Irrigating the desert: water management, agricultural practices, and social complexity in Southern Turkmenistan during the Bronze Age

Arciero, R.

Acknowledgments

Embarking on a Ph.D. journey is a lengthy endeavor, but one rarely travels it alone. This path is marked by highs and lows: moments of immense satisfaction and joy in your work, contrasted with times when you might feel like giving up and opening a bar on a Caribbean island. During these fluctuations, friends and colleagues are invaluable; they inspire you, uplift your spirits with a simple conversation at the coffee machine, and provide new ideas, perspectives, and critical encouragement for your research. In this context, a Ph.D. is a collective effort and a testament to collective memory. Science is inherently collaborative, and the notion of the "lone scientist" in the tower is a romanticized myth. Throughout my Ph.D. journey, many individuals inspired and contributed to this research. While completing this thesis is a personal achievement, their contributions were essential in elevating my work.

First and foremost, I extend my gratitude to my two supervisors, Bleda Düring and Peter Akkermans. Bleda, thank you for patiently reading and discussing my thesis multiple times, encouraging me to improve, and helping me give my best. Peter, thank you for encouraging me to view my research from different perspectives and highlighting aspects I might have overlooked.

I am also grateful to those who brought me to Central Asia region and supported my research. Barbara Cerasetti, thank you for sharing your knowledge and passion for Turkmenistan's archaeology. Lynne Rouse, I appreciate your allowing me to join your project and aiding my research in Turkmenistan. Daniela Müller, thank you for your contributions to the geoarchaeological and OSL analyses, and Ayushi Nayak, for conducting the isotope analysis. A heartfelt thank you to the late Maurizio Tosi, who introduced me for the first time as a student to Central Asian and Iranian archaeology from the moment I walked into his office at Bologna University, your lectures have been truly inspiring to me

I extend my sincere gratitude to those who shared their data and findings with me: Robert Spengler, Traci Billings, and Rita dal Martello for the archaeobotanical part; Elise Luneau for pottery analysis; and Tuna Kalayci for advising on statistical analysis. Your research and advice were crucial to my interpretations. I also want to thank my colleague Luca Forni, who worked alongside me in Turkmenistan for many years, and all the students and local workers who dedicated their time during fieldworks. Additionally, I appreciate the local Turkmen authorities who allowed me to conduct my research there. Fieldworks for this project would not have been possible without the support of National Geographic Society Grant, Leiden University Fund (LUF) and Asian Modernities and Traditions Grant (Leiden University).

My journey would not have been the same without my colleagues and friends, from my first officemates, Aris Politopoulos, Mark Locicero, and Sufyan Al Karaimeh, to my latest officemates, Mink van IJzendoorn, Sam Botan, and especially Riia Timonen. I also thank my Leiden friends in random order, Maria Hadjigavriel, Martina Revello Lami, Tijm Lanjouw, Victor Klinkenberg, Irini Sifogeorgakis, Femke Reidsma, Alex Brandsen, Giulia Russo, Georg Cyrus, Giacomo Fontana, José María Castro, Miguel Cabral, and many others I met during my years. I am sure I am forgetting people, but if we ever discussed, shared, or laughed together over a beer…dear reader, know that you contributed to this research, and I thank you deeply. I also thank all my friends and best friends across Europe and Italy. There's no need to mention each of you by name—you know how grateful I am. *Grazie!*

Finally, I owe this achievement to my family, who always encouraged me to follow my dreams. Thank you for your unwavering support.

References

Abate, N., Lasaponara R. (2019).

Preventive Archaeology Based on Open Remote Sensing Data Tools: The Cases of Sant'Arsenio (SA) and Foggia (FG), Italy, *Sustainability* 11 (15), 41-45.

Adams, R. M. (1957).

Settlements in Ancient Akkad, *Archaeology* 10 (4), 270–273.

Adams, R. M. (1958).

Survey of ancient water courses and settlements in Central Iraq, *Sumer* 14, 101–103.

Adams, R. M. (1965).

Land Behind Baghdad: A History of Settlement on the Diyala Plains, Chicago: University of Chicago Press.

Adams, R. M. (1981).

Heartland of Cities: Surveys of Ancient Settlement and Land use on the Central Floodplain of the Euphrates, Chicago: University of Chicago Press.

Adrianov, B. V. (1969).

Drevnie Orositelnye Sistemy Priaralya, Moskva: Hayka.

Adrianov, B. V. (2016).

Ancient Irrigation System of the Aral Sea Area: The History, Origin and Development of Irrigated Agriculture, edited by Mantellini S., Oxford: Oxbow Books.

Akkermans, P.M.M.G., Kerner S., Plicht J., Dann R.J., Bangsgaard P., Nieuwenhuyse O.P., Russell A., Kaneda A. (2015).

Cultural Transformation and the 8.2 ka Event in Upper Mesopotamia, in Kerner S., Dann R., Bangsgaard P. (eds), *Climate and Ancient Societies*, Charlottenlund: Museum Tusculanum Pres, 97-112.

Alexandrowicz, W. P. (2021).

Spatial distribution and diversification of mollusc communities in flood sediments within the river valley based on the examples from Baskid Maly Range (West Carpathians, Southern Poland), *Carpathian Journal of Earth and Environmental Sciences* 16 (2), 315 – 328.

Allen, J. R. L. (1963).

The classification of cross-stratified units with notes on their origin, *Sedimentology* 2, 93-114.

Altmaier, A., Kany, C. (2002).

Digital surface model generation from CORONA satellite images, ISPRS, *Journal of Photogrammetry & Remote Sensing* 56, 221-235.

Alyekshin, V. A. (1980).

K robleme geneticheskoy svyazi yuzhno turkmenskikh kompleksov epokhi bronzy, Kratkie Soobshcheniya 161, 24-31.

Amiet, P. (1977).

Bactriane proto-historique, *Syria* LIV 1–2, 89–121.

Amiet, P. (1988).

Elam et Bactriane, in Gardin J. C. (ed), *L'Asie centrale et ses rapports avec les civilisations orientales des origines a l'Age du Fer. Actes du colloque franco-sovietique*, Paris:de Boccard, 27–30.

An, C. B., Lu Y., Zhao J., Tao S., Dong W., Li H., Jin M., Wang Z., (2011).

A high-resolution record of Holocene environmental and climatic changes from Lake Balikun (Xinjiang, China): implications for central Asia, *Holocene* 22, 43-52.

Anthony, D. W., Brown D., Brown E., Goodman A., Kokhlov A., Kosintsev P., Kuznetsov P., Mochalov O., Murphy E., Peterson D., Pike-Tay A., Popova L., Rosen A., Russel N., Weisskopf A. (2015).

The Samara Valley Project: Late Bronze Age Economy and Ritual in the Russian Steppes, *Eurasia Antiqua* 11, 395–417.

Araus, J., Febrero A., Buxó R., Rodríguez-Ariza M., Molina F., Camalich M., Martín D., Voltas J. (1997).

Identification of ancient irrigation practices based on the Carbon Isotope discrimination of plant seeds: a case study from the South-East Iberian Peninsula, *Journal of Archaeological Science* 24, 729–40.

Araus, J., Febrero A., Catala M., Molist M., Voltas J., Romagosa I. (1999).

Crop water availability in early agriculture: evidence from Carbon Isotope discrimination of seeds from a tenth millennium BP site on the Euphrates, *Global Change Biology* 5, 201–12.

Araus, J., Slafer G., Buxó R., Romagosa I. (2003).

Productivity in prehistoric agriculture: physiological models for the quantification of cereal yields as an alternative to traditional approaches, *Journal of Archaeological Science* 30, 681–93.

Araus, J., Ferrio, J., Buxó, R., Voltas, J. (2007).

The historical perspective of dryland agriculture: lessons learned from 10,000 years of wheat cultivation, *Journal of Experimental Botany* 58 (2), 131–45.

Arciero, R., Forni L. (2018).

La prima urbanizzazione in Turkmenistan: coesistenza tra nomadi e sedentari nel delta interno del fiume Murghab—risultati preliminari delle indagini archeologiche ed etnografiche presso il sito di Togolok 1, in Ferrari A., Pupulin E., Ruffilli M., Tomelleri V. (eds), *Armenia, Caucaso e Asia Centrale: Ricerche 2017, Euroasiatica. Quaderni di Studi su Balcani, Anatolia, Iran, Caucaso e Asia Centrale 7*, Venezia: Edizioni Ca' Foscari, 11–38.

Atamuradov, K.I. (1994).

Paleogeography of Turkmenistan, in Fet V., Atamuradov K. I. (eds), *Biogeography and Ecology of Turkmenistan*, Dordrecht: Springer Science and Business, 49-64.

Avanesova, N. A. (2021).

The Zeravshan regional variant of the Bactria-Margiana Archaeological Complex: interaction between two cultural worlds, in Lyonnet B., Dubova N.A. (eds), *The World of the Oxus Civilization*, New York: Routledge, 665-697.

Babaev, A. G., Vitkovskya, T. P. (1985).

Hydrogeological conditions and freshwater resources of the Karakum, *Problems of Desert Development* 2, 3-8.

Babaev, A.G. (1994).

Landscapes of Turkmenistan, in Fet V ., Atamuradov K. I. (eds), *Biogeography and Ecology of Turkmenistan*, Dordrecht: Springer Science and Business, 5-22.

Bader, A., Gaibov V., Gubaev A., Koshelenko G. (1996).

The Oasis of Merv: the dynamics of its settling and irrigation, *Ancient Civilization from Scythia to Siberia* 3, 49-60.

Bakels, C.C. (2003).

The contents of ceramic vessels in the Bactria-Margiana Archaeological Complex, Turkmenistan, *Electronic Journal of Vedic Studies* 9 (1c), 1-4.

Banning, E. B. (2002).

Archaeological Survey, New York: Plenum Publisher.

Barendse, R. J. (2009).

Arabian Seas 1700-1763, Leiden: Brill.

Bates, J., Choi J. (2023).

Different strategies in Indus agriculture: the goals and outcomes of farming choices, *Antiquity* 97 (396): 1488–1500.

Bazilevich, N. I., Degopik I. Ya., Kryukov P. A. (1956).

Elementy gidrologicheskogo rezhima i vodno-khimicheskogo sostava Takyrskikh ravnin v takyrakh Yugo-Zapadnoy Turkmenii [Elements of the Hydrological Regime and Water Chemistry of Takyric Plains], *Takyry Yugo-Zapadnoy Turkmenii*, Nauk SSSR, Moskva: Akad,91–103.

Beazley, G. A. (1920).

Surveys in Mesopotamia during the war, *Geographical Journal* 55, 109-127.

Beck, A., Philip G., Abdulkarim M., Donoghue D. (2007a).

Evaluation of Corona and Ikonos high resolution satellite imagery for archaeological prospection in western Syria, *Antiquity* 81, 161–175.

Beck, A, Wilkinson K, Philip G. (2007b).

Some techniques for improving the detection of archaeological features from satellite imagery, in Ehlers M., Michel U. (eds), *Remote Sensing for Environmental Monitoring, GIS Applications, and Geology VII*, Proceedings of SPIE, Florence: SPIE, 6749, 1-12.

Becker, H. (2007).

First test of Caesium-Magnetometry in the Murghab Delta Project, Unpublished AMMD Report.

Bendezu-Sarmiento, J., Mustafakulov S. (2013).

Le site proto-urbain de Dzharkutan durant les ages du bronze et du fer. Recherches de la Mission archeologique franco-ouzbeque-Protohistoire, *Cahiers d'Asie centrale* 21–22, 207–236.

Bendezu-Sarmiento, J., Lhuillier J. (2019).

