Virtual Neanderthals : a study in agent-based modelling Late Pleistocene hominins in western Europe

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6. THE ARCHAEOLOGICAL DATA IN THE MODEL

6.1 Introduction

Archaeological data is often used to validate the results of simulations (Lake 2014). HomininSpace takes data points from the archaeological record from which we know that hominins *were there* at a specific point in time. This presence information is the main core of the archaeological database in HomininSpace (Section 6.2). The archaeological record of western Europe is probably the area with most detail in both temporal scale and geographical distribution of Neanderthal sites, specifically for the Late Pleistocene (Locht *et al.* 2010).

For HomininSpace a chrono-archaeological database (compare van Andel (2002, 6)) has been built to store Checkpoints in Space and Time (CSTs) (Scherjon 2012). Each CST has a list of radiometric dating results (Section 6.3) that indicates in what time frames hominins were at that location. The date with the associated 1-δ uncertainty values form an interval of presence during which hominins were at that site with 68.3% certainty. Thus a CST consists of X and Y coordinates (a latitude/longitude location) and a list of chronological intervals, compiled according to specific criteria. In HomininSpace the CSTs are implemented as active agents storing data about the hominin agents that are present in that area (Section 6.4). Checkpoint locations and associated dates have been selected when they fulfil the following requirements:

- The location is an archaeological site featuring in peer reviewed scientific publications;
- Methods, techniques and results of sampling and dating are described in detail;
- Stratigraphy is clearly described and position of the samples is unambiguous or from a closed archaeological context;
- Samples have a good association with other finds and are properly described;
- Results of the laboratory are discussed;
- There is no dispute in the literature on the nature of the dates;
- Calculated dates are earlier than 50 ka;
- Standard deviation of a date is not larger than half the date itself (dates like 130 ka +/- 90,000 are rejected). Informative value of measurements violating this rule is considered low;
- Results are actual chronometric dates (not given in MIS periods or relative to other localities).

Some included CSTs do not fit all the criteria. Any deviation from these quality standard selection criteria is indicated and discussed. The database file with all the checkpoints is included in the Supplementary Materials[24].

6.2 The archaeology of presence and absence

The use of large datasets in a spatial context to validate the model of past hominin behaviour is an attractive approach to assess the quality of a simulation model. Related work to this study is done in Germany on modelling the earliest hominins in Europe and in the Role of Culture in Early Expansions of Humans (ROCEEH) project (Timm *et al.* 2014), and with a similar focus in Italy (Muttoni *et al.* 2018), in Japan on Initial Upper Palaeolithic populations in Eurasia in the Replacement of Neanderthals by Modern Humans (RNMH) project (Kondo *et al.* 2018). Previously the Stage 3 project in the UK collected an extensive database on European Palaeolithic sites (van Andel and Davies 2003) which was updated in the Préhistore à l'Actuel: Culture, Environments et Anthropologie (PACEA) database (D'Errico *et al.* 2011); both were used in many studies. None of these projects however attempts to combine a detailed environment reconstruction with a generic hominin model and an evolutionary algorithm to find parameter values validated against a database of hominin presence and absence.

When using archaeological data it must be acknowledged that such data becomes available only through many biasing filtering processes (Clarke 1973, 16-17; Schiffer 1985). These include excavation biases, where some areas are more scrutinized than others (Dennell and Roebroeks 2005, 1102; Surovell and Brantingham 2007), biases introduced by the geography of the region with accessibility of relevant deposits (Bynoe *et al.* 2016), a research bias (Roebroeks *et al.* 2011), a bias created by the archaeological methods used (Discamps and Faivre 2017; Wheatley 2004), or a bias created by taphonomy (Soressi 2016) where younger sites are over-represented due to the loss of older sites to environmental and climatic factors, to mention just a few.

A bias can also be introduced through differences in the site function type. The archaeological materials in caves (living areas) might be different from those found at special activity sites like kill/butchery sites. Certain sites might not be recognized due to the fact the typical artefacts are not present there because they were not needed for the

[24] Named "Neandertal sites - north west Europe.xlsx".

specific task at that site. A (small) bias is also imposed by the limitations of this author since only English and French literature was studied.

