for Writing

For many works of art, modern photographic and digital reproductions have artificially separated the image from its physical original. One of the clearest examples of this can be found in the works of painter Pieter Mondrian. Many people will have seen pictures of his most famous works which are composed of vertical and horizontal lines forming red, yellow, blue, black, or white squares and rectangles. What is completely lost in such a picture, however, is the three-dimensional nature of his work, so clearly illustrated by his last and unfinished work: Victory Boogie Woogie. This "painting" was made by applying layers of painted self-adhesive tape onto a canvas. And the Victory Boogie Woogie seems to have been one large experiment with working with this newly invented material. Photographic reproduction has done a similar thing to the precolonial Mesoamerican codices. It is now possible to study photographs of the originals and come to a new interpretation of what the texts mean without considering these codices as unique three-dimensional objects. In the first two chapters of this work, the material aspect of these codices is brought back to the centre of attention. The first chapter focusses on the materials that have been identified as ingredients for the codices, using scientific methods. The difficulty here is that, due to the rarity and fragility of the codices, their caretakers have adopted an understandably protective conservation policy. As such, all modern investigation needs to be fully non-invasive. This means that no samples can be taken and that all investigation is done with different forms of electromagnetic spectroscopy (see Charola & Koestler, 2006, pp. 14-19; Pollard, Batt, Stern, & Young, 2007, pp. 45-137). These techniques at present have difficulty securely identifying organic materials. Their similar chemical composition, being mostly a specific arrangement of carbon and hydrogen molecules, makes it impossible to distinguish between them. To come a step closer to identification, a second source of information needs to be consulted: the early colonial Spanish sources describing the use of plants and animals in the Americas. Combining these two types of information yields a list of certain and likely ingredients. This in turn forms the basis for the second chapter, which focusses on the actual technical process of working with these materials. It was decided to divide the materials used into different categories of ingredients needed for making a codex. These categories are: the writing surface, composed of the support and the white covering layer; the covers, of which multiple types can be identified; the paints, subcategorized by colour; and the different glues used in and between each of the previous ingredients. Each of these categories will be considered in turn.

1.1 THE WRITING SURFACE

The surface on which the Mesoamerican books are written comes in two types, both of which seem to be rather unique combinations of materials within world literature. In Medieval Europe, books were made of parchment, which was created by drying and stretching animal skins, while in China the art of making paper has been perfected for centuries. From the few remaining examples in existence today it is clear that in Mesoamerica both a type of paper and animal skins were in use for the creation of a writing surface. The main difference between these book-making traditions and those in practice in Europe and Asia is that these surfaces were not written on directly. All precolonial Mesoamerican documents have a surface that was covered with a white layer before it was deemed fit to write upon. In general, a book consisted of a long strip of this skin or paper covered on both sides with a white layer, which was folded to form a so-called screenfold book. This combination of materials formed the blank book which was then filled with writing either on one, or on both, sides of the support. The materials that were used to make these supports have been relatively well identified.

Figure 1.1 top left: Detail of Paris Codex showing structure of amate paper (from gallica.bnf.fr accessed 04-01-2016); bottom left: modern day amate paper showing same structure; right: amate tree in ethno-botanical garden of Oaxaca City (courtesy of A. Rojas).

The surface of the Mesoamerican books is a strong, yet flexible material. As stated above, the material of choice was either paper or animal skin. The nature of precolonial Mesoamerican paper is well understood, as in the early 20th century Rudolf Schwede (1912) studied and identified the paper of the three remaining Maya codices. These three are all made from the bark fibres of the amate tree (Ficus spp.) (see figure 1.1). Though this identification is over a hundred years old, the bark paper used for these books is still on occasion erroneously called Agave paper. This may be related to the fact that in one of the first semi-scientific descriptions of these manuscripts, that by Alexander von Humboldt, can be read as stating that [some are painted]:

"*..sur des peaux de cerfs, les autres sur des toiles de coton, ou sur du papier de maguey*". (Humboldt, 1989, p. 66)

Unlike the work by Von Humboldt, which quickly attained fame around the world, the article by Schwede was never translated from the original German. Von Hagen (1944) first brought this discussion to the attention of the Anglophone world, but to this day some confusion still remains. The first chroniclers such as Mártir de Anglería (1964, p. 425) were very clear in their descriptions: "paper is made from the bark of a tree". According to von Hagen (1944, p. 42), Motolinía (1969, p. 199)[5] is the first

5. It must be noted however that Motolinía does continue to talk about a different tree that is called Amatl, so he is not

to cloud the discussion with his statement that "good paper is made of metl". This "metl", the Nahuatl word for agave, is probably used erroneously instead of the word amatl, the word used for both paper and for the fig tree from which the paper is made. The statement "paper is made from agave" cannot possibly be true as it is virtually impossible to make high quality paper of agave, due in the most part to the coarse nature of its fibres. Agave is very suitable for the creation of strong ropes, but for the creation of paper the wooden material would have to be cut up into very fine pieces and joined together in a mould akin to the modern way of papermaking (von Hagen, 1944, pp. 43-44). This technique was not available in precolonial Mesoamerica.

Schwede (1912, pp. 28-33) tested a number of Central Mexican documents, which were thought to be made from agave. Not only were these proven to be made from the bark of the Ficus genus, the actual species used could be correlated with the climate of the region from whence the documents came. This showed that the creation of amate paper was not only widespread but also a more or less local affair. To this day, paper is made from the bark of the Ficus tree also known as Jonote in Nahuatl. The term Jonote seems to refer to a range of fibrous trees from which paper can be made, including, but not limited, to the Ficus spp. As such, any identification of the specific species of tree from which amate paper is made would require detailed analysis of the fibres possibly including an invasive DNA analysis.

Although it is clear from later colonial documents and from present day traditions that paper was – and still is – being made and used in Central Mexico and Oaxaca, the surviving precolonial codices from this region were made on a material that was taken from an animal source. It has been referred to variously as: (deer) hide; skin; leather; and even parchment. Except for the term skin, all these designations imply a specific processing method of the product to keep it from degradation, each resulting in very different final materials. As these treatments have effects upon the structure of the skin, a short explanation of this structure is in order. Skin is composed of multiple layers. The outside of the skin is the epidermis: a layer of dead skin cells, which during life are shed and constantly renewed. Below the epidermis is the grain. This is a mass of small collagen fibres, hair follicles, and sweat glands, criss-crossed by arteries and veins. Further down into the skin the fibres start to become thicker. This is termed the corium layer. In this layer, depending on the thickness of the skin of the animal, the fibres can run from perpendicular to the body to parallel along the body. In the deepest part of the skin all fibres run along the body, forming a more or less smooth surface over the fat and flesh. The main structural components of skin are the collagen fibres. This collagen is composed of about twenty different amino acids, combining to form long helical chains or polypeptides.[6] Three of these chains combine to form a right-twisting coil, or triple helix, which is the collagen molecule. These three strands are held together by hydrogen bonds between the NH and the CO groups of two adjacent chains (see Haines, 2006a, p. 6). The strength of skin, its ability to stretch, and its resistance to tearing comes from these molecular chains and coils, which in turn twist together to form fibrils, which again twist together to form fibres and fibre bundles. These coils of coils interweave to give strength in any direction (Haines, 2006b, p. 11). When processing skin, the bonds between these coils need to be strengthened or at the least protected from degradation.

The term hide usually refers to nothing more than the skin of a larger animal. However in some cases, especially with the term rawhide, some measures may have been taken to allow the skin to be temporarily preserved. It may, for example, have been salted to dehydrate the skin, thus temporarily preventing bacterial growth (see Lockwood, 1912, pp. 22-26). However, none of these techniques provide a long-term solution. Besides that, the introduction of massive amounts of salt into a codex' substrate would have major ramifications for the end result, such as leaching of the salt and formation of salt crystals on and beneath the surface. These salt crystals would have caused major damage in a manner similar to the

completely to blame for the confusion.

6. For an overview of the amino acids in collagen as well as the structures of the most common ones, see Haines (2006a, pp. 4-5).

salt deterioration often found in mural paintings (see Petersen, 2006, pp. 243-244). Parchment implies a very specific procedure of liming, dehydration, and stretching (Woods, 2006, pp. 200-203). This processing changes the collagen structure, opening it up and making it even more susceptible to water (Woods, 2006, p. 206). This makes it a very unsuitable product for a Mesoamerican context, as the climate is often warm and at times especially wet.[7] The application of the white layer, glues, and paints (see below) all involves further introduction of moisture.

Since the codices are made on flexible material that has been able to withstand microbial attack and variations in humidity, the terms skin, hide, and parchment are clearly not applicable to these surfaces. The only candidate left, then, is leather. True leather has undergone a tanning process that causes chemical changes, giving it specific qualities that differ from ordinary skin. There are many process by which tanning can be achieved. The look and feel of the end product is as much dependent on the process used as it is on the type of animal from which the skin is taken. The main characteristic of leather is that it is resistant to microbiological degradation even if kept wet. Thus, the difference between true leather and otherwise preserved skins is to be found in the permanence of the preservation. If skins that have been treated with salt, pickled, or dehydrated become wet, then they quickly lose their protection and will start to degrade. Tanning is a way to reinforce or protect the bonds between collagen coils. It stops them from collapsing or unravelling by introducing more, or other types of, chemical bonds between the collagen coils. The type of bond created between the coils depends on the tanning material used. However, a genuine leather requires a chemical reaction to take place inside the leather, thus strengthening the material with new connections between the collagen strings. This is why tanning with oil, such as brain tanning, which is very common in Native North American processing of hides (Richter & Dettloff, 2002), cannot technically be considered a true tanning technique. While the resultant product is every bit as resistant to microbiological attack, as the individual fibres are insulated in a layer of oil, no new chemical bonds are created. This is important for a second characteristic of leather: an increased resistance to heat. When a skin becomes too warm, the hydrogen bonds between the coils fail and the coils collapse, forming a ball-like mass. The result is a dramatic shrinkage of the leather to about one third of its original size. While true leather has more bonds and is thus better able to withstand the heat, oil tanned leathers are not resistant to heat and will collapse at a temperature of 53-56°C (Thomson, 2006c, p. 2). Secure identification of the tanning agent, therefore, would require further (partially destructive) investigation, and it thus remains unclear whether the codices were made from true leather or if they are merely oil tanned. Considering the properties of the material, however, it must be considered as at least a leather-like material.

The treatment of the skin is only one aspect that determines the look of the leather. The second is the selection of the animal itself. Any vertebrate has a skin that can in principle be turned into leather. The usefulness of the resultant leather is dependent on the intended use, as different animals have skins of different thickness and structure. These skins can be turned into leathers of different suppleness, strength, and aesthetic appeal. Identification of an animal skin can be done based on the differences in fibre structure of the skin or of hairs attached to it; on the basis of follicle patterns on the surface of the skin; or by DNA analysis. The first two methods have as a downside the fact that they require reference collections and are not fully conclusive due to intra-species and intra-individual variations. DNA analysis, on the other hand, is conclusive, though this method requires taking a tissue sample. Though no conclusive evidence has thus far been generated, all research on the codices thus far categorically states that these books are made on deerskin. This attribution is based on the idea that deer was the most widely available source for a skin of that size. Given the lack of domesticates, the number of species available for the production of leather in pre-colonial Mesoamerica was limited. The size of the individual pieces of material that were stuck together to form

7. The highly mountainous Mixtec region, or as it is called in the Mixtec language Ñuu Sau (Land of the Rain), is especially wet during particular seasons.

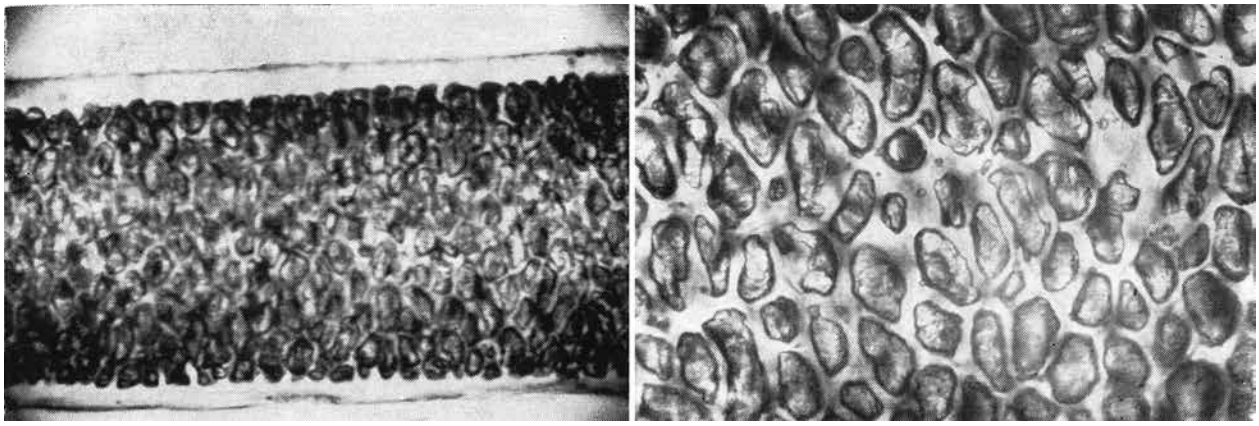


Figure 1.2: Microscopic images of hair and its marrow from Codex Iya Nacuaa (Colombino) enlarged 10x 25 and 10 x 50 respectively (from Alvarez, 1966, image 10 and 13).

the substrate of the codices indicates that the animal from which they came was relatively large. Codex Añute, for instance, is built-up of pieces that cover 3 to 4 pages of the codex, each page measuring 27.5 by 27.5 cm. The individual pieces of leather thus needed to be big enough to cut out a piece of roughly 75-100 cm by 27.5 cm. The most widely available source would indeed have been the most common species of deer in Mesoamerica: the white-tailed deer (Odocoileus virginianus). This deer has four subspecies that inhabit the current state of Oaxaca (Odocoileus v. oaxacensis, Odocoileus v. acapulcensis, Odocoileus v. toltecus and Odocoileus v. thomasi) (see Goodwin & MacDougall, 1969, p. 255), the area where a large part of the codices on leather comes from. On average, a skin of 0.9-1.3 m2 can be attained from a deer (Haines, 2006b, p. 15), which meets the size requirements for a document such as codex Añute. A second type of deer, the Red Brocket (Mazama temama), which is related to the tropical deer in South America, is found in the coastal tropical regions. But this animal is too small to yield enough skin for a good sized codex. Still, when considering the size of the skin which can be obtained, a number of other candidates for the fabrication of codex substrates must be taken into account. Eastward from the modern-day provinces of Oaxaca and Veracruz, a species of tapir (Tapirus bairdii) can be found. Throughout Mesoamerica a number of felines such as jaguars (Felis onca) and mountain lions (Felis concolor), and canines such as wolves (Canis lupus) can be found that would yield a skin large enough for the strips of material constituting the codices (Maldonado Alvarado & Maldonado Alvarado, 2004, p. 103).

In attempting to solve the issue, Alvarez (1966) was allowed to extract some hairs from the Codex Iya Nacuaa (Colombino fragment). These were microscopically analysed and compared with reference samples (see figures 1.2 and 1.3). This investigation showed that this codex had clearly not been made on a large feline or canine skin. The hairs are most similar to those found on a Pronghorn (Antilocapra Americana), though this animal currently does not live in the central or the southern area of Mexico, but is confined to desert areas further north. Alvarez (1966, p. 102) suggests that these hairs, and thus the skin, could come from the white-tailed deer only if the difference in appearance of the hairs could be explained by the tanning process or the degradation of the fibres over time. More likely, he states, is that the skin actually comes from the Pronghorn and that its range was more extensive in precolonial times. There is archaeological evidence for the use of Pronghorn in Nopalera cave (Hidalgo) from the period 350-1100 A.D. (Flannery, 1966, p. 801). In principle, this species could have lived in the central dry and hot region of Oaxaca as these areas are climatologically and ecologically similar to present day ranges (Alvarez, 1966, p. 102).

Whether or not it lived in Central Mexico, the Pronghorn was certainly an animal known to the

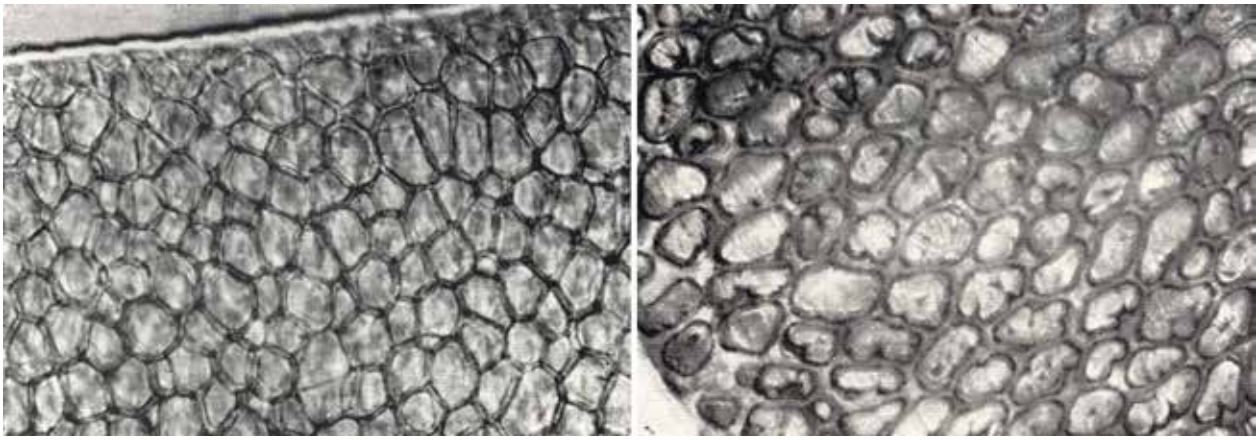


Figure 1.3 Left: Microscopic image of the marrow of white-tailed deer hair; right: Microscopic image of the marrow of Pronghorn hair (after Alvarez, 1966, image 12 and 14).

Aztec, under the name of Tlamacazcamazatl and is described in the Spanish text in the Florentine Codex (1577c, Book 11, fo. 16v) as:

"It is very big, very tall, it has a spotted face, black around the eyes; and below the eyes it has a white stripe going around the snout."
(translation by the author)

Although this is a quite clear description of the Pronghorn, it does not give an indication of whether or not this animal was used for anything like codex production. It is unclear whether the Pronghorn skin has any specific physical attributes other than perhaps its superior size that would make it a more suitable candidate for codex production. Iconographically, the Pronghorn seems to be absent, although perhaps this is to be explained by the fact that any image of a quadruped with horns is likely to be automatically identified as a deer. Although speculative, there may be a symbolical importance to this animal, as it is the fastest land animal in the Americas. Furthermore its name in Nahuatl is composed of the words Tlamacazca and mazatl. The latter can be translated as deer, while the former is a word translated by Molina (1970, p. 125) as "Ministros y servidores delos templos delos ydolos"; i.e. an indigenous priest or servant of the temple. Whether this is a reference to its likeness to the prototypical priests of Mesoamerican culture, often depicted with a black face, or a reference to a more general symbolic meaning, is unclear. If indeed there is some characteristic of the skin that makes it symbolically or physically more suitable for codex production, there is no reason to assume that Mesoamerican peoples could not obtain it, even if its range was limited to the south of North America. Long distance and down the line exchange or tribute payed by conquered peoples of the Aztec empire are known to have crossed great distances. Thus, the Pronghorn must also be seriously considered as a possible source for the raw material used for the codices.

Most forms of tanning will darken a piece of leather, making it less suitable as a writing surface. Though amate bark paper comes in both dark and light shades, this too is not completely white. While other writing systems may not need a completely white surface, the brightly coloured polychrome designs of the Mesoamerican writing system do make such a surface desirable. Besides this, both the natural structure of skin and the structure created by felting together amate fibres, is rather irregular. This hinders the smooth movement of a brush or pen over the surface, thus interfering with the creation of fine details. In order to solve both these problems, the surviving pre-colonial Mesoamerican books were covered with a layer of white material that could be smoothed. Multiple codices have been subjected to investigation of the chemical nature of this white layer. The codices Añute, Tlamanalli (Cospi), and Iya Nacuaa (Colombino-Becker) all have as major component gypsum (Dark & Plesters, 1958b, p. 532; Miliani et al., 2012, p. 674; Zetina et al., 2011, p.

351).[8] In his investigation of the pre-colonial Maya codices, Schwede (1912, p. 47) concluded that these are mostly composed of chalk (CaCO3) and not of gypsum. However, as Schwede undertook an optical investigation, M. D. Coe and Kerr (1998, p. 144) did not accept his conclusions and suggested instead that the white layer was probably similar to the one on central Mexican books, thus assuming that they were made with gypsum Recent spectroscopic investigation of one of the Maya codices, the Madrid Codex (Buti, 2012, pp. 65-66), has revealed that Schwede was correct and that indeed the major component of the white layer is calcium carbonate and not calcium sulphate.

Though the colonial sources do not give recipes for working with these materials, there are some Nahuatl names given to white minerals which may have been used to create the white surface of a codex. Three names are given by Sahagún (1577c, Book 11 of 221r.) for stones used to make white paints or varnishes. The first and second are closely related and seem to be the raw and the processed version of limestone. The raw version, Tetiçatl, is a contraction of tetl "stone" and tiçatl, the Nahuatl name for purified chalk. In the work of Hernández, d'Ardois, and Miranda (1960b, p. 408), Tetizatl is mentioned as a material which is used by painters to make something white, though it is, according to them, clearly less bright than Chimaltizatl (Hernández et al., 1960b, p. 405). The latter – Chimaltizatl – is the processed version and is described as a white diaphanous mineral that easily breaks into laminates. It is also likened to mezcuitlatl, which also breaks in sheets and is golden or purple and especially fireproof. The golden sheen may be the reason for the similarity in name of mezcuitlatl and teocuitlatl, the Nahuatl word for gold. This mezcuitlatl must be mica, famed for its heat resistant properties. Close observation of the surface of the Codex Tonalpouhqui (Vaticanus B) showed that on some pages the surface was different than on others. Pages 12, 72-73, and 95-96 have a surface that includes a sparkling material, suggesting that this mezcuitlatl could on occasion be incorporated in the writing surface as well. These pages are different in more respects than just the writing surface, however. The images painted on them are of a different colour and there seem to be other images hidden underneath as well (see chapter 3). When this over-painting was done and whether or not these materials used are completely pre-colonial warrants further investigation, but is beyond the scope of this work. The likeness to mica and the fact that it can be used for gesso indicates that Chimaltizatl must be selenite, a form of mineral gypsum. This is consistent with Clavigero (1970, p. 61), who indicates Quimaltizatl as a form of gypsum, which after burning can be used as a good gesso and a white paint.

Calcium sulphate is found in two different forms in nature: as the minerals gypsum ($CaSO4{\cdot}H2O$) and as anhydrite (CaSO4). Both of these are precipitated when seawater evaporates, with the difference being that anhydrite requires a higher temperature to reach the complete dehydration required (Skinner, Porter, & Park, 2004, p. 90). Calcium carbonate is found in two natural forms of identical chemical composition. Both calcite and aragonite are forms of CaCO3, differing only in their crystalline structure (see Eastaugh, Walsh, Chaplin, & Siddall, 2008, pp. 80-81; Skinner et al., 2004, p. 89). Calcite is harder than gypsum; they are respectively 3 and 2 on the Mohs scale. But as the Mohs scale is not a linear scale, calcite is in fact three times as hard as gypsum. The rarer form of gypsum, anhydrite, with its more compact crystalline structure, is in turn harder than calcite (3.5-4 on the Mohs scale).[9] While aragonite is harder than calcite, it is also relatively unstable. When heated, it will spontaneously convert to calcite. This is an important material property because of the process by which gypsum and chalk are most

8. Although in the article by Zetina et al. (2011, pp. 349-350) it is stated that this codex dates to the 12th century, it must actually have been created in during the end of the Postclassic period (Jansen & Pérez Jiménez, 2011, p. 75). The confusion probably arose because of the content of this document, which does indeed deal with events taking place centuries earlier. However, I argue that the document itself should be seen as a literary work describing actions of heroic ancestors, not as a description of "current" events.

9. Though the crystalline structure is the only physical difference, this difference is the cause of some further differences in other properties, such as hardness, in much the same way that graphite and diamond have different degrees of hardness despite the fact that they are both completely constituted of carbon atoms.

commonly purified. Through an endothermic chemical reaction, both can be transformed into a powder that, by the addition of water, can be made into a paste which can in turn be moulded into any desired form. This paste sets and through another chemical reaction reverts back to the stable calcium carbonate or sulphate. The two chemical reactions can be expressed as follows:

Gypsum:

$CaSO4 \cdot 2H2O + 150°C \rightarrow$
$CaSO4 \cdot nH2O + (2\text{-}n)H2O$ (steam)

$CaSO4 \cdot nH2O + (2\text{-}n)H2O \rightarrow$
$CaSO4 \cdot 2H2O$ + heat

Chalk:

$CaCO3 + 825°C \rightarrow CaO + CO2$
$CaO + H2O \rightarrow Ca(OH)2$ + heat
$Ca(OH)2 + CO2 \rightarrow CaCO3 + H2O$ (evaporates)

This way of working with these materials is very well known around the world and it is clear from the many architectural features moulded in chalk that this technique was also known in Mesoamerica (cf. Barba Pingarrón & Villaseñor Alonso, 2013; Villasenor, Graham, Siddall, & Price, 2011, pp. 329-334). It is not possible to work with Anhydrite in this manner. Since it has lost its crystallization water completely it does not readily reabsorb water, so it does not harden as quickly as gypsum would. Long-term exposure to water will, however, slowly convert it to gypsum.

It is striking that of all the investigated precolonial codices, all the Maya documents made on amate paper are covered with chalk, while the central and southern Mexican ones on leather are covered with predominantly gypsum. The corpus of codices is so small, with the number of published material analyses even smaller, that there can be no statistically significant statements made about the preference for chalk or gypsum when making a codex. If it were to be assumed that it is a general trend, however, then the reasons for this trend could be sought in three areas: availability; physical properties; and cultural preference. The geographic locations in which calcite can be found are spread all over Mesoamerica. Calcite itself can also be extracted from shells which are almost pure calcium carbonate. And, what is more, the Yucatan peninsula is largely composed of calcite. Gypsum, on the other hand, is found in large quantities in the north of Mexico, as the world-famous Cave of Crystals shows, though it is certainly not exclusive to this area. It can thus be concluded that in principle both in the Maya area as well as in central and southern Mexico the codices could have been made with either material, as both could have been obtained. The fact that there was an abundance of calcite in the Maya area, then, must have been the stimulating factor for its use. Not to mention that the use of chalk also has a number of downsides.

Chalk is harder and more durable, though that comes at a price. It is more difficult to process (Russell & Dahlin, 2007). In order to create quicklime (CaO), the powder from which the mouldable paste can be made, a source of calcium carbonate needs to be selected in the form of stones, shells, or coral. These stones, shells, or coral need to be either already rather small or broken down to a size that allows the applied heat to fully penetrate the pieces, so the calcium carbonate is completely converted into quicklime. As shown in the formulaic representation of the reaction above, a minimum temperature of 825° C is necessary to start the conversion process. However, in order to fully penetrate the stones a higher temperature of around 1000° C is generally needed (Russell & Dahlin, 2007, p. 414). As the reaction that releases CO2 from the limestone is a gradual process, this high temperature needs to be maintained for hours. A structure that has been interpreted as a lime plaster kiln was discovered in the Southern Maya city of Copan, which could potentially have served this purpose (Abrams & Freter, 1996). Since this is one of the few examples of kilns discovered, it is likely that most lime was being made in an open fire. This would require a very large amount of fuel. An open fire is also very susceptible to wind. In their work, Russell and Dahlin (2007) noticed that in order to reduce the influence of the wind, the pyres were lit in the night when there would have been less wind in the area and additionally they were built in low-lying areas. To ensure a good result of the process, specific rituals

were performed. This all shows the complexity of the process and the large amount of resources needed. Once the calcium carbonate has been completely turned into quicklime, the resultant material needs to be mixed with water. One advantage of using an open fire is the possibility of simply waiting for rain to mix with the quicklime. This would circumvent the need for a strong container capable of resisting the potential violent exothermic reaction. As long as this mixture is kept wet it can be stored, as it only hardens into chalk by the evaporation of water. If for some reason the mixture cannot be stored in wet condition, the quicklime would need to be stored. This should then be stored in a completely dry environment, with the added risk of causing possible dangerous uncontrolled chemical reaction if the stored material were to get wet accidentally.

Gypsum, in contrast, does not require any specialised equipment, as it does not need to be heated for such a long period nor at such high temperatures. As it is much softer, gypsum is easier to crush into smaller fragments, which allows for an even shorter heating time. Being this soft, however, means it is more susceptible to friction. A further difference between gypsum and calcium carbonate is that in the final reaction when these products harden, calcium carbonate produces water (which needs to evaporate) while gypsum absorbs it. This means that the gypsum would further dry out its substrate, lowering the dangers of microbial attack. The addition of small amounts of anhydrite could be a way to prolong the drying effect of the layer as the slow conversion of anhydrite to gypsum allows for it to continue to act as a drying agent. While calcium carbonate is harder than gypsum and thus more resistant to mechanical friction, it is very susceptible to chemical degradation because of its high reactivity with acids. When calcium carbonate comes into contact with an acid, the introduction of extra H+ ions causes a reaction that causes the CaCO3 to disintegrate into water and carbon dioxide gas. The carbon dioxide escapes in the form of gas creating the characteristic bubbles which are so useful for identifying a calcium carbonate material. The consequences of this high reactivity with acids will be discussed in the next chapter when the actual practice of working with these materials is considered in detail.

So far the assumption has been that the writing surface was made through a process involving a chemical reaction as it is commonly used to model three-dimensional architectural features. This heating and subsequent mixing with water is necessary to allow the modelling of three-dimensional objects or ornaments as the structural strength of such an object is created by re-crystallization of the minerals; i.e. the setting of the plaster. Once set, the model is rigid and strong. A very thin layer of gypsum or chalk on a somewhat flexible ground, however, requires more than the strength provided by the crystalline structure. Though there are no recipes or prescriptions for this process from the Americas, clues for working with these materials on a flat surface may be found in medieval European sources. Many medieval paintings were made on a layer of gessoed panel; i.e. a white inert substance mixed with an adhesive that covered an underlying wooden or cloth substrate. When it comes to understanding this material, however, inter-translatability becomes a big problem as many languages use only one word to refer to a range of ingredients. For example, the Spanish yeso can refer to the mineral gypsum or to the final product gesso made with either gypsum or chalk. English also does not distinguish different types of gesso and needs to resort to adjectives such as “thick” or “thin”. It is possible to catch a glimpse of the world of gesso through the famous work by Cennino Cennini written in the 15th century (1933). This Florentine artist wrote his treatise Il Libro dell’Arte containing recipes for materials and general tips for artists. During this time, different types of gesso were made for a range of purposes. In his description of the creation of an ancona[10] two types of gesso are used. The first is used as an under-layer to create the basis for three-dimensional decorations. In the translation by Thompson (1933) this gesso grosso is translated to “plaster of Paris”, which is hemihydrate gypsum (CaSO4·H2O). As such, this type of gesso would be similar to the material that we suppose was used to model three dimensional features in Mesoamerica. However, the gesso sottile that according to Cennini should be used to cover the grosso underneath is fully hydrated gypsum ground

10. An ancona is a type of panel or polyptych with modelled gothic decorative elements.

Figure 1.4A: Examples of colours as they appear today in a selection of the Precolonial Codices: Dresden; B: Mictlan; C: Añute; D: Ñuu-Tnoo-Ndisi Nuu (image A from SLUB-Dresden.de, B-D by the author).

down to powder. This top layer is thus made from powdered fully hydrated and inert gypsum mixed with a size (an adhesive such as animal skin glue). Whether or not the codices are made with dehydrated or hydrated gypsum is difficult to establish through either chemical or physical investigation, as the end result is chemically identical. And, moreover, hemihydrate gypsum absorbs water from the size and over time from the air and thus would also eventually turn into fully hydrated gypsum. Federspiel (1995, pp. 58-59) suggests that the translation by Thompson is actually incorrect when it comes to the gesso grosso. Instead of Plaster of Paris, she suggests that Cennini was referring to a soluble anhydrite ($CaSO_4$), created by heating gypsum to 300-650 °C. Regardless, the end result is the same in this case: soluble anhydrite mixed with a size such as animal glue results, though slower, in the same dihydrate gypsum by absorption of water from the animal glue and over time from the air.

Natural mineral gypsum is difficult to process as it may contain impurities. As such, it is very likely that the gypsum was heated and subsequently ground and used for gesso, whether in dihydrate or anhydrite form. When gypsum is being heated to temperatures above 650 degrees, insoluble anhydrite is formed, which reacts with water very poorly. Mixing this

type of anhydrite with size will not result in the chemical reaction leading to dihydrate gypsum, as the water will evaporate before it is able to be absorbed by the insoluble anhydrite. The essential difference between using either semi-hydrated or fully hydrated gypsum to make this writing surface is whether or not a chemical reaction and thus re-crystallisation takes place after application to the object. It seems that for the creation of a uniform writing surface crystallisation would be undesirable. Crystal formation would result in a heterogeneous surface, composed of individual crystals surrounded by glue. This would make the surface coarse and fragile.

Although it is therefore clear that both differences in availability and differences in material properties between chalk and gypsum exist, it cannot be ruled out that there were some other cultural factors that influenced the Mesoamerican's choice of one or the other. The aragonite in seashells such as Spondylus or conch is potentially a symbolically significant way of producing material for the creation of the symbolically significant books. Furthermore, it may well be that gypsum and chalk were procured from symbolically significant places, such as specific mountains or caves. But since both materials are geologically very common, it is impractical, if not impossible, to specify where the materials found on the codices were sourced. Still, a better understanding of the symbolical significance of these minerals may be gained if extraction sites are found and if these sites can be shown to be accompanied by a ceremonial assemblage.

1.2 IDENTIFICATION OF COLOURANTS

Cultures across the globe have used a wide range of materials to give colour to their world. Despite the fact that archaeological materials are often grey or brown after ages in the ground, the Mesoamerican world was, likely even more than our own, a brightly coloured one. Giving a colour to a surface can today be done in a myriad of ways. Modern pigments are for the largest part the result of centuries of alchemy and later chemistry (cf. Ball, 2001). Starting with the quest for the philosopher's stone, many new coloured materials were discovered allowing painters to use new stable, cheap, and beautiful colours. Most archaeological material, however, is coloured with materials already available in nature. These materials fall into two separate categories: mineral pigments and organic lakes. Mineral pigments are coloured minerals that, when ground down to a powder, retain or attain the desired colour. This powder can then be used directly, by mixing it with an adhesive and, if necessary, as a paint by thinning this with water. Organic lakes, on the other hand, are dyes extracted from plants or animals, which often need to be precipitated onto an inorganic substance in order to create a stable coloured substance (see Kirby, van Bommel, & Verhecken, 2014, p. 28). While this second material may be more complex than collecting stones and grinding them down to a powder, the organic lakes come in a much wider variety of colours. A disadvantage, however, is that the resistance to decolouration and the speed of decay of the dyes used to colour the inorganic substance varies enormously from plant to plant and from animal to animal. As such, it is very important when trying to make an organic lake that the appropriate source for the colour is used. In the case of the Mesoamerican codices, the colours used were mostly bright primary colours, though today some of these colours have become darker, faded, or even completely discoloured (see figure 1.4 and Chapter 3.4).

Though brightly coloured, the palette used for these works was relatively limited. The basic colours used and found in virtually all the codices were black, red, yellow, blue, and green.[11] The latter four are also often found in the numerals of the pictorial codices, though the blue paint is at times severely degraded. In general, the Maya codices seem to be less colourful, as the hieroglyphs they wrote were not filled in with colour. The images that accompany these texts, however, could be very complex and contain many colours. The best example of this is the Codex Dresden. The high level of degradation of this codex (see chapter 3) makes it the case that there is little left of the splendour this codex once must have had

11. It is important to take the linguistic differences into account here. Where most western languages differentiate between green and blue, most Mesoamerican indigenous languages do not distinguish these two "colours".

Material	Codex*	Source**
(Vegetal) carbon	Colombino; Cospi; Madrid	(Buti, 2012; Miliani et al., 2012; Zetina et al., 2011)
Cochineal	Colombino?; Cospi	(Miliani et al., 2012; Zetina et al., 2011)
Unknown red (not Cochineal)	Cospi	(Miliani et al., 2012)
Red Earth (Ochre)	Madrid	(Buti, 2012)
Yellow Organic Dye***	Colombino; Cospi	(Miliani et al., 2012; Zetina et al., 2011)
Orange Organic Dye***	Cospi	(Miliani et al., 2012)
Yellow Organic Dye on Clay	Cospi	(Miliani et al., 2012)
Grey Indigo	Madrid	(Miliani et al., 2012)
Blue Indigo on Clay	Colombino?; Cospi; Madrid	(Buti, 2012; Miliani et al., 2012; Zetina et al., 2011)
Yellow Orpiment	Cospi	(Miliani et al., 2012)

* Names as used in the articles.
** Publications are ordered to correspond with the codex investigated.
***Different shades are made probably with different plants, not by mixing of red and yellow.

Table 2. Colourants found in Mesoamerican codices by recent non-invasive investigation.

(see also chapter 5). Recently a number of both Maya and Central Mexican pictographic codices have been subjected to non-invasive research to uncover the composition of their colourants (see Table 2). Both pigments and lakes were used, though it seems that the Maya codices were mostly made with mineral pigments (see also M. D. Coe & Kerr, 1998, p. 151). As is seen in the table below, for many colourants it is unclear what organic source was used to make it. To provide an anecdote for these uncertainties, historical and ethnographic sources can be consulted. Using this information a more complete list of available materials can be gained. It must be kept in mind that the codices investigated thus far are only the tiniest fraction of what must once have existed. As such, they may not be completely representative of the material used for making books. Again, the historical sources are important, as they can suggest alternative materials. But these historical sources do need to be approached with care, as the Europeans also brought techniques and materials with them that quickly become incorporated in the Mesoamerican writing and art styles. In the following section, the available materials are discussed and categorised based upon the colours they produce.

BLACK

One of the most ubiquitously used pigments is carbon black. The X-ray fluorescence investigation by Miliani et al. (2012, p. 675) shows that the characteristic peak for carbon black from the charring of animal bones is absent. This peak is

caused by organic impurities still present in the not fully burned black remains. It is, therefore, clear that the carbon black used in this case (on the Codex Tlamanalli (Cospi)) was of a vegetal origin and was not made by the burning of bones. The way to create carbon black is relatively easy, since carbon black is nothing more than pure carbonised wood in powdered form. In principle, then, it can be made by carbonising wood and grinding it. However, controlling a fire so that it completely carbonises, yet does not destroy the wood, is difficult. Besides that, grinding carbon is a laborious task. An easier, though possibly more lengthy way of obtaining the carbon black, is given by M. D. Coe and Kerr (1998, p. 151). They suggest that soot was scraped off the bottom of cooking vessels. Not much soot would be collected each time the vessel was scraped, making production a laborious process. However, since every household used cooking vessels on a daily basis, the supply would be continual and endless. The resultant soot is pure carbon, which, given that it was precipitated onto the vessel in the form of airborne particles, does not need to be ground down. A second source of soot may be the roof in the kitchens of precolonial Mesoamerican homes. Open fires are used to cook. The smoke of these fires deposits soot not only on the cooking vessels, but in much larger quantities on the roof. There it forms such a thick layer that it forms stalactites.[12] This is not recovered archaeologically, as the houses have long since decayed, though it can still be observed in indigenous communities today.

Next to carbon black, the Florentine Codex (Sahagún, 1577c Book 11, fo. 218r-219v) gives a very different recipe for a black ink:

"Ay en esta tierra un fructo de un árbol que se cria en tierras calientes: el qual fructo no es de comer, llamase este fructo nacazcolotl, usase este fructo para con el y cin aquella tierra que se llama tlaliyac o hazeche, y con casgaras de granadas y con goma que llaman mizquicopalli se haze muy buena tinta para escreuir."[13]

"There is in this land a fruit from tree which grows in warm lands: this fruit is not for eating, they call this fruit nacazcolotl, (Caesalpinia coriaria) they use this fruit with and without the earth which they call Tlaliyac (copperas i.e. Iron(II)sulphate) and with casks of pomegranates, and with gum which they call mizquicopalli (gum of the mesquite (Prosopis spp.)), see section on gums below) it makes a good ink for writing"
(translation by the author)

The underlying chemical principle of such an ink is explained by Cardon (2007, pp. 264-469). The pods are very rich in hydrolysable tannins which react with iron, introduced by the addition of Tlaliyac, to form a black dye. To this a gum is added to turn it into a well-adhering ink. This Nacazcolotl ink is chemically very close to the iron gall inks introduced by the Spaniards. As such, if Sahagún here describes a truly precolonial practice, the presence of an iron-containing black ink in a document cannot be used as proof that the document is post-colonial. The role of Nacazcolotl in the production of pre-colonial manuscripts has never been considered. It seems that any iron-tannin ink is automatically assumed to be a European introduction. Thus far, no clearly pre-colonial documents containing iron-gall inks have been found. The Nahuatl text about Nacazcolotl is different from the Spanish text, because it does not contain the reference to the "casgaras de granadas", which are not native to Mesoamerica. The Nahuatl text[14] rather extensively described the shape and form of a species of tree that grows pods. These pods have the shapes of scorpion tails and so can easily be identified from a description. The Nahuatl text, then, does indeed seem to refer to the pods of the Divi-Divi (Caesalpinia coriaria). If the native Nacazcolotl ink is indeed an iron-gall ink, it would be susceptible to degradation processes similar to European iron gall inks. It may be that this is one of the reasons for the lack of pre-colonial examples of this ink. Iron-gall inks can be notoriously damaging to the writing surface if the components are mixed in the wrong amounts (Daniels, 2006, p. 41). Furthermore, over time Iron-gall inks themselves degenerate to a

12. Thanks to Prof. Maarten Jansen for pointing out this possible source of carbon.

13. In the original text the separation between different words is sometimes unclear, therefore in transcriptions of the original texts, words have been separated according to modern Spanish conventions to facilitate reading.

14. Translated by R.Macuil.

brown colour and eventually may lose their colour altogether (Woods, 2006, pp. 206-208). The texts in the Florentine Codex give a prime example of this loss of colour by iron-gall ink.

Logwood is a third possible black colourant. The botanical name for logwood is Haematoxylum campechianum. It contains a flavonoid called haematoxylin. This flavonoid can be used to make a whole range of colours from blue to purple and black. However, with the exception of the black colours, these are not light resistant. If a black colour is desired, the haematoxylin can be oxidised to haematein, which is a very colourfast black dye (Cardon, 2007, p. 268). Next to this flavonoid this wood contains a large amount of tannins (Cardon, 2007, p. 268) which, as with the Nacazcolotl mentioned above, help to create a black colourant. Historically many species of tree have been used as dyewoods to obtain red, black and, blue colours, and this has led to some confusion about their naming. Oftentimes, the names reflect their place of origin. To make matters more complicated, in colonial times the Spanish referred to Logwood as Brasil (Eastaugh et al., 2008, p. 248). Haematoxylum campechianum does not grow everywhere in Mesoamerica, but is limited to the Yucatan peninsula and is also found in the Greater Antilles (Cardon, 2007, p. 264). Although it was available as a dye in the Yucatan area, whether this black material was used as a paint is unclear. Considering the availability of carbon as the by-product of any cooking or heating activity, it would seem unlikely that other sources for black inks were specially imported. However, since carbon does not work as dye for clothing, it may well be that other substances – such as logwood – were traded to dye textiles black. As such, it is not unthinkable that in those cases where it was available, this was subsequently used as ink.

Although traces of these substances have not been found in the codices thus far, some minerals were clearly in use in Mesoamerica to make black paints. These have been encountered in murals in, for example, Teotihuacan. Next to carbon black, the murals at this site were made with black made of manganese oxide (Magaloni, 1996, pp. 212-213). Manganese oxides and hydroxides are also found on Maya pottery (Houston, Brittenham, Mesick, Tokovinine, & Warinner, 2009, p. 63). Black manganese oxides and hydroxides exist in different forms, each a different combination of Manganese, Oxygen, and Hydrogen (Eastaugh et al., 2008, pp. 256-257). Most mineral forms, such as the most common form Pyrolusite, form in shallow water, such as shallow seas, lakes, or swamps (Eastaugh et al., 2008, pp. 319-320).

RED

The studies performed thus far show that besides black, red paint has also shown a remarkable consistency in its material composition. In all the investigations of central and southern Mexican codices, red turned out to be an organic lake. The UV-vis reflectance spectra made by Miliani et al. (2012, p. 675), as well as the results of earlier invasive chemical reaction tests by Dark and Plesters (1958b, p. 532) on Codex Añute, were shown to be consistent with cochineal. Cochineal is a red substance harvested from the bodies of the cochineal insect (Dactylopius coccus) (Cardon, 2007, p. 620). This is a parasitic bug native to Central and South America that lives on the prickly pear cactus (Opuntia spp.) (Phipps, 2010, p. 10). It can also be extracted from other insects, some of which are native to Eurasia, though none of these insects yield such a high concentration of this red substance. The chemical component responsible for the red colour is carminic acid ($C_{22}H_{20}O_{13}$). The processing and use of cochineal bugs is described in detail in colonial sources describing the pre-colonial situation (Sahagún, 1577c B11 216v-217r), as well as sources describing its colonial use (see Sánchez Silva & Ávila Blomberg, 2005). It remains an important industry in the province of Oaxaca (Mexico) today, as cochineal is used as a food colourant and as a tradition dye for clothing. In order to make the colourant, the insects are harvested from the cactus and dried in the sun for the best quality. An alternative method, of lesser quality but with a faster production time, involves drying the bugs in an oven or on a hot (metal) plate (Cardon, 2007, p. 623). Once dried, the carminic acid can be extracted from the eggs inside the bodies of the female insects, by crushing them and heating them in water (Phipps, 2010, p. 10). A range of colours can be achieved

using cochineal, by adding acids or alkali, as the colour of the carminic acid varies from pink and red to purple and even black depending on the pH level of the solution (Cardon 2007, 625; Phipps 2010, 10). By the time of European colonisation, a full industry of cochineal dyeing was established in Mexico, being not only part of a system of trade but also of tribute, as is clear from the Codex Mendoza (1541, folio 45r.). What the principle use of cochineal was, however, remains unclear. Although it is possible to dye fabric made of vegetal fibres such as cotton, the dyeing process is far more effective on animal fibres such as wool. Sahagún describes the dyeing of rabbit furs with cochineal. It seems that cochineal originated from the Andean region, where many cochineal dyed alpaca textiles have been found. Lacking large wool producing animals, the corpus of Mesoamerican cochineal dyed textiles is smaller. In Mesoamerica, where the only animal fibres that could be dyed were rabbit hairs and bird feathers, it may well be that the principle use of the substance was as an ink for writing. Next to cochineal, a second organic red substance was found on the obverse of Codex Tlamanalli (Cospi), though it is uncertain what this substance is exactly (Miliani et al., 2012, p. 675). There are numerous plants in the area that could be used to make red lakes. Nicaraguawood (Haematoxylum brasiletto) and the very similar Brazilwood (Caesalpinia echinata), grow in highland areas throughout Central America (Cardon, 2007, p. 278). Both species contain a flavonoid that differs from the abovementioned logwood to which they are closely related. This flavonoid – called brazilin – can, like haematoxylin, be oxidised to form a stronger colourant – in this case brazilein – which has a bright red colour (Cardon, 2007, p. 282). Although the value of brazilwood as a dye is reflected even in the name of an entire country,[15] it does have one major drawback. Although bright colours can be obtained, brazilwood is not lightfast. Had this substance been used in the creation of the codices, then, it would most likely have faded to a yellow or brown colour.

Wallert (1995, pp. 655-656) identified six words in Nahuatl for plants yielding red colourants, taken from colonial sources, specifically the Florentine and Badiano codices and the texts by Hernández. Two of these could be the abovementioned Brazilwood, (in Nahuatl Uitzquauitl) however, Wallert identifies the same words as Haematoxylum campechianum, which, for previously mentioned reasons, can only be H. brasiletto if it is to be red. In the work of Sahagún (1577c fo. 218r.), the name Uitzquauitl is also mentioned, though here it is clearly meant to designate logwood. It seems, therefore, that for the early colonial writers the difference between these two types of wood was not well conceptualised.

Nacazcolotl is also identified by Wallert as a red coloured material, though it has been shown that this in fact refers to a black colourant (see above and see Cardon, 2007, pp. 464-469). Besides these plants, Wallert lists tlacuahuac and tlapalli, neither of which could be identified as red colourants. Tlapalli is given by Sahagún as a generic name for colour without specific identification:

"Este nombre tlapalli, que quiere decir color, y comprehende todas las colores, de qualquier suelte que sean negro, blanco, colorado, açul, amarillo, verde, etc" (Sahagún, 1577c B11, fo. 222v.).

Tlacuahuac features in Sahagún's discussion of cochineal:

"A la grana que ya esta purificada y hecha en panecitos llaman tlaquahuac tlapallo que quiere decir grana recia o fina" (Sahagún, 1577c B11, fo. 216v.).

Molina (1970, p. 133) gives the translation "cosa dura o empedernida" for Tlaquauac. In this phrasing, it seems that Sahagún uses the word as an adjective, simply referring to good or strong cochineal.

Other plants that could have been used to make red dyes or paints are the Poinsetta (Euphorbia pulcherrima) and the Purging Nut (Jathropa curcas)

15. Brazil was first Ilha, then Terra de Vera Cruz, but ultimately the name was changed to the name of the dye Brazil, since the richness of this source of wood was clear. Cut into logs of 20 to 30 kg., this wood was transported to Europe and processed into wood chips, which could be boiled to extract the dye (Cardon 2007, 280). The name brazil already existed as similar trees containing the same substance and thus used to make similar dyes were known from Asia such as Sappanwood (cf. Cardon 2007, pp. 274-289).

or in Nahuatl the quauhayohuatli (Wallert, 1995, pp. 655-656). The origin of the Nahuatl name for Poinsetta – Cuetlaxochitl – is debated. The disputed issue is where the first part of the word – cuetl- or cuitl- – derives from. According to popular belief it finds its origin in the combination of the words cuitlatl (excrement) and xochitl (flower). This name could be explained by the fact that the seeds of the plant under consideration are often eaten by animals, ending up on dung heaps where the flower can be often found (Karttunen, 1983, p. 74). Another possibility is the relation to the word cuetlaxtli (leather) (Hernández, d'Ardois, & Miranda, 1960a, p. 320) as the crimson flowers of the shrub have a colour similar to freshly skinned hides. Whether any of these explanations is correct is hard to prove. What is clear, however, is that this plant is still very widely known in Mexico today, and is commonly used for Christmas decorations.

According to the study by Wallert (1995, p. 655), no Madder type of plants, such as Gallium or Relbunium species, were much used in the creation of Mexica objects. He links this to the fact that there are many other dyes available that already compose a full palette of resilient reds. Other Mesoamerican societies, especially those with less direct access to, for example, cochineal, may have used these dyes. A piece of textile found in the Chihuahua caves of Mexico is reported to be dyed with Relbunium (Cardon, 2007, p. 164). In South America, many textiles have also been found that were dyed with Relbunium species (Cardon, 2007, p. 163). While in Mesoamerica it seems to have been rapidly replaced by other colourants, in South America it stayed in use until the Spanish conquest, though even there it was in the process of being slowly replaced by the use of cochineal (Cardon, 2007, pp. 165-166).

Next to the organic colourants, there are mineral pigments available for the creation of red paints. Red ochre (Fe2O3) and cinnabar (HgS) are the most common. The second of these has the downside that it is highly poisonous. As a result it is generally only found in archaeology sprinkled on burials or offerings, the most famous example of which is the tomb of the so-called Red Queen of Palenque. Red ochre on the other hand is found extensively throughout Mesoamerican antiquity, used as a paint on pottery, on architectural features, and, as seen in Table 2, in some or perhaps all of the Maya codices. It is also found in the descriptions of Sahagún (1577c, p. fo. 221r.) under the name Tlauitl. Generally the colour obtained from red ochre is less bright than cochineal, though the major advantage is that iron oxide is present in a very common type of red earth found throughout Mesoamerica. A recent study by Dauda, Jigam, Jimoh, Salihu, and Sanusi (2012) has shown the antimicrobial properties of ochre from sources in North central Nigeria, due to the presence of iron and other metals such as Copper and Zinc. The study also shows that presence of these metal ions can be highly variable between ochre sources, which in turn influences the antimicrobial effect. More in depth study of Mesoamerican ochres would be needed to see if similar effects against pathogens can be seen, taking into account which pathogens were present in Mesoamerica before the conquest.

YELLOW

Organic yellow colourants are the most difficult of all to identify, especially in a non-invasive manner. This is due to the nature of plants in general. Two chemical substances are very commonly found in plants: the flavonoids and the carotenoids. Most forms of these substances can be used to make yellow or orange dyes, which in turn could theoretically all be used to make lake paints. Because they are so extremely common, it is very hard to identify the exact species of plant from which the paint is made, based solely on chemical composition. This is made even more difficult by the fact that there are no good databases with which to compare the studied materials. For this category, then, the colonial sources are thus especially important. Based on the "Historia general de las cosas de Nueva España" also known as the Florentine Codex by Fray Bernardo de Sahagún, By reference to the Codex Badianus and the "Natural History of New Spain", Wallert (1995) compiled a list of plants used as yellow colourants. These are: Zacatlaxcalli; Quauhtepuztli; Tepozcavil; Achiotl; and lastly Xochipalli.

Figure 1.5: Left: Image of Zacatlaxcalli from Sahagún (1577c fo. 217v.). Right: wild Zacatlaxcalli on the road to Santa Caterina, (Hidalgo, Mexico).

According to Wallert, the name Zacatlaxcalli actually refers to a whole range of species from the Cuscuta or dodder family. All of these species produce a very bright yellow colour. The name Zacatlaxcalli comes from the Nahuatl çacatl and tlaxcalli, the words for "grass" and "tortilla" (Wallert, 1995, p. 658). The substance causing the colour in these plants is stated by Wallert to be carotene.[16] During fieldwork in February 2014, Zacatlaxcalli was identified by native Nahuatl speaker Macuil Martinez and collected for study. The plant is not really a grass, but rather a parasitic vine in trees. Once dried it has the look and smell of hay, which may explain the naming. The drawing in Sahagún (1577c fo 217v.) is quite clear as to its shape (see figure 1.5). Unfortunately, it is not in colour and thus the most striking feature of this plant – its bright colour ranging from green when it is young to bright orange in the older shoots – is not shown.

Quauhtepuztli or Cuauhtepoztli is listed as a yellow pigment by Wallert (1995) which, according to him, is also known as Tepozcavil or Tepozcahuil. He identifies this as Copaifera himenifolia. This Latin family name meaning "copal bearing" would indicate that this tree produces the incense resin Copal. However, a recent study by Stacey, Cartwright, and McEwan (2006) revealed that the origins of true copal are diverse and poorly understood, but definitely not limited to this species of Copaifera. No other sources mentioning Copaifera himenifolia or the Nahuatl names for it could be found. It therefore remains unclear what colourant this could be and how it would have been made.

The Annatto (Bixa Orellana L.) shrub – called Achiotl in Nahuatl – produces a fruit of about 4 cm long containing many seeds which are encapsulated in an orange-red fleshy coat. This coat can be used to produce an orange-yellow dye. To extract this colourant, the seeds are soaked and pressed in water to dissolve the seed-coat (Cardon, 2007, p. 313). Annatto contains the carotene pigments: bixin and crocetin (Eastaugh et al., 2008, p. 56).

Xochipalli is given in Sahagún (1577c fo. 217r.) as a yellow colour made from yellow flowers:

"Al color amarillo fino llaman le xuchipalli, que quiere decir, tintura de flores amarillas: este color amarillo, traen la, y criase entierras calientes"

The accompanying image (see figure 1.6) shows that the paint made from these flowers was used

16. A Zacatlaxcalli sample was tested using High-Powered Liquid Chromatography (HPLC) at the Rijksdienst voor het Cultureel Erfgoed (RCE, the Dutch agency for cultural heritage) in Amsterdam. These tests showed that the main component was Quercetin, a flavonoid, rather than carotene. This difference in results may be due to the fact that the age of the plant influences its colour. A young sample is green, which later becomes yellow and finally orange. This contradictory finding suggests to the need for further study.

Figure 1.6: Drawings of Xochipalli harvesting and use in Sahagún's Florentine Codex (1577c B11, fo. 217r.).

for painting and/or writing. The same flower can be seen first harvested and in the bowl containing the ink or paint that is being used by a scribe wielding a pen. These flowers were identified by Wallert (1995) as Cosmos sulphurous (also known as Bidens sulphurea), a plant used for making an orange-yellow colour. Cardon (2007, 239) states that yellow paint could have been made from many different species of Coreopsis, Bidens, and Dahlia flowers. The name Xochipalli is a compound for the word for flower (xochitl) and the word for colour (tlapalli) (Karttunen, 1983 see also ; Wallert, 1995, p. 659), which does not help much for its precise identification. Its colouring substances are most likely flavonoids which have to be extracted from the flowers by boiling them for a long time (Cardon, 2007, p. 237). The images in Sahagún (1577c fo. 217r.) of xochipalli (see figure 1.6), which Wallert does not seem to take into account, throw some doubt onto the identification of this flower as Cosmos sulphureus. The many-petaled nature of the flower suggests that it is closer to the Cempaxochitl, a species of Marigold (Tagetes erecta). Despite the fact that this flower is often called African Marigold, it actually is indigenous to Mexico. Moreover, this flower was, and is today, ritually very significant, as an integral part of the celebration of the Day of the Dead. Marigold flower petals contain a high concentration of the carotene Xanthophyll, which

Figure 1.7: Drawing of Matlali in Sahagún's Florentine Codex (1577c B11, fo. 217v.).

is also commercially exploited as a natural food colourant (see Pratheesh, Benny, & Sujatha, 2009).

In Hernández (1615) B3, fo 131v. Xochipalli is described as well:

"La xochipalli, es una yerua de seys codos de alrgo, que produze las ojascimbossas, y en cierta manera semejãtes à las del Artemissia, los tallos de un dedo de gruesso, las flores del cempoalxochitl, pero menores, q de color amarillo tiran à rojo, las rayzes delgadas, y largas. Nace à cada passo en tierras calientes, y es yerua q todas la conocen, usase solamente de la flor. ...y es de grandissima utilidad para teñir las flores, digo las canas, y para pintar las ymagines, y cosas de color amarillo, y q en cierta manera tira à rojo, para lo se cuezen en agua, juntamente con salitre, y al final se exprime el çumo y se cuela, del qual usan los pintores y tintoreros para lo q auemos dicho."

The flowers of the Artemisia with which Hérnandez compares xochipalli are also a multi-petaled, making the identification of xochipalli as Tagetes erecta likely. Houston et al. (2009, pp. 104-105), mention two other yellow colour-producing plants in the Maya area, which are Maclura tinctoria L. (also known as Chlorophora tinctoria) or Old Fustic and Gliricidia sepium or Mexican lilac. When using Old Fustic, only the heartwood produces a lot of colour (Cardon, 2007, p. 196). In the case of the Mexican lilac, the roots are used. One of the Maya names given for this plant by Houston et al. (2009, p. 105) is Kanté. Interestingly, Magaloni (1998, p. 76) mentions a

paint made by present-day Lacandon Maya, also from the roots of the Kanté tree. She believes that Kanté is a likely candidate for the organic yellow pigment found on the Bonampak murals (Magaloni, 1998, pp. 75-76). One last possibility for the creation of an organic yellow colourant was suggested during the fieldwork in February 2014 by a local resident of Santa Catarina (Hidalgo, Mexico), Don Alejandro. According to Alejandro, the bark of the Colorin or Coral tree (Erythrina corallodendron) is used by some to create a yellow paint. All these yellow organic colourants have in common that they have a relatively poor light fastness (Cardon, 2007, p. 167), which inevitably leads to fading over time.

A very common yellow mineral is yellow ochre. Related to red ochre, yellow ochre is the hydrated form of iron oxide (FeO(OH)·nH2O). Like red ochre it is very commonly found as a type of earth. It is likely that this earth was used in the creation of the Maya codices. The investigated Madrid Codex, however does not contain any yellow areas. As previously mentioned, the Dresden Codex does contain yellow areas, although the colourants in these areas cannot be identified without the use of investigative methods capable of penetrating the glass pane to which the codex has become fused after the flooding of the Library basement (see Chapter 3.4). Like its red variant the colours obtained with yellow ochre are generally less bright than those from plant sources. On the Codex Tlamanalli, the mineral orpiment was identified as a yellow paint (Miliani et al., 2012, p. 675). This mineral is a compound of arsenic trisulphide (As2S3). The name orpiment (from the Latin Auripigmentum) is a good indication of the golden colour that is achieved when painting with this mineral. It is a sublimate of volcanic activity, meaning that it needs rapid cooling of the fused arsenic and sulphur, which happens above 390 °C and results in the formation of the crystals. It is commonly found in circumstances such as hot springs where water acts as a cooling agent for the escaping arsenic and sulphur compounds. Such circumstances are also where the abovementioned cinnabar is found. Another feature of orpiment that is similar to cinnabar is the fact that it is highly toxic (Eastaugh et al., 2008, p. 291). However, the toxicity of orpiment as a solid mineral is low. It is the arsenic contained within the orpiment compound that is dangerous and as the mineral is not very soluble, the arsenic remains bound with the sulphur and is thus relatively harmless. This changes if orpiment is being ground to use it as a pigment. The finer the substance is ground, the easier it becomes to dissolve in water and thus to be absorbed in the bloodstream after ingestion (see Buchanan et al., 2013). The implications of working with a poisonous powder are clear. For safety reasons, though orpiment has been securely identified as ingredient for at least one codex, it is not used in the experimental replication.

Blue

While yellows are so abundantly available, blue is a notoriously difficult colour to produce. The colour blue holds a special place in virtually all cultures (Ball, 2001, pp. 231-232). The main problem with blue is that there are virtually no minerals that retain their blue colour when ground to a powder, a requirement to make a smooth and brightly coloured paint. The few minerals that do have the right properties are scarce. Malachite, Azurite, and Veszelyite have all been attested on Mesoamerican painted objects (Garcia Moreno et al., 2008; Houston et al., 2009, pp. 54-56). These receive their blue and green colour from the copper that is bound with carbonates and phosphates in these minerals. However, on the codices that have been investigated so far, no trace of these minerals has been found, suggesting that the blues are of an organic origin.

In Sahagún (1577c) a number of different names of plants are given which were used to make blue paints. The first one is made from blue flowers and is called Matlali (fo. 217 v.). The images accompanying the text show a fourlobed flower on a plant with long, pointed leaves attached to the stem (see figure 1.7). Identification of this plant is made difficult by confusion regarding the translation of the terminology for green and blue. It seems, in fact, that Matlalin can be both a dark green and a blue. The interpretation of this colour being somewhere halfway between blue and green is further strengthened by the comparison made by Sahagún to Cardenillo, a copper acetate. This oxidated copper has a blue-greenish colour that is difficult to name in English.

Figure 1.8 left: Matlalxochitl (Codex Badianus 1577, fo 10v.); middle: Çacamatlalin (Codex Badianus 1577, fo. 48r); right: example of Commelina coelestis (photo by the author).

Making a blue colour from a blue flower is not straightforward. The colourant that gives blue flowers their colour is anthocyanin, a type of flavonoid that is generally very unstable (Cardon, 2007, pp. 241-242). Using blue flowers on a large scale means that the plant needs to produce flowers in large quantities. In the Codex Badianus (Cruz & Badiano, 1991[1552]), two plants can be found that may be the same as the one given by Sahagún: Matlalxochitl and Çacamatlalin (fo 10v. and fo. 48r, see figure 1.8 left and middle). Both these plants have blue flowers and the structure of the leaves is very similar to the drawing in Sahagún, even though the number of petals seems to be different. These two plants are both identified as Commelina coelestis, a species of dayflower common in central Mexico (see figure 1.8 right). According to Cardon (2007, p. 242), the related Commelina communis was used in Japan on awobana paper. What makes this flower special is that it gets its colour not from regular anthocyanin, but from a complex metalloanthocyanin. Similar to the process used when making a stable pigment from a colourant, the anthocyanins are bound together with metal ions (see Shiono, Matsugaki, & Takeda, 2008). The result is that the blue extracted from the Commelina flowers is much more stable than most blue flowers.

According to Sahagún (1577c fo. 217v.), however, this same Matlalli is used for the creation of the blue clothing:

"Ay color azul claro, de color del ceilo, lo qual llaman texotli, y xoxouic: es color muy usada en las ropas, que se visten, como son las mantas delos hombres, y uipilles de las mujeres: haze se de las mismas flores, que se haze el matlalli, o/ o color fino."

This does not fit the description of the Commelina, as the metalloanthocyanins are insoluble and thus not suitable as a dye. Thus, it seems that either multiple flowers are known by the same name or the Spanish chroniclers were themselves confused by the many different names.

The other blue paint given by Sahagún (1577c fo. 219r.) is easier to interpret. It is a herb named Xuiquilitl or Tlaceuilli, which is macerated and

Figure 1.9: Drawing in Sahagún (1577, B11 219 r.) of Tlaceuilli or Xuihquilitl.

squeezed to extract the required juices:

"Ay una yerua, en las tierras calientes que se llama ~~Tlaceuilli~~[17] Xuihquilitl, maian esta yerua, y esprimela el zummo, y echan lo en unas vasos: allo se seca o se guaja: con este color se tinen lo verdes azul oscuro, y res plan deciente: es color preciada."

Although the plant in the drawing (see figure 1.9) copies the structure of one individual side branch rather than the entire shrub, it bears a great similarity to Indigofera suffruticosa, source of the dye Indigo, or as it is known in Mexico today, Añil.[18] The process to make blue colours with indigo has been described extensively elsewhere (see Balfour-Paul, 2006, pp. 89-145; Cardon, 2007, pp. 335-353). Chemical dyeing with indigo involves the conversion of indican and isatan in the plant to indoxyl, which is colourless but water-soluble. In practical terms, this means that the leaves of the indigo containing plant need to be cut and crushed in hot water. Enzymes then convert the indigo in the leaves into indoxyl, making the solution colourless. This state needs to be maintained by adding an alkali such as lime potash or sodium carbonate to counteract acidification. Only when fully converted to soluble indoxyl can the substance penetrate the fabric that needs to be dyed. Once the textile has been saturated it can be hung out to dry. Two colourless indoxyl molecules combine by the absorption of oxygen and turn to blue indigotin. Often more than one bath in the indoxyl solution is needed to attain the desired shade of blue.

Indigo was used as a dye for centuries in the Americas before the Europeans arrived. Although most archaeological evidence for its use comes from South America, the fact that indigo is a much better dye for vegetal fibres (unlike cochineal discussed above) makes it likely that it was used in Mesoamerica as a dye as well. It was not only used as a dye though, as Arnold (1987, pp. 69-70) points out when cataloguing the use of indigo as a medicine for a range of diseases.

While indigo is stable when bound to a textile, it is fugitive in its unbound state. It surprised researchers, therefore, when it was encountered in a bright blue paint, called today Maya Blue, in murals that had been exposed to the elements for centuries, all the while remaining stable in colour. When this substance was first studied by Merwin (1931) in Chichen Itza's murals, it was assumed not to be organic, though it was recognised that it did not have any relation to copper minerals or ultramarine (Gettens, 1962, p. 557).

In rejecting the possibility that the Ancient Mesoamericans had overcome the susceptibility to decay that plagues all organic blues, Merwin (1931) believed the material to be related to a blue clay called beidellite. It turns out that Merwin was not completely wrong in the sense that this paint did indeed contain clay. However, its colour was the result of Ancient Mesoamerican people's ingenuity, not nature. In 1962, while the material was still believed to be an inorganic pigment, one constituent was identified as attapulgite, today called palygorskite (Gettens, 1962). By 1966, van Olphen managed to produce a stable blue colourant by colouring palygorskite with indigo. The exact molecular structure of Maya blue is still under debate (Arnold, 2005, p. 53). The underlying principle giving stability to the indigo must however be explained by the shape of palygorskite, showing that Maya Blue is truly an ancient nanostructured material. Palygorskite has a laminar structure with holes in each layer which overlap (see figure 1.10).

17. Corrections appear in the original.

18. This term has had a long history showing the route that indigo took in the Old World. It is derived from the Sanskrit word nila meaning dark blue, transferred to Arabic as an-nil which became añil in Spanish (Balfour-Paul, 2006, p. 11).

19. Giustetto et al. (2012) show the possibility of a red colourant being stabilised by encapsulation in palygorskite, indicating the possibilities of creating a whole spectrum of colours based on this ancient technology.

This creates a series of tunnels that are of just the right size for an indigo molecule to enter, where it is shielded from biological and chemical attack (José-Yacamán, Rendón, Arenas, & Puche, 1996). Van Olphen (1966) discovered that heating the clay-indigo mixture was the key to fixing the indigo inside the clay structure. Eastaugh et al. (2008, p. 262) state that to make Maya blue the material need to be heated to about 150 °C for about two days. Variation in temperature during the production process has been shown to produce other colours such as a "Maya Green" and "Maya Yellow" (Domenech, Domenech-Carbo, & Vazquez de Agredos-Pascual, 2011).