Habitat and Occupancy during the Bronze Age in Central Asia Recent work at the sites of Ulug-depe (Turkmenistan) and Dzharkutan (Uzbekistan). in Baumer C., Novák M. (eds), *Urban Cultures of Central Asia from the Bronze Age to the*

Karakhanids Learnings and conclusions from new archaeological investigations and discoveries, Wiesbaden: Harrassowitz Verlag, 97-114.

Berkelhammer, M., Sinha A., Stott L., Cheng H., Pausata F.S.R., Yoshimura K. (2012).

An abrupt shift in the Indian monsoon 4000 years ago, in Giosan L., Fuller D.Q., Kathleen N., Flad R.K., Clift P.D. (eds), Climates, Landscapes, and Civilizations, American Geophysical Union: Washington, D.C., 75–87.

Berking, J. (ed) (2018).

Water management in Ancient Civilizations, Berlin: Topoi.

Berking, J., Beckers B., Reimann T., Pollock S., Bernbeck R. (2017).

Modern impacts on an ancient landscape, the piedmont plain in south-west Turkmenistan, *WIREs Water* 4, 1-20.

Bernbeck, R. (2008).

An Archaeology of multisited communities, in Barnard H., Wendrich W. (eds), *The Archaeology of Mobility: Old World and New World Nomadism*, Los Angeles: Cotsen Institute of Archaeology, 43-77.

Bewley, R. H., Kennedy D. L. (2013).

Historical aerial imagery in Jordan and the Wider Middle East, in Hanson W. S., Oltean I. A. (eds), *Archaeology from Historical Aerial and Satellite Archives*, Heidelberg: Springer, 221-242.

Bezori, G., Astori B., Guzzetti F. (2002).

GPS and photogrammetric methodologies for an archaeological survey, in Warmbein B. (ed), *Proceedings of the Conference Space Applications for Heritage Conservation*, Strasbourg: European Space Agency, 1-8.

Billings, T., Cerasetti B., Forni L., Arciero R., Dal Martello R., Carra M., Boivin N., Spengler III R. N. (2022).

Agriculture in the black sands of the Karakum: an archaeobotanical analysis from Togolok 1, Turkmenistan (2nd millennium B.C), *Frontiers in Ecology and Evolution* 10, 1-22.

Bini, M., Zanchetta G., Perşoiu A., Cartier R., Català A., Cacho I., Dean J. R., Di Rita F., Drysdale R. N., Finnè M., Isola I., Jalali B., Lirer F., Magri D., Masi A., Marks L., Mercuri A.M., Peyron O., Sadori L., Sicre M., Welc F., Zielhofer C., Brisset E. (2019).

The 4.2 ka BP Event in the Mediterranean region: an overview, *Climate of the Past* 15, 555–577.

Bintliff, J. L., Snodgrass A. M. (1985).

The Cambridge/ Bradford boeotian expedition: the first four years, *Journal of Field Archaeology* 12, 123-161.

Bintliff, J. L., Snodgrass A. M. (1988).

Off-site pottery distributions: a regional and interregional perspective, *Current Anthropology* 29, 506-513.

Bird-David, N. (1992).

Beyond 'The Hunting and Gathering Mode of Subsistence': Culture-Sensitive Observations on the Nayaka and Other Modern Hunter-Gatherers, *Man* 27(1), 19–44.

Biscione, R. (1977).

The crisis of Central Asia urbanization in II millenium BC and villages as an alternative system, in Christophe J., Deshayes J. (eds), *Le plateau iranien et l'asie centrale des origines à la conquête islamique: leurs relations à la lumière des documents archéologiques*, Paris: Éditions du Centre national de la recherche scientifique, 113-127.

Biscione, R., Tosi M. (1979).

Protostoria degli Stati Turanici. Aspetti dell'Evoluzione Urbana e Forme d'Insediamento nel Popolamento dell'Asia Centrale nell'Età del Bronzo (2500-1000 a. C.) alla luce dei Dati Archeologici, 20 (39), Napoli: Istituto Orientale di Napoli.

Biscione, R., Vahdati A. A. (2011).

Excavation at Tepe Chalow, Northern Khorasan, Iran, *Studi Micenei ed Egeo-Anatolici* 53, 236– 241.

Biscione, R., Vahdati A. A. (2021).

The BMAC presence in eastern Iran: state of affairs in December 2018 – towards the Greater Khorasan Civilization?, in Lyonnet B., Dubova N.A. (eds), *The World of the Oxus Civilization*, New York: Routledge, 527-550.

Blair, T.C., McPherson J.G. (2009).

Processes and forms of alluvial fans, in Parsons A.J., Abrahams A.D. (eds) *Geomorphology of Desert Environments*, Heidelberg: Springer, 9-14.

Blodeaux, P., Seminara G. (1985).

A unified bar-bend theory of river meanders, *Journal of Fluid Mechanics* 157, 449-70.

Boazar, M., Yazdanpanah M., Abdeshahi A. (2019).

Response to water crisis: How do Iranian farmers think about and intent in relation to switching from rice to less water-dependent crops?, *Journal of Hydrology* 570, 523-530.

Bogaard, A., Fraser R., Heaton T. H. E., Wallace M., Vaiglova P., Charles M., Jones G., Evershed R. P., Styring A. K., Andersen N. H., Arbogast R.-M., Bartosiewicz L., Gardeisen A., Kanstrup M., Maier U., Marinova E., Ninov L., Schäfer M., Stephan E. (2013).

Crop manuring and intensive land management by Europe's first farmers, *PNAS Nexus* 110 (31), 12589-12594.

Boggs, S. (2001).

Principles of Sedimentology and Stratigraphy, London: Pearson.

Bolelov, S. B. (2016).

Boris Vasilevich Andrianov and the study of irrigation in ancient Khorezm, in Adrianov B. V., *Ancient Irrigation System of the Aral Sea Area: The History, Origin and Development of Irrigated Agriculture*, edited by Mantellini S., Oxford: Oxbow Books, 7-9.

Bondioli, L., Tosi M. (1998).

Introduction, in Gubaev A., Koshelenko G. Tosi M. (eds), *The Archaeological Map of the Murghab Delta: Preliminary Reports 1990-1995*, Roma: IsIAO, IX-XIX.

Bonora, G.L. (2021).

The Oxus Civilization and the Northern Steppes, in Lyonnet B., Dubova N. A. (eds), *The World of the Oxus Civilization*, New York: Routledge 734-776.

Bonora, G. L., Vidale M. (2008).

An aspect of the early Iron Age (Yaz I) period in Margiana: ceramic production at Site No. 999, in Salvatori S., Tosi M., Cerasetti B. (eds), *The Bronze Age and Early Iron Age in the Margiana Lowlands: Facts and methodological proposals for a redefinition of the research strategies*, Oxford: BAR, 153-194.

Bonora, G. L., Vidale M. (2013).

The Middle Chalcolithic in southern Turkmenistan and the archaeological record of Ilgynly-Depe, in Petrie C. A. (ed), *Ancient Iran and its Neighbours, Local developments and Long-Range Interactions in the Fourth Millennium BC*, Oxford: Oxbow Books, 140-165.

Bonora, G. L., Rossi Osmida G., Cengia A.R. (2020).

A general overview of the Oxus Civilization graveyard of Adji Kui in Margiana (south Turkmenistan), *East and West* 2 (61), 47-80.

Boomer, I., Wünnemann B., Mackay A.W., Austin P., Sorrel P., Reinhardt C., Keyser D., Guichard F., Fontugne, M. (2009).

Advances in understanding the late Holocene history of the Aral Sea region, *Quaternary International* 194 (1–2), 79-90.

Boroffka, N., Cierny J., Lutz J., Parzinger H., Pernicka E., Weisgerber G. (2002).

Bronze Age tin from Central Asia: preliminary notes, in Boyle K., Renfrew C., Levine M. (eds), *Ancient Interactions: East and West in Eurasia*, Cambridge: McDonald Institute for Archaeological Research, 135–159.

Boroffka, N., Oberhansli H., Sorrel P., Demory F., Reinhardt C., Wünnemann B., Alimov K., Baratov S., Rakhimov K., Saparov N., Shirinov T., Krivonogov S. K., Röhl U. (2006).

Archaeology and climate: settlement and lake level changes at the Aral Sea, *Geoarchaeology* 21, 721-734.

Bowen, R. L. (1958).

Irrigation in the ancient Qataban, in Bowen R. L., Albright F. P. (eds), *Archaeological Discoveries in South Arabia*, Baltimore: Johns Hopkins University, 43-131.

Bradford, J. (1957).

Ancient Landscapes, Oxford: Bell.

Bradley, J. B., Fahenstock R.K., Rowekamp E. T. (1972).

Coarse sediment transport by flood flows on Knik River, Alaska, *Bulletin of Geological Society of America* 83, 1261-1284.

Brice, J. C. (1984).

Planform properties of meandering rivers, in Elliott C. M. (ed), *River Meandering*, New Orleans: American Society of Civil Engineers, 1-15.

Bridge, J.S. (2003).

Rivers and Floodplains: Forms, Processes, and Sedimentary Record: Massachusetts, Malden: Blackwell Publishing.

Briere, P.R. (2000).

Playa, playa lake, sabkha: proposed definitions for old terms, *Journal of Arid Environments* 45 (1), 1-7.

Bristow, C. S. (1987).

Brahmaputra River: channel migration and deposition, in Ethridge F G., Flores R. M., Harvey M. D. (eds), *Recent Developments in Fluvial Sedimentology*, Claremore: SEPM Special Pubblication 39, 63-74.

Bristow, C. S., Skelly R. L., Ethridge F. G. (1999).

Crevasse splays from the rapidly aggrading, sand-bed, braided Niobrara River, Nebraska: effect of base-level rise, *Sedimentology* 46 (6), 1029-1048.

Broadmeadow, M., Griffiths H. (1993).

Carbon isotope discrimination and the coupling of CO2 fluxes within forest canopies, in Ehleringer J., Hall A., Farquhar G. (eds), *Stable Isotopes and Plant Carbon-Water Relations*, London: Academic Press, 109–30.

Brown, A.G. (1997).

Alluvial Geoarchaeology, Cambridge: Cambridge University Press.

Brusgaard, N., Fokkens H., Kootker L. M. (2019).

An isotopic perspective on the socio-economic significance of livestock in Bronze Age West-Frisia, the Netherlands (2000–800 BCE), *Journal of Archaeological Science: Reports* 27 (101944), 1-10.

Buccellati, G. (2008).

The origin of the tribe and of "Indrustial" agropastoralism in Syro-Mesopotamia, in Barnard H., Wendrich W. (eds), *The Archaeology of Mobility: Old World and New World Nomadism*, Los Angeles: Cotsen Institute of Archaeology at UCLA, 141-159.

Buławka, N., Orengo, H. A. (2024).

Application of multi-temporal and multisource satellite imagery in the study of irrigated landscapes in arid climates, *Remote Sensing* 16, 1-25.

Bull, W. B. (1977).

The alluvial-fan environment, *Progress in Physical Geography: Earth and Environment* 1 (2), 222-270.

Byung-Kee, B., Ullrich S. E. (2008).

Barley for food: characteristics, improvement, and renewed interest, *Journal of Cereal Science* 48, 233-242.

Cadbury, D. (2006).

Space Race: The Epic Battle Between America and the Soviet Union for Dominance of Space, New York: Harper Collins Publishers.

Callahan, E. M. (2013).

To Rule of the Roof of the World: Power and Patronage in Afghan Kyrgyz Society. Ph.D Thesis, Boston University, Boston, USA.

Callander, R.A. (1978).

River meandering, *Annual Review of Fluid Mechanics* 10, 129-58.

Campana, S. (2017).

Drones in archaeology: State-of-the-art and future perspectives, *Archaeological Prospection* 24(4), 275-296.

Campana, S., Francovich R. Marasco M. (2006).

Remote sensing and ground-truthing of a medieval mound (Tuscany-Italy), in Campana S., Forte M. (eds), *From Space to Place: 2nd International Conference on Remote Sensing in Archaeology*, Oxford: British Archaeology Reports, 491-496.