A comprehensive overview of all Neanderthal sites is currently missing in the literature, although some attempt to collect as many as possible (for instance the database constructed in the Replacement of Neanderthals by Modern Humans (RNMH) project (Akazawa *et al.* 2013)). Some collection biases can be accommodated or corrected by statistical techniques (Surovell *et al.* 2009) but in this study the individual radiometric dates are used as they are reported, and as such no corrections were applied to this data to compensate any collection bias. The literature was searched for radiometric dates obtained for Palaeolithic sites in the case study area. Undated archaeology is ignored for all purposes. The actual archaeology, its inferred function, or cultural affiliation is ignored. For individual sites only presence information is extracted and used. The traces of hominin activity in the past rarely survive sufficiently to support inferences about the behavioural patterns of past hominins but HomininSpace will use as many securely dated time points as possible from a large area to attempt such inferences.

True absence information, the fact that hominins were *not* somewhere at certain periods, is at least equally valuable as presence information. However there are two issues with absence information: absence of evidence is not evidence of absence and the inherent limited applicability of any absence data. Absence of information can have many reasons including inaccessibility of sites, unavailability of research resources, inhospitable climate, natural barriers, or removal of evidence by taphonomy. Excavation preferences can also induce preferential site selection, suggesting absence caused by simply not looking.

Any cause of absence can have a local or wider effect. When for instance continent wide glaciation occurs larger areas can become devoid of life, by restricting access to all resources. However, a clear local absence in one site caused by a rock fall blocking access to a cave does not mean that hominins were not present in any other location nearby. For individual sites it is very difficult to ascertain that given absence truly means that hominins were not in the area and that the evidence can be extended to a wider area around the site (Phillips, Anderson, *et al.* 2006).

6.3 What dating information to use?

When modelling past hominins faith increases in models that match the archaeology well and decreases for models that predict distribution patterns poorly. For HomininSpace, only absolutely dated archaeology is used as a reference against which simulation results will be matched. This study uses the radiometric dates associated with archaeological deposits resulting from visits by past hominins. Only dates that indicate a presence before 50 ka are used to validate the simulations. Computational resources have further limited the lower boundary to 131 ka, resulting in a simulation period of 81 kyr.

The chronological framework for the area is mainly based on a number of stratigraphic sequences with mostly luminescence dating of heated flint and sediments, added to U-Th/ESR dates, measured on bones clearly associated with human occupation. Dating information derived from stratigraphic, archaeostratigraphic or bio-climate correlations are not included in the database (e.g. dating using the occurrence of early Weichselian "sols steppiques" in Goval (2008)). Identification of exact dates is difficult for relative dates and the database in HomininSpace is therefore constructed without qualifiers like 'before' or 'after'. It is acknowledged that by applying such rigorous selection standards many potential positive presence data points are rejected, but priority has been given to an radiometrically dated framework to validate against.

Radiometric dates are included to construct presence intervals with 1-δ uncertainty (within one standard deviation). The probability of a measurement dating actual presence on the site for 1-δ is only 68.3%. 2-δ could be used, which would give a 95.5% certainty (Richter *et al.* 2013). But 1-δ is chosen since this is the de facto standard in reporting archaeological dates. This follows Guibert *et al.* (2008), a major collection of dates for the area and period of study. The individual ages are combined per layer where possible. A one sigma interval in dating accuracy is deemed sufficient in this research and this limited precision is taken into account in the discussion.

6.3.1 Database structure

All collected data is stored in an Excel database file. The name of the file is "Neandertal sites - north west Europe.xlsx". The structure of this database is given in Table 10. Included for each site is dating information. Each radiometric date represents an individual moment in time, defined by the calculated date plus and minus one standard deviation given in kilo years (ka). As such, when a bovid tooth from La Ferrassie is dated using the isochron ESR technique with a resulting date range of 61 +/- 5 ka (Blackwell *et al.* 2007), a checkpoint for this site is created that checks for presence of hominins from 66 to 56 ka inclusive. In total there are 470 dates in the database. Dates from the same locality (archaeological site) are combined into a single Checkpoint object with multiple ranges.

The date ranges are henceforth referred to as Presence Intervals, both in the source code as well as in this thesis. Other checkpoints may overlap the area (when two sites are in the same grid cell) but the check for presence is done for each checkpoint separately. Table 11 lists all the included checkpoints, with all the intervals in Table 12.

Table 10: Data fields in the archaeological data database.