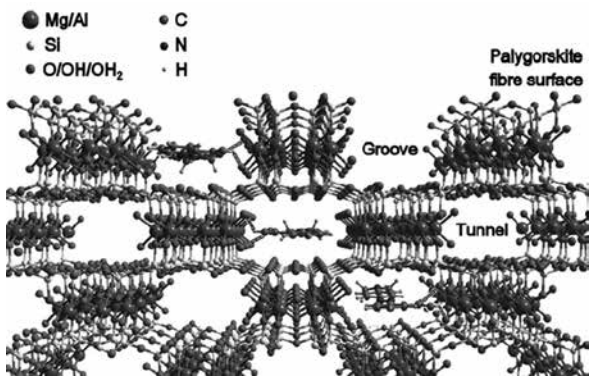


Figure 1.10: Structure of Palygorskite. Positions a, b & c are examples of locations where indigo could enter the structure and be protected from degradation. (from Giustetto, Seenivasan, Pellerej, Ricchiardi & Bordiga, 2012 fig. 10).[19]

OTHER COLOURS

Apart from the already mentioned colours black, white, red, orange/yellow, and blue, a few other colours which can be called "derived colours" are also found in the precolonial codices. The green thus far identified on the codices was made by mixing blue and yellow, most likely Maya blue or Matlallin combined with an organic yellow colourant on a clay base. Sahagún (1577c fo. 221v.-222r.) describes how, by changing the relative amounts of yellow and blue pigment, brighter or darker green was made, each having a different name (quiltic and yiapalli respectively). As it is known that in the Maya codices mineral pigments were used, green may have been made from green earth. This mixture of minerals, most of which is glauconite or celadonite, is mostly Iron Aluminium Magnesium Silicate (Eastaugh et al., 2008, pp. 180-181). This may well be the green seen in the Dresden Codex. Though used extensively in murals (see Magaloni, 1998; Magaloni Kerpel & Falcón Álvarez, 2008) no minerals such as Malachite have been securely identified on the codices. Malachite is in general a brighter green colour than that made with green earth. Besides these minerals, the green colour created by varying the temperature when making Maya Blue is a third candidate for these green paints.

Both pink and grey are relatively often found in the codices, but thus far they have only once been identified as truly separate colourants. Generally they are simple dilutions of red and black, allowing the white surface to shine through. Only when investigating the Codex Madrid, the presence of indigo on a grey area could be established (Buti, 2012, p. 69). It has been suggested that there is a symbolic similarity of blue and grey (see Buti, 2012, p. 69). However, this use of indigo as grey may also be unintentional as it may be the result of discolouration over time. The Codex Añute displays areas of degraded blue that now are grey or cream coloured. Inferior quality of either processing method or raw materials may have led to a less stable Maya Blue, and thus to the degradation of the indigo molecules over time.

Purple is a colour found only very rarely in the surviving precolonial documents. Both Codex Tlamanalli (Cospi) and Tonindeye (Nuttall) exhibit some areas that can be called purple. In the descriptions on mixed colours Sahagún (1577c fo. 221v.) describes how a mixture of cochineal and alum is used to make purple. His description continues, however, with the statement that this is the way painters make shadows, which is a colonial drawing technique. A famous purple dye was used in precolonial Mexico and is still used today, which is similar to a technique used in Ancient Rome. A purple dye extracted from sea snails was used to dye the robes of the Roman Emperor, and is used today on the Mixtec coast to dye cloth as well. A precolonial expression of this can be found in the Mixtec codex Añute. On page 7 of this manuscript a huipil can be seen on which a shell is drawn. Most likely this is an

Figure 1.11: Image of the Codex Mictlan (Laud) before and after removal of red and yellow channels, showing thee pattern of black spots.

expression that is to be read as a purple dyed huipil. The sea snails producing this purple dye all belong to the same family: the Muricidae. The source of the Mexican dye is the Purpura patula pansa, (Sayer, 1988, p. 24). The chemical component that gives the dye its colour – and pungent smell – is 6,6'-dibromoindigotin (Eastaugh et al., 2008, p. 379). The presence of bromine should make a pigment made with this material relatively easy to distinguish, if non-invasive investigation is performed on these areas in the future.

1.3 COVERS

Leather or paper covered with a white mineral layer is both fragile and susceptible to water and dirt. Furthermore, the contents of these books were very important and thus warranted both physical and symbolic protection. One way of protecting a book would be is to attach covers to front and back. Only of three codices, the Codex Tonalpouhqui, the Codex Mictlan, and the codex Tonindeye, is it certain they still have their original covers, though there is clear evidence that others once had a cover as well. None of these original covers has received much scholarly attention, however, thus far three identifiable types are: fur, feather mosaic, and inlaid or encrusted wood. The cover of the Codex Mictlan, for example, was identified by the author (Snijders, 2014) as a jaguar fur cover. The front and the back of the codex have a second piece of leather attached to the outer surface. These pieces are thinner, harder, and slightly larger than the main part of the codex, overlapping the folios about 1mm on all sides (see also Burland, 1966, p. 9). On the front of the document, some texts were written when the book entered the collection of the Archbishop of Canterbury in 1634 and later when it entered the Bodleian Library of the University of Oxford. While all the texts thus postdate the creation of the codex itself, the material of the cover has already been described by Burland (1966, p. 9) as pre-colonial. Although currently only one small patch is left, according to earlier descriptions (Burland, 1966, pp. 9-10; Paso y Troncoso, 1961, pp. 31-32), the front cover once contained multiple small patches of fur. Since the process of creating leather involves as one of the first steps the removal of hairs, it is clear that these are fur, rather than leather covers. Apart from the small surviving patch of dark fur, the overall colour of the covers has become dark beige due to the tanning and aging of the skin. When digital images of these covers were studied using Photoshop© and the yellow and red channels were removed in order to reduce the discolouration of the skin, a clear pattern of black spots became visible (see figure 1.11).

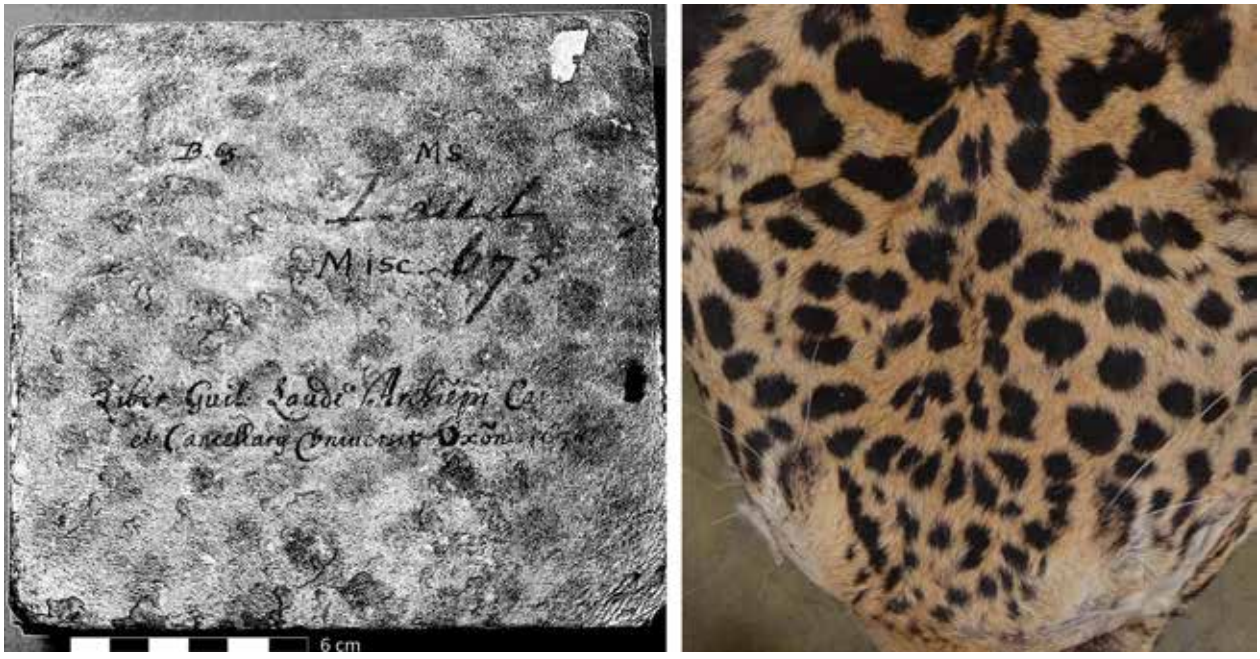


Figure 1.12: Comparison of the edited image of the cover with the head of an average sized jaguar (images by the author).

In order to identify the animal used to make this cover, detailed photos of the front and back cover were compared with modern skins in the natural history museum Naturalis (Leiden, The Netherlands). As these skins retained their fur, it was only possible to make a comparison based on the size, frequency, and distribution of the spots. The earlier assumption that these covers are made of deerskin (Paso y Troncoso, 1961, p. 31) were easily dismissed. Though young deer may have spots of the appropriate size and distribution, their spots are white on a dark background. Only three species of spotted animal live in Mesoamerica that have black spots on a light coat: the ocelot (Leopardis pardalis), the margay (Leopardus wiedii), and the jaguar (Panthera onca). Both the margay and the ocelot have spots that form large, linear shapes, very different from the pattern found on the cover. The jaguar's spots usually form large rings, except for the area on the top of the head, where the individual spots are more evenly distributed. If the image of the spots on the cover of Codex Mictlan are compared at the same scale with the head of a jaguar of average size (body length of 1,2m), it is clear that the spots are also of similar size (see figure 1.12).

Considering the fact that the jaguar shown in figure 1.12 was not very large and that furs can be stretched significantly, the area on the top of the jaguars head would be large enough to create the cover of the relatively small Codex Mictlan. On the back cover spots of similar size can be seen as well, though with more difficulty. They form two large rings as is the more general pattern found on the jaguar's back and sides.

Because of the relatively poor state of conservation of one of the skins in the Museum Naturalis, one small piece (approximately 3 by 6 cm.) detached from the main skin during the investigation. This piece was made available to the author for the investigation of the skin itself, allowing for a comparison of the follicle pattern on the skin of the jaguar with that found on the cover. Though the piece came from the relatively light-coloured and longhaired belly side of the animal, some valuable information could be gained. Due to early conservation treatment of the pelt, the removal of hairs was difficult as the sin had become brittle, causing the epidermis to easily detach from the corium. Once shaved, it was studied under a stereoscopic microscope (Nikon

Figure 1.13: Comparison of the skin of a modern jaguar (left) with the cover of the Codex Mictlan (right) (images by the author).

SMZ800) with a magnification range: 10x-63x. The downside of using a 60 year old and desiccated skin became immediately apparent, as it was impossible to remove the hairs completely without damaging the skin and thus destroying the follicle pattern. It could be observed however that the hairs grow in clear clusters. Furthermore, the dark hairs sprout from hair follicles that are themselves darker than the surrounding skin. As a result the dark spots of the jaguar's fur are seen on the level of the skin as clusters of darkened hair follicles. A similar pattern can be discerned on the cover of the codex (see figure 1.13).

As with the substrate, definitive identification through such follicle pattern analysis is problematic due to variation within the species and individual skins. As such, definitive identification of this fur, just like the definitive identification of the leather used as substrate for the codices, may only be possible with (invasive) DNA analysis. Depictions of codices, especially those found in Maya art, generally show the books with a black spotted cover. Given the high quality of the codex, it is only fitting that it was given a special cover. The symbolic significance of the jaguar in the Americas has been well established (cf. Saunders, 1994). Using the skin of the head may have made this cover even more symbolically significant, though there are two practical considerations as well. First of all, as the book is so small, selecting an area of the jaguar skin with small and more or less equally distributed spots may have been more aesthetically pleasing. Secondly, as a result of its size the skin on the head of the animal is not the most versatile and it may thus have been a practical consideration to use a piece of fur that fitted nicely as a book cover but could not have been used for anything else.

It is likely that another original fur cover exists underneath the silk velveteen cover of the Codex Tezcatlipoca. Burland (1971, pp. 20-21) observed that the thicker leather attached to the front and back of the codex exhibits large hair follicles. Therefore, he suggested that this codex had a fur cover similar to the Codex Mictlan, though of a coarser fur. From what animal this fur was obtained is unclear, however, and warrants further investigation. The loss of hair of both the cover of the Codex Mictlan and possibly that of the Codex Tezcatlipoca can have multiple causes. The first is desiccation. When a skin dries out, the hair follicles open up and the hair may fall out (Kite, 2006b, p. 167). Secondly, insects may have caused the loss of much of the hair as was already noted by Burland (1966, p. 10). A third problem may be mechanical friction caused by sliding the manuscript in and out of the box it has been kept in, or between other books if it was kept vertically on a shelf. Codex Mictlan is today kept in a box, the leatherwork of which does not seem to be English in style. It may be, then, that the book

was put in this box before it arrived in England. This box is, however, slightly too big, suggesting that, if the box was made for this particular manuscript, the book used to be thicker. This could be explained if the covers were still covered in hair when it arrived in Europe, presumably at some time in the 16th century. By 1634, however, most of the hairs on the cover of the Codex Mictlan must have been gone, as the alphabetic text and date is written over the damaged areas.

A second type of codex cover is that found on the Codex Tonalpouhqui. This cover is made of wood on which in one corner a single piece of turquoise-coloured inlay remains. The rest of the design has been lost, though close study of the original shows that it was probably not very complex. Next to the one remaining inlay in the upper right corner, a second circular indentation in the bottom right corner suggests a similar inlay was placed there. In the central part of the cover four clusters of indentations are found. What these originally depicted is difficult to assess as the indentations are rather uneven and are filled with a partially decayed resin used to hold the inlays in place. Next to these indentations the colour of the wood itself indicates that something may have been glued onto the entire surface. The wood has, in places where it is not worn off, the same dark colour as the resin found in the indentations. Neither the wood nor the inlays have been definitively identified, though the inlay has been called turquoise (Anders, Jansen, & Reyes García, 1993c, p. 16). Because of the size of the inlay and inability to take samples it is difficult to truly determine the nature of this green-blue stone. Many chemically different, yet visually similar, precious stones were in use in Mesoamerica (see Ruvalcaba-Sil, Melgar-Tisoc, Curado, Laclavetine, & Calligaro, 2013). A second wooden cover can be found on the Codex Yuta Tnoho. This cover was identified by Anders, Jansen, Reyes García, and Pérez Jiménez (1992, p. 17) as a type of Pine. This tree is native to Mexico and it could therefore be an original cover. The wooden boards are both split and held together with more modern metal clamps. The surface of the wood has dark discolourations similar to the Codex Tonalpouhqui. The corners of the wooden boards are worn and rounded again similar to the Codex Tonalpouhqui. Investigation of the original is needed to compare the way this wooden cover is attached to the leather in order to establish if this could be another original cover.

Very little has been written about the cover of Codex Tonindeye. In facsimiles it is visible that both the front and the back show traces of a brown material adhering to the leather surface. When studying the surface in detail, Troike noticed that this brown was a resin or glue into which the imprints of feathers were visible (Anders & Troike, 1987, pp. 39-40). A square imprint may be the only remaining trace of stone or shell inlays that also decorated the surface. Since there are only very few imprints left, as the brown resin or glue is severely worn, it seems unlikely that it will ever be possible to recover the design of the cover. The other codices exhibit either post-conquest covers or have no cover at all. The Codex Añute, for example, does not have a cover, but has a year glyph written on the verso side of page 1. This glyph clearly is contemporary with the images of the known codex, as it is written on top of the gesso that covers the palimpsest (see chapter 6). In order to protect this document, however, the leather at the end of the document is long and flexible so it can be wrapped around the book. A protective white parchment-like material has been attached to this by the curators of the Bodleian Library to further protect the whole document. All the Maya books, as well as the Mixtec Codex Iya Nacuaa, are broken up into sections or individual leaves. There is no clear evidence where and how a cover may have been attached to these manuscripts. The Paris Codex has a dark discolouration on the first page, which may be glue to attach a cover. However, this leaf is so damaged that it is difficult to ascertain whether or not a cover was ever actually affixed to the page.

Next to the previously mentioned Codex Tezcatlipoca, two more codices were given at some point in their history a European cover. The clearest of this is the Codex Tlamanalli, which received a new leather cover when it was given to Count Cospi, as can be read in the text on this European leather cover. Another European-style cover has at an unknown point in time been added to the Codex Yoalli-Ehecatl. Around the edges of the first and last

page of the document small holes can be seen that have been discoloured. Through these holes iron nails were once placed to attach the document to this cover. The codex is still stored between these covers, though the nails have been removed. The two covers have since then been connected by a spine, making it impossible to attach the cover without making half the book inaccessible. When this new cover was added is unclear, and the reasons for the removal of the old cover are also unclear. It appears to have been common practice in the Vatican Library to give books new covers.[20]

1.4 ADHESIVES

All the elements described above need an adhesive to hold them together. The term adhesive is an overarching term that covers any material that can create a bond between two substances. The adhesives available in Mesoamerica are all organic and thus suffer from the same difficulty for identification as the organic paints: they are difficult to detect using non-invasive investigation techniques. An additional challenge is that the concentration of binding medium relative to what is bound is generally very low. Because of this, no non-invasive technique exist at this time that can securely identify adhesives. From historical sources and from invasive tests done on pre-colonial objects other than the codices, it is possible to determine the range of options available to the pre-colonial codex makers. Evaluation of the advantages and disadvantages caused by their physical properties can help to select the most likely candidates for specific parts of the codices. The three types of adhesives available in Mesoamerica are glues, gums, and resins. These three categories differ in the sources of the material and in their properties. Natural glues are often won from animal origins, being composed of hydrolysed collagen, and extracted from the connective tissue in bones and skin (Kite 2006, 192). Hot water is used to break the hydrogen bonds between the individual collagen molecules, thus untangling the triple helix structure into a mass of gelatine. The animal glues are of different strength depending on their source. Both the species of animal, as well as the part of the animal used, are factors that influence the strength of the resulting glue. These factors have an impact on the purity of the gelatine extracted. Hide glue is, as the name suggests, made of the skins of land animals. It is relatively strong and had historical applications ranging from bookbinding to furniture making. A special type of hide glue is rabbit glue, made from the skin of rabbits or hares. This type has less structural strength, but more flexibility than regular hide glue. Another type of glue can be extracted from bones and is predictably called bone glue. It is generally considered inferior to hide glue, as its structural strength is weak and it is quite inflexible. Fish glue is made from swim bladders or, if it is of inferior quality, fish bones and skin. One of the properties of fish glue – its ability to stick to a porous surface – made it the glue of choice in Medieval Europe for the illumination of manuscripts (Kite, 2006a, p. 194). Both skin and bone glue were probably available in Mesoamerica as they are natural by-products of the hunt. Whether or not fish glue was used, especially outside of the coastal areas of Mesoamerica, is uncertain. Like the process of leather making, the fabrication of glue from skins and bones is not a subject that receives attention in the colonial codices. Most likely this was a job so familiar and of such little value that it was not considered necessary to describe it. The physical properties of animal glue, however, do put one restriction on its use. If it is to be applied, it needs to be mixed with water and warmed up to 30-50° C. to melt the glue (Kite, 2006a, p. 192). When the mixture cools down, it becomes a gel. Overheating the mixture should be avoided as this breaks the collagen molecules, which will make the glue lose its adhesive strength.

Mesoamerica is an area rich in plants that secrete gums and resins. Both are won from trees, the only difference being the extraction method. Gums are naturally secreted from the bark of trees, while resins require cuts to be made in the tree to make it “bleed’. Gums generally harden when exposed to air, but they are also generally water soluble. Resins on the other hand do not generally dissolve in water, though they too harden over time. One of the most useful gums in the world is Gum Arabic, won from

20. According to Dr. Roth, Director of the Department of Printed Books of the Vatican Library, who described this practice, the general policy had been to throw the old covers out.

species of Acacia. Although, as the name suggests, the best gum of this type is won from an Arabic species of Acacia (Vachellia seyal), similar gums are extracted from Mesoamerican Acacias. One example which is used today by artists is extracted from the mesquite tree[21] (Acaciella angustissima). The most well-known resin from Mesoamerica is Copal. This resin was ritually very important, as it served as a form of incense. It was also used as an adhesive, especially in order to make stone mosaics. The investigation by Stacey et al. (2006, 338) of the adhesives used to make the Mesoamerican mosaic objects now kept in the British Museum showed that copal-like resins could be extracted from different sources such as Pine; i.e. Boswellia spp. and possibly Bursera spp. The material commercially sold today as Copal ranges in colour from white to brown and black, reflecting different origins. While very useful for mosaics, Copal resins have one key disadvantage: their insolubility in water. Unless it is used directly after extraction from the tree, Copal resin will first need to be liquefied if it is to be used as an adhesive (McEwan, Middleton, Cartwright, & Stacey, 2006, p. 41). This can be done in the case of Copal by heating it to several hundreds of degrees Celsius.[22] On cooling it will again set and create a strong bond between, for example, a wooden surface and stone mosaics. However, both of the materials between which the bond is created need to be able to withstand the high temperatures required to liquefy the Copal resin. One problem of resins is that they set rather quickly, as the experiments of Berdan (2007, p. 18) have shown. As a result, they are not applicable to situations where the applied material needs to stay liquid, as is the case with the gesso and the paints and inks.

A fourth type of adhesive that needs to be considered in the Mesoamerican context was produced from orchids. These have been the subject of recent study, most prominently by Berdan, Stark, and Sahagún (2009) who also tried to replicate the process of making the glue. Martinez-Cortés (1970, pp. 17-22) provides an overview of the plants identified by various authors as having been used to make the different versions of tzacuhtli. He based his taxonomy on the information found in Hernández (1615), Sahagún (1577c), and the Badiano Codex (Cruz & Badiano, 1991). The use of a plant specifically named tzacuhtli by painters is recorded in both Sahagún and in Hernandez:

"...se prepara con ella un gluten excelente y muy tenaz que usan los indios y principalmente los pintores para adherir más firmamente los colores, de suerte que no se borren fácilmente las figuras." (Hernández, 1615, p. 377)

And

"El color amarilla mezclando que se llama Çacatlaxcalli con color açul clara que se llama texotli y con tzacutli: hazese un color verde escuro, que se llama yiapalli: que es verde escuro." (Sahagún, 1577cBook 11, fo. 221 r. and v.)

Atzauhtli, an aquatic plant, was clearly seen as related, at least in function. The name is composed of the word for water "a(tl)" and the same tzauhtli as seen above:

"sirve de pegamento a los indios,y principalmente a los pintores, que procuran y consiguen así la firmeza y adherencia de sus colores." (Hernández, 1615, p. 373)

While the importance of this material for the understanding of Mesoamerican paint compositions is clear, to this day there is no agreement as to the identification of the species of plants used to make these glues. Martinez-Cortés (1970, p. 21) identifies Tzacuhtli as the epiphytic Epidendrum pastoris and Chranichis speciosa as Atzauhtli. Berdan et al. (2009, p. 149), however, argues in contrast that the drawings in Hernández (1615) of Tzacuhtli look more like Bletia or Govenia species which are terrestrial orchids. The experiments conducted by Berdan et al. (2009) show the difference in strength between the glues made from the different species of orchid, which helps explain why sources such as Hernandez stress the difference in quality between the glues

21, During fieldwork in Mexico in 2014 the author met with a local artist, José Luis García in Huajuapan de Leon, who explained he used mesquite gum in his mural paintings.
22. Slightly variable, depending on the species of plant from which the Copal is extracted, but on average 300 °C.

Figure 1.14: Bottom right corner of the cover Codex Mictlan, no traces of white "cement" are visible, only what appear to be the remains of brown glue.

made from the different plants they mention. The general principles for working with orchid-glue are also given by Sahagún (1577c). First the roots or pseudo-bulbs need to be cut into small pieces, which are subsequently dried in the sun and ground into a fine powder. Berdan et al. (2009, p. 149) found a large difference between the terrestrial and epiphytic orchids in the amount of fibres in their bulbs, making the terrestrial orchids much easier to process to a powder. They also yield a stronger gum, though overall it is clear that orchid gums are relatively weak in their adhesive strength. A major advantage of this glue, however, is that it is completely clear. As such, it leaves no discolouration on the surface it is applied to.

There are numerous bonds in a codex that need to be created using adhesives, each one between specific materials and at different times in the production process. Many of these bonds are not directly visible, resulting in some confusion about which materials are attached to what. For example, for the cover of the Codex Mictlan (Burland, 1966, p. 9) states that "…the cement used for affixing these pages is the white paste which covers the rest of the codex…". This would mean that the covers were attached using the gypsum gesso. Close observation of the original, however, shows that this is not the case. The bottom right corner of the front cover is slightly detached and curled up, allowing for a view of the inside between these two pages (see figure 1.14). There is no trace of a white layer in-between these two sheets. Instead, a brown residue can be seen.

For their application in the production of a codex, three properties of the glues need to be taken into account: strength, colour, and way of application. The structural components of the codex require the strongest bonds. In principle, this would be copal resin. However, the application of this resin while being hot makes this impossible, as the leather could not resist the heat required. Besides this, both the paint and the gesso cannot be made using copal, as this would set too quickly. Furthermore, the paint requires glue that does not interfere with the colour. The experiments in the next chapter will provide more insight into which adhesives are best for what purpose.

DISCUSSION AND CONCLUSIONS

The amount of direct data on the materials used in the Mesoamerican writing traditions is limited by three factors: the size of the corpus itself; the amount of investigations; and, finally, the types of techniques that can be applied on the material categories that are encountered. Given these limitations, it is impossible to determine how the codices must have been made. Variation between the codices indicates that there was more than one recipe. The historical and ethnographic sources are essential as they provide alternatives to the materials identified and likely candidates for those that cannot be identified. These sources together allow for a creation of a first list of materials that have the affordance to make a codex. Following the approach in Hodder's Entangled (2012), it is possible to continue with the materials that are identified in these books and search for their dependences and dependencies. This reveals that many more things will be needed when one works with them. For example, making a stable pigment of a specific red colour out of cochineal requires more materials than just the cochineal insects. Making a codex thus requires technology and a specific toolkit,

all of which may not leave a directly identifiable trace on the codex. The few investigations that have been done in this area have stopped at the chemical or physical identification of major components. Although these kinds of identification are interesting from a scientific point of view for present-day researchers, one may argue that the chemical or physical identification of a specific substance used in a codex should not be the end of investigation. For some purposes it may be enough, for example when the process of chemical decay is studied. It does not, however, contribute to a better understanding of past human behaviour. In order to get a better grasp of precolonial writing technology, the materials have to be followed from the moment of acquisition through all production steps until they are finally combined into a book. The lack of eye-witness description and the inability to observe the process first-hand means that the only way to come to a better understanding of the practice of codex making is by re-doing it: that is, by undertaking a process of experimental replication. Thus, both the materials securely identified as ingredients of the codices and the materials that are given by the historical and ethnographic sources as possible ingredients, need to be used as the basis for experimental replication of the production process. It will be seen that the materials themselves limit what can be done with them and require in some cases whole ranges of material in order to function properly. In the next chapter, this experimental replication will be a central tool in an attempt to come closer to precolonial Mesoamerican codex production technology.

2. The Practice of Codex Making

In the previous chapter, an overview was given of the materials which can be identified, either directly or indirectly, as ingredients for the creation of codices. This was based on earlier (non-) invasive chemical or physical investigations of the originals, as well as on the materials known from historical sources and contemporary knowledge. Table 3 shows this full list of materials divided into five groups. Each group represents a specific stage of the creation process. The last two groups represent materials that may be used in any stage, but which leave too few traces to identify. This list forms the basis for a series of experiments with these materials and experimental replication of the production process of a codex. During the summer of 2015, collaboration with the RCE (Rijksdienst voor het Cultureel Erfgoed) researcher A. Ness Proaño Gaibor and the Museum Volkenkunde of Leiden allowed for full-scale reconstructions to be made of two pages of Codex Añute, two pages of Codex Yuta Tnoo-Ndisi Ñuu and 8 pages of Codex Tonalpouhqui. During this process, much was learned about the technology of codex making. For example, many of the materials in Table 3 are not directly usable when found in nature and need an often complex process of pre-processing before they can be used in codex making. In this sense, this process may be seen as a special form of experimental archaeology, if the term is understood to incorporate a more exploratory form of experimentation, as suggested by Hurcombe (2008). The difficulty is that because of the inability to take samples, only very few materials can be securely identified, which does not allow for the strict scientific control over the experiments that usually characterises experimental archaeology (Mathieu, 2002; Van Gijn, 2010, p. 30). In the general script proposed for experimental archaeology put forward by Lammers-Keijsers (2005), it is clear that the feedback loop which should allow for a testing of the experimental results against the original is not as strong as would be desirable. As Schiffer, Skibo, Boelke, Neupert, and Aronson (1994, p. 198) argue, archaeological experiments require a specific question to be answered, relating to production or use of an artefact. Because of the many unknown factors in this process, on both the level of ingredients and the tools used to make them, the question became very general: How could a similarly looking codex be made, using the materials and tools available in precolonial Mesoamerica?

For the experimental reproduction of a codex only those materials were used that are securely identified botanically, zoologically, or chemically and that are suitable for the making of a codex; i.e. those materials that are relatively stable and are available in the quantities needed. Some materials can today be bought (partially) pre-processed. For these materials the production process is well understood and their fabrication in a precolonial context can be made sense of without experimentally replicating the entire process. All of this allows for the formation of a complete overview of the technology, materials, knowledge, and skill involved in the making of a codex.

2.1 MAKING THE SUPPORT

As was shown in the previous chapter, there are two ways of making a support for a Mesoamerican book. One involves amate paper and the other a form of animal leather. The process of creating this amate paper has been documented both in colonial sources (Hernández et al., 1960a, pp. 85-90) and in more recent ethnographic and archaeological studies (M. D. Coe & Kerr, 1998, pp. 143-145; von Hagen, 1944, p. 57). In order to understand the full range of dependencies (sensu Hodder, 2012) of paper, it is worthwhile summarizing the procedure here. From the description by M. D. Coe and Kerr (1998), it is possible to distil seven steps:

- Cutting the branches;
- Stripping the bark lengthwise;
- Separating inner from outer bark after which the inner bark is soaked in water and the coagulating latex is removed;

Material	Identified Botanically, zoologically or chemically	Measured (non-invasive) investigation of the codices	Described in colonial/ ethnographic sources	Suitable (availability/ stability)
Support				
Deer leather	X	?	X	X
Pronghorn leather	X	?	-	X
Amate Paper	X	X	X	X
Chalk	X	X	X	X
Gypsum	X	X	X	X
Covers				
Jaguar Fur	X	X	-	X
Wooden cover	X	-	-	X
Mosaic	X	X	X	X
Gold	X	-	-	X
Pigments				
Carbon Black	X	X	X	X
Logwood	X	-	X	-
Brasilwood	X	-	X	-
Nacascolotl	?	-	X	?
Annatto	X	-	X	X
Cochineal	X	X	X	X
Zacatlaxcalli	X	?	X	X
Matlalin	X	?	X	X
Maya Blue	X	X	X	X
Xochipalli	X	-	X	?
Potonxihuitl	X	-	X	?
Pericon	X	-	X	?

Purpur	X	-	X	?
Red Ochre	X	X	X	X
Yellow ochre	X	-	X	X
Green earth	X	-	X	X
Adhesives				
Hide Glue	X	X	-	X
Mezquite	X	-	X	X
Tzacutli	X	-	X	X
Additives				
Alum	X	X	X	X
Copperas	X	-	X	X

Table 3. Overview of materials identified on the codices and likely alternatives.

- Nixtamalization of the fibres by boiling in alkali water;
- Rinsing of the now pliable fibres;
- Laying of the fibres on a board in a crosswise manner and beating them with a stone beater to felt the fibres together, thus forming the sheets of paper.
- Drying of the sheets in the sun to form the finished product.

Though von Hagen (1944, p. 57) suggests that for making paper "only two instruments are necessary", which are the board and the beater, the above procedure shows this to be untrue. Cutting and stripping the branches of its bark requires a cutting tool and nixtamalization requires clean water, a container, and an alkaline material. This alkaline substance was most likely lime[23] (Ca(OH)2). Perhaps as early as 1500 B.C. the process of nixtamalization had been invented, which allowed the processing of maize to release more protein for human consumption by the addition of lime (S. D. Coe, 1994, p. 14). Having such a high dependence on lime for the processing of everyday food items, makes it the most likely candidate when an alkali substance is required. Another possibility would be potash (K(OH)), which is made by leaching the lye from wood ash. The resulting solution is a stronger alkaline, thus making the process somewhat faster. However, the potash solution also poses greater health risks, which is one of the reasons why it is generally not used in the preparation of food.

As the process of making paper involves laying out the fibres on a board, which has a limited size, the size of the individual sheets of paper is also limited. For a full length codex, multiple sheets of paper needed to be attached end to end in order to make a single support. Unlike the leather codices, in the case of the Maya paper codices it is not visible where

23. Not to be confused with the lime fruit which is a strong acid rather than an alkali, and is furthermore not native to the Americas.

Figure 2.1: Scenes from codex Madrid (page 46) depicting deer caught in traps (after Fahsen & Matul, 2007).

different sheets of material were attached together. This is because when two sheets of paper need to be attached, the edges can be made wet, which will soften the fibres. And pounding the overlaying edges of the two sheets will effectively felt together the pieces of paper into one long piece.

As was shown in the previous chapter, two types of animal are possible sources for the skin on which the central Mexican codices are made: pronghorn and white-tailed deer. Neither of these animals can be domesticated and as such need to be hunted. White-tailed deer is a very adaptable species which has a very wide range, and could thus be caught in many areas throughout Mesoamerica. While most abundant in forested areas, the white-tailed deer can adapt to many environments, including man made agricultural landscape. Catching deer, however, is by no means a simple exercise, because of their speed and agility. Furthermore, while one may be able to shoot a deer with bow and arrow if the terrain is open enough to allow such a strategy, this will invariably damage the skin of the deer. None of the codices have any surface damage that could be attributed to the hunt itself, though some, such as the codex Ñuu Tnoo-Ndisi Nuu (Bodley) and the codex Tonindeye (Nuttall), do have holes in the surface. These holes can, however, be most straightforwardly explained by the tanning process. The reason for this is because they are very round holes, which were most likely caused by putting too much pressure on the tanning knife when the skin was under tension. A piercing wound of an arrow, even one made perfectly perpendicular to the skin, would in contrast leave a more elongated mark on the skin.

Other hunting techniques must thus be considered, such as trapping the animals. In the Codex Madrid (see figure 2.1), depictions of deer caught in a snare indicate how this may work. Trapping of this kind requires a rope tied into a noose and a flexible piece of wood set up into the ground or, as the images of the Madrid codex seem to suggest, bending down branches of trees. This wood is then bent to create a spring onto which the noose is connected. A trigger is needed which sets off the trap when the animal steps into the noose, releasing the bend wood and allowing it to spring up and tighten the noose around the paw of the animal. As an adult deer is quite strong, the use of a strong but flexible branch still attached to a tree is probably preferable over a loose branch that needs to be set up into the ground. The latter construction, however, is more useful for hunting smaller game such as rabbits and other rodents. Once caught it should be relatively easy to kill the animal as deer are prone to shock after panicking for some time in a trap. A second way of hunting deer is to make use of multiple hunters to drive the animals into a canyon where they can be easily shot with a bow and arrow or captured with lines, nets, or even by hand. This technique obviously relies on the topography of the region, which may explain the preference of traps in the rather flat Yucatec peninsula. Besides this obstacle, catching a male deer armed with antlers by hand or even in a net is not without obvious risk. Capturing a pronghorn may be done using similar techniques, although the more open habitat (see Chapter 1), makes both setting a trap and driving the animals into a confined space more difficult.

Once an animal is killed, it needs to be skinned quickly to avoid putrefaction. In order to have a skin that is of the optimum size and quality a specific way of skinning is usually applied. The way of cutting the skin is related to the growth of the skin of the animal, as it is the growth that determines the run of the fibres throughout the skin as well as its thickness. In a quadruped, the skin is thickest on the back of the animal, as this is the oldest part of the skin. The fibres radiate outwards from the top of the buttocks. Many strong fibres are located on the ridge of the spine. From the spinal ridge the fibres run down the sides of the animal towards the belly. The belly is the least strong part of the skin, so it is there that the skin of the animal would normally be split to leave the strong area on the back and sides intact. The optimal way of cutting a piece of leather for the creation of a codex would thus be to cut a rectangular piece of the back along the spine. Farnham (1922, pp. 27-28) uses a cow in his demonstration of how to skin an animal, but the basic principle is the same for any quadruped, especially those with horns. First the head is skinned by cutting down from the base of the horn, along the eye and across the nose and back between the horns. The skin can then be removed from the head. After this an incision is made down from the nose across the mouth and down through the belly all the way down to the tail. Another four incisions are made on the inside of the legs and the skin is severed at the hooves or paws. Once this is done the hide can be skinned from the sides after which, starting from the tail, the hide can be removed.

Once removed and cooled,[24] the skin can either be processed immediately or stored for later processing. It is unlikely that the processing of leather happened on an industrial scale in precolonial Mesoamerica. The main reason for this is simply because all the animals needed to be hunted and, unless a large group of hunters would supply one centralised tannery, the uncertainty of the hunt would lead to an unreliable flow of raw materials. Considering this and the fact that many tanning methods require preparation of tanning baths (see below) that could be used to tan multiple hides, it may well be that hides were stored until a specific number were available, after which all of these were tanned at once. If this was indeed the preferred method, some action would have needed to have been undertaken to temporarily protect the skin from decay. The most common way of preserving the stored skins is to salt the hide. The salt protects the skin from microbial decay by creating a saline environment which dehydrates any bacteria or fungi, thus preventing their growth and spread. This salt needs to be removed by washing in clear water before the process of tanning begins. This act of pre-tanning washing also rehydrates the hides so they became supple again.

The process by which precolonial Mesoamerican tanners tanned their hides is not clearly understood. While there are methods to investigate the tanning agents used in leathers, none of these are non-invasive, either involving taking samples or the application of a chemical substance that reacts chemically and discolours to indicate the presence or absence of a specific tanning agent (c.f. Driel-Murray, 2002). The historical sources are also remarkably silent on the subject of tanning. One reason for this may be that historically the profession of tanner was one of low esteem, as it involves close contact with putrefying matter, often using different types of excrement in the process. Secondly, since the animals available in pre-colonial Mesoamerica for making leather were relatively few and small, it is likely that Spanish chroniclers familiar with the European leather working tradition were not particularly impressed by the Mesoamerican's tanning capabilities.

Maldonado Alvarado and Maldonado Alvarado (2004) describe a number of methods for tanning leather that are used today in Oaxaca. This includes the full range of tanning techniques. The simplest is oil tanning, which is also described by Richter and Dettloff (2002, pp. 301-317) as the common way of processing deer skin by North American Midwest native peoples. Oil tanning involves dry or wet scraping, followed by brain tanning. Scraping is needed to remove fat and flesh from the inside as well as hairs from the outside of the skin. It can be done in either running water or while the skin is stretched on a frame. For the removal of hairs, the

24. The Mexican deer mostly lives in high, cooler, and wetter climates, thus allowing the skin to cool, but causing problems with drying the skin.

skin should be immersed in an alkali bath such as a lime or potash liquor (Thomson, 2006a, p. 105). This loosens the hairs after which they can be scraped off without damaging the skin underneath. After the skin is thoroughly cleaned, the actual tanning process can start. When tanning with oils the process is relatively simple, though labour intensive, as the oil simply needs to be rubbed into the skins. These oils then form a protective layer around the fibres of the leather protecting them from decay. This technique is thus suitable for the processing of small amounts of skins, as one would expect when the skins need to be hunted. When tanning larger numbers of skins, processing them one at a time becomes less desirable. The alternative is submerging a large amount of skins in a bath filled with tanning agents. This is a very long and slow process. In Medieval Europe, cleaned skins were laid in a pit with layers of vegetal tanning material – such as oak shavings – between each skin. This pit was subsequently filled with water and the skins left to soak up the tanning material for at least a year (Thomson, 2006b, p. 70).

There are many plants all over the world that contain substances that can be used to tan a skin, and Mesoamerica is no exception. The range of tannins found in plants and the new chemical bonds they create are thoroughly discussed in Covington (2006, pp. 23-26). Though there may be many plants in Mesoamerica that could theoretically be used to tan skins, the amount of tanning material needed is relatively large, therefore it is unlikely that rare or difficult to access materials would have been used. Maldonado Alvarado and Maldonado Alvarado (2004, p. 65) give the following examples of Mesoamerican vegetable tannins: "quebracho, mimosa, sauce, mangle, encino o timbre". Quebracho, a common word for a range of hardwoods (Schinopsis spp.); Mimosa, a genus of shrubs and herbs (Mimosa spp.); and Sauce or Willow (Salix spp.), each contain condensed tannins. These cause the leather to redden when exposed to light (Covington, 2006, p. 26). The documents studied at the Bodleian Library are not markedly reddened and it does not seem advantageous to create a reddened surface which potentially could stain the gypsum used to make the writing surface. Timbre is another common name that probably refers to Acaciella angustissima. This plant is also known as Ocpatli, Quapatli, or Palo de Pulque, as the root is used in the alcoholic drink pulque (Hernández et al., 1960b, pp. 119-120). Encino refers to Oak trees (Quercus spp.), of which several species are native to Mexico. The tanning properties of Oaks have long been exploited in Europe as well. Oak contains ellagitannins, hydrolysable tannins which do not necessarily change the colour of the leather on exposure to light (Covington, 2006, pp. 23-25). Another possibility is that these hides were tanned using minerals. Although (Maldonado Alvarado & Maldonado Alvarado, 2004, p. 65) name two minerals as the most well-known tanning agents – aluminium and chrome salts – tanning with the latter is a process that was only invented in the 19th century (Thomson, 2006b, p. 74). Alum on the other hand was available and used, especially as a mordant for the dyeing of cloth and the creation of paints (see below). Covington (2006, p. 29) argues that alum is actually not a good tanning agent if used by itself, as it does not bind well with the collagen and the alum can easily be washed out of the skin (the process is not really tanning but rather thawing).

After tanning, the excess tanning agent needs to be removed by washing and the leather needs to dry. This should be done on a frame on which the leather can be stretched by tying it up with ropes. By putting more tension on the body than on the limbs and head, the hide is pulled into a more square shape. If the leather is dried in the sun the risk exists that the surface dries too quickly, hardening it and trapping any remaining moisture underneath (Lockwood, 1912, p. 156). This will cause internal bacterial growth and damage, which will only become apparent later-on in the process when the hide is cut. During drying the leather can be rubbed with grease in order to improve the flexibility and suppleness, as well as to increase protection against water. Both vat tanning and oil tanning are laborious, long processes. Combining this with the uncertainty of the hunt makes good leather a valuable commodity. The 13.5 meter long codex Yuta Tnoo (Vindobonensis Mexicanus I) contains fifteen pieces of leather. It is very unlikely that the scribe who made this codex went out to hunt the fifteen deer needed and tanned each of them. Although not described in, for example, Sahagún's description of merchants or the market (Books 8 and

10), there must have been a lively trade in leather as well. Such a hypothesised leather trade was an important part of the Aztec tribute network, as the codex Mendoza (1541) shows.

Compared to paper, the production of "sheets" of leather for bookmaking purposes seems to be more laborious. However, it is also a stronger product, with less risk of tearing the material. Although the production of paper is rather specialised to the specific needs of writing, making leather is an almost natural by-product of hunting. Once available it must have been a small step to incorporate it as a surface for writing, one that may have started out as a form of decoration of for example leather clothing. The process by which paper is made is well understood and studied. The leather-making process is also well understood, as far as the general principles go, and unverifiable when it comes to specifics. Because of this, the process of making these materials was not part of the experimental replication. For the replication process, amate paper was used that was bought on a market in Oaxaca,[25] and leather tanned with natural materials was bought online.[26]

Unlike with paper, connecting "sheets" of leather does need an adhesive. For this task only glues of animal origin need to be considered. As has been shown in the previous chapter, the other glues available in Mesoamerica each have their downsides in either physical properties or in their way of being processed for their application to leather. As such, these other glues were excluded a priori from the experimental replication of the support. If an animal glue was used to create the bond between individual leather pieces, this means that its type and origin are impossible to identify non-invasively. Due to the composition of the glue, such investigation will only detect collagen and gelatine, which are also the building blocks of leather itself. The glue must be either skin or bone glue. Three different terrestrial animal glues are sold commercially today: bone glue; hide glue; and rabbit skin glue. Hide glue is today extracted from the skins of slaughtered livestock (cow in general) or the skin left-overs after processing of the hides. In the case of Mesoamerican cultures, it must have been a by-product of the hunt, as a way of recycling the scraps of skin left over after leather or fur production. The differences between rabbit skin glue and hide glue show that the properties of such glues are dependent on the properties of the skin itself. As was mentioned in the previous chapter, this is due to the differences in collagen in the skins. Bone glues are made of bones, sinews, and cartilage which all contain collagen. These contain other substances as well, however, making bone glue inferior in adhesive strength (Ebnesajjad & Landrock, 2008, p. 99; Kite, 2006a, p. 193). As the leather used in the codices is relatively heavy, the glue used needs to have a high structural strength. Therefore hide glue made from larger animals such as deer is the best choice.

Once the long strip of either leather or amate paper is completed, it needs to be covered with a layer of gesso. This gesso is a combination of a white inert powder and an adhesive. Again the adhesive is of an animal origin, likely also animal hide glue. For the experimental replication, four different surfaces were prepared: an amate surface covered with chalk and animal glue; and three leather surfaces covered with a mixture of chalk and gypsum. The gypsum was bought in purified form as dehydrated model plaster. If dehydrated gypsum is added to the glue it will crystalize inside the gesso and form clumps. To avoid this scenario, the gypsum needs to be submerged in a large amount of water for about a day and frequently stirred to avoid it setting on the bottom of the container. This process will result in what Cennini (1933, p. 71) called gesso sottile; i.e. thin or subtle gesso. The resultant gesso sottile was mixed with chalk, as the investigations of the original codices all showed that the gesso contained both gypsum and chalk. Three small samples were made with different ratios of gypsum and chalk to determine if there were noticeable differences depending on the concentrations used. One contained only gypsum, the other 25% chalk and the third

25. All thanks to Dr. A. Rojas Martínez Gracida for this supply of paper.
26. Supplied by skin and leather shop heartline http://www.huid-en-leerhandel-heartline.nl/.

50% chalk. A series of tests[27] was designed to see if the variations in surface had a significant impact on the behaviour of the paints applied to them (see section on paints below). No significant differences were encountered, though it was observed that the addition of chalk makes the mixture more opaque. It was decided to use a ratio of 25% chalk and 75% gypsum for all leather surfaces.

The leather surfaces were first covered with two layers of animal glue. This was done to reduce the absorption of gesso by the leather, so that less gesso needed to be applied. The first layer of glue was thin, made by mixing solid animal glue (bought in the form of grains[28]) with water at a ratio of 1:25. The second layer was thicker and had a water ratio of 1:10. Next to making the surface less absorbent, the glue had two other effects. First of all the leather surface becomes much darker in colour, and secondly it becomes very stiff. This is a major advantage for the codex, as a more rigid support makes it less likely that the gesso flakes off. It was observed that the glue has a tendency to warp the surface due to the shrinking effect of the glue. It is thus important to treat both sides at the same time. Weighing down the leather after it has dried will reduce the curling effect to a minimum. Before application of the glue and during and after drying, the support needs to be folded into pages. By doing this the surface regains its flexibility at the folds.

For the preparation of the gesso no recipe can be given. The starting point is animal skin glue which has a glue:water ratio of 1:10. At room temperature this has the consistency of a gel. It needs to be warmed up to about 40°C in order to liquefy it. If heated up too much, the collagen in the glue will break up and it will lose its adhesive strength. To this liquid glue the mixture of chalk and gypsum needs to be added until the mixture has the consistency of yoghurt. This may seem like a strange directive, however, the viscosity of the mixture is determined by many factors, of which the ratio between solid particle (gypsum and chalk) and the liquid (glue) is only one. Thus, there is no way to give a recipe in the form of grams of chalk and gypsum per litre of glue. Once made, the gesso must be applied on both sides, again to avoid warping of the surface. It must also be applied in two directions, both in horizontal and vertical lines over the surface, to give it strength. Once two layers are applied on both sides the whole needs to dry completely before the next layer is added to avoid locking moisture in the object. If needed, the surface can be sanded before adding a new layer of gesso. The total amount of layers needed is highly dependent on the thickness of the gesso. In general, however, it is better to add more, but thinner, layers, as this increases its strength.

For the experimental replication, one support of about 100 cm long was made which was folded into 8 pages (plus six on the reverse as the outer two pages would be used to attach a cover). Each page measures approximately[29] 12.5 x 12.5 cm on which scenes of the Codex Tonalpouhqui could be copied. Two more surfaces were made: one the right size to copy two pages of the codex Añute and the other the size of two pages of the Codex Ñuu Tnoo-Ndisi Nuu.

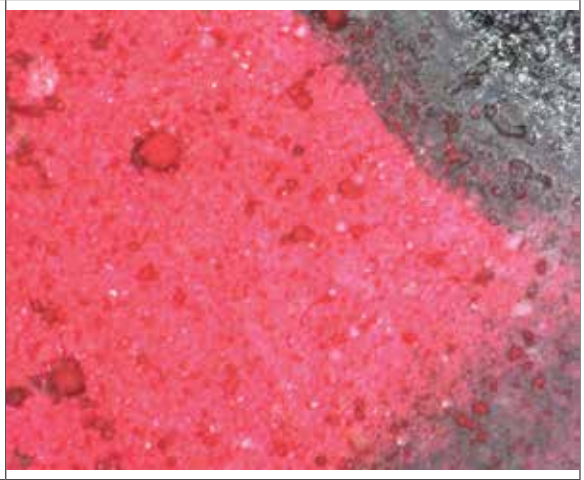
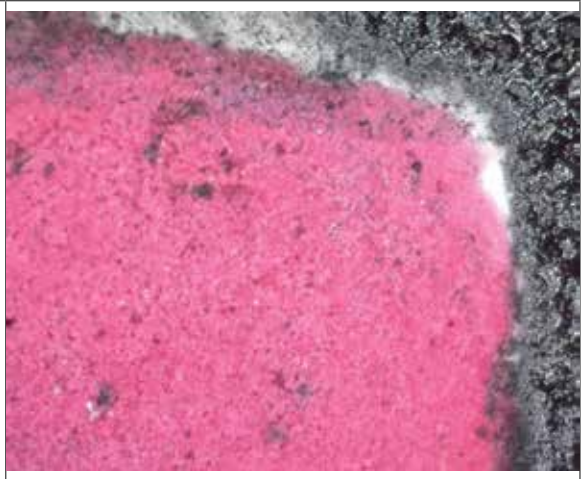
2.2 MAKING PAINT

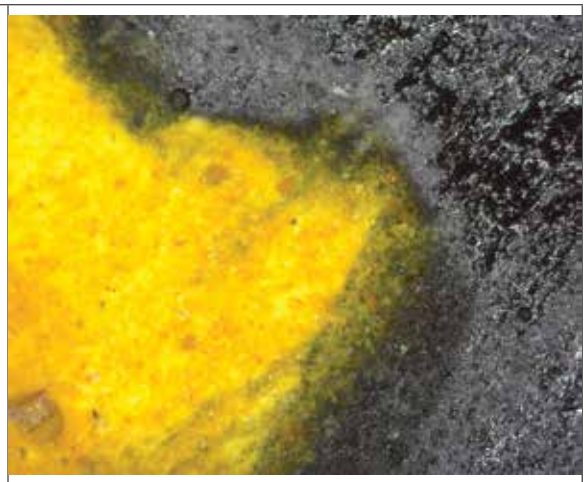
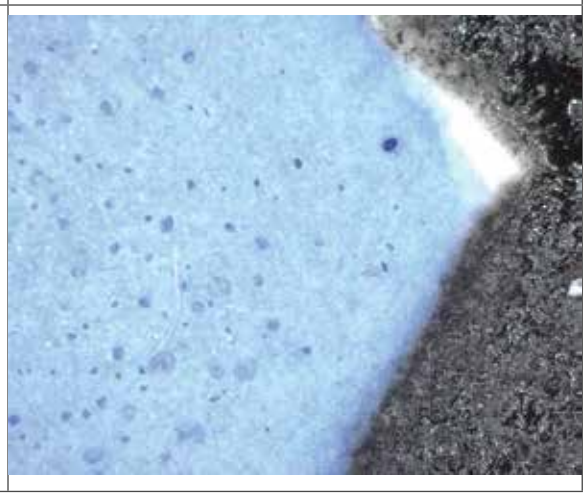
Once the surface was made, the next step was the application of paint. For this experimental replication, different paints were made and tested. Table 4 shows the pigments and colourants as they were tested on the three samples with differing concentrations of chalk and gypsum. The ingredients of these materials can be seen as well as the microscopic images of the coloured surface. It is clear that some colourants are better than others. For example, Tyrian Purple,

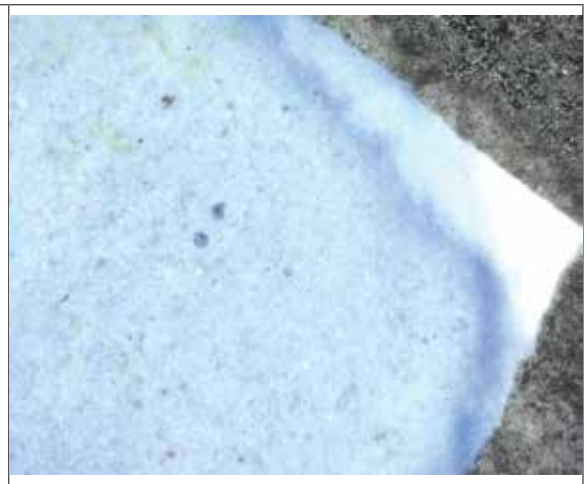
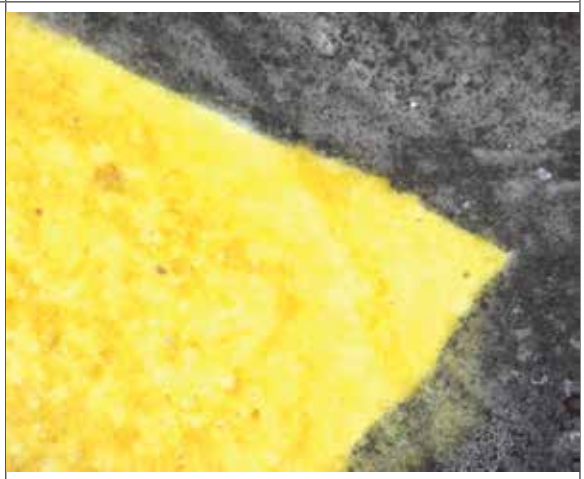
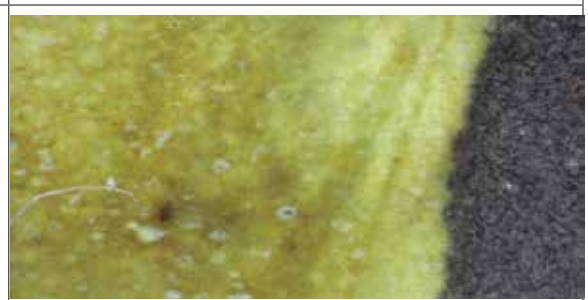
27. Twelve different organic paints and dyes were applied to the three samples with differing concentrations of gypsum and chalk. The resultant colours on the surface were compared visually. Subsequently the samples were compared microscopically, both in cross-section and at the surface. A final test was to determine the behavior of cochineal red on these surfaces. As will be discussed in chapter 3, on some of the codices this material is highly penetrative and stains the leather. A drop of distilled water was applied to a cross-section of each sample with a layer of cochineal red at the surface. Unless the cochineal is perfectly washed, the strong dye can be seen to bleed into the sample. There was no observable difference between the three tested concentrations, however.

28. Supplied by Verfmolen de Kat.

29. The folding of the leather, combined with the shrinkage of the leather due to the applied glue, caused some variation in the length of each page.

Number	Colourant	Ingredients and process	Microscopic image
1	Cochineal	Pure Carmine (bought) + binder	
2	Cochineal	Ground cochineal + demineralised water + Calcium Carbonate + Alum+binder	
3	Cochineal (dye)	Ground cochineal + demineralised water	

4	Zacatlaxcalli	Dried vines + water + potash + Alum+binder	
5	Zacatlaxcalli (dye)	Dried vines + water	
6	Commelina coelestis	Flowers + water + binder	

7	Delphinium spp. (dye)	Flowers + water	
8	Buckthorn (Rhamnus spp.)v	Ground berries + potash + alum +binder	
9	Mix of 6 and 8	2 mixtures, top mixed in separate container, bottom: layer of yellow covered with a layer of blue	 

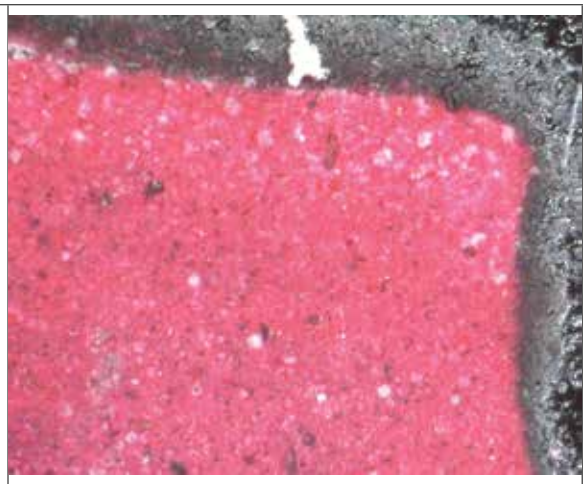
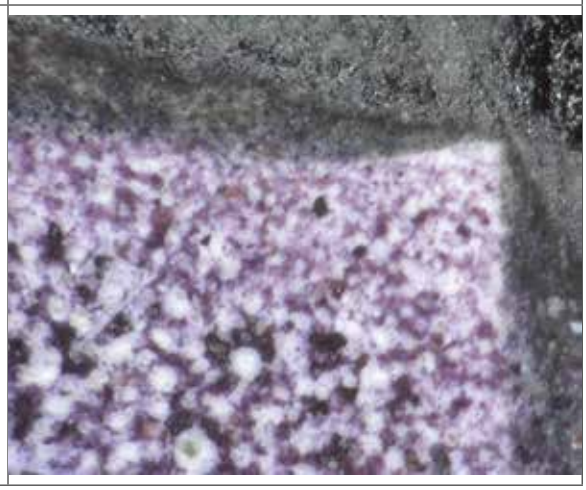
10	Cochineal	Mixture of 1 and 2	
11	Achiotte (Bixa orellana)	Boiled seed + water + potash + alum + binder	
12	Tyrian purple	Pigment + binder	

Table 4. The tested pigments and colourants with microscopic photographs.

though a very strong dye, cannot be used to make a good paint. Using cochineal as a direct dye (Table 4 no. 3) is likewise not advisable as it discolours rapidly. The comparison of numbers 6 and 7 shows the advantage of Commelina coelestis over other blue flowers such as the Delphinium spp., which can theoretically be used to make a blue paint (see Table 4 no. 7). These anthocyanins, as noted in chapter 1, fade very quickly. Commelina coelestis, however, is stable due to the metalloanthocyanins it contains. This table also shows the effect of the addition of certain additives that make a lake out of a dye (compare no. 4 and 5). Close observation of the original codices shows that greens are often made by mixing yellow and blue. This can be done in two ways, as can be seen in Table 4 no. 9.

The recipes for these paints were determined by two factors: stability and colour. All the materials used were organic. Except for Commelina and Tyrian Purple, they were all soluble colourants which need to be stabilised by allowing the colourant to bind to a metal. This ”complexation” is traditionally done with aluminium salts such as Alum. Kirby et al. (2014, pp. 28-30) give the most common recipe for making a pigment from a dye. First the dye is extracted by heating the material in an alkali solution, often a mixture of potash and water. The coloured solution then needs to be filtered to remove any insoluble traces of the colouring material. If Alum is then added to the mixture, it will react with the alkali and together with the colourant precipitate. The now insoluble particles can be filtered from the solution and can be used as a pigment.

A very important aspect here is the properties of the water used to make the pigment. The presence of metals in the water can have a big impact on the chemical process and alter the colour of some pigments severely. This is most strongly seen in the production of cochineal. Thus, for the experimental replication, demineralised water was used. In precolonial times, the paint makers would have had to select water from the best source. Many springs produce water that contains all sorts of minerals and metals, making rain water probably one of the best sources for water for this particular application.

Washing of the pigment has an effect on the colour, but also on the properties of the paint. A comparison of the damaged areas of the Codex Añute and the Codex Ñuu Tnoo-Ndisi Nuu shows this most clearly. In case of the codex Añute, the red colour has leached through the gesso down to the leather, while on the Ñuu Tnoo-Ndisi Nuu the red paint flakes off leaving no trace (see also chapter 3). For the experimental replication, a mixture was made of a store-bought, perfectly washed, carmine red and a red pigment made in the lab from cochineal insects (see Table 4 no. 10) This mixture best approximated the colours seen in the codices and had some of the bleeding effects seen in codex Añute.

The yellow pigment used in these reconstructions was a substitute for Zacatlaxcalli. A sample of this plant was obtained directly from Mexico and was analysed using HPLC (Hofenk de Graaff, 2004) by A. Ness Proaño Gaibor. This technique allows for the identification of organic colourants on the molecular level. Since Zacatlaxcalli is a parasite for trees that do not grow in the Netherlands, a substitute, buckthorn, was found that contained the same colouring molecules: quercetin. The colour that these paints give to a surface is heavily dependent upon the thickness of the applied layer. One very thin layer results in a lemon yellow colour, while a thicker layer or more layers result in a darker brown colour.

The source of the blue paint was the flowers of the Commelina coelestis, which with proper care can grow in the Netherlands. This dayflower produces dozens of flowers each day, which have to be plucked before the flower wilts. By plucking only the flower petals the purest colour can be obtained as the pistils of the flower give off a bright yellow colourant. These flower petals need to be dried quickly or the colour will deteriorate. However, after drying the flowers can be stored for, as experiments have shown, at least a year without losing their colour. This means that although the flower is seasonal, this paint can be used all year round. The Maya Blue used in these experiments was also store-bought.[30] The process of making Maya Blue is relatively well understood (see Chiari, Giustetto, Druzik, Doehne,

30. Supplied by Kremer Pigmente.

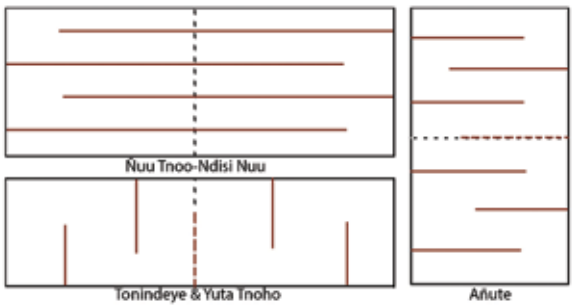


Figure 2.2: Schematic representation of basic types of reading lines as found in the Mixtec historical codices, Codex Iya Nacuaa mixes elements of all three these types.

& Ricchiardi, 2008; Domenech et al., 2011; Polette-Niewold, Manciu, Torres, Alvarado, & Chianelli, 2007) and the raw materials are difficult to come by. The process of making Maya blue is, therefore, not further discussed in this work.

Each of these insoluble lakes and pigments needs to be bound to the writing surface using a binder. For these replications, a mixture was made of gum Arabic with an orchid glue substitute. A bulb of the epiphytic orchid Lycaste lasioglossa was cut, dried, and ground. The resultant powder made for a very good glue. The orchid glue was analysed using HPLC by A. Ness Proaño Gaibor and was shown to be about 80% starch. As these orchids are not easily accessible in the Netherlands, a substitute starch binder had to be found. Multiple tests were done by Ness after which potato starch was selected as the best option. Also Gum Arabic was used as a substitute for mesquite as it is readily available, also comes from a species of acacia, and has similar properties.

2.3 THE PROCESS OF WRITING

Much more than alphabetic texts, both the Maya and the Central Mexican codices are works of composition. Like paintings, they require a process of advanced planning to make sure that proportions are correct and that the available space is used in the best way possible. It is clear that many of the known codices are copies of earlier versions. At the same time, each scribe has his own style of writing. The sizes of the surviving codices show that the size of the support was in no way standardised. This means that the page on which the script is copied is most likely different in size and proportion from the page containing the copied text. In the remaining codices, a number of strategies can be observed to deal with such problems. The first aid for setting up the composition is the division of the page into sections using the writing lines. Figure 2.2 gives a schematic overview of the types of divisions as they are found in the Mixtec historical codices. These texts required a continuous reading order as they are true narratives, with events preceding and being causative for other events. Of the five Mixtec documents that have survived, four use the support horizontally. While the sample is too small to function as statistically significant evidence it is suggestive that of the total corpus, including the Maya books, only the codex Añute and a small part of the Codex Yoalli Ehecatl use the support in a vertical fashion. The Codex Iya Nacuaa is difficult to categorize in the basic schemes as it incorporates elements of all three systems almost eclectically throughout the document. The support is used horizontally like in most codices, and divided into three horizontal bands. These run either over two pages or only over one page like in the Codex Añute. On page 8 of the Becker I section of the codex Iya Nacuaa vertical lines, such as used in the codex Tonindeye and Yuta Tnoho, are incorporated to subdivide one of the three horizontal bands.

The large variation in the codex Iya Nacuaa suggests that the thick red lines were drawn after the composition was completed. Whether or not the lines were first set up using thin red lines, as can be seen on Codex Añute, is difficult to establish given the extent of the damage on the codex itself. For the codex Ñuu Tnoo-Ndisi Nuu, however, it is clear that the scribe first divided the whole document using thick red reading lines. What is more, it seems that during writing he or she discovered that in some places more space was needed to draw all the figures. The reading lines are in these places removed and new lines are drawn (see figure 2.3).

The Central Mexican religious manuscripts do not contain single narratives, but are often combinations of table-like structures. For these tables the pages are again divided into sections using red lines. At times, these also need to be adjusted. For example, in the

Figure 2.3: Codex Ñuu Tnoo-Ndisi Nuu page 9 and 10 showing alteration of the reading line (after Jansen & Pérez Jiménez, 2005, pp. 62-63).

Codex Yoalli-Ehecatl, pages 9-13 were originally divided into 8 sections per page. The horizontal lines dividing the four quadrants were, however, removed when it was noticed that some figures took up a whole quadrant.

Once the page is divided up, the process of planning the individual figures can commence. Close observation of the codices shows the use of underdrawings on some of them. Grey or very thin black lines can be seen on the codices Tonalpouhqui (p. 18), Iya Nacuaa (p. 51), Tlamanalli (only on one side, pp. 21-31), and Yoalli Ehecatl (c.f. p. 25). What tool was used to make these very thin lines is unclear. The lines are so thin that they are most reminiscent of a pencil. Perhaps some soft mineral with a grey streak was used to make these lines, though this would require that it naturally had, or could be sharpened to, a thin point. Codex Añute and one side of the codex Tlamanalli exhibit thin red lines used to further divide the page and set up the larger figures. The underdrawings are mostly visible if a change in composition is made and if the underdrawing is not erased. That lines can and have been removed to perform corrections is clearly visible in the codex Ñuu Tnoo-Ndisi Nuu on page 31 line II. The gesso is here removed in the place where at first a leg was drawn. Also on the codex Añute page 2 there are traces of the removal of gesso to correct a mistake (below the head of Lord 2 Grass being born from the tree). On the Codex Yoalli Ehecatl gesso is used to correct mistakes. This new layer of gesso that is locally applied has over the last five centuries remained whiter than the surrounding writing surface, making these sections easy to spot today. This may indicate that this precolonial "tipp-ex" had a different composition than the original writing surface.

The three Maya books are content-wise similar to the central Mexican religious manuscripts. They also contain much calendrical information. It is, therefore, not surprising that their pages are often divided into sections using thick brown-red lines. These sections are in all three Maya codices subdivided, often into columns or into a grid, using a very transparent and light brown-red line (see figure 2.4).

For the reconstructions, two different strategies were followed. For the first reconstruction, that of select pages of the codex Tonalpouhqui, it was decided to start with the division of the pages using cochineal red paint. These lines were drawn with a thin brush.[31]

31. The brushes were store-bought synthetic hair brushes,

Figure 2.4: Codex Dresden: page 41 mid-section, showing the transparent and light brown-red lines used to divide the page into columns (image from digital.slub-dresden.de, accessed 29-02-2016).

After this graphite tracing paper was used to copy the outlines of the images onto the gesso. Although this was not the technique originally used to make the codex, it did provide a correct intermediate point in the process, by providing the underdrawings which can be seen in the original document. As the codex Tonalpouhqui is highly detailed, it would take years of practice to make these underdrawings by hand. The thin grey lines were subsequently traced with carbon black ink using a fine paintbrush. After the black outlines were completed, these were coloured in using Cochineal, Maya Blue, Matlallin, and the Zacatlaxcalli replacement pigments. The decision to use both Maya Blue and Matlallin was motivated by the fact that two different types of green are to be found in the original codex.