Cappers, R. T. J. (2006).

Roman Footprints at Berenike: Archaeobotanical Evidence of Subsistence and Trade in the Eastern Desert of Egypt, Los Angeles: Cotsen Institute of Archaeology.

Cappers, R. T. J., Fantone F., Neef R., van Doorn C. J. G. (2012).

Archaeobotanical evidence of the fungus covered smut (Ustilago hordei) in Jordan and Egypt, *Anacleta Praehistorica Leidensia* 43/44, 159-164.

Carson, M.A., Lapointe M. F. (1983).

The inherent asymmetry of river meander planform, *Journal of Geology* 91, 41-56.

Cattani, M. (2008a).

Excavations at sites No. 1211 and No. 1219 (Final Bronze Age), in Salvatori S., Tosi M., Cerasetti B. (eds), *The Bronze Age and Early Iron Age in the Margiana Lowlands: Facts and Methodological Proposals for a Redefinition of the Research Strategies*, Oxford: BAR, 119-132.

Cattani, M. (2008b).

The final phase of the Bronze Age and the “Andronovo Question” in Margiana, in Salvatori S., Tosi M., Cerasetti B. (eds), *The Bronze Age and Early Iron Age in the Margiana Lowlands: Facts and methodological proposals for a redefinition of the research strategies*, Oxford: BAR, 133-152.

Cattani, M., Genito B. (1998).

The pottery chronological seriation of the Murghab Delta from the end of the Bronze Age to the Achaemenid period: a preliminary note, in Gubaev A., Koshelenko G., Tosi M. (eds), *The Archaeological Map of the Murghab Delta: Preliminary Reports 1990-1995*, Roma: IsIAO, 75-87.

Cattani, M., Salvatori S. (2008).

Transects and other techniques for systematic sampling, in Salvatori S., Tosi M., Cerasetti B. (eds), *The Bronze Age and Early Iron Age in the Margiana Lowlands: Facts and Methodological Proposals for a Redefinition of the Research Strategies*, Oxford: BAR, 1-27.

Cattani, M., Cerasetti B., Salvatori S., Tosi, M. (2008).

The Murghab delta in Central Asia 1990-2001: the GIS from research resource to reasoning tool for the study of settlement change in long-term fluctuations, in Salvatori S., Tosi M., Cerasetti B. (eds), *The Bronze Age and Early Iron Age in the Margiana Lowlands: Facts and Methodological Proposals for a Redefinition of the Research Strategies*, Oxford: BAR, 39-45.

Cerasetti, B. (1998).

Preliminary report on ornamental elements of "Incised Coarse Ware", in Gubaev A., Koshelenko G., Tosi M. (eds), *The Archaeological Map of the Murghab Delta: Preliminary Reports 1990-1995*, Roma: IsIAO, 67-74.

Cerasetti, B. (2008).

A GIS for the archaeology of the Murghab Delta, in Salvatori, S., Tosi M., Cerasetti B. (eds), *The Bronze Age and Early Iron Age in the Margiana Lowlands: Facts and Methodological Proposals for a Redefinition of the Research Strategies*, Oxford: BAR, 29-38.

Cerasetti, B. (2012).

Remote sensing and survey of the Murghab Alluvial Fan, southern Turkmenistan: The coexistence of nomadic herders and sedentary farmers in the Late Bronze Age and Early Iron Age, in Matthews R., Curtis J. (eds), *Mega-cities & Mega-sites, The Archaeology of Consumption & Disposal Landscape, Transport & Communication, Proceedings of the 7th International Congress on the*

Archaeology of the Ancient Near East 12 April – 16 April 2010, Wiesbaden: Harrassowitz Verlag, 539-558.

Cerasetti, B. (2021).

Who interacted with whom? Redefining the interaction between BMAC people and mobile pastoralists in Bronze Age southern Turkmenistan, in Lyonnet B., Dubova N. A. (eds), *The World of the Oxus Civilization*, New York: Routledge, 487-495.

Cerasetti, B., Mauri M. (2002).

The Murghab Delta palaeochannel reconstruction on the basis of remote sensing from space, *Space Applications for Heritage Conservation*, Strasbourg (France), November 2002, 1-9.

Cerasetti, B., Codini G.B., Rouse L.M. (2014).

Walking in the Murghab alluvial fan (southern Turkmenistan): an integrated approach between old and new interpretation about the interaction between settled and nomadic people, in Lamberg-Karlovsky C. C., Genito B., Cerasetti B. (eds), *'My Life is like the Summer Rose' Maurizio Tosi e l'Archeologia come modo di vivere: Papers in honour of Maurizio Tosi for his 70th birthday*, Oxford: BAR, 105-114.

Cerasetti, B., Arciero R., Carra M. L., Curci A., De Grossi Mazzorin J., Forni L., Luneau E., Rouse L.M., Spengler R. N. (2019).

Bronze and Iron Age urbanization in Turkmenistan. Preliminary results from the excavation of Togolok 1 on the Murghab alluvial fan, in Baumer C., Novák M. (eds), *Urban Cultures of Central Asia from the Bronze Age to the Karakhanids Learnings and conclusions from new archaeological investigations and discoveries*, Wiesbaden: Harrassowitz Verlag, 63-72.

Cerasetti, B., Arciero R., Billings T. N., Cattani M., D'Ippolito L., Forni L., Luneau E., Olson K.G., Potenza A.C., Rouse L.M., Spengler III, R.N. (2022).

The Rise and decline of the desert cities. The last stages of the BMAC at Togolok 1 (Southern Turkmenistan), in Baumer C., Novák M., Rutishauser S. (eds), *Cultures in Contact Central Asia as Focus of Trade, Cultural Exchange and Knowledge Transmission*, Wiesbaden: Harrassowitz Verlag, 89-116.

Cerasetti, B., Arciero R., Forni L., Rouse L.M., Carra M., Luneau E., Spengler III, R.N (Forthcoming).

Interactions between sedentary and mobile peoples in the Bronze Age of southern Central Asia: Excavations at Togolok 1 in the Murghab region, in Boroffka N. (ed) *Farmers, Traders and Herders: The Bronze Age in Central Asia and*

Khorasan (3rd – 2nd Millennium BCE), Berlin: Deutsches Archäologisches Institut, Eurasien-Abteilung/Dietrich Reimer Verlag.

Cerasetti B., Luneau E. (Forthcoming).

The transitional period from Bronze to Iron Age in Turkmenistan: the Late and Final Bronze Ages, in Kurbanov A., Wordsworth P. (eds) The Oxford Handbook of the Archaeology of Turkmenistan,Oxford: Oxford Press.

Cez, L. (2019).

Le paysage fluvial et irrigué de Sarazm dans la moyenne vallée du Zeravchan, Tadjikistan, Asie centrale, *Projets de Paysage* 20, 1-21.

Challis, K., Priestnall G., Gardner A., Henderson J., O'Hara S. (2002).

Corona remotely-sensed imagery in dryland archaeology: the islamic city of Raqqa, Syria, *Journal of Field Archaeology* 29, 139–153.

Chang, H.H. (1988).

On the cause of river meandering, in White W. R. (ed), *International Conference on river regime*, Hoboken: Wiley, 83-93.

Chang, C., Tourtellotte P., Baipakov K. M., Grigoriev F. P. (2002).

The Evolution of Steppe Communities from Bronze Age Through Medieval Periods in Southeastern Kazakhstan (Zhetysu), Sweet Briar: Sweet Briar College.

Charles, M., Hoppé C., Jones G., Bogaard A., Hodgson J. (2003).

Using weed functional attributes for the identification of irrigation regimes in Jordan, *Journal of Archaeological Science* 30, 1429–1441.

Chen, W., Xuanqing Z., Naihua H., Yonghong M. (1996).

Compiling the map of shallow-buried palaeochannels on the North China Plain, *Geomorphology* 18 (1), 47–52.

Cheng, H., Sinha A., Verheyden S., Nader F. H., Li X. L., Zhang P. Z., Yin J. J., Yi L., Peng Y. B., Rao Z. G., Ning Y. F., Edwards R. L. (2015).

The climate variability in northern Levant over the past 20,000 years, *Geophysical Research Letters*, 42, 8641–8650.

Cherry, J. F. (1983).

Frogs round the pond: perspectives on current archaeological survey projects in the Mediterranean area, in Keller D. R., Rupp D. W (eds), *Archaeological Survey in the Mediterranean Area*, Oxford: BAR, 375–416.

Church, M. (2006).

Bed material transport and the morphology of alluvial river channels, *Annual Review of Earth and Planetary Sciences* 34, 325-354.

Civil, M. (1994).

The Farmer's Instructions: A Sumerian Agricultural Manual, Barcelona: Editorial Ausa.

Clemmens, A. J. (2006).

Improving irrigated agriculture performance through an understanding of the water delivery process, *Irrigation and Drainage* 55, 223–234.

Clezious, S., Gaibov V., Annaev T. (1998).

Off-site archaeological transects in Northen Margiana, in Gubaev, A., Koshelenko G., Tosi M. (eds), *The Archaeological Map of the Murghab Delta: Preliminary Reports 1990-1995*, Roma: IsIAO, 26-34.

Collier, P. (1994).

Innovative military mapping using aerial photography in the First World War: Sinai, Palestine and Mesopotamia 1914–1919, *The Cartographic Journal* 31 (2), 100-104.

Conolly, J., Lake, M. (2006).

Geographical Information Systems in Archaeology, Cambridge: Cambridge University Press.

Coombes, P., Barber K. (2005).

Environmental determinism in Holocene research: causality or coincidence?, *Area* 37 (3), 303–11.

Costantini, L. (1977).

Le piante, in Basaglia P., Tucci G., Goss B., Salvatori, S. (eds), *La Città Bruciata del Deserto Salato*, Venezia: Erizzo, 159-228.

Costanzo, S., Forti, L., Morandi Bonacossi, D., Zerboni, A. (2023).

A thin section micromorphology photomicrographs dataset of the infilling of the sennacherib assyrian canal system (Kurdistan region of Iraq), *Data in Brief* 49, 1093, 1-7.

Cotellucci, A., Pellegrino L., Costa E., Bruno M., Dela Pierre F., Aquilano D., Destefanis E., Pastero L. (2023).

Effect of different evaporation rates on gypsum habit: mineralogical implications for natural gypsum deposits, *Crystal Growth & Design* 23 (12), 9094-9102.

Cowan, P. J. (2007).

Geographic usage of the terms Middle Asia and Central Asia, *Journal of Arid Environments* 62(2), 359–363.

Crawford, O. G. S. (1923).

Air survey and archaeology, *Geographical Journal* 23, 324-366.

Cremaschi, M. (1998).

Palaeohydrography and Middle Holocene desertification in the northern fringe of the Murghab Delta, in Gubaev A., Koshelenko G., Tosi M. (eds), *The Archaeological Map of the Murghab Delta: Preliminary Reports 1990-1995*, Roma: IsIAO, 15-25.

Crumley, C. (1995).

Hetararchy and the analysis of complex societies, *Archaeological Papers of the American Anthropological Association* 34, 1-5.h

Cullen, H.M., de Menocal P.B., Hemming S., Brown F.H., Guilderson T., Sirocko F. (2000).

Climate change and the collapse of the Akkadian empire: Evidence from the deep sea, *Geology* 28, 379–382.

Dalfes, H. N., Kukla G., Weiss H. (1997).

Third Millennium BC Climate Change and Old World Collapse, Heidelberg: Springer.

Da Pelo, P., D'Orazio T. (2013).

Automatic and semi-automatic approaches to support archaeological trace extraction and digitalization, in Lasaponara R., Masini N., Biscione M., Hernandez M. (eds), *Proceedings of the 4th EARSeL Workshop on Cultural and Natural Heritage "Earth observation: a window on the past"*, Matera (Italy), 6–7 June 2013, Hannover: EARSeL, 347–362.