Field	***Name***	***Remarks***
1	#	Unique number
2	Locality	Site name
3	Latitude	Position: latitude (decimal format)
4	Longitude	Position: longitude (decimal format)
5	Age (ka)	Radiometric age
6	Plus (kyr)	One sigma (standard deviation) plus
7	Minus (kyr)	One sigma (standard deviation) minus
8	Dating method	Take from the literary source
9	Year	Identification of measurement: year
10	Laboratory	Identification of measurement: laboratory where measurement was done
11	Sample	Identification of measurement: sample identification with number given by the laboratory
12	Layer	Identification of measurement: layer (also used to combine multiple measurements into one single interval)
13	Associated material/culture	Cultural interpretation or association of dated object (illustrative purposes only)
14	Type of site	Open air or cave (this value is not used in this study)
15	Confidence	1, 2, or 3, with a 1 indicating the lowest confidence level
16	Remarks	Any additional information
17	Reference (found in)	Literature source from which measurement was taken
18	Primary source	Original source where the date was first published (if different from the Reference)

When two or more intervals are within the same archaeological *layer*, they are combined into one single interval using the minimum and maximum interval values. This process is illustrated here with data depicted in Figure 23, where multiple TL dates are present in two layers for the open air site Port Racine (Cliquet *et al.* 2003, 53). Combining these dates with their standard deviations per layer results in two intervals for Port Racine: (1) Port Racine 62-81 ka for “secteur 4” and (2) Port Racine 55-88 ka for “secteur 1”. This assumes that the layers were correctly identified by the original researchers, that these layers separate different periods with visits by past hominins, and that these dates do not contain anomalous dating results.

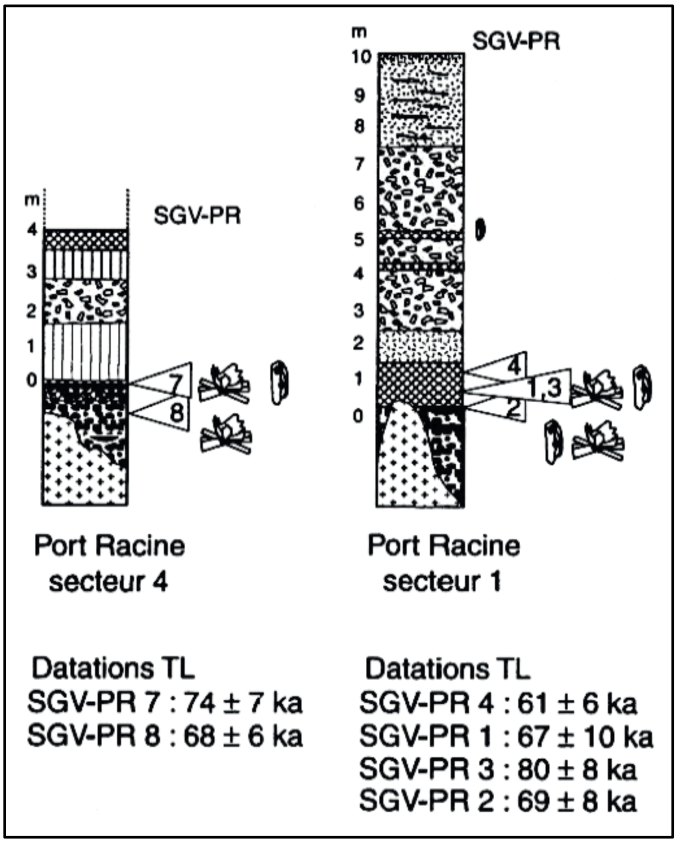

Figure 23: Example illustrating the interval construction. Port Racine, two layers with dates, taken from Cliquet *et al.* (2003).

Geographical locations are taken from the Radiocarbon Palaeolithic Database Europe (RPDE), which can be downloaded in ".kmz" format, the native Google Earth specification language. The RPDE is a collection of Lower, Middle and Upper Palaeolithic sites with environmental conditions and available chronometric dating. Version 11 supplied most locations and was downloaded November 2012[25]. Version 20 supplied more locations and was downloaded in August 2016, and was renamed to RPED v20. The Access database was constituted by the INQUA-Commission on Palaeoecology and Human Evolution and can be freely downloaded and used.