The second set of reconstructions was made in the Museum Volkenkunde. Two pages of the Codex Ñuu Tnoho-Ndisi Nuu were reconstructed by A. Ness Proaño Gaibor using a procedure similar to that used for the first reconstruction. Here, however, only the rough outlines of the figures were traced. Once completed the figures were coloured in using Cochineal, Matlallin, Zacatlaxcalli replacement and Achiotte. The last of these pigments was added to give a better matching skin colour.

size 1 for the black lines, size 1 and 2 for colouring in the figures.

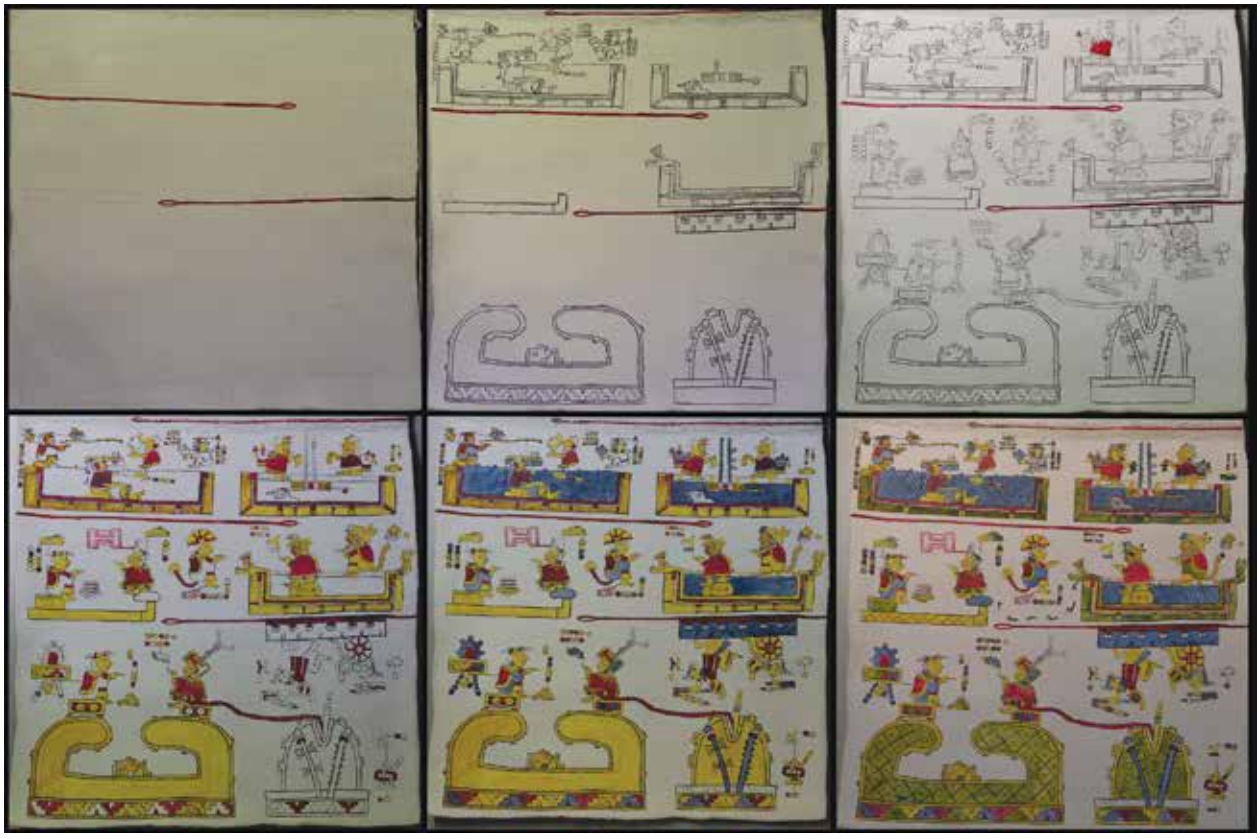


Figure 2.5: Stages in the reconstruction process (images by the author).

Two pages of the Codex Añute were copied by the author using a different system (see figure 2.5). According to this system, the pages were first divided using the thick red reading lines. After this the pages were divided using a watered-down cochineal paint. The thin pink lines gave the dimensions of the figures that were to be put in these places. This strategy is especially helpful when copying segments of the composition in other locations or at a different size from the original scene. The Mixtec historical codices are largely composed of persons and places. As the place-glyphs are often relatively large in the codex Añute, designating space for these glyphs already largely structures the composition.

During the replication process, the first things drawn were these place glyphs. It quickly became clear, however, that in some cases the persons seem to have been drawn before the place glyph was completed. This is especially the case for people sitting in rather than on glyphs such as happens with rivers. After the persons and the places have been made, the calendar signs and personal names, if these are not already incorporated in the dress of the persons, can be used to fill in the empty spaces. As the reconstruction is of a slightly different dimension than the original first two pages of the codex Añute, there are small variations in the orientation of some of the calendar glyphs to better fit them in the available space. After all the outlines are drawn and dry, the figures can be coloured in. Since the paints used are water colours, care should be taken that two wet paints do not come into contact and mix. In the reconstruction, cochineal red was used first, followed by yellow and blue. As can be seen in figure 2.5, the colour green was created by applying a layer of blue over yellow. After all figures are coloured in, details in black can be added. It was important to do this after the colours, as these watercolours will dissolve and blur the fine

Figure 2.6: Comparison of a facsimile of the Codex Añute (from Jansen & Pérez Jiménez, 2007b) and the reconstruction made by the author.

black lines. At this time any black outlines that have been covered with paint can be traced in black again. The end result is very different from the present-day visual appearance of the codex (see figure 2.6). Restoring the original vibrancy of these books therefore helps appreciate the original visual impact.

Not all codices are equally precise in their execution, though a few are true masterpieces. What has been baffling is that some of these contain figures on different pages that are exactly alike (see figure 2.7). It requires a true master painter to execute the same exact figure multiple times. The Aztecs also had a form of tracing paper, however, which may have expedited the process. A description of this is found in the Nahuatl text of chapter 21 of book 9 of the Florentine codex that deals with featherworkers. This section does not have a Spanish translation in the book and the translation of the Nahuatl here followed, was made by Dibble and Anderson (1959). This tracing paper was made by laying out a very thin layer of cotton on a very flat surface like a maguey leaf. The thin layer of cotton was glued together to form a thin transparent sheet. This could be pulled of the maguey leaf, and the design could be traced on this thin paper. After this it was done, it was glued on a thicker piece of paper to reinforce it, and then the design could be cut out. This stencil could then be used to transfer the design to some other medium. Since the codices are made with closed

figures, stencils cannot be made of whole figures, as this would mean that the centre of the figure, which is completely enclosed by the outline, falls out. This might explain why in, for example, the codex Mictlan, only parts of the heads perfectly match up with other figures (see figure 2.7). The use of a stencil should be possible to detect microscopically. When a stencil is used, paint is applied to all empty parts of the stencil. Thus the striations in the paint, caused by the brush applying it, would all be going in the same direction rather than following the direction of the line itself. This hypothesis requires further investigation of the original object.

Figure 2.7: Comparison of two figures in the codex Mictlan (pages 34 and 38) showing the similarity between the faces of the two figures (after Anders, Jansen, & Cruz Ortiz, 1994).

2.4 COVERS

As described in the previous chapter, there are only three original covers which have been securely identified. The one of the codex Tonalpouhqui which was made from wood with turquoise inlays; one from the Codex Mictlan which was made from jaguar fur; and one from the Codex Tonindeye which originally had feathers. No experimental replication of these types of covers has been undertaken as these materials are very rare and the techniques needed for them so sophisticated that this would require a separate research. In the case of feather work, extensive experimentation has already been performed (Berdan et al., 2009). The general production process that must have been part of the creation of these objects, can be reconstructed here based on artefacts made from similar materials. For each of the types of cover postulated in the previous chapter, the acquisition of raw materials and their subsequent processing can thus be discussed. Besides these three types of material, a fourth likely cover type, gold, is also discussed. Although none of the codices contain gold, this material was extensively used in both feather works (Haag, Maria y Campos, Rivero Weber, & Feest, 2012, p. 50) and mosaic artefacts (McEwan et al., 2006, p. 31). Considering the European appetite for this precious metal, it is a likely material for the covers that have since been completely removed.

The production of the wooden cover of codex Tonalpouhqui can best be understood in comparison with more complex and more complete mosaic-decorated pieces. Recent investigation of the turquoise mosaics in the British Museum (McEwan et al., 2006) has given clear insight into the technology behind these artefacts, which is equally applicable to the codex cover. Although the cover of the Tonalpouhqui is relatively simple, wooden boards found in Cueva Cheve (González Licón & Morfín, 1994, pp. 230-235) (see figure 2.8), as well as mosaic decorated shields (see McEwan et al., 2006, pp. 59-66) give an indication of how a complex cover may have looked and what its composition may have been. One of these boards depicts a complex battle scene, completely in the style of a codex (figure 2.8 top). The other board portrays what may have been a shield and arrows. It may be that these mosaic-covered boards were in fact once the covers of a codex. They were recovered stacked, with two fragments facing up and two facing down, as described by Steele and Snavely (1997). However, it is unclear from this publication how they were arranged exactly, and if there were traces of gesso between them, which could be expected if a codex was once kept between these boards. Even if there was, it may have escaped notice as the abundance of white minerals in a limestone cave is to be expected.

Not much research has been done on these tablets. The few remaining shields covered in mosaic show similar styles and codex scenes, and have received more scholarly attention. The materials identified thus far on these mosaics (see McEwan et al., 2006, pp. 24-41) are five types of mineral tesserae (Turquoise, Malachite, Pyrite, Gold and Lignite); three types of shell tesserae (Strombus spp., Spondylus princeps and Pinctada mazatlantica); three types of adhesives (Pine resin, Copal and beeswax); and two

main types of wood substrates (Cedar and Pine). These materials come from very different areas. A Mesoamerican source of turquoise has not yet been identified, although the presence of large quantities of the material on artefacts from the Mixtec area is difficult to explain without a local source. Melgar (2014) argued that the mosaic objects from the Mixtec area and those recovered at the Templo Mayor in Tenochtitlan show differences in material composition. Where the Mixtec objects are composed of a mixture of turquoise and other materials, such as shells, the Templo Mayor objects are made almost exclusively out of turquoise (Melgar Tisoc, 2014, p. 286; Ruvalcaba-Sil et al., 2013). At the same time though, the Mixtec turquoise itself is chemically similar, while the Templo Mayor objects are made with blue and green stones with differing composition, some of which have to be classified as minerals other than turquoise (Melgar Tisoc, 2014, p. 194).

All the sources of turquoise that have been securely identified are located in the southwest of what is today the United States of America (McEwan et al., 2006, pp. 27-30). Turquoise manufacturing techniques on Templo Mayor objects investigated by Melgar Tisoc and Solis Ciriaco (2009) show two distinct patterns. The difference is the way in which the individual tesseracts are abraded. One type is made with sandstone, while the other is made with basalt. This may reflect differences in location of the manufacture of the tesseracts (Melgar Tisoc & Solis Ciriaco, 2009, p. 123). The sandstone type would be made in the South-west of North America, while the basalt type reflects a technology seen on other, locally produced, Central Mexican objects.

The other minerals found in mosaics are all volcanic and can be found in the central Mexican highlands. Both types of wood are also found in the same areas. The shells, however, require access to coastal waters. In order to create the individual tesserae the minerals and shells need to be cut and ground to size. In the mosaics investigated by McEwan et al. (2006), some pieces of mosaic have decorations that were not part of the mosaic design, indicating that these pieces were not originally designed for this purpose. It may well be that these pieces were moved pre-processed from mines and workshops in the north. The mosaic tesserae are attached to the wooden surface using a strong resin. In the artefacts of the British Museum, this resin has been shown to be pine resin or copal (McEwan et al., 2006, pp. 35-37). Resin could also be moulded to form relief on the surface. In the case of the cover of the codex Tonalpouhqui, traces of resin are found in the holes in the centre of the cover. The diverse materials found in some of these mosaic objects were all part of the tribute system of the Aztec empire. In the Codex Mendoza, shells are shown coming in from two areas. The coastal areas in Veracruz supplied conch shells (Berdan & Anawalt, 1997, p. 123), while on the Pacific side (Codex Mendoza, 1541 folio 38r) the province of Çihuatlan provided Spondylus shells (Berdan & Anawalt, 1997, p. 84). Turquoise was brought in from Veracruz (Codex Mendoza, 1541 folio 52r.), most likely following an eastern route from mines in Cerrillos (today in the south of the United States) down along the coast of the bay of Mexico (see Melgar Tisoc, 2014, p. 130). It was also paid in tribute from the western provinces of Quiauhteopan and Yoaltepec (Codex Mendoza, 1541 folio 41r), where it also must have been obtained through trade from the north.

Making a mosaic required true mastery. Evidence of advanced techniques including those of woodworking, lapidary, glue making and shell working can be seen in the exquisite artefacts that still remain today (see McEwan et al., 2006, pp. 38-41). If the codices had indeed once such elaborate mosaic covers, then these would have been made by specialists. As symbolic significant and integral protective parts, they must nonetheless be considered part of the production process.

The fur cover of the codex Mictlan has been shown to be jaguar (see chapter 1). Creating this cover would have consisted of three steps: obtaining raw material; preparation of the fur; and creation of the fur cover. Obtaining such a dangerous animal was never a simple task. The range of the jaguar is smaller than that of the deer used for normal leather, as jaguars prefer forested areas in the highlands. As the jaguar is today still seen as a very dangerous animal, especially threatening to livestock, its range has been significantly reduced since precolonial times. Historically, the jaguar was prevalent throughout

Mesoamerica, preferring areas away from daily human activity; i.e. mountaintops and dense forests. The jaguar makes a home in caves, further adding to the symbolic importance of the animal (Miller, 2011).

In the description of the jaguar by Sahagún (1577c fo. 3r.), it is clear how dangerous this animal could be. Next to the practical constraints that it would be unwise to try and pierce the valuable skin of the animal with countless arrows, this description shows that the speed and strength of the jaguar would make the hunt very dangerous for the hunter. Although it is not very clear from the translation by Dibble and Anderson (Sahagún, Dibble, & Anderson, 1963, p. 3), the original Nahuatl text gives a very concise description of the way to hunt a jaguar:

"Auh in mozcalia tlamjnquj, in ce qujtlaxilia, acatl, intla oqujmacuj:njman concuj, in quaoacazoatl, in quauhxioatlapalli: yiacac qujtllia, yiacac qujço, in acatl: njmã qujtlaxilia, papatlacatiuh: in acazoatl. Iuhqujn chapolin: ic iauh, aço tlatlaco, aço ie itlan: in patlanj, in vetzi, in quaoacazoatl, ic qujxpatilia : ic vel qujmjna, in tlamjnquj: ic vel câci"
(Sahagún et al., 1963, p. 3)

"Y se el cazador bien entendido, el coloca con la mano, Después toma el quaoacazoatl,[32] la madera de colores para cubrir, en la esquina la coloca. En la esquina la hizo la caña: después coloca hojas de papatla[33] en la trampa. Y así salta: bien sólo por dentro se daña cuando cae del vuelo, la trampa de madera, en frente: bien se esconde el cazador, bien llega.[34]"

"And the hunter who understands it well, he traps it (the jaguar). He takes a hollow and flexible wood and coloured wood to hide (the trap) and he puts it (sets it up) in a corner. In the corner he puts up the rod and he covers the trap with large leaves. And when the wooden trap springs, (the jaguar) will fly through the air and hit the ground, damaging his insides. If the hunter is patient, it will go well"
[free translation by the author].

Figure 2.8: Two wooden boards covered in fine turquoise mosaic discovered in a cave in the Cañada de Cuicatlán (after González Licón & Morfín, 1994).

The trap described is similar to the one depicted in the Madrid codex for catching deer (see figure 2.1), although it provides even more details, such as the need for covering it up with leaves. It is unclear if the wood that needed to be brought was used to cover the trap itself or perhaps was merely used as a shelter for the hunter. The passage on damaging the insides of the jaguar can be understood when considering the objective of the hunt: the collection of the precious skin of the jaguar. By using this method the jaguar can be caught and killed without posing any danger to the hunter and without any damage to the fur. In contrast to the trapping of a deer described above, a jaguar will not go into shock that easily when caught and will still put up a fight. The alternative would be to wait once the cat is caught, in order for the animal to weaken and eventually die. This option may, however, have a detrimental effect on the fur. As such, it is better to have a trap that can safely kill the animal.

32. This word is a contraction of the words for wood, hollow, and elongated, combining to describe properties of the wood itself; i.e. it can be understood as a hollow and flexible wood.
33. Hojas de papatla refers to a type of large leaf, similar to banana leaves.
34. Translation into Spanish by Raul Macuil Martinez.

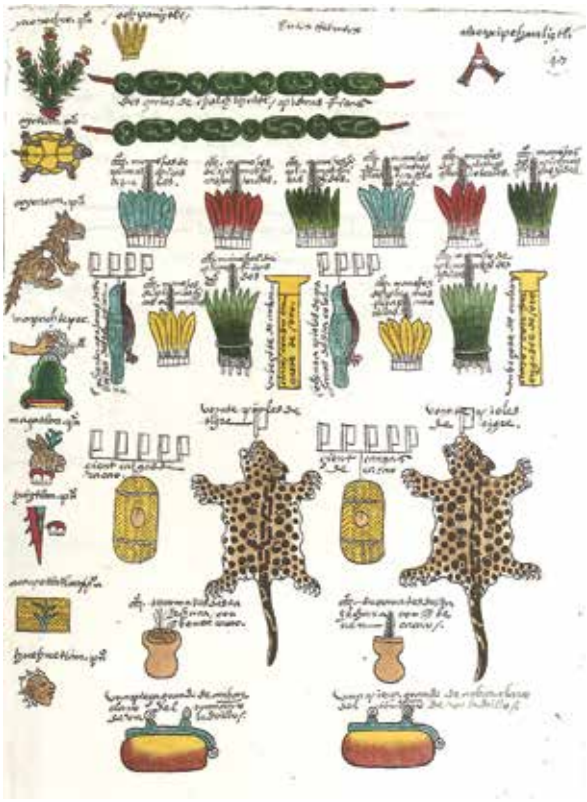


Figure 2.9: Codex Mendoza folio 47 r. (from Clark, 1938 folio 47r.).

Once a skin is acquired it needs to go through a similar process as is needed to make leather. The big difference is that now the hairs need to be preserved in an aesthetically pleasing manner. As was stated in chapter 1, one of the dangers to preserving fur is that when it dries out, the hair follicles will open up and the hair will fall out. Furthermore, furs are first and foremost valued for their aesthetic appeal. Thus, while it would not matter so much what the colour of the leather of a codex is – as there would eventually be a gesso layer that would cover it – furs needed to keep the natural appearance of the animal. While for leather making often tannin from tree bark is used, fur makers resort to oils, alum, and salt (Kite, 2006b, p. 148). As with leather making, the profession of the fur maker was not one of great interest for Spanish chroniclers. Thus, exactly which materials were used is not known. To obtain this information, invasive methods may have to be used, which is not possible at the moment. Jaguar furs were also paid in tribute and probably traded throughout Mesoamerica. In the codex Mendoza, the outpost province of Xoconochco is recorded as paying part of the tribute in jaguar skins (see figure 2.9). Seeing as the transport of such skins would take quite some time, it seems likely that these were processed furs rather than skins.

Once fur was obtained, an appropriate part needed to be cut out. In the case of the Codex Mictlan, the fur cover is slightly larger than the pages of the codex. Therefore, it also slightly protects the sides of the cover page. This also has the advantage of preventing foreign material sticking between the cover and the codex page, thus breaking the bond between the two. In depictions on Classic Maya vases, codices are often depicted with thick jaguar covers. It may be that this is simply the result of painting convention. In order to show that these books had jaguar covers, then, one would need to depict the document from a somewhat oblique direction. The alternative explanation is that indeed these books had larger covers that overlapped the sided of the manuscript more completely, thus forming a complete wrapping of the book. The latter is suggested by the depiction of the codex on the famous so-called Princeton Vase. The third type of cover is encountered on the codex Tonindeye. This codex contains imprints of feathers in a resin or glue-like material (Anders & Troike, 1987, pp. 39-40). There is also a square imprint of what may have been a piece of stone that was inlayed. Although there are only a few traces left on this codex, the use of feathers to make highly complex feather mosaics is well known. Like stone mosaics, feather mosaics can also be found on shields. Though not many originals remain, the few original feather mosaics and headdresses that still exist have been studied (Filloy Nadal, Solís Olguín, & Navarijo, 2007). The bright feathers found in many of these come from birds found in the tropical lowland regions, either on the coasts or the lowland Maya regions (Haag et al., 2012, pp. 83-94).

How the featherworkers made these works of art is extensively described in the Florentine codex. Though it is one of the most extensive descriptions of one procedure, the Spanish text does not give any translation. Instead, it states that people who want to know more should go and visit the featherworkers themselves. The Nahuatl text, as translated by

Figure 2.10: Overview and detail of an engraved and embossed golden disk currently held at the MNA (Mexico) (images by the author).

Dibble and Anderson (1959), shows some important insights into the creation of featherworks. First of all, two different types are described: one on a flat surface, such as the codex cover; and another three-dimensional type, made on a wooden frame. For the flat surface version, the previously described tracing paper was used to transfer a design that a scribe had made to the medium that the mosaic was made on. The first feathers to be applied to this were glue-hardened feathers. These were inferior feathers that formed the background for the design. A whole process of colour-matching is described for these feathers (Sahagún et al., 1959, pp. 94-95). It may be that the creators of feather mosaics were also one of the prime consumers of tzacutli orchid glue (see chapter 1), as this glue is colourless and thus does not mar the iridescence of the feathers. The depictions in the Florentine codex suggest that a bulbous plant such as this orchid was used as glue. Though there are many bright colours of feathers available, especially from the tropical lowlands, a process of dyeing feathers is also known. Some of these feathers seem to have been dyed using Zacatlaxcalli, and the addition of alum and saltpetre, both mordents, is mentioned for this process (Sahagún et al., 1959, p. 95).

Feathers were a common form of tribute in the Aztec empire, as seen in the Codex Mendoza and the Matricula de Tributos. The provinces of Coayxtlahuacan and Tlachquiavco, both in the Mixteca Alta, are reported to have paid tribute to the Aztec empire in the form of rare green stones, gold, and dyes, as well as quetzal feathers (Berdan & Anawalt, 1997, pp. 102-105, 110-111; Codex Mendoza, 1541 folio 43r. and 45r.). Quetzals do not live in these highlands, thus these feathers must have been imported from tropical areas, either at the coast or further east in the Maya area. Feathers were also paid in large numbers by the tropical coastal provinces of Tochtepec (Veracruz) and Xoconochco, the outpost in the far south-east of the empire. As can be seen in figure 2.9, there were feathers of different colours and sizes. The design that was outlined on the surface was made by carefully placing feathers of the right length and colour and gluing them on the surface. To do this a special elongated tool, made of bone or wood, was used. This tool is also depicted in the Florentine Codex (Sahagún, 1577a fo. 65v.-66r.).

Though at least fifteen codices have survived, only three contain traces of their original cover. The exposed codices most likely had their covers intentionally removed, in some cases probably taking with it part of the book. This allows for some speculation about the nature of these removed covers. They must have been either attractive to the Europeans or so appalling that they were removed and thrown away. The latter could be the case if they

Tool	Use	Raw Material	Evidence
Making the support			
Bow and arrow/ atlatl	Hunting for skins	Wood, flint, string	Archaeological, Iconographic, Historical
Traps	Hunting for skins	Wood, rope, leaves	Iconographic, Historical
Axe, adze, or knife	Cutting tree bark	Obsidian or flint and wooden handle	Inferred
Scrapers	Scraping hides	Obsidian, flint, or bone	Experimental
Container	Tanning hides	Ceramic, excavated pit?	Inferred
Rack	Stretching hides	Flexible wood and string	Experimental
Blades	Cutting of skin and amate	Obsidian or flint	Inferred
Fuel	Chalk/gypsum dehydration	Wood (Pine?)	Inferred
Container	Storage of gesso	Ceramic	Inferred
Paper beater	Felting together of amate fibres	Stone	Archaeological, Ethnographic
Coarse brush	Application of gesso	Hair, rope/adhesive, and handle	Inferred
Polishing stones	Polishing the gesso surface	Smooth hard stone	Archaeological, Inferred
Paint making			
Grinding stone	Grinding the colourant source	Coarse stone	Historical
Container	Boiling of pigment source	Ceramic	Inferred
Firewood	Fuel for fire	Pine?	Inferred
Sieve/filter	Filtering the colourant from	Cotton?	Inferred
Painting			
Containers	Paint storage/palette	Shell, ceramic	Archaeological, Iconographic, Historical
Fine Brush	Application of paint	Fine hair, adhesive/string, wooden handle	Iconographic, Inferred
Blade	eraser	Obsidian or flint	Inferred
Cotton “paper”	Tracing and transferring paper	Cotton and glue	Inferred
Pen	Writing fine lines	Bone, wood	Inferred

Making a stone mosaic cover			
Blade	Carving wood	Obsidian, flint	Inferred
Abrasive	Polishing stones/ tesseracts	Emery?	Historical
Lubricant/coolant	Polishing stones/ tesseracts	Water	Inferred
Brush	Application of adhesive	Fine hair, adhesive/string, wooden handle	Inferred
Cotton “paper”	Tracing and transferring paper	Cotton and glue	Inferred
Tweezers/other positioning tool	Placement of tesserae in glue	Wood?	Inferred
Container	Storage of adhesive	Ceramic	Inferred
Making a feather mosaic cover			
Blade	Cutting feathers	Obsidian, flint	Inferred
Container	Dyeing feathers	Ceramic	Historical, Inferred
Fuel	Dyeing feathers	Wood	Inferred
Dye	Dyeing feathers	Zacatlaxcalli/water	Historical
Container	Storage of adhesive	Ceramic, shell?	Inferred
Tweezers/other positioning tool	Placement of feathers in glue	Wood?	Historical
Cotton “paper”	Tracing and transferring paper	Cotton and glue	Historical
Making a fur cover			
Preservative	Fur making	Salt, Alum	Inferred
Rack	Stretching the fur	Flexible wood, rope	Inferred
Blade	Cutting fur to size	Obsidian, flint	Inferred
Container	Storage of adhesive	Ceramic	Inferred

Table 5. Tools used in each of the production processes.

were made of fur which was severely degrading and putrefying, or if they were worked with imagery that needed to be destroyed; i.e. images of the "devil" (see chapter 5). This last option is rather strange though, as the rest of the documents certainly contained images that could be considered "evil" as well. A more likely alternative is that these covers were decorated with materials that the Europeans coveted. It is well known that many objects that were either decorated with, or made out of, precious metals were destroyed. From the viewpoint of the Europeans this was simple recycling, the metal being molten down to fuel European economies. A few delicate examples of gold work on a flat surface have survived, giving some insight into how these covers may have looked. The golden disks held at the National Museums of Anthropology in Mexico City are good examples (see figure 2.10). They are very thin and thus must have originally been attached to a strong surface such as a wooden base in order to survive. They are finely engraved or embossed and show elaborate figurative scenes.

Gold work was, for obvious reasons, a category of interest for the Spanish conquerors. Thus, like feather working, the processing of gold is described in the work of Sahagún (1959, pp. 73-78). Much of this description is, however, focused on the creation of complex three-dimensional objects, using the lost wax method. When making a cover the work would have to be more or less two-dimensional, requiring the work of a gold beater. In Sahagún et al. (1959, p. 76) it is further mentioned that it is the feather worker who makes the design. It is likely that he would do this using a stencil made after the work of a scribe, similarly to the way that the feather mosaic was made. Once copied, the design was then traced by the goldbeater using a flint knife. These descriptions of the feather worker and the goldbeater show the intimate relations between these crafts and the scribes.

2.5 TOOLS

A category of material culture that is not physically present in the codices, but nonetheless essential for their creation, is the toolset needed for each of the production steps. Not all these tools have been recovered archaeologically, though some are known from depictions or have left interpretable traces on the codices. For some rare cases, such as the production of amate paper, the production process can be observed. Based on the understanding of the processes gained from experimentation and the archaeological and historical data that was presented in this and the previous chapter, it is possible to infer what other tools would be needed in each step of the process. Table 5 gives an overview of all of these objects. For each tool the specific use is given, as well as the materials needed to make the tool in question. The final column shows on what evidence the identification is based. Direct archaeological evidence is scarce, as many of the steps in the production process leave little traces that are archaeologically preserved. Thus, although there are plenty ceramic pots which could have been used for the boiling of cochineal, there is no direct evidence – for example, through residue analysis – that shows that a vessel has been used for that purpose. Other tools are not preserved at all, such as sieves, pens, brushes, and stencils, which were themselves made of perishable materials.

What this table shows is the large dependency of the codex maker on other people. The series of different containers, for example, integrate the making of codices with the production of ceramics, but also shell fishing. While paint may be stored in a shell, glue which needs to be heated before use cannot. In order to heat it, fuel is needed, linking the profession of the scribe with that of the woodcutter. The cutting of wood, but also the hunt, the cutting of paper, fur, leather, and the grinding of pigments and polishing of gesso and mosaic tesseracts link it with another industry: the mining and processing of stone objects. Such cross-craft interaction (Rebay-Salisbury et al., 2014, p. 2) has not been a major focus of study for the Mesoamerican world, though this deserves more attention. All these links show the integration not only of multiple crafts, but also of the Mesoamerican world in the geographical sense. In part, this can be seen as the result of the expansion of empire. As empires grew, more materials become accessible that could be incorporated in the available corpus of material culture. However, in some cases the expansion of empire is caused by the desire to

have access to new or at least previously inaccessible tools. Durán gives a very explicit example of this:

"Los lapidarios de la ciudad de México y de Santiago (Tlatelolco), y de todas las demás provincias tuvieron noticia cómo en la provincia de Tototepec y Quetzaltepec había una arena apropiada para labrar las piedras, y que también se hallaba allí el esmeril para bruñirlas y ponerlas muy limpias y resplandecientes. Lo cual dieron noticia al rey Moctecuhzoma y significaron la dificultad con que los de aquella provincia lo daban y el mucho precio con que se compraba."
(Durán, 1967, p. 425)

The chapter continues with a description of the war with the Mixe people that ensued and that was ultimately, though not without difficulty, won by the Aztecs. Although this material plays only a small part in the production of codices, it is clear that the need of a tool can have far-reaching consequences.

DISCUSSION AND CONCLUSIONS

This chapter started out with a list of materials identified as ingredients for precolonial codices by scientific investigation, or suggested as likely ingredients by historical and ethnographic sources. Through experimentation an attempt has been made to expand this list to include materials that are not clearly identifiable on the codex' surface, but which are essential to obtain a comprehensive understanding of the codices and of codices making traditions. A lot was learned about the process of writing, which only came to light by trying to replicate the entire process. First of all the experimental replication has also shown the difficulty of the writing itself. At the same time, some small discoveries, such as the realisation that a sharp stone makes for a perfect eraser when writing on gesso, revealed aspects of the material that made life easier for the precolonial scribe. Furthermore, the replicas made illustrate the vibrancy of the materials when they are fresh. These bright primary colours give an indication of the colourful world that the Mesoamericans inhabited. The extraordinary material complexity of these books is in no way a natural given. The often exotic materials incorporated are a first indication of the special place these books held in Mesoamerican society. Although some limitations of the experimental method have already been mentioned in the introduction, a more thorough critical reflection is in order. The first point of discussion could begin from the following question: Were the experiments significantly authentic? There are a number of factors that were not taken into account in relation to the experiments, either because of limitations in availability of raw materials, practical limitations, or because inclusion of these factors would introduce an unacceptably high level of uncontrollability or uncertainty. For instance, the extraction and heating up of dyes was done on an electric stove rather than on a wood fire. Although the use of a wood fire would have increased the authenticity of the procedure, it would have been impractical and the temperature could not have been as easily controlled. A second significant deviation from the original procedure is that the pigments were made in glass containers to ensure that no trace chemicals would enter the paint. This was important to ensure that the paints can in the future be analysed using HPLC, to become part of a standard reference collection. However, this does mean that an interesting line of research is not yet explored: the interaction of Mesoamerican pottery with paint creation. It would be interesting to see if this type of paint production could be inferred from residue analysis in pottery vessels. This would be yet another step towards a better understanding of cross-craft interaction.

From a theoretical perspective, it is complex to situate the experiment. In the typology proposed by Mathieu (2002, pp. 2-6), elements of the experiment can be distinguished from three different typologies. First of all the objective was to make a visual replica, while using materials and techniques available in precolonial Mesoamerica. As such, the experiments were also a form of technological replication. In the process and especially the last stage where the drawings had to be made, the experiments also became phenomenological, as the intense two-week effort to create two pages of such a book left a deep impression of the skill of the original authors that would not have been attained without this experience. Throughout the experiment there remained a tension between a desire to create an

object that looked like a pristine codex, while at the same time trying to mimic the original creation process. The creation of the paints from natural materials is a delicate process. All credit for the creation of the colours used for the replicas has to be given to A. Ness Proaño Gaibor who with his extensive knowledge of colour chemistry and precise formulas was consistently able to create high quality paints. From a theoretical perspective, however, A. Ness Proaño Gaibor's preacquired skills and expertise simultaneously created a control and also undermined the authenticity and phenomenological experience of the replication itself. In ancient times, without the knowledge of chemistry and the use of scales and beakers, uncertainty was as much part of the process as the ingredients themselves. It is very likely that such uncertainty prompted the performance of certain rituals to help guide the process. To truly mimic the production process of the codices thus would not only require as Ingold (2013, pp. 28-29) suggests a return to alchemy, but also a complete immersion in precolonial ceremonial life. Obviously, then, the experimentation remains an incomplete approximation, which was nonetheless informative.

In trying to understand the production technology of these books, it also has to be taken into account how people acquired certain materials. Not all of the materials identified are readily available in the areas where these books were made. Some of these codices, such as the otherwise rather unassuming codex Tonalpouhqui, are by their incorporation of cochineal, Maya Blue, and turquoise, material manifestations of a network of interactions that must have bound together areas that are thousands of kilometres apart. As shown in chapter 1, the amount of data is too small to draw statistically significant conclusions about this, though it is rather striking that Maya Blue has not been identified in the Mixtec codices, nor does cochineal appear in the Maya books. This fits in the idea of the world that the Aztecs would like to portray, with their empire as the central hub for all goods. The incorporation of Maya Blue and Turquoise in this network raises the question of what went back out of the empire to the areas producing this material. Although the codex Mendoza shows that certain provinces under control of the Aztecs paid tribute in turquoise, they lacked the natural resources to produce it. Thus, the codices are evidence of the activity of trade. The material dependences shown throughout this chapter also imply dependences on human behaviour. It can be inferred, therefore, that the raw materials for the codices depended upon activities such as hunting (hides, furs, bones, feathers), mining (turquoise, gold, mineral pigments), farming (cochineal), fishing (shells), gathering (flowers, orchids), and woodcutting (firewood, hardwoods). Archaeological evidence for some of these activities does not exist and the practice of, for example, gathering or perhaps even a type of farming of Commelina flowers can only be reconstructed based on these rare artefacts. Some differences may be observed here again between the Maya books and the rest of the corpus, as the activity of hunting does not play a major role for the production of these books, except possibly for the creation of their covers. Many of these activities have different geological or ecological requirements. Thus, the role of the merchants comes to the fore. All of these raw materials also needed to be processed. Most of this processing must have been specialised work that was outside of the domain of the scribe. The making of a codex, then, may have involved a trip to the lapidary, the featherworker, the tanner, the fur maker, the glue maker, and the gypsum seller, assuming the scribe would be tasked with making his own tools and paints. It is unknown how all of these materials would come together. Did the scribe have to go to a market and buy his supplies? It is possible that some books were so important that craftsmen contributed to this work freely or as a form of tribute, but this is only speculation. Regardless, what this chapter has shown is that from whatever perspective one takes on codices and codices making, there must have been a vast amount of people and skills involved in making one of these books. What made these books so special, then, is not only their material composition, but what their contents made possible. Once a book was finished it would become an instrument for some very specific contexts of use. The next chapter explores the use of these books as a series of very important affordances.

3. The Lifecycle of the Mesoamerican Codices

The previous two chapters focused on the process of creating a codex. In selecting this focus, the entanglements of the process of creating a codex have been explored. It has been shown that making these books requires a lot of materials, knowledge, technology, and people. The connections of these books with other "things" (as defined by Hodder, 2012, pp. 7-9) do not end there, however. Their use, which is relatively well understood from their contents, forms a further web of relations. This third chapter focusses on the life of the codex as a useful object within its originally intended context. It is in their use and thus in the interaction between these objects and human beings, that these books acquire meaning (Gosden & Marshall, 1999). A number of seemingly separate uses can be distinguished. Based on their content it is clear that they often acted as guides for ritual, though in some very different contexts. A secondary use is didactic. Any text can in theory be used as an example to help new scribes acquire skills. And to entangle the function of these books further, it must be considered that every use would have taken place within a certain physical setting and in relation with other objects. Even when not in use these books needed to be kept somewhere. This storage needs to be rather careful as the material used to make them is susceptible to wear. Even the best care cannot avoid damage to these books entirely. In the last part of this chapter, the processes that may have caused – or at least had the potential to cause – damage to these books are discussed based upon what can be observed on the codices as they are today. Processes of deterioration that continue, even if the books are treated with the utmost care as they are in modern libraries and museums, must have had an even bigger impact during their time of regular use. Some codices exhibit strategies of repair or reuse intended to reinvigorate the books. But, still, eventually books will reach an end of their useful life. A discussion of the life cycle of these codices, then, would not be complete without an examination of the intended end of these books.

3.1 CONTEXT OF USING A RELIGIOUS CODEX

The practical use of large parts of the religious codices is relatively well understood. The contents as they have been reconstructed are indicative for the setting of use. Different types of texts may be incorporated in one document, however. For example, in the codex Yoalli-Ehecatl there are clearly different sections that may have been consulted on separate occasions. Their incorporation in one physical book, however, means that even if different types of texts were incorporated which were each meant for a separate occasions, the book as a whole was in use in both occasions. Thus, when dealing with the use of the object, it is not helpful or informative to subdivide these religious documents into separate sections. This observation applies equally to the three Maya books, which contain texts in a genre similar to the central Mexican religious books. The only types of books discussed in a separate subsection of this chapter are the Mixtec historical documents. As will be shown, these books are also in a sense religious, however, their use did take place in a different setting. Analysis of the Mixtec historical documents, therefore, allows for us to identify at least two types of usage of the codices: private and communal.

Private usage of a religious codex would take place when an individual or a restricted amount of people consulted with a ritual specialist in order to resolve or avoid a problem. In the codices there are numerous pages that illustrate what such problems could have been. The pages on marriage, childbirth, and health, for instance, found in the codices Mictlan, Yoalli-Ehecatl, Tezcatlipoca, and Tonalpouhqui are good examples of potential problems (Anders, Jansen, & Cruz Ortiz, 1994; Anders, Jansen, Pérez Jiménez, & Reyes García, 1994; Anders et al., 1993a, 1993b; Boone, 2013, pp. 134-141). What characterises the private use, therefore, is that it arises out of a specific need, and not because of a predetermined timing mechanism. So rather than being texts used to predict

the future, as some see fortune telling presumes to do today, the private use of the codices indicates that these by nature ambiguous texts were likely used as tools to come to the (re)solution of problems. The healing specialist, for example, may ask specific questions and by consultation of the calendar and the sacred text, find a solution for a person who is feeling unwell. It is likely that such consultation involved practices that continue today, such as the reading of maize (see Anders et al., 1993c, pp. 71-80; Rojas Martínez Gracida, 2012, pp. 143-166).

As with contemporary psychotherapy, the resolving of personal problems works best in a safe environment. In some cases, especially if a person is sick and cannot leave the house, the calendar specialist will have to make a house-call. Codex Tonalpouhqui, with its diminutive size and sturdy wooden covers, was renamed thusly by Jansen and Pérez Jiménez (2004) because of the great likelihood that this book was a true "working manual" that the specialist could take with him or her. Other documents are very unlikely to have travelled far. The clearest example of this is the codex Yoalli-Ehecatl. The size of this document in particular makes it simply impractical for frequent transportation. It is likely that this book remained in a permanent context, such as a temple. The most effective way of creating a private space is to physically block off prying eyes; i.e. construct a space where one can work in peace. Two archaeological sites discovered near each other may offer a glimpse into such an environment.

The murals found in Ocotelulco and Tizatlán exhibit iconographic features similar to those found in the codex Yoalli-Ehecatl. In Ocotelulco, an altar was uncovered which displays on the front an animated bowl on top of which a large flint is depicted from which a face of Tezcatlipoca emerges (see figure 3.1). On the sides of this central image and on the sides of the altar, descending fire-serpents can be seen. A series of skulls, hearts, hands, and eyes decorates the banks on either side. This structure was built in three phases. During the first phase, the bank and altar were made and used. This phase is roughly dated to 1400-1450 (Contreras Martinez, 1993). After this an adobe wall was build, effectively closing in the bank and altar in a room. This room was still accessible through a door in the adobe wall. In the third phase, roughly dated to 1500-1550, the altar was no longer used, and the room was filled in with earth containing abundant fragments of figurines and ceramics vessels (Contreras Martinez, 1993, p. 55).

At nearby Tizatlán two more painted altars were recovered (see figure 3.2). These altars have different shapes, however, being larger, more rectangular, and lower than the one at Ocotelulco. What is more, there is no bank next to these altars. These two altars are located within a building on a platform which can only be accessed by a staircase on the southern side (see figure 3.3). This staircase was almost two meters high, thus severely limiting the visibility of whatever went on inside the building.

The iconographical similarity between the murals of both these sites and the codex Yoalli-Ehecatl has been noted extensively (Boone, 2013, pp. 222-224; Caso, 1927; Contreras Martinez, 1993, p. 59; Noguera, 1927; Peperstraete, 2006). Both the murals and the codex fall within the widespread Mixteca-Puebla style (see Rojas Martínez Gracida, 2006, p. 16). Because this style was so widespread, the presence of these murals cannot be used as evidence for the provenience of the codex from either of these sites specifically. However, because of the highly religious nature of these murals, which would have a function beyond simple decoration, it is safe to assume that these murals are located in a context where the use of a codex like the Yoalli-Ehecatl would not be extraordinary, if out of the ordinary at all.

Communal ritual is by definition open to the community. In the codices there are numerous indications of rituals that would be performed to the benefit of the community. These rituals are not related to the lifecycle of the individual, but rather to natural or social processes that affect all. Some examples are rituals related to natural phenomena such as rain or the passage of celestial bodies; all sorts of subsistence activity such as planting and harvesting of crops or hunting; but also rituals concerning warfare. Many of these rituals are timed, sometimes indirectly, by the movement of the celestial bodies. The movement of the sun causes the seasons, which in turn dictate the agricultural cycle, which dictates other activities

Figure 3.1: The altar at Ocotelulco, showing the flint scene on the front, flanked by fire serpents and skulls, hearts, hands, and eyes on the adjacent banks (photos by the author).

Figure 3.2: Altars at Tizatlán (photos by the author).

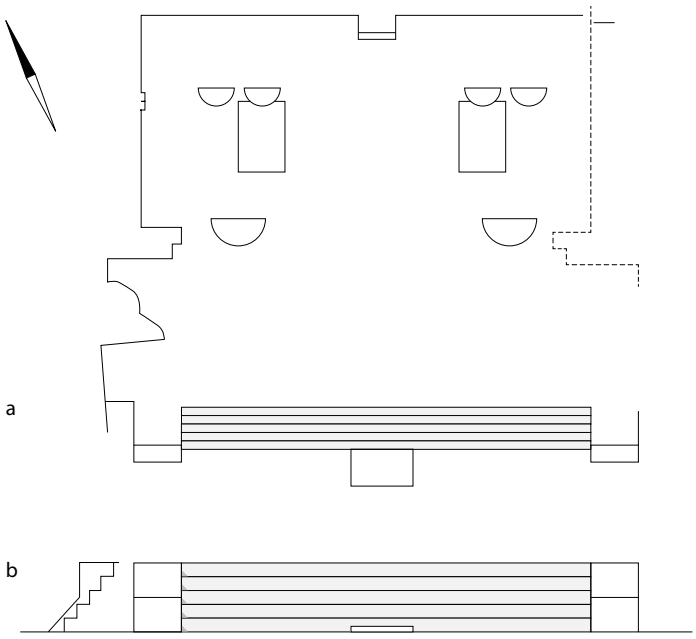


Figure 3.3: Plan of Tizatlán temple (a); frontal and side view of the stairs of the Tizatlán temple (b) (after Moedano Koer, 1943 Plano 1).

such as hunting and even plays a role in the timing of battles. Others are based on the 260 day calendar, which means they are structure by human invention. In these cases, it may have been the codex itself, through consultation of the calendar it embodies, that prompted the performance of a ritual.

Performance of a large scale ritual would have to happen in exterior space. Depictions of such rituals can be found in the precolonial codex Yoalli-Ehecatl as well as in the colonial Codex Borbonicus and in descriptions of Spanish chroniclers. Although the latter two tend to exaggerate the amounts of human sacrifice and general bloodiness of the rituals, the fact that such communal rituals took place is certain. The archaeologically well distinguishable temple and plaza complex, as well as the ball court, were the ideal setting for this. The rituals as they are depicted in the codex Borbonicus pp. 23-37 (see Anders, Jansen, & Reyes García, 1991, pp. 191-231), and those depicted in the codex Yoalli-Ehecatl pp. 29-46 (Anders et al., 1993a, pp. 175-245), show the large amount of material culture involved in such ritual or ceremonial events. Every ritual would require a distinctive ceremonial dress for the priests. Incense, firewood, flowers, and tobacco would have been common objects consumed during ritual. Plants, paper, and animals – especially birds – would have been sacrificed. The rituals involved also performance, such as dancing, which in turn depended on the performance of music. Although not depicted, the large amount of people gathered must also have been fed and supplied with drink.

The role that books such as the Yoalli-Ehecatl played in such ceremonies is not recorded anywhere. There are no depictions or descriptions of these books being present at the ceremonies. One possibility, then, is that the books were used solely for the preparation of the ritual and perhaps as directives “behind the screens”. It may be that the knowledge encoded in them was restricted to the initiated few. In any case, even if a book was used and held by, for example, the “high priest”, if he or she was standing on the top of a pyramid, the general populace standing in the plaza would see nothing of the text.

Intertwined with these rituals is a second use of the codices as objects which were instructional in nature. While the mantic texts are open to interpretation,

Figure 3.4: Detail of page 15 of Codex Añute. The bottom lines shows the marriage of Lord 3 Death and lady 3 Lizard and her parents. The top line shows the birth of lord 1 Monkey and the defence of the town of Añute by lord 3 death against his father in law (from Jansen & Pérez Jiménez, 2007b).

the sections on the counted offerings found in the codices Mictlan, Tlamanalli, and Tezcatlipoca (see Boone, 2013, pp. 159-169) are rather explicit in their instructional ambition. They show, for example, how an altar needs to be laid out and with what amount of what material. It may well be that the selection of which altar to build is open to interpretation, but once selected the instructions seem rather strictly defined. In this sense, these pages function more like the astronomical tables in the Maya codices. These also encode complex information that the user does not have to remember. These texts can be consulted individually. Building altars and bringing sacrifices is often an integral part of a ritual. This continues in indigenous communities today, with altars being built and sacrifices made at significant places such as mountains tops, caves, and other striking features in the landscape (see Akker, 2015; Macuil Martínez, 2015; Posselt Santoyo & Jiménez Osorio, 2015). The books that contained the instructions on building an altar may have had to be carried to all these places. The physical size of the codices containing these instructions, therefore, would indeed need to allow for easy transportation.

3.2 USING A HISTORICAL CODEX

Analysis of the practical use of the Mixtec historical codices has received less attention than the interpretation of their content. Because they are so rich in information for western researchers, who have had to base much of their knowledge about the precolonial Mixtec culture on these texts, it requires some effort to place the codices back into a living context as useful objects. The name "historical codex" makes it seem that these books are simple records of events that happened in the past. However, they are far more complex. Like the religious codices, these books are not made for individual reading, but require background knowledge and elaboration to be made understandable. As such, they cannot have been made – like texts in the western context – for communication without the interference of human interlocutors (see Ong, 2013, pp. 77-78). To Western science, a book is a self-contained whole, something which one can read, as long as language and jargon are familiar, even when one does not yet know the story. To read the Mixtec historical codices one requires a certain familiarity with the subject matter, one which goes beyond the familiarity with pictorial

Figure 3.5: Codex Añute page 16. Bottom line shows the daughters of Lord 3 Death and Lady 3 Lizard getting married and going to a temple. Then line II also records the death of Lord 3 Death, followed by his succession by Lord 1 Monkey, his marriage and subsequently his defence of the town of Añute. (from Jansen & Pérez Jiménez, 2007b).

conventions which is obviously needed as well. A short example taken from Codex Añute can make this more explicit. Based solely on what is represented in this book, but following the names as translated by Jansen and Pérez Jiménez (2007b, pp. 264-268), the reading of this small passage (see figures 3.4 and 3.5) would be as follows:

On page 14 lines III can be read that in the year 5 Flint on the day 10 Rabbit Lord 3 Death Precious Bird and Lady 3 Lizard Flower Garland get married. She comes from a town depicted as "Black Mountain with Waterhole" ruled by Lord 8 Eagle Rain, War of Heaven, Venus-Sun and Lady 11 Rain, Precious Hair, Spider Web with Fog. Then on line IV it can be read that in year 1 Flint Lord 1 Monkey, Rain-Sun, was born. Then in the year 9 Flint, day 2 Eagle the aforementioned Lord 3 Death defends his town of Añute against an attack by his father in law.

Lord 3 Death's daughters, who are mentioned on page 16 lines I and II, get married and the oldest goes to a temple, but they do not succeeded him after his death in the year 11 Wind, day 3 Flint. It is the aforementioned Lord 1 Monkey who does, depicted as marrying Lady 7 Water, Plumed Sun. She comes from Black Town ruled by Lord 4 Flower Precious Bird and Lady 7 Vulture Quetzal Fan. Lord

1 Monkey than defends the town of Añute against an attack by the Lord 3 Monkey Jaguar of the Mexicans in the year 8 House, day 5 Serpent.

This sequence may be a bit unusual, having to defend a kingdom against ones father in law was likely not the norm. It becomes stranger if the dates are analysed and compared in chronological order (see Jansen & Pérez Jiménez, 2007b, pp. 264-268). The first glitch is that the marriage of Lord 3 Death and Lady 3 Lizard is described as taking place when Lord 3 Death was only 5 years old. Normally the birth of a person depicted after the marriage of a couple would indicate that this is the child of that couple. In the case of Lord 1 Monkey this is impossible, as he is described as being born four years before the marriage, when Lord 3 Death was only one year old. Who this Lord is remains unclear, but his unusual positioning in the story would suggest that that he is the reason for the attack of Lord 8 Eagle on Añute. If this is indeed the case, there are only two explanations: either Lord 8 Eagle went to war because he wanted Lord 1 Monkey on the throne of Añute, in which case he eventually got his way; or he did not get his way and Lord 1 Monkey got the throne despite the attack of Lord 8 Eagle. Jansen and Pérez Jiménez (2007b, pp. 258-278) are able to show, by using data from other codices, the context of this passage and to fill in a number of blanks. However, within this one document, many things do not fit, or at the very least require much more explanation than is given in this document itself. It is thus clear that the entire story is not described, and so required knowledge to be completed; i.e. somebody with knowledge of the situation would have to explain what happened and why. As such, these books must be considered as useful objects within the context of an oral performance of the historical narrative.

If analysed from this perspective, there are a number of ways in which these texts could have facilitated oral performance (see Ong, 2013, pp. 31-76). The most obvious is the way in which people were named. The naming structure conforms to the expectation of an oral culture in the sense that it is aggregative. Every person in the codices that is of any importance is named with what is called his or her personal, or given, name. These names, however, are more like epithets as they are used in, for example, Homeric (oral) narratives such as the "Clever" Odysseus or the "Wise" Nestor. Thus, they conform to what Ong (2013, p. 39) calls obligatory stabilization. Especially the names of the Lords seem to be highly formulaic as they centre on either large raptorial birds or felines. For the Ladies, the names may be just as formulaic, often involving jewels, feathers, and elements incorporated in the quechquemitl, which Jansen and Pérez Jiménez (2005, p. 15) have shown to be translatable as virtues. The range of actions portrayed in the codices and thus, it has to be assumed, the backbone of the oral narrative, is narrowly defined. In essence, there is the display of three moments in life: birth, marriage, and occasionally death. These moments form the basic temporal structure of the narrative, but do not add much in the sense of information about actual events, other than the linking of different places at different times through marriage. The actual events that seem to be noteworthy are in general only of two kinds: the performance of rituals at temples and the attack and defence of places. Reference to actual events, therefore, is concerned mostly with moments of external crisis or, through appropriate ritual practice, the aversion of crisis. As such, these action can be seen to be highly agonistic, another characteristic of oral performance (Ong, 2013, pp. 43-45).

The Mixtec writing style itself further facilitates oral performance of the text by presenting events in clearly distinguishable and coherent blocks. This gives flexibility in the sense that there is no inherent direction of reading, as opposed to an alphabetic text which has to be read in one direction. Although translations of these codices generally start in the beginning of time and go from there to the present, the narrative could be told starting in the present and working back. According to Macuil Martinez,[35] in present day narratives during the Day of the Dead this is the form in which the ancestors are recalled. The narrative is started with people that are known to the listener – i.e. their immediate ancestors – and goes further back in time from there. The pictorial script

35. Macuil Martinez is one of the co-researchers at the Faculty of Archaeology of Leiden University. He is a native speaker of Nahuatl and recalled the way his grandmother used to tell about their ancestors during this celebration.

also makes it easier to jump through the document as passages are easily found. This would allow the performer to be both redundant and repetitive (Ong, 2013, pp. 39-41), mentioning important characters and events multiple times and referring back and forth throughout the narrative.

Even though these books are important tools for oral performance, they are also more than that, as Jansen and Pérez Jiménez (2007a) already made clear. First of all, this type of recitation may facilitate the creation of community identity through a shared cultural history or memory. It is clear that the individual documents deal with the history of individual communities, even though because of the nature of the Mixtec political system it shares this history in part with many other towns in the area. Through such shared memory a sense of community could be created. However, the documents themselves are heavily focussed on the deeds of the leader, even though in certain cases it is clear that the leader is actually too young to perform the deeds recorded, making clear that the leader is more a symbol of the community as such. Second of all, these books not only describe past actions but encode proper future behaviour: instructions, that is, about how individuals and communities are to comport themselves and about what etiquette they are to adopt and encourage..

These performances would likely take place during important moments in royal and community life. One of the most probable moments would be the marriage of a new ruling couple. This can be better understood in relation to what is known about the Mixtec political system. The structure of the Mixtec political landscape and actually of many Mesoamerican areas is one of loosely integrated collections of autonomous units. This means that in general there were no large empires in Mesoamerica, with only a few obvious exceptions, which were able to muster the coercive force needed to control larger areas. Even the largest of these, however, the Aztec empire, was based on tribute extraction and indirect rule, rather than complete conquest. The basic political unit in the Mixtec region was called the ñuu. More than a simple designation of political autonomy, the ñuu had, and has today, a meaning combining community, territory, and religious-political centrality (Jansen & Pérez Jiménez, 2011, pp. 14-16; Terraciano, 2001, p. 103). The ñuu was led by what is termed the yuvui tayu (Jansen & Pérez Jiménez, 2011, p. 505), literally the mat and throne, which can be seen as a metaphor for the ruling couple. It is important to stress that the basic political actor was the ruling couple. From what can be seen in the historical codices, such a couple consisted of the child of the previous couple who generally married with a child of the ruling couple of another ñuu. Because of this, every yuvui tayu connected two ñuu (see Terraciano, 2001, p. 158). It would seem that such a system would integrate the whole area within a few generations by a network of familial relations. Such alliances were, however, only temporary, as both members of the ruling couple would designate their own heir for their own ñuu, thus dividing their temporarily joined realm amongst their children (Jansen & Pérez Jiménez, 2011, pp. 242-243; Terraciano, 2001, p. 173). This system allows for the creation of many loose alliances over a longer period of time without necessarily creating large, monolithic power blocks. In fact, this system maintained the autonomy of individual ñuu very successfully for even when two ñuu were joined together for a longer time – as with when, for example, a ruling couple only had one heir – subsequent generations would ideally distribute the individual ñuu when they would have the necessary heirs (Terraciano, 2001, p. 174). Each ñuu thus had a specific lineage, which, while it had many ties with other ñuu, was unique. A marriage involved a whole complex of ritual performance. This started with the visit of a family member of the groom or special marriage broker to the family of the intended (Terraciano, 2001, p. 172). And this occasion in particular may have provided the first opportunity for the display and use of a codex, when both parties showed the deeds and valour of their own ancestors in the brokering process.

The actual marriage ceremony has been described in the Relaciones Geográficas del Siglo XVI:

"Y, asimismo, cuando el cacique se había de casar con hija de algún cacique de otro pu[ebl] o, [dicen] que se juntaban muchos principales y grandes para ir por la d[ic]ha cacica, y llevaban muchos presentes de mantas, joyas de oro y piedras

Figure 3.6: Codex Yanhuitlán page 5r, showing a gathering akin to the parlamento described by Acuña (form Biblioteca Digital Mexicana http://bdmx.mx/ accessed 06-01-2016).

preciosas; y llevaban muchas gallinas, venados, conejos, y otros muchos bastimentos para celebrar la d[ic]ha fiesta y traer la d[ic]ha cacica. Y, traída la cacica a casa de su marido, tornábanse a juntar de noche todos ellos, y los sacerdotes con ellos, y hacían su parlam[en]to. Y, después de hecho el parlamento entre todos ellos, tomaban el canto de la manta que traía esta el cacique, y asimismo tomaban el canto de una ropa que traía la cacica, la cual ropa llaman en su lengua HUIPILE, y añudaban los dos cantos de la d[ic]ha manta y HUIPIL de manera que quedaban atados, y, hecho este ñudo, les traían de comer. Y el cacique partía un pedazo de pan de la tierra y un pedazo de carne, y la daba el bocado a comer a la d[ic]ha cacica, y la cacica hacía lo mismo, y así quedaban casados. Y éste era el casami[en]to entre ellos."
(Acuña, 1984, p. 286)

What is important in this description is that during the marriage ceremony a large number of elders and priest are said to have congregated as a type of conclave (the parlamento). Only after this conclave was the marriage ceremony performed, by tying the clothing of the couple together and beginning the sharing of food.

There is no precolonial description or depiction of such a conclave, thought page 5 recto of the colonial codex of Yanhuitlán (see figure 3.6) may show such a type of gathering.

Although it is not mentioned explicitly, it stands to reason that the historical codices had a large part to perform during such a parlamento. The recitation or performance of the historical narrative is more than a form of simple entertainment. It would have created a direct link between the present or future ruling couple and their ancestors. That the ancestors are important is clear even in the present day celebration of the Dia de los Muertos, but the ancestor cult is visible in precolonial society as well. The mummy bundles visible in some parts of the codices and the archaeologically registered re-entry of tombs (Middleton, Feinman, & Villegas, 1998) testify to this. These ancestors were in direct relation with other Sacred elements such as the power of specific trees or creator forces, the Ñuhu (Jansen & Pérez Jiménez, 2011, p. 256).

As the ancestors throughout the document move through and act within the political landscape, the political system as a whole becomes sanctified. This system is by no means a natural given, but by giving the founders of the socio-political order a sanctified origin, one which exists in contradistinction to their non-human predecessors, the stone people (Jansen & Pérez Jiménez, 2011, p. 327), the system become naturalised. The more ancestors continue this system the greater its sanctity. The whole process can be seen to function exactly according to Rappaport's ideas on the relation between ritual and social structure:

"Sanctity [...] stabilizes the conventions of particular societies by certifying directives, authorities who may issue directives, and all of the mythic discourse that connects the present to the beginning, establishing as correct particular

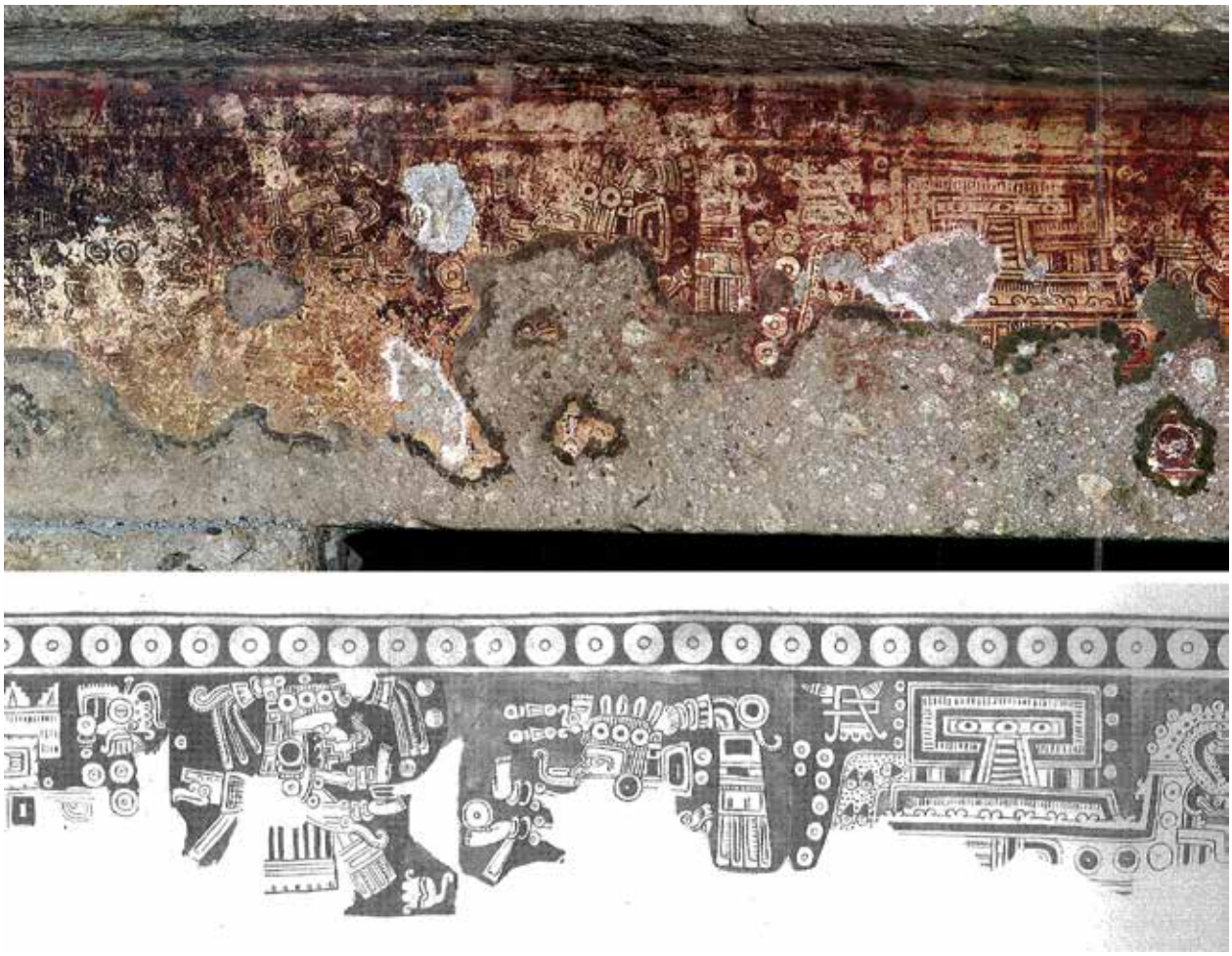


Figure 3.7: Detail of Murals in Mitla, Church Group, Patio A, North Lintel. Notice the difference between the photo and the drawing, indicative of the rapid decay of these murals (photo from Fuente, 2005; drawing from Seler, 1895).

meanings from among the great range of meanings available."
(Rappaport, 1999, p. 321)

In practice, the connection between the current rulers and the ancestors needs to be established in performance with the active participation of the congregation; i.e. the people who support the ruling couple. Participation in a ritual performance that recounts the achievement and the proper behaviour of the ancestors would create an implicit obligation (Rappaport, 1999, p. 123) for the new ruling couple to behave in a similar manner. It would also create an obligation for the community to act in a similarly responsible way. None of the Mixtec states were very large. Important towns that are known from the codices are archaeologically rather insignificant. For example, the valley of Tilantongo, about which much is known from the Codex Ñuu Tnoo-Ndisi Nuu (Bodley), covered according to Kowalewski et al. (2009, p. 75) about 900 ha and had 18,000 inhabitants. These inhabitants were spread over a large area, probably reflecting their reliance on agriculture, and there was very little monumental architecture. With such low population densities and a dispersed settlement pattern, concepts such as right to rule may not be that applicable (see Jansen & Pérez Jiménez, 2011, pp. 204-205). If rulership is considered in terms of a service to the community rather than a right, it becomes clear why ritual reinforcement of the bond between the ruling couple and the community is important.

Next to marriage, other events may have called for the performance of the narrative. It is highly possible that a certain periodic festival existed at which the narrative was performed. Moreover, it is likely that the codex would be consulted at moments of crisis; i.e. the death of a ruler, a conflict over succession, or a conflict with neighbouring communities. This last function, the solving of conflicts, became a much more important aspect, if not the only aspect, for which these books were used after the arrival of the Europeans. When land became property, conflicts over where borders were to be drawn ensued. The indigenous peoples, who had encoded their political relations in these codices tried to use them as evidence in Spanish courts. Perhaps similar conflicts – though likely about tribute gathered from other communities, rather than the actual possession of land – may have prompted their use in the precolonial situation. In his discussion of the Murals of Mitla, Pohl (1999) argues that this site had a central function in resolving such conflicts. The murals at this site (see Fuente, 2005; Seler, 1895) are very similar to the texts found in the codices (see figure 3.7). They are located on lintels above doors and are severely damaged. This decay has continued during the last century, as a comparison of the work by Seler (1895) with the recent photographs in the work by de la Fuente (2005) shows.

That they are found above doors means they are very visible to anyone who is in the vicinity. They are, however, only found above the doors that surround the patios, not on the outside of the buildings. Thus one first has to enter the building before the murals can be seen. However, these patios are larger by far than the spaces that contained the Ocotelulco and Tizatlán murals. Thus, here a larger group could observe the supposed narrative in these murals together. The content of these murals is, because of the severe damage to them, still a matter of debate (see Arfman, 2008, pp. 52-55; Pohl, 1999; Seler, 1895). That they contain a narrative similar to the historical codices is clear. In fact, the murals are the best explanation for the, due to their fragility somewhat puzzling, description by Burgoa of codices being hung on walls (see Boone, 2000, p. 23). These so-called palaces at Mitla give a window into the setting of codex use. The parlamento described by Acuña, and possibly depicted in the codex Yanhuitlán, may well have taken place in patios like these in Mitla.

Although there is not much evidence to support the hypothesis that the occasions for using the historical codices were drunken revelries as Pohl (1999, p. 191) suggests, the fact that such large gatherings involved the sharing of food and drink is very likely. Other things that would have been needed for such ceremonies would have depended on the occasion. Seeing as they are intimately related with the ruling couple, one thing would have to be present, however: the symbol of Mixtec rule, the mat and the throne.
All the pre-colonial historical codices that have survived come from the Mixtec area. This seems to be the result of a lack of preservation more than anything else. Motolinía (1969, p. 5) lists five types of books that were known to the Aztecs, one of which was a recounting of years. Although none of these books survived, a hint of what they may have looked like can, as Douglas (2010, pp. 96-97) suggests, be found in the early colonial documents, such as the many lienzos from that area. From the Maya area very little is known about how, or even if, lineages were recorded in the Postclassic period.

3.3 SECONDARY USES AND NON-USE

From the contents of the codices it can thus be made out what the principle use of each codex must have been. However, these codices were likely not in this use continuously. There are two more settings in which each of them may have been placed. The first of these settings is the teaching of writing skills to pupils; the second is simply the storage of the books between uses; i.e. during periods of non-use. Teaching of writing skills requires learning materials. No clear internal evidence can be found in any of the codices for this use, but any type of writing could serve as an exemplar text. There is relatively little known about the context in which writing was performed or where it was learned. Some inferences can be made based on archaeological evidence, though none of this evidence is contemporary to the remaining codices. Late Classic Maya murals, for example, have been encountered in the Los Sabios household group of Xultun (Guatemala) that contain astronomical calculations which could have been used as tools in

Figure 3.8: Classic Maya ceramic vase showing the instruction of young scribes by older men (from Kerr database K1196).

the creation of books (Rossi, Saturno, & Hurst, 2015, pp. 120-121). A burial near the building housing these murals contained a bark paper beater and a smoother for gesso, leading Rossi et al. (2015) to the hypothesis that the person in the grave was a paper maker or scribe. The problem with identification of localities that were used to write books, however, is that the activity itself leaves very little material traces that can be recovered archaeologically. While numerous workshops of specialised activity have been recovered in Mesoamerican archaeology (see Manzanilla & Hirth, 2011), this is mostly only possible because of the material traces that the production activity leaves behind. Thus, a lithics workshop is recognisable because of the stone debris it leaves behind. Writing a codex, on the other hand, although it requires many materials, does not leave behind many long-lasting traces. Archaeological evidence for the practice of writing or painting is mostly limited to the pots used to store inks while working. In Teotihuacan, ink containers carved from stone were recovered, while the Maya tended to use cut shells. Cutting a conch shell in half yields a container with multiple compartments (see M. D. Coe & Kerr, 1998 Figures 66,118,119). That these were ink containers is clear from the fact that some conch shells that have been archeologically recovered still have ink in them. One ceramic vessel in the form of a shell was found in a burial in the Classic Maya site of Tikal and has glyphs on it that read "inkpot" (M. D. Coe & Kerr, 1998, p. 151).