Defelice, M. S. (2002).

Catch weed bedstraw or cleavers, Galium aparine L.—A Very ''Sticky'' subject, *Weed Technology*, 16, 467–472.

Dewar, R. E. (1991).

Incorporating variation in occupation span into settlement-pattern analysis. *American Antiquity* 56 (4), 604–620.

Dewar, R. E. (1994).

Contending with contemporaneity: A reply to kintigh, *American Antiquity* 59(1), 149–152.

Di Cosmo, Nicola (2002).

Ancient China and Its Enemies: The Rise of Nomadic Power in East Asian History, Cambridge: Cambridge University Press.

Dixit, Y., Hodell, D.A., Petrie, C.A. (2014).

Abrupt weakening of the summer monsoon in northwest India ~4100 yr ago, *Geology* 42 (4), 339–342.

Dolukhanov, P. M. (1981).

The ecological prerequisites for early farming in southern Turkmenia, in Kohl P. L. (ed), *The Bronze Age Civilization of Central Asia: Recent Soviet Discoveries*, New York: M. E. Sharpe Inc, 350-358.

Dolukhanov, P. M. (2010).

Archaeology in colonial and postcolonial U.S.S.R, in Lydon J., Rizvi U.Z. (eds), *Handbook of Postcolonial Archaeology*, New Yourk: Routledge, 113-123.

Dolukhanov, P. M. (2016).

Central Asian archaeology: the Russian and soviet times, in Andrianov B. V, Ancient Irrigation Systems of the Aral Sea Area: The History, Origin, and Development of Irrigated Agriculture, edited by S. Mantellini, Oxford: Oxbow Books, 1-6.

Doumani Dupuy, P.N., Luneau E., Rouse L.M. (2021).

Pluralising power: ceramics and social differentiation in Bronze Age central Eurasia, *World Archaeology* 53, 779-808.

Dregne, H.E. (1976).

Soils of Arid Regions, New York: Elsevier.

Dubova, N. A. (2019).

Gonur Depe - City of Kings and Gods, and the Capital of Margush Country (Modern Turkmenistan). Its discovery by Professor Victor Sarianidi and recent

finds, in Baumer C., Novák M. (eds), *Urban Cultures of Central Asia from the Bronze Age to the Karakhanids*, Wiesbaden: Harrassowitz Verlag, 29-53.

Dubova, N. A. (2021).

The Royal Necropolis at Gonur Depe: an attempt at systematization (plan, construction, rituals), in Lyonnet B., Dubova N. A. (eds), *The World of the Oxus Civilization*, New York: Routledge, 333-366.

Dubova, N. A., Antonova E. V., Muradov R. G., Sataev R. M., Tishkin A. A. (2018).

Foreword, in Dubova N. A. (ed), *Trudy Margianskoj Ekspeditsii*, vol. 7, Moskva: Starij Sad, 1-8.

du Plessis, A. (2019).

Water as an Inescapable Risk. Current Global Water Availability, Quality and Risks with a Specific Focus on South Africa, Heidelberg Springer Water.

Edgar, A. L. (2004).

Tribal Nation: The Making of Soviet Turkmenistan, Princeton: Princeton University Press.

Emeljanenko, T. (1994).

Nomadic year cycles and cultural life of Central Asian livestock-breeders before the 20th century, in van Leeuwen C., Emeljanenko T., Popova L. (eds), *Nomads in Central Asia: Animal husbandry and culture in transition (19th-20th Century)*, Amsterdam: Royal Tropical Institute, 37-68.

Emerson, R. W. (2023).

Mann-Whitney U test and t-test, *Journal of Visual Impairment & Blindness* 117 (1), 99-100.

Endo, E., Shoda S., Frachetti M., Kaliyeva Z., Kiyasbek G., Zhuniskhanov A., Liu X., Dupuy P.D. (2023).

Pottery impressions reveal earlier westward dispersal of foxtail millet in inner Asian mountain corridor, *Agronomy* 13, 1706, 1-13.

Ertsen, M. W. (2010).

Structuring properties of irrigation systems: understanding relations between humans and hydraulics through modeling, *Water History* 2, 165–183.

Ertsen, M. W. (2016).

Improvising Planned Development on the Gezira Plain, Sudan, 1900-1980, Heidelberg: Springer.

Ertsen, M. W., Kaptijn E. (2015).

A narrow place can contain a thousand friends: irrigation as a response to climate in the Zerqa Triangle, Jordan, in Kerner S., Dann R., Bangsgaard P.J. (eds), *Climate and Ancient Societies*, Copenhagen: Museum Tusculanum Press, 137-155.

EU Communication (2021).

Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, and the Committee of the Regions, Forging a climate-resilient Europe. The new EU Strategy on Adaptation to Climate Change, SEC:89.

FAO (1998).

World Reference Base for Soil Resource, World Soil Resources Report 84, Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

FAO (2012).

AQUASTAT Country Profile – Turkmenistan Report, Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

Farrington, I. (1980).

The archaeology of irrigation canals, with special reference to Peru, *World Archaeology* 11 (3), 287–305.

Fattahi, M. (2015).

OSL dating of the miam qanat (KARIZ) system in NE Iran, *Journal of Archaeological Science* 59, 54-63.

Fernea, R. (1970).

Shaykh and Effendi Changing Patterns of Authority Among the El Shabana of Southern Iraq, Cambridge: Harvard University Press.

Ferrio, J. P., Araus J. L., Buxo R., Voltas J., Bort, J. (2005).

Water management practices and climate in ancient agriculture: inferences from the stable isotope composition of archaeobotanical remains, *Vegetation History and Archaeobotany* 14, 510–517.

Fet, G. (1994).

Vegetation of Southwest Kopetdagh, in Fet, V., Atamuradov, K. I. (eds), *Biogeography and EcoIogy of Turkmenistan*, Dordrecht: Springer Science and Business, 149-172.

Fiorentino, G., Caracuta V., Calcagnile L., D'Elia M., Matthiae P., Mavelli F., Quarta G. (2008).

Third millennium BC climate change in Syria highlighted by carbon stable isotope analysis of 14C-AMS dated plant remains from Ebla, *Palaeogeography, Palaeoclimatology, Palaeoecology* 266, 51–58.

Fiorentino, G., Caracuta V., Casiello G., Longobardi F., Sacco A. (2012).

Studying ancient crop Provenance: Implications from δ13C and δ15N values of charred arley in a Middle Bronze Age silo at Ebla (NW Syria), *Rapid Communications in Mass Spectrometry* 26, 327–335.

Fleskens, L., Ataev, A., Mamedov, B., Spaan, W. P. (2007).

Desert water harvesting from Takyr surfaces: assessing the potential of traditional and experimental technologies in the Karakum, *Land Degradation & Development* 18, 17-39.

Flohr, P., Mülder, G., Jenkins, E. (2011).

Carbon stable isotope analysis of cereals remains as a way to reconstruct water availability: preliminary results, *Water History* 3, 121–44.

Flohr, P., Jenkins, E., Williams, H.R.S., Jamjoum K., Nuimat S., Müldne G. (2019).

What can crop stable isotopes ever do for us? An experimental perspective on using cereal carbon stable isotope values for reconstructing water availability in semi-arid and arid environments, *Vegetation History and Archaeobotany* 28, 497–512.

Foley, R. A. (1981).

Off-site archaeology: an alternative approach for the short-sited, in Hodder I., Isaac G., Hammond N. (eds), *Patterns of the Past: Studies in Honour of David Clarke*, Cambridge: Cambridge University Press, 157-183.

Fontugne, M., Zajtseva G. I., Lyonnet B., Dubova N. A., Burova N. D. (2021).

Radiocarbon dates related to the BMAC/Oxus Civilization, in Lyonnet B., Dubova N.A. (eds), *The World of the Oxus Civilization*, New York: Routledge, 863-91.

Forni, L. (2017).

Bronze Age Terracotta Anthropomorphic and Zoomorphic Figurines from the Murghab Region (Turkmenistan): New Evidence and Interpretations", *Ocnus. Quaderni della Scuola di Specializzazione in Beni Archeologici* 25, 9-18.

Forni, L, Arciero R. (2022).

Identity and interaction at Togolok 1 in the Murghab region (Southern Turkmenistan) during the Bronze Age, in Coppini C., Cyrus G., Golestaneh H. (eds) *Bridging the Gap: Disciplines, Times, and Spaces in Dialogue. Sessions 4 and 6 from the conference Broadening Horizons 6 held at the Freie Universität Berlin, 24-28 June 2019*, 3, Oxford: Archaeopress, 25-40.

Foster, B.R. (1986).

Agriculture and accountability in ancient Mesopotamia, in H. Weiss (ed), *The Origins of Cities in Dry-farming Syria and Mesopotamia in the Third Millennium B.C.*, Guilford: Four Quarters Pub. Co., 109–128.

Fouache, E., Besenval R., Cosandey C., Cousso, C., Ghilardi M., Huot S., Lamothe M. (2012).

Palaeochannels of the Balkh River (northern Afghanistan) and human occupation since the Bronze Age period, *Journal of Archaeological Science* 39, 3415-3427.

Fouache, E., Cez L., Andrieu- Ponel V., Rante R. (2021).

Environmental changes in Bactria and Sogdiana (Central Asia Afghanistan and Uzbekistan) from the Neolithic to the Bronze Age, in Lyonnet B., Dubova N.A. (eds), *The World of the Oxus Civilization*, New York: Routledge, 82-109.

Fowler, M. (1996).

Declassified intelligence satellite photographs, *Aerial Archaeology Research Group News* 13, 30–35.

Frachetti, M., Spengler R., Fritz G., Mar'yashev A. (2010).

Earliest direct evidence for broomcorn millet and wheat in the central Eurasian steppe region, *Antiquity* 84 (326), 993-1010.

Frachetti, M. D. (2012).

Multi-regional emergence of mobile pastoralism and non-uniform institutional complexity across Eurasia, *Current Anthropology* 53 (1), 2–38.

Francfort, H. P. (1984).

The early periods of Shortughaï (Harappan) and the western bactrian culture of Dashly, in Allchin B. (ed), *South Asian Archaeology 1981*, Cambridge: Cambridge University Press, 170– 175.

Francfort, H. P. (2009).

L'âge du bronze en Asie centrale. La civilisation de l'Oxus, *Anthropology of the Middle East* 4 (1), 91-111.

Francfort, H. P., Tremblay X. (2010).

Marhaši et la Civilisation de l'Oxus, *Iranica Antiqua* 45, 51– 224.

Frenez, D. (2018).

Manufacturing and trade of asian elephant ivory in Bronze Age middle asia: evidence from Gonur Depe (Margiana, Turkmenistan), *Archaeological Research in Asia* 15, 13– 33.

Fribus, A.V. (2020).

Rural settlements in the ancient delta of the Murghab River and problems of interaction between Bronze Age farmers and mobile pastoralists in the South of Central Asia, in Guboglo M.N., Kufterin V.V. (eds), *Nature, Man, Society: from Past to Present, Collection of papers in honor of Nadezhda Dubova's jubilee*, Institute of Ethnology and Anthropology, Moscow: RAS, 45-52.

Galbraith, R.F., Roberts R.G., Laslett G.M., Yoshida H., Olley J.M., (1999).

Optical dating of single grains of quartz from Jinmium rock shelter, northern Australia. Part I: experimental design and statistical models, *Archaeometry* 41, 339-364.

Garner, G. (2021).

Metal sources (tin and copper) and the BMAC, in Lyonnet B., Dubova N.A. (eds), *The World of the Oxus Civilization*, New York: Routledge, 799-826.

Gayduchenko, L. L. (2002).