Although much effort has been put into collecting as many published dates as possible and to include when available unpublished archaeological data for the research area, the publication archive is huge and added to on a daily basis. By the nature of such an archive completeness is unattainable and as such, the database used by the simulation system is implemented to be easily updatable when new dates are published. Simulations are reproducible and can be rerun with the same parameter values but with new checkpoint datasets when needed.

[25] From http://ees.kuleuven.be/geography/projects/14c-palaeolithic/index.html, accessed 2012.

6.4 Checkpoints in Space and Time (CSTs)

The regular Checkpoints in Space and Time (CSTs) are simulation objects that register the presence of hominin groups that move through the area within defined presence intervals based on archaeological information. There are other types of (check)points that need a location in HomininSpace (Subsection 8.5.3): monitoring checkpoints that register presence data without intervals, starting points where initial hominin groups are created, and climate monitoring points that record the local climate. See Figure 24 for an overview of all checkpoints. Checkpoints are defined in the checkpoint input file.

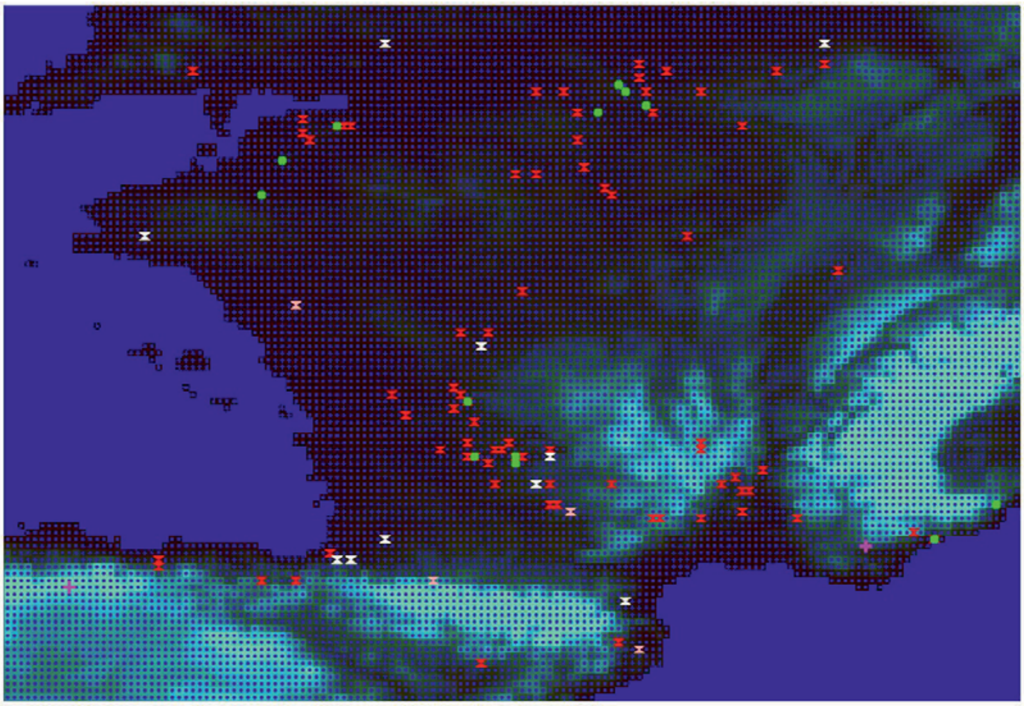

Figure 24: Overview of all checkpoints. Red are regular checkpoints, white monitoring checkpoints, green starting locations, pink climate monitoring points and purple plus signs are core areas.

All CSTs are associated with an archaeological site and have one or more intervals defined. A hominin group will be recorded by a CST whenever the gridcell containing the CST is visited in the foraging phase of that group. Information stored includes visiting group type, visit count, and whether the visit is within any of the presence intervals. Table 11 gives geographical position of all regular checkpoints. The size of this collection is limited (n=83), illustrating the deficiency in accurate chronological information for western Europe which is the most intensely studied Late Pleistocene area (Vieillevigne *et al.* 2008). In total 470 intervals are associated with these checkpoints. This provides only a snapshot view on the behaviours of hominins living in this huge area and during this large time span.

Table 11: Regular Checkpoints in Space and Time with geographical position.