Some depictions of scribes at work do exist. Quite a large number of Classic Maya so-called codex-style vases show scribes at work creating codices, which are recognisable by their jaguar skin cover. One vase in particular shows how scribes would be taught the skills necessary for writing. The codex style "vase with two scenes of Pawahtun instructing scribes" (see figure 3.8) held at the Kimbel Art Museum (Dallas, Texas), shows an elderly person or deity instructing two young scribes. The older man or deity is depicted once as saying "receive my bad omens[36]" a rather poetic way of indicating that he is pointing out errors that were made by the pupils. According to Tedlock (2011, p. 153), the glyphs above the head of the older man are out of order to indicate what the error was. The second time he is depicted, he is pronouncing numbers. The order of the numbers starts again above the head of the older person and in this case also shows some strange order, it reads 7,8,9,12,13 and 11. Thus, the number 11 is out of order while 10 is missing. Rather than being some difficult to follow numerical sequence, it appears that the older man is again simply showing the arithmetic error that has been made (Tedlock, 2011, pp. 152-153).

Other ceramic vessels also depict scribes at work (see M. D. Coe & Kerr, 1998; Reents-Budet & Ball, 1994). These vessels, however, only rarely show any context for the activity. A few do show a context, such

36. Translation given in Museum database, www.kimbellart.org, accessed 06-01-2016.

as K717, which shows a scribe at work in a workshop together with carvers of masks; or K511, which shows a one at work in a palace scene. However, neither of the scribes depicted in K717 or K511 is depicted as human. The former seems to represent either a deity or a person dressed as one, while the latter is a rabbit depicted in the act of writing. It is, therefore, difficult to ascertain if these are to be construed as actual contexts for writing, or if these are scenes from some (sacred) narrative that are depicted. In the murals recently discovered at Calakmul, one scene may depict a scribe, albeit in a rather unusual setting. On the left a vomiting man is depicted, who is faced by a second sitting person holding an elongated object, possibly a pen, and a bowl. This person also wears a headdress often worn by scribes. The glyphs above it, however, read "ah mahy" or "he of tobacco". This has lead (Martin, 2012, p. 66) to interpret the scene as a person performing a cleansing ritual rather than a scribe. A very similar scene is found on K6020 (see Reents-Budet & Ball, 1994, p. 58). In this instance, a person is depicted seated and vomiting, surrounded by a number of people. Facing him is a person that can be securely identified as a scribe. It may be that this scribe was simply there to record the events. An alternative interpretation is that what is represented should be seen as a scribe or, more specifically, specialists of the written word, performing a ritual curing. The context of the Calakmul murals indicates that these persons plied their trade in a market context. Considering the vast amount of texts found on the most mundane objects it is not unreasonable to think that the Maya scribes in the Classic period worked in a market context. Objects become clearly marked as personal property with the use of the Primary Standard Sequence. During this period, the work of the scribe itself also becomes increasingly personal, with artists signing their work and even incorporating their own portraits in their creations (Reents-Budet & Ball, 1994, p. 46). Beyond the Maya area, scribes are in general not so personally present in the visual arts. In the material culture of the Mixtecs, there are hardly any depictions of scribes. Thus, the scribes of all the historical codices remain anonymous and there is very little evidence to inform how scribes learned their trade. The only clear depiction of someone writing is found on page 48 of the codex Yuta Tnoho, in the form of Lord 9 Wind; i.e. the god Quetzalcoatl. This deity introduced the art of writing to humans, together with a range of other arts. This does indicate the importance and the high status that writing in itself had in Mixtec society. The Spanish chroniclers give a little more detail on the training of Aztec scribes. Reading and writing was one of many skills taught at the Calmecac. This was in principle a school for children of noble birth, though in the codex Mendoza it is claimed that commoners could enter as well. The Calmecac in the centre of Tenochtitlan was dedicated to Quetzalcoatl. Children that entered the school lived there for multiple years. They were not allowed to go home and were harshly punished for disobedience (Durán, 1964, p. 132). Most likely depending on their aptitude, they were taught skills in warfare; those needed to govern; or those needed to be priests (see Boone, 2000, p. 26).

The Calmecac is also a rather likely place for the storage of codices, at least for those codices that were used in the "teaching programme". Besides that, Bernal Díaz del Castillo (1979, p. 184) suggests that the house of books that Moctezuma had probably also functioned as an archive of tribute lists. Temples may have stored books, but individual calendar specialists would likely have owned their own books as well. Alva Ixtlilxóchitl (1985, p. 468) describes the destruction wrought in Texcoco, which included the partial burning of the royal archives. Whether these archives also mainly contained tribute records or included other texts as well, is not recorded. The presence of late precolonial libraries or archives in the Mixtec area is documented in colonial testimonies (Jansen & Pérez Jiménez, 2011, p. 68). Of all these Central and Southern Mexican places designated to store books, there is no more information than the occasional mention in a colonial source. None of these archives have been found archaeologically and neither were they depicted or extensively described in precolonial sources.

From the Maya area, there is again only direct evidence of the existence of archives from the Classic period. Ajch'uh huun is a title found on a Classic Maya ceramic vessel, which means "he who looks after books" (Tedlock, 2011, p. 155). Although there is no information on how many books there were in the Classic Maya society, the frequency of writing

itself on all sorts of other media indicates that books may have been relatively common. Having someone characterised as "the one who looks after the books" seems to indicate a librarian or archivist type of functionary. If such an individual existed, then there must also have been areas specifically designated for the keeping of books. This may not have been more than a chest in a room, but it would have needed to be some kind of a specialised area to help protect the books. At Copán one building was discovered that was decorated on the outside with a carving of a scribe (Fash, 1991, pp. 118-120). This may be one of the best candidates for either a scribal workshop or, perhaps, a place where books were kept.

At the time of the conquest, multiple descriptions were given that indicate that indeed a large number of books was present. Diego de Landa, for example, described how large numbers of books were encountered, which all had to be burned as they were books of the devil (see chapter 4). The materiality of the books sets certain requirements for their storage akin to contemporary conservation concerns. Tedlock (2011, p. 241) states that a book shown to de Landa was covered in Verdigris to prevent insect and fungal damage. Although it is unclear whether or not this material was indeed Verdigris – a copper carbonate or acetate – it does show a concern of the possible dangers to the codices. The growth of moulds and the essential edibility of the codices for insects were real problems that needed to be dealt with.

3.4 DECAY OF BOOKS

The codices are fragile objects, yet some have survived for hundreds of years. It is not known how long these books were in use in their original context, but they must have been cared for to have lasted for so long. The fact that in the Maya codices information is incorporated that was gathered over centuries, shows that either the documents themselves were in use for very long time periods or they were copied multiple times. Use inevitably brings wear. In the case of the codices, either this wear was repaired or the document at some point became illegible and needed to be replaced. Close study of the few remaining books shows that both these practices may have been common.

Figure 3.9 left: Water damage to the codex Dresden: Detachment of gesso layer on page 23; right: Blurring of the paint lines on page 37 (from www.slub-dresden.de, accessed 06-01-2016).

In spite of being given the best of care, codices would invariably start to deteriorate from the moment that they were finished. Some catastrophic events have left the most obvious types of damage on the remaining books. The most recent example is the damage to the codex Dresden. This damage was caused by the bombing of Dresden on the night of February 13th 1945, after which the codex sustained severe damage when the cellar in which it had been stored stored for safekeeping flooded with water (M. D. Coe & Kerr, 1998, p. 177). Water dissolves many natural binders which, in the case of this document, meant that large flakes of the gesso fell off from the paper support. This is clearly visible on page 23, where a whole section detached and shifted to the bottom left (see figure 3.9 left). A second problem with the Dresden codex is that the binders that hold the paints in place dissolved as well. As a result of this dissolution, the lines became fainter and blurrier, making the texts illegible (see figure 3.9 right). The only reason that the codex survived at all was because of the set of glass plates between which the book was kept. In their original contexts without such a protective layer, the books would simply have been lost if it had been similarly submerged in water for days.

The damage to the Codex Yoalli-Ehecatl may be representative of a tragedy that could have happened in a precolonial context. At one end of the document, fire and water damage can both be seen. The fire

Figure 3.10: Comparison of pages 1 and 19 of codex Añute shows the dramatic consequence of using a thinner leather for a codex (after Jansen & Pérez Jiménez, 2007b).

damage is limited to three sections: the cover; pages 1 and 2; and their reverse pages 76-74. The fire damage is rather limited, both when considering the size of the damaged areas, as well as the number of pages affected. It is clear from the position of the damage, that the document was closed when it caught fire. It was probably the salvation of this document that it was made on leather rather than bark paper, which would probably have burned much more rapidly. A second effect resulting from the application of heat to leather is visible on these pages, however. This effect can only be appreciated when the original document is closely studied, though the result is visible in regular photographs as well. The heat has induced localized shrinkage, which means that the surface is no longer flat, but has become waved. Thus, when the book is closed, some areas touch the adjacent page, while other areas do not. This means that friction is concentrated on the areas of contact. In photographic reproductions this is visible as areas where the gesso is severely damaged. The water damage on this codex seems to be related to the fire damage. It is concentrated on the same pages as the fire damage, only coming from a different angle. It may be that the book was burned on one corner, the top right, and that someone tried to save it by throwing some water over it from the bottom right corner. Clearly, however, the water damage was left to dry rather quickly as it did not do as much damage as was done to the codex Dresden.

The type of water damage seen on these two examples as well as fire damage is severe, though relatively easy to prevent. Thus, while accidental fires and floods both could have played a role in precolonial loss of written material, it does not seem to be the biggest threat. What would have been a more severe problem is simple wear through use. This type of damage is caused by the combination of materials that constitute these books. The flexible leather and paper, combined with the rigid gesso, is a potential recipe for disaster. When the support bends, the gesso will crack and start to flakes off. This is most clearly visible in the Codex Añute, where on the last five pages an inferior quality of support has added to the problem. The last five pages are made on thinner leather. This thin leather is more flexible, which has dramatic consequences, as can be seen in figure 3.10. The gesso layer is severely worn. As a result, the entire page seems more yellow, as the underlying leather shines through. When the gesso flakes off, the paint also largely disappears. With

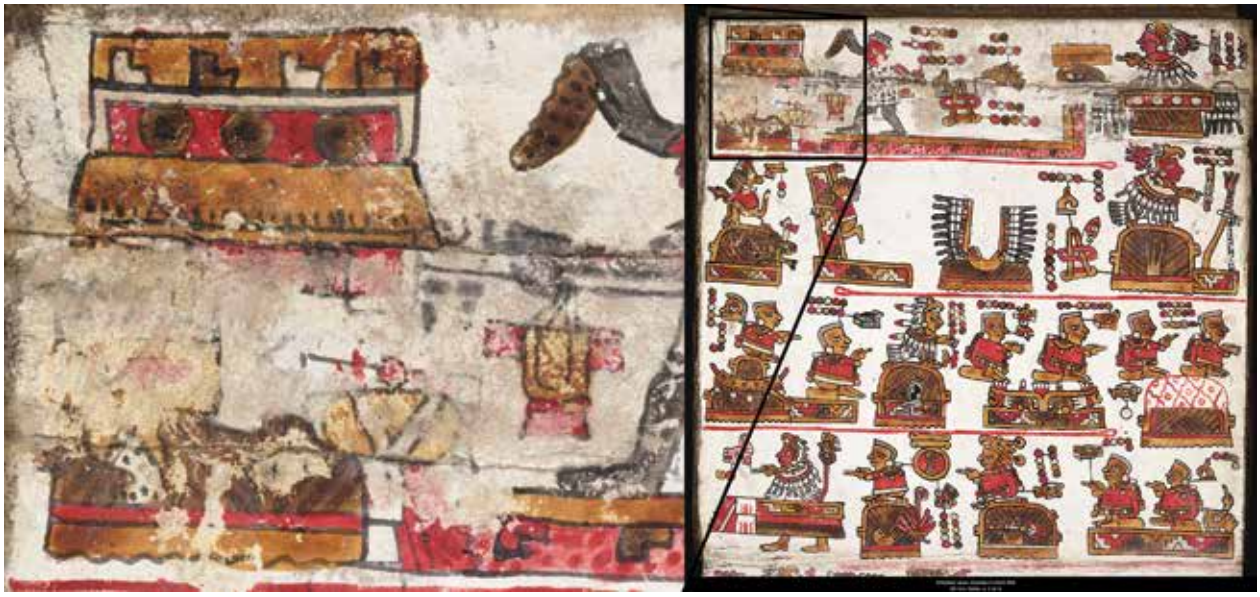


Figure 3.11: Damage on page 4 of the Codex Añute caused by the connection of two pieces of leather (after Jansen & Pérez Jiménez, 2007b).

wear of the gesso, the paint flakes off as well. The black outlines are most completely erased, as the carbon black paint does not bleed through the gesso surface. Paint that does penetrate the gesso, such as yellow and to a greater extend cochineal red, leaves more traces.

The problem of a flexible support is also encountered in the codex Tonalpouhqui. Some of the pages of this small, but long, codex are so thin that the page has curled up. This causes severe damage to the surface, which can be seen on page 62 of that codex. Flaking of the gesso is not limited to areas where the support is too thin. It also happens where two pieces of leather are connected, such as on page 4 of the Codex Añute (see figure 3.11). Because there are two overlapping pieces of leather in this area, combined with the adhesive that holds them together, this section is more rigid than the surrounding page. Consequently, when the book is opened, force is applied and the page slightly bends. Because of the localised higher rigidity of this page, however, a stress concentration is created just besides the thicker area. As a result, two large cracks in the surface run parallel on either side of the thicker section. Similar problems plague most codices, though in some, such as in the Codex Mictlan, this is partially avoided by attaching the pieces of leather in such a way that one ends exactly at the fold. Although these sections are more rigid and thus protected from bending, they are more susceptible to friction as the increased thickness makes it a point of contact with the other page. The wear that takes place is similar to that previously described on the fire-damaged pages of the codex Yoalli-Ehecatl.

Cassidy (2004, pp. 146-147) suggests that the Codex Yoalli Ehecatl (Borgia) and Tlamanalli (Cospi) have water damage caused by salt water. This is based on the idea that salt water combined with an iron based red could make pink stains by the formation of iron iodine. Although it is clear that the Codex Yoalli Ehecatl has water damage, such damage is not found in the places Cassidy indicates. And so the conclusion that damage to Codex Yoalli Ehecatl was caused by salt water is not warranted. As is now clear from the investigation of Codex Tlamanalli (Miliani et al., 2012), the red colour does not contain a significant iron compound. Furthermore, the Codices Ñuu Tnoo-Ndisi Nuu (Bodley) and Añute

Figure 3.12: Detail of codex Ñuu Tnoo-Ndisi Nuu page 3, showing the flaking off of the red paint (after Jansen & Pérez Jiménez, 2005).

Figure 3.13: Detail of Codex Añute page 1, showing some of the last traces of blue paint (photo by the author, courtesy of Bodleian Libraries, University of Oxford).

both exhibit this type of pink staining due to damage. What is seen on the Codex Yoalli Ehecatl, then, is not some discoloration of the paint, but rather the bleeding effect that the red paint often exhibits. It may well be that the damage observed along Codex Yoalli Ehecatl's bottom edge is actually caused by mechanical friction caused by sliding the document over a bookshelf. This hypothesis is substantiated by the fact that damage of this kind only occurs on what is the bottom of the codex. What is clear from the damage on the last pages of the codex Añute, is that once a section loses its gesso, it becomes more flexible, thus resulting in the loss of still more gesso, thus creating a downwards spiral of continuing damage. If the Tlamanalli was stored in a vertical position, it stands to reason that this created repeated stress along the bottom of the document. Furthermore, the damage is not consistent over all pages. If the document had become wet, the damage would follow a distinct pattern. On the Tlamanalli, however, some pages have damage all along their bottom edge while others have only partial damage.
The codex Tezcatlipoca also exhibits what could be considered damage, but may in fact be something caused as the result of the impatience of its creator. Throughout the document, yet most clearly visible on page 37-38 and 20-19, imprints of the opposing page can be seen. These imprints are mostly limited to the black outlines. This may have been caused by the creator of the book closing it too soon after writing, or it may have been caused by moisture dissolving the binder and making it adhere to the opposing side. There is some indication for the latter option on pages 24-23, where whole sections of paint lifted of one page and are now stuck to the opposing one. The physical removal of paint layers from the surface is not limited to the Codex Tezcatlipoca, as it is a very clear problem of the Codex Ñuu Tnoo-Ndisi Nuu as well. Here it is the red paint that has disappeared. Unlike the Codex Añute, the red has left very little trace on Codex Ñuu Tnoo-Ndisi Nuu. As figure 3.12 shows, only the red paint has flaked off. The surrounding design is almost perfectly preserved, indicating that the damage is not caused by any external force. It must be, then, that something inside the paint itself deteriorated, causing it to fall off of its own accord.

Next to physical decay due to friction and stress, these books also face chemical decay. This is also what causes the loss or change of colour of the paints themselves. Close study of the codex Añute shows that the decay of the blue colour is still at work in this document. Although it is completely lost on most pages, on page 1 there are some faint traces left in the skirt of Lady 8 Rabbit and in the clothing of Lord 4 Eagle (see figure 3.13). It can be seen in these instances that the blue is fading to a light grey colour. Also clear form the edge of the quechquemitl of Lady 8 Rabbit is that the green colour was made by overlaying yellow with blue. This is obvious in the case of, for instance, the yellow edge of the

quechquemitl, which has become green as traces of blue have spilled over the black partition line. Thus, the decay of blue is a process that also affects the green colour. This, in turn, explains the rather brown look of areas that must have originally been green in this codex.

In the Codex Yoalli-Ehecatl, a similar brown can be seen which must also once have been green. When he copied this codex in the early 19th century, Aglio made a similar observation (see chapter 5 figure 5.3). In both the Codex Yoalli-Ehecatl and the Tonalpouhqui, the blue colour itself has not decayed as much as the green colour. It therefore seems likely that two different materials were used to make both colours. A yellow or orange colour is faded in the codex Tezcatlipoca, which was used for fine details on the bases of temples on, for example, pages 31 and 32. The conservation state of the yellow paint is variable throughout the document. However, in the codex Tezcatlipoca both blue and green are well preserved.

Changes in the colour of paint can be caused by a number of factors, such as the absorption of optical light or microbial growth. In organic paints, the complex molecules that give the material a certain colour are broken down into subsequently smaller, eventually colourless parts. Thus, the paint becomes transparent. Microbial growth of any kind requires some level of moisture (Petersen, 2006, p. 247). Next to the dissolving effect of water on the binders, moisture also has this secondary, though no less damaging, effect.

In order to better understand the deterioration of the materials used in the codices, a series of samples was made using the paints used in the experimental replication described in chapter 2. These samples are currently undergoing a series of tests to be artificially aged.[37] One test will help determine the lightfastness of the colours in comparison with the Blue Wool Scale. And a second test will determine the effect of moisture on these colours. These tests, taken together, may help conservators to make more informed conservation and exhibition decisions in the future.

37. Publication of the test results by Ness and Snijders is in process.

3.5 DISPOSAL OR REINVIGORATION

The decay of these books was noticeable to their users as well. Paint faded and gesso crumbled. Some codices, however, exhibit changes that are human and intentional. Such changes can be either repairs or changes to the narrative that were deemed necessary. The latter is found extensively in the codex Tonindeye on, for example, page 47, 49, 51, and 53. However, since the figures that were erased were never coloured-in, it seems that these changes took place during the writing process itself. A very different situation obtains in the case of codex Tonalpouhqui. As Cassidy (2004) argued, this codex has been repainted with a white layer on pages 12; 71-73; and 95-96. Although this is not visible in any of the facsimiles, the pages have been repainted with a gesso that contained a glittering mineral, possibly mica. This difference in surface immediately distinguished it from the rest of the document and ascertains that these figures were made at a different moment in time from the rest of the book. This glittering white layer covers earlier drawings, which follow a distinctly different composition. In order to better understand why these figures were covered up, it would be necessary to recover these figures entirely. This would require further investigation. The most extreme version of a re-painted codex is codex Añute. As will be shown in chapter 6, this book was actually entirely repainted.

It is clear that a codex cannot be infinitely retouched, as the breaking-off of the gesso layer will make the surface too uneven to make good drawings. Unless the surface is completely re-covered in gesso as happened with the codex Añute, at some point it would have to be replaced. The old document then needs to be disposed of. As should be clear, these books were not commonplace, everyday objects. Their sacred nature meant that they would have to be desacralized before they could be thrown away or else they would have needed to be kept in a new, sacred environment. This second strategy may have been applied by inclusion of books in burials. Multiple colonial sources tell of documents being interred with people. Diego de Landa, for example, is explicit about it in his description of mortuary practices in Yucatan:

"Enterrábanlos dentro de sus casas o a las espaldas de ellas, echándoloes en la sepulture algunos de sus ídolos; y si era sacerdote, algunos de sus libros…" De Landa chapter XXXIII (1966, p. 59)

"They bury them in their houses or on the sides of them, putting some of their idols in them and if he/she was priest, some of his/her books" (translation by the author).

Considering the sanctity of the ancestors, burial must have been a sacred environment, and thus one where it was deemed safe to deposit a sacred object. That priests would be buried with their books indicates that at least some codices, probably those used for divination, were the private property of the individual priest in question. De Landa's description also shows that not all books went with the priest into the grave. Those recording long-term astronomical observations may have been passed on to the next generation. The practice of burying codices with a deceased was common much earlier in time. At the Classic Maya site of Copan a burial was found in structure 10L-26 which included a desiccated codex (Fash, 1991, pp. 104-111).

A second important description is given in the Geografica Descripción written in the 17th century by Francisco Burgoa (1997). In this work, Burgoa describes the travels of his colleague Bernito Hernandez who encounters a cave near Chalcatongo (Oaxaca) that was filled with the bodies of the Kings of many towns in the Mixtec region. Amongst many objects of clothing, stone, and wood, these Kings also were accompanied by "lienzos de pinturas" (Burgoa, 1997, p. 340).

Putting the old historical books with the bodies of the ancestors would also solve a number of issues. As sacred books, they need to be disposed of in a respectful manner. What's more, they needed to be disposed of every time that a new book was made, as they reify a political situation that, because of shifting alliances, may no longer be the correct one. This also may help explain the lack of books from earlier periods. The Mixtec people may not have had the same obsession with collecting and keeping all the records of earlier times that is common in the Western World today.

Besides being a safe way of disposing of a book, there may have been another reason for interring the codices with the deceased. The cave at Chalcatongo is described as a place where the bodies of kings were kept from a large area of the Mixteca. This cave must, therefore, have contained a large number of bodies, probably put there in the form of mummy bundles such as depicted in some precolonial codices (c.f. Codex Tonindeye page 82 or Añute 18-20). As was shown above, the veneration of the ancestors was important. It is also known that tombs were re-entered and re-used continually (Middleton et al., 1998). Thus, it stands to reason that there was interaction with the dead was common even after they buried. The codices that accompanied the dead in their burials, then, may have functioned as identifiers of these persons and of their personal lineage. If that was indeed the case, a problem would soon arise, as the decay of these books, like the ancestors themselves, would continue and likely even accelerate if the cave was moist. Other objects that accompanied the dead may have functioned in a similar, though more permanent, way to mark the identity of the buried person. In tomb 7 of Monte Alban, a Classic period tomb re-used in Post-classic times, as well as in tomb 1 of Zaachila, carved bones have been found, some of which contain narratives similar to those found in the codices. From these bones it is clear that although in the Mixtec area no codices have been found in funerary contexts, the narrative remained important after death. It may be that it was chosen to make these bones as a more durable form of "codex" which were interred with the dead after it was discovered that the codices themselves were not durable enough.

Not all history was sacred and books were also intentionally destroyed in precolonial Mesoamerica. Not unlike the Spanish policy that followed a hundred years later, the Aztec ruler Itzcoatl is described in book 10 of the Florentine codex (Sahagún, 1577b fo. 142r.) as the one being responsible for the destruction of books. The books that he destroyed recorded a part of the history of the Aztec people. Sahagún describes that a council took place where it was decided that

it was better if the common people did not know all this, so they burned the books.

DISCUSSION AND CONCLUSIONS

In the previous two chapters, it has been shown how the material composition of the codices is proof of a web of relations that encompassed these books, connecting them with different materials, regions, and people. This chapter explored the idealised next steps in the biography of these books: their use and subsequent discard. It has been shown that these books had a central place in the religious and community life of the Mesoamerican peoples. It is in this performative context that these books attained or at least reaffirmed their meaning. In communal ritual, the Mixtec historical codices afforded the creation of community by setting out the proper behaviour of the ruling couple and reaffirming community support. Communal ritual was also one of the functions of the religious documents, both in the Maya and in the Central Mexican area. But it is also clear that communal ritual requires more than just a book; it requires communal participation in certain acts. Although detail of the specifics of these rituals is outside of the scope of this work, it is clear that the use of these books connects them in a relation of mutual dependence with monumental architecture, ceremonial dress, and general ritual behaviour. Without observation of the rituals, which is encoded in it, these books become nothing more than abstract curiosities.

Private consultation of these books had a different, though no less important, nature. It was aimed at resolving private or semi-private crises. Considering the nature of the topics covered in these books, the consultation of the calendar healing specialist was likely common and something that every person would have been accustomed to do. Thus, although the individual consultation may have been private, the importance of these texts was community-wide. This not only justifies the effort it would have taken to make one of these books, but also the construction of semi-private spaces that would have allowed the calendar specialist to work in peace. Whether any of the spaces shown in this chapter actually were the stage of use of any codex cannot be known. They are, however, spaces that would afford the use of specific types of texts.

As with any used product, at some point it becomes worn out. As was shown in the previous two chapters, some of the materials used in the creation process of these books make them rather fragile. Thus, the codices can be shown to have a continued dependence on proper care and repair. The codices that have survived do not show much repair, however. Still, they are not all in the best of condition, especially the Paris codices is in a poor shape.

The use of any object for ritual purposes requires society to observe a specific set of religious unquestionable ‘Truths’ (see Rappaport, 1999, pp. 293-297) within which the object functions. The sanctity of the ancestors and of certain deities that appear in these books forms a core ‘Truth’ underpinning the usefulness of these books. As objects describing or belonging to the ancestors and deities, proper care as well as proper disposal when needed was logical. Dramatic change can occur when an object no longer fits the Truth. It is likely that Itzcoatl’s burning of historical documents took place because the narrative that needed to become the official history contradicted the narrative that was encoded in those books. Rewriting history has happened everywhere. Rewriting religious Truth, however, is something altogether more violent. In the next chapter, just such a change is discussed. Again the affordances of these codices are of central importance, though the context is vastly different.

4. Demons and Colonization, the Destruction of Written Culture

When the European conquerors entered the mainland of the Americas, they encountered a completely different world. In that encounter, the Spaniards brought with them an already complete worldview. This worldview was subsequently projected upon all they encountered, leading to reinterpretation of Mesoamerican culture and tradition that was often wrong. The class of objects that is being dealt with here – the indigenous written material culture – was perceived by the Spaniards as being dangerous and as a consequence was virtually eradicated. To be able to understand the reasoning for the destruction of what is now considered priceless heritage, this chapter focuses on the historical and ideological developments that led to the conceptualization of the codices as "evil" for Medieval Europeans. During the high and Late Middle Ages, a changing understanding of the role and nature of demons and the Devil combined with a changing perception of "Others" to give rise to an increasingly hostile attitude towards non-Christians. During this period, a canon for the depiction of Evil was created, giving form to shapeless demonic horrors. As will be shown, these now embodied evil figures were encountered by the Europeans in a very explicit manner when they arrived in Mesoamerica.

This chapter is divided in three parts. First, an explanation is given to show how the general Christian European perceptual framework concerning Evil and Others came into being during the Late Middle Ages. Second, an account is provided of how internal developments combined with the external perception of the other to form a complete demonology including demon worshippers. Both these factors will be shown to be for a large part responsible for the attitude of the colonizers in Mesoamerica, especially their attitude towards religion and writing. In the third part, the direct result of this attitude will be examined by considering the local treatment of the Codex Iya Nacuaa (Colombino-Becker).

4.1 CHRISTIAN PERCEPTION OF EVIL AND THE OTHER

While many religions have some opposing forces incorporated within their pantheon, Christianity, with its eternal struggle between Good and Evil, has taken this polarisation to the extreme. Around the fourth century BC, the concept of Satan fully crystallized as a separate identity opposing God. In what Cohn (1993, p. 17) calls apocalyptical writings – Jewish texts written between the second century B.C. to the first century A.D. – the court of Satan was first expanded to include the counterpart to God's angels: the demons. These demons are said to have a similar origin to Satan in the sense that they are seen as fallen angels. Thus, they are described as also originally being a part of the realm of God himself, but then broke away from God's grace. Moreover, it was because of their sins, which according to the Book of Enoch Chapters VI-X (Charles, 1912) was the lusting after the daughters of men, that they fell from grace.

To cleanse the earth, God created the Hell to which all who fell from grace were sent. While in this early text the fallen angels are stated to be bound until judgment day, in later centuries evil would be seen as far from neutralized.

According to Early Middle Age theology, the remaining angels had reasserted their status as good by resisting temptation. Like God, they too became more and more inherently benevolent as the demons fell further from the light of God. During the Middle Ages, then, the schism between Good and Evil is complete, with the earth perceived as divided into two kingdoms: one living in the light of God, the other living in the darkness of the Devil. What's more, these entities were conceived as being locked in an eternal struggle between Good and Evil, until the end of days. However, it is clear that from the earliest roots of Christianity until the Middle Ages, Evil was limited in both its role and power. In early Christianity, for example, Satan and his host of fallen

angels are limited to their powers to seduce people to stray from the righteous path of Christianity. And by this logic Satan is also to blame for all non-Christian belief systems. The early limits of Satan's power can be explained by the historical success of Christianity in the first few centuries of its existence (Cohn, 1993, p. 67), in which it became the pre-eminent religion of the Roman Empire and subsequently becoming the dominant religion in virtually the whole of Europe. Figures in older religions and belief systems were incorporated within Christianity to make the religion more palatable to pagan-dominated cultures, though these figures were often twisted in the form of demons. Kobolds, Fairies, and Elves, which were in their original Celtic, Germanic, and Slavic context ambivalent and not necessarily evil creatures, were identified as demons in the Christianised world (Dinzelbacher, 1996, p. 27). This ambivalent potential remained part of the Christian conceptualisation of demonic character, in the sense that demons were still taken to have the ability to do beneficial things, though within Christian doctrine they never do so willingly or without a price.

In the Early Middle Ages, demons were mostly a practical problem for people, because they were taken to be the cause of drought, disease, and famine (Cohn, 1993, p. 29). As a consequence, they formed a special challenge for the clergy, as they had to face and overcome demons in order to stay on the path of righteousness, but they remained in essence a surmountable hurdle (Dinzelbacher, 1996, p. 28). The fact that evil is destined to lose in Early Christian theology, is reflected in the idea that when a demon is resisted by a good Christian he will be tossed into hell and can no longer harm humanity. As the number of demons was seen to be limited, Early Middle Age Christians may have felt reassured that the power of the demonic host must be slowly but surely dwindling. It can thus be seen that in the early Christian view, the demon is a being that has fallen from heaven to earth and is eventually destined to take its place of eternal damnation in hell. From this it follows that Christianity was seen as the natural religion, one that would, after the vanquishing of the demons – including those at the heart of other religions, be the only "True Religion".

This view of the inevitable fall of the forces of evil and with it the inevitable victory of the forces of light would drastically change during the High and Late Middle Ages. The original conception of the demonic being was during their time on earth they are ethereal beings floating through the air and it was only after their failure that they went to hell. This was the view that dominated Christian theology in the Early Middle Ages. By the 13th century, however, both the celestial hierarchy and a fully developed mirror image in the infernal realm was introduced as doctrine by St. Thomas Aquinas (Cohn, 1993, p. 24; Plaisance, 2012, p. 88). By then, both the angels and the demons, as a result of neo-platonic thinking, had become incorporeal and purely spiritual beings (Hopkin, 1940, pp. 31-32). The significance of this change is that their incorporeal nature allows for an infinite number of demons plaguing the world, as they do not take up any physical space. It must be kept in mind that still no demon can use force to make a person do a bad thing, as this goes against the divinely ordained free will of human beings. Instead, demons were taken to be omnipresent tricksters, trying to exploit every possible moment of human weakness. Far from being the strong and natural winners in the battle against Evil as in Early Middle Age Europe, humans were now seen as slaves to their vices, and resisting Evil was taken to be a constant and infinite struggle.

This sudden hopelessness can again be related to historic events at the time. A sense of helplessness plagued the populace after such disasters as the Black Death, famines, and economic instabilities (Dinzelbacher, 1996, p. 136), but surely also because of the constant struggle that Christianity found itself in with groups of "Others" during the High and Late Middle Ages. The threats to Christianity were perceived to be coming from all sides. The biggest threats were the Muslim peoples, who as early as 711 AD had conquered virtually the whole Iberian peninsula (O'Callaghan, 2003, p. 1) and were threatening the eastern Orthodox Christian Byzantine Empire. And to the North, the Slavs plagued the borders of Christendom (O'Callaghan, 2003, p. 20). The response to these threats was a series of Crusades starting in the 11th century to recover land lost to the non-believers in the Holy Land, Northern Europe,

and Iberia. In hindsight, the success of these crusades – especially those to the Holy Land – was minimal. Even its most fruitful form – the Crusades directed towards the reconquest of the Iberian Peninsula – the whole venture took almost five hundred years to complete.

The conquest of new territories in the Americas and the way in which this conquest was perceived and justified by Spanish conquistadors is firmly rooted in the medieval history of the Iberian peninsula itself. The religious differences between invading Muslims and the Christians was, according to O'Callaghan (2003, p. 15), not frequently noted in the earliest centuries following the spread of Islam. However, from the 9th century onwards, when the influence of Islam became more apparent, references to the invader became increasingly hostile and increasingly biblical. Already as early as A.D. 1063, Pope Alexander II declared in a papal bull directed mostly at French knights that if they would take up arms to fight in Spain, then they would have relief of their penance and remission of their sins (O'Callaghan, 2003, 24). This trade-off – combat and holy war for penance and remission of sin – was a crucial aspect of all the true crusades. This was thus a precursor for the crusades that would later be declared to retake the Holy Land.

The knights not only received spiritual compensation for their efforts, however. When in 1064 the city of Barbastro was captured and plundered, it became clear to the French knights that the war in Spain was a lucrative business (O'Callaghan, 2003, p. 26). And this economic profit was not limited to knights. For example, while Pope Gregory VII encouraged French knights to conquer the lands of the Muslim principalities or Taifas, he also declared that from ancient times the land had belonged to the papacy. As such, crusading knights were free to take the land in vassalage so long as they did nothing that went against the will of the Church. Pope Gregory VII also claimed that these lands had traditionally paid a tribute to the Church and that this was a tradition that should be reinstated once the lands had been liberated.

The success of the reconquest depended on the stability of the Islamic states to the south and far to the east. When a strong dynasty took possession of the Islamic empire, the Taifas formed a united front against the divided Christian kingdoms. The rise and fall of the Almoravid, Almohad, and Merenid empires saw the integration and disintegration – and simultaneous stability and instability – of the Islamic lands (Fletcher, 1992, pp. 105, 157; Hillgarth, 1976, pp. 16-18; O'Callaghan, 2003, pp. 57-77). When the Taifas were isolated, the Christian states used a strategy of economic deprivation by taxation, followed by military conquest. To the annoyance of the Papal See, the Christians Kings fought each other as much as they fought the Muslims. For these kings, it did not matter who used to control newly conquered lands, as long as new war taxes could be imposed. The Papacy, however, could only expand its tax revenues by the conquest of Islamic states. Employing the policy of heavy taxation to cripple the states followed by physical conquest, the states of Leon-Castile, Catalonia-Aragon, and Portugal conquered new territories to the south and grew larger, until in the mid-13th century when only the emirate of Granada was still standing.[38]

Hostilities remained between these Christian kingdoms and remnants of this can still be seen today in the tension between the Catalonian and Castilian areas of Spain. Deep mistrust between individual Christian kingdoms was bridged for the first time with the marriage of Isabella of Castile and Ferdinand of Aragon. Many different parties, the French, Portuguese, but also their own relatives, laid claim to the territories of Castile and Aragon (Hillgarth, 1978, pp. 351-365). Anarchy reigned for over ten years, for even though their marriage bonded the pair in 1469, it was not until 1480 that they could make effective political decisions (Kamen, 2005, p. 3). Even then there was no united kingdom of Spain. Each realm had its own customs, laws, economy, and, consequently, their own interests. The only practical way that Ferdinand and Isabella could rule such a kingdom, then, was by personal appearance. They were constantly travelling throughout the

38. For more information on the individual battles see O'Callaghan 2003, 77-120.

land with their entire court, which thus had to be relatively small (Kamen, 2005, p. 26). There was, therefore, no capital or centre of power other than the one residing in the royal personages themselves. They did, however, create a number of councils and positions that would allow for the rule of lands from which the monarch was currently absent. One of these positions – that of viceroy – became very important in the Americas (Kamen, 2005, p. 30).
The final Muslim frontier in Spain was one of the top priorities of the Catholic Monarchs. In 1481, the town of Zahara had been overrun by Muslim forces from Granada, which was the final push needed for Ferdinand and Isabella to launch a full-scale assault on the emirate. A campaign of devastation and siege crippled the emirate further, until eventually in 1492 the city capitulated to Castilian forces (Fletcher, 1992, p. 165). Whether it was a conscious effort or not, these ten years of warfare against the Islamic caliphate created some form of unity in the face of a common enemy: an Other. The ways in which these Others were dealt with in this period became considerably much more grim. This was particularly the case with those Others who were either Muslim or Jewish.

Before the coming to power of the Catholic Monarchs, the policy of dealing with non-Christian minorities had been one of convivencia. The conversion of individual people was not as big an issue as was the official conversion of the land. It was the objective, then, that the land first fall under Christian rule; both in the sense of a secular ruler and in the sense of the ecclesiastical system of bishops. What the people themselves believed seems to have been of secondary importance, as for a long time Spanish conquerors allowed the conquered Muslims to live their own lives in their own way according to their own religious beliefs. When a town was conquered, in general the inhabitants were not killed, but many were captured and sold as slaves (Fletcher, 1992, p. 136). This may be one of the primary reasons why the Christianization of the population was not deemed to be a high priority, because slave owners feared losing their property if they converted to Christianity. The remaining nominally free Muslims – called Mudejars – were all of low social status, because those who could afford it left for Northern Africa or the last remaining Muslim state in Iberia: Granada. One of the main reasons for the tolerance of Muslim ways of life was the need to pacify the conquered lands to facilitate settling. Because of the centuries of warfare preceding conquest, large tracts of land remained unpopulated on the Iberian Peninsula. In order to consolidate control over these lands, it was necessary to have people actually living there. And while there were many colonists coming to the Iberian peninsula from other parts of Europe, the Christian rulers could not afford a full depopulation of tax-paying an economy-driving peoples before Christian migrants could be settled there (Fletcher, 1992, pp. 144-147; Hillgarth, 1976, pp. 22-29; 1978, pp. 390-391). For this reason, the Mudejars were initially tolerated, if not actively welcomed.

Attempts to convert Muslims to the Christian faith had begun in earnest in the 13th century with two founders of orders that would later come to dominate the conversion efforts in the Americas. Domingo, the Prior of Osma, wanted to follow his bishop Diego and preach the gospel to the Moors. He was persuaded that his order of Preachers was better used by preaching against heresy (Fletcher, 1992, p. 154). Also during this time, the founder of the Franciscan Order – St. Francis – travelled to Egypt to preach to the Sultan (Fletcher, 1992, p. 154). The objective of these two missionary missions still seemed not to be the conversion of individual unbelievers, but, rather, the conversion of prominent enough unbelievers – e.g. heads of state – that could ultimately result in the conversion of entire lands and possibly entire peoples.

Convivencia did not mean equality. Legally speaking the Christian rulers issued fueros: laws stating the way in which the Muslims should be treated. Fletcher (1992, p. 137) shows that legally these Mudejar communities were allowed to choose a governor according to the conventions of their own law; they were free to worship in their own way; were guaranteed possession of their properties; had freedom of movement; and were allowed to trade. They were also subject to the same taxes and dues to the crown. These general terms may seem reasonable; however, specific clauses of the fueros show a much darker aspect of this convivencia. Segregation and inferiority seems to have characterized the nature

of Mudejar and Jewish communities. In some cases, they were physically isolated from the rest of the population. This was done by the creation of ghettos – such as in Murcia – and laws, for example, regulating the days allotted to different religious groups on which they could use bath houses or forbidding Muslim men to have sexual intercourse with Christian women. These segregationist actions and laws illustrate just how pervasive discrimination against perceived Others was (Fletcher, 1992, p. 138).

By 1499, when archbishop Cisneros of Toledo asked the Monarchs for permission to take more direct measures against the Moors, the mentality had clearly hardened (Kamen, 2005, p. 38). A new phase of compulsory conversion and baptism dawned. In 1492, the Catholic Monarchs changed the official policy and all Jews were given the choice: either convert to Christianity or leave. By then the Jews had become so suppressed by anti-Semitic laws that their economic value to the state, which previously had been great due to their function as moneylenders, had become negligible (Kamen, 2005, p. 45). Jewish people who did convert to Christianity (conversos) were looked upon with suspicion by the "old Christians". In 1478, Ferdinand and Isabella had already made a request to Rome for the institution of the Inquisition, specifically to investigate the relapsing behaviour of converted Jews. Working as a self-fulfilling prophecy, it is no surprise that anti-Semitism and distrust of the conversos, which were seen by some as secret Jews, only increased. Stimulated by suspicion over the sincerity of the forced conversions, distrust in conversos grew further, with the result that discrimination shifted from one of religious difference to one of race. The New Christians were discriminated by new rules at institutes (such as colleges and churches) aimed at excluding the conversos (Kamen, 2005, p. 47). These so-called limpieza de sangre rules did not become official state policy, but must have fed into the public opinion of conversos and the Others in general.

Official Church policy concerning the way in which the church should deal with non-Christians was detailed in papal decrees, but until the mid of the 13th century these were only related to the treatment of non-Christians within Christian lands. It was Pope Innocent IV (1243-54) who was the first to officially address the question of whether or not the Church had the right to interfere with foreign non-Christian societies (Muldoon, 1979, p. 5). In essence, his argument was that the Church had the responsibility to intervene in a society if their own rulers were either unable or unwilling to enforce natural law as written down in the Holy Book, because all peoples, regardless of their origin and geographic locations, were part of the flock of God. Pope Innocent IV did, however, decree that non-Christians had the right to govern themselves. And conversion to Christianity was only supposed to happen voluntarily. Muldoon (1979, pp. 10-11), however, shows that there were some actions that could be taken in order to help the uninitiated see the light. For example, as the worship of idols was forbidden by natural law, it was the duty of the Church to have them burned. This included the burning of non-Christian Holy Scriptures – such as the Talmud – because of the heresies it contained. In addition, while the conversion of people could not be done by direct force, according to Innocent IV it was the church's duty to send missionaries to non-Christian lands for the spiritual well-being of all people. And if a ruler were to block the free passage of these missionaries in his lands, the Pope could order Christian rulers to take up arms against the one blocking the missionaries. According to Innocent IV, the Church thus had indirect power over all peoples. Other opinions were heard as well, stating that the Church had even greater, direct power over all people, because the infidels did not in actuality have the right to govern themselves. Henry of Segusio, better known as Hostiensis a student of Innocent IV, argued that because Christ was both king and priest, he holds ultimate power over both secular and ecclesiastical matters (Muldoon, 1979, p. 17). By the fact that they were non-believers, therefore, people lost all their right of property and government. This power of judgment had, according to Hostiensis, been passed on to the vicars of Christ.

Thus, both Innocent IV and Hostiensis concluded that the Church had at least some power to intervene in non-Christian society, either directly or indirectly. In practice, however, this was not so easy. The only true power the Church had was excommunication, which had no efficacy against non-believers. The

other weapon available to the Church was to declare a crusade, which was very costly (Vose, 2009, p. 24) and had to be carried out by willing Christian rulers. With the increase of power of kings and emperors during the 14th and 15th century, the balance of power shifted. By the 15h century, Panormitanus (1386-1453), commenting on the viewpoints of Innocent IV and Hostiensis, concluded that Church law would take precedence in cases of ecclesiastical crimes, but the empire – or the state – was responsible in case of violation of civil law (Muldoon, 1979, pp. 24-25). This declaration was one that reflected the changing power relations between the Imperial powers and the Church in general at that time, as it increasingly became the norm that the support of the Church was sought only after action by an empire had already been undertaken (Muldoon, 1979, pp. 132-133). In this context, the role of the pope became more and more one of arbiter in the conflicts between empires. This is most clearly visible in the conflicts between Portugal and Spain about first West Africa and later about the Americas and Asia.

The rights bestowed on Portugal in 1454 to conquer new lands are clearly detailed in a decree by Pope Nicolas V:

> *"[they have the right] to invade, search out, capture, vanquish and subdue all Saracens and pagans whatsoever, and other enemies of Christ wherever they live, along with their kingdoms, dukedoms, principalities, lordships, and goods, both chattels and real estate, that they hold and possess…"*
> (Muldoon, 1979, p. 134).

Spain's American imperial program was the result of multiple accidents. Columbus only came to Ferdinand and Isabella because he had been shot down by the Portuguese, English, and French rulers (Kamen, 2005, p. 57). Once the news of the newly discovered lands reached the Spanish crown, they were quick to lay their claim to them with the help of Pope Alexander VI, who happened to be the former Spanish Cardinal Rodrigo Borgia. Eventually, Spain and Portugal reached an agreement in the famous treaty of Tordesillas, paving the way for the Spanish expansion in the Americas. And the formation of the European branch of the Spanish Empire was due to yet another accident. Upon the death of Ferdinand, twelve years after Isabella, rule passed to their daughter Juana (later known as Juana the Mad) and her husband Philip the Fair of Burgundy. When Philip died, however, it became clear that Juana was unfit to rule and in 1516 their oldest son Charles was summoned to Spain to take the throne. He had until that time always lived in the Netherlands, part of the realm of his father. Having a foreigner come in and take over the hard-earned throne of the Catholic Rulers led to old ruptures resurfacing. Once again, many different factions vied for power (see Hillgarth, 1978, pp. 592-604; Kamen, 2005, pp. 65-70). A major shift took place when Charles I of Spain received news of the death of his grandfather Maximilian I Emperor of the Holy Roman Empire. Charles was recognised as Holy Roman Emperor Charles V in 1519, making his empire the largest that Europe had ever known.

While Charles may have been the de facto ruler of an empire, this in no way meant that there was a unity of these lands under his rule. In the north, Charles faced the threat of the reformation, which occupied a great deal of his time. As a result, he did not introduce many changes into the government of Spain, meaning that it was mostly the local nobility that was in control (Kamen, 2005, p. 88). For the newly conquered territories in the Americas there was even less state control. The only interest for the state at that time was the influx of gold coming from the Americas. This was sorely needed to finance the campaigns of Charles in Europe, mainly against the French in Italy. However, all the income coming from the Holy Empire, the Netherlands, the Kingdoms of Spain, and the Americas could not cover the expenses of Charles. His only solution was to loan money, a custom started by Isabella and Ferdinand to finance the conquest of Granada. Ever increasing costs drove up the interest rates at which money could be loaned, thus increasing the national debt, a burden that lay heavy on the Spanish Empire for centuries.

As a result, by the time that Cortés returned with news of his discoveries, the Iberian Peninsula was a place that had been ransacked by wars for centuries. The strategy used against the individual Taifas – that of economic deprivation by taxation followed by

military conquest – made it possible to conquer them, but it also reduced the economic value of the lands enormously. On the level of the individual, there was much wealth to be gained from the conquest of new territories and the right to collect taxes that came with this conquest. So much, in fact, that the treasuries of the Spanish rulers had traditionally been filled by booty obtained from conquest or the tribute extorted from land to prevent conquest. By the High and Late Middle Ages both of these options were gone. Much like in the case of the Islamic caliphates that had to keep on expanding to sustain themselves, the Spanish Empire hungered for new lands from which to extract wealth. With the fall of Granada and the unification of the territories of Spain under one banner, the desire to conquer new lands needed a new vent. This desire, combined with observations of the successes of Portugal in exploiting new lands in the south along the coast of Africa, inspired Spanish dreams of riches overseas.

4.2 THE INTERNAL DEMON

A second perceived threat to Christianity came from within the border of the Christian lands. Heretical behaviour by Christians themselves was not as clearly visible, yet was perhaps an even bigger problem to the power of the Church, as it was harder to combat by force. Throughout the Middle Ages, groups of people that had ideas which diverged from the orthodoxy of the Holy Roman Church were persecuted as heretics. Most of these differences were not manifested as a result of a difference in belief of scripture, but, rather, as a result of differences in regards to the authority of the dominant religious power structures of the time. Most of the groups who challenged the orthodoxy of the Holy Roman Church considered themselves to be the true Christians. The Holy See, however, seeing itself as the vicar of Christ, saw these religious dissenters as offenders against divine majesty.

By 1231 AD the various penalties for heresy were firmly established (Cohn, 1993, p. 42). The most grievous acts after being tried as a heretic were either not repenting or reverting back to non-Christian beliefs after repenting; both of which were deemed to be crimes punishable by death through burning at the stake. The process by which an individual was tried – and generally found to be guilty – was the inquisitorial procedure. In this old procedure the individual first had to be denounced by his or her peers, and only after this denouncement would an official inquiry be conducted. This inquiry was conducted in secret and generally involved torture. A confession of whatever nature was thus not hard to obtain. And the later withdrawal of a confession was seen as relapsing heretical behaviour and thus grounds for immediate execution. The Inquisition was thus easily abused, which can already be seen in the procedure of the earliest officially sanctioned inquisitor, Conrad of Marburg, and the two self-appointed inquisitors, Conrad Torso and Johannes, who joined him a few years later (Cohn, 1993, pp. 43-47). These three devised a very "effective" system, in which the accused could only come out of a trial alive if he or she repented and gave up the other members of their "heretical school". This process whereby reformed "heretics" denounced other "heretics" who were then tried for heresy, created a snowball effect leading to many abuses, such as resolving personal feud through inquisitorial denunciation. Ironically, the early inquisition process was even used by people who could be considered to be actual heretics to denounce and take revenge on Catholics (Cohn, 1993, pp. 46-47).

Paradoxically, then, it is the process and nature of the early inquisition which brought into existence the charges levelled against heretics. The combination of torture and suggestive questioning meant that the accused could in most cases be coaxed to confess to anything, no matter how absurd it might sound to the modern reader. The view of heretical behaviour gets expanded over the course of multiple generations of inquisition trials, each elaborating the accusations of the previous one. The ideas about heretical behaviour come to a peak during the witch-hunt, as evidenced by the fantastic views held by the public and found in Inquisitorial manuals such as the Malleus Maleficarum of Kramer and Sprenger (2012[1484]). At the core of these heretical practices lies the idea that the heretic commits to a pact with evil. This idea was on the one hand fuelled by the non-Christian religions that the Europeans come into contact with. And, on the other hand, by practices which were profoundly Christian in origin. The best example of

this was the practice of Ritual Magic. The central aim in this practice was to summon a demon and to subjugate it, forcing it to use its powers to the benefit of the summoner. The practice can supposedly be traced back to the biblical first magician – Solomon – about which a Jewish text from the second century AD – the Testament of Solomon – tells that he used a ring given to him by the archangel Michael to command demons (Rankine, 2012, pp. 95-96). He forced the demons to tell him their names as well as divulge the names of angels they feared, thus making it possible to create incantations which would coax them into service out of fear of these holy names. It was with these invocations that the powers of evil were harnessed in and through the names of the righteous. A long process of syncretism, combining elements from alchemy, astrology, and ritual, which in turn descended from Neoplatonic philosophy, Indian cosmology, and Jewish Cabbala (Agrippa ab Hildesheym, 1967, p. 387), but was also firmly grounded in Christian and Jewish Holy Scripture, led to the conception of magic as it existed in the 15th and 16th century (Shelomo & Gollancz, 1914, pp. iv-v).

While the summoning of demons may, then, have been grounded in Christian and Jewish scripture, it did not go well with Roman Catholic doctrine in the High and Late Middle Ages. By the 13th century, Thomas Aquinas had raised questions about whether or not it was possible for a human to command the demon or whether or not it was in fact the demon who was in charge, but by complying to the magician's wishes was influencing the magician himself (Hopkin, 1940, pp. 113-115). He came to the conclusion that in any form of magic a pact between the magician and the demon was made, in the sense that the magician pays homage to the demon, which should be the sole prerogative of God. Aquinas thus reached the conclusion that the magician is displaying heretical behaviour (Cohn, 1993, p. 114). By 1320, Pope John XXII empowered the inquisition to act against the practitioners of Ritual Magic as heretics (Cohn, 1993, p. 114). A number of grimoires reflect this change of mentality (Butler, 1979, p. 84). The Grand Grimoire (Waite, 2008, p. 249), clearly states that a pact is made with the demon, and that if the magician does not follow the prescriptions to the letter, his soul will be lost to the demon.

That words may have such a power can be understood through Agrippa's explanation:

> *"..in this very voice, or word, or name framed, with its Articles, the power of the thing as it were some kind of life, lies under the form of the signification. First conceived in the mind as it were through certain seeds of things, then by voices or words, as a birth brought forth, and lastly kept in writings."*
> (Agrippa ab Hildesheym, 1967 B1, Chapter LXX).

It is in this light that it may be understood why saying blasphemous things, sharing forbidden knowledge, or writing the wrong texts may be conceived as dangerous or evil in and of itself.

Even though Weyer in his work De Praestigiis Daemonum argues fervently that these books are ridiculous and do not work, he nonetheless states that "[these books] should be signed forthwith to Vulcan, among the books that may not be read" (Weyer, Mora, & Kohl, 1991, p. 112). No matter the actual efficacy of the ritual text, by virtue of its blasphemous content it should be burned. Ritual texts were notoriously difficult to read. This is the result of the use of different languages and also the use of Cabbalistic ciphers. Books that were written in other languages – especially those in Arabic – were suspect by virtue of this characteristic alone, not to mention the fact that they may have contained religious texts of a non-Christian nature. These texts, of course, were also taken to be works of the Devil. During a large part of the Middle Ages, the only translations of Arabic religious texts that were made had the purpose of showing that they were wrong (Fletcher, 1992, pp. 153-155).

As a book aimed at debunking popular myths about the power of demons and witches, De Praestigiis Daemonum is a very rich source of information, giving insight into popular beliefs about demons and their human collaborators in 16th century Europe and thus indirectly also about the extent of the inquisitions' success in demonising European heretics. Even at this early point in the history of the colonisation, references to practices in the Americas were already incorporated in the Christian worldview

about the demonic threat. In the chapter called "on the sacrifice of human blood, originated by the Devil and widely observed among the people of God, the Greeks, The Romans and other peoples", Weyer cites a letter from Cortés saying: "In America, Hernando Cortez attests, idols of Temextita[39] were sprinkled with the blood of human victims." (Weyer et al., 1991). The significance of this passing note is that by the 1580's the Americas had been integrated within the framework of demonology in Europe. As Weyer was not a court historian but a humanist who studied in Bonn under Agrippa of Nettesheim and later at the University of Paris (Weyer et al., 1991, pp. XXXI-XXXII), his access to these letters is an indication of the early spread of this information amongst the general learned public.

While these books of magic do describe the demons that may be conjured, they contain virtually no depiction of what these demons and devils would look like. Depiction of the supernatural had for Christianity long been a problem. In the earlier Christian period, imagery of the Divine was not taken to be possible, since no one could know what God looks like. Also the angels, by virtue of their ethereal nature, were hard to capture in imagery. However, despite the earlier prohibitions against the worship of images, during the late Middle Ages the imagery of the divine beings became extremely common (Walker Bynum, 2011, p. 125). These images were much more than mere depictions. In a sense they were what they depicted – they were divine – similar to the present-day use of the Icon in the Eastern Orthodox Church (see Vikan, 2007). Walker Bynum (2011, p. 49) points furthermore to the violent reaction of reformed Christians, to show that even those that were very much acting against the worship of these images, saw the power emanated by them. During the 16th century, this culminated in many of the northern European countries in what is known by its Dutch name the "Beeldenstorm" – literally the "statues storm" – a period where many of the statues of saints and depictions of the divine were decapitated or otherwise destroyed.

Just like in the case of angels, by the 15th century demons had been firmly established as non-corporal beings. However, ever since their incorporation in Christian faith they had also been considered to have the ability to take on any shape they desired. There are many textual descriptions of demons and of the devil both in the books of magic, but also in ecclesiastical works. Dinzelbacher (1996, p. 114) categorizes demons into three different groups: human, animal (generally composed of a mix of different animals), and the small black Eidolon or "spirit". It depended upon the context in which a demon was found what type of form it takes. In a situation where the demon is tempting a person, it is likely to have a beautiful human form, but when it wants to scare, it takes the form of a grotesque monster. To understand why beings that were said to be able to take any form they wanted would choose to appear often as grotesque creatures, it is necessary to look at ideas first formulated in Classical Greece about "the Other" (Mason, 1990, pp. 71-77).

Grounded in humoral, climatic, and astrological theory (see Higgs Strickland, 2003, pp. 30-35), the idea of the monstrous races eventually becomes central for the iconography of evil. The idea in its Greek and later Roman context can be distilled from the perception that all outsiders are uncivilised and barbaric because of their non-Greek-ness or non-Roman-ness (Mason, 1990, pp. 71-79). Because the Greeks and Romans thought of themselves as ideally balanced – both because of their diet and because of the climatic conditions in which they lived – their external features were thought to be optimally balanced as well. As a result, those that lived further away, lived in more unbalanced conditions and therefore looked more unbalanced and grotesque.
The existence and nature of the monstrous races had

39. The original Latin text, in the 6th edition of the de praestigiis daemonum from 1583 on which this translation is based, reads: Temixtitæ in America, idola ſanguine hominum oblatorum conſperſa fuiſſe, author eſt Ferdinandus Cortheſius. This suggest a slightly different reading if we consider that Temixtitæ should be read as Tenuxtitæ due to a common error of the interpretation of handwriting in Spanish changing -nu- (-nu-) into -mi- (-mi-) (Jansen personal communication, 25-09-2012). Furthermore, because this is a copy to Latin from Spanish, the -ch- in Tenuchtita changed to -x- as Latin does not have the -ch- combination. This would suggest that the original meaning was not "idols of [the god] temixtita", but rather: Tenochtita (either referring to the people or the capital of the Aztecs) in America, have idols which they sprinkle with human blood.

Figure 4.1: Jesus before Annas detail of Salvin Hours, f.7r 1275 A.D. Annas was one of the Jewish high priests to judge Jesus. The Jews are clearly identified by their beard and long crooked nose (from http://www.bl.uk/, accessed 10-08-2014).

to be explained and accommodated in the Christian worldview. This was ideologically challenging, as God was supposed to have created all humans in his image. Multiple narratives were devised, all revolving around a link between the sins committed by humans and their having deformed offspring. Having explained them in such a way, an important theological issue comes to the fore: the essential humanity of these monstrous races. If they were considered to be humans, which they were from at least the 9th century onwards by some theologians, then they fall under Christ's charge to spread the word of God (Higgs Strickland, 2003, pp. 50-51). As such it becomes the Church's responsibility to find and save these wretched creatures.

This deformity takes on even greater dimensions in the imagery of demons. These beings of pure evil were depicted as a combination of different bestial characteristic combined with human deformities to show how far removed they were from God's creations and thus how full they were of sin. A number of aspects of human physiology that were of special interest to characterize sinful people are singled out by Higgs Strickland (2003, pp. 78-79). Of those, three aspects are of special interest in the current context. The large crooked nose and the goatee beard became two traits stereotypical for the non-Christian groups living in Europe (see figure 4.1). As these were living within the Christian community and thus visible on a daily basis, they are depicted not as monstrous as those living on the edge of the earth. One group that was heavily stereotyped were the Jews. The stereotypical Jew nose is sadly still alive as a discriminative term today.

The third human figure that was heavily demonized is the dark skinned "Ethiopian". Figures designated by this umbrella term for all dark skinned African people have a number of important features: "dark skin, woolly or tightly coiled hair, large eyes, flat nose and thick, everted lips" (Higgs Strickland, 2003, p. 79). As was discussed above, the original idea of the devil and demons was an insubstantial antithesis to angelic beings. From this dark insubstantial form, the figure of the devil as a dark man arose. The oppositions light/dark, angel/demon, and white man/dark man were created and equated during the High Medieval period. Not in all contexts was the devil or demon taken to be black though; what is more important is the non-whiteness of the figure that clearly puts it on the side of evil (see figure 4.2).

Within Christian iconography, specific rules were thus in place in order to depict non-Christians and, by extension, Evil. The monstrous nature of non-Christians is even more clearly apparent in their perceived behaviour. All antisocial and barbarous acts such as sorcery, cannibalism, and sacrilegious acts were ascribed to Jews and Muslims and even more so to peoples and cultures encountered in colonies overseas.

4.3 THE EFFECT OF THE EUROPEAN MIDDLE AGES ON THE MESOAMERICAN CODICES

Late 15th century Europe – and especially the new kingdom of Spain – was a place plagued by both religious and mundane strife. The discovery of the Americas created an opportunity for (virtually exclusively) men of all ranks to try and find wealth, glory, and fame. In a very similar way as with the reconquest of territories in the Iberian Peninsula, newly claimed land brought great advantages. The

downside was that one would have to leave everything behind and go on a perilous journey to get it. This made it more attractive to people who had nothing to lose. The conquest of the American continent was thus mostly done by peasants, sailors, and soldiers of fortune, rather than the upper echelons of Spanish society. The other category of people going to the New World was interested primarily in the spiritual conversion of its people. And people in this category were willing to travel to the other side of the world to convert the non-Christians. This in itself is a sign of their zealotry.

Although the laymen coming to Mesoamerica were responsible for much physical harm and destruction, their main aim was not the extirpation of all non-Christian influences. Instead, their focus was on material gain acquired through the encomienda system. This system was a continuation of the Iberian system of the reconquest, whereby individuals that had recovered land for the Crown and Christianity had the right to exact taxes from this land in exchange for the Christianisation of its populace. The lack of regulation and the large physical distance from the Spanish capital led to many abuses of this system, and it de-facto became an excuse to enslave the population and put them to work in gold mines or on plantations (Carmack, Gasco, & Gossen, 2007, p. 156). For these encomenderos, then, making their subjects into good Christians was generally not a first priority.

Assuring the spiritual welfare of the people meant introducing missionaries to the Americas. The priests coming to Mesoamerica encountered the exact things that the European inquisition trials had prepared them for: people worshipping demons by building temples, making offerings, and writing magic books about the proper way to pay them homage. Christian doctrine dictated that if there would be people already settled in the New World they would be likely non-Christian, as they were so far removed from the Holy See. Just like the Jews and Muslims, however, they were to be converted and brought into the flock of Christ. The main difference between them and the Jews or Muslims with whom the missionaries were familiar, was that where the Old World infidels practiced their evil works hidden from view, but in the Americas Evil roamed free. Public ceremonies worshipping

Figure 4.2: Devils tormenting the souls of the damned. Ms Douce 134, f.95v. Besides the obvious combination of animal and human characteristics, a second signifier of the demonic being is its non-white colour (courtesy of Bodleian Libraries, University of Oxford).

these devils on a grand scale were the norm. The missionaries really felt themselves under attack from those evil forces. The depiction of the first cross set up by the Franciscan monks in the Relacion Geográfica de Tlaxcala (Acuña, 1984 cuadro 8) shows how the monks were attacked by demons (see figure 4.3). The depiction of those demons is a compilation of characteristics of Mesoamerican deities. Clearly visible are the de-fleshed jaws as well as the flint in front of the nose known from Mictlantecuhtli (see Codex Yoalli-Ehecatl page 73); the round "goggled" eye of Tlalloc; and the conical hat with two wing-like elements known from Quetzalcoatl (see Codex Borbonicus page 22).

Figure 4.3: The first cross set up by the Franciscan friars and the demons that besieged them. The detail on the right shows that these depictions of demons are combinations of characteristic elements of Mesoamerican deities such as Mictlantecuhtli, Tlalloc and Ehecatl (after Acuña, 1984 cuadro 8).

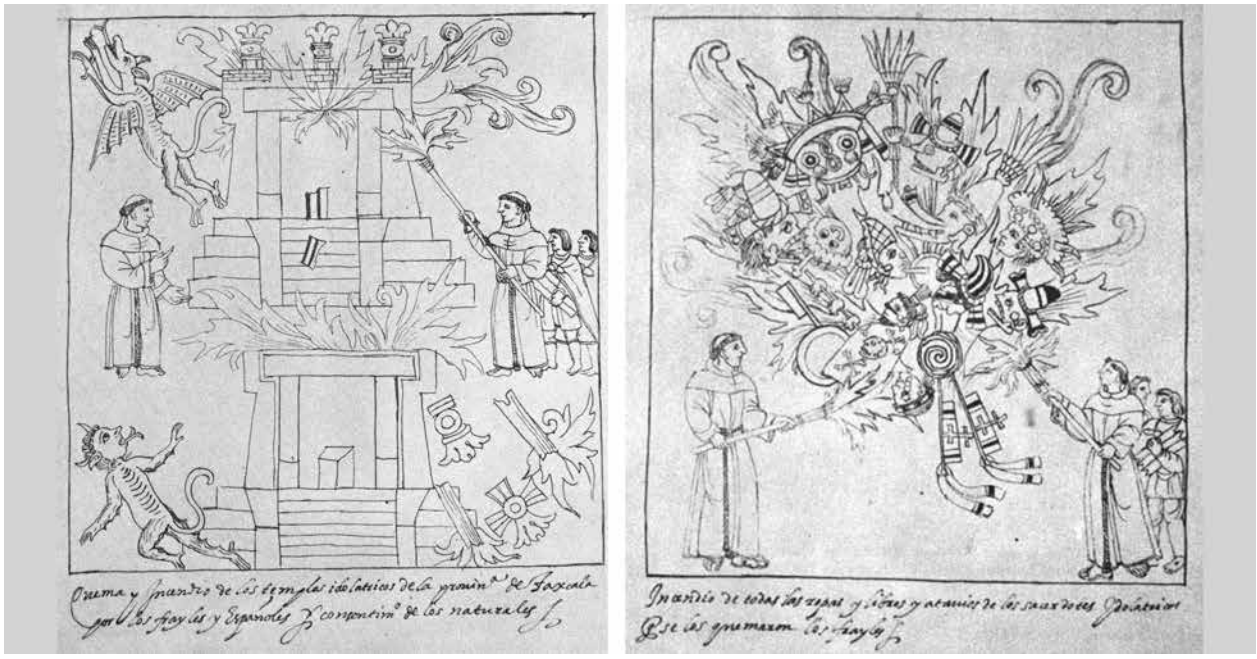


Figure 4.4: The destruction of temples and sacred objects as depicted in the Relacion Geográfica de Tlaxcala (Acuña, 1984 cuadro 10 and 13).

Figure 4.5: Detail of Codex Dresden page 7. Maya gods as displayed in the codices fit perfectly within Christian iconography as demons (from www.slub-dresden.de, accessed 06-01-2016).

The remedy to this situation had already been prescribed in the Old World before Columbus. What was important was to remove the influence of the demons over the people, by the destruction of the objects that allowed such influence to be transmitted. In the Relaciones Geográficas de Tlaxcala (Acuña, 1984), a number of drawings show the burning of temples and sacred objects (see figure 4.4).

This explains the burning of the many religious texts that would have been in existence in precolonial Mesoamerica. If the Spaniards had fully understood the use and value of the historical codices – which was as described in the previous chapter also partially ritual – these would likely have been considered books of the devil as well. A second characteristic inherent to Mesoamerican writing systems contributed to the massive destruction of these books. The combination of animal and human characteristics of many divine figures in Mesoamerican Iconography fits perfect in Christian iconography of the demonic grotesque. Fundamental differences in worldviews on the role of and relation between humans and animals led to different interpretation of iconography. Coincidentally, some specific features of Mesoamerican divinities would have strengthened the interpretation of their demonic nature for the Christians. For example, the enlarged nose and the beard had been indicators of Evil in Europe for centuries. These also appear as indicative features of different rain deities (the nose) and as a general marker for aged and wise men (beard) (see figure 4.5).

Another example is the black, grey, or blue painted skin often used to signify a priest in Mesoamerican manuscripts. The interaction of these people with Mesoamerican Gods would have further solidified these characters as representing evil. That indigenous Gods were seen as demons by Christians becomes explicit in the colonial Historia de Tlaxcala.

Outside of religious contexts, all writing styles in Mesoamerica incorporate elements that could have been seen as demonic to Christian eyes. In Mixtec writing, for instance, the incorporation of names as part of the depiction of a person creates to the uneducated eye an image of a composite creature (see figure 4.6), again hinting at the perverted nature of the demonic realm.