Organic remains from fortified settlements and necropolis of the "country of towns", in Jones-Bley K., Zdanovich D.G. (eds), *Complex Societies of Central Eurasia From the 3rd to the 1st Millennium BC: Regional Specifics in Light of Global Models*, Washington: Monograph Series, 400–416.

Genito, B. (1998).

The Iron Age in Merv oasis, in Gubaev A., Koshelenko G., Tosi M. (1998), *The Archaeological Map of the Murghab Delta: Preliminary Reports 1990-1995*, Roma: IsIAO, 89-96.

Gerasimov, I. P. (1954).

Cherty skhodstva i razlichiya v prirode pusryn. Priroda 2.

Gerasimov, I. P. (1978).

Ancient rivers in the deserts of soviet Central Asia, in Brice W. C. (ed), *The Environmental History of the Near and Middle East Since the Last Ice Age, School of Geography*, Manchester: Manchester Academic Press, 319-334.

Ghassemi, M. R., Garzanti E. (2019).

Geology and geomorphology of Turkmenistan: a review, *Geopersia* 9 (1), 125-140.

Giardino, M. J. (2011).

A history of NASA remote sensing contributions to archaeology, *Journal of Archaeological Science* 38(9), 2003-2009.

Gibson, Mc. (2020).

Introduction, in Lawrence, D., Altaweel, M. Philip, G. (eds), *Studies in honoring Tony J. Wilkinson, New agenda in remote sensing and landscape archaeology in the Near East: Studies in Honor of T.J. Wilkinson,* Chicago: The Oriental Institute of the University of Chicago, 1-6.

Gintzburger, G., Toderich K. N., Mardanov B. K., Mahmudov M.M. (2003).

Rengelands of the arid and semi-arid zones of Uzbekistan, Paris: Cirad-Icarda.

Goldberg, P., Macphail R. I. (2006).

Practical and Theoretical Geoarchaeology, Hoboken: Blackwell Publishing.

Goudie, A. S. (2003).

Great Warm Deserts of the World: Landscapes and Evolution Geomorphological Landscapes of the World, Oxford: Oxford University Press.

Grubov, V.I. (1966).

Chenopodiaceae, Rasteniya Tsentralnoi Azii Nauk, Leningrad 2: 1-135.

Gubaev, A., Koshelenko, G., Tosi, M. (1998).

The Archaeological Map of the Murghab Delta: Preliminary Reports 1990-1995, Roma: IsIAO.

Guichard, M. (2021).

The Oxus Civilization and Mesopotamia: A philologist's point of view, in Lyonnet B., Dubova N. A. (eds), *The World of the Oxus Civilization,* New York: Routledge, 66-81.

Guljamov, Ya. G., Islamov U., Askarov A. (1966).

Pervobytnaja kul'tura i vozniknovenie oroshaemogo zemledelija v nizov'jakh Zerafshana, Tashkent:Fan.

Halkon, P. (2006).

Reconstructing an Iron Age and Roman Landscape: new research, in Foulness Valley, East Yorkshire, England, in Campana S., Forte M. (eds), *From Space to Place: 2nd International Conference on Remote Sensing in Archaeology*, Oxford: Archeopress:, 235-242.

Halstead, P., O'Shea J. (1989).

Introduction: cultural responses to risk and uncertainty, in Halstead P., O'Shea J. (eds), *Bad Year Economics: Cultural Responses to Risk and Uncertainty, New Directions in Archaeology*, Cambridge:Cambridge University Press 1-7.

Hamzeh, M.A., Mahmudy-Gharaie M. H., Alizadeh-Lahijani H., Moussavi-Harami R., Djamali M., Naderi-Beni A. (2016).

Paleolimnology of Lake Hamoun (East Iran): implication for past climate changes and possible impacts on human settlements, *PALOIS* 31, 1-14.

Harris, D. R., Masson V. M., Berezkin Y. E., Charles M. P., Gosden C., Hillman G. C., Kasparov A. K., Korobkova G. F., Kurbansakhatov K., Legge A. J. (1993).

Investigating early agriculture in Central Asia: new research at Jeitun, Turkmenistan, *Antiquity* 67, 324–338.

Heaton, T. H. E., Jones G., Halstead P., Tsipropoulos T. (2009).

Variations in the 13C/12C ratios of modern wheat grain, and implications for interpreting data from Bronze Age Assiros Toumba, Greece, *Journal of Archaeological Science* 36 (10), 2224–33.

Heinecke, L., Mischke S., Adler K., Barth A., Biskaborn B.K., Plessen B., Nitze I., Kuhn G., Rajabov I., Herzschuh U. (2016).

Late pleistocene to Holocene climate and limnological changes at Lake Karakul (Pamir Mountains, Tajikistan), *Climate of the Past Discussions*, 1-30.

Hermes Taylor, R., Frachetti M. D., Doumani Dupuy Paula N., Mar'yashev A., Nebel A., Makarewicz C. A. (2019).

Early integration of pastoralism and millet cultivation in Bronze Age Eurasia, *Proceedings of the Royal Society B* 286 (1912), 20191273, 1-9.

Hidy, D., Haszpra L., Barcza Z., Vermeulen A., Tuba Z., Nagy Z. (2009).

Modelling of carbon isotope discrimination by vegetation, *Photosynthetica* 47 (3), 457–70.

Hiebert, F. T. (1994a).

Origins of the Bronze Age Oasis Civilization in Central Asia, Cambridge: Peabody Museum of Archaeology and Ethnology.

Hiebert, F. T. (1994b).

Production evidence for the origins of the Oxus Civilization, *Antiquity* 68(259), 372-387.

Hiebert, F. T., Moore, K. M. (2004).

A small steppe site near Gonur, in Kosarev M. F., Kozhin P. M., Dubova N. A (eds), *U istokov tsivilizatsii: Sbornik statej k 75-letiyu Viktora Ivanovicha Sarianidi* [Near the Sources of Civilizations: the issue in honor of the 75th anniversary of Victor Sarianidi], Moskva: Staryj sad, 294-302.

Hiebert, F.T., Lamberg- Karlovsky C. C. (1992).

Central Asia and the Indo- Iranian borderlands, *Iran* 30, 1– 15.

Hobbs, J.J. (1990).

Bedouin Life in the Egyptian Wilderness. Austin: University of Texas Press.

Hollander, M., Wolfe D.A., Chicken E. (2015).

Nonparametric Statistical Methods, Hoboken: John Wiley & Sons Inc.

Hopkirk, P. (1990).

The Great Game: On Secret Service in High Asia, London:John Murray.

Hritz, C. (2010).

Tracing settlements pattern and channel system in southern Mesopotamia using remote sensing, *Journal of Field Archaeology* 35, 184-203.

Hritz, C. (2014).

Contributing of GIS and Satellite-based Remote Sensing to Landscape Archaeology in the Middle East, *Journal of Archaeological Research* 22, 229-276.

Hritz, C., Wilkinson T.J. (2006).

Using Shuttle Radar Topography to map ancient water channels in Mesopotamia, *Antiquity* 80 (308), 415–424.

Hritz, C. Darweesh, N., Pournelle, J. (2020).

Resilient landscapes: riparian evolution in the wetlands of southern Iraq, in Lawrence D., Altaweel M., Philip G. (eds), *New Agenda in Remote Sensing and*

Landscape Archaeology in the Near East: Studies in Honor of T.J. Wilkinson, Chicago: The Oriental Institute of the University of Chicago, 228-266.

Hu, N., Li X., Luo L., Zhang L. (2017).

Ancient irrigation canals mapped from Corona imageries and their implications in Juyan Oasis along the Silk Road, *Sustainability* 9, 1283, 1-14.

Hübner, C., Novák M., Winkelman S. (2019).

The Swiss IAW-EurAsia Project on Urban Development and Land use in Gonur Depe (Turkmenistan), in Baumer C., Novák M. (eds) *Urban Cultures of Central Asia from the Bronze Age to the Karakhanids Learnings and conclusions from new archaeological investigations and discoveries*, Wiesbaden: Harrassowitz Verlag, 55-61.

Hunt, R. C. (1988).

Size and the structure of authority in canal irrigation systems, *Journal of Anthropological Research* 44 (4), 335-355.

Jacobberger, P.A., (1988).

Mapping abandoned river channels in Mali through directional filtering of thematic mapper data, *Remote Sensing of Environment* 26, 161–170.

Jacobsen, T. (1960).

The Waters of Ur, *Iraq* 22, 174–185.

Jacobsen, T., Adams R. M. (1958).

Salt and silt in ancient Mesopotamian agriculture, *Science* 128 (3334), 1251–1258.

Jacobson, P., Jacobson K., Seely M. (1995).

Ephemeral Rivers and Their Catchments: Sustaining People and Development in Western Namibia, Windhoek: Desert Research Foundation of Namibia.

Jacobson-Tepfer, E. (2008).

The emergence of cultures of mobility in the altai mountains of mongolia: evidence from the intersection of rock art and paleoenvironment, in Barnard H, Wendrich W. (eds), *The Archaeology of Mobility Old World and New World Nomadism*, Los Angeles: Cotsen Institute of Archaeology University of California, 200-229.

Jacobson-Tepfer, E., Kubarev V. D., Tseveendorj D. (2007).

Mongolie du Nord-Ouest: Haut Tsagaan Gol, *Répertoire des pétroglyphes d'Asie Centrale* 7, 380-444.

Ji, Z., de Vriend H., Hu C. (2003).

Application of SOBEK model in the Yellow River estuary, Proceedings of the International Conference on Estuaries and Coasts 2003, Hangzhou: Zhejiang University Press, 909-915.

Jones, G., Charles M., Colledge S., Halstead P. (1995).

Towards the archaeobotanical recognition of winter-cereal irrigation: an investigation of modern weed ecology in northern Spain, in Kroll H., Pasternak R. (eds), *Res Archaeobotanicae: 9th Symposium IWGP*, Kiel: Institut für Ur- und Frühgeschichte der Christian-Albrecht-Universität, 49–68.

Jopling, A.V., Walker R. G. (1968).

Morphology and origin of ripple-drift cross-lamination, with examples from the Pleistocene of Massachusetts, *Journal of Sedimentary Research* 38 (4): 971–984.

Jotheri, J. (2016).

Holocene avulsion history of the Euphrates and Tigris rivers in the Mesopotamian Floodplain. Ph.D Thesis, Durham University, Durham, UK.

Jotheri, J. (2018).

Recognition criteria for canals and rivers in the Mesopotamian floodplain, in Zhuang Y., Altaweel M. (eds), *Water Societies and Technologies from the Past and Present*, London: UCL Press, 109-126.

Jotheri, J., Altaweel M., Tuji A., Anma R., Pennington B., Rost S., Watanabe, C. (2018).

Holocene fluvial and anthropogenic processes in the region of Uruk in southern Mesopotamia, *Quaternary International* 483, 57-69.

Jotheri, J., Feadha M., Al-Janabi J., Alabdan R. (2022).

Landscape Archaeology of Southern Mesopotamia: Identifying features in the dried marshes, *Sustainability* 1 (2), 1-20.

Jotheri, J., Allen, M. B. (2020).

Recognition of ancient channels and archaeological sites in the Mesopotamian floodplain using satellite imagery and digital topography, in Lawrence D., Altaweel M., Philip G. (eds), *New Agenda in Remote Sensing and Landscape Archaeology in the Near East: Studies in Honor of T.J. Wilkinson*, Chicago: The Oriental Institute of the University of Chicago Illinoi, 283-305.

Joseph, G. (2005).

Fundamental of Remote Sensing, Hyderabad: Oriental Blackman.

Kakroodi, A. A., Kroonenberg S. B., Hoogendoorn R. M., Mohammd Khani H., Yamani M., Ghassemi M. R., Lahijani H.A.K. (2012).

Rapid Holocene sea-level changes along the Iranian Caspian coast, *Quaternary International* 263, 93–103.