#	*Name*	*Latitude*	*Longitude*	*#*	*Name*	*Latitude*	*Longitude*
1	**Abauntz**	43.02722	-2.04166	**43**	**Igue des Rameaux**	44.1524	1.75329
2	**Abri Bourgeois-Delaunay**	45.66667	0.4667	**44**	**Jupiter**	43.47889	-1.45306
3	**Abri des Canalettes**	43.993	3.257	**45**	**Kent's Cavern**	50.46987	-3.53
4	**Abri des Pêcheurs**	44.40806	4.20722	**46**	**La Butte d'Arvigny**	48.63278	2.61778
5	**Abri du Brugas**	44.05889	4.48389	**47**	**La Chapelle aux Saints**	44.9833	1.7167
6	**Abri du Maras**	44.31694	4.55528	**48**	**La Ferrassie**	44.9667	0.9333
7	**Abri Suard**	45.66667	0.46667	**49**	**La Folie**	46.61904	0.35471
8	**Angé**	47.29444	1.251944	**50**	**La Quina**	45.504	0.303
9	**Anse de Query**	49.65167	-1.23972	**51**	**La Roche à Pierrot**	45.75389	-0.63833
10	**Artenac**	45.85	0.3333	**52**	**La Rochette**	45.01667	1.10167
11	**Ault**	50.1075	1.45167	**53**	**La Roquette II**	43.94278	3.90278
12	**Barbas I**	44.8499	0.5667	**54**	**Le Moustier**	45.00198	1.07
13	**Baume Vallée**	44.96667	3.88306	**55**	**Le Prissé**	43.48139	-1.45833
14	**Beauvais 1**	49.4325	2.13278	**56**	**Le Rescoundudou[26]**	44.40833	2.575
15	**Bérigoule**	43.98425	5.2547	**57**	**Le Rozel**	49.47111	-1.8425
16	**Biache-Saint-Vaast**	50.3	2.95	**58**	**Les Canalettes**	43.95	3.1833
17	**Boxgrove**	50.86901	-0.69028	**59**	**Les Cottés**	46.67333	0.83333
18	**Cantalouette II**	44.864	0.54793	**60**	**Les Forêts**	44.98804	0.11429
19	**Caours**	50.13028	1.87833	**61**	**Les Pradelles**	45.733	0.4333
20	**Champlost**	48.02417	3.67111	**62**	**Lezetxiki**	43.08	-2.5
21	**Chez-Pinaud Jonzac**	45.43774	-0.41926	**63**	**Mauquenchy**	49.60389	4.46778
22	**Combe Brune**	44.87167	0.50444	**64**	**Ormesson**	48.78583	2.54083
23	**Combe Grenal**	44.8084	1.223	**65**	**Payre**	44.68	4.75
24	**Combe-Capelle Bas**	44.76619	0.81344	**66**	**Pech de l'Azé I**	44.85883	1.25331
25	**Coudoulous I**	44.16864	1.69023	**67**	**Pech de l'Azé II**	44.85937	1.25264
26	**Cova de l'Arbreda**	42.16111	2.74694	**68**	**Pech de l'Azé IV**	44.85941	1.25259
27	**Covalejos Cave**	43.38639	-3.95722	**69**	**Pié-Lombard**	43.71667	7.04972
28	**Croix du Canard**	45.09174	0.47448	**70**	**Pont-des-Planches**	47.53556	5.92167
29	**El Castillo**	43.29	-3.965	**71**	**Port Racine**	49.53333	-1.9
30	**Estret de Trago**	41.87	0.72	**72**	**Roc de Marsal**	44.90636	0.96705
31	**Fermanville-La Mondrée**	49.68306	-1.45	**73**	**Saint Germain-des-Vaux**	49.72639	-1.92278
32	**Fonseigner**	45.3167	0.6095	**74**	**Saint-Amand-les-Eaux**	50.44806	3.42722
33	**Fresnoy-au-Val**	49.83974	2.06103	**75**	**Sainte-Anne**	45.06667	3.86667
34	**Gouberville**	49.69	-1.32	**76**	**Saint-Hilaire-sur-Helpe**	50.13222	3.90417

[26] In the RDPE database this is not "Le Rescoundudou" but "Rescoundudou" (without Le), to the south.