Even in Maya writing, though hieroglyphic in nature and thus more difficult to interpret at face value, all the different head variants and full-figure variants,

Figure 4.6: Example of how the Mixtec writing system creates meaning through combination of different elements, a practice that to Christian eyes may be conceived as depictions of demons due to their composite nature (Codex Añute page 12 verso, photo by the author, courtesy of Bodleian Libraries, University of Oxford).

either as anthropomorphised animals or composite human beings, could have been interpreted as demons for the same reasons. It is thus no surprise that the Conquerors were quick to condemn Mesoamerican books as they embody all the characteristics of evil that they themselves had invented in the Old World.

The result of seeing the Mesoamerican writing style in this manner is seen in the Codex Iya Nacuaa[40] (Colombino-Becker). This document is the precolonial codex that survived the longest in its original context under colonial rule. At an early stage, the codex was cut into seven pieces and partially re-assembled in the wrong order. It is today known under two names: the Codex Colombino, held in Mexico; and the Codex Becker I, kept in Austria. All sections contain glosses written in alphabetic script in Mixtec, though the Colombino part contains more texts. This document also contains a date written in Roman numerals: 1541. If this is the date for all the glosses on this document, then that means that the fragments were re-attached in their present order by that date as the glosses form a continuous narrative. The glosses are, however, not at all related to the content of the precolonial document; i.e. the exploits of famous Mixtec Lord 8 Deer. They rather detail the boundaries of the town of Tututepec and surrounding communities. The Codex Iya Nacuaa was, in fact, used in 1717 as a legal document in a land dispute between Tututepec and Sola (Smith, 1966, pp. 152-153). At the time it was evidently still kept in its original community and used and valued as an important document. Although the glosses have nothing to do with its original content and it would be easy to assume that the document had lost its original meaning, Troike (1974, p. 31) shows that the indigenous owners of the Codex Becker I fragment knew they were about the exploits of a Mixtec King as late as the mid-19th century.

Although it was a document that was probably more actively handled than its counterparts that quickly ended up in private collections and libraries, its handling was most likely much more reverent and careful. What is striking about this document, however, is its current state. Unlike such codices as the Codex Mictlan or Codex Tonindeye, this document is highly damaged. This damage is not due to careless handling or extensive wear, but is the result of heavy and selective censure.

Caso (1966, pp. 12-13) already noticed the curious pattern of the selective erasure (see also Troike, 1974, pp. 99-100). He, however, makes it seem more widespread and complete than it in fact is:

> *"Se borraron cuidadosamente los glifos de los nombres de los personajes, los días y años de los acontecimientos y aun personajes completos…"* (Caso, 1966, pp. 12-13)

This description makes it look as if the entire codex is illegible. That is not the case. By going through the identification by Caso and studying the high resolution images of the Codex now available online,[41] as well as conducting investigations of the original document,

40. Because there is still discussion on the order of the pages and fragments and because the documents are today physically separated and connected in a specific order, the page numbering used in this section is simply left to right, starting with the number 1 for each of the two parts. For the two loose Becker I fragments, the order followed is the one used in the facsimile of Nowotny (1961). In order to keep with the new naming system introduced by Jansen and Pérez Jiménez (2004), a reference to a specific scene will have the following format: codex "Iya Nacuaa, Colombino/Becker I section page X".

41. World Digital Library http://www.wdl.org/en/item/3245/ (accessed 01-04-2015).

Figure 4.7: Two examples of the erasure of animal head on headdresses (Codex Iya Nacuaa, Colombino section, p3) (from Biblioteca Digital Mexicana www.bdmx.mx, accessed 07-01-2016).

Figure 4.8: Place glyph on page 21 of Codex Iya Nacuaa, Colombino section page 21, showing traces of the bird that was part of the original design (from Biblioteca Digital Mexicana www.bdmx.mx, accessed 07-01-2016).

it has become clear that the removed images can be categorized into three different groups. By looking at these three categories within the context of Spanish demonology and conceptions of evil, it becomes clear why this document was treated this way.

The first category of erasure is the animals. Not all calendar names have been removed as there are numerous instances of the glyphs House, Flint, or Movement, for example, and yet not a single complete depiction of an animal glyph can be found. This erasure happened not only in the calendar names but also on other dates – both days and years – on which events happened such as conquests. Throughout the document animals have suffered erasure, as the removal of animals went beyond the erasure of animal calendar signs. Because of the custom to indicate valiant warriors by incorporating fierce animals in their dress, many of the characters in this document seem to "wear" either an eagle or a jaguar or puma suit (as in figure 4.6). These suits are normally depicted in such a way that the head of the animal sits on top of the head of the individual in the form of an animal headdress. These animals have open eyes and thus look to be alive. All these heads of animals have been removed in the codex Iya Nacuaa (see figure 4.7).

Besides these elements that are related to the identity of persons, other animal elements were removed as well. Many pictographic representations of towns incorporate either whole animals or parts of animals. In some cases, these are direct logographic representations of the names of places, while in others the reading relies on homophonic relations between the depicted animal and the name of the town. The comparison made with related documents such as the Codex Tonindeye and the Codex Ñuu Tnoo-Ndisi Nuu in Caso (1966) is of great help in identifying the original design of these partly erased glyphs.[42] Most of the places mentioned in the codex are places conquered by Lord 8 Deer, each of which happened on a specific day. As such, next to identifiers specific to each town, the calendrical sign that accompanies it can be used as a reference for correlating even the damaged place-signs depicted in the Codex Iya Nacuaa with those found in the Codices Tonindeye and Ñuu Tnoo-Ndisi Nuu (at least when not completely erased for being an animal). A few examples will show this pattern of erasure as well as one striking, but explainable, exception.

On Page 21 in the bottom left corner, a place name with a bend mountain (probably read as big mountain) can be seen. On its right flank it is just possible to see the feathers of some bird (see figure 4.8). Thus, clearly more than a bend mountain, this

42. Although for the reconstruction of the total reading of the document Troike is a much better referent, as Caso reconstructs the order of the individual codex fragments incorrectly (Troike, 1974, p. 57).

Figure 4.9: Central place glyph of page 21 of Codex Iya Nacuaa, Colombino section, showing traces of a claw sitting on top of the place glyph. (from Biblioteca Digital Mexicana www.bdmx.mx, accessed 07-01-2016).

place would have been something akin to the big mountain of the bird or the big bird mountain. In his identification of the place glyphs, Caso (1966, p. 35) identifies the central place glyph of page 21 as place of the snake, analogous to the depiction of Codex Tonindeye page 74 II. Close inspection of this glyph shows the remains of a claw that sits on top of the remnants of the outline of the place glyph (see figure 4.9), making it more likely that here also a bird was part of the place glyph, in the same way as the place of the bird found in Tonindeye 73II. This would also make it likely that the sign for rain that follows this place glyph is actually connected to this place glyph, like it is in the Tonindeye. Having the date follow the place instead of preceding it is not the common way of depicting events, but it does also happen of page 19 of the same codex.

Though the abovementioned erasure is rather extreme with the entire animal being removed, in other cases it was apparently enough to only remove the heads of the animals. In the Colombino section on page 8, as well as in the Becker I section page 8-9, for example, a snake without a head can be seen; on page 7 of the Colombino section, a lizard missing his head is also visible; and page 20 of the same section sports a turtle that is missing both its head and tail.
The exceptions to the rule that all animals needed to be removed is to be found in the place names that are related to birds and mountains. In the Colombino section, this combination appears four times on pages 5, 8, 14, and 20 respectively. It does not appear in the Becker I section. This at first appears to be a strange exception, until it is taken into consideration that the document was kept in a town called Tututepec in Nahuatl or Yucu Dzaa in Mixtec, which is translated as Hill of the Bird. Although these towns are not all the same bird hill – as some of them are depicted as conquered by Lord 8 Deer of Tututepec and some not – the fact that they bear this glyph would have made them understandable and defendable. The emblematic depiction would not only be easily defended against charges of heretical depiction, it would also be important to prove the historical link of the document with the town.

The question remains: Why would animals need to be removed in the first place? The first reason has already been given above: the combination of animal and human characteristics was indicative of the demonic nature of a depicted being. A second contributing factor was nahualism – the idea that there was a link between a human being and an animal and that people could change into that animal at night. Again a parallel can be seen with the European idea of witches and them changing into animals of all sorts. The link of a person with a specific animal could have been perceived as expressed in the calendar signs. Thus, a person with a jaguar name could be considered (wrongly) by Spanish friars as someone who was believed to have a jaguar nahual.

These reasons do not yet account for the removal of animals from place names, however. The first explanation for this action may be that erasure represented a "better safe than sorry" strategy on behalf of the person removing the depictions. It may have been feared that any document hinting at the link of animals with humans would end up on the pyre, and this may have provided enough of an incentive to remove all animal references. A second factor may be that the place glyphs were more than simple geographical markers. They were also indicators for the words for community or People. As such, a place called the place of the snake can also be read as the people of the snake, thus again crossing the human-animal divide.

A second category of images that needed to be removed were the images of precolonial deities and/

Figure 4.10: Detail of Codex Iya Nacuaa, (Colombino section) pages 3 and 12, showing the temple of death and the destroyed areas in front of the temples where Lady 9 Grass would have been depicted. (from Biblioteca Digital Mexicana www.bdmx.mx, accessed 07-01-2016)

or spirits. In precolonial Mesoamerican society, there was no difference between what Western science calls the natural world and the supernatural. Both function as component parts of the same world and thus everyday mundane events such as marriage and warfare are depicted in the codices intermeshed with spiritual experiences such as the consultation of oracles or performance of ritual to specific spiritual beings. Some of these appear to be very powerful beings and are integral parts of the historical narrative. One such is Lady 9 Grass who resided at a "place of death". She can be found in Codex Tonindeye and Codex Ñuu Tnoo-Ndisi Nuu, and is a figure consulted by and giving gifts to Lord 8 Deer. She is depicted as a woman with a skull as head. She is a deity of war and the one who presides over a cave where Mixtec rulers were buried (Jansen & Pérez Jiménez, 2005, p. 57). It is most likely that because of that connection many rulers visit her and receive gifts – both real and metaphorical – which help them to govern their towns. In the Codex Iya Nacuaa, such consultation happens twice: on pages 3-4 and on page 12. On page 3, the temple of death is clearly visible and the remains of the grass glyph are still intact as well. The number has been reduced to 5, however, by censors, and the figure of Lady 9 grass – which would have been depicted as sitting against the back of the chair depicted in the entrance of the temple – has been thoroughly erased. On page 12, not only the figure and name of Lady 9 grass have been removed, but also the skulls on the temple roof are damaged. Comparing the temples in the two scenes (see figure 4.10) makes it clear that this is the same place and that this scene should be reconstructed as another consultation of Lady 9 Grass.

Figure 4.11: Detail of Codex Iya Nacuaa, Colombino section page 13, which depicts the piercing of the nose of Lord 8 Deer by the Cholulan ruler 1 Wind, at the temple of Quetzalcoatl (after Biblioteca Digital Mexicana www.bdmx.mx, accessed 07-01-2016).

A version of the well-known scene in which the nose of lord 8 Deer gets pierced by Lord 1 Wind is found on page 13 of the Colombino section. A similar ritual happens later in the narrative on page 15 of the Becker I section. Here it is Lord 4 Wind who gets his nose pierced. This ritual took place in a place of reed, identified by Nowotny (1961, p. 16) as Cholula. Nowotny also gives a text explaining this ritual occurrence (1961, pp. 25-26), which provides a better understanding of the sections that were removed in the Colombino representation of this ritual (see figure 4.11).

The text itself was send to Spain between 1579 and 1581 in response to questionnaires sent by the crown. The text explains that Cholula had a temple dedicated to Quetzalcoatl, where rulers from all over the region came to reaffirm their allegiance to this deity and receive piercings through their ears, nose, or lower lip. In the representation of this ritual in the Colombino section, it is clear that a large part of the figure – especially that inside the temple – has been removed. However, on the right side of the roof of the temple the traces of plumes – possibly from a plumed serpents' tails – can be seen. The representation of this temple is thus similar to the depictions on the

Figure 4.12A: The erased Tlaloc head and erased ñuu on page 14 of Codex Iya Nacuaa Colombino section page 14 (from Biblioteca Digital Mexicana www.bdmx.mx accessed 07-01-2016); B: similar depictions of ñuu in Codex Yuta Tnoo page 25 and 27 (after Anders, Jansen, Reyes García, et al., 1992); C: and the depiction of a sacred bundle on codex Añute page 5 (after Jansen & Pérez Jiménez, 2007b)

pages 33 and 34 of the Codex Yoalli Ehecatl. Here the serpents are curled all around the temple. In the case of the temple of the Codex Iya Nacuaa, the red band with blue curls or volutes may in fact be part of that serpent's body. Close inspection of that area shows that it curls slight upwards on the left side and a little further up the remains of another curl can be seen (see detail of figure 4.11).

On the following page – page 14 (because of the boustrophedon pattern, the preceding scene), two further examples of spiritual beings that were the victim of erasure are found. The first is the figure on the central place name, identified by Caso (1966, p. 30) as the rain deity Tlaloc (see also Codex Tonindeye page 52). On both sides of this figure, sacred bundles can be seen which originally had a figure on top of it. This figure can be interpreted by comparison with the Codex Añute and the Codex Yuta Tnoho (see figures 4.12A and 4.12C). When representing a sacred bundle, the scribe of the codex Añute chose to draw a face on top of it. The protrusion on his head, as well as the teeth and the round eye show that this is in fact a ñuu. Similar protrusions can be discerned on the figure erased from the sacred bundle on the right in figure 4.12. In case of the Iya Nacuaa ñuu, however, the depiction is upright, much like the ñuu depicted in the Codex Yuta Tnoho, though these are depicted without the sacred bundle.

A third category of images that was removed is a rather loose category, related to behaviour that was considered inappropriate. It includes scenes of sacrifice and ritualized execution. The clearest scene of sacrifice that was removed was located on page 1 of the Colombino section and was identified by Caso (1966, p. 23) as the same as found in the Codex Tonindeye page 44 line IV, the sacrifice of dogs. Not much remains of this scene except three persons in black, who originally would have carried the knives to kill the now also removed dogs.

Making offerings was in the Mesoamerican tradition also depicted in the form of scattering or burning of a certain substance, mostly tobacco or incense. Many characters in the codex Iya Nacuaa are depicted with green volutes coming from their hands. This in itself could be construed as a depiction of demon worship, if it was understood that these offerings were made to the precolonial deities or to the ancestors. However, that is not what is being depicted. The figures making such offerings are not shown as offering it to anything. In cases where they are clearly scattering to or over something this object has been removed, such as on the central band of page 15 of the Colombino section. On page 10 of the Becker I section, a person is being executed by having atlatl darts thrown at him while he is tied to a rack. This depiction may well have been understood as a form of human sacrifice, which was very much condemned by the Spaniards. What is interesting, however, is that there are a few other highly violent scenes that were not removed and were apparently not taken to be depictions of rituals. Apparently, then, in these cases the Spaniards did not take the circumstances of death to be ritualised in any way. This may be evident in the case of the depiction on page 11 of the Becker I fragment, where the death of lady 6 monkey and lord 11 Wind is detailed (Troike, 1974, pp. 324-325). From the way in which their deaths are depicted – having their chests cut open – it can be surmised that these two were indeed being sacrificed after having been taken captive, something depicted in the previous scene. Unlike similar scenes in other codices, however, there is no religious context to this scene. The figure on the left of the dead pair has the protrusions on his body indicating that this may have been a ñuu, but his head has been removed. Furthermore, while

the chests of the two have been cut open, there is no depiction of their hearts having been removed, nor are they depicted on an altar. As such, without knowing the narrative, the scene may be equated with the depiction on page 16 of the Colombino section: the murder in the steam bath. It is clear from all depictions of Colonial times that the Spaniards have in itself no problem depicting violence and gore. As such, without the ritual context, this image of a person killed, especially since it is put inside a black quadrant and thus isolated from any form of interaction with the world of the living, was acceptable.

All in all, it can be shown that the person who erased the parts of the Codex Iya Nacuaa did so in a highly selective way and with a clear aim in mind: the removal of anything going against what was allowed by the new colonial rulers. Troike (1974, p. 99) suggests that the person responsible for the destruction of selected areas of the Codex Iya Nacuaa, was probably not knowledgeable of Mixtec writing and could not read the codex. If that had been the case it could be expected that the destruction would be much more random and extensive. Furthermore, someone not knowledgeable of the narrative encoded in the document would not have bothered to preserve the document at all. There are much easier ways of getting rid of such a document than selectively removing the offensive part. One possibility would have been to simply put the torch to the documents, or to have scraped and washed it much more completely. The great care with which sections are removed is indicative of the value this manuscript had for the one removing it. It must, therefore, be concluded that the damage done to the codex was the minimum amount of damage that had to be done, in order for it to be an acceptable document under Spanish colonial rule. As seen in the previous chapter, the historical codices are not complete records of events and require a knowledgeable person to read and use them. In such a case, even when removing part of the headdresses, characters would still be recognizable, as the context of the narrative is known. As such, even removal of the specific calendar glyph does not render the document unusable. Moreover, what is very striking is also the removal in most cases of only the calendar sign, not the number. This would have helped the reader further identifying these figures. As such it can be concluded that this document was heavily censured by someone with intimate knowledge of not only the writing style itself, but also of the narrative contained in it, as well as a what would have been offensive within the new Christian context. The addition of the glosses after the document had thus been censured effectively provided the codex with yet another layer of protection. It transformed the documents from being a precolonial book related to a precolonial family, into a colonial text related to the ownership of land. This latter category was not just familiar to the new Spanish governors, it also gave it another layer of protection by enabling it to become an official and indispensable part of the Spanish legal system.

DISCUSSION AND CONCLUSIONS

The difficulty with reconstructing the process of destruction of the codices is that only the exceptions survive and can be subsequently investigated. Thus, it is only possible to discuss general trends that would have impacted these documents rather than specific local realities. Comparing the relations of these books as they were shown in the previous chapters and in the present one shows a fundamental transformation in meaning. It has been shown in this chapter how the massive destruction of the precolonial Mesoamerican codices can be better understood in the context of the European struggle against “Others”, and the affordance of these books within that context. Over centuries this struggle grew out into religious wars against mostly Islamic states. On the surface, these were wars that were fought in the name of Christianity against Evil. There was also, however, a clear economic reason for conquest. Especially in the Iberian peninsula, the extraction of wealth from newly conquered areas was a prime source of income for monarchs and for newly (self-)appointed nobility. Such a system is highly destructive and can be seen as a precursor for the later colonial models, for it is based solely on extraction rather than on the building up a sustainable economy. Such extractive models require a continuing expansion to claim new resources. The problem was that the enemies of the Roman Catholic Church – both beyond and within

the borders of its territory – were not defeated that easily. This reality, combined with the devastation caused by natural disasters such as the Black Death, changed the perception of the forces opposing those of Christ; i.e. changing demons and the devil into an eternal and very real adversary.

Within Christianity itself a practice had originated that allowed for the interaction with demons. In its earlier form this was perceived as a highly pious endeavour, though with the changes in ideas about demons, the ideas about this Ritual Magic also changed. Conjuring a demon was now making a pact with it and thus serving the cause of Evil. Similarly, the books of other religions were increasingly perceived to be works of the devil. Depictions and descriptions of devils and demons revolved around the grotesque, often involving physical deformity or the combination of animal and human characteristics. Witch trials and the inquisition of supposed heretics only further established and reified the fantasy world created by Christian of non-Christians worshipping and serving demons.

When the Europeans encountered the Americas, these fears became more concrete than ever before. There people built large temples with statues of demonic figures in them, where they made all sorts of sacrifices to worship these demons. The books that were written in this area contained pictures that fell exactly within the expectation of the demons as the Europeans had imagined them. Thus, from the European perspective these codices afforded the conjuring or at least the worship of Evil. Still, the destruction of these demonic writings did not happen overnight. While there are descriptions of book and effigy burnings in the colonial literature, it may be that besides active destruction of books, the passive suppression of these writings had an even greater impact. In a situation where the precolonial writing is no longer publically accepted, the role that they can play in creating community becomes non-existent. The censure of the codex Iya Nacuaa described here is one way of dealing with this culture of suppression. However, the methods of censure used in the document do illustrate that it continued to have an affordance even during those suppressive times. Furthermore, that it was still known in the 19th century as a document about a great Mixtec King shows that some of the affordance of this manuscript for the community survived beyond the suppressive Spanish conquest. The addition of the Mixtec glosses only heightened the documents significance.

The continued existence of the precolonial codices thus depended on two things: a strategy of reinterpretation so it could be used in the new context under colonial rule, but also a continued successful protection of the object. This last aspect is made difficult in a context where a document continues to be used and where skills for making new copies, as well as the materials to do so, are no longer accessible. In this sense, it is not a great surprise that most of the documents that have survived are those that were removed from their context of regular use. In European collections, these books were mostly treated with a strategy of "benign" neglect and for some it was long forgotten where they even came from or what they were. It was not until their rediscovery and reproduction that these books regained a new set of relations. And it is these new relations that will be the subject of the next chapter.

5. Reproduction of the Codices

The number of precolonial codices known to exist today is very small. As seen in the previous chapters, the reason for this is threefold: the material of which the codices are composed makes them susceptible to damage; codices were not meant to be kept indefinitely; and an active extirpation campaign by the Spanish conquerors effectively wiped the writing system out. Because of their rarity and the fact that they are spread thin over a dozen institutes mostly in Europe (see Table 1 in the introduction), these books have long been rather isolated from one another and from particular groups of researchers. Consequently, a better understanding of them required, as M. D. Coe (1992, p. 90) suggests, a correct reproduction. Such a reproductive process allows for a comparison of multiple texts not held at one place, and also allows for multiple persons to study the texts at one and the same time. Without faithful reproduction, these books would still be isolated curiosities in the institutes that hold them. In other words, without reproduction there would be no corpus of precolonial codices.

The way in which the codices have been reproduced is the central topic of this chapter. Within the cultural biography of these books, their replication can be seen as essential for their present day perception and for present day ways of dealing with them. Through time the objective for making these reproductions has changed, which has had a direct impact on the techniques used to copy and disseminate them. These changes in objectives for making reproductions also reflect a change in stakeholders, as increasingly large audiences became interested in these extraordinary books. In the context of these multifaceted changes, reproduction has been essential to spread these texts to non-researchers, which has had both positive and negative effects. Although increased access may be seen as a good thing in itself, processes of commercialisation and (mis-)appropriation have the potential to completely change the nature of these works.

In this chapter, only full reproductions of codices are considered. There are three reasons for this. First of all, there are too many publications of single images or a limited set of images of the codices to be considered here. Second, many of these are simply reproductions of one of the earlier facsimile versions, and therefore do not produce any new visual material. Third and perhaps most importantly, these individual images are reproduced in isolation within a new context. In the process of isolated reproduction, the codices are reinterpreted in a new and not always transparent context, which may have resulted in an intentional or unintentional change to the meaning of the texts. Moreover, the selection of pertinent images is highly dependent upon the argument that is put forward. Showing only select pages of a document pushes the reader towards a specific interpretation of the document as a whole. For example, it is very easy to portray a vision of the Codex Yoalli-Ehecatl – and by extension of its creators – as being extremely bloody. All that is needed is the selection and presentation of specific bloody scenes, while omitting any other scenes the rest of the document. Any text which includes images – including the present work – will work in the same way through selection of images that support the argument made. This has happened with the precolonial codices from the very beginning of their rediscovery in European libraries, in which they had been more or less forgotten until the 19th century.

The fact that the codices had been largely forgotten in Europe was made clear from the very first time that copies of images from the precolonial Mesoamerican codices reached a wider audience in Europe, with the publication in 1810 of the travelling accounts of Alexander von Humboldt. These accounts, however, contained only fragments of multiple documents and were not intended to show to the public the complete extend of the Mesoamerican literature, but more to illustrate a specific point. In the case of Von Humboldt, there is a clear tension between his respect for the architectural accomplishments he

encountered during his travels through Middle- and South America and his distaste for the writing system encountered in the codices:

"Chez les Mexicains, la férocité des moeurs sanctionneé par un culte sanguinaire, la tyrannie excercée par les princes et les prêtres, les rêves chimériques de lástrologie et lémploi fréquent de l'éscriture symbolique, paroissent avoir singulièrement contribué à perpétuer la barbarie des arts et le goût pour des formes incorrectes et hideuses."
(Humboldt, 1989, p. 215)

This chapter, therefore, considers only reproductions that aim at presenting the entire document and that give the document space to explain itself, so to speak. These reproductions are not necessarily all presented in the same format as the original – and this brings in other problems considered below – but they do (aim to) give a replica of the original encoded message. Four major projects of physical reproduction can be distinguished that aimed to reproduce multiple codices in the same form: Antiquities of Mexico; the copies of the so-called Borgia group funded by the Duc de Loubat; the first series of reproduction published by ADEVA in Graz; and the series of reproduction published by the Fondo de Cultura Económica (Mexico) in collaboration with ADEVA. Besides these large projects there have been quite a number of publications of reproductions of individual codices. Of these individual reproductions, only a few are selected and used here to illustrate how and why the reproduction of codices is currently undertaken. All these reproduction were made within a specific context and the accompanying commentary as well as the physicality of the reproduction itself can give clear insight into the intended function of the reproduction itself.

Next to physical reproductions, digital technology has made it possible to disseminate imagery without a physical medium. Here, again, the objectives for image-based reproduction and dissemination differ from case to case. The internet is an almost infinite place, though the number of websites presenting complete codices is limited.

As stated above, the dissemination of imagery of the codices to the general public has had unintended side-effect. One of these side-effects is re-production of this type of book, where "re-production" is meant to denote the creation of new inauthentic originals based on the precolonial examples. Two negative examples are given of this, which show how ancient precolonial codices can come to be misused.

5.1 ANTIQUITIES OF MEXICO

The first time that all the Mexican codices – as they were known at the time – were reproduced within one format, was within the project of Edward King, better known as Lord Kingsborough, under the name of "The Antiquities of Mexico" (Kingsborough, Aglio, & Dupaix, 1831). In the first three volumes, thirteen documents were copied (see Table 6). A fourteenth document – the Paris codex – was copied though never published.

Much has been made about this Lord Kingsborough and how he supposedly "Lost his Fortune trying to prove the Maya were the Descendants of the Ten Lost Tribes", as the title of an article in the 1985 issue of the Biblical Archaeology Review reads (Goodkind, 1985). Whitmore (2009) already showed that the situation was far more nuanced than a doomed biblical quest. The family had been burdened by debt by the father and grandfather of Edward King, long before he started his project.

Reviewers at the time of its publication were of a mixed opinion about the quality of the work. For a large part this had to do with the interpretation that Kingsborough himself gave to the images. Like North American researchers talking about the 'Mound Builders", Kingsborough did not believe that the cultures making these codices could have originated in the Americas. His argument was that these cultures were part of the Lost Tribes of Israel was outmoded even in his own time. Rather than focusing on Kingsborough's interpretations, the real contribution of this work is found in the replications themselves.

Copied Document	No. of Pages
Book One	
Codex Mendoza*	73
Codex Telleriano Remensis*	93
Boturini Codex*	23
Codex Ñuu Tnoo-Ndisi Nuu (Bodley)	40
Codex Añute (Selden)	20
Selden Roll	12
Book Two	
Codex Vaticanus A*	149
Codex Mictlan (Laud)	46
Codex Tlamanalli (Cospi)	24
Codex Yuta Tnoho (Vindobonensis Mexicanus I)	65
Humboldt Fragments*	18
Book Three	
Codex Yoalli-Ehecatl (Borgia)	76
Codex Dresden	74
Codex Tezcatlipoca (Fejérvàry-Mayer)	44
Codex Tonalpouhqui (Vaticanus B)	96
Book 10**	
Paris Codex**	13?
* Colonial Document ** Unpublished	

Table 6. Codices copied in the Antiquities of Ancient Mexico.

Whitmore (2009, 10) argues that it may have been the friendship with the bibliophile Sir Thomas Phillips that set Kingsborough on the road to his Magnum Opus (see also Graham, 1977). However, a second important impetus was the Grand Exhibit, which opened on the 8th of April 1824 in the Egyptian Hall in Piccadilly. In this exhibit, William Bullock had brought together for the first time in English history a large number of Mexican antiquities, plants, animals, minerals, and other objects (cf. Costeloe, 2006). This exhibit was made possible by a major political shift: the independence of Mexico from the Spanish crown in 1821. This political shift made Mexico much more open to foreign visitors and thus also to foreign explorers. Costeloe (2006, p. 277) argues that the exhibit by Bullock was for a large part responsible for the thousands of British people that left for Mexico in the first few years after Mexican independence. It is certain that it inspired Kingsborough and it was at the exhibit that he was introduced to Augustine Maria Aglio (see Aglio, 1853). Aglio had been commissioned by Bullock to make a number of lithographs for the promotion of the exhibit (Costeloe, 2006, p. 283), one of which was of the Codex Boturini, which was also part of the exhibit. Bullock had taken a number of documents – including the Boturini Codex – from Mexico without permission. When he returned to Mexico with his family after he sold the entire exhibit in 1825, he did however return the 'borrowed' books (Costeloe, 2006, pp. 289-290).

After having made the copies of the Boturini codex, Kingsborough commissioned Aglio to make copies of the codices in the Bodleian Library of the University of Oxford. But then, at some unknown point in time, there seems to have been a falling out between Aglio and Kingsborough. This falling out probably occurred for two reasons. The first is that in the earliest print of the Antiquities of Mexico, Aglio and not Kingsborough is mentioned as the author, and it seems that Aglio was the centre of attention when this book came out, as can be seen in a review from 1832 (Anonymous, 1832). The second reason was money. In his autobiography, Aglio laments the fact that he had always been careless about his financial wellbeing and that he regularly was cheated into working for either too little money or even for

Figure 5.1 left: Example how colour-coding letters become part of the design. Drawing with colour-coding, (©Trustees of the British Museum); middle: Kingsborough facsimile; right: detail of photographic reproduction of page 42 (Anders et al., 1993c).

free or at a loss (Aglio, 1853). At first, he seems to have trusted Kingsborough on the basis of "[…] the honour and liberality of a Nobleman"(Aglio, 1853, p. 9). But when Kingsborough died in 1837, Aglio had still not been paid.

Aglio's drawings of the codices are very precise, which is due to his way of reproducing the works. He traced the outlines of the figures using tracing paper placed directly on the surface of the document, which resulted in very accurate reproductions. The British Museum has in its collection some of the original tracing papers made by Aglio. According to the database of the British Museum,[43] Kingsborough donated these objects so that his facsimile could be compared to these drawings. He did not, however, include the papers of the codices held in English institutes, because for these objects the comparison with the original was possible. In order to save time, Aglio used two systems to record the colours. The first system was used on the small Codex Tonalpouhqui. Aglio started by drawing the outlines of the figures using tracing paper. He then used a reference system of letters to indicate specific colours (see Table 7). Since the Mesoamerican writing style does not use shading but instead colours areas in solid colour, for each field of colour enclosed with a black outline, a letter within a delineated area was enough to know what colour the figure had in the original.

Letter	Colour
bl.	blue
b.	black
v.	verditter
l.	carmine
s.	burned Siena
y.	yellow (bright)
g.	green
as.	ash colour

Table 7. Colour-coding used by Aglio and explained on the drawing of Codex Tonalpouhqui pages 49-50
green

Although this system has the major advantage that no coloured paint or ink needs to be used, it also has three drawbacks. The first is that occasionally the letters are mistaken for parts of the design. In figure 5.1, for instance, the face of the original image does not have the curl on the cheek as found in the printed Kingsborough edition. The line-drawing of Aglio shows clearly that this is the remnant of the letter v. used as a referent to the blue colour of the face.

43. http://www.britishmuseum.org/research/collection_online/, Accessed 24-12-2015.

Figure 5.2: Comparison of the drawing of Aglio (©Trustees of the British Museum) (left), the print in Kingsborough et al. (1831) (central), and photographic reproduction of page 42 (Anders et al., 1993c) (right).

The second issue is that some letters may be confused; especially the y, s, and g in the handwriting of Aglio can be confusing. In some cases though, it is clear that the one making the colour just did not read properly, as is clear in the example given in figure 5.2, where the bottom left numeral dot is coded as l. (red) while it was eventually printed as green.

The third issue with this system is that areas that are not coloured would sometimes get a colour as they were not explicitly coded as colourless. The one filling in the colour may have interpreted the omission of a letter for the colour as a fault in Aglio's drawings, one that needed to be corrected by adding a colour to the section based on best guesses. This is also clearly visible in figure 5.2. If the original depiction of the skirt is compared with the drawing and the facsimile, it is clear that a lot of the areas that were supposed to be white have been filled in with green, blue, red, and yellow.

A second system seems to have been more extensively used by Aglio and is found on the drawings of the codex Yoalli-Ehecatl, Tlamanalli, and Yuta Tnoho held at the British Museum. On these drawings, he only partially coloured every section (see figure 5.3). Aglio seems to have been intent on copying the codex as he saw it, as well as how it had originally been. He understood, however, that there was great uniformity in the selection of colours within this writing system. His note on his tenth drawing of the Codex Yoalli-Ehecatl is very informative in this respect. He recognised that the brown colour found in the coils in the border of this image originally must have been green. This tells something about the condition of the document at that time. Aglio only gives this note on this one page, simply colouring the other areas green. Today, all areas that once were green are degenerated to a brown colour. Aglio must have seen areas that were only partly degenerated, allowing him to come to the conclusion that all these areas originally had a different colour. As such, this gives some more indications as to the speed of degradation of the colorants discussed in chapters 1 and 3 above.

Aglio was in general very precise in drawing his facsimile. According to his own notes on the drawings, he checked them against the original and in some cases he made small comments where necessary. In drawing 64 of codex Yoalli-Ehecatl, Aglio recognised his mistake and added the comment to place the Rabbit year glyph higher and put the numbers below (see figure 5.4A). In the published editions, this was not done, creating a slightly different composition than the original depiction (compare figures 5.4B and 5.4C). In the drawings of the Codex Dresden, Aglio was very thorough and he ends his work with:

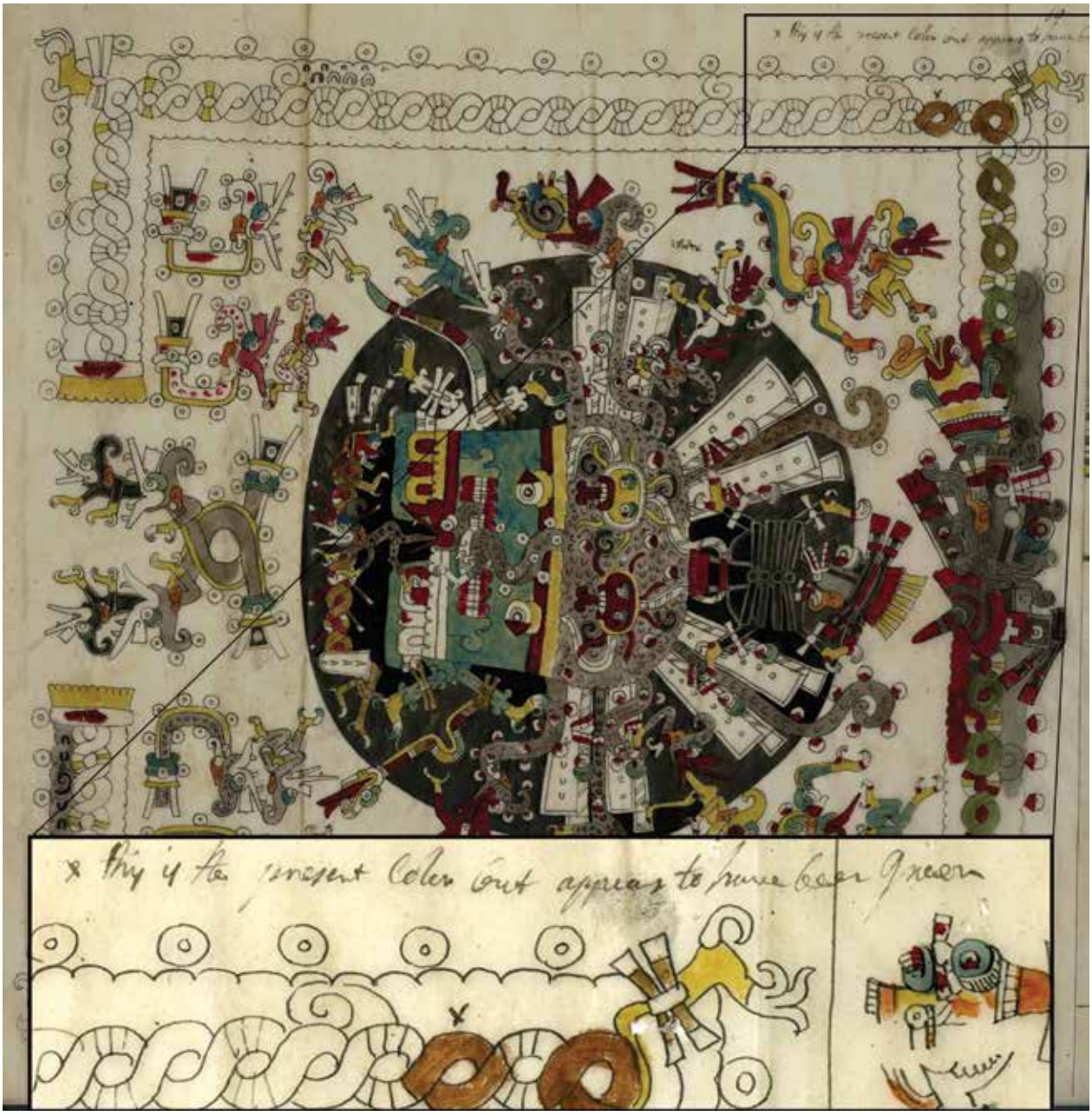


Figure 5.3: Aglio's drawing no 10 of the Codex Yoalli-Ehecatl, showing his system of partially colouring the images. The texts on the top continues on to the next page and reads "X this is the original color but appears to have been green", ©Trustees of the British Museum.

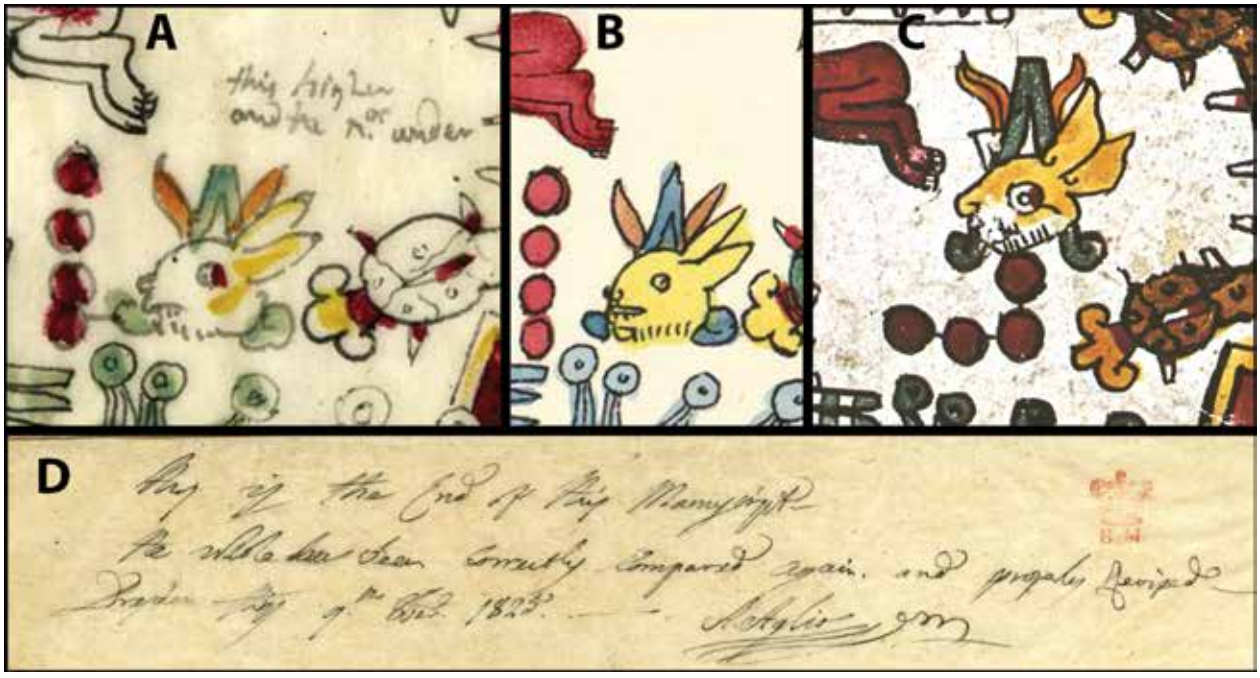


Figure 5.4A-C: Details of reproductions of page 50 in drawing by Aglio, Kingsborough et al. (1831) and Anders et al. (1993a); D: Comments of Aglio on his own work, showing his scrutiny of his own work, though not of the actual printed version (A and D ©Trustees of the British Museum).

> *"This is the end of this manuscript*
> *The whole has been correctly compared a*
> *gain and properly revised*
> *Dresden this 9th dber 1825 – A Aglio"*

(see figure 5.4D)

The exception to the rule of Aglio's precision is to be found in the calendar glyphs, which may help explain why the comment of Aglio shown in figure 5.4A was never copied into the facsimile. In the calendrical tables in the Codex Yoalli-Ehecatl and the Tonalpouhqui, Aglio used a system of numbers to designate the calendar signs. He numbered and drew the first row of signs, but only filled in the rest of the table with the corresponding numbers. As a result, the facsimile of the table looks very different, though it does contain the correct signs at the right locations in the table.

For the Codex Dresden, the drawings by Aglio are particularly helpfull because of the damage it suffered after the bombing of Dresden (see chapter 3). Probably because of its complexity, Aglio made very precise copies, colouring each area when needed. Where in the other codices Aglio did not seem to care too much what the exact colour was in his drawings, the large palette used by Aglio for the copy of the Codex Dresden indicates his desire to get the colours absolutely right. In figure 5.5, it can also be seen that the palette used by Aglio in his own drawings better reflects the original than do the published images in Antiquities of Mexico. A detailed comparison of the original codex and the drawings of Aglio can further help to understand the extent of the damage done to the document.

Although this did not end up in the facsimile, Aglio did note the existence of three blank or heavily damaged pages of the Dresden Codex. He notes (see figure 5.6):

Figure 5.5 left: Codex Dresden page 60. Drawing by Aglio (©Trustees of the British Museum); middle: printed facsimile in the Antiquities of Mexico (1831); right: image of the original in its current condition (from www.slub-dresden.de accessed 06-01-2016.

"In this three pages the Original appears to have been entirely defaced by water, in the accident. The pages are all over of a dirty red wash. – but not the smallest indication appears of having had any cifers or figures on it.
Dresden dber 9th 1825 A Aglio"

The drawings made by Aglio formed the basis for the printed Antiquities of Mexico, which was made using a lithographic process. This printing technique – first invented in 1796 (Wijnekus & Wijnekus, 2013, p. XXIII) – relies on the principle that oil and water do not mix. On a flat stone, the drawing is drawn in wax or oil. The surrounding areas are then etched away using an acid. When the stone is then completely wetted, it will retain water in the etched areas. The areas of the original drawing can then be filled with an oil-based ink which, because of the repellent function of the water, stays in the right place. This ink can then be transferred onto paper.

Since a way of printing colour with this system was not yet invented, the prints of Aglio had to be colored-in after printing by hand. In this procedure, there are three stages in which errors are inevitably introduced. The first is the drawing by Aglio; the second is the copying of the drawing onto the lithographic stone; and the third is the colouring in of the lithographs. As a result of this way of working the facsimile in the Antiquities of Mexico are of

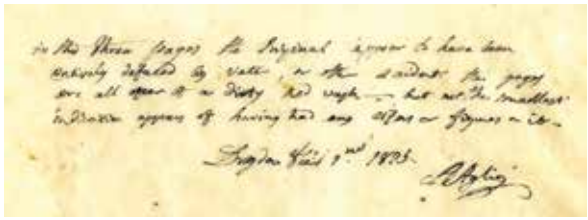


Figure 5.6: Aglio's comment on the defaced pages in het Dresden Codex (©Trustees of the British Museum).

varying quality. Nonetheless, for many of the codices they remained the only reproductions for almost a century. Furthermore, as the originals are not static, these facsimiles and especially the drawings of Aglio will remain important windows into an earlier state of the codices.

5.2 THE AGE OF PHOTOGRAPHY

The differences between the drawings and the printed versions of the codex show the fundamental problem of Lord Kingsborough's reproductions: their essential unreliability. Add to that the great expense of these versions and the outdated commentaries of Kingsborough himself, and it becomes understandable why half a century later new efforts were undertaken to create and publish another reproduction of these works (see Saville, 1901). The most important series representing this effort was sponsored by Joseph Florimont, the Duc of Loubat. Florimont had the codices of the so-called Borgia Group – including some post-colonial documents – reproduced using a technique called fotochromografia in the Italian commentary. It was thus a reproduction made using colour photography. This effectively removes one of the liabilities of the copying process: the recording of the original. Aglio's tracing papers were replaced with a photosensitive glass plate. Printing of colour photographs was, however, still somewhat difficult in this period, because the photo had to be transferred onto a printing plate before it could be printed on paper. This transfer, which in the time of Kingsborough still had to be done by hand, could be done directly using a principle called collotype printing since the late 1800's. In collotype printing, light is passed through the negative and shines onto a photosensitive, gelatine covered plate. The areas

Figure 5.7: Codex Borgia Loubat edition detail of page 56. Both the issue of shifting colours as well as the low contrast of the black lines due to the other colours printed over them can be seen.

exposed to light harden, while the areas that are kept in the dark remain gelatinous. The basic principle that underlies this technique is similar to that used in the lithographic technique. Ultimately, the hardened areas will retain ink, while the gelatinous areas will repel it (Wijnekus & Wijnekus, 2013, p. 137). With this technique only one colour of ink can be printed at a time, which is clear when the reproductions are studied in detail. Each page had to be photographed multiple times, each from exactly the same direction and each with a colour filter in front of the lens so that the colours could be registered individually. To make a coloured print, therefore, the three basic colours plus the black outlines needed to be registered separately. By using semi-transparent inks, other colours can be made by applying different layers of each individual colour.

A number of issues are clear with the reproductions undertaken by Loubat. The first is the issue of alignment. As each colour is printed separately, it is very important to align the paper correctly for each print run. In the versions of the Codex Yoalli Ehecatl (Borgia), Tezcatlipoca (Fejérvàry-Mayer), and Tonalpouhqui (Vaticanus B) held at the library of Leiden University, it is clear that sometimes the paper slightly shifted, resulting in one or more colours being printed in not quite in the right place (see figure 5.7). The second issue has to do with the printing of lighter and damaged areas. Since the prints are made by the mixing of colours, in order to make a lighter version of a colour – for example, making

Figure 5.8: Codex Yoalli Ehecatl (Borgia) Loubat edition details of pages 76 and 75 showing the extend of the fire damage before conservation treatment.

pink with the red ink – it has to be printed in such a way that the white background shines through. This means printing small dots instead of a solid colour. A third issue is that because the colours are only semi-transparent, the contrast of the images is not very good. The original codex creators had a similar problem, as seen in chapter 2. But in the case of the original Mesoamerican production of the texts, when a figure was coloured-in and some of the paint went over the black outline, these outlines were retouched to correct mistakes. With Loubat's prints, however, this did not happen, meaning that black outlines and small details are often not clearly distinguishable.

Still, it must be said that all of these issues are only minor problems for the study of these books and do not hinder the interpretation of these books. These reproductions were in fact the most faithful reproductions possible at the time, even reproducing for the first time the screenfold format. Moreover, because of the photographic method used, the Loubat reproductions also still valuable to researchers. When the printing issues are taken into account, they represent an earlier stage in the development of the codices that is invaluable to modern researchers. In particular, the Loubat editions of the more damaged books – such as the codex Yoalli Ehecatl (Borgia) – contain unique information that is today lost. For example, the Loubat edition shows the extent of the fire damage to the codex Yoalli Ehecatl (Borgia) before these areas were treated and reinforced (see figure 5.8). Besides these major advantages, the duc of Loubat also donated many of these copies to important libraries around the world, making his project a truly important one for the study of ancient Mesoamerica in general and this corpus specifically. Between 1930 and 1940, the Librería Antiquaria Guillermo Echániz in Mexico City made a further series of facsimiles. An overview of the facsimiles produced by this editorial can be found in Glass (1975). Officially, only 25 seem to have been made of each codex replicated, as can be read on the frontispiece of the Codex Ñuu Tnoo-Ndisi Nuu (Bodley) version found online.[44] However, when Troike tried to find a copy of the Codex Tonindeye (Nuttall) in 1987 she only encountered a version from 1963 (Anders & Troike, 1987, p. 28). An example of this version is kept in the Dumbarton Oaks library and used in their online exhibit of rare books "standing on ceremony".

Comparing this edition with photographs of the original shows that the copies are of a relatively good quality, though damaged areas are completely restored and the colours, which are filled in by hand, are off. How exactly these outlines were copied and what the source of the copies was remains unclear and would require close examination. Comparison with the Dover editions (Nuttall, 2013), which is directly based on the drawings by Zelia Nuttall in 1902, and with the photographs of the original shows that the Echániz copies are closer to the 1902 reproductions than to the original. Comparison of pictures of three pages and the frontispiece of the 1947 edition of the Codex Ñuu Tnoo-Ndisi Nuu (Bodley) found on the website of a rare books seller48, with the at that time available facsimiles, shows that the Echániz edition was copied from the Antiquities of Mexico, not from the original. There are also errors in the Kingsborough edition that were copied in the Echániz version. In figure 5.9, a comparison of one line of page 16 illustrates these errors and divergences. In the original codex, the mouth of the mask on the back of Lady 7 Flower is red, while in the Kingsborough and the Echániz version it is blue. Furthermore, the eagle headdress of Lord 4 Water is coloured in blue in both later versions. There are also some new errors introduced by the creator of the Echániz version, making this a less reliable reproduction than the one drawn by Aglio.

44. http://books.ioba.org/details.php?dcx=537219047&aid=vialibri#, accessed 30-10-2015.

Figure 5.9: Comparison of the central line of page 16 in the original Codex Ñuu Tnoo-Ndisi Nuu (Bodley), the Kingsborough edition and the Echániz edition. It is clear that the latter copied errors form the Kingsborough edition.

Although other copies would have to be investigated to affirm this claim, the series of Echániz seem to be copies made of copies, which were made and coloured-in manually. Combining this claim with the fact that only twenty-five of each were made, it becomes unlikely that the Echániz copies ever had, or ever will have, a great impact on the study of these books beyond being historical curiosities.

The first largescale project with the objective to reproduce all the codices in their original format was the Codices Selecti program undertaken at the Akademische Druck- und Verlagsanstalt in Graz. This series of prints was the first series of facsimiles of Mesoamerican codices to be made from single colour photographs. The codices are reproduced in true size and colour, and are folded in leporello format. Both the verso and the recto sides of the codices are printed when they contain something noteworthy. Commentaries on each codex were added as separate books or booklets. The contents of these commentaries – written by various authors – all excel in their physical descriptions of the codices. The commentaries also illustrate an important difference in the Akademische Druck- und Verlagsanstalt approach to dealing with these books when compared with prior reproductive efforts. Where previously all reproductions (and studies) were performed within the conceptual framework of the astral interpretation (see Seler, 1902), Karl Anton Nowotny and Ferdinand Anders took a different approach. It was the express purpose of these authors to create a series of facsimiles with accurate, systematic physical descriptions, without going into the interpretation. The idea was that only after all these books were widely and freely available could comparison and interpretation begin.

Though the Akademische Druck- und Verlagsanstalt reproductions are the first ones to be made from single colour photographs, they are not perfect. Agfachrome 50s photographs form the basis for these prints, except for the earliest run of the Codex Yuta Tnoho (Vindobonensis Mexicanus I) (Adelhofer, 1963), which was made using old collotype plates used for a publication by Lehmann and Smital (1929). The

Figure 5.10: Three prints of the codex Mictlan (Laud) by ADEVA. Left: a red colour proof; centre: the final 1974 version and right: the 1994 version.

Codex Yuta Tnoho (Vindobonensis Mexicanus I) was later re-issued (Adelhofer, 1974) with the same commentary, but with a facsimile based on the new photographs.

Besides being made with new techniques of colour photography, these new facsimiles were made using a different printing technique as well. Instead of collotype printing they were made with offset halftone printing, which, according to the editors, was far superior as it required no manual correction (see Adelhofer, 1974). With this technique each colour in a photograph is first transformed into a series of dots of varying sizes. Most halftone prints are composed of yellow, magenta, cyan, and black dots. These dots are too small to see with the naked eye, but by varying the size of these dots the intensity of that colour is also varied (see Stulik & Kaplan, 2013).

This same technique and even the same photographs were used for the second run of ADEVA printed facsimiles; that is, those facsimiles that accompanied the series of new commentaries "Códices Mexicanos" printed by the Fondo de Cultura Económica between 1992 and 1996 (FCE, Mexico). These new commentaries, written by Maarten Jansen, are very different from earlier Graz editions, as these do focus on the interpretation of the codices. There in-depth discussion of the meaning of the texts and each commentary illustrates the parts of the Mesoamerican culture that these books would have been interrelated with. In an epistemological way, these commentaries also go beyond their predecessors. For the FCE editions, it was decided to include the commentaries of a number of Mexican indigenous experts, including Luis Reyes Garcia (Nahua) and Gabina Aurora Pérez Jiménez (Ñuu Dzaui), for the creation of new interpretations. Without question, the cultural and linguistic background of these contributors greatly enriched the accompanying commentaries.
The multiple editions that rolled off the presses at Graz show that even the technique of photographic reproduction is not without its faults. Photosensitive glass plates had been replaced with plastic films, which contained photosensitive chemicals just like the glass plates used to. Every manufacturer of photographic films, however, used its own mixture of chemicals and its own procedure for developing the resultant negatives. The different chemicals in use resulted in photographs that differed in hue. When printing a photograph using the halftone process, the colour balance can be adjusted. In figure 5.10, three prints of the Graz facsimile can be seen. The left print was a trial run and it can be seen to be much too red. The trial run is an important part of the process of colour proofing, because it enables the identification of colours that need to be adjusted and to assess the accuracy of the resultant print overall. This can, however, be a very time-consuming process as each time the balance between the three colours of dots needs to be adjusted and a new print needs to be made. This new print then needs to be evaluated, preferably by comparison with the original. This process may have to be repeated many times over depending on the results of each trial run, and on

each occasion new printing plates would need to be made. The middle image of figure 5.10 shows the final result, which is relatively close to the original. On the right the same page can be seen but from the later FCE edition. Here the colour balance was adjusted more to the red, resulting in a more orange colour for areas that in the original are dark green; such as the feathers in the headdress or the fringe of the robe.

Next to these large scale projects reproducing multiple codices in the same format, numerous efforts have been made to reproduce individual books. There are too many of these smaller reproduction projects to introduce them all here. However, a few examples can be used to illustrate the formats in which the codices have become available today. The oldest of these, but still the most extensively sold ones, are the Dover publications of "The Codex Borgia" and "The Codex Nuttall" (Díaz & Rodgers, 1993; Nuttall, 2013). These paperback booklets incorporate drawings instead of photos, which are in turn copies of drawings made of the originals. For the codex Nuttall version, these were the drawings of Zelia Nuttall from 1902; while the Dover edition of The Codex Borgia is a photographic representation of the drawings made by Díaz and Rogers. In the latter the scenes that were damaged have been reconstructed. This makes the Dover edition hard to use for scientific research, since it is not indicated where the restoration took place. In the introduction to the Dover edition, it can be seen why and how these drawings were originally made. They were made in the context of a research on amate paper, and they were drawn on this material even though the original codex was made on skin. There is, therefore, a contradiction to this work. It is stated from the onset that the aim of drawing copies of the original codex was to reproduce the original splendour of the documents (Díaz & Rodgers, 1993, p. XI), yet the colours reproduced are the decayed colours visible during the late 20th century (Bruce E. Byland, 1993, p. XIII). Furthermore, the drawings are made based on photographs of the original, which, as seen above, may themselves exhibit differences in colour from the original. What's more, the commentaries in these editions are today relatively outdated as they are mostly based on work done in the late 1970's. And they also do not represent the form of the original codex, as both are written in a continuous run of pages in European book format. Thus the two-sided leporello format is lost. Despite all these issues, the Dover edition of both "The codex Nuttall" and "The codex Borgia" are to this day the cheapest and therefore most accessible editions of these documents. They are the most commonly found reproductions of codices in museum gift-shops and they are probably, with the possible exception of the latest Codex Ñuu Tnoo-Ndisi Nuu (Bodley) edition (Jansen & Pérez Jiménez, 2005), the only full reproductions that have reached beyond the specialist audience.

The very opposite of this is found in the reproduction of the codex Yoalli Ehecatl (Borgia) by Batalla Rosado (2008). This edition is made for the eccentric bibliophile, as is stated in the introduction to the over five hundred page long commentary that comes with the facsimile (Batalla Rosado, 2008). It is published by Testimonio, an editorial house that specialises in making very high-grade facsimiles, usually of European or Arabian manuscripts, each of which cost thousands of Euros. The edition of the Codex Borgia is no exception. Having only access to the commentary, not the facsimile, it was not possible to assess the quality of the latter. From the price alone, as the author admits in the introduction, it can be predicted that the impact of this facsimile on scientific interpretation will be lamentably low.

As can be clearly seen by these two examples, there is a direct relation between the quality of a reproduction and its price, and it is ultimately the choice of the author or the editor which to favour. Obviously, this is all related to the intended audience and the goal of the publication. The Dover editions are aimed at the masses, while the Testimonio publications are exclusive collector's items. Two publications of codices by Jansen and Pérez Jiménez (2005, 2007b) are exemplary cases of finding a middle ground between these two extremes. Though they are not technically facsimiles as they do not give the images at their original size and the colours are off, these publications do present the codices in their entirety. The codex Añute is presented in its original screenfold format, though printed smaller than the original; while the Ñuu Tnoo-Ndisi Nuu

(Bodley) is printed as separate images per page in a European book. The advantage of the latter is that below the image of the codex, a thorough explanation of each scene can be given. In case of the Añute, line drawings are used in the commentary to guide the reader through a step-by-step reading of each scene. What characterizes these editions is the clear aim not only to present the codex itself, but also to give an understanding of the way in which these documents are to be read. As such, they become a way for the reader to familiarise him or herself with the Mixtec writing system in general. Both editions are made with a different audience in mind, which is reflected in the language used in the commentary and the titles of the books. In the commentary to the Añute codex there is much more emphasis on the Mixtec language. This would likely be lost on the British audience for which the Ñuu Tnoo-Ndisi Nuu (Bodley) edition is written, without a much more thorough introduction to, and familiarisation with, that language. The differences between the reproductions are great as well. First of all, the format of the Añute reproduction allows it to be used without the commentary. In the first edition, the reproduction was contained in a separate thin cardboard "sleeve". For the second edition, the long strip of cardboard on which the images were printed was glued between two covers. Since the reverse of neither edition was printed, this works out well, though this gives no indication of the palimpsest on the reverse (see chapter 6). In case of the codex Ñuu Tnoo-Ndisi Nuu edition, the leporello format is explained and the reading order is thoroughly discussed (Jansen & Pérez Jiménez, 2005, pp. 32-35).

All the physical reproductions available today suffer from two fundamental problems: the physical limitations of the reproduction techniques itself and the cost of those reproduction techniques. The first physical problem is caused by the fact that normal photography and printing techniques can only give a relatively accurate representation of colours on a two-dimensional surface, but will always miss the third dimension – and with that the texture – of the original document. Surface texture can have a large influence on colour. Although it will not matter much for the study of the interpretation of these books, the lack of surface texture makes for a very different appreciation of the books. Physical reproductions lack the fragility of the original, and this in turn has an impact on the possible interpretations of how, where, and why these books could have originally been used (see chapter 3).

As has been shown, in order to make accurate photographic reproductions, the costs can skyrocket, making them less accessible. The better facsimiles become artefacts in their own right, only affordable to libraries, museum, or the rich. There is a direct inverse relationship, therefore, between the accuracy of the reproduction and its accessibility when it comes to physical reproductions. And even if the costs can be brought down, physical copies need to be transported to the user. The indigenous peoples in Mesoamerica are in general both economically and geographically marginalised.[45] This makes giving them access to their own heritage through these conventional physical means challenging.

5.3 DIGITAL REPRODUCTION

The digital age has greatly changed the image. Rather than being a physical reflection of a real world referent, the digital image exists as pure information. The information is encoded on a pixel level in the form of a code of ones and zeroes. The number of ones and zeroes is dependent on the number of colours that can be encoded per pixel. In a monochrome image – i.e. black and white – the number of bits per pixel is one. This means that the pixel is thus either white or black with nothing in between. In a two bit image, there are four possible outcomes: 0.0; 0.1; 1,0; and 1,1. This is translated into four colours per pixel. Currently most standard images encode in 8 bits, resulting in 256 possible colours per pixel. Since this colour information is encoded on a pixel base, determining the amount

45. Some communities – such as the Mixtecs – have a long history of migration. Thus, while their home towns may be located in geographically marginal areas, they themselves move in and out of the centers. This may give new opportunities to connect with their cultural heritage. This was the main reason for allowing the Los Angeles County Museum of Art to borrow the Codex Añute for a unique exhibit Children of the Plumed Serpents, because Los Angeles has the largest migrant community of Mixtec origin in the world.

of pixels in an image is a case of the determining factors for the level of detail of that image.

Although like with a printed version the existence of images is predicated on a prior existing medium – i.e. a computer – as digital objects images themselves have no material presence. Because they are pure information, they can be infinitely copied and they can be infinitely transferred and transformed. With the internet, images can be downloaded from servers around the globe in mere seconds. All that is required is a computer with internet access. Both computers and internet connections are becoming more and more widespread even in indigenous communities around the world; although this is still an area where more work needs to be done. Once realised, the internet forms a way of providing access to indigenous heritage in a much more egalitarian way. It must be made clear, however, that the internet has thus far never been explicitly used for this in the case of the Mesoamerican codices. As with physical books, there are many websites in existence, which present parts of the codices, often only singular images, in order to make a point. There are relatively few websites that present the user with a representation of a full codex. Again, a few examples will be selected below to illustrate how the codices are made available to the public.

One of the oldest collections of images of the Mesoamerican codices on the web is found on the website of the foundation for the advancement of Mesoamerican research (famsi.org). Here pictures or scans are brought together from the first ADEVA edition and the Loubat edition, as well as many other resources for study, such as dictionaries, drawings of monuments, and research papers. This early attempt to make the codices accessible online must be given credit when considering the limitations of the technology when it was launched in September of 2004. The introduction of faster broadband internet connections was only just getting started. This combined with the fact that the images provided were copyrighted to the ADEVA publisher, must have prompted the decision to make the images available in small format only. The scanning of a printed photo also introduces problems of quality, such as the formation of artefacts in the image, shifts of colour, and, when the scanning is done improperly, the blurring of the image or uneven exposure. Most probably due to the inconvenient format of the facsimile for flatbed scanners, all of these problems occur in the Famsi images. As the Famsi site copied the images from the Graz edition, little was done to provide new information on the codices. Over time this website grew, acquiring more resources that allowed for the study of all Ancient Mesoamerican topics, though the overview of newest content shows a distinct Maya preference. As with all projects, it was – and is – dependent on continued financial support. Since 2012, no new content has been added and grant provision by Famsi to researchers has ceased since 2007.[46] Recently, management of the site was transferred to the Los Angeles County Museum of Art, which may allow the site to make a second start in the future.

In January 1999, a large scale project[47] started to digitise all Mexican documents held at the National Library of Paris. This National Library houses a large part of the Boturini Collection and is thus a major collection of especially colonial Mesoamerican documents. The objective of the project was to study a number of codices using the same methodology, deconstructing each to its smallest elements and thus create a dictionary-like database. The database was first planned to be distributed on compact discs in French, English, and Spanish. The website amoxcalli.org.mx presents digital photographs of the original investigated documents. Since many of these digital photographs were never published – at least not in such a detailed way – this website is an important source of new information. Each of these images is subdivided into sections or individual elements, which form entries into the database. It is clear that this project was originally designed to be presented in the form of CD's, with only one document per CD. Although the database itself is standardised and thus for each element has the same field that can be filled in (though in practice they are often not), there is no cross-referencing between the elements presented.

46. See http://research.famsi.org/grants/index.php, (accessed 20-10-2015).
47. A description of this project is found at http://www.ciesas.edu.mx/proyectos/Amoxcalli/Indice1.htm, (accessed 20-10-2015).

Thus, the database is strictly hierarchical. Because of this, the website is a great tool for those trying to understand a specific element in a specific known document, but it cannot, for example, help to locate the same glyph in other documents. As such, the website functions best as a repository for knowledge gained from a single previous investigation, rather than as a tool for new knowledge production. The images themselves are not of a great quality either. Although they are large, they are also generally made with a high ISO level, resulting in a high level of granularity. This means that fine details – such as small alphabetic comments on the document – become difficult to read due to the noise. The only precolonial document on this website – the Paris codex – remains important, however, as it is the only publically accessible version that is in colour.

Not all webpages on which the codices can be found are entirely made for researchers. A website devoted to teaching people about Nahua and Ñudzavui[48] (Mixtec) culture is Mesolore.[49] On this website, detailed readings can be found of three colonial Nahua documents (Matricula de Tributos; Lienzo de Tlaxcala; and The Molina Vocabulario), and three Mixtec documents (Codex Tonindeye (Nuttall); Codex Añute (Selden); and the Alvarado Vocabulario). Set up in 2008 by Liza Bakewell and Byron Hamann as a continuation of an earlier project which also started on CD-ROM, the current mesolore.org presents only the codex Añute (Selden) in full. This is also a scan of a facsimile – that by Caso (1964) – though in a high resolution. Next to this, the site presents a lot of background information, colonial documents, dictionaries, and vocabularies, as well as lectures and workshop tutorials and class materials. By linking to social media, the website also spreads news items, which are usually related to new archaeological discoveries. In essence, this website does not offer much unique new information. Still, the concise way in which the information is presented, accompanied by all the material to give a workshop or class, does make it a good resource for teachers.

The sites presenting entire documents are for a large part the product of researchers of those documents trying to present and disseminate their research. The exception to this is the dissemination of codices by the institutes that have them in their collections. With the advancement of the digital age, more and more institutes are starting to realise the potential of digitisation of their collections. Thus far, only the British Museum, the Sächsische Landesbibliothek, the Vatican Library, and the Museo Nacional de Anthropologia (Mexico) have made precolonial codices available, though the Vatican has only digitised one of the two in their collection (the Codex Yoalli-Ehecatl). The Vatican Library has also decided to add large watermarks to all its images, thus distorting the otherwise high quality result.

The fact that the other institutes have not digitized their precolonial codices should not be seen as a sign of unwillingness of the institutes themselves. At the Bodleian Library, for example, there is a strong desire to disseminate the codices. In fact, the Bodleian Library is the only library to have itself published a book on one of the precolonial Mesoamerican manuscripts in their collection (Jansen & Pérez Jiménez, 2005). As one of the legal deposits in the United Kingdom, the Bodleian Library now has over 11 million printed items.[50] The collection of manuscripts is equally impressive. As such, although they have the largest collection of precolonial Mesoamerican manuscripts in the world (three, if the Codex Añute is counted as precolonial), but within the total corpus of the Library they are not a priority. Until 2011 digitisation took place on a project base, resulting in clusters of images of different works being put on separate project sites. Since November 2011 the Bodleian Digital[51] has become a central hub into which all digital images are to be incorporated. The biggest issue for all these efforts is funding. Though most institutes holding codices are not aimed at making profit, they still need to pay for the maintenance of their facility as well as the collection itself. Whereas the publishing of a book can (at least in theory) pay for itself by

48. Spelling as given on this website.
49. www.mesolore.org, accessed 21-10-2015.
50. http://www.bodleian.ox.ac.uk/about-us, accessed 21-10-2015.
51. http://digital.bodleian.ox.ac.uk/, accessed 21-10-2015.

the sale of the final product and even generate an income, digitisation does not result in any direct financial gain. There is even a fear that it may reduce the number of people coming to the library and thus spending money locally, even if such expenditure is just for an annual reader's card.

If digitisation is done correctly, however, it can be of a major benefit to the items themselves, as for many aspects of research they would no longer need to be physically handled. This, in turn, can help reduce the costs of conservation and restoration. Besides these considerations, there is a moral aspect that these institutes in general understand well. As the last remnants of a literate tradition, the value of access to these documents for the indigenous people is understood. As these documents in general do not travel and as the trip to Europe is for most indigenous people in present day Mesoamerica not an option, digitisation can help to bridge the gap between contemporary Mesoamericans and the objects of their own heritage. With this moral dimension in mind, major downsides in the way that the documents have been made available by the institutes up to this point can be identified. First of all, there is no explanation of the documents given in the catalogue of these institutes, besides a very basic form or type description. This is understandable as the focus of these institutes is to provide access to the material, not to interpret them, but it does mean that a user must be familiar with the subject to find interpretations elsewhere. The exception is the Codex Dresden at the Sächsische Landesbibliothek. This website has a lot of information on this codex, however thus far this seems to be available only in German. For English or Spanish users, a small leaflet can be downloaded which contains basic information in a manner similar to the other digitally available codices. The British Museum website does not provide a lot of interpretative information, but does give a small bibliography where this can be found. Being a museum rather than a library, it also links the entry of this codex to other types of objects from the Mixteca. The second issue related to the moral dimension mentioned above is that these digital reproductions are often buried deep in digital catalogues, making them impossible to find unless one knows exactly where to look. Thus, someone who does not know that the so-called codex Borgia is held at the Vatican Library will likely never find the images. This is made even more difficult by the names used for many of these codices compared to the names used in the catalogues. Codex Yoalli Ehecatl (Borgia) is recorded under its Latinised name Codex Borgianus or the call number Borg.Mess.1. A problem first signalled by Jansen and Pérez Jiménez (2004) is that their names make them even harder to find for non-specialists and especially for indigenous peoples, because names like Codex Selden or Codex Bodley do not reflect the Mesoamerican origin. Digital catalogues have the advantage that it is very easy to search on keywords and to link one entry to another, thus an easy way to start renaming the codices is already to be found in these kinds of databases.