Kalayci, T., Lasaponara R., Wainwright J., Masini N. (2019).

Multispectral Contrast of Archaeological Features: A Quantitative Evaluation, *Remote Sensing* 11 (913), 1-23.

Kalutskov, V. N., Glukhov A. I. (2014).

Landshafty okrestnostej Gonura, in Sarianidi V. I., Kozhin P. M., Kosarev M. F., Dubova N. A (eds), *Trudy Margianskoy Arkheologicheskoy Ekspeditsii 5, Issledovaniya Gonur Depe* v 2011–2013, Moscow: Staryj Sad, 158–165.

Kamakhina, G.L. (1994).

Kopetdagh-Khorassan flora: Regional features of Central Kopetdagh, in Fet, V., Atamuradov, K. I. (eds), *Biogeography and EcoIogy of Turkmenistan*, Dordrecht: Springer Science and Business, 129-148.

Kanstrup, M., Thomsen, I. K., Andersen, A. J., Bogaard, A., Christensen, B. T. (2011).

Abundance of 13C and 15N in emmer, spelt and naked barley grown on differently manured soils: towards a method for identifying past manuring practice, *Rapid Communications in Mass Spectrometry* 25, 2879–288.

Kaptijn, E. (2009).

Life on the Watershed. Reconstructing Subsistencei in A Steppe Region Using Archaeological Survey: A Diachronic Perspective. Ph.D thesis, Leiden University, Leiden, The Netherlands.

Kaptijn, E. (2015).

Irrigation and human niche construction. An example of socio-spatial organization in the Zerqa Triangle, Jordan, *Water History* 7, 441–454.

Kavosh, H. A., Vidale M., Nashli H. F. (2019).

Teppeh Graziani, Sistan, Iran: Stratigraphy, Formation Processes and Chronology of a Suburban Site of Shahr-i Sokhta, Prehistoric Sistan 2, Roma: Serie Orientale.

Kellerhals, R., Church M., Bray D. I. (1976).

Classification of river processes, *Journal of the Hydraulics Division American Society of Civil Engineers* 93, 63-84.

Kennedy, A. (1925).

Petra: Its History And Monuments, London: Country Life.

Kennedy, D. L. (1998).

Declassified satellite photographs and archaeology in the Middle East: Case studies from Turkey, *Antiquity* 72, 553–571.

Kennedy, D. L., Bewley R.H., Radcliffe R. (2011).

Aerial archaeology in the Middle East. Progress and achievement in Jordan (1997-2008)…and the future, in Cerasudo G. (ed) *Archeologia Aerea 4/5 (100 anni de Archeologia aerea in Italia: Atti del Convegno Internazionale* (Roma 15/17, Aprile 2009),Lecce: Claudio Grenzi Editore, 333-337.

Kennedy, H., Moore, O. (1999).

Some ancient and medieval texts about Merv, in Herrmann G. (ed), *Monuments of Merv: Traditional Buildings of the Karakum*, London: Society of Antiquaries of London, 120–32.

Khalaf, N., Insoll T. (2019).

Monitoring islamic archaeological landscapes in Ethiopia using open source satellite imagery, *Journal of Field Archaeology* 44, 401–419.

Kharin, N. G. (1994).

Desertification of the arid lands of Turkmenistan, in Fet V., Atamuradov K. I. (eds), *Biogeography and EcoIogy of Turkmenistan*, Dordrecht: Springer Science and Business, 65-76.

Khazanov, A. M. (2005).

Nomads and cities in the Eurasian steppe region and adjacent countries: a historical overview, in Leder S., Streck B., *Shifts and Drifts in Nomad-Sedentary Relations*, Wiesbaden: Ludwig Reichert Verlag, 163-178.

Kirchner, H. (2009).

Original design, tribal management and modifications in medieval hydraulic systems in the balearic islands (Spain), *World Archaeology* 41, 151–68.

Kircho, L.B. (2021).

The rise of early urban civilization in southwestern Central Asia.From the Middle Chalcolithic to the Middle Bronze Age in southern Turkmenistan, in Lyonnet B., Dubova N. A. (eds), *The World of the Oxus Civilization*, New York: Routledge, 110-142.

Knighton, D. (1998).

Fluvial Forms and Process: A perspective, New Yourk: Routledge.

Knighton, A. D., Nanson G. C. (1993). Anastomosis and the continuum of channel pattern, *Earth Surface Processes and Landforms* 18, 613–625.

Kohl, P. (1984).

Central Asia Palaeolithic Beginnings to the Iron Age: L'Asie Centrale Des Origines l'Age Du Fer, Paris: Éditions Recherche sur les Civilisations.

Kohl, P. L. (2002).

Archaeological Transformations: Crossing the Pastoral/Agricultural Bridge, *Iranica Antiqua* 37, 151-190.

Kohl, P. L. (2007).

The making of Bronze Age Eurasia, Cambridge: Cambridge University Press.

Kozlov, N. P (1991).

Earth's Nature from Space, New Delhi: Amerind Publishing Co.

Kramer, C. (1977).

Pots and people, in Levine L.D., Cuyler Young T. (eds), *Mountains and Lowland: essay in the Archaeology of Greater Mesopotamia*, Malibu: Undena Publication, 91-112.

Kraus, S. (2021).

Archaeometallurgical studies on BMAC artifacts, in Lyonnet B., Dubova N. A. (eds), *The World of the Oxus Civilization*, New York: Routledge, 779-798.

Kroll, S., Bendezu-Sarmiento J., Lhuillier J., Luneau E., Kaniuth K., Teufer M., Mustafakulov S., Khasanov M., Vinogradova N., Avanesova N., Fiorillo D., Tengberg M., Sharifi A., Bon C., Bosh D., Mashkour., (2022).

Mobility and land use in the Greater Khorasan Civilization: Isotopic approaches (87Sr/86Sr, δ18O) on human populations from southern Central Asia, *Journal of Archaeological Science: Reports* 103622, 1-15.

Kuftin, B.A. (1956).

"Polevoj otchet o rabote XIV otrjada JuTAKE po izucheniju kul'tury pervobytno-oshchinykh osedlozemledel'cheskikh poselenii epokhy medy i bronzy v 1952 g". *Trudy Juzhno-Turkmenistanskoj Arkheologicheskoj Kompleksnoj Ekspeditsii* 7, 260-290.

Kühne, H. (ed) (2018).

Water for Assyria, Wiesbaden: Harrassowitz.

Kurukulasuriya, P., Mendelson, R. (2006).

Crop Selection: Adapting to Climate Change in Africa, CEEPA Discussion Paper No. 26. Centre for Environmental Economics and Policy in Africa, Pretoria: University of Pretoria.

Kuz'mina, E. E. (1991).

Die urgeschichtliche metallurgie der Andronovo-Kultur, Bergbau, *Metallurgie und Metallbearbeitung, Zeitschrift für Archäologie* 25, 29– 48.

Kuz'mina, E. E. (1994).

"Otkuda prishli Indoarii? Material'naja kul'tura plemen andronovskoj obshchnosti i proiskhozhdenie indoirantsev", Moskva: Kalina.

Kuz'mina, E. E. (2007).

The Origin of the Indo-Iranians, Indo-European Etymological Dictionary Series 3, Leiden: Brill.

Kuz'mina, E. E., Lyapin. A. A. (1984).

New finds of steppe ceramics in the Murghab, In Masson V. M. (ed), *Problemy arkheologii Turkmenistana*, Ashkhabad: Ylym (Akademia Nauk Turkmen SSR), 6–22.

Lalymenko, N. K. (1989).

Use of surface runoff in crop development of takyr lands, *Problems of Desert Development* 2, 83–86.

Lamberg-Karlovsky, C.C. (1994a).

The Bronze Age khanates of Central Asia, *Antiquity* 68, 398-405.

Lamberg-Karlovsky, C. C. (1994b).

Foreword: Initiating an archaeological dialogue: The USA-USSR archaeological exchange, in Hiebert F. (ed), *Origin of the Bronze Age Oasis Civilization in*

Central Asia, Cambridge: Peabody Museum of Archaeology and Ethnology, 16-34.

Lamberg-Karlovsky, C. C. (2003).

Civilization, state or tribes? Bactria and Margiana in the Bronze Age, *The Review of Archaeology* 24, 11-19.

Lamberg-Karlovsky, C.C. (2013).

The Oxus Civilization, *Cuadernos de Prehistoria y Arqueología de la Universidad Autónoma de Madrid* 39, 21–63.

Lamberg-Karlovsky, C.C. (2016).

Irrigation among the Shaykhs and Kings, in Andrianov B. V, *Ancient Irrigation Systems of the Aral Sea Area: The History, Origin, and Development of Irrigated Agriculture*, edited and by Mantellini S., Oxford: Oxbow Books, 23-48.

Lamothe, M., Auclair M., Hamzaoui C., Huot S. (2003).

Towards a prediction of long-term anomalous fading of feldspar IRSL, *Radiation Measurements* 37 (4-5), 493-498.

Lasaponara, R., Masini N. (2012).

Remote sensing in archaeology: from visual data interpretation to digital data manipulation, in Lasaponara R., Masini N. (eds), *Satellite remote sensing: a new tool for archaeology*, Heidelberg: Springer, 3-16.

Laserna, M. R. (2003).

Sensitive analysis of a SOBEK hydrodynamic model for wetland management. MSc Thesis, IHE Institute for Water Education, Delft, The Netherlands.

Lauterbach, S., Witt R., Plessen B., Dulski P., Prasad S., Mingram J., Gleixner G., Hettler-Riedel S., Stebich M., Schnetger B., Schwalb A., Schwarz A. (2014).

Climatic imprint of the mid-latitude Westerlies in the Central Tian Shan of Kyrgyzstan and teleconnections to North Atlantic climate variability during the last 6000 years, *The Holocene* 24 (8), 970–984.

Lavrov, A.P., Larin E.V., Sanin, S.A. (1976).

Rayonirovanie takyrov Turkmenistana dlya sel'skohozyaistvennih zeleyè , Ashgabat:Ylym.

Lawler, A. (2007).

Society for American archaeology meetin: climate spurred later Indus decline, *Science* 316, 978–979.

Lebedeva-Verba, M. P., Gerasimova M. I. (2010).

Micromorphology of takyrs and the desert "Papyrus" of southwestern Turkmenia, *Eurasian Soil Science* 43 (11), 1220–1229.

Leopold, L. B., Wolman M. G. (1957).

River channel patterns: braided, meandering and straight, *United States Geological Survey, Professional paper* 282B, 39-85.

Leonard, W. H., Martin J. H. (1963).

Cereal Crops, New York: MacMillan Publishing.

Leroy, S.A.G., Marret, F., Gibert, E., Chalie, F., Reyss, J. L., Arpe, K., (2007).

River inflow and salinity changes in the Caspian Sea during the last 5500 years, *Quaternary Science Reviews* 26, 3359-3383.

Leroy, S. A. G., Lopez- Merino L., Tudryn A., Chalié F., Gasse F. (2014).

Late Pleistocene and Holocene palaeoenvironments in and around the Middle Caspian Basin as reconstructed from a deep- sea core, *Quaternary Science Review* 101, 91– 110.

Lezhinsky, G. T. (1974).

Resursy vremennogo poverhnostnogo stoka pustin' Srednei Asii I Zapadnogo Kazakhstana, Ashgabat:Ylym.

Lillesand, T., Kiefer, R., Chipman, J. (2008).

Remote Sensing and Image Interpretation, Hoboken:Wiley.

Lioubimtseva, E., Simon B., Faure H., Faure-Denard L., Adams J. M. (1998).

Impacts of climatic change on carbon storage in the Sahara- Gobi Desert belt since the Late Glacial Maximum, *Global and Planetary Change* 16 (17), 95– 105.