35	**Grossoeuvre**	48.94111	1.19638	**77**	**Saint-Illiers-la-Ville**	48.97778	1.54278
36	**Grotte de Coudoulous II**	44.46864	1.69023	**78**	**Savy**	49.84278	3.20861
37	**Grotte des Barasses II**	44.51167	4.36472	**79**	**Scladina**	50.48528	5.02583
38	**Grotte du Figuier**	44.32333	4.54889	**80**	**Seclin**	50.55	3.03333
39	**Grotte du Lazaret**	43.69094	7.29499	**81**	**Sous les Vignes**	44.48332	0.93333
40	**Grotte Vaufrey**	44.80023	1.19922	**82**	**Villiers-Adam**	49.07083	2.22083
41	**Grotte XVI**	44.80348	1.18453	**83**	**Walou Cave**	50.59056	5.69389
42	**Havrincourt 1**	50.11722	3.0825				

In names, dashes are optional. For example “Sous les Vignes” is also known as “Sous-les-Vignes”.

In the database, a Confidence level is used with the following meaning:

1. unsure, data missing, disputed in the literature, only available through secondary sources (n=28)[27];
2. reasonable, well dated element but with incomplete description or it is disputed (n=204);
3. very confident, well described, undisputed, complete results in literature (n=237).

In the database is indicated upon what criteria the confidence level is based. Where reasonable the level is based on an evaluation by the original source (mainly Guibert *et al.* (2008, 20)) with the criteria described by the authors (all the zero level or very bad dating results have already been dropped since these are considered unusable in the context of this research). Note that when intervals are combined the confidence level of the resulting interval is the lowest level of the original intervals. The combined presence intervals per checkpoint are listed in Table 12.

Table 12: Checkpoints with x and y grid cell locations and their interval ranges.

Checkpoint	**X**	**Y**	**Intervals**
Abauntz	42	17	40000 - 54000
Abri Bourgeois-Delaunay	67	43	130000 - 166000, 91000 - 116000, 111800 - 128670, 77060 - 79280, 107000 - 117000, 65000 - 121000
Abri des Canalettes	95	26	68500 - 78500
Abri des Pecheurs	104	31	49000 - 59000
Abri du Brugas	107	27	57200 - 68800
Abri du Maras	108	30	81000 - 99000, 53000 - 57000, 40000 - 52000, 69000 - 95000
Abri Suard	67	43	111000 - 141000, 217000 - 287000, 45000 - 57000, 94000 - 108000
Ange	75	59	59700 - 161800
Anse de Query	50	83	114720 - 136360
Artenac	65	45	96650 - 119000, 122200 - 123200, 64000 - 70000

[27] Included in the database to increase geographical spread.

Ault	77	88	45000 - 65000
Barbas I	68	35	117000 - 175000
Baume Vallee	101	36	71000 - 86000
Beauvais 1	83	81	51600 - 59600
Berigoule	115	26	61300 - 122100, 49800 - 97600
Biache-Saint-Vaast	92	90	162000 - 188000, 112000 - 166000
Boxgrove	55	95	72000 - 142000
Cantalouette II	67	35	55000 - 66870
Caours	81	88	109000 - 139000, 108700 - 124500, 105000 - 131000
Champlost	99	67	52500 - 60900
Chez-Pinaud Jonzac	58	41	55300 - 80700, 67000 - 95600, 59500 - 82700, 40200 - 75300, 56100 - 79200, 56000 - 75200, 36400 - 79600, 47900 - 89300
Combe Brun	67	35	56600 - 69600, 105000 - 131000
Combe Grenal	74	35	40000 - 48000, 54000 - 68000, 55000 - 69000, 61000 - 75000, 91000 - 126000
Combe-Capelle Bas	70	34	48000 - 57000, 48300 - 57500, 49100 - 64700, 33900 - 61600
Coudoulous I	79	28	88200 - 112600, 110100 - 146200, 127700 - 152000, 119000 - 161000, 40300 - 65300, 61800 - 67600, 99600 - 138300
Cova de l-Arbreda	89	8	74300 - 93700
Covalejos Cave	22	20	87857 - 95857
Croix du Canard	67	37	74900 - 83700
El Castillo	22	19	58500 - 79900, 54300 - 84400
Estret de Trago	69	5	65600 - 141000, 67500 - 122000, 37200 - 46200, 42900 - 58800, 38400 - 47600, 41500 - 50700
Fermanville-La Mondree	48	83	63700 - 75700
Fonseigner	68	40	44900 - 55500, 47300 - 58300, 49600 - 63200
Fresnoy-au-Val	83	85	99300 - 114300
Gouberville	49	83	108000 - 148000
Grossoeuvre	74	76	122000 - 138000
Grotte de Coudoulous II	79	31	39000 - 51000, 34600 - 85700, 23300 - 56600, 79100 - 97400, 78000 - 102600, 86900 - 147500
Grotte des Barasses II	106	32	98000 - 124000, 43000 - 53000, 53000 - 66000
Grotte du Figuier	107	30	43000 - 61000
Grotte du Lazaret	135	23	53000 - 175000
Grotte Vaufrey	74	35	110000 - 140000, 102000 - 116000
Grotte XVI	74	35	53600 - 74500
Havrincourt 1	93	88	61200 - 71500, 50800 - 65200
Igue des Rameaux	80	28	34800 - 53500, 34500 - 69200, 129300 - 158600, 75600 - 102200
Jupiter	47	21	45000 - 55000, 58000 - 78000, 90000 - 132000
Kents Cavern	27	91	72000 - 142000
La Butte d-Arvigny	88	73	97000 - 141000, 56000 - 116000, 59000 - 87000, 42000 - 94000, 75000 - 125000
La Chapelle aux Saints	79	36	44000 - 60000
La Ferrassie	71	36	56000 - 66000, 53000 - 57000, 41800 - 57800, 41800 - 59600, 58500 - 78800, 79500 - 100300
La Folie	66	53	55300 - 60100
La Quina	65	42	39400 - 46600, 40300 - 58000
La Roche a Pierrot	56	44	29700 - 52000, 33100 - 43600, 38100 - 46700
La Rochette	73	37	49100 - 55900
La Roquette II	101	26	52900 - 61500