5.4 RE-PRODUCING CODICES

Next to the production of facsimiles of known codices some people have busied themselves with the production of new originals. This can be seen as the direct, though unintended, result of the dissemination of the codex images to the general public. Rather than printing codices on paper, these people have tried to reproduce codex images – or codex-inspired images – by hand. In some cases, these efforts were presented as new works; i.e. artistic or commercial works inspired by the pre-colonial and colonial originals. This is, in essence, not problematic and the interaction with indigenous heritage to form new artistic expressions may be very valuable, if done in a respectful way. Some of these copies or new works, however, are presented disingenuously by their producers or by later owners as ancient originals. Often these producers use materials that they consider to be authentic to provide support for their claims. In general, there is not much difficulty in proving that such a fake is in fact new. However, since the corpus of these documents is so small, even the addition of a few pages can potentially alter the interpretation of the whole corpus and of ancient Mesoamerican history in general. A case in point is the Grolier Codex. A lot of discussion surrounds this document which has still not been conclusively proven to be a real

Figure 5.11: The document brought in by local Leiden arts dealer (photo by the author).

precolonial document or a recent fake. The problem is that if it is real, it would be so old that there are no comparable documents to determine its authenticity content-wise. Materially, it does not contain anything to indicate that it is a fake (Ruvalcaba et al., 2007), but this in itself is not however an argument for its authenticity. Even radiocarbon dating cannot be used to determine the true origins of the Grolier Codex, as it is not impossible to find ancient paper in caves or other dry contexts. One thing that throws doubt on the authenticity of this document is the pattern of wear. Some areas seem deliberately cut, while at other areas the inks overlap with areas of gesso degradation (Ruvalcaba et al., 2007, pp. 7-8). Moreover, the stains at the edges have the appearance of being applied intentionally, though these need to be further analysed to be better understood (Ruvalcaba et al., 2007, pp. 6, 8). However, since there is no recorded provenance of this document and it is thus unclear what the conditions were in which this document would have been kept over the last hundreds of years, the presence of intentional staining would not in itself be conclusive evidence to declare the Grolier Codex a fake. But whether or not the Grolier codex is real, there are certainly many fake codices around (see Glass, 1975). During this research project alone, two new fakes came to the attention of the researchers. A discussion of these two is here included to show two ways in which codices are reproduced and to explain the rationale of the

Figure 5.12: The Leiden copy under UV light showing the texts written between the figures (photo by the author).

producers of these fakes. Interestingly, at the surface at least, two very different rationales lay behind the two fakes that the researchers came across during the period of research.

The first re-production came to the attention of the Leiden research group when it was brought in for examination by a local arts-dealer. He claimed to have bought this document on an auction, though was reluctant to say where and when. The document (see figure 5.11) consisted of a single sheet of amate paper of approximately 35 x 45 cm, on which nine pictorial scenes could be seen.

What is immediately clear to anyone familiar with the precolonial codices is that these nine scenes are directly copied from a number of different codices. From top to bottom and left to right these are: Codex Tlamanalli (Cospi) page 12; Codex Yuta Tnoho (Vindobonensis Mexicanus I) page 48 (part); codex Yoalli Ehecatl (Borgia) 17; Codex Tezcatlipoca (Fejérvàry-Mayer) page 34; Codex Tonindeye (Nuttall) page 52; Codex Yoalli-Ehecatl page 71; Codex Mictlan (Laud) page 16; Codex Mictlan page 13; and Codex Tlamanalli, also page 12. Besides these figurative scenes all but the middle and top-middle scene have a series of calendar signs below them, even though not all of the original figures have these calendar signs themselves. In the top

Figure 5.13: Page 1 of the Tzolk'in of Wenk'al, The snake or dragon that dominates this page is clearly not Maya in style.

Figure 5.14: Page 7 verso of Tzolk'in of Wenk'al, demonstrating the pseudo-glyphs that cover this side.

left sequence of calendar signs, the sign for House appears twice, though in different styles. This shows that the author of this document was not completely familiar with what he was copying. As there are scenes copied from both historical and religious documents, it is clear that there is no internal logical consistency between the scenes. What makes this document more complex is the alphabetic texts added between the figures (see also Appendix B). These texts were made using an ink that faded and are now only visible using a UV light (see figure 5.12).

These texts show a conscious attempt to trick the observer into thinking this document is more than it is. The creator of this document added partially legible Spanish comments and Nahuatl-like words to make the document appear like a precolonial document with notes in the style of the early colonial friars. For example, multiple texts start with the phrase "dizen que fue, " – i.e. "they say that there were" – recalling the way that early colonial friars related what their informants told them. There also appears a date "año 1527" below the central figure. All the texts are only partially legible and thus suggest an old age for the document, without saying so much that the creator would be forced to betray the fact that he was not completely – or not at all – knowledgeable about the subject. There is one point where this goes completely wrong. Above the central figure is written "8 Venado". This particular way of writing the calendar names of the Mixtec Lords and Ladies with a European numeral was first introduced by Alfonso Caso, best expressed in his dictionary of Mixtec Kings and Queens (Caso, 1979). This shows that this document cannot have been made before the writings of Caso. Purely by coincidence, a very likely source-text for this copy was encountered. In 1953, a small book was published called "Magic Books

from Mexico" (Burland, 1953). This book contains 16 colour plates, which include all nine of the plates copied on this sheet of amate. A further indication that this book was copied comes from the text above the top left figure, which reads ixcaliuhqui. The figure on the top left and that in the bottom right in this copy are printed above each other in the 1953 book. This could explain why the name of the deity depicted in the bottom right – given as itzcoliuhqui by Burland (1953) – appears above the top left figure. If indeed "Magic Books from Mexico" is the source text for this copy it is clear that the document is in a very rough shape for its age and it must be considered that indeed this is a fake, rather than a simple copy. It is, then, consciously made to look older than it is. The inks used would have to be a very inferior quality or specially treated to have faded that much, and the paper itself should not be in such a poor condition. All of this shows that the creator of this document had a specific idea of what a potential buyer would think an ancient document would have to look like. The choice of substrate, the worn look, and the faded colours were all specifically chosen to trick the buyer into thinking he had something more special than it in fact was.

A second document – called the Tzolk'in of Wenk'al – came to the attention of the author in the summer of 2015. It is a supposed Maya codex of which coloured photocopies were offered by a self-proclaimed Maya Elder called "Hunbatz Men" to the Wereldmuseum in Rotterdam (The Netherlands).[52] This codex-style document contains thirteen pages, each of which is painted on both sides. They were supposedly connected in an accordion format, though the copies show each as a separate sheet. The damage along the edges shows the paper has a very coarse fibre. Comparing the edge damage as well as the surface scratches near the edges casts doubt on whether these pages were ever part of one whole, as the scratches do not align. The pages are extraordinarily large in comparison to the known Maya codices, each measuring 20 by 26 cm according to the text written by Hunbatz Men[53] and included in the folder of images. Besides the fact that the style of the iconography is clearly not ancient Maya (see figure 5.13), the glyphs are also either completely made up or at least nonsensical within the context that they appear.

On one side of the document, glyphs are used that seem to be inspired by the known codices, specifically the Dresden Codex. On the reverse side, the pseudo-glyphs seem to be inspired by real glyphs found on Classic Stelae, though they are completely nonsensical and have an almost comical appearance (see figure 5.14).

The explanation of this document as it is given by Hunbatz Men, shows how this "codex" would have been used and why it was made. First, the document is compared and equated with the three known Maya codices held in Madrid, Dresden, and Paris. No mention is made of the Grolier codex or any other documents of which the authenticity is under discussion. It is then claimed to be a precolonial original document. The Tzolk'in of Wenk'al is interpreted in a numerological way, where the number of glyphs is important, rather than the actual meaning of the glyphs, which is never given. The dot and bar numerals that abound throughout the codex on the other hand are completely ignored. Even the size of the codex is clearly not accidental, with thirteen pages each measuring 20 cm making a total length of 260 cm, the number of days in the calendar. This of course skips over the fact that the ancient Maya did not measure in centimetres. The images that fill more than half of every page are interpreted in a very superficial manner. For example, about page 2a (see figure 5.15) the reader is only informed that:

"the central figure is the head of a fox, an animal that represents trickery, observation, patience and other qualities."

Besides the fact that this interpretation is very shallow going into only one element of this rather complex design, these attributes given to the fox are not Maya

52. These copies as well as the "interpretation" of Hunbatz Men are now held at the Library of the Museum Volkenkunde in Leiden.

53. No scale is included in the image so it is difficult to be sure about this.

Figure 5.15: Detail of page 2 of the Tzolk'in of Wenk'al showing the "Fox head"

at all but European. This document is thus interpreted by and for people that have very little knowledge of ancient Maya culture or writing. What Hunbatz Men is trying to convey to the reader, therefore, is how this document can be used as proof for his own ideas about Maya spirituality and the secret Maya wisdom that they encode for predicting the future.

This is symptomatic for the way in which New Age religions (there are many forms) deal with both ancient and contemporary cultural expressions. The movement is firmly rooted – and even a result of – Western capitalism (Aldred, 2000, p. 329; York, 2001, p. 367). As was shown in chapter 3, religion creates community through communal ritual. Religion in the Western capitalist society is an increasingly a private affair that one can choose to belong to or not. Secularisation combined with globalisation has turned religion into something chosen from a competitive marketplace, rather than a state-sponsored and predetermined certainty (York, 2001, pp. 362-363). This has led to a lot of uncertainty, as the foundation of any religion is an unquestionable Truth (see Rappaport, 1999). But all of the New Age religions try to combine different elements of religious practices from around the world into something new. In this sense, New Age religion plays right into the uncertainty that the religious marketplace has created. Often some ancient, secret, exotic, or extra-terrestrial element is included. This provides a source of sacred knowledge that is beyond the understanding of regular persons. And, in turn, this becomes a new unquestionable Truth which can only be interpreted by the initiated few.

Because it comes from the principles of the free market economy, there is no inherent contradiction in asking money for the spiritual service within the New Age movement. As consumers, the believers are generally happy to pay for these services and for the products that are being sold both in stores and online. Thus multiple websites[54] hail Hunbatz Men as an almost heroic figure of great knowledge and yet simultaneously charge large amounts of money for his books, videos, and for so-called healing sessions with him personally.

Both fake documents discussed here are thus part of a continuing process of commercialisation of an appropriated culture. It is unclear who made the central Mexican fake, yet it ended up in a Western-style arts auction. Although Hunbatz Men claims to be Itza Maya (his true identity is somewhat unclear), many non-indigenous, mostly North American, New Age specialists profit from the sale of indigenous spirituality. As can be seen with the faked Maya codex, in the process these belief systems are often dumbed down and re-cast into Western – and market capitalist – terms.

The use of indigenous spirituality has provoked much anger in North America (Aldred, 2000, p. 335). But in Mexico and Guatemala the use of Indigenous culture has in general received a more mixed reaction. This is mostly due to the fact that centuries of colonialism by the European powers and by later policies of the national regimes have been internalised and left many indigenous peoples with the idea that their culture and language is not worthy of attention. As such, some Indigenous peoples see the interest in their cultural expressions – even though they are completely misinterpreted – as a form of valorisation of their cultural roots. Another large factor is the financial gain of having groups of New Age believers coming to indigenous communities to visit sacred places and talk to "real shamans". While some may grudgingly welcome the New Agers, others see all precolonial spirituality as

54. These sites include http://www.cosmicmysteries.com/; http://www.council-of-world-elders.de/; and http://www.prophecykeepers.com/hunbatz-men.html. A very different view of Hunbatz Men is found on http://www.newagefraud.org/smf/index.php?topic=1035.0 (all accessed 19-10-2015).

something that needs to be wiped-out, mostly under the influence of new protestant missionaries. Thus, the link between precolonial roots and contemporary indigenous society is under pressure from all sides.

DISCUSSION AND CONCLUSIONS

A general trend can be seen in the reproduction efforts discussed in this chapter: a definite and systematic increase in the accuracy of the capturing of the images that compose the codices. The tracing paper of Aglio was replaced by photosensitive chemicals on glass plates and later on plastic films. At first, these plastic films were only able to register one colour at a time, but later inventions made it possible to record the image as a whole. Digital photography then removed the dependence on chemical substances altogether, replacing it with photosensitive sensors. With this increase in accuracy, the faith put in photographic reproductions also increased. However, as shown in this chapter, the reproduction of the codices did not only depend on the techniques used to record the image, but also on the printing of that image. In order to get a truly accurate depiction, multiple proofing prints needed to be obtained at great expense. Thus, the most accurate reproductions were – and are – very expensive. These reproductions have become a type of artefact in their own right or at least a stand-in for the inaccessible originals. This has led to a number of issues, as for some of these reproductions the colours may be off, they may appear to be less fragile than the originals, and they are completely two-dimensional.

The digital age has provided some solutions to these issues. First of all, digital photography and image processing has allowed for a much easier calibration or correction of the colours. Here there are again some issues, however, with the presentation of the gathered data, as, for example, computer screens may not be correctly calibrated. Still, these are all issues that can be checked and corrected, so long as photographs are taken with a reference standard. Digital photos do, however, remain two-dimensional. A number of techniques exist for making a 3D recording of a surface, though these methods are still very much in development. The difficulty in this case is that, rather than with many other (archaeological) artefacts for which such methods are already used, the variation in one of the three directions (the Z axis) is much lower than in the other directions (X and Y axes). Thus, the techniques need to be very precise as errors during recording have a much greater impact on these small variations. Such precise techniques are generally developed for other types of cultural heritage and so it is likely to take time to adapt these techniques to the reproduction of codices. Lessons can be learnt from the present application of these techniques, however. For instance, one application where similar problems have been encountered is with the recording of the three-dimensional structures of oil paintings. A recently developed portable and non-invasive technique – called fringe encoded stereo vision – is now able to record both the local colour and the variations in height in high detail (Zaman, Jonker, Lenseigne, & Dik, 2014). This technique, then, allows for the creation of a digital height map of the surface in colour, which could be applicable in the case of codices. A second, potentially useful technique that can mimic the three-dimensional effect of the surface is RTI imaging (see Malzbender, Gelb, & Wolters, 2001). This technique uses a series of digital photographs taken from a fixed point, while varying the direction of illumination. Differences in recorded colour occur because of variation in surface topography. Thus, from these photographs a single image can be created in which the user can place the light source in any desired position. In order to increase precision, the number of photographs can be increased, but this only works if there is no variation between the position of the camera and the position of the recorded object in each photograph. The location of the light source must also be known as exactly as possible for each photograph. This second technique has already been applied to the codex Añute for the recording of surface information and is discussed further in chapter 6.

The generation of 3D data is picking up speed in many different areas of research, but also in commercial application in, for example, the field of 3D printing. Now, in fact, even the printing of the 3D scans of oil paintings belongs to the realm of possibilities (see Zaman et al., 2014). But there is a general challenge with this type of data, because as the accuracy increases, so does the file size. And many

high-resolution files are too large to be accessible to non-professional users. It may be that technological advances will remove these problems in the future, but at this time 3D technology is not yet at a stage where it can be effectively used to disseminate these relatively large objects of cultural heritage in detail.

In this chapter, it was also seen that the dissemination of the codices to the general public has had some unintended consequences. With increasing accessibility of these codices both as physical reproduction and on the internet, re-appropriation, commercialisation, and general misuse only becomes easier. Although the making of fake codices may appear at first relatively harmless, there is an entire industry behind some of these objects that is intent on making money through the exploitation of the Mesoamerican indigenous heritage. In this way, this heritage is being misrepresented and misinterpreted, which ultimately devalues it. It is, therefore, important to consider how data is presented either online or in print, and to critically evaluate what information is provided with that data. In the general conclusion of this work, a possible framework for doing just this will be discussed.

6. Recovery of a Hidden Chapter in the life of Codex Añute

Codex Añute, or Ms. Arch. Selden (A.2) as it is catalogued at the Bodleian Library in Oxford, is unique even amongst such a small group as the Mesoamerican Codices. It is a palimpsest, meaning that underneath the gesso surface another series of images is to be found. This chapter reports on an ongoing effort to recover these sub-gesso images using advanced non-invasive techniques. The unique materiality of these documents makes this a challenging endeavour. The only published project to investigate this palimpsest was undertaken during the 1950's at a time when technical capabilities were limited, but also at a time when a concern for conservation had not led to the implementation of strict regulations for research. Taking lessons from this project, a new project was set up by the collaboration of Leiden University, University of Delft, and the Bodleian Library in affiliation with an intervention of the Italian MOLAB. At the University of Delft, Tim Zaman has developed new techniques specifically for the investigation of this document. Although the interpretation of the results of this inter-university collaborative non-invasive investigation is still ongoing, the final part of this chapter will try to draw some general conclusions about the nature of the hidden text.

6.1 DESCRIPTION OF THE CODEX

The codex Añute came to its current location after it was bequeathed to the Bodleian Library by John Selden as part of his massive collection of over 8000 printed books and thousands of manuscripts upon his death on November 30th 1654 (Philip, 1983, p. 48). Because it was part of this important donation, it is also known as Codex Selden, or by its library shelfmark: MS. Arch. Selden. A. 2 (S.C. 3135).[55]

Like with the other Mesoamerican manuscripts that entered the United Kingdom, not much happened with the codex Añute until it was published in facsimile by Lord Kingsborough (1831) (see chapter 5). It would take another hundred years, however, before it received true scholarly attention (see Glass, 1975, p. 196). These earlier investigations were not yet able to securely identify the origins of this document (see Spinden, 1933), though with the work of Alfonso Caso (1949, 1964) it finally became clear that this document was Mixtec.

The document known today as the codex Añute is technically a colonial document, though in style, materiality, and in content it has all the characteristics of a precolonial manuscript. It is a historical codex, dealing with the dynasty of a relatively small town which is identified by a glyph of a mountain spewing sand. This "sand belching mountain" has been identified by Smith (1983) as the town of Magdalena Jaltepec (see also Jansen & Pérez Jiménez, 2007b, p. 23). Jaltepec – or Xaltepec – means mountain of sand and is a Nahuatl translation of the Nuu Dzaui (Mixtec) name Añute, "Place of Sand". This prompted Jansen and Pérez Jiménez (2004) to propose renaming the document the codex Añute. A complete translation of this codex can be found in Jansen and Pérez Jiménez (2007b). It is known to be a colonial document, because it refers in its last two pages to events such as births, marriages, and deaths during the early colonial period. Besides the correlation of dates, the fact that some of the later people involved are also known from Spanish records – having been baptized and given a Spanish name – is further evidence that the document is colonial in origin (Jansen & Pérez Jiménez, 2007b, p. 285). This codex is different from the other known codices as it is the only codex that has to be read completely[56] from the bottom to the top. It is made

55. This is the correct format for this shelfmark as provided by Dr. Barker-Benfield of the Bodleian Libraries. The notation given by Caso – "Codex Selden 3135, A.2" (Caso, 1964) – is erroneous as 3135 is only the running number of the summary catalogue.

56. As opposed to some other documents such as the Codex Yoalli-Ehecatl which require the reader to turn the codex for the reading of particular sections.

Figure 6.1 left: pages 1 and 2 recto of the Codex Añute showing the present day palette; right: detail of page 12 recto showing the last remnants of the original blue and green colours (photo by the author, courtesy of Bodleian Libraries, University of Oxford).

on six pieces of leather connected end-to end to form a long strip of approximately 27.5 by 550 cm. The document itself was folded into 20 almost perfectly square pages. Although the last two pieces of leather are thinner than the first four (as was shown in chapter 3) and there is an empty space at the end of the document for future additions, it seems that the later text was made in one hand as one single project. It was, therefore, not a continuous, documentary project to which new texts were being systematically added over a longer period of time, which could have been one explanation for the addition of two sheets of different and inferior sheets of leather. The reverse side of the document is only covered with a roughly applied white gesso layer, which was not used as a writing surface. As has been shown in chapter 2, this layer is needed to give strength to the support. It seems unlikely that the codex in its final form had a cover, as on the outside of the first page a large year sign is drawn which seems to take the place of a cover. Furthermore, the leather on the last pages is too thin to support an attached heavy cover.

The codex Añute is not in the best condition. First of all, the execution of the drawings is in itself of a sub-par quality. Individual lines are shaky and not of a consistent thickness, while the colours used to colour-in the figures often run over the black lines or over other colours (see figure 3.13). Contrast this with the Codex Mictlan, for example, in which the individual sheets of leather are difficult to recognize as the overlapping sections have been trimmed down and carefully smoothed. In the Añute, the sheets of leather are clearly visible. These overlapping sections distort the drawings to some extent, but, more importantly, they are areas susceptible to degradation as the difference in thickness leads to increased localised friction as seen in chapter 3. Due to the thin leather used on the last pages, the conservation state of these pages is poor. This thin leather is flexible, meaning that it bends easily, causing the covering gesso to crack and flake off. The conservation of the colours in this document is not good either. The present day document as can be seen in figure 6.1 (top) contains only black, yellow, red, a greenish brown colour, and a cream colour, together with diluted variants such as grey and pink. In one particular section in the lower register of page 12, the original colours are visible (see figure 6.1 below). The brown colour can thus be seen to be a degraded form of green, while the cream colour can be seen to be a degraded blue. Both of these colours, then, can be explained as a degradation of blue, because the green colour itself would have been achieved through a simple combination of the yellow and the blue paint.

Gesso also flakes off on the reverse of the document. Even prior to the Second World War both Thomas Athol Joyce and Guda v. Giffen-Duyvis noticed that traces of paint could be seen through the cracks in

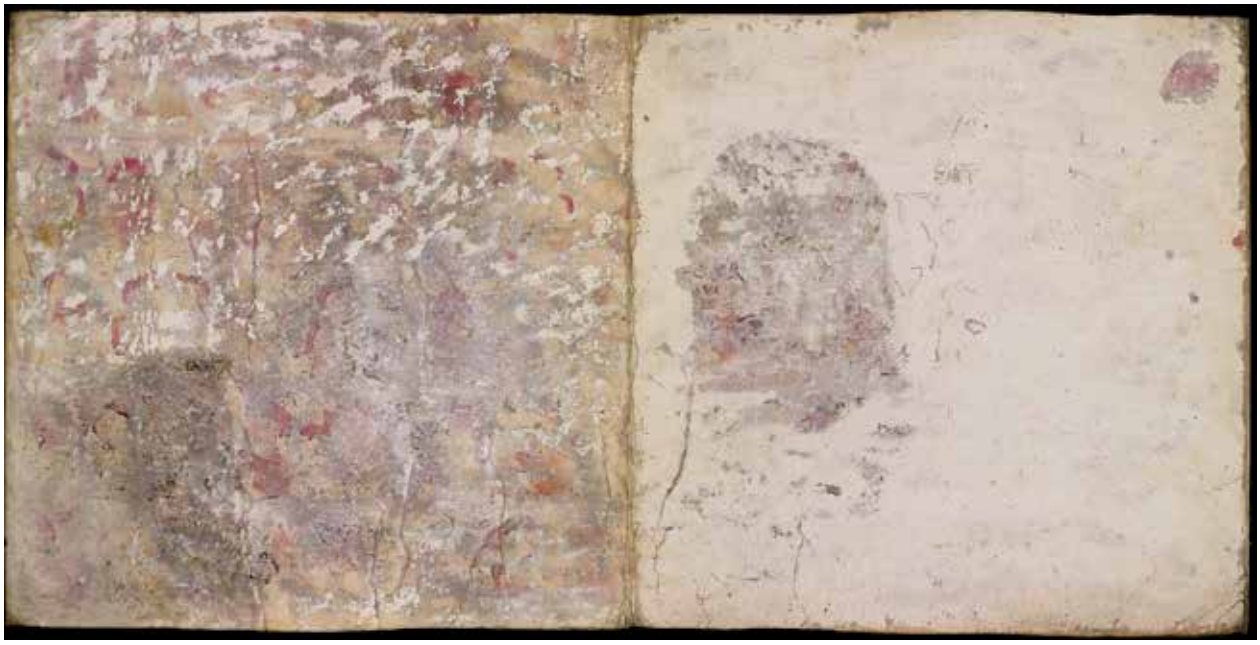


Figure 6.2: Reverse of pages 11 and 10 verso, showing the areas where the gesso was removed during the 1950's investigation (courtesy of Bodleian Libraries, University of Oxford).

the gesso on the reverse of the document (see Dark & Plesters, 1958b). It was Alfonso Caso, however, who first recognised the potential importance of these covered paintings. In 1952, the famous Mexican archaeologists arranged with Mr Braunholtz to have the document pass onto the British Museum after the 30th International Congress of Americanists at Cambridge, where the document had been exhibited (Dark & Plesters, 1958b, p. 531). While at the British Museum, it was subjected to a number of investigative techniques in order to reveal the nature of the palimpsest.

6.2 THE INVESTIGATION OF THE AÑUTE PALIMPSEST IN THE 1950'S

The investigation performed in the 1950's, partially at the British Museum and partially at the National Gallery, was published as one ten page article in the Proceedings of the International Congress of Americanists in 1958 (Dark & Plesters, 1958b). One of the main reasons for the lack of further publication on the matter may be the devastating review by Caso (1959) of a book on the interpretation of the two Mixtec codices at the Bodleian Library written by Dark (1958). The critique that Dark had on Caso's reconstructions of the histories in the Mixtec codices was not appreciated by the Mexican archaeologist. It seems, in fact, that Dark was so discouraged by Caso's negative review, that he discontinued his work on the study of Mesoamerican cultures. An informative, though unpublished, report on the investigation of the palimpsest is held at the Bodleian Library (Dark & Plesters, 1958a). It appears that this report formed the foundation for their later article, though it contains some important details that do not appear in the shorter article. These two sources, combined with the also unpublished infrared photos made during this investigation, are able to give a better insight into their methods and their findings. These photos were held partially at the Bodleian Library, while others are still in the possession of the National Gallery.

The first investigation, performed at the British Library, was carried out by Dr. Plenderleith. His aim was to confirm the palimpsest nature of the document. He used benzol to make the gesso more translucent and was able to see black lines and red colours through a binocular microscope (Dark & Plesters, 1958a, p. 4). Having thus confirmed that

Figure 6.3: IR photo taken at the National Gallery of page 11 verso after treatment by Dr. Plenderleith (courtesy of Bodleian Libraries, University of Oxford).

the codex is a palimpsest, he set out to physically remove the covering gesso layer on page 11 verso using bauxite blast and on a section of page 10 verso using scalpel and bedacryl varnish (Dark & Plesters, 1958a, p. 4) (see figure 6.2).

The codex was subsequently returned to the Bodleian library, but was in 1956 transferred to the National Gallery, which had better equipment for further study. At this point, it was unclear what the composition of the paints was and thus there was still hope that X-ray based techniques could work to reveal at least part of the palimpsest. This proved not to be the case. With the permission of the curators of the Bodleian Library, cross-sections and samples of less than 1mm2 were taken to determine

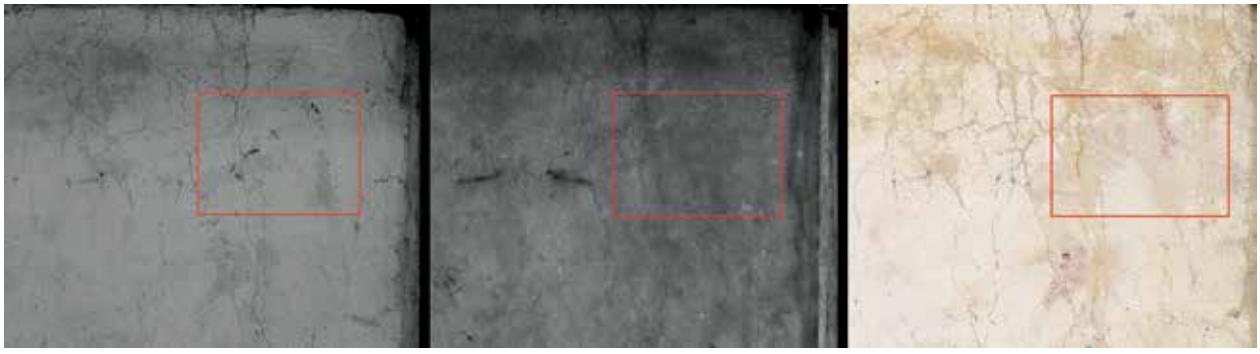


Figure 6.4: Comparison of images taken at different stages of the 1950's investigation (left: image recorded as number 6) (middle: image recorded as number 4) and the present day state (courtesy of Bodleian Libraries, University of Oxford).

the composition of the paints as well as the structure of the document. However, it was not possible to determine the complete composition of the paints, though it could be seen that the red colour was the same in the hidden images as it was on the visible images on the front. The black was determined to be carbon black, but the yellow and blue could not be securely identified, though they were determined to be organic (Dark & Plesters, 1958b, pp. 532-533). This explains why X-rays did not yield any results.
Because of the presence of carbon black and the lack of mineral pigments, it was decided to first attempt to recover the palimpsest using infrared photography (see figure 6.3). Three photos were made of page 1, 2, and 5 of the verso side. The photos themselves showed very little results. The next step was to attempt to increase the penetrability of the gesso for the infrared radiation. One way to do this is to coat the surface with a material with a high refractive index. According to Dark and Plesters (1958a), this method was deemed not to be damaging to the codex. At first, a white spirit and later xylene thinned with an odourless kerosene were applied to reduce evaporation due to the heat of the infrared source and to create a temporary coating of the surface (Dark & Plesters, 1958a note 6). Infrared photos were then made while the pages were wet. This worked to some extent, though still the underlying designs could not be made clearly visible. Still, the determination of researchers to uncover the secrets of the palimpsest did not waver and subsequent to the failure infrared investigation they decided to subject page 5 verso to a number of tests to see if the thickness of the gesso layer could be reduced in a safe way. Introduction of vibrations with a vibrator; dampening with water; followed by dry rubbing cotton wool; and stripping film were all tested on the page, but none gave satisfactory results (Dark & Plesters, 1958a, p. 10). A third infrared photo was made of this page after wetting it with the xylene solution for a second time. But this was once again unsuccessful and so after these photographs were completed the codex was returned to the Bodleian Library. Dark and Plesters state in both their preliminary report and in the published article that the underlying images were probably erased by the creator of the later document and that it was therefore useless to attempt any further recovery of the palimpsest.

Was this conclusion warranted? On page 11 verso, it is indeed clear that there is little paint still attached to the surface as was stated in the preliminary report (Dark & Plesters, 1958a, p. 11). An examination of the areas laid bare by the investigation on page 5 also shows only smudged red stains instead of clear paint layers. It must be taken into account, however, that the techniques for the removal of the gesso layer were highly invasive. Bauxite blast and scraping or removal through vibration of the layer is much more likely to remove both the covering gesso layer and the underlying gesso layer together from the skin, than it is to separate two layers of gesso from one another. What is left, as is especially clear on page 5, is the leather with some remnants of paint that seeped through the first gesso layer and thus stained the leather itself. The carbon black paint is

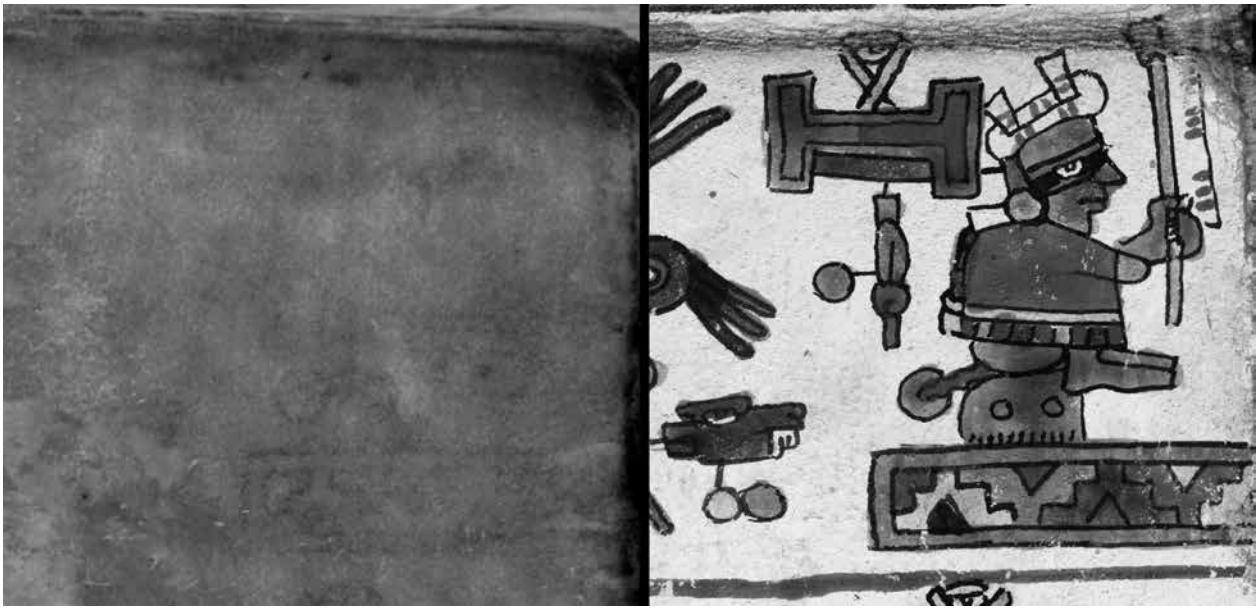


Figure 6.5: Comparison of Infrared image interpreted as positive result and the design on the front of that page (flipped for comparison) (courtesy of Bodleian Libraries, University of Oxford).

described as rather coarse lamp-black. As such, it is unable to penetrate into the gesso, but rather lies on top of it. When covered with a second layer of gesso it lies sandwiched in-between the two layers. Even a slight removal of the lower layer of gesso would, therefore, mean that the carbon would be completely destroyed. This is clearly seen if the infrared photos of the intervention on page 5 verso are compared (see figure 6.4).

It seems that the numbering of the infrared images was confused at some point at the National Gallery: the image recorded as image 4 is actually number 6 and vice versa. This can be determined by the fact that on image 6 cracks in the gesso layer are visible in areas where image 4 shows no gesso layer at all. Image 4 can also be compared to modern colour photos which indicate the same shapes of removed gesso. Although they considered it an improvement, the removal of gesso on page 5 can be shown to be highly destructive. In Figure 6.4, it can be clearly seen that the area in the red square originally contained traces of black pigment, all of which were lost by the time the last infrared photo was made. The present-day photo shows this area to be completely bare.

The statement of Dark and Plesters (1958b, pp. 533-534) that the wear of the hidden image can in no way be attributed to the thinning of the gesso layer is thus clearly false. It may be doubted whether or not the hidden images are as worn and smudged as they suggest, if it is taken into account that both xylene and white spirit act as paint solvents. The success that Dark and Plesters claim to have had with the final thinning of the gesso on page 5 verso (1958a, p. 10; 1958b, p. 533) is based on a misinterpretation of the data. The figure they refer to as visible in the top right corner of that page is in fact not an image of the palimpsest but a design that shines through from the front side (see figure 6.5).

A fortunate accidental discovery was made on the front of the document when this side was being observed to monitor the effect of the wetting with xylene. When the page was wet and thus more transparent, it was observed that on traces of black outlines could be seen as well. This would imply that the scribe who made the later codex used a book that had text on both sides. The infrared photos taken of two pages on the recto side are suggestive, as there are indeed traces of hidden drawings, though the possibility still exists that these are traces of

pentimenti or corrections rather than truly different designs. The fact that the design shines through on page 5 does not bode well. If there were other figures hidden underneath the picture on the front, these figures would have to be more clearly visible than the surface drawings. It can thus be concluded that the study by Dark and Plesters only had limited value for the interpretation of the state and the extent of the palimpsest in the Codex Añute.

6.3 THE TECHNIQUES OF THE 2012-2016 SCIENCE4ARTS INVESTIGATION

Much has changed since the 1950's, both in technical capabilities and in conservation concerns. Technological advances have made it easier to investigate the material composition and properties of objects, while at the same time rigorous conservation policies limit these possibilities, as they often demand fully non-invasive investigation. As such, the taking of samples or the physical removal of the covering gesso layer as was done in the 1950's is no longer an option. Getting better insight into the nature of the Añute palimpsest and possibly uncovering some parts of the hidden imagery thus must be done with non-invasive electromagnetic radiation based techniques. This radiation needs to penetrate the surface and interact in a way with the material which can be registered. The infrared photography used in the 1950's uses this principle as well. The basic principle is that the carbon black will absorb the infrared radiation while the white layer will reflect it, which can be registered with a camera sensitive to infrared radiation. Infrared has the advantage over, for example, visible light in that it is able to penetrate many materials, especially at higher wavelengths. X-rays also penetrate materials, though these do not interact well with any of the organic materials, due to the low molecular weight of these chemical substances.

Although their representativeness is circumspect, the treated pages 11 and 10 verso form the clearest indication at hand for the state of the images of the palimpsest. The black outlines are so severely damaged on the uncovered areas that is seems unlikely this was all due to the intervention of Dr. Plenderleith. It is, therefore, to be expected that the carbon-black outlines of the figures on other pages were at least partially removed. In order to reconstruct the images, it was therefore necessary to gain a picture of the other colours. As can be seen in figure 6.2, there are red, orange, and yellow areas visible. These colours were considered to be organic from the start of the project, based on the analysis of Dark and Plesters and as the result of a comparison of Añute with other known codices. This was later confirmed by the MOLAB team.[57] At the beginning of this project, no technique was though capable of revealing such organic materials below a gesso surface. It was thus clear that some new technology needed to be developed in order to do this. As a result, the challenge of the project became twofold. On the one hand, the staff at the Bodleian Library needed to be convinced of the necessity of this investigation and the potential benefits; while, on the other hand, the effectiveness and applicability of the proposed techniques for doing the investigation needed to be proven. The rather dismissive attitude to the potential of this palimpsest after the investigation in the 1950's had left the Bodleian Library sceptical of such investigative procedures. As any investigation of the original documents is potentially damaging to these fragile objects, they are closely guarded and access is strictly regulated.

One advantage of modern technology over those available during the 1950's is the ability to investigate and edit images digitally. For example, by redrawing the outlines of the figures after close study of high resolution digital images it was possible to reconstruct part of page 11 verso. This showed the potential information that could be gained from this document digitally, and this in itself warranted the investigation of the original document further, provided that a technique was available that had a chance of finding new information on the still covered images.

A new technique was initially thought of by Prof. Schmidt-Ott (TU Delft, The Netherlands) and was given the name of Photothermal tomography (PTT).

57. These results are to date unpublished. However, a preliminary report was provided by the team.

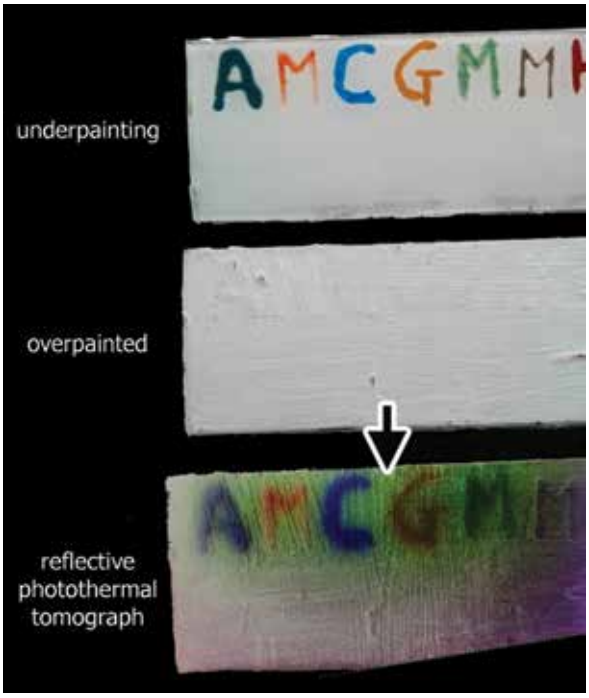


Figure 6.6: Early tests on sample show the effectiveness of Photothermal tomography (image made by T. Zaman).

In order to make sub-surface images visible, PTT relies on the registration of thermal energy generated by the absorption of visible light. When visible light hits an object, part of it is absorbed while the rest is reflected. The human eye registers the reflected wavelengths and constructs an image out of it. The absorption of visible light generates warmth, as the energy of the radiation is transformed into thermal energy. If one were able to register the amount of thermal energy created in this manner, it would be possible to determine the relative lightness or darkness of the object compared to its surroundings. In other words, if a white light is sent onto a white surface with a black line on it, a thermal camera will see little thermal energy coming from the white surface, but high thermal energy from the black line. As such, the thermal camera registers the inverse of a human eye.

An opaque solid reflects light rather than letting it through. On a molecular level, the light wave – or, more precisely, a photon – is absorbed by the electrons of the surface molecules, which start to vibrate. Shortly after this, a photon is re-emitted out of the object. In a translucent object on the other hand, the vibration of the electrons is passed on from molecule to molecule until it reaches the other side of the object where it is emitted. In reality, no object is perfectly reflective or transmitting, but the light beam gradually loses its intensity as it travels through the surface. This process is called attenuation. The attenuation of the light also happens on the way back out of the object after it gets reflected by a sub-surface feature. As such seeing a sub-surface feature with the naked eye requires light travelling the distance from the surface to the sub-surface feature twice (in and out), without losing so much intensity through attenuation that our eyes cannot distinguish it anymore. If the intensity is too low, then the emitted light is no longer visible, as it is lost in the other light that is reflected off of the surface. The advantage of Photothermal tomography over our eyes or regular photography, then, is that the visible light only needs to make a one-way trip through the gesso surface, as the registered signal is not the returning light, but the thermal energy in the form of infrared radiation. Infrared radiation does not suffer from much attenuation in solids like gesso, making the signal relatively strong when it reaches the camera.

Colours can be reconstructed using this principle as well. For this task, the object is illuminated using different colours of light. Just like the human eye registers colours as the relative amount of red, green, and blue, the registration of the relative absorption of red, green, and blue light can be used to calculate the colour of a surface. Measuring the thermal energy of a blue surface will thus yield high results for red and green, but low results for blue, as red and green are absorbed, while blue light is reflected.

In order to test the applicability of this technique for the particularities of the codex, a testing prototype of the device was made. Its main component is a FLIR SC7000 infrared camera capable of recording minute temperature variations. These variations are so minute, however, that distortion can take place because of passing air flows. To prevent this from occurring, the particular model used for these tests had a lock-in function, meaning it could filter out the

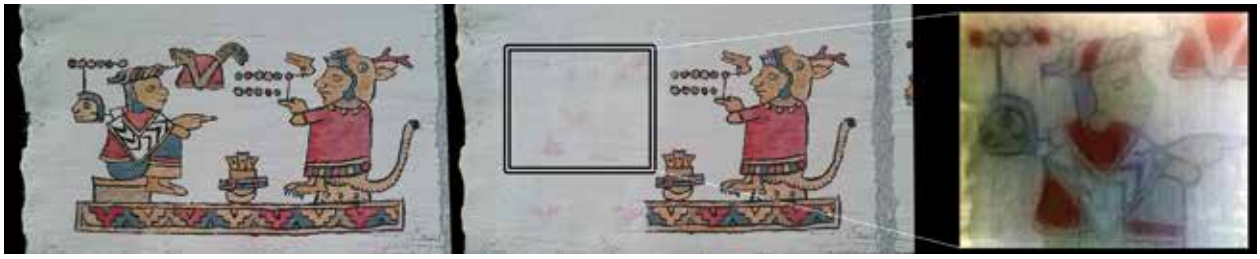


Figure 6.7: Test sample partially covered with new gesso layer and the resultant image from Photothermal tomography (image by Zaman).

signal from the environmental noise by amplification with a reference signal. This signal comes directly from the light source. For the early experiments, a beamer was used as a light source, as these are easily targeted sources for red, green, blue, and white light. Early tests were done on a sample: a glass plate on which letters had been written using different materials which was covered with a layer of lead white paint. These tests were very successful, as the full range of colours of the completely covered letters could be recovered (see figure 6.6).

With this proof of concept, a second step was to test the technique on a sample that was as close to the original codex as possible. At this stage, the results of the MOLAB investigation had not been published yet, and as a result the sample was made based on the results of Dark and Plesters (1958a, 1958b), combined with published information on the material composition of other codices. The sample was made on leather covered with a gesso made of gypsum and animal glue, on which two figures were drawn. These were made using carbon black; a yellow made from old fustic;[58] blue from a mix of indigo[59] and clay; and red from cochineal. The left of the two figures was covered with gesso until it was completely obscured. For the purpose of studying the effectiveness of this technique, the composition of the paints is almost of no consequence. This is because the production of thermal energy is dependent mostly on the absorption of visible light, a property that is directly related to the colour of the substance. Of greater importance to the effectiveness of this technique are the thermal and optical characteristics of the layer covering the drawings. In figure 6.6, it can be seen that the thermal energy spreads through the material of the sample, giving the letters in the result a green halo. This spread of heat through the sample can obscure the signal. The attenuation is a property of the covering material as well, but this is also related to the thickness of the applied layer. It became clear during these secondary tests, that completely obscuring a drawing so that it was invisible even for the TTT can be done relatively easily by simply covering it with a much thicker layer. Nonetheless, it was possible to recover the hidden image on the sample (see figure 6.7). These tests also showed a secondary challenge to the PTT technique. As can be seen in the picture of the covered sample, the cochineal red paint bled through to the surface. It is clear that this happened because the cochineal paint was not well washed, meaning that it was composed of a mixture of pigment and dye (see chapter 2). When covered with a white layer, the dye stain would rise to the surface. The resultant differences in surface colour caused differences in the production of thermal energy at the surface, by direct absorption of the light in the red areas. In the resultant PTT image, the red has therefore a much stronger presence, which results in a suppression of the other colours.

With these tests the limit of what could be learned from tests on samples was reached. Since there was no possibility of taking samples of the original codices, there was no secure identification of the exact composition of the covering gesso. Besides this, there was no way to accurately measure the thickness of the layer over the entire document. Therefore there was no other way to proceed than to test the technique on the original codex.

58. At this point the Zacatlaxcalli was not yet available.
59. At this point Matlallin was not yet identified.

Figure 6.8: Setup of the Photothermal tomography prototype at Bodleian Library during the 2013 investigation of the Añute palimpsest (photo by T. Zaman).

In order to do this, however, not only the proof of concept of the technique needed to be provided to the Bodleian Library, but also a risk assessment of the technique. Since in PTT registration is done with a thermal camera, there is a continuous live application and monitoring of thermal fluctuations in the object. Thermal fluctuation in an object can in principle be very damaging to a fragile artefact. The thermal variation that is introduced by the pulsing light is, however, extremely low. The FLIR camera used in this setup measures thermal fluctuation in the order of 0.001°C. The maximum temperature fluctuation measured during testing was around 0.05°C. This is well within safety margins, as larger temperature fluctuations result from simply touching the object. But in addition to the thermal aspect, concerns about the exposure of the object to prolonged periods of intensive light could be raised. However, since the technique is only applied to the reverse of the codex, which has no drawings on the surface, there is no danger of discoloration due to exposure to light.

With the obtained test results, a first investigation of the original codex was allowed in November 2013. During this visit the investigation of the MOLAB team also took place. Despite a planning meeting two weeks prior to the intervention, the codex Añute was only available for this investigation after the MOLAB finished its investigation. This meant a two hour window on the last day of the visit. Since the lock-in function requires the comparison of a measurement with a reference signal, a longer measurement results in better extraction of the signal from the background noise. Thus, there is a continuous tension between the number of images that can be taken in a given time and the quality of those recordings. In the two hours of the first visit, 41 images were taken. In order to reconstruct the colour, three images need to

be taken of each section (with red, green, and blue light). But since the light needed to be focused on a small area to make sure that a large enough amount of light penetrates the gesso layer, only a small area could be investigated at any one time. In figure 6.8, the prototype setup is shown. The resultant images were somewhat promising in the sense that they revealed some features that were not visible before. However, these features could not at that time be identified. The test was most successful in indicating where improvements to the technique's design were necessary. The issues that came up with the images taken mostly had to do with distortion due to the angle of the camera to the surface. As the camera could not be placed perpendicular to the surface, problems arose with focussing the image, as the camera had a low depth of field. And since the light source was also not perpendicular to the surface, attenuation in the surface was larger, because the light had to travel further through the surface.

It was decided that an integration of the light source and the camera was needed. First tests with a ring flash design around the lens of the camera proved ineffective, as the LED lights were not powerful enough to guarantee a high enough degree of penetration of the surface. Moreover, simply making use of stronger LED lights would result in the generation of too much heat by the light source itself, resulting in more noise when analysing the images that were acquired by means of PPT. A second prototype was a linear flash arrangement composed of a series of LED's in a tube that could be placed under the camera. This tube was cooled by fans on the sides, thus reducing the heat that would interfere with the measurement.

In March of 2015, a second investigation of the palimpsest by the Delft-Leiden team took place. In order to maximize chances of recovering new information, a range of auxiliary non-invasive techniques were also brought and calculated in the schedule. For the PTT, both the linear light source and the projector used earlier were brought. One advantage of the projector turned out to be the biggest issue with the linear flash arrangement: the ability to focus the produced light in a sufficient manner. Once the technique was tested again with the projector – this time in a different configuration with both the camera and the light source virtually perpendicular to the surface and the light right next to it – a true stumbling block was discovered.

In the infrared images taken during the 1950's investigation, a specific black feature had been identified that was, as could be observed on the original codex, completely covered with gesso. This feature, therefore, would make for a good target for the testing of the PTT. In the area where the black feature was known to be, the PTT recording showed a colder area. Since the feature was black, this clearly should not be the case. Furthermore, this colder area did not have the shape of the feature seen in the 1950's IR image. The only explanation for this can be that the gesso surface contains internal faults which prevent the transmission of heat back to the surface. While we know that the technique itself functions, it thus turned out to be inapplicable on this specific case.

This set-back meant that the objectives of the intervention needed to be re-evaluated. The focus shifted away from the recovery of subsurface features to the recording of information visible at the surface. Techniques that were brought as auxiliary techniques in order to help the interpretation of the Photothermal results now became the new, main tools of the investigation. In many places, either because of the investigation in the 1950's or because of natural wear, part of the palimpsest had already become physically exposed. By recording these areas in as much detail as possible, a better understanding of the covered texts could still be attained. One of the ways in which these surface features could be recorded was RTI imaging. As described in chapter 5, RTI imaging is a technique that reconstructs surface texture from a series of regular photographs. It creates a dynamic image where the user can manipulate the position of the light source and thus interpret the surface features. This technique was first developed by Malzbender et al. (2001) under the name "polynomial texture mapping". Multiple images with known position of a light source are used to calculate the colour of each pixel under specific lighting conditions. In general, more input images amounts to a more detailed picture, if the position of the camera is consistent and the position of the light source known precisely.

Zaman had developed his own device to function as a light source: sixty circuit board struts with an LED on each assembled into a geodesic dome. Zaman mounted this dome directly onto the lens of the camera, which, in combination with the right lens, allowed pictures to be taken at a distance of about 30 cm from the object. The dome was connected to the camera so that once started, 60 pictures with varying illumination could be taken without further human interference, which would inevitably move the camera. These sixty images can then be turned into one composite RTI image. Because of the quality of the camera (50 megapixel Nikon D800) and the short distance at which the photographs were taken, the results are almost microscopic images. On the RTI images hairs embedded in the surface, as well as any other irregularities in the surface, can easily be distinguished. Surface topography can be of great importance for the interpretation of visual data. When a normal two-dimensional image is made where either the light source or the lens is positioned at an angle to the surface,[60] differences in height will cast shadows. Such surface shadows are captured by the camera and registered as areas that are darker than their surroundings. In practice, it can be difficult to distinguish between such shadows and areas that are darker because of painted features. And in the interpretation of the uncovered palimpsest, shadows are a major issue, because if not recognised as shadows they may result in faulty or flawed inferences on the part of the interpreter. Not only is the gesso layer removed in a very uneven manner, the uncovered leather exhibit folds. All of these features, then, need to be taken into account when reconstructing the outlines of the figures.

The fragmentary nature of the black outlines – as uncovered using infrared photography in the 1950's – suggested that modern techniques would not reveal much new data on the black outlines. Nonetheless, digital infrared photographs were taken of all pages, to give researchers a complete overview rather than forcing them to make do with information only about the six pages which were photographed in the 1950's. Insofar as they could be seen, the black outlines were fragmented on all the codex pages and no large features appeared. Owing to the same subsurface faults that prevented the transmission of heat back to the surface, however, the quality of the photographs taken using infrared radiation was rather limited.

While performing these investigations using (IR) photography, RTI imaging, and PTT, the department of conservation at the Bodleian Library obtained equipment for hyperspectral imaging. In hyperspectral imaging, a scanner detects the spectral response of the surface. For each pixel of the image, a complete spectral curve is thus known. The level of detail, as well as the range at which this data is gathered, depends on the type and model of scanner. The Headwall scanner used at the Bodleian Library (Hyperspec® VNIR E-Series) measured the spectral response between 380 and 1,000 nm in 923 steps.[61] This benchtop system had a scanner mounted vertically above a linear translation stage moving perpendicular to the scan line. This model takes a line scan of 1,600 pixels. The translation stage moves the object underneath the scanner. This results in scans of 1,600 by X pixels, where X is determined by the speed of the stage and the recording speed. In case of the scans made of the codex pages, each measured 1,600x~1,200 pixels.[62] The resultant data contains 923 data points for each of the resultant 1,920,000 pixels. These 1.8 billion data points can also be seen as a stack of images representing the reflection of the surface of the object under study if illuminated with only one of those 923 measured wavelengths. It is, then, not surprising that this so-called data cube is very large. Each of the scans made is between ten and twelve gigabytes. This fact, combined with the limited time left for this investigation and the fact that it was unknown what the investigation would yield, meant that not all pages were scanned during this 2015 intervention. Since the focus of investigation had shifted away from the recovery of

60. In practice this is always the case as the light source is never located inside the lens. The RTI image does have the ability to calculate what the image looks like when the virtual light is positioned exactly in the middle of the image.

61. Information from Headwall Datasheet (see http://www.headwallphotonics.com/spectral-imaging/hyperspectral/vnir, accessed 07-12-2015).

62. Though the codex pages are square the capture was intentionally rectangular, this is because the lens of the scanner did not have a great depth of field meaning that at the edges of the line, the image became less sharp.

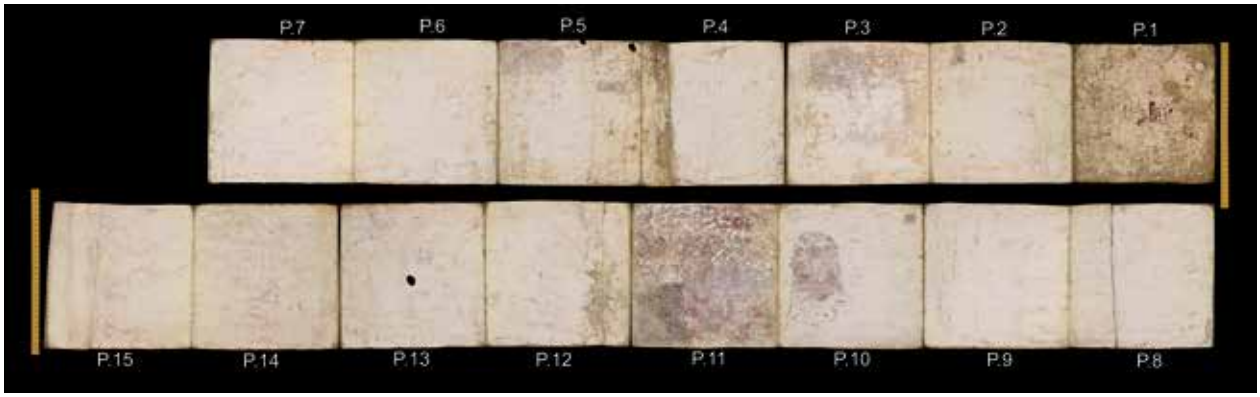


Figure 6.9: Overview of the reverse of Codex Añute, damaged areas are mostly concentrated in pages 1, 3, 5, 10, and 11 (images courtesy of Bodleian Libraries, University of Oxford).

the palimpsest towards the recording of the visible surface features, it was decided that those pages that were most damaged should be the main focus: i.e. page 11, 10, 5, 3, and 1 verso. After these pages were scanned there was some time to continue with pages 6 and 7, as well as two pages of the front: pages 1 and 2 recto. Even this limited endeavour resulted in a large amount of data that needed to be analysed using specialised software. One such piece of software is Exelis ENVI®, software originally designed to analyse hyperspectral imaging data from satellites. This software has many applications in data analysis, but the feature that yielded the best results in the case of our investigation was MNF or Minimum Noise Fraction Transform. This operation uses Principle Component Analysis to determine the spectral differences of the material investigated, after the noise has been filtered out.[63] In practical term, this method generates a series of grey-scale images – or MNF bands – each representing the distribution of a computer-estimated unique spectrum. The MNF transform orders these images in a way that the noise increases in each following image. As such the most common spectra are in the first images. Since only few colours were used, only the first five or six bands contain much useful information. One of these is the distribution of white, which resulted in a more or less black and white picture of the surface. Comparison between these images can show not only the distribution of different colours, but can also indicate those areas where colours are mixed.

6.4 THE VISIBLE AREAS

By bringing together all the information from the techniques discussed above, it has been possible to reconstruct part of the palimpsest. The most detailed reconstructions came from those areas that have been uncovered by the 1950's investigation, though other areas where the gesso is damaged were informative as well. Figure 6.9 shows an overview of the fifteen pages on the reverse that contain covered images. On the left of page 15, the first bit of added blank leather is visible. The areas with the most damage to the gesso and where parts of the hidden images are visible are page 1; the top and right of page 3; the top of page 5; the central area of page 10; and the entirety of page 11 (see figure 6.10).

Page 11 is most completely uncovered. While this means that it is probably one of the most damaged sections of the palimpsest (with the possible exception of the cover page 1 verso), it is also the easiest to investigate, because the damage allows for an almost complete overview of the entire page. This overview in turn can be utilised to help to shape the expectancy for what is to be found on the other pages. What is clear immediately from macroscopic investigation is that the pages are to be read in a horizontal manner in contrast to the text on the front

63. For more on this operation see http://www.exelisvis.com/docs/MinimumNoiseFractionTransform.html, accessed 24-10-2015.

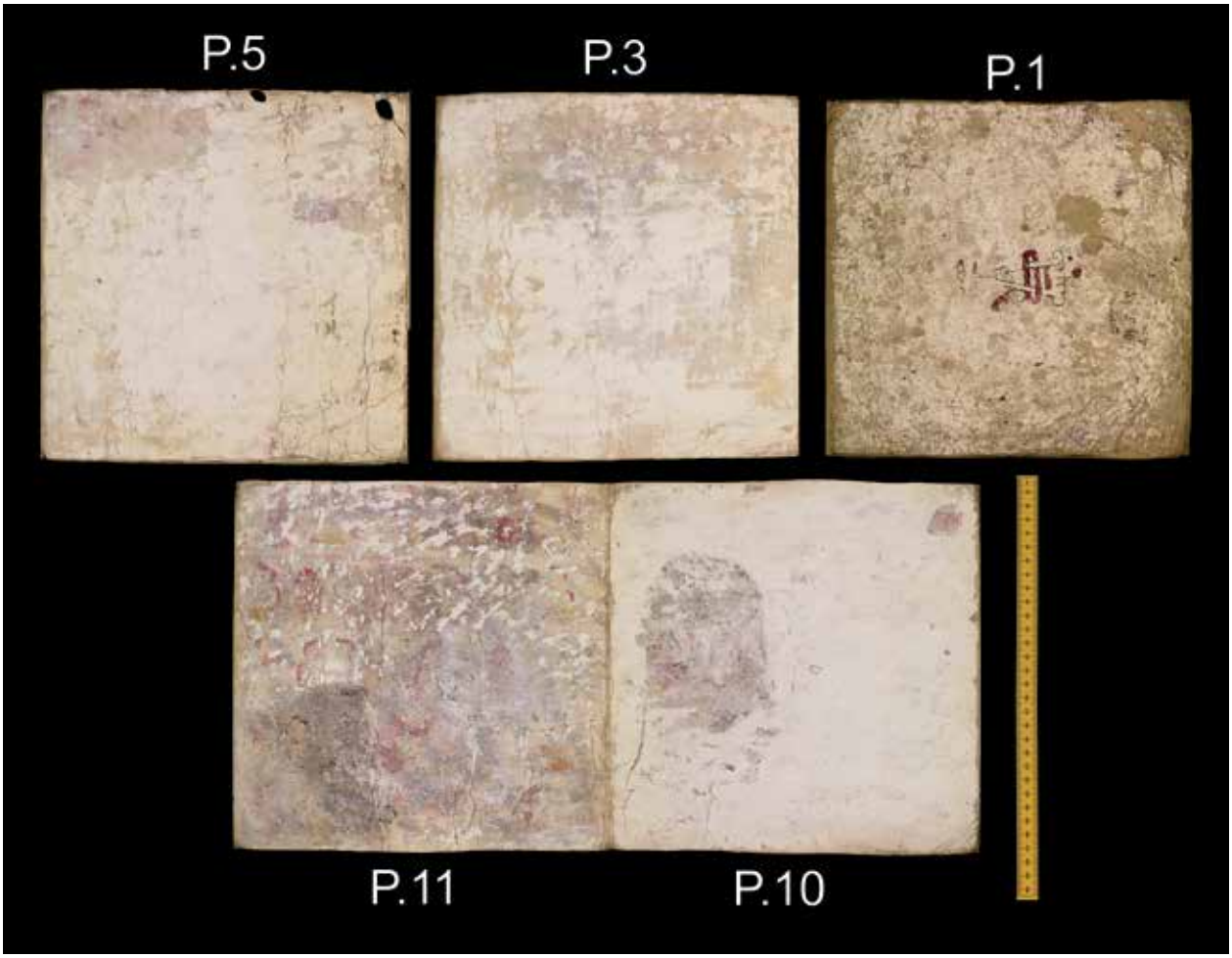


Figure 6.10: The uncovered areas of the Añute palimpsest (images of individual pages courtesy of Bodleian Libraries, University of Oxford).

which is read vertically. It is also immediately clear that page 11 is divided into five lines.

The process of reconstruction itself involves a continuous switching between the four techniques used to record surface information. As an example, the reconstruction of the central figure will be discussed in detail. After this, the general interpretation of the reconstruction as a whole will be explained.

On a normal photograph of the section, a sitting person facing right can already be distinguished (see figure 6.11 top left). This figure is in a relatively good condition. The person in the figure is sitting on his/her knees, in a position also found in the codex Tonindeye (Nuttall), though in the case of the codex Tonindeye only women are depicted sitting like this (see figure 6.11 top right). We can infer, then, that the person in the figure on page 11 of Codex Añute is most likely a woman. She is depicted wearing a red quechquemitl and also has a red section on the top of her head. It is unclear whether this red section was red hair, part of a headdress, or if the red was simply a base over which some other, now removed, colours were painted. Somewhat less clearly visible, though still distinguishable, are her eye, the bridge of her nose, and her feet. As in the other codices most seated figures make specific hand gestures and so it stands to reason that the traces in front of her chest are remnants of her arms and hands, though the exact

Figure 6.11 left: central image of page 11 verso Codex Añute (courtesy Bodleian Libraries, University of Oxford); central: Lady 8 Eagle, of Codex Tonindeye (Nuttall) (after Anders, Jansen, & Pérez Jiménez, 1992 facsimile p.13); right: IR image from 1958 made with xylene covering the surface (courtesy of Bodleian Libraries, University of Oxford).

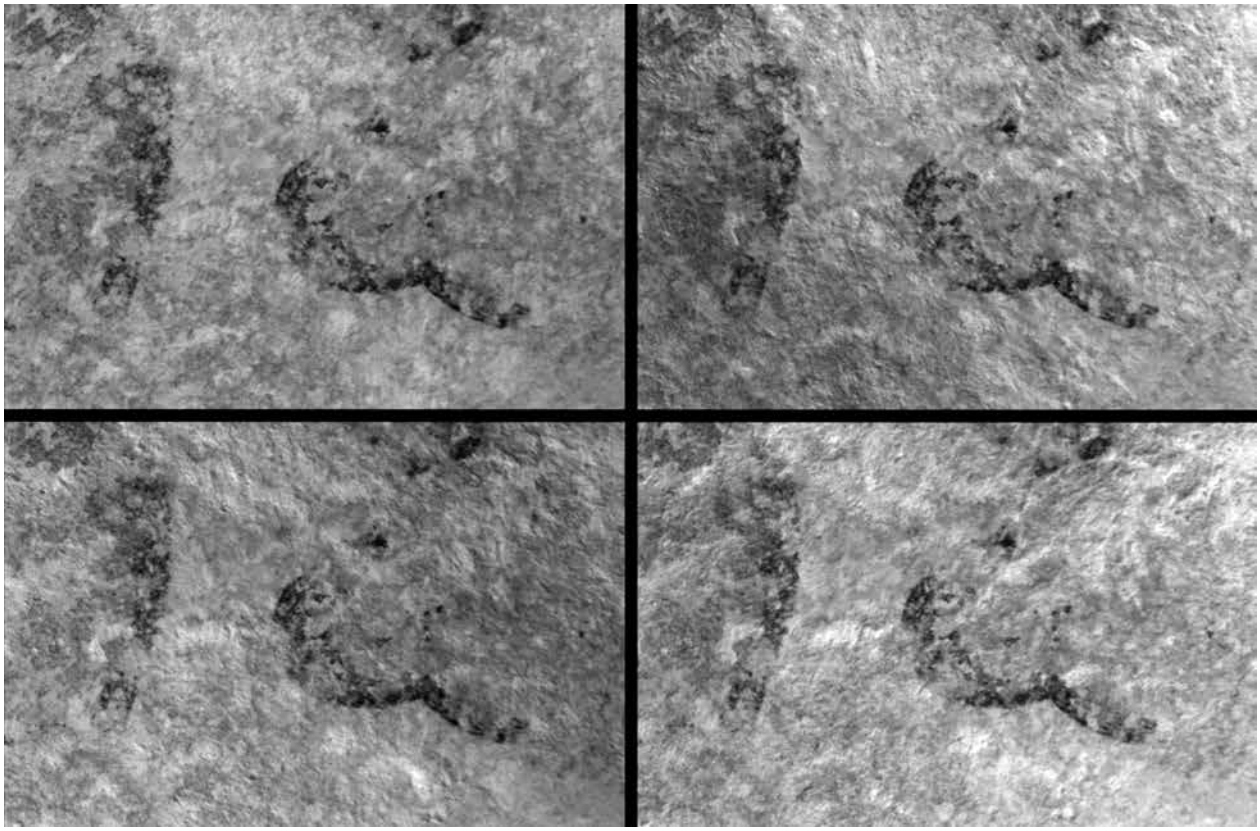


Figure 6.12: Macro images from the centre of page 11 verso of Codex Añute generated from RTI image, illuminated from four different angles (images by Zaman).

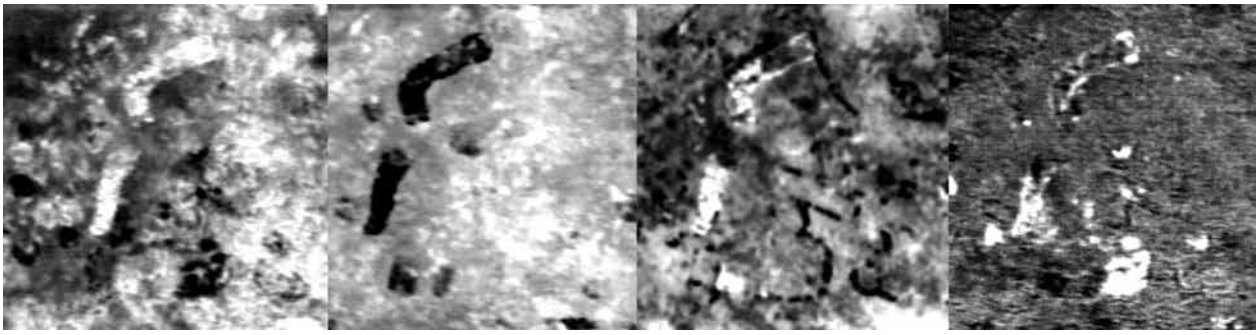


Figure 6.13: Results after noise reduction of hyperspectral image of central area on Codex Añute page 11 verso (images by the author).

posture cannot be seen here. It seems in this photo as though her chin is visible in the dark and rounded stain directly below her eyes. When this photo is compared with the infrared image that was made in the 1950's, however, this dark area is no longer visible (see figure 6.11).