Lioubimtseva, E., Henebry G. M. (2009).

Climate and environmental change in arid Central Asia: Impacts, vulnerability, and adaptations, *Journal of Arid Environments* 73, 963–977.

Lioubimtseva, E., Kariyeva J., Henebry G. M. (2014).

Climate Change in Turkmenistan, in Zonn I. S., Kostianoy A. G. (eds), *The Turkmen Lake Altyn Asyr and Water Resources in Turkmenistan*, The Handbook of Environmental Chemistry 28, Heidelberg: Springer, 39-57.

Lisitsina, G. N. (1965).

Oroshayemoye Zemledleliye Epokhi Eneolita na Yuge Turkmenii, Moskva: Nauka.

Lisitsina, G. N. (1969).

The Earliest Irrigation in Turkmenia, *Antiquity* 43, 279-288.

Lisitsina, G. N. (1976).

Arid soils: the source of archaeological information, *Journal of Archaeological Science* 3, 55-60.

Lisitsina, G. N. (1978).

Stanovlenie i razvitie oroshaemogo zemledeliya v yudjnoy Turkmenii, Moskva: Nauka.

Lister, D., Jones M. (2013).

Is naked barley an eastern or a western crop? The combined evidence of archaeobotany and genetics, *Vegetation History and Archaeobotany* 22 (5), 439–446.

Lombard, P. (2021).

The Oxus Civilization/BMAC and Its interaction with the Arabian Gulf: A review of the evidence, in Lyonnet B., Dubova N. A. (eds), *The World of the Oxus Civilization*, Routledge: New York, 607-634.

Luneau, E. (2010).

L'Âge du Bronze Final en Asie Centrale Méridionale (1750-1500/1450 avant n.e.). Ph.D Thesis, UMR 7041 – ARSCA, Université Paris 1 - Panthéon-Sorbonne, Paris, France.

Luneau, E. (2014).

La fin de la civilisation de l'Oxus. Transformations et recompositions des sociétés de l'âge du Bronze final en Asie centrale méridionale, Paris:De Boccard.

Luneau, E. (2016).

The fall of the Oxus civilization and the role of exchanges with the neighboring societies during the first half of the second Millennium B.C., in Lefèvre V., Didier A., Mutin B. (eds), *South Asian Archaeology 2012, Man and environment in Prehistoric and Protohistoric South Asia: New Perspectives*, Turnhout: Brepols, 169–183.

Luneau, E. (2019).

Climate Change and the Rise and Fall of the Oxus Civilization in Southern Central Asia, in Yang L., Bork H.-R., Fang X., Mischke S. (eds), *Socio-Environmental Dynamics along the Historical Silk Road*, Heildeberg: Springer, 275-299.

Luneau, E. (2021a).

The end of Oxus Civilization, in Lyonnet B. and Dubova N.A. (eds), *The World of the Oxus Civilization*, New York: Routledge, 496-524.

Luneau, E. (2021b).

Effondrement ou évolution de la civilisation de l'Oxus ? Une révision de la transition de l'âge du Bronze à l'âge du Fer en Asie centrale méridionale, *Les nouvelles de l'archéologie* 163, 36-43.

Luneau, E., Shirazi, R. (2020).

Figurines féminines nues protohistoriques d'Asie Centrale et d'Iran oriental. Typologie, usages et symbolique, in Donnat, S., Hunziker-Rodewald, R., Weygand, I. (eds), *Figurines féminines nues Proche-Orient, Égypte, Nubie, Méditerranée Orientale, Asie Centrale (VIIIe millénaire av. J.-C. – IVe siècle ap J.-C.)*, Paris: Éditions de Boccard, 153–173.

Lyapin, A. A. (1990).

Paleogeografiya del'ty Murgaba (Bronzovy t zhelezny veka, *Problemy Osvoeniya Pustyn'*, 3, 57-65.

Lyapin, A. A. (1996).

Early Murgap Dams, *Problems of Desert Development* 1, 13-21.

Lyapin, A. A. (2014).

K istorii oroshenija v del'te Murgaba [On the history of irrigation in the Murghab region], in Sarianidi V.I. (ed), *Trudy Margianskoj Arkheologicheskoj Ekspeditsii*, vol. 5, Moskva: Staryj Sad, 60– 91.

Lyonnet, B., Dubova N. A. (2021a).

Questioning the Oxus Civilization or Bactria- Margiana Archaeological Culture (BMAC): an overview, in Lyonnet B., Dubova N. A. (eds), *The World of the Oxus Civilization*, New York: Routledge, 7-65.

Lyonnet, B., Dubova, N. A. (2021b).

The World of the Oxus Civilization, New York: Routledge.

Lyonnet, B. (2005).

Another possible interpretation of the Bactria- Margiana Culture (BMAC) of Central Asia: the Tin trade, in Jarrige C., Lekesvre V. (eds), *South Asian Archaeology 2001*, Paris: Éditions Recherche sur les Civilisations, 191– 200.

MacFarland, T.W., Yates, J.M. (2016).

Mann–Whitney U Test, in Mac Farland T.W., Yates J.M. (eds), *Introduction to Nonparametric Statistics for the Biological Sciences Using R*, Heidelberg: Springer, 103-132.

Madella, M., Jones M. K., Echlin P., Powers-Jones A., Moore M. (2009).

Plant water availability and analytical microscopy of phytoliths: implications for ancient irrigation in arid zones, *Quaternary International* 193 (1–2), 32-40.

Maddison, D. (2006).

The Perception of and Adaptation toCclimate Change in Africa, CEEPA Discussion Paper No. 10, Centre for Environmental Economics and Policy in Africa, Pretoria: University of Pretoria.

Magny, M., Vanniére B., Calo C., Millet L., Leroux A., Peyron O., Zanchetta G., La Mantia T., Tinner W. (2011).

Holocene hydrological changes in south-western Mediterranean as recorded by lake-level fluctuations at Lago Preola, a coastal lake in southern Sicily, Italy, *Quaternary Science Reviews* 30, 2459–2475.

Maheu, A., Caissie D., St-Hilaire A., El-Jabi N., (2013).

River evaporation and corresponding heat fluxes in forested catchments, *Hydrological Processes*, 28, 5725– 5738.

Makaske, B. (2001).

Anastomosing rivers: a review of their classification, origin and sedimentary products, *Earth-Science Reviews* 53, 149–196.

Malatesta, L.C., Castelltort S., Mantellini S., Picotti V., Hajdas I., Simpson G., Berdimuradov A. E., Tosi M., Willett S.D., (2012).

Dating the irrigation system of the samarkand oasis: a geoarchaeological study, *Radiocarbon*, 54:1, 91–105.

Maman, S., Tsoar H., Blumberg D. G., Mamedov B., Porat N. (2011a).

Central Asian ergs: a study by remote sensing and geographic information systems, *Aeolian Research* 3 (3), 353– 366.

Maman, S., Orlovsky L., Blumberg D. G., Berliner P., Mamedov B. (2011b).

A landcover change study of takyr surfaces in Turkmenistan, *Journal of Arid Environments* 75, 842-850.

Mantellini, S., Rondelli B., Stride S. (2008).

Analytical approach for representing the water landscape evolution in Samarkand Oasis (Uzbekistan), in Jerem E., Redo F., Szeverenyi V., *On the Road to Reconstructing the Past: Computer Applications and Quantitative Methods in Archaeology (CAA)*, Budapest: CAA, 387-396.

Marcolongo, B., Mozzi, P. (1998).

Outline of recent geological history of the Kopet-Dagh mountains and the southern Kara-Kum, in Gubaev A., Koshelenko G., Tosi M. (eds) *The Archaeological Map of the Murghab Delta: Preliminary Reports 1990-1995*, Roma: IsIAO, 1-14.

Markofsky, S. (2010).

Illuminating the Black Sands: Survey and Settlement in the Bronze Age Murghab Delta, Turkmenistan. Ph.D thesis, University College London-UCL, London, Uk.

Markofsky, S., Bevan A. (2012).

Directional analysis of surface artefact distributions: a case study from the Murghab Delta, Turkmenistan, *Journal of Archaeological Science* 39, 428-439.

Markofsky, S. (2017).

Perspectives on an alluvial margin: settlement patterns in the northern Murghab Delta, Turkmenistan, *Iran* 53 (1), 65-92.

Markofsky, S., Ninfo, A., Balbo, A., Conesa, F. C., Madella, M. (2017).

An investigation of local scale human/landscape dynamics in the endorheic alluvial fan of the Murghab River, Turkmenistan, *Quaternary International*, 1-19.

Masimov, I. S. (1979).

Izuchenie pamatnikov epokhi bronzi nizovii Murgaba, *Sovetskaya Arkheologiya*, 111-131.

Masimov, I. S. (1981).

The study of Bronze Age sites in the lower Murghab, in Kohl Ph. L. (ed), *The Bronze Age Civilization of Central Asia. Recent Soviet Discoveries*, New York: M. E. Sharpe Inc, 194-220.

Masimov, I. S., Salvatori S., Udeumoradov B. (1998).

Preliminary analysis of the Bronze Age material collected by the Margiana Archaeological Project and a first chronological assessment, in Gubaev A., Koshelenko G., Tosi M. (eds), *The Archaeological Map of the Murghab Delta: Preliminary Reports 1990-1995*, Roma: IsIAO, 35-46.

Masimov, I.S., Salvatori S. (2008).

Unpublished stamp-seals from the north-western Murghab Delta, in Salvatori S., Tosi M., Cerasetti B. (eds), *The Bronze Age and Early Iron Age in the Margiana Lowlands: Facts and Methodological Proposals for a Redefinition of the Research Strategies*, Oxford: BAR, 99-110.

Masini, N., Gizzi F.T., Biscione M., Fundone V., Sedile M., Sileo M., Pecci A., Lacovara B., Lasaponara R. (2018).

Medieval archaeology under the canopy with LiDAR. The (Re)discovery of a medieval fortified settlement in Southern Italy, *Remote Sensing* 10, 1598, 1-26.

Masson, V. M. (1959).

Drevnezemledel'cheskaya Kul'tura Margiany, 73, *Materialy i Issledovaniya po Arkheologii SSSR*, Moskva: Akademia Nauk SSSR, 30-43.

Masson, V. M. (1967).

Protogorodskaya kultura Altyn-depe, Moskva: Archeologicheskie Ostrytiya 1966, goda.

Masson, V. M. (1988).

Altyn Depe, Hoboken: Wiley.

Masson, V. M. (2002).

Cultures of the steppe Bronze Age and urban civilizations in the south of Central Asia, in Jones-Bley K., Zdanovich D. G. (eds), *Complex societies of Central Eurasia from the 3rd to the 1st millennium BC: regional specifics in light of global models*, Washington: Institute or the Study of Man, 547–57.

Masson, V. M., Sarianidi V. I. (1972).

Central Asia: Turkmenia before the Achaemenids, London: Thames & Hudson.

Mayewski, P. A., Rohling, E. E., Stager, J. C., Karlén, W., Maasch, K. A., Meeker, L. D., Meyerson, E. A., Gasse, F., van Kreveld, S., Holmgren, K., Lee-Thorp, J. (2004).

Holocene climate variability, *Quaternary Research* 62, 3, 243–255.

McIntosh, R.J. (1983).

Floodplain geomorphology and human occupation of the upper inland Delta of the Niger, *Geographical Journal* 149, 182–201.

McIntosh, R.J., Tainter, J.A., McIntosh, S.K. (2000).

Climate, history, and human action, in McIntosh R.J., Tainter J.A., McIntosh S.K. (eds), *The Way the Wind Blows: Climate, History, and Human Action*, New York: Historical Ecology Series, 1–42.

Meyer-Melikyan, N. R., Avetov N. A. (1998).

Analysis of floral remains in the ceramic vessel from the Gonur Temenos, in Sarianidi V. I. (ed), *Margiana and Protozoroastrism*, Athens: Kapon Editions, 176-177.