Le Moustier	73	37	32400 - 45200, 35500 - 53900, 36300 - 53800, 37700 - 42900, 36500 - 45300, 36600 - 51000, 38000 - 45200, 37300 - 44500, 38700 - 53300, 38200 - 48200, 44800 - 55800, 50800 - 60800, 40700 - 49500
Le Prisse	47	21	78700 - 89900
Le Rescoundudou	88	31	62500 - 201000
Le Rozel	44	81	92000 - 112000, 102000 - 124000, 97000 - 117000, 104000 - 126000
Les Canalettes	94	26	60800 - 88400
Les Cottes	70	53	46100 - 55300
Les Forets	63	36	85300 - 103900
Les Pradelles	66	44	53000 - 62200
Lezetxiki	37	17	109000 - 153000
Mauquenchy	107	83	69800 - 84200, 75400 - 90600
Ormesson	87	74	46800 - 53000, 41400 - 48200
Payre	110	33	117000 - 147000
Pech de l-Aze I	75	35	24000 - 60000, 66000 - 196000
Pech de l-Aze II	75	35	60000 - 162000, 102000 - 158000, 120000 - 155000, 113000 - 161000, 37300 - 133000, 47800 - 63000, 51000 - 66300, 35900 - 101400, 40700 - 84700, 49900 - 85000, 63200 - 90400, 105000 - 133000
Pech de l-Aze IV	75	35	40000 - 59600, 41000 - 57000, 61900 - 78500, 61900 - 97800, 79600 - 118000, 46000 - 76000
Pie-Lombard	132	24	62300 - 77700
Pont-des-Planches	121	62	45000 - 60900, 41100 - 54800
Port Racine	43	82	62000 - 81000, 55000 - 88000
Roc de Marsal	72	36	45000 - 52200, 48900 - 57100, 46900 - 53900, 42600 - 60700, 52000 - 82000
Saint Germain-des-Vaux	43	84	55100 - 87600
Saint-Amand-les-Eaux	96	91	45860 - 52540
Sainte-Anne	101	37	96200 - 129700, 82700 - 97500, 80800 - 102300
Saint-Hilaire-sur-Helpe	101	88	89600 - 108200
Saint-Illiers-la-Ville	77	76	97200 - 112800
Savy	94	85	48000 - 54000
Scladina	112	91	110000 - 150000
Seclin	92	92	80000 - 106000
Sous les Vignes	71	31	40300 - 47800
Villiers-Adam	84	77	99000 - 121000
Walou Cave	119	92	78500 - 105800, 38000 - 57000