In this photo, the codex had been wetted with xylene, which made it possible to look through the remnants of gesso and distinguish all traces of black outlines. Besides the outline of her face, the arm, stomach, and knees are also clearly visible. The hand too can be better distinguished and a stretched-out finger, as if she is pointing at something, can be seen. This gesture would indicate that this lady is instructing (see Jansen & Pérez Jiménez, 2011, p. 227). It seems that in the IR image a black line connects the knees of the female with a series of dots. This would indicate that her calendar name is to be found in front of her. If the RTI image of this section is studied more closely, however, it becomes clear that this dark line is a surface shadow, cast by an elongated remnant of the covering gesso.

Although the dynamism of the RTI image does not translate well into the static printed style of this work, the four images in figure 6.12 do show these differences in surface shadow, as each is illuminated from a different angle. By combining the RTI and the infrared photos with the hyperspectral imaging results (see figure 6.13), a more thorough reconstruction is possible. With this last technique in particular, it is possible to distinguish between visually similar materials. This can help, for example, to distinguish yellow paint from the yellowed leather background.

Since the surface of this image is very rough due to the scraping of the gesso, during the interpretation of the hyperspectral data it is important to refer to the RTI images as well. Combining all the data, it becomes possible to reconstruct this small section in more detail (see also figure 6.15 and Appendix C).
This same procedure has been repeated for all the figures on this page. Two issues make the interpretation of some sections more difficult, however: damage to the images and distortion of the hyperspectral imaging data. As can be seen in figure 6.10, the damage to this page, as well as the thickness of the remaining gesso, is variable. On the top register, it seems that the investigators in the 1950's went rather deep with their removal techniques. As a result, there is a lot of bare leather visible and not that much remains of the designs. In the bottom left, on the other hand, it seems that the removal did not go that far. A large dark stain is visible, which was possibly caused by smearing the carbon black outlines that are most visible in this area when covering it with a new gesso layer. Furthermore, the hyperspectral data becomes less clear towards the upper and lower edges. This is because of distortion due to surface irregularities – such as flakes of unremoved gesso – is bigger when the angle between the surface and the camera is less than 90 degrees. Thus, the centre of the scan, above which the camera hangs, is quite clear, while at the top and bottom surface irregularities create shadows and other aberrations.

What is clear from the hyperspectral imaging data (see also figure 6.18) is that the reading lines continue on the right-hand side of the page. Thus, the

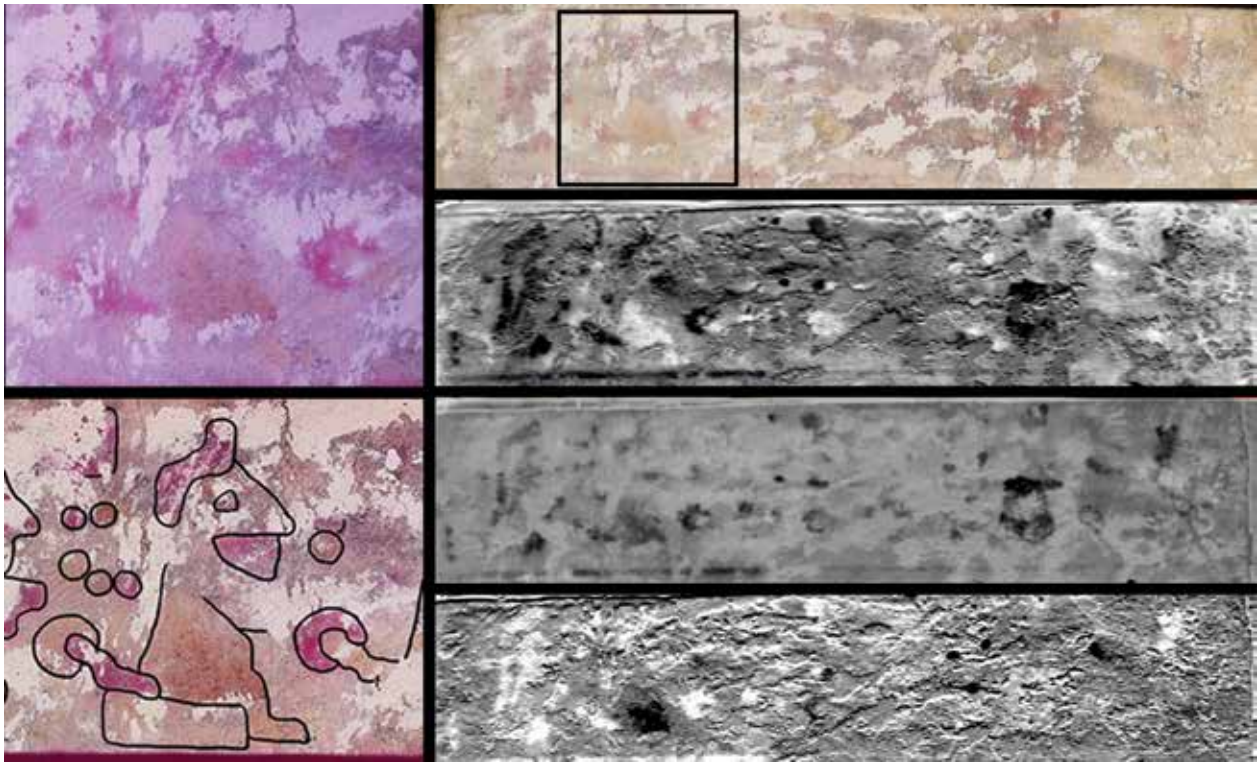


Figure 6.14: Compilation of photographs and hyperspectral imaging results of the top section of page 11 verso (by the author).

images in the palimpsest need to be read two pages at a time in a boustrophedon manner akin to the reading of the codex Ñuu Tnoo-Ndisi Nuu (Bodley). For the purpose of interpreting an individual page – such as the uncovered page 11 – this makes everything a lot more difficult, because rather than having one continuous page, there are three sections of the narrative on each page. The top section of this page contains an important clue as to the direction of reading of this document. A series of persons is sitting in a row facing right. At least three of these have an element connected to their behind. This elongated element leads to a circular element of a different colour. This is the regular way of representing an umbilical cord (see figure 6.14). Parts of this diagnostic element can be seen at least three times, either in the form of the circular or crescent moon shape to which it connects, or as elongated element representing the cord itself. For the figure on the far left, one cannot be completely certain if he/she has an umbilical cord attached to its behind, as it is not visible how the yellow line behind the individual ends. However, given that this figure is followed by at least three figures that display this umbilical cord very clearly, it is likely that this first person is also depicted as being born. The general rule is that persons being born are looking in the direction of reading (Jansen & Pérez Jiménez, 2011, p. 232). This would mean that the codex is read from left to right and that on these two pages 11 and 10 the order is top to bottom. This allows for the reconstruction of the full reading order of the entire document, assuming that there are no clean breaks like those found in the codex Tonindeye.

Even though they are not all clearly visible, it is possible to reconstruct six people on the top section of this page, the left four of which are likely being born. The reading order would suggest that their parents are depicted on page 12 on the top row. On the top right of page 11, there is again a person sitting facing right. He or she is facing right just like the others. The body as well as a feather-like headdress are depicted in red. It is unclear if this person is

Figure 6.15: Drawn outlines of Codex Añute page 11 verso sections 1 and 2 (image by the author).

also part of the group being born or if this person represents the start of a different scene. Generally, a new scene coming after a depiction of persons being born would start with an action performed by one of these neonates, perhaps in later life. In that case there would be a repetition of an earlier depiction, most often of the oldest child; i.e. the one depicted first in the series. In order to check this hypothesis, the top of page 12 would have to be revealed to check if the person on the top left of page 11 verso is the first born or not. On the top right of this page a sixth figure was depicted. This is very difficult to reconstruct due to the damage in this area. It may be another person, though if so, it is impossible to determine the direction that he or she is facing, which makes it impossible to further determine the possible personal relation with the preceding figures. The identity of the persons on this line are is also still a mystery. The calendar names, some of which can be localised, cannot be identified. Due to the damage to this page, they remain nothing more than a series of dots, the exact number of which cannot be determined. Moreover, there is only an unidentifiable stain where the calendar glyphs used to be.

The second section (see figure 6.15) starts on the right of line two and runs until the right of line three. It starts with a woman, similar to the central figure described above, wearing a quechquemitl, sitting on her knees, and facing left. She is pointing down with one hand, a gesture often made in marriage scenes in the codex Tonindeye – for example, on page 32 – or in the context of persons greeting each other (see Jansen & Pérez Jiménez, 2011, pp. 223-229). In front of her, barely visible in the regular photographs, are traces of what most likely is another person. This person is almost completely depicted in yellow with the exception of a red area on the top of the head. Considering the context of the noted hand gesture, it is likely that this person is facing right. The general shape of the figure in the hyperspectral results also makes this likely. Between these two figures there is a series of dots and a calendar sign that resembles an eagle looking upwards. The numeral that goes with

it is unclear and could be anywhere from five to ten. Since there are more numerals behind the Lady on the right, which is the regular place for the calendar name, it stands to reason that the name 5? Eagle?[64] belongs to the second person on this line. To the left of these first two persons, another left-facing woman is seated. Between the second and third person on this line a possible calendar name can be found. At least two dots can be seen, though there may be more. The calendar sign itself is illegible. In the centre of line two, a series of non-person glyphs can be located. Their meaning is unclear, though the two central elements look like a twisted cord and a giant flint. Following this, on the left side of the line, two more persons can be seen facing left. The first is most likely male, the second is clearly female. The first has a calendar name behind him that may be sign for Reed, though the numeral is hard to reconstruct. The lady has a calendar name 2? Rain?. On the following line, five more people can be seen facing right. The first seems to be standing and has a Tlaloc-type face. If there is consistency in the placing of the calendar names, the first person is named 2-13 Rain. The number is hard to distinguish because it is close to the edge of the page and there is a lot of wear there. Two dots are clearly visible above the Rain sign, while another series may be below it. It is unusual to have the numerals divided in such a way by the sign, though it is not unknown in the other codices (see Codex Añute page 4 Lord 10 Reed, for example). The second person on line 3 is lady 6? Rain. She is followed by what at first appears to be the face of a person looking at her. This would indicate a marriage and it has been interpreted in this way by Caso (1964). However, close study of all the available data shows that there is no body under the head, but rather a string of dot numerals. It, therefore, appears that this head is the sign for Monkey, belonging to the figure following it. This character is mostly depicted in yellow and is therefore difficult to distinguish from the background, though again it appears to be facing in the direction of reading. After this follows the central character discussed above, who cannot be identified beyond the fact that her calendar name has

64. In order to indicate the uncertainty of identifications of persons here, the question mark is placed behind uncertain identifications. If a sign is completely illegible, an X is used to indicate this. For some numerals, a range is indicated.

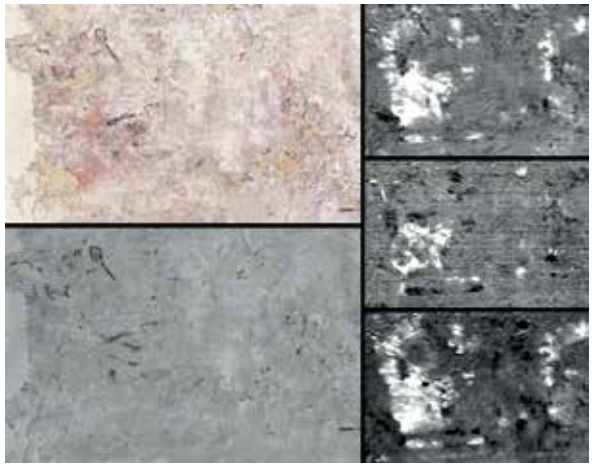


Figure 6.16: Exposed part of page 10 verso in different modes: visible light photography (top left, courtesy of Bodleian Libraries, University of Oxford); IR Imaging (bottom left); and three MNF bands of hyperspectral imaging (right).

a numeral of at least five, and the calendar sign is likely some mammal. She is followed by a person, most likely male, 13? Jaguar? A black feature seen in the IR images from the 1950's suggests that this person had a tooth sticking out of his mouth, identifying this character as an elderly man. To the right of him there is a very damaged section. In this section, very little paint traces remain. The IR data shows only fragments of black lines. It may be that this section contained a year sign, though it is difficult to be certain. This section continues on page 10 in the area that was cleaned there. Here again two persons are seen facing in the reading direction. Both of them are wearing a feathered headdress or eagle dress. In the infrared photos, the details of these feathers can be seen (see figure 6.16 bottom left). Since only such a small part of the page was uncovered, there is not much more that can be said about these two persons without further recovery of subsurface images.

The bottom two lines of page 11 verso (see figure 6.17) start with another continuous line of persons looking in the reading direction. Line 4 has seven such figures. The first has a body with an orange colour and may have a tail and a claw on his foot. This would give him a given name related to puma or jaguar. Unfortunately, his calendar name cannot be made out. He is followed by a figure of which the

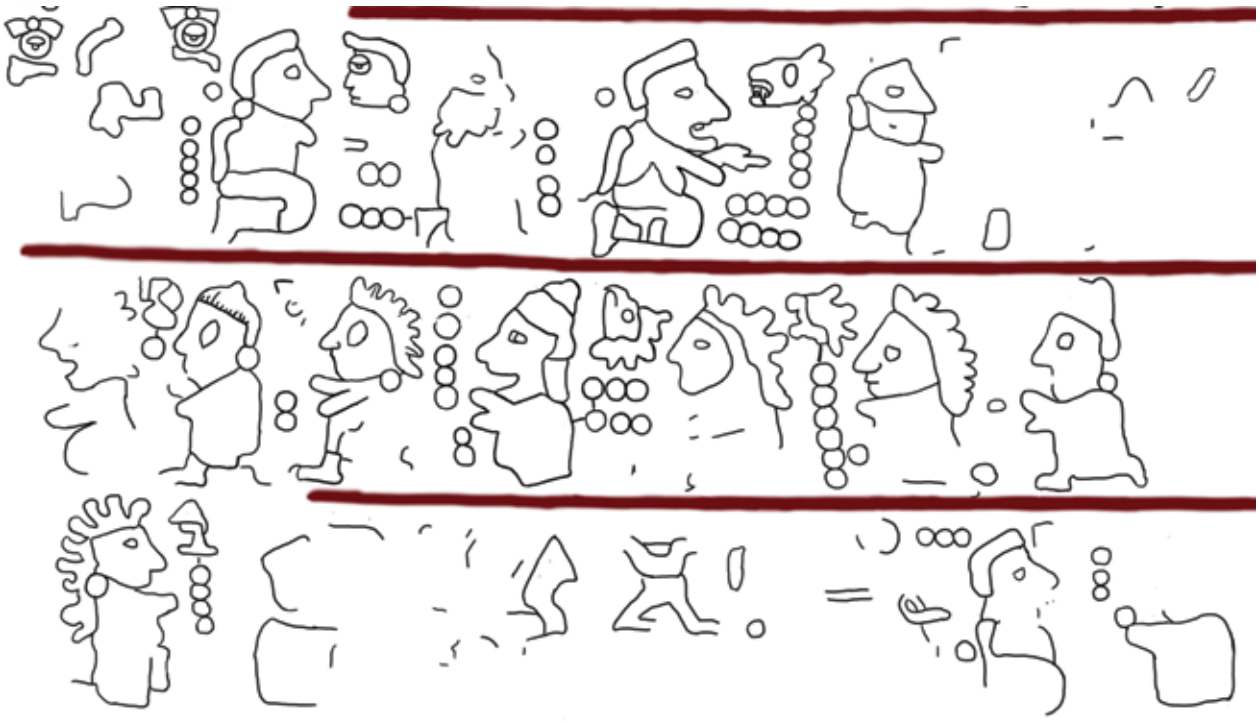


Figure 6.17: Drawn outlines of Codex Añute page 11 verso section 3 (image by the author).

face can be clearly made out, though no identifying elements can be reconstructed. The third person is also very difficult to distinguish, and only what may be a feathered headdress or part of an eagle dress can be seen besides the rough outline of the face.

For this person, the calendar sign seems to be water, with a number 7. Following this is another likely male person. He seems to have an opened or differently coloured mouth. His calendar name can be rather securely identified as 6 Eagle. This Lord 6 Eagle is followed by three more persons. The first is in the middle of the darker area, which as mentioned before, seems to have this colour because less gesso has been removed here. On the one hand, this makes it more difficult to interpret, as there are more surface irregularities and parts still covered; on the other hand, there are a lot more black outlines visible in this area as well. This figure has a headdress similar to the third figure of this line. He may be wearing a full eagle dress. The location of his calendar name is due to the uneven surface hard to determine. It may well be that some of the circles here reconstructed are actually part of the calendar sign. The last two persons on this line are Lord? 2-4? X and Lord? 1 Death. The first of these two has an eye in the shape of a knife. The left figure again seems to be wearing a feathered headdress or eagle suit. The first person on line 5 wears the clearest example of such a feathered headdress. Only very faint traces of the numeral of his calendar name can be seen, though these can again not be reconstructed, due to the wear at the edge of the page. He is followed by another person, probably male and also facing right. His calendar name is 4-9? House. This person is followed by a section that looks similar to that found on line 2. There may again be a twisted cord and a large flint design present, though here they are more difficult to reconstruct due to surface irregularities. On the far right of these otherwise uninterpretable designs, are the very vague remains of what may have been two figures facing each other. But the severe damage here does not allow for any further interpretation.

With this reconstruction of page 11 and a little of page 10 verso, a part of the style of the subsurface

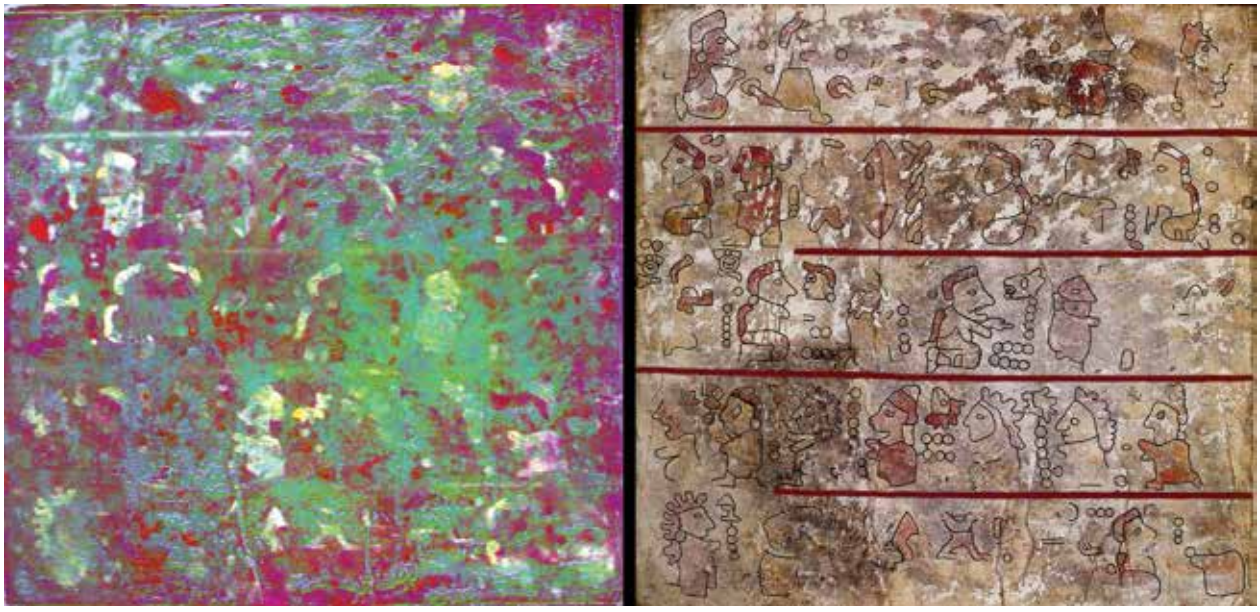


Figure 6.18: False-colour composite made with three hyperspectral minimum noise fractions of page 11 verso (images by the author)

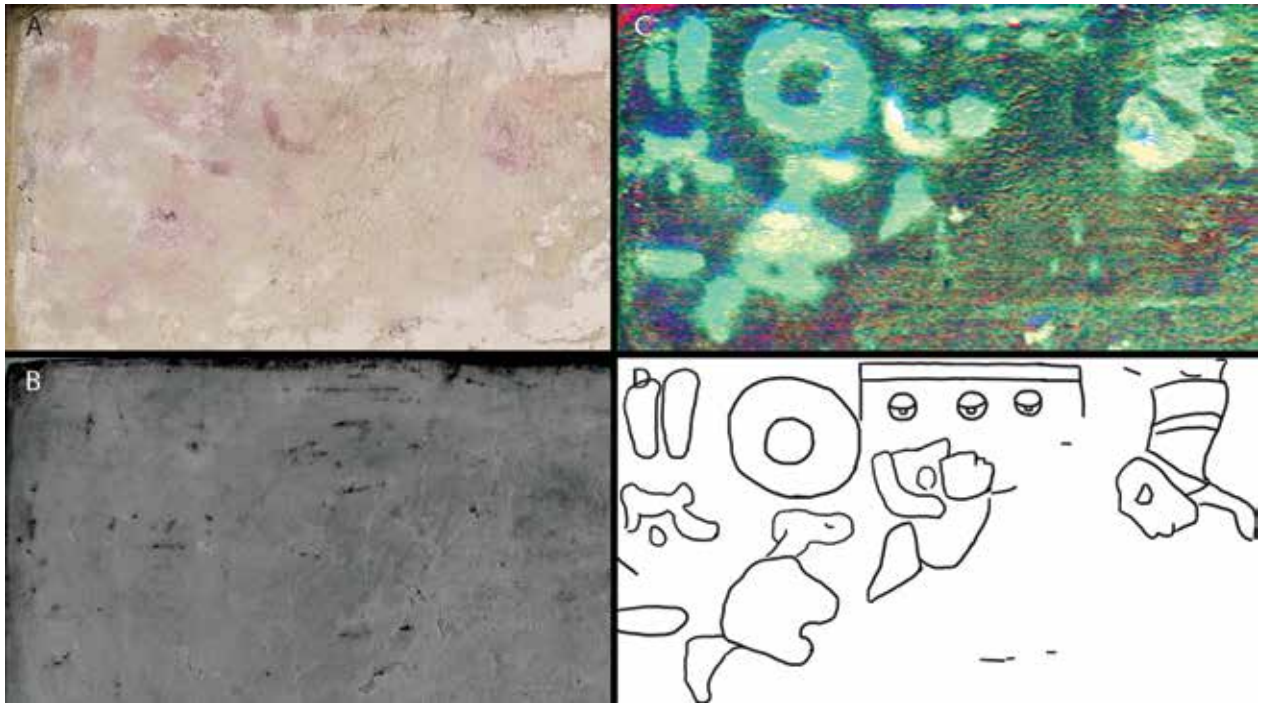


Figure 6.19: Top left of page 5 in four modes: normal photography (A, courtesy of Bodleian Libraries, University of Oxford); hyperspectral imaging (B); pre-1950's intervention infrared image (C, courtesy of Bodleian Libraries, University of Oxford); and (D) line drawing.

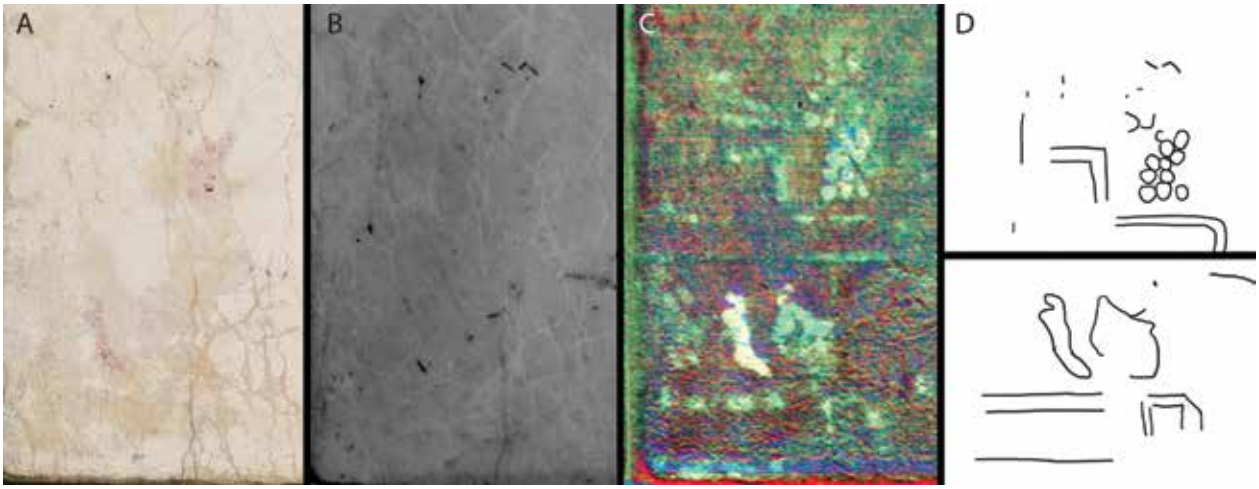


Figure 6.20: Bottom left of page 5 in four modes: normal photography (A, courtesy of Bodleian Libraries, University of Oxford); hyperspectral imaging (B); pre-1950's intervention infrared image (C, courtesy of Bodleian Libraries, University of Oxford); and (D) line drawing.

document has become clear. The other three sections that were partially uncovered can be interpreted using this information.

Page 5 was the test-ground for the investigators of the 1950s; multiple techniques were used to remove the gesso. Some of these techniques were more destructive than others. Three distinct sections were uncovered using these methods. When the document is held vertically – the orientation from which the palimpsest should be read – these sections are: the top left; the bottom left; and the mid right of the page. Although the investigators report a success with the recovery of a place frieze in the top left corner of page 5 (as shown above), they were not seeing remnants of the palimpsest, but were rather photographing infrared signals originating on the recto side. Thus, what they considered to be a new discovery was in fact a mirror image of the design on the front. That they were able to see this, shows that the document was thoroughly soaked in xylene. It also shows that in this section the removal of the gesso went too far. All that remains in this section are some traces of red paint that leached into the leather (see figure 6.19 top left). These sections can be more clearly distinguished in the hyperspectral imaging data. Furthermore, one infrared image of this page, made before the gesso was removed, indicates some areas where black lines used to run. Combining these two sources of information, this section can be partially and tentatively reconstructed as can be seen in figure 6.19. What is visible in the section is a person looking up at a sky glyph, and another person coming down from it. Without the context of this scene it cannot be determined if this is part of the narrative or if this should be construed as part of someone's name. On the far left of the image, a large circular design can be seen. For this as well as the figures below and to the left, it is unclear what is represented. The circular design may be part of a solar design, used as part of a personal name. In other known cases of this design, however, rays of the sun are also usually incorporated, which are not seen here. Alternatively it could also be a shield, as seen for example on page 1 recto of codex Añute.

The bottom left of this page also has an exposed section (see figure 6.20). This section is located on the left parts of the bottom two reading lines. At the surface not much is visible at all, except for a series of small dots at the top of the exposed section and an elongated red stain at the bottom. In the hyperspectral image, more is visible and it can be seen that these scenes were rather complex. There are large rectangular designs at the bottom of each line which may be place glyphs or the base for a larger glyph such as those used for temples. On top of the bottom rectangle and connected to the elongated

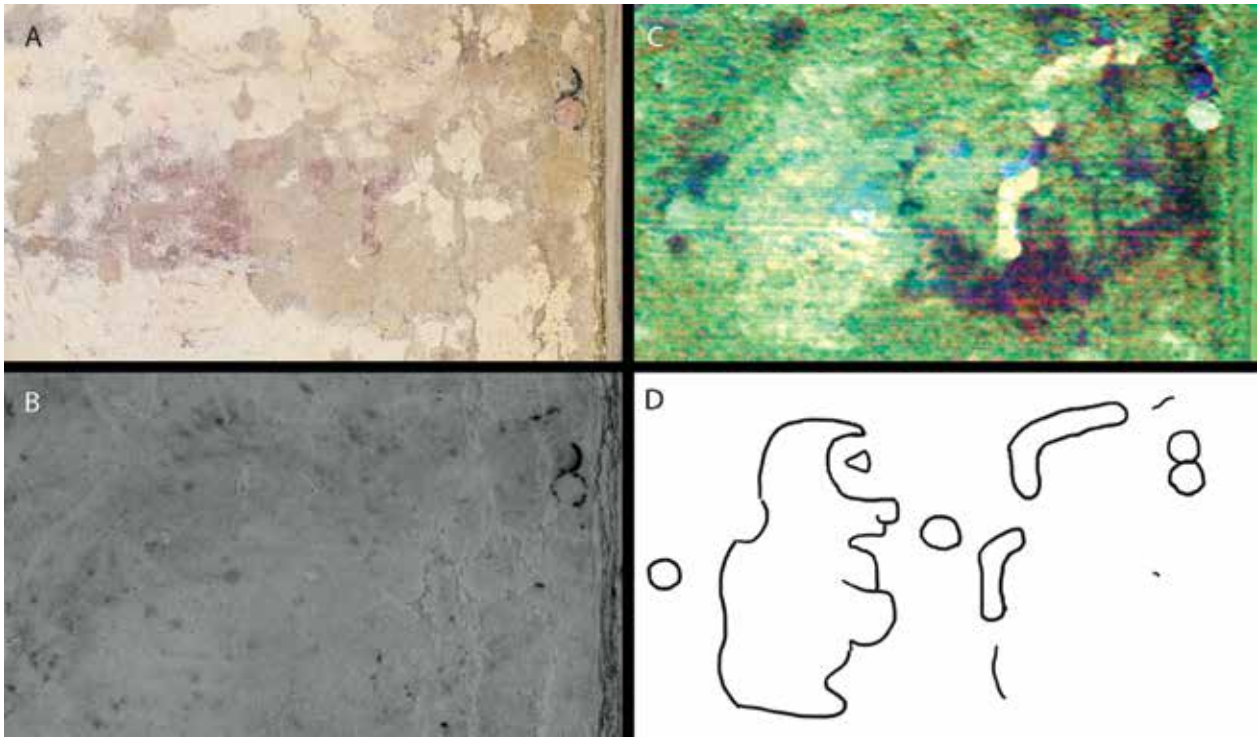


Figure 6.21: Mid-right of page 5 in four modes: normal photography (A, courtesy of Bodleian Libraries, University of Oxford); hyperspectral imaging (B); pre-1950's intervention infrared image (C, courtesy of Bodleian Libraries, University of Oxford); and (D) line drawing.

"stain", a person may be sitting facing right. If so, the red stain may be part of his or her name. The series of dots is as intriguing as it is enigmatic. Series of small red dots may, perhaps, have been a decoration on clothing. Intricate designs are drawn on the dress of many persons in the Codex Ñuu Tnoo-Ndisi Nuu. If so, it may be that here a person is sitting in the entrance of a temple, a design commonly often encountered in the codices.

What is much clearer is the section on the mid-right of page 5 (see figure 6.21). Although the photograph only shows some red stains as well as the traces of two dots on the far right, the hyperspectral image reveals far more. Two persons, the right female and the left most likely male, can be seen. Some more dots indicate where calendar names are to be found, though none can be fully reconstructed. The figure on the right has no further identifiers than the quechquemitl and the red hair or headdress consistently seen on women. The left person, however, has a very clear circular decoration around his eye. Multiple explanations can be given for this. The first would be the black "burned-face" motive used for Nahuatl speakers in the Mixtec codices; i.e. Mexicas or Toltecs (Jansen & Pérez Jiménez, 2011, p. 335). However, the infrared image shows no indication that there was a large amount of black concentrated in this area, thus making this interpretation unlikely. A more plausible epxlanation is that this person had a round Tlalloc-type goggle around his eye. However, the mouth of this person does not display any of the incidative attributes normally given to people named after rain or the rain diety.

Although it is not reported as the subject of extensive investigation, page 3 also shows a lot of damage. The entire top and right of the page is exposed. For this page there are no available infrared photos made with the aid of xylene in the 1950's, so all reconstructions have to be based on the hyperspectral data and regular visual data (see figure 6.22). The top of this page is the only part that yields some interpretable data. In the centre of this portion, a couple can be

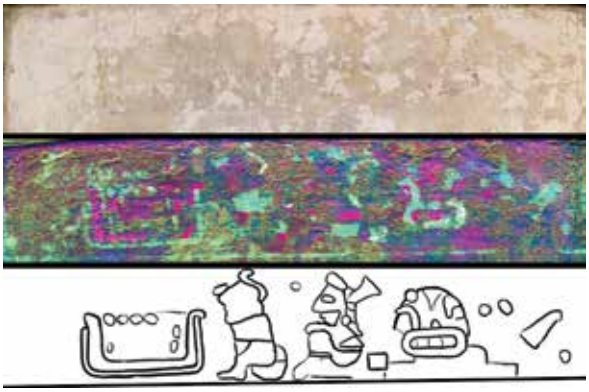


Figure 6.22: Top of page 3 in three modes: normal photography (top, courtesy of Bodleian Libraries, University of Oxford); hyperspectral imaging (middle); and line drawing.

Figure 6.23: Detail of page 1 verso (courtesy of Bodleian Libraries, University of Oxford).

seen, both looking against the direction of reading. This suggests that these people are parents that are included as a parentage statement, as is common in depictions of a marriage. On the left of this couple a glyph can be seen that looks a lot like a river design. On the right of the pair another figure may represent a mountain. Both the potential river and the mountain contain complex designs. These would identify them. However, considering the sheer amount of possible rivers and mountains already present in the codices, it is better to refrain from speculation about which mountain or river is represented here.

Page 1 verso is the current cover page of the codex. Because of this it is severely damaged. The main features are the A-O year sign 2 Flint, day 5 Reed, and the alphabetic text which reads: Don Diego hijo de don Domingo yuchaña (Jansen & Pérez Jiménez, 2007b, p. 31). Who this exactly was or what his relationship with this codex was is unknown. It is also unclear what the function of this year sign was, though it is likely that it refers to the event for which this codex was made (Jansen & Pérez Jiménez, 2007b, p. 164). Both these features are written on top of the gesso and thus clearly belong to the time period of creation and/or use of the known codex Añute on the recto side. Through the cracks in the surface, some remnants of subsurface paint can be seen, though the damage to the gesso is so extensive that not much remains to be analysed. Figure 6.23 shows one of the most complete elements on this page. Going through every exposed detail on this page is not a very useful exercise as the details are too small to be informative. However, as the above images have shown, hyperspectral imaging is capable of collecting data from still covered areas as well.

6.5 HYPERSPECTRAL RESULTS REVEALING SUB-SURFACE IMAGES

As explained above, hyperspectral imaging is able to reveal differences in colour that the human eye cannot distinguish. As with Photothermal tomography, a part of the visible incoming light enters a surface and can thereby interact with the colours. This means that hyperspectral imaging can also, albeit to a very limited extent, see inside the surface. The complex mathematical processes of MNF transformation turned out to be capable of filtering out the resultant sub-surface signal form the surface noise, as long as there is not too much disturbance on the surface. As stated before, because of time constraints and because it was not at first expected that any subsurface results would be found using this technique, only seven pages of the reverse were scanned using hyperspectral imaging. These were page 1; 3; 5-7; 10; and 11. In the following, a description of the hyperspectral results will be given. These are illustrated with composite false colour images. To achieve this, multiple MNF band images were combined into one RGB image. Each band is manually adjusted to give the optimum amount of

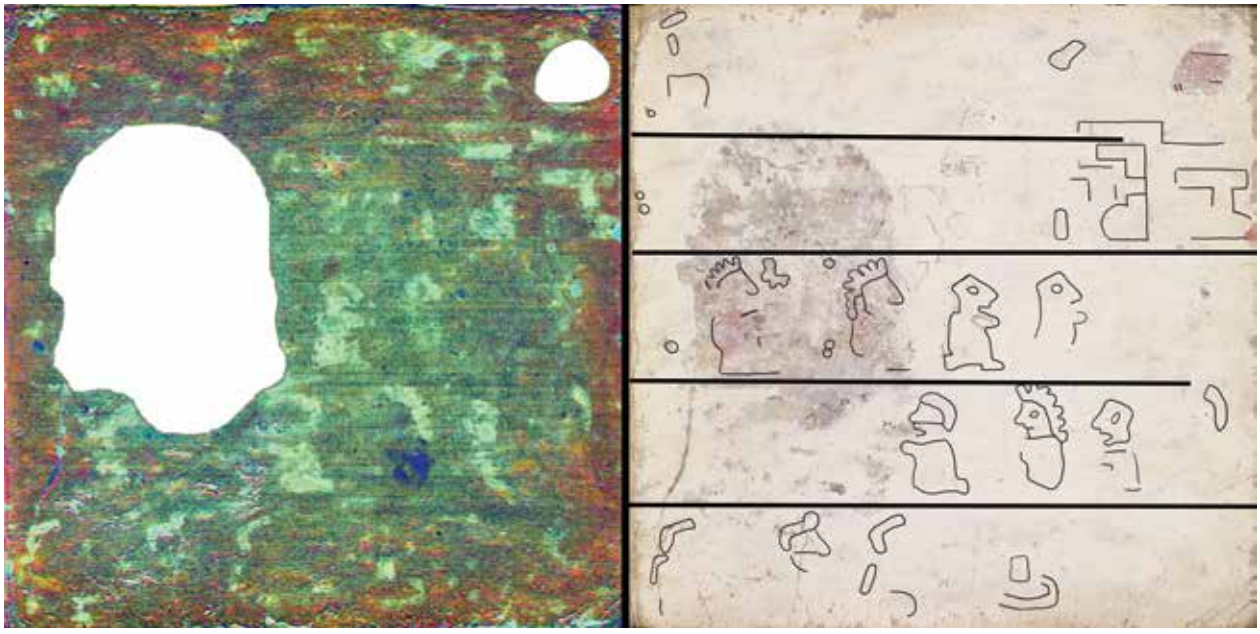


Figure 6.24: Hyperspectral results after MNF analysis and partial reconstruction of Codex Añute page 10 verso.

information using the custom stretch tool in ENVI, after this it was exported as a .tiff file and combined in Photoshop with the images of other bands. This procedure, however, also combines three noise signals. It was found that by reducing the resultant green and blue colours using the "selective colour" filter, this noise could be reduced. The description of the palimpsest as it is given here is based on what is seen in the hyperspectral imaging results, combined wherever possible with additional data from infrared or RTI imaging. The complexity of the hyperspectral and the RTI data does not allow for a complete presentation of the raw data on paper. This data can, however, be requested from the copyright holder: the Bodleian Library. In Appendix C, the reconstruction as proposed by the author and the false-colour hyperspectral images can be seen in more detail. It must be stressed that these drawings are based on a lot of interpretation of the data at hand. Additional data, especially the scans of the other pages, may in the future throw new light on these hidden images, which will necessitate alterations in these reconstructions.

In order to make these reconstructions in such a way that they follow the style of the original Mesoamerican author, it is necessary to start with the visible drawings and work from there to the invisible. Page 11 and 10 can be used as a template that shows how the original painter drew his figures and, since hyperspectral imaging creates images of specific colours, what colours he or she used for which part. In figure 6.18 it could already be seen that the two main colours that are differentiated at the surface are yellow and red. On the exposed part of page 10, these same colours could also be differentiated. When the hyperspectral image of that page as a whole is analysed, however, it becomes clear that especially cochineal red can be found in areas that are still completely covered by gesso (see figure 6.24). Some traces of the yellow paint can be found as well, though these are much rarer. That these red signals can be rather well distinguished can be explained by the characteristic spectral response of cochineal. Based on the style of the drawings in page 11 verso, it can be seen that if only the cochineal can be retraced, already quite a few diagnostic features of, for example, persons can be recovered. Some persons have completely red faces, while others have specific headdresses in red, and most women are easily distinguished by the red quechquemitl and hair or headdress. Obviously, recovering only one

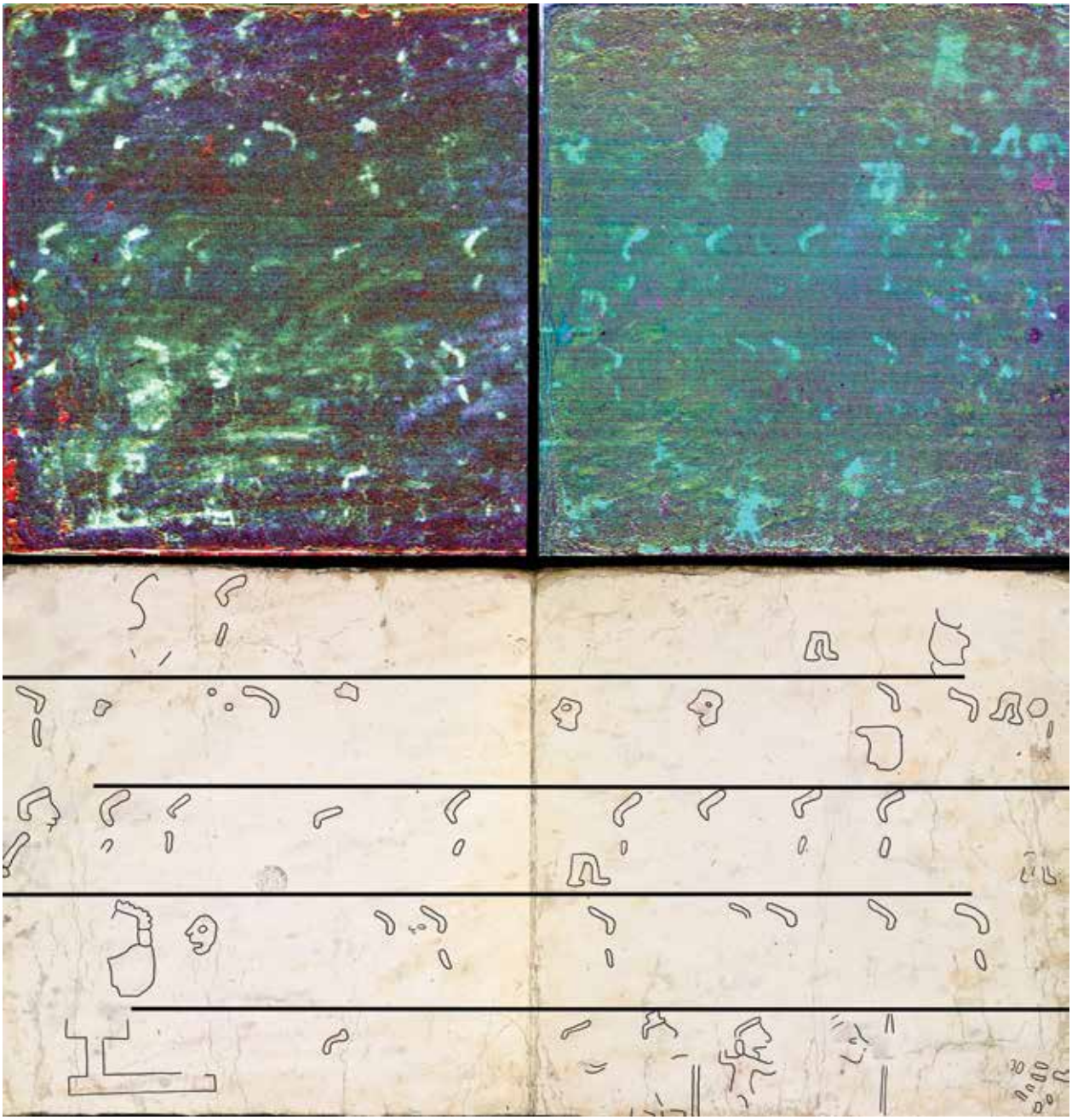


Figure 6.25: Hyperspectral results after MNF analysis and partial reconstruction of Codex Añute pages 6 and 7 verso.

of the colours means that for interpretation a lot of holes remain. It is, for example, never possible to give a certain identification of a person, as recovery of only red does not give certainty about calendar names. Nonetheless, the ability to recover the red paint does allow the recovery of many new scenes. In the following, a general description of the features of each page is given. More in-depth interpretation will have to wait until the document as a whole can be analysed. At this moment, the many holes in the data make it impossible to construct a true narrative. The first page to be analysed in this way was page 10. Because of the exposed paint of the surface, for the analysis of the subsurface features a new MNF analysis was done with the exposed areas masked. What can be seen in the resultant image (see figure 6.24) is that the two figures on the middle row that were exposed during the 1950's intervention are part of a longer sequence of people. They are followed by two seated persons, also facing right. To the right of this is a section that cannot be reconstructed, though there seems to be a rectangular feature on top of which something or someone is placed. This line continues on the third line with a series of persons facing left. At least four of these can be reconstructed, the third of which has a clearly differently coloured body, which is most likely yellow or orange. To the left of the fourth person, there is again a difficult to interpret area. It is striking though, that on page 11 line 4 and 5 there is again a series of individuals all facing the same direction. Such a long sequence of seated persons is unusual in the other codices. It is also striking to see that of the 17 persons found from page 10 line 3 until page 11 line 5 not one can be identified securely as female. On the fifth line of page 10 verso three figures can be found facing right. These can be only recognised by their red hair and their red quechquemitl. The right side of this line is again illegible.

As for the top two rows, these are very much distorted by the presence of the black drawings that were made, possibly during the 1950's investigation. It can be seen that most of these drawings have no reflection of what is underneath here. Especially the almost Maya-looking face makes no sense in this location, being cut in two by the reading line.

Having established that hyperspectral imaging can find some of the colours hidden by the gesso surface, and knowing how some of this can be interpreted, the other scanned pages were analysed. Following the reading order of the document, the next section that was scanned was pages 7 to 5. The first thing that can be noted is that these pages follow the same reading-line order as established for pages 11 and 10. Thus, the reading begins in the top left of page 7 and continues in a boustrophedon manner to the bottom right of page 6, where it continues on the bottom left of page 5. Page 7 and 6 are depicted and discussed together (see figure 6.25).

On the top left of page 7, some large red features can be found. Although these cannot be interpreted securely, there is a similarity between this figure and the large flint-like sign depicted on page 11. This section is followed on the right by a person, only locatable by the clear red hair or headdress and red quechquemitl. In the middle of the top line of page 6, what may be a pair of legs can be seen. On the far right of the same page, a seated person in red facing right can be partially seen.

On line 2 of these pages, at least seven figures, all facing left, can be located. For most of these figures, only the hair or headdress can be seen, though the third and fourth figure have a clear red face. The second visible face also has a red-coloured body, the position indicating that this person is likely male. There are large gaps between the persons, suggesting that there was more depicted than is here revealed. Especially between the second and third person and the sixth and seventh, there is an unusual – and ultimately wasteful – amount of space. Between the latter two some remnants of other colours can be seen, though they offer no clear indication as to their meaning. The third line is another unusual scene, as it shows a series of at least eight female figures facing the same direction. In most cases, there is not enough space between the eight female figures for any other figure. Only after the third and after the fourth person is there enough space for another feature. The motif seen in the middle of the top line of page 6 can be found three more times on page 6 (on the far right between lines 1 and 2; on the left on line 3; and on the right of line 3). If this is indeed a set of legs, it would

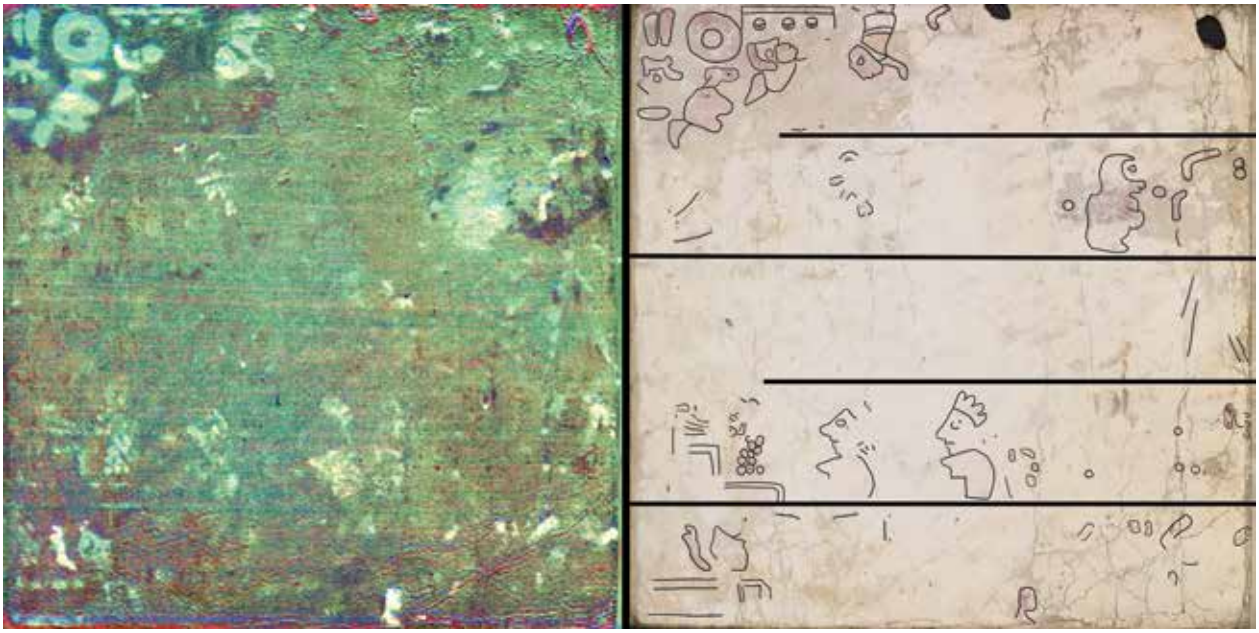


Figure 6.26: Hyperspectral results after MNF analysis and partial reconstruction of Codex Añute page 5 verso.

fit considering the size and position of this design in the rest of the composition. Since for many of these figures only the hair/headdress and the quechquemitl can be seen, it could be that most figures on this page are in fact walking rather than sitting. On the fourth line again a series of persons can be located due to their hair/headdress. At least five can be seen on page 6 and a further two on page 7. On the left of these, there are two more figures clearly distinguishable by the red face and the red body and feather headdress. The bottom line starts off with a large red design. It is reminiscent of the way that ballcourts are generally depicted. On the page 7 section of line five, only one person can further be located by the presence of the hair/headdress design. On page 6, however, four persons can be distinguished. These are depicted standing upright and are holding something in their hands. Travellers are often depicted walking with sticks in their hands. It is more likely, however, that the figures depict warriors, as the third figure seems to have his hands raised, thus standing in a position similar to the warriors in codex Tonindeye page 75. On the far right of this line appears what may be a person wearing a striped suit. If this is indeed a person, he or she also has one arm raised as if holding something.

If this reconstruction is correct, then page 5 (see figure 6.26) would start with a series of warriors coming in from the bottom left. Page 5 has a rectangular feature in the bottom left corner which could well be a place name. On top of this rectangle a red elongated feature is visible. This feature looks like the way that blood is portrayed in the codex Ñuu Tnoo-Ndisi Nuu (Bodley) on, for instance, page 16 line 3 Lord 4 Water. Two possible explanations for this are that either the blood is related to what could be a person to the right of it, in the same way as it is in the example from the codex Ñuu Tnoo-Ndisi Nuu. In that case it would be part of the name. The other possibility would be that it is related to the place and that the feature to its right may not be a person but an identifier of the place. In that case, the blood could refer to a conquest by the warriors preceding it. The rest of the bottom line of page 5 is hard to interpret. Only one person can be located sitting on the far right, but unfortunately this individual has no further identifiers.

The next two lines form one continuous section. This section did not yield much information either, however, except for two persons clearly visible due to the red face paint and red body of the left one and the red body and headdress of the one on the right. They

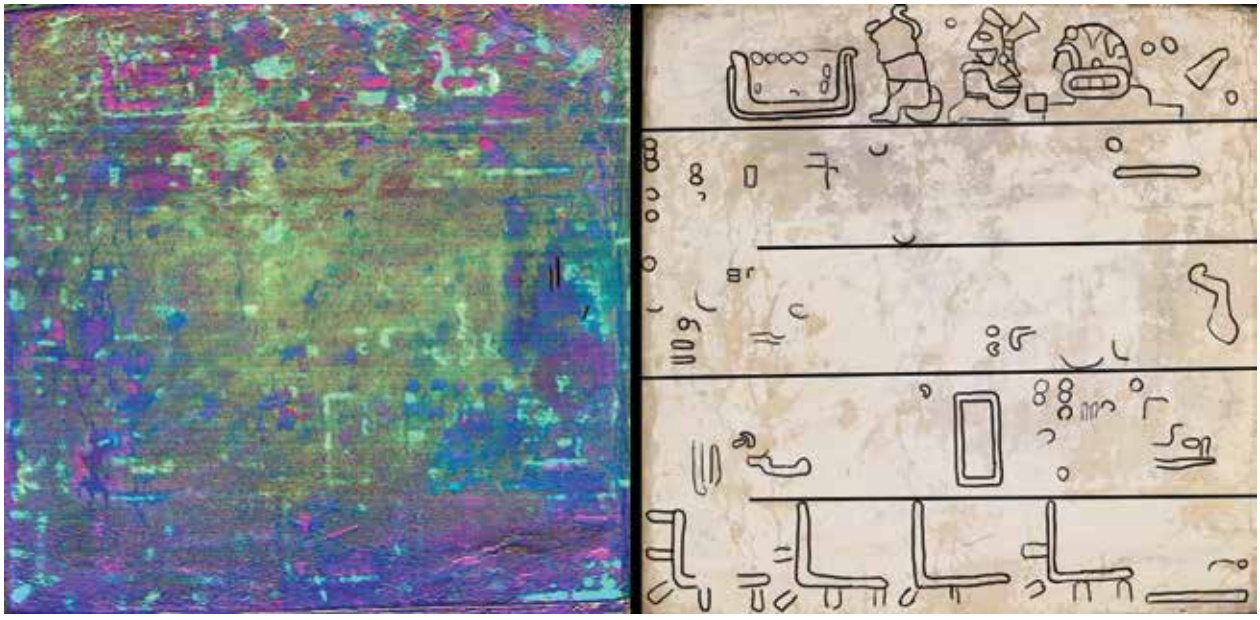


Figure 6.27: Hyperspectral results after MNF analysis and partial reconstruction of Codex Añute page 3 verso.

are both facing left, which is the direction of reading on this fourth line. What's more, they are facing the design discussed earlier, which may be someone or something placed on the first of a series of steps. If it is a person, than he or she is wearing clothing or has a body decorated with red dots. He or she would also be seated higher than the two facing him or her. It is possible, then, that the scene as a whole refers to a visit of the two depicted persons to a specific deity or priest in a temple. The third line of this page has only yielded very vague features. On the far right a large triangular shape appears. This could be part of a year sign, though that would make it very large, because as it is as it fills the entire line. The second line from the top begins with the exposed section discussed above. In this line, two persons are seated, looking against the reading direction. The rest of the line is illegible, though traces of red paint are visible in the central and left sections of the line. The top left corner of this page was already discussed above. And the top right section of this page did not yield further details that could be interpreted.

The next page scanned was page 3 verso (see figure 6.27). As stated above, the gesso layer on this page is rather damaged, though no invasive investigation of this page was recorded. Because of this, there is a large difference in the amount of images that could be recovered in each section of the page. The difference in recoverable images has mostly to do with the amount of deterioration of the gesso surface. In the centre, for example, there were relatively few traces of images recovered, because here the gesso layer is rather thick. As a whole, page 3 is one of the few pages where more than one colour can be recovered, though this is mostly limited to the largely exposed top line. The two colours are here depicted in this image as cyan (depicting cochineal red) and magenta (depicting yellow). The dark blue areas are mostly areas of surface damage. The figures on the top line have already been discussed above. Although the second, third, and fourth line do contain many fragments of paint, not much can currently be made from this, besides a large rectangular shape in the centre of line four. On the bottom line, a series of four very similar figures can be reconstructed. These may represent rivers, depicted in a manner similar to that found in the Codex Ñuu Tnoo-Ndisi Nuu, as cross sections cut in half.

The last page scanned – page 1 verso – is the extensively damaged cover. Even the hyperspectral

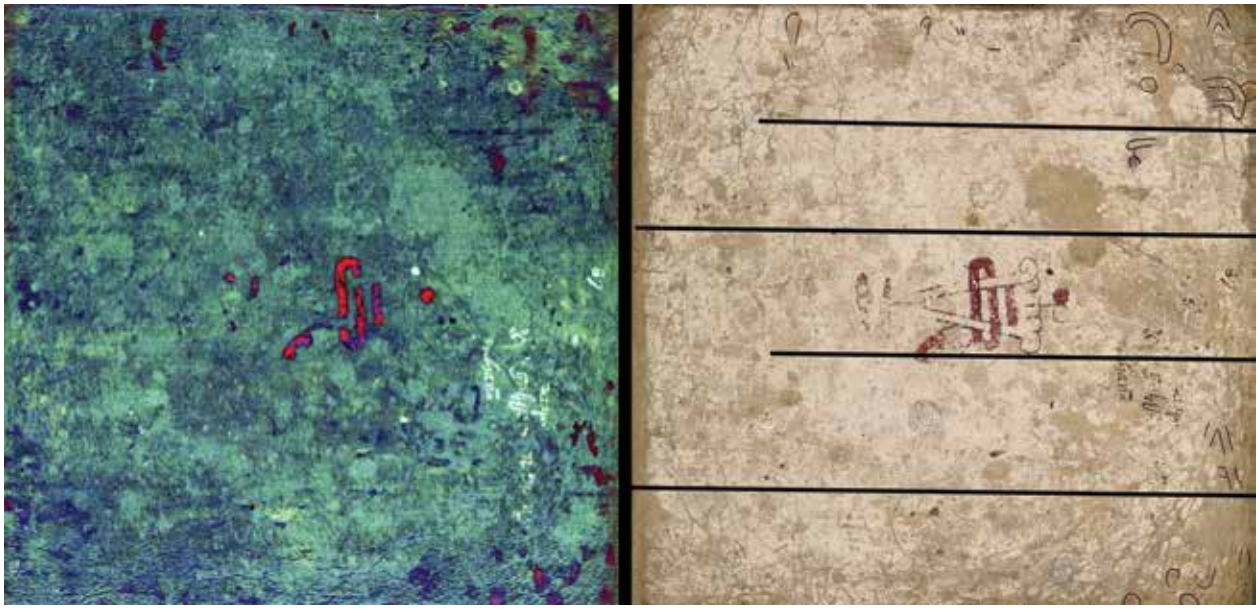


Figure 6.28: Hyperspectral results after MNF analysis and partial reconstruction of Codex Añute page 1 verso.

imaging data does not reveal much. Moreover, added to the damage is the distortion caused by both the A-O year sign and the alphabetic text. Because of the high signal that these surface colours give, the traces of the palimpsest disappear as background noise. The most important result of this scan, then, is that it illustrates the fact that this page cannot be the end of the text. The reading order on the other pages follows the pattern first seen on page 11 and 10. This means that the text on page 1 verso starts in the bottom left. As can be seen in figure 6.28, the reading line separating the bottom two lines continues right all the way to the edge of the page. From this it can be concluded that there must have been at least one more page. Considering the format of the text, it is almost a necessity that there was another page here. Without another page to the back of which a cover could have been attached, the texts would be exposed on the outside of the document. If indeed a cover was attached to the missing page, it is logical that it was cut off when the new codex Añute was made. Attaching a cover would require the use of a layer of glue, which would be difficult if not impossible to remove properly. That the text is not complete means that even if it were possible to reconstruct the entire palimpsest, it will probably not be possible to date the codex as precisely as has been done for the known codex Añute. The top two rows of page 1 verso are as close to the end of the narrative as it is possible to get. This is assuming that the text does not continue on the verso side. It is still unclear if the front of this book also contains a palimpsest, because the surface drawings create such a large amount of noise here, that is has not been possible to sufficiently analyse these images yet.

Two further elements of this page are of interest. On the top right as well as on the right of line four, two triangular elements can be found which may be year signs. However, no calendar signs can be distinguished which would allow for a more useful reconstruction. In all four corners of the page, some further pictorial elements appear, none of which can be reconstructed any further due to the damage.

DISCUSSION AND CONCLUSIONS

This chapter has shown that with the now available technological possibilities much more can be revealed about the palimpsest of the codex Añute. This can even be done in a completely non-invasive manner, which is a very important aspect as it points to the idea that new technological capabilities will be able to reveal even more in the future. Nonetheless, it is

important to investigate the palimpsest as thoroughly as possible, as the condition of the book continues to deteriorate. The tool that has yielded the best results thus far is hyperspectral imaging. This technique has been able to reveal much of the red paint that lies hidden underneath the gesso surface. Still, there are a number of ways in which the obtained results may be improved. First of all, the data acquisition can be improved by making scans of smaller areas, thus increasing detail. Problems that arose with focussing the lens because of the curvature of the surface and surface relief can also be solved by scanning a smaller area. Both of these solutions mean that more scans need to be made of each page, resulting in more data. Increasing the intensity of the light source may further help to improve the signal-to-noise ratio, thus allowing the recovery of weaker signals and, with that, possibly other colours as well.

Another way to possible improve the results acquired by hyperspectral imaging is to better harness and exploit the potential of the data generated. With the current analysis, pictures are generated from the data, which are then manually combined and analysed by simply looking at the picture and manually draw the outlines of the figures. A different approach would be to analyse the data mathematically, for example, through a pattern recognition algorithm. This has only recently been applied to cultural heritage research in order to restore alphabetically written documents using multispectral images (see Hedjam & Cheriet, 2013).

Although not all information could be recovered from the palimpsest of the codex Añute, there is already a lot that has been learned about this covered text. The process of reconstructing these images needs to happen carefully, however, as it is easy to over-interpret the images. First of all, it is clear that the book is read in a boustrophedon manner over two pages, with the document held horizontally. It is in this sense much like the codex Ñuu Tnoo-Ndisi Nuu. It has also been shown that the palimpsest is not complete, as the part located on page 1 verso requires at least one more page to connect the observed reading lines. It is still unclear whether the front of the codex is also a palimpsest or not. If it is, then either the missing page after page 1 verso is the end of the narrative or it is the section connecting the narrative on the front and the back. It may be possible to resolve this uncertainty by scanning the other pages on the verso side and determining if traces of a Mixtec origin narrative can be found there.

At least fifty new depictions of persons have been localised as a result of hyperspectral imaging investigations, even though many of these are only recognisable by their red hair or headdress. For the actual identification of the figures it would be essential to recover their calendar name, but this is not possible as it requires not only the identification of the calendar sign, but also the determination of the numeral that goes with it. As only the colour red is now recovered, it is never possible to be sure about the accompanying numeral of the calendar name. A rather curious observation is the fact that most of these figures look in the same direction. This may be explained by pure chance as the sections scanned may simply depict long series of individuals that are all incorporated in the same event. But it may also indicate that this codex uses a different way of writing and that things like marriage are depicted in a different, not yet recognised, way. If this were true it would represent a style of depiction unlike anything that is known from the other codices. Another striking difference from the known codices is that the persons recovered so far hardly ever sit on place glyphs. This may again be caused by chance, but it too could be the product of a different writing convention. To answer these questions, the remaining pages need to be scanned and analysed. If a complete overview can be given of even only the red paint, a lot more clarity about the structure of this text can surely be obtained. As a result of this new investigation, some new light can be shed on three phases in the biography of Codex Añute. On the one hand, a previously unknown phase in the life of this object is revealed by the investigation of the hidden images. Although with the current information it is still not possible to come to an interpretation of the text, if it can eventually be revealed it will undoubtedly shed new light on the history of Mesoamerican precolonial society. Seeing as there are no clear parallels to the known codex, and as has been shown in chapter 3 it is unlikely to have contradictory histories in such

manuscripts, it seems that this older text either contains an older history or at least a history with a different focus. Thus, we can say that the meaning of this object as a codex changed, since the contents radically changed. Besides this, a second part of the biography that is clearly embodied in this work is the point of transformation of the object itself. When and why this was done is unclear, though there seems to be a completely opposite rationale in the way of changing the story than was shown in codex Iya Nacuaa in chapter 4. Where the person editing the codex Iya Nacuaa did his or her best to keep the text legible and to preserve the text by removing things that could be deemed heretical, the writers of the later codex Añute were intent on covering the entire narrative up. To find out the cause of this difference in attitude, the text of the palimpsest would need to be investigated further and in more detail. And this is exactly where the present investigation touches upon a third biographical episode: the future. The technical investigation itself can be seen to add meaning to this codex. In fact, the images of the palimpsest only exist in the digital realm. This is a prelude for the future dealing with this book and possibly with the other codices. On the one hand there is a clear tendency to shift to the digital realm. Increasingly all types of cultural heritage become digitized. This has the major advantage that the object no longer needs to be handled for research purposes. But as this investigation has shown, in some cases the original object still holds many secrets that could be lost in a digitised world. Artistically, the codex can be considered one of the lesser texts and certainly the original object did not receive much scholarly attention. With this new information, however, this may all change.

7. Conclusions and Reflections

Throughout this work, the cultural biographies of the Mesoamerican codices have been followed. Each chapter approached specific episodes in these biographies from a different angle. The relations that these books were caught up in, whether in the form of the dependences or the form of affordances defined by Hodder (2012), can be seen to change over time. In over five hundred years the codices have travelled thousands of kilometres and have been transformed from sacred objects, to books of the devil, to worthless colouring books, and, finally, to celebrated relics of "lost" cultures and important sources for future research.

In chapters 1 and 2, the initial stages of the chaîne opératoire of these books were central. It was shown that a large amount of materials, skills, and people were needed to make one of these books. The implications of this may be far reaching. The tribute system of the Aztec empire was based on providing materials for all sorts of activities, which may have included the production of codices. This is not to say that the codices were the cause for this tribute system, but they were definitely entangled with it. If, for example, turquoise, Maya Blue, cochineal, or jaguar skins all of a sudden were no longer available, then codices simply could not have been made in the same way. As was shown in chapter 2, these resources were highly valued and securing access to them even led to military action. It is lamentable that there are no older codices left, because this appears to mean that there is no way to observe how the Mesoamerican codex production technology developed. It would be interesting to see if there is a way around this obstacle by undertaking a study of the integration of cross-craft production in general. Although there are not many examples of other objects that are the result of such extensive cross-craft interaction, there are older artefacts that may embody specific parts of the total set of interaction. It would thus be very interesting to connect the research on the codices with the study of, for example, Mesoamerican mural, pottery, textile, and mosaic production.

The amount of codices that have remained is so low that a statistically significant statement about recognised types of codices cannot be justifiably made. Nonetheless, there are some observable differences between the codices. The Maya codices are made on paper covered with a layer of chalk; while the central and southern Mexican codices are made on leather covered with gypsum. Furthermore, the Maya books seem to be made with predominantly mineral pigments; while in central and southern Mexico the use of cochineal and other organic paints has been evidenced. The choice to use cochineal over red minerals like ochre seems to be a purely aesthetic one, as red ochre is freely available throughout Mexico, while cochineal requires arduous farming and processing of the cochineal lice. Thus, as a material cochineal has a much greater entanglement than ochre. In fact, the use of cochineal as a paint for the codices may have been the reason for the use of gypsum as a writing surface, because the acidity of the cochineal dye would have had a detrimental effect on a chalk surface.

With the approach taken in the first two chapters, the limit of what can be achieved in a non-invasive investigation of the codices has on some level been reached. It is clear that further non-invasive investigation of the original codices is needed, so as to get a better understanding of the similarities and differences in the corpus. However, many materials have been shown to be organic and not accurately specifiable using the non-invasive methods now available. Consultation of the historical sources has supplied researchers with ideas about likely candidates for these materials and the experimental replication has provided further support for the notion that a codex can be made with materials identified. However, the question remains: how are we to make the step from likely candidate to secure identification? At this moment there is no way to do that without taking samples. But this poses a dilemma. The no-sample policy of the museums and libraries that guard these codices closely is understandable,

however, there are some colours that continue to fade whether samples are taken or not. This especially applies to the blues and by extension many of the greens: these colours are at risk of fading to the point of being perceptually undetectable. In the codex Añute, this can be seen most dramatically with the colour blue, which is only visible in very few places. It is clear that once it is completely discoloured, it can never again be identified, as the fading process is the result of disintegration on a molecular level. Consequently, this may justify the taking of samples on some of the codices in the areas of highest risk. What's more, the taking of samples in this instance need not be greatly damaging to the codex at all. The reason for this is because the technological capabilities of some advanced HPLC techniques requires only that micro samples are taken, which do not leave a trace on the sampled object that is visible to the naked eye. Ultimately, then, it is going to be a tough decision for the conservators of the institutes to make one way or the other. It is hoped that the contents of this work can help the institutions to make a more informed and considered decision.

The relationship between people and these codices in their original intended context was the central focus of chapter 3. It was argued that one of the codices main uses was the creation and sustainment of community. The issue with this part of the work is that it can only be based on inference as no context of use can be directly accessed. Since these codices do not preserve well once they are buried, it is unlikely that one will ever be recovered in an archaeological context. The complex combination of materials makes this only possible in a completely dry environment such as a cave, and even here (micro-)biological deterioration may not leave such a book unharmed. Although there are descriptions of books being placed in cave and in the ground as part of the mortuary ritual, it seems unlikely that this was the primary context of use for these books. For the living use of these books even less hard evidence exists. Their highly religious nature – even for the historical codices – makes it the case that all colonial descriptions and depictions need to be taken with a grain of salt. A context of use, therefore, has to be reconstructed based on the inscribed meaning in these books. Knowledge of the inscribed meaning may lead to a better understanding of the affordances of these books; i.e. what they allowed people to do with them. It has also been argued in this chapter that these books were part of performance. By combining the inscribed meaning with the physical evidence of the contexts in which they could have been used, it may be possible to get a better picture of what part these books had to play in the performances that were taking place. Even though for some codices, especially the historical ones, it is clear where they came from, the lack of good archaeological investigation of these sites limits the ability to reconstruct the contexts of use. Hopefully, future archaeological discoveries will help to improve upon this, presently uncertain, state of affairs.

As was shown in chapter 4, one of the main reasons for the current lack of precolonial documents was the destruction wrought in colonial times. The new colonial context was essentially a medieval one, inspired by fears of the non-Christian that arose from European struggles. In this new context, the affordance of a codex was not the creation of community, but, rather, the worship of demons. No matter what the original inscribed meaning of the books was, the writing style itself was a perfect fit within the European model of demonology and thus justified this ad hoc identification. Because of this ideologically driven identification, a new way of looking at these books emerged and their continued existence started to depend upon more than just physical preservation. If a document was to stay in a community under colonial rule, then it would have to be edited and transformed into something acceptable, or kept secret. Keeping a document that is meant to be used for the benefit of the community secret, however, is contrary to its purpose. In such a context the object itself will start to lose its meaning. Thus, besides the active persecution of the writing system, a lingering danger to these books was simple neglect. It has been shown in this chapter that the current damaged state of one codex – the codex Iya Nacuaa – may be understood as an active indigenous adjustment to the new Spanish-imposed worldview. This document was not kept secret, but rather made safe – or acceptable by colonial standards – through the removal of all animal elements which could have been interpreted as evidence of heretical behaviour.

After this removal process was complete, a new layer of meaning was added to the codex in between the images in alphabetic script. It is interesting to see how this one codex continued to function as an important document for the community for centuries after the conquest. Even though the art of reading the pictorial part of the manuscript was lost, as late as the 19th century there was a shared community memory that this document had something to do with a great ancient king. In this case, then, the transformation undergone in colonial times did not completely erase the meaning inscribed in precolonial times. Instead, the context of use became different such that even if the codex was primarily used in colonial courts to resolve land disputes, the old meaning lingered on below the official and sanctioned relations in which the object was embedded.

The books that were brought to European collections lost their meaning soon after their arrival. For some, it was even unknown from which continent they originated. These books were only revived with the reproductions that were made starting in the 19th century. These facsimiles allowed the codices to leave the confines of the institutes in which they were kept, thus allowing their reinterpretation. Although the development of new techniques for reproduction allowed for more truthful replication, it also further separated the images contained in these books from their physical originals. Because of this separation, some aspects of the documents were completely overlooked. Besides the physical composition of the originals, most of these forgotten aspects have to do with the three-dimensional nature of the originals. Although techniques to record this are still in their infancy, it is likely that such registration will eventually be the only way to preserve the information encoded in the original codices. The fragile nature of the gesso or chalk layer means that eventually it will break off and the codex will be lost. 3D recording techniques can help to not only record the present state, but also to track future deterioration.

The codex Añute can be considered as a perfect example of an object that was and still is influenced by all the entanglements that it was ever caught up in. The materials used to make it not only caught it in a web of relations with people, skills, and raw materials, but also influences the techniques that can be applied to recover its palimpsest today. Although there is not enough known about the covered text to understand what the relation is between it and the known codex Añute, using an old document was a conscious decision. It may be that there was not enough material available to make a new document or that the older codex was too far worn to be useful. In any case, the creation of the later codex Añute is in itself a prime example of both worlds of entanglement discussed in chapter 3 and 4. The neighbouring community of Yanhuitlán made a book in European style, and so the codex Añute is both an expression of the precolonial importance of these books, but also an expression of the act of resistance against the new colonial forms of writing.

This work has shown the applicability of the cultural biography approach for the precolonial codices. In doing so, an added dimension of these books has been explored which makes them even more interesting as archaeological artefacts. With the better understanding of the chaîne opératoire of these books this work has provided, it becomes possible to relate them to a whole range of crafts and cross-craft interactions. Some of these are very well known archaeologically, while for others these codices yield rare insights. Understanding the use of these books in the context of ritual performance may also have significant consequences for archaeological interpretation. Rather than seeing these books as isolated oddities in European archives, they may be better interpreted as highly significant objects used in those performances that go to the heart of community creation. In this light, other ritual behaviour may also have to be reinterpreted. The bringing of sacrifice, for instance, is at its core also a community creating performance. That so much literature on Mesoamerican culture still focusses on the bloody and macabre side of Mesoamerican religion can be explained in the light of processes similar to those that led to the destruction of the codices. Thus, contemporary investigations of the religious world of the Aztecs, Mixtecs, Maya, and other Mesoamerican peoples can proceed from a new vantage point. A vantage point, that is, that does not suffer from the tendency prevalent among the earlier researchers to reinterpret Mesoamerica from within

the paradigm that at least tacitly accepts the picture that is grounded in Medieval Europe's internalised attitudes towards a supposed demonic world.

Cultural biography is aggregative or, in other words, the present-day situation of an ancient object is the result of continuous entanglement, disentanglement, and re-entanglement of materials and people. The material dependencies that entangled and restrained the codices use in the original context are still present today in the form of conservation issues. The attitude of demonisation in the colonial period expresses itself today on three levels. The most obvious is the rarity of the objects, due to their destruction and neglect, although it has been shown that this may also be partially due to precolonial policies of disposal. The second consequence of colonialism in general is the rift that has been created between the decedents of the creators of these books and this form of cultural heritage. The perceived inferiority of indigenous cultural expressions has been engrained in present-day communities and is still perpetuated by state-wide education. It is still taken for granted, for example, that it was the Europeans who brought culture and the light of Christianity to the Americas. This attitude has also engrained a type of fear directed towards the state in those communities that still possess precolonial or colonial documents. It is feared in this case that if the existence of these documents becomes known, official agents of the state – in Mexico these agents are often taken to be the researchers of the INAH – will come and take the documents away. The progress made in terms of reproductions – as discussed in chapter five – has done little to bridge the gap between the precolonial codices and present-day indigenous communities. An exception, perhaps, is the recent efforts by Jansen and Pérez Jiménez who distributed their interpretations of the codex Añute (Jansen & Pérez Jiménez, 2007b) in the community of Jaltepec (Añute). An objection raised during presentation of this book in the community was that it was still not the members of the community itself that were creating their own new interpretations. Although the way in which this critique was levelled at these authors made it clear it was more an act out of spite by a political or scientific opponent, it does signal a general problem.

Because of the impact of colonialism and the fact that most of these codices are in European collections, there is little if any knowledge about them in many Mesoamerican communities. At the same time, the knowledge stored in the language, narrative, songs, and rituals (to name a few) of the Mesoamerican peoples, has its roots in precolonial times. Clearly, then, this knowledge could help researchers to come to a much better understanding of these codices. Bridging the gap between the precolonial codices and present-day indigenous communities is not only the next logical step for research on the codices, but is also ethically the right way to deal with these important pieces of indigenous heritage in the future. But to successfully bridge the gap will require navigating a veritable quagmire of stakeholders, each of whom has their own interest in these documents. In this final part of this work, some practical issues will be discussed that would have to be considered and resolved in order to give access to these works and facilitate indigenous knowledge production.

The first issue is how to disseminate the material in the first place. As has been shown in Chapter 5, physical reproduction of the codices is less cost-effective than digital reproduction. Unless it becomes possible to make a lot of prints and hand those out for free, therefore, the solution must be found in media such as the Internet, which takes care of distribution by its very nature. However, this does mean that those that do not have access to a computer with an Internet connection will never even hear about them. Moreover, even if people do have access to the internet, simply setting up a website and hoping people will stumble upon it will obviously not work effectively. Thus, direct outreach or collaboration with local institutes will be necessary. It follows, then, that to allow people to see and interact with the full range of precolonial codices without spending hours finding them and bringing them all together, a centralised digital space needs to be created. Such a platform would have to be easy to find and easy to use.

What is disseminated is as important an issue as how it is disseminated. The spread of low resolution scans of reproductions only exacerbates the problems of interpretation already mentioned, but dissemination

of those facsimile editions that are of a good quality will also have to deal with the problems of scanning and file compression. The newer scans recently made suffer in most cases from the problems that all photographs suffer from, because such things as colour, quality, and file size are often not standardised. In order to create a good photographic record of all the codices, a number of standards would have to be set and metadata presented, which would allow for these standards to be checked. Creating such standards would require the active collaboration of all the institutes with codices in their collection. In order to achieve such a collaboration, differences in policy, conservation strategy, and budget would have to be negotiated to create sufficient quality access for the long-term. As has been shown in Chapter 5, photography alone may not be enough to adequately access these objects. But as many indigenous peoples live in areas where high-speed internet and computers are not available, there has to be a constant weighing of quality versus accessibility in dissemination efforts. And the reality is that some data may never be able to be effectively made accessible to non-specialists. The hyperspectral data presented in chapter 6, for example, requires not only software, but also expertise, to interpret. The challenge, therefore, is to present this data in such a way that it becomes accessible and valuable.

Beyond a simple display of an image, there needs to be some form of introduction that accompanies those images. Although there is a lot of knowledge in indigenous communities about subjects that are incorporated in these codices – such as the calendar and certain narratives, the way in which these things are encoded in the documents requires some specialised knowledge to be accessed. Since this kind of specialised knowledge has crystallised in the course of over a century of research, it would make little sense to make users of these images re-invent the wheel and do such work all by themselves. However, in order to allow new interpretations to develop, one would have to take care not to over-interpret or fully project a dogmatic Western view of these books. Thus, a balance needs to be struck between distributing a tool for interpretation and distributing one's own version of the narrative.

In order to have indigenous people truly involved in the process of interpretation, the platform would have to incorporate an open space for discussion or reaction to what is presented. There are multiple formats from which such a space could be chosen, which each have their own advantages and disadvantages. In any case, there would have to be a form of moderation. Who would oversee and implement this moderation is again a difficult question, as it is the moderator who has the final say on what does and does not remain on the site. Competing and contrary interpretations will inevitably arise. Present-day social issues – such as conflicts over land – may penetrate into some interpretations, as members of different communities may choose to present distinct versions of history that best suit their particular social, political, or economic agendas. It also has to be taken into account that indigenous people will not be the only audience, as other interested people will inevitably find the website and could contribute to the open space. Inevitably, non-indigenous people will also interpret these books from their own religious and cultural background. What is clear, however, is that the choice of moderator will be influenced by the choice of which languages to use. On the one hand, much of the research done is either in English or in Spanish. However, in order to reach a large indigenous audience there are many more languages that would have to be considered, and at the very least, the languages in which Mesoamerican people would likely comment would have to be included.

These are only some of the issues that can be expected when setting up such a multilingual interactive digital platform for dissemination of the codices. During development, more issues will undoubtedly arise. If such a platform can be made, however, the codices will regain some of their original intended purpose: it will be possible to put these books to work again in the formation of community identity. Rather than presenting precolonial society as something savage and uncivilised, these books can help to validate precolonial heritage. The total corpus of precolonial Mesoamerican codices is small, thus clearly defining the scope of this endeavour. However, European institutes are full of objects that were taken from communities from all over the world where similar problems are at work. An increasing amount of

digital data is being produced, both on the side of analysis of the objects and on the representations of the artefacts. The next step is to explore what can actually be done with all this data, and to determine how it can be effectively used for the improvement of both science and society.

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Appendix A

In this table an overview is given of the materials mentioned in selected colonial or ethnographic sources. The references are abbreviated with the following letter codes:

(C.B.) Cruz, M. de la, & Badiano, J. (1991) [1552]. Libellus de medicinalibus Indorum herbis: Versión expañola con estudios y comentarios por diversos autores, Fondo de Cultura Económica, Mexico City.

(H.) = Hernández, F. (1615). Quatro libros De la naturaleza, y virtudes de las plantas, y animales que estan receuidos en el vso de medicina en la Nueua España, y la methodo, y correccion, y preparacion, que para administrallas se requiere con lo que el Doctor Francisco Hernandez escriuio en lengua Latina (F. Jímenez, Trans.): en casa de la viuda de Diego Lopez Daualos.

Accessible at https://archive.org/details/quatrolibrosdela00hern (accessed 21-06-2016)

(M.G.) = Unpublished works of Manuel Martinez Gracida, held at the Library of Oaxaca, archive digitized by

Since this unpublished work does not contain any page numbers, in the table the names of the sections are given.

(MTM) = Atlas de las Plantas de la Medicina Tradicional Mexicana at http://www.medicinatradicionalmexicana.unam.mx/ (accessed 24-07-2015). As this is a database with a rather chaotic structure, the ID number of each record has been incorporated to make the reference here more complete.

(S.) = Sahagún, B. de. (1577). Historia general de las cosas de nueva España, Book XI: Natural Things. Florentine Codex, Medicea Laurenziana Library, Florence.

In the table, colours are only given when indicated by the source itself.

Colour	Latin name/ mineral	Mixtec name	Nahuatl name	Zapotec name	Refer-ence	De-pict-ed	Notes
Whites							
White	Chalk?	Yuuñuucachi	Tlazcahuac	Yuuyati	(M.G.) Pintura p.2	-	Identified as yesso, used in combination with gum and oil. Is used for houses.
White	Gypsum?	Ñuucachicuisi	Tizatl	yuucete	(M.G.) Pintura p.2	-	Identified as yesso, used in combination with gum and oil.
White	Chalk?		Tizatl		(S.) 221r.	Yes	Used for spinning. Watered chalk (mud), fired in an oven to refine it.
White	Limestone?		Tetizatl		(S.) 221r.	Yes	Ground, fired and pulverized, used for varnish.
White	?	-	Chimatizatl	-	(M.G.) Pintura p.2	-	Identified as yesso, used in combination with gum and oil.
White	Gypsum?	-	Chimatizatl	-	(S.) 221r.	-	Comes from Uaxtepec, is won in the form of rocks, fired, ground and mixed with glue to paint on it.
-	?	-	Xicaltetl	-	(S.) 221r.	-	Found in gorges in the reeds. Used for burnishing vessels.

Colour	Latin name/ mineral	Mixtec name	Nahuatl name	Zapotec name	Refer-ence	De-pict-ed	Notes
Blacks							
Black	Acacia foetida	??? illegible	Huitzache	… (only given as dots, clearly meant to be filled in later)	(M.G.) Pintura p.2	-	Pods are used.
-	Acacia farnesiana	ínucua	Huizache	-	(MTM) 7841	-	
Black	Caesalpinia coriara		Cacalotl	-	(M.G.) Pintura p.2	-	Pods are used.
-	Caesalpinia coriacea	-	Cascalote	-	(MTM) 7133	-	
			Cascalote		(H.)		
Black	-	-	Nacascolotl	-	(S.) 218r. - 218v.	Yes	Comes from warm areas. Pods used and mixed with Tlaliyac and “garas de Granada” and Mezquite resin.
Black	?	-	Tlalihixac	-	(M.G.) Pintura p.2		Mineral, given as fetid earth.
Spak -ling Black	-	-	Tetlilli	-	(S.) 219v.	Yes	Hard glistening black rock used for, used to paint tecomates.
Black	-	-	Ocote	-	(M.G) Pintura p.2	-	“ Smoke of pine” soot?
-	Pinus patula	-	Ocotl	-	(MTM) 7879	Yes	
Black	-	-	Tlilli ocotl	-	(S.) 219r. - 219v.	Yes	Fine powder made from pine smoke soot.

Colour	Latin name/ mineral	Mixtec name	Nahuatl name	Zapotec name	Refer-ence	De-pict-ed	Notes
Blues							
Tur-quoise	Indigofera argentea/I. tinctoria	Quehui/ yucuquchui	Xiquilitl/ xiuhquilitl	yucohui	(M.G.) Pintura p.2	-	
Blue	-	-	Xiquilitl/ Tlaceuilli	-	(S.) 219r.	Yes	Juices pounded and pressed from leaves and gathered in a bowl where it is left to thicken. Used for both dyeing and painting
-	Indigofera suffruticosa	-	-	-	(MTM) 7114	-	Used as medicine for a large range of ailments.
Sky blue	-	-	Matlalxihuitl	-	(M.G.) Pintura p.2	-	
-	Tradescantia sp.?	-	Matlalxochitl	-	(C.B.) 10v.	Yes	According to Gates (2000, 133) as Tragescantia sp.
Fine Blue/ Verdigris	-	-	Matlali	-	(S.) 217v.	Yes	Made from blue flowers.
-	Commelina erecta	-	Matlali	-	(MTM) 7582	Yes	Used as for the treatment of eye problems.
-	-	-	Zacamatlalin		(C.B.) 48r.	Yes	No identification given by Gates 2000
Sky blue	-	-	Texotli	-	(M.G.) Pintura p.2	-	
Sky blue	-	-	Texotli	-	(S.) 219r.	-	Dye for clothing, made from the same flowers as matlalli (does not say this in Nahuatl text)

Colour	Latin name/ mineral	Mixtec name	Nahuatl name	Zapotec name	Refer-ence	De-pict-ed	Notes
Sky blue	-	-	Xocohui	-	(M.G.) Pintura p.2	-	May be related to Tlalxocotl see below
Sky blue	Cestrum mutisi	-	Potonxihuitl	-	(M.G.) Pintura p.2	-	Fruits used to make paint, used in writing and painting.
-	Cestrum dumetorum	-	Potonxihuite	-	(MTM) 7665	-	Medicine against inflammation.
Yellows							
Bright Yellow	Cuscuta americana	Yucu yahacuaa	Zacatlaxcalli	Lob???? (il-legible) Beze-chinagache (this 2nd name is given in the description of Xochipalli).	(M.G.) Pintura p.2	-	
Bright Yellow	-	-	Zacatlaxcalli	-	(S.) 217v.	Yes	Sold in the market in the form of “tortillas” Used for painting and dyeing
Dark Yellow	Yellow Ochre	Nuhucuatnoo	Tecozahuitl	yoogui	(M.G.) Pintura p.2		Ochre is mixed with oil and used in certain ceremonies.
Yellow			Tecozahuitl		(S.) 219r.	Yes	Stone used for dyeing and painting bright yellow.
Bright yellow	-	Nuhucuaha	-	yoozonagachi	(M.G.) Pintura p.2		Ochre is mixed with oil and used in certain ceremonies General name: Almagre.

Colour	Latin name/ mineral	Mixtec name	Nahuatl name	Zapotec name	Refer-ence	De-pict-ed	Notes
Yellow	-	-	Xochipalli	-	(M.G.) Pintura pp.2-3		Mixed with nitro (Potassium nitrate?), zacatlaxcalli and leche del chicalote (and the flowers of Hypericum formosum/H. fastigiatum given as “Pericon”).
-	Cosmos sulphureus Cav.	-	Xochipal	-	(MTM) 7272	-	Used as medicine against diarrhoea.
Fine Yellow	?	-	Xuchipalli	-	(S.) 217r.	Yes	Discussion about identification, see chapter 1.
-	Tagetes lucida	-	yauhtli	-	(MTM) 8002	Yes	Common name is Pericón.
Reds							
Bright Red	Coccus cacti	Dug / Ducu	Nocheztli	Bea	(M.G.) Pintura p.3	-	Sold in cakes.
Bright Red	-	-	Nocheztli	-	(S.) 216v.-217r.	Yes	Purified grana in cakes is called Tlaquahuac Tlapalli, it is sold to and used by painters and dyers of rabbit skins (Tochomitl).
Lower quality red	Coccus cacti	-	tlapalneztli	-	(M.G.) Pintura p.3	-	“Grana Silvestre”.

Colour	Latin name/ mineral	Mixtec name	Nahuatl name	Zapotec name	Refer-ence	De-pict-ed	Notes
Lower quality red	-	-	tlapalnextli	-	(S.) 217r.	-	Mixture of grana with other materials.
Chili Red (with alum)		-	Uitzquauitl	-	(S.) 218r.	Yes	Big tree with coloured wood, used with alum it becomes red. Suitable for dyeing not for painting (amo tlacuiloloni).
Red-Brown	Haematoxy-lum campe-chianum/ Caesalpina echinata	-	-	-	(M.G.) Pintura p.3	-	Paló de Campeche/ Paló de Brasil.
Beautiful bright red	Haematoxy-lum campe-chianum/ Caesalpina echinata	-	-	-	(M.G.) Pintura p.3	-	Mixed with alum.
-	-	-	Huitzquauitl	-	(C.B.) 38v.	Yes	According to Gates 2000, p. 133 Caesalpinia crista (L.) and reporting as giving Logwood or Brazil dye
Red			Huitzquahuitl		(H.) 63v.-64r.	-	Colour ranges from orange to red and with alum to vermillion.
Red?	Jatropha sp.	-	Teoezquahuitl	-	(C.B.) 38v.	Yes	According to Gates 2000 p. 125 a source of red dye
Vermil-lion	Bixa orellana		Achiotl		(M.G.) Pintura p.3		Flowers or seeds mixed with “grease” of Coccus axin (insect) results in a lacquer.

Colour	Latin name/ mineral	Mixtec name	Nahuatl name	Zapotec name	Refer-ence	De-pict-ed	Notes
-	Bixa orellana L.	-	Achiote	-	(MTM) 7082	-	Used for the treatment of a wide range of ailments.
Light Red	-	-	Achiotl	-	(S.) 217v.-218r.	-	Also mentioned is a medicinal use.
Blushing red (pink?)	Melastoma tezoatlan-ensis	-	Tezoatl	-	(M.G.) Pintura p.3	-	Leaves used Mixed with Tunas (Nopal) to paint houses
Fine red	-	-	Tezoatl	-	(S.) 218v.	Yes	From warm areas. Combined with tlaliac and alum. Used for dyeing rabbit skin
Cherry	Hybiscus sabdariffa	-	-	-	(M.G.) Pintura p.3	-	Flowers of the Jamaica are used
-	Hibiscus sabdariffa	-	-	-	(MTM) 7854	Yes	Generic name: Jamaica
Secondary Colours							
Grey	Graphite	-	-	-	(M.G.) Pintura p.2	-	in oil
Purple	Coccus cacti	Ducu	Nocheztli	Bea	(M.G.) Pintura p.3	-	Mixed with alum
Purple	-	-	Camopalli	-	(S.) 221v.	-	Mixture or Cochineal and alum
Purple	Frijolillo silvestre	-	-	-	(M.G.) Pintura p.3	-	Flowers of Frijolillo silvestre are used.
Brown	-	-	-	-	(M.G.) Pintura p.3	-	Mix of purple and black.
Green	-	-	Zacatlaxcalli + Texotli + Tzacutli	-	(M.G.) Pintura p.3	-	

Colour	Latin name/ mineral	Mixtec name	Nahuatl name	Zapotec name	Refer-ence	De-pict-ed	Notes
Dark Green	-	-	Iiapalli	-	(S.) 221v.	Yes	Texotli is added to Zacatlaxcalli and mixed with Tzacutli.
Light Green	-	-	Quiltic	-	(S.) 221v.-222r.	Yes	Spanish text gives Zacatlaxcalli and Texotli, Nahuatl text gives no ingredients
Very Dark Brown	Haematoxy-lum campe-chianum?	-	Uitztecolli	-	(S.) 222r.	Yes	Spanish gives brasil, i.e. Logwood. Used for the dyeing of rabbit skins.
Leonado (light brown?)	-	-	Tecoxtli + tzacutli	-	(M.G.) Pintura p.3	-	
Yellow Brown	-	-	quappachtli?	-	(S.) 222r.	Yes	Spanish text seems wrong. Nahuatl gives it as a moss growing on a tree to which nacascolotl and a mud called palli (a rare black clay see (S.) 232r.) is added to improve it. This is consistent with the depiction.
Additives							
-	Argemone mexicana	-	Chicalote	-	(M.G.)	-	Sap used
	Argemone ochroleuca		Chicalote	-	(MTM) 7516	Yes	Principle cure against “Mal de Ojo”, but also used for other aiments
-	-	-	Chicalotl	-	(S.)252r.	Un-clear	Also called Michioauhtli

Colour	Latin name/ mineral	Mixtec name	Nahuatl name	Zapotec name	Refer-ence	De-pict-ed	Notes
-	-	-	Tlaliac	-	(M.G.)	-	Identified as a plant, used in combination with other plants
-	Copperas	-	Tlaliiac	-		-	Used for making paints and dyes
-	Alum	-	Tlalxocotl	-	(S.) 219v.	Yes	Described as sour to the taste (related to how this material was distinguished?)
Adhesives							
Adhesive	Dendrobium alba/ D. rubia/ D. sulfurea (No other record of this name found)	Itandaca	Tzautli	Guiagana/ guiaxeneba	(M.G.) Pintura p.4	-	Mixtec name means flower of glue.
Adhesive	-	-	Tzauctli	-	(H.) 163 r.		Mentioned as a glue for painters, as well as a medicine for various ailments.
Adhesive	-	-	Tzacutli	-	(S.) 185r.	Yes	Roots are mentioned as sticky, identified as a glue.
Adhesive	Prosopis dulcis	Dzusadzee	Mezquitl	xenebee	(M.G.) Pintura p.4	-	Gum used as an adhesive.
-	Prosopis juliflora	-	Mezquite	-	(MTM) 7712	-	
-	-	-	Iztacpatli	-	(C.B.) 16r.	Yes	Identified by Gates (2000, p.126) as Prosopis juliflora, Mimosa sp, or Acacia farnesiana.

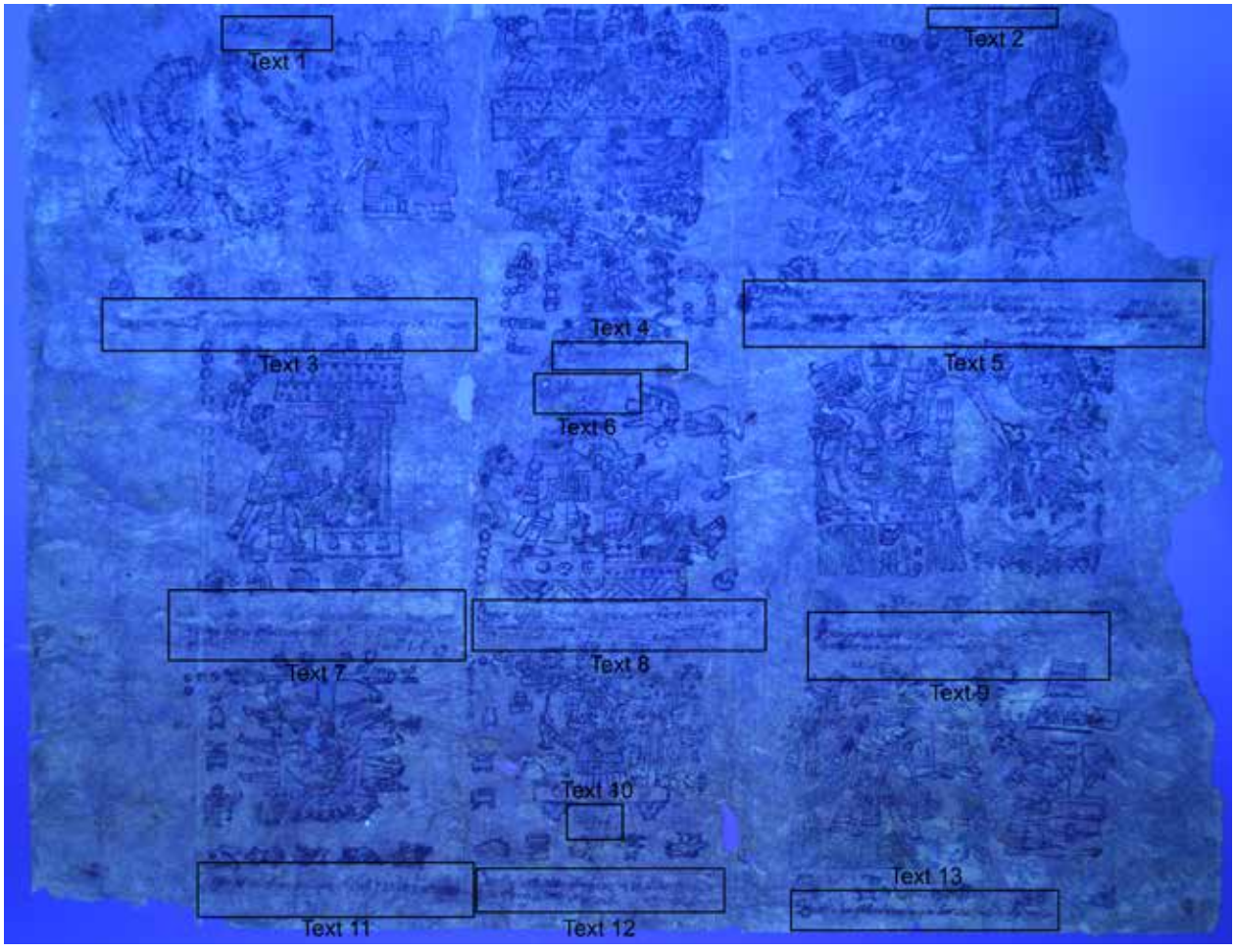
Colour	Latin name/ mineral	Mixtec name	Nahuatl name	Zapotec name	Refer-ence	De-pict-ed	Notes
-	-	-	Tlalmizquitl	-	(C.B.) 24v.	Yes	Identified by Gates 2000, p140 as Mimosa circinalis.
Adhesive	-	-	Mizquitl	-	(S.) 124r.	Yes	The use of the gum as adhesive is only mentioned in the Nahuatl text. Bark is described as very rough.
Adhesive	Rhyzofora mangle	-	-	-	(M.G.) Pintura p.4	-	Gum of the Mangrove
Adhesive	Hymenaea courbaril	-	Cuapinole	-	(M.G.) Pintura p.4	-	Also known as Jatoba. Gum is used as adhesive and it is also used in Atole.
-	Hymenaea courbaril	-	Guapinole	-	(MTM) 7648	-	Primarily used as remedy against respiratory ailments.
Adhesive	Mentzelia hispida	-	Zazalic	-	(M.G.) Pintura p.4	-	Mentioned that it can trap bats with its sticky sap
-	Mentzelia hispida	-	-	-	(MTM) 7998	-	Generic name is “Pegarropa”.
Varnish	Coccus axin	dugdzacua	Axe	beazaa	(M.G.) Pintura p.4		Art of making this was lost in the 18th century except for few places.

Appendix B

This appendix contains a number of photographs made using different forms of illumination, each allowing the study of a specific aspect of this forged document.

The image above is a regular RGB photograph, showing how faded the document appears, especially in the areas where alphabetic text is found.

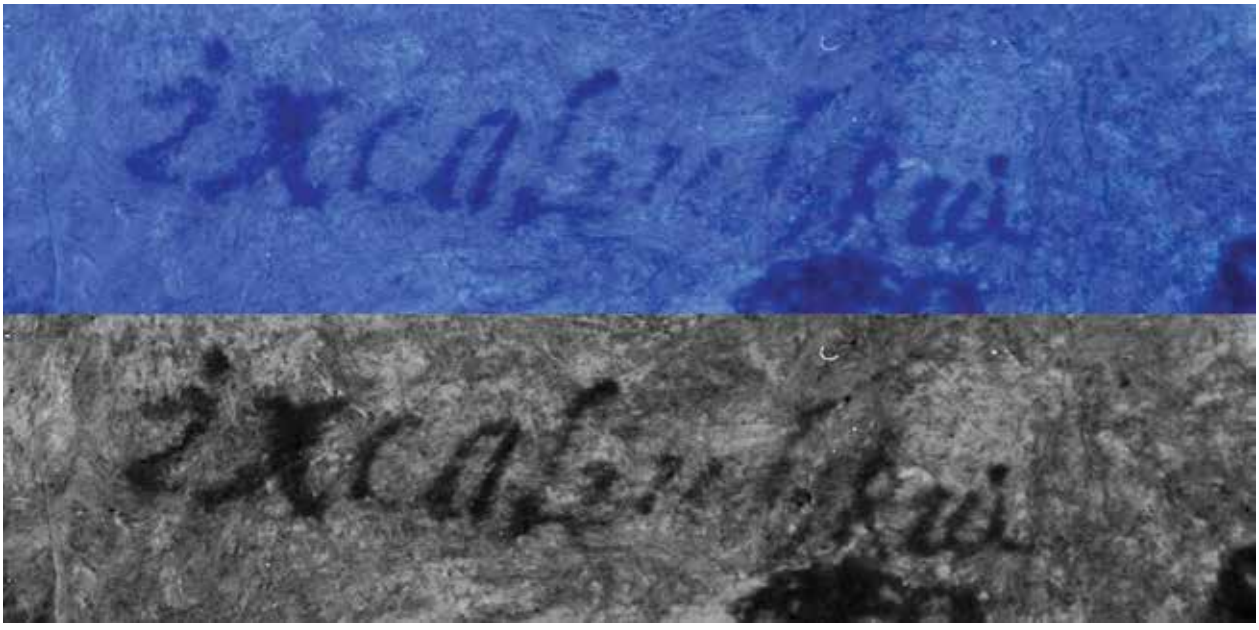
The image above is a photograph made using transmitted light, showing the deteriorated state of the support.



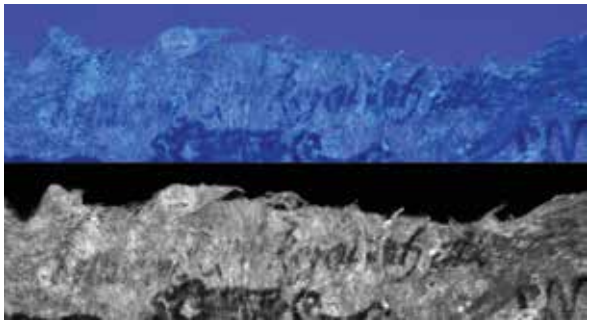
The image above is a photograph made using UV illumination; the outlines show the locations of the texts shown in the next section.

Detailed pictures of texts under UV light and digitally edited to improve legibility.

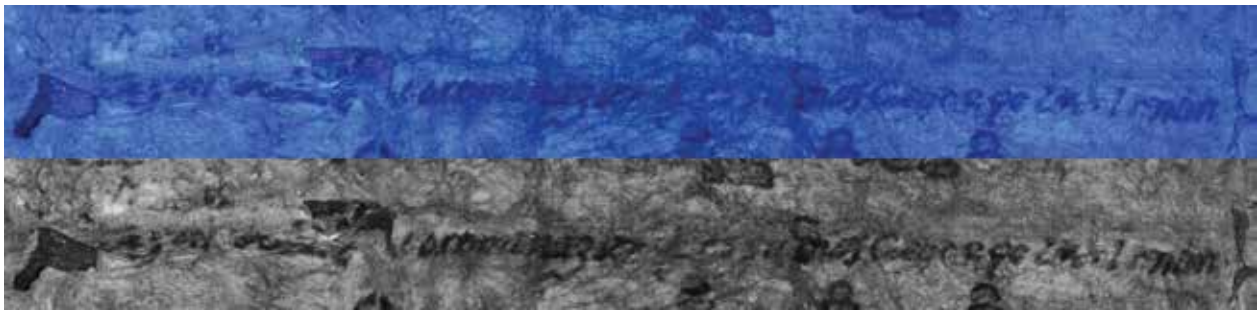
Text 1



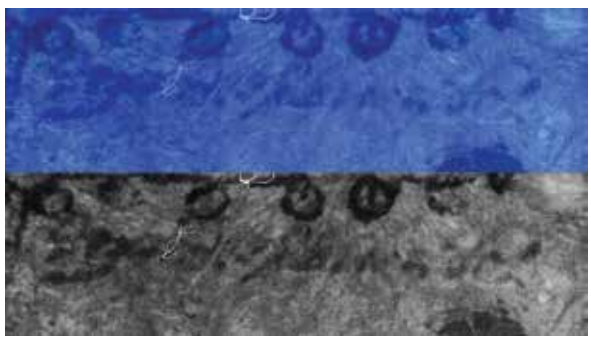
Text 2



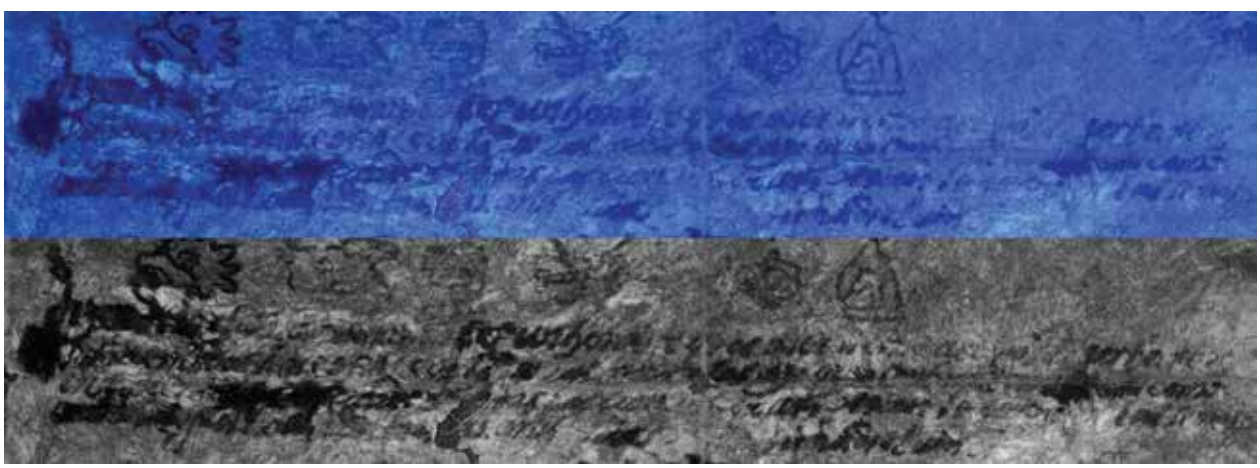
Text 3



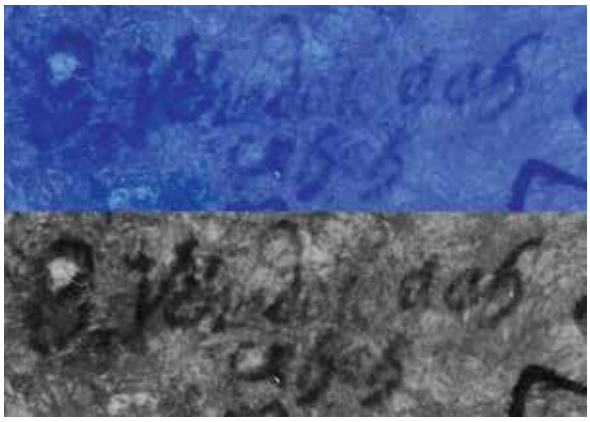
Text 4



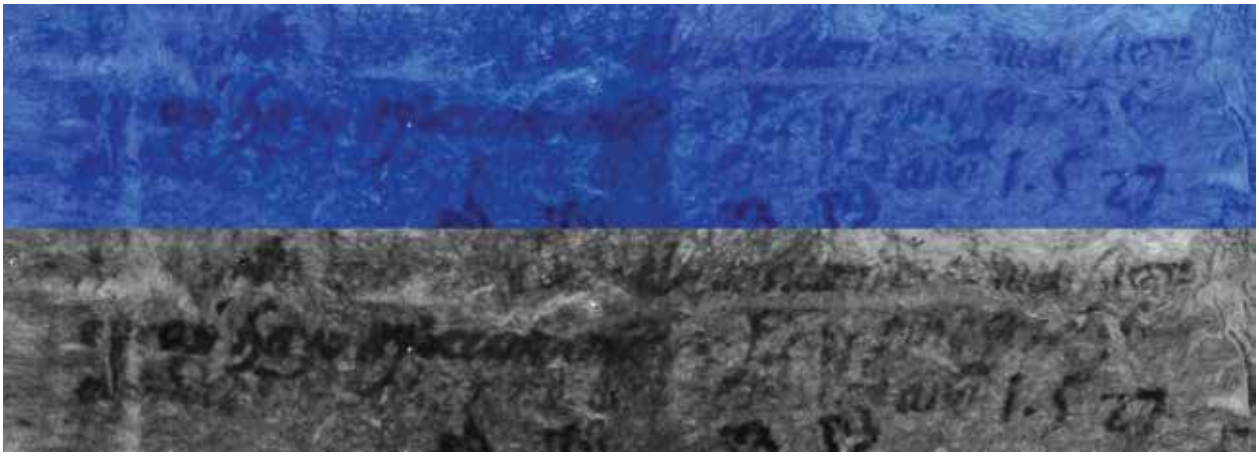
Text 5



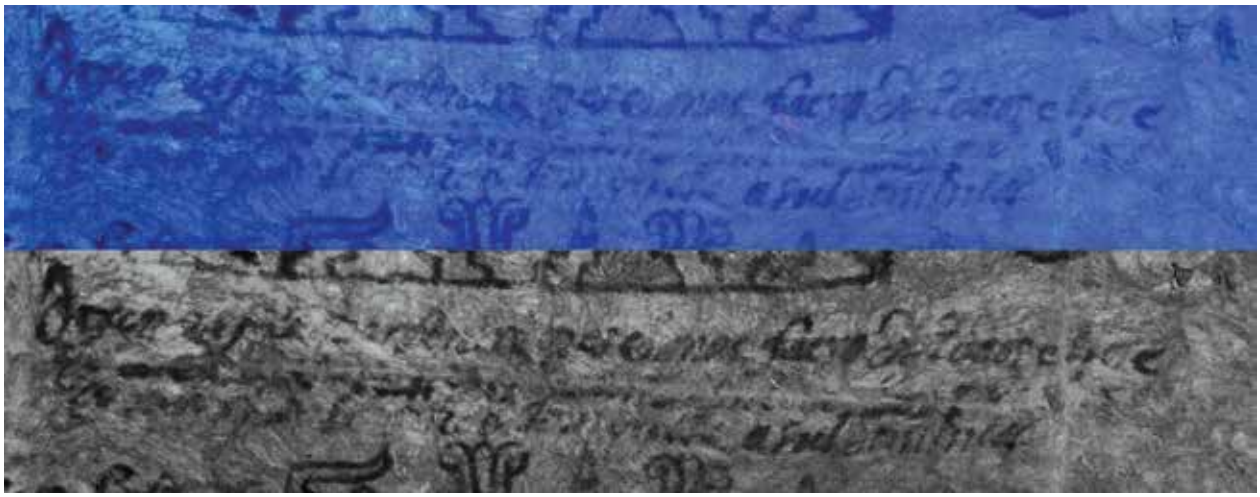
Text 6



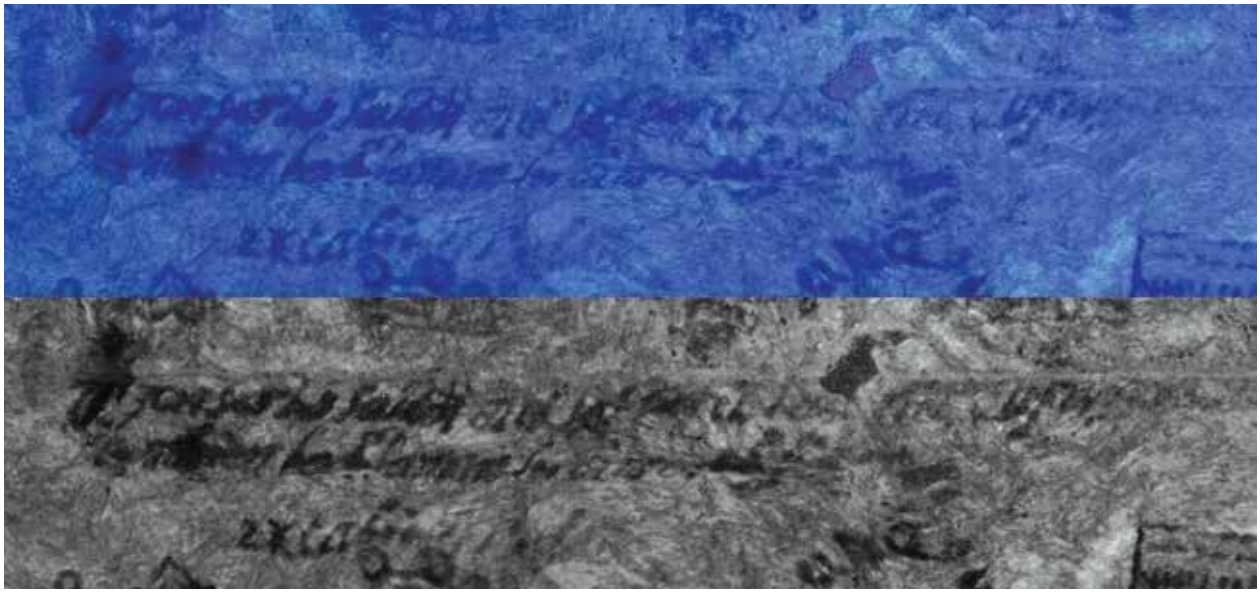
Text 7



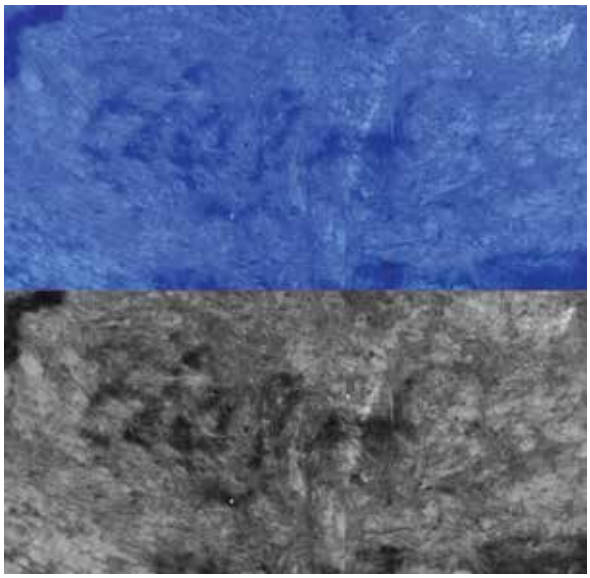
Text 8



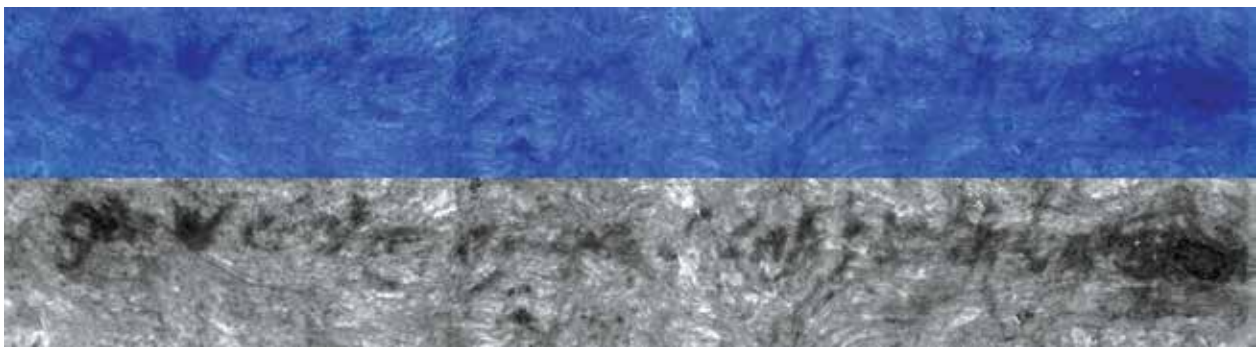
Text 9



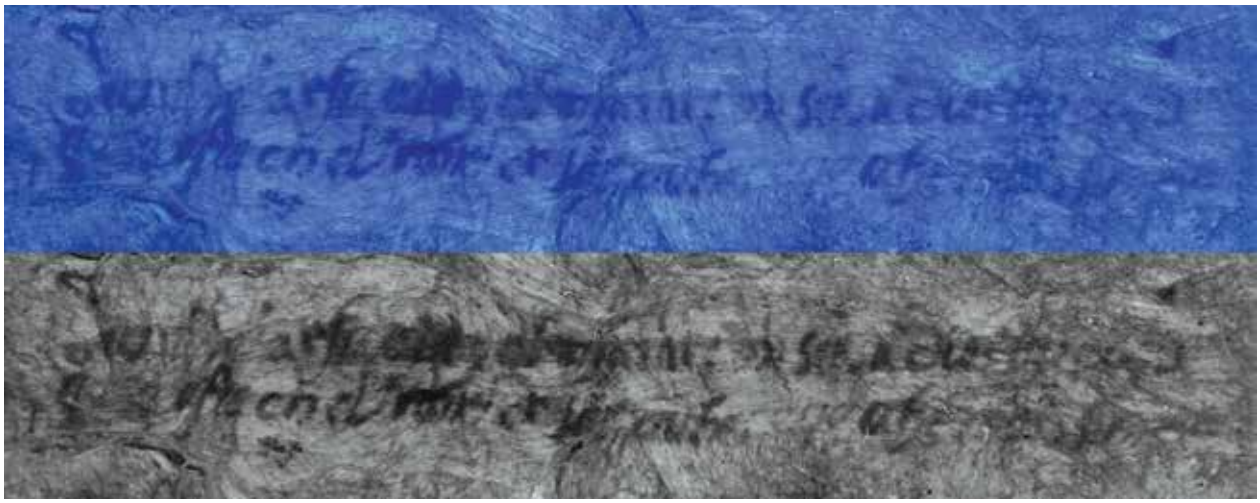
Text 10



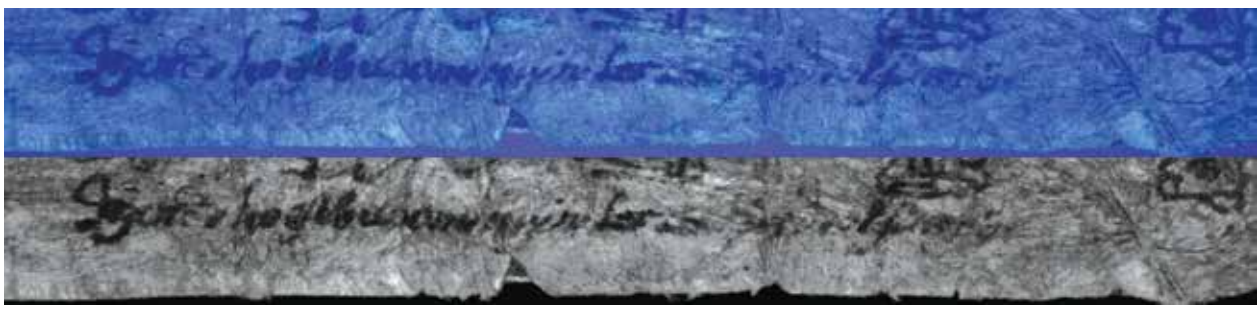
Text 11



Text 12



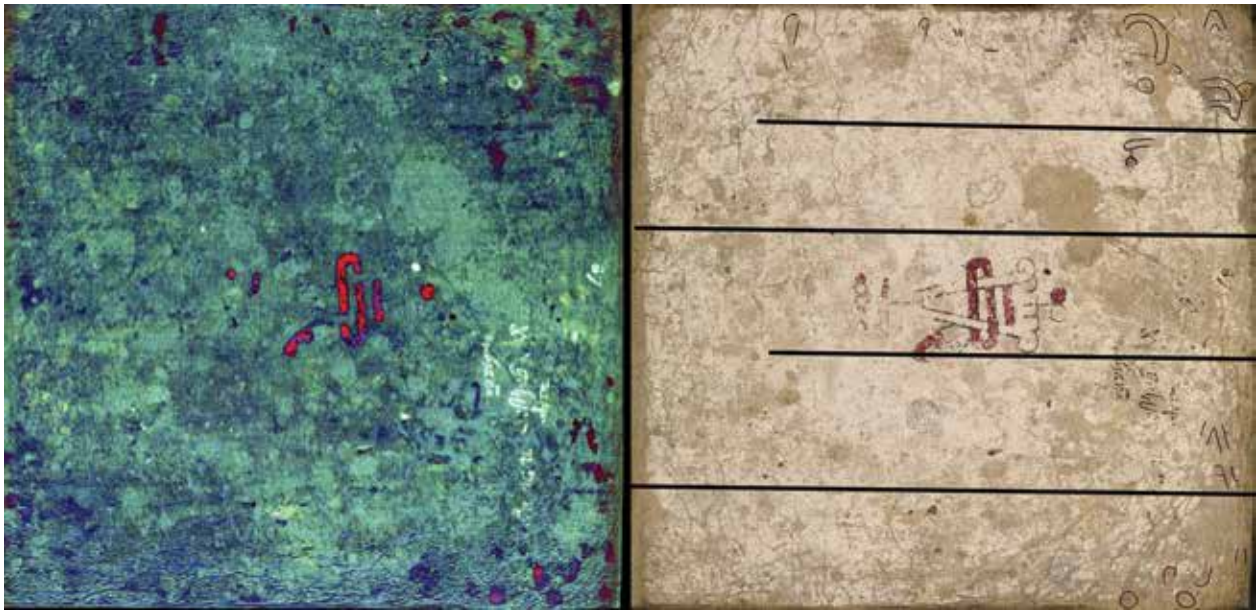
Text 13



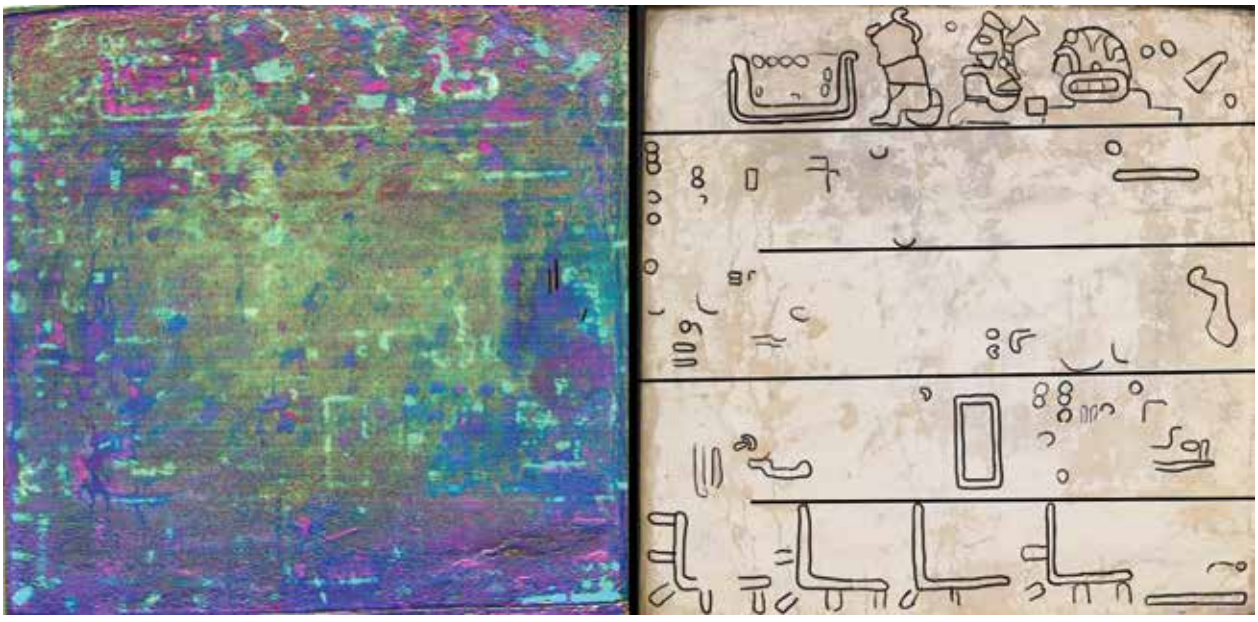
Appendix C

This appendix contains the large format images of the hyperspectral imaging results of the seven pages of codex Añute investigated during this project (See chapter 6).

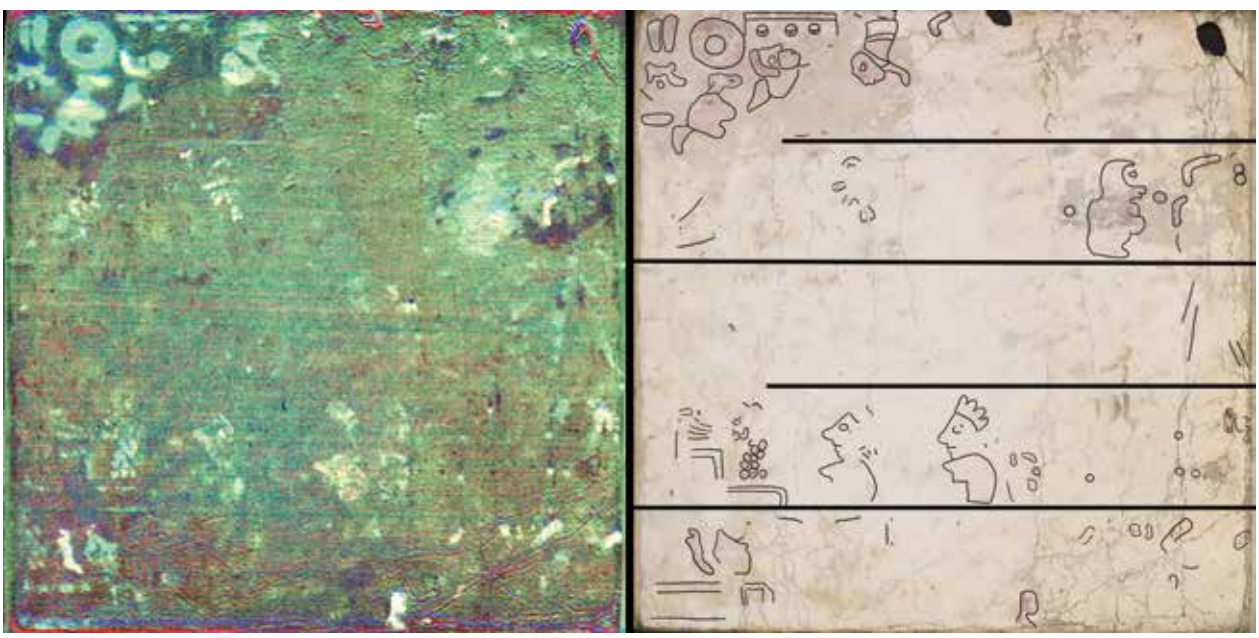
Page 1 verso



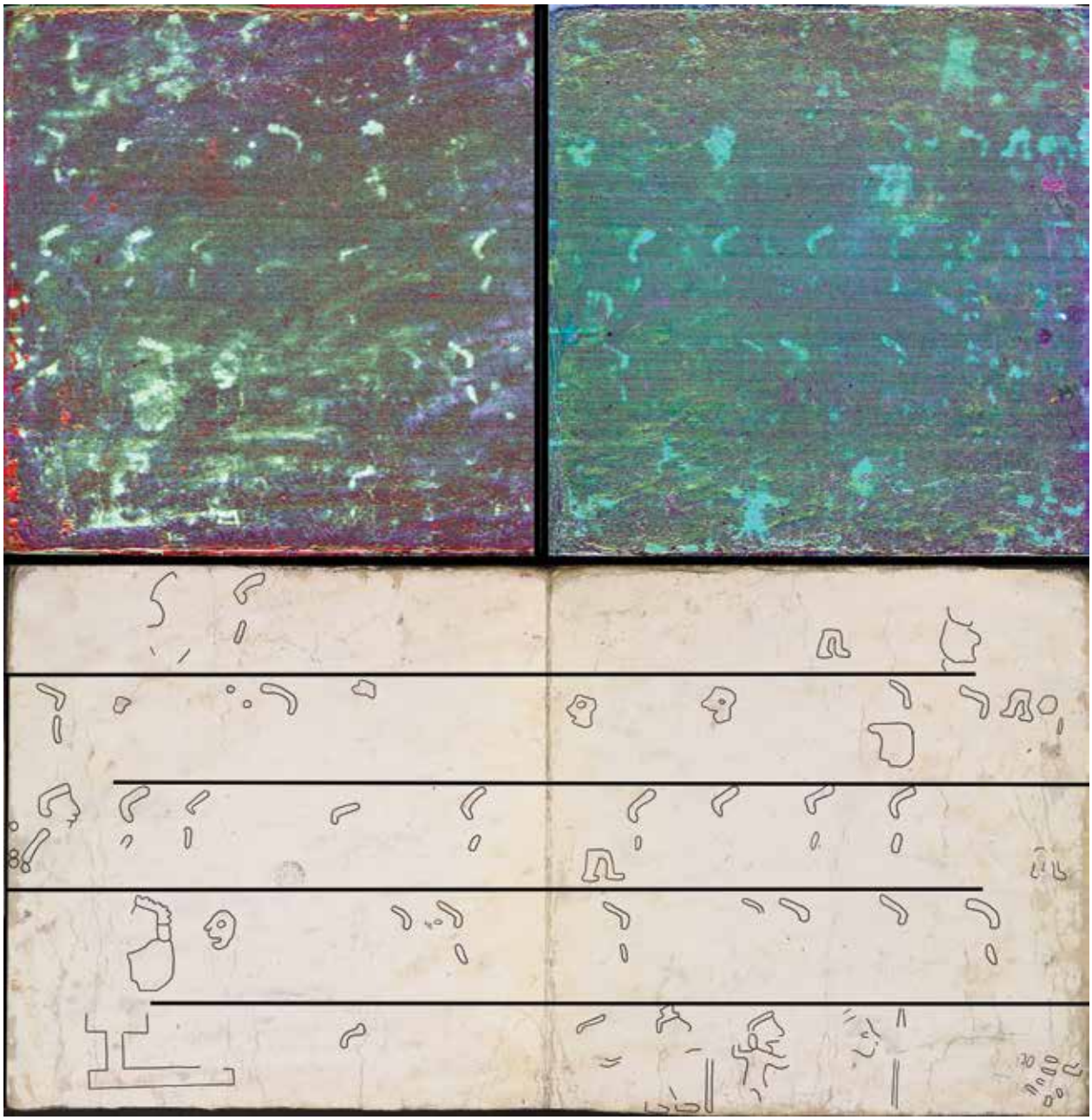
Page 3 verso



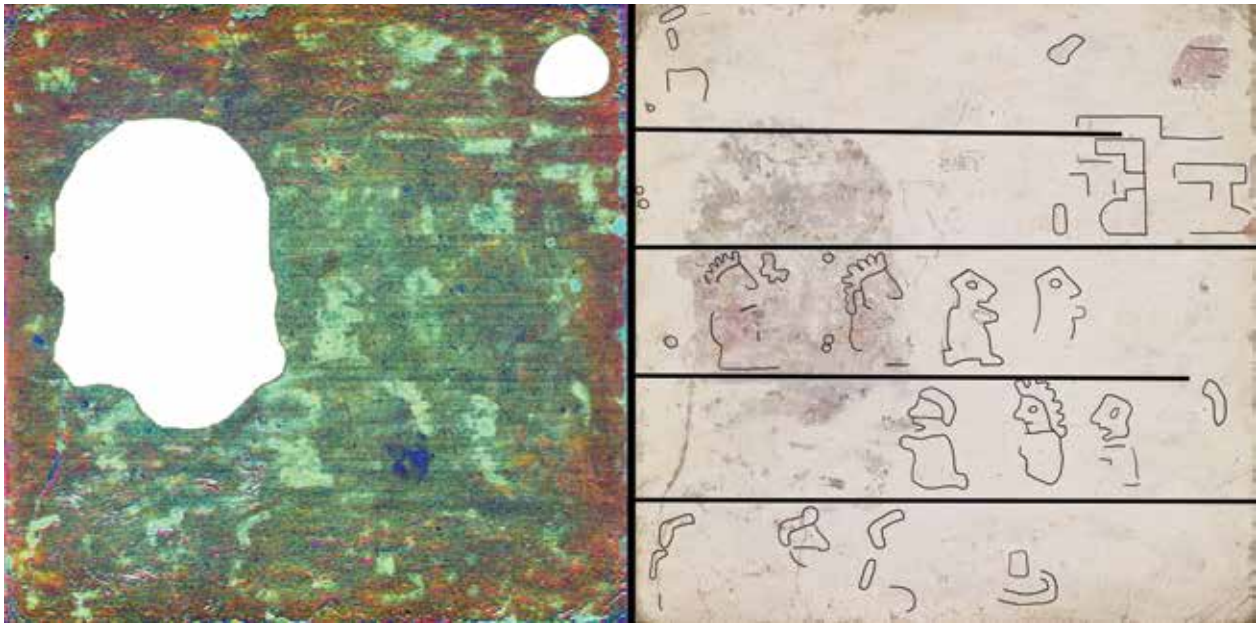
Page 5 verso



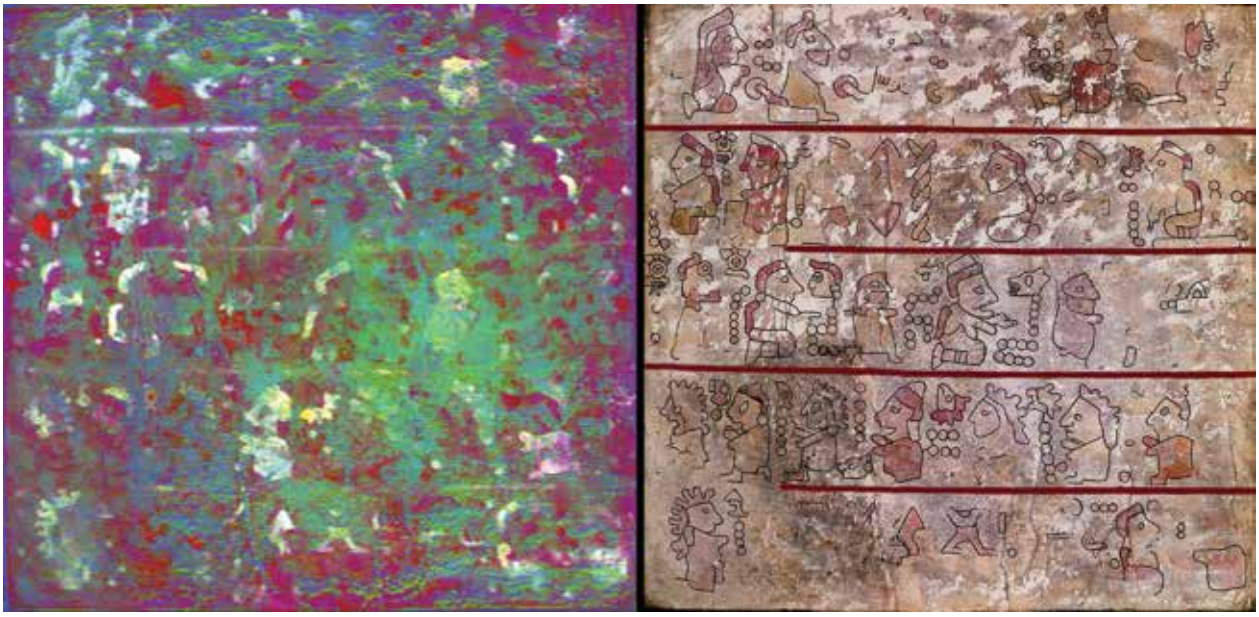
Page 6 and 7 verso hyperspectral imaging results and reconstruction



Page 10 verso



Page 11 verso



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Curriculum Vitae

Ludo Snijders was born in Rotterdam in 1987. He started his Bachelor studies in archaeology at Leiden University in 2006, focussing in his thesis on the precolonial Maya people and their supposed fascination with the stars. During a two-year Research Master his focus shifted, first on the Murals of Bonampak, then to the monuments of Yaxchilán and surrounding sites. Eventually his focus left the Maya area when he was awarded the position of KNAW Academy assistant to Prof. Maarten Jansen, during which the foundation for his PhD project was laid. He finished his two-year Research Master in Mesoamerican Archaeology at Leiden University in 2011 with a thesis "A colorful picture: Investigating the physical properties of pigments used on Mesoamerican painted objects" which allowed him to familiarise himself with non-invasive investigation techniques. This would turn out to be essential for later communication and collaboration with engineers, chemists and physicists.

In 2012 the NWO Science4Arts program funded the project "Shedding light on endangered mutual heritage. Developing non-invasive imaging techniques to uncover, understand and preserve ancient Mexican pictorial manuscripts", led by Prof. Maarten Jansen and Prof. Schmidtt-Ott. Snijders became one of two PhD students in this project, together with Tim Zaman of the Technical University of Delft.

During his time as a PhD student, Snijders has given multiple classes and guest lectures. He has also presented his work at international conferences, such as the 2016 conference "Mesoamerican manuscripts: new scientific approaches and interpretations" (Oxford), the 2015 meeting of the European Association of Archaeologists (Istanbul), the 2014 meeting of the Society for American Archaeology (San Francisco) and the 2013 conference "Il Tesoro Messicano" at the Accademia Nazionale dei Lincei (Rome).

The following publications were prepared during the PhD research:

Snijders, L., T. Zaman, D. Howell, (2016) Using Hyperspectral Imaging to reveal a hidden precolonial Mesoamerican codex, Journal of Archaeological Science: Reports (accepted).

Snijders, L. (In Print) Colourful Pictures, Reconstructing the Añute palimpsest, Thule proceedings of XXXVIIth conference of Americanists, Perugia.

Snijders, L., T. Zaman, (2015). Analyse du palimpseste du codex mixtèque Añute, (MS Arch Selden A. 2). Support/Trace, 15, 17-22.

Snijders, L. (2014). Seeing spots: Identification of a codex cover. Mexicon, XXXVI, 13-14.