Miall, A.D. (1977).

A review of the braided river depositional environment, *Earth-Science Reviews* 13, 1-62.

Miller, N. F. (1993).

Preliminary archaeobotanical results from the 1989 excavation at the Central Asian site of Gonur Depe, Turkmenistan, *Informational Bulletin of the International Association of the Study of Cultures of Central Asia* 19, 149-163.

Miller, N. F. (1999).

Agricultural development in western Central Asia in the Chalcolithic and Bronze Ages, *Vegetation History and Archaeobotany* 8, 13-19.

Miller, N. F. (2008).

Sweeter than wine? The use of the grape in early Western Asia, *Antiquity* 82, 937–946.

Miller, N.F., Smart T.L. (1984).

Intentional burning of dung as fuel: A mechanism for the incorporation of charred seeds into the archaeological record, *Journal of Ethnobiology* 4, 15–28

Miller, N. F., Marston J. M. (2012).

Archaeological fuel remains as indicators of ancient west Asian agropastoral and land-use systems, *Journal of Arid Environments* 8, 97-103.

Miller, N. F., Spengler R. N., Frachetti F. (2016).

Millet cultivation across Eurasia: origins, spread, and influence of seasonal climate, *The Holocene* 26, 10, 1566-1575.

Minashina, N. G. (1978).

Melioratsiya zasolennykh pochv, Moskva: Kolos.

Minnis, P.E. (1996).

Notes on economic uncertainty and human behavior in the prehistoric North American Southwest, in Tainter J.A., Tainter B.B. (eds), *Evolving Complexity and Environmental Risk in the Prehistoric Southwest*, Santa Fe: Institute Studies in the Sciences of Complexity Proceedings 24, 57–78.

Mischke, S., Rajabov I., Mustaeva N., Zhang C., Herzschuh U., Boomer I., Brown E.T., Andersen N.,Myrbo A., Ito E., Schudack M. E. (2010).

Modern hydrology and Late Holocene history of Lake Karakul, eastern Pamirs (Tajikistan): A reconnaissance study, *Paleogeography, Palaeoclimatology, Palaeoecology* 289, 10– 24.

Mitgartz B.B., Shevchenko N. G. (eds) (1972).

Gidrogeologiya SSR, T. XXXXVIII. Turkmenskaya SSR, Moskva:Nedra.

Mohammed-Aslam, M., Balasubramanian, A. (2010).

History of river channel modifications: a review, *Journal of Ecology and the Natural Environment* 2 (10), 207–212.

Moore, K., Miller N., Hiebert F. T., Meadow R. (1994).

Agriculture and herding in the early oasis settlements of the Oxus Civilization, *Antiquity* 68 (259), 418-427.

Morandi Bonacossi, D. (2017).

Water for Assyria: irrigation and water management in the Assyrian Empire, in Morandi Bonacossi D., Petit L. P. (eds), *Nineveh the Great City: Symbol of Beauty ad Power*, Leiden: Sidestone Press, 132-136.

Mori, L. (2020).

Water and power: what is left? An introduction to the workshop “Waterscapes: new perspectives on hydrocultural landscapes in the ancient Near East”, *Water History* 12, 11–22.

Morton, J. (2007).

The impact of climate change on smallholder and subsistence agriculture, *PNAS*, 104(50), 19680-19685.

Motuzaite Matuzeviciute, G., Ananyevskaya, E., Sakalauskaite, J., Soltobaev, O., Tabaldiev, K. (2022).

The integration of millet into the diet of Central Asian populations in the third millennium BC, *Antiquity* 96(387), 560-574.

Muradov, R. G. (2021).

The architecture of the Bactria-Margiana Archaeological Culture, in Lyonnet B., Dubova N. A. (eds), *The World of the Oxus Civilization*, New York: Routledge, 145-177.

Murphy-Bokern, F. L. S., Watson C. A. (ed) (2017).

Legumes in Cropping Systems, London: CABI Publishing.

Musa, Z. N., Popescu I. I., Mynett A. (2015).

Sensitivity Analysis of the 2D SOBEK Hydrodynamic Model of the Niger River, The Hague: IAHR World Congress, 1-8.

Mutin, B., Lamberg-Karlovsky, C.C. (2021).

The relationship between the Oxus Civilization and the Indo-Iranian Borderlands, in Lyonnet B., Dubova N. A. (eds), *The World of the Oxus Civilization*, New York:Routledge, 551-587.

Nanson, G. C. (2013).

Anabranching and anastomosing rivers, in Shroder J.F., Wohl E. (eds), *Treatise on Geomorphology: Volume 9: Fluvial Geomorphology*, London: Elsevier, 330-345.

Nanson, G.C., Gibling M.R. (1978).

Anabranching rivers, in Fairbridge R. W., Bourgeois S. (eds), *Sedimentology*, Encyclopedia of Earth Science, Heidelberg: Springer, 17-20.

Narasimhan, V. M., Patterson N., Moorjani P., Rohland N. *et al.* (2019).

The formation of human populations in South and Central Asia, *Science* 365, eaat7487, 1-15.

Nelson, J. M., Smith J. D. (1989).

Evolution and stability of erodible channel beds, in Ikeda S., Parkers G. (eds), *River Meandering*, Hoboken: Wiley, 321-77.

Newson, P., Baker G., Daly P., Mattingly D., Gilbertson D. (2007).

The Wadi Faynan field systems, in Barker G., Gilbertson D., Mattingly D. (eds), *Archaeology and Desertification: The Wadi Faynan Landscape Survey, Southern Jordan*, Oxford: Council for British Research in the Levant (CBRL),141-174.

Ninfo, A. (2007).

Missione Turkmenistan 2006, *Quaderni del Dottorato, Dipartimento di Geografia, Università di Padova* 1, 113-125.

Ninfo, A., Perego, A., (2006).

Evoluzione geomorfologica del delta interno del Murghab: relazione missione Turkmenistan 2006 University of Pisa, Unpublished Field Report Submitted to Italian Ministry of Foreign Affairs, Rome, Italy, 1-9.

Niyazklychev, K. (1973).

Zemledlel'cheskii kalandar I skotovostvo u Turkmen-chovdurov v kontse 19-nachale 20 v, Ashkhabad: Ylym.

O'Connell, T., Levine M., Hedges R. (2003).

The importance of fish in the diet of Central Eurasian peoples from the Mesolithic to the Early Iron Age, in Levine M., Renfrew C., Boyle K. (eds), *Prehistoric Steppe Adaption and the Horse*, Cambridge: Mc Donald Institute Monographs, 253–268.

O'Donovan, E. (1882).

The Merv Oasis, Vol II, London: Smith.

Olson, S. A., Williams-Sether T. (2010).

Streamflow characteristics at stream gages in northern Afghanistan and selected locations, U.S Geological Survey Data Series, 529.

Olson, K. G, Rouse L. M. (2018).

A Beginner's guide to mesoscale survey with quadrotor-UAV systems, *Advances in Archaeological Practice* 6 (4), 357-371.

Orengo, H. A., Petrie C. A. (2017).

Large-scale, multi-temporal remote sensing of palaeo-river networks: A sase study from northwest India and its implications for the Indus Civilisation, *Remote Senings* 9 (735), 1-20.

Orlovsky, N.S. (1994).

Climate of Turkmenistan, in Fet V., Atamuradov K. I., *Biogeography and Ecology of Turkmenistan*, Dordrech: Springer Science and Busines, 23-48.

Orlovsky, L., Dourikov M., Babev A. G. (2004).

Temporal dynamics and productivity of biogenic soil crusts in the central Karakum Desert, Turkmenistan, *Journal of Arid Environments* 56, 579-601.

Ovezberdyev, K. (1962).

Materialy po etnografii turkmen-sarykov Pendinskogo oazica', *Trudy Instituta istorii, arkheologii i etnogratfii AN Turkmenskoy SSR*, t. VI, 50-63.

Parcak, S. H. (2009).

Satellite Remote Sensing for Archaeology, New York: Routledge.

Pashkevich, G (2003).

Paleoethnobotanical evidence of agriculture in the steppe and forest steppe of East Europe in the Late Neolithic and Bronze Age, in Levine M., Renfrew C., Boyle K. (eds), *Prehistoric Steppe Adaptation and the Horse*, London: McDonald Institute for Archaeological Research, 287–297.

Pearsall, D. M. (2015).

Paleoethnobotany: A Handbook of Procedures, Walnut Creek: Left Coast Press Inc.

Peterson, L. (1982).

A field Guide to Edible Wild Plants, Boston: Houghton Miffiin.

Petrie, C. A. (2019).

Diversity, variability, adaptation and 'fragility' in the Indus Civilization, in Yoffee N. (ed), *The Evolution of Fragility: Setting the Terms*, Cambridge: McDonald Institute for Archaeological Research, 109–133.

Petrie, C. A., Singh R. N., Bates J., Dixit, Y., French C. A., Hodell D. A., Singh D. P. (2017).

Adaptation to variable environments, resilience to climate change: investigating land, water and settlement in Indus Northwest India, *Current Anthropology* 58, 1-30.

Petrie, C., Lynam F. (2020).

Revisiting settlement contemporaneity and exploring stability and instability: case studies from the Indus Civilization, *Journal of Field Archaeology* 45 (1), 1–15.

Philip, G., Beck A., Galiatsatos N. (2002).

CORONA satellite photography: an archaeological application from the Middle East, *Antiquity* 76, 109–118.

Piperno, D. (2006).

Phytoliths: A Comprehensive Guide for Archaeologists and Paleoecologists, Lanham: Altamira Press.

Pittman, H. (2019).

Bronze Age interaction on the iranian plateau: from Kerman to the Oxus through seals, in Meyer J. W., Vila E., Mashkour M., Casanova M., Vallet R. (eds), *The*

Iranian Plateau During the Bronze Age. Development of Urbanisation, Production and Trade, Lyon: Mom editions, 267– 288.

Plog, S., Plog F., Wait W. (1978).

Decision making in modern survey, *Advances in Archaeological Methods and Theory* 1, 385-421.

Postage, N. (1994).

How many sumerians per hectare? Probing the anatomy of an early city, *Cambridge Archaeological Journal* 4 (1), 47-65.

Potts, D. T. (2001).

Excavations at Tepe Yahya, Iran 1967– 1975: The Third Millennium, Vol. III, Cambridge: Peabody Museum of Archaeology and Ethnology.

Potts, D. T. (2008).

Puzur- Inšušinak and the Oxus Civilization (BMAC): reflections on Šimaški and the geo-political landscape of Iran and Central Asia in the Ur III Period, *Zeitschrift für Assyriologie und Vorderasiatische Archäologie* 98, 165– 194.

Pournelle, J. R., (2003).

Marshland of Cities: Deltaic Landscapes and the Evolution of Early Mesopotamian Civilization. Ph.D Thesis, Department of Anthropology, University of California, San Diego, USA.

Pournelle, J. R. (2007).

From KLM to Corona: using satellite photography toward a new understanding of 5th/4th millennium BC landscapes in southern Mesopotamia, in Stone E. (ed), *Settlement and Society: Ecology, Urbanism, Trade and Technology in Ancient Mesopotamia*, Los Angeles: Cotsen Institute, 26-62.

Powell, M. A. (1985).

Salt, seed, and yields in sumerian agriculture: a critique of the theory of progressive salinization, *Zeitschrift für Assyriologie und Vorderasiatische Archäologie* 75 (1), 7–38.

Powell, W., Frachetti M., Pulak C., Bankoff H.A., Barjamovic G., Johnson M., Mathur R., Pigott V.C., Price M., Aslihan Yener K.A. (2022).

Tin from Uluburun shipwreck shows small-scale commodity exchange fueled continental tin supply across Late Bronze Age Eurasia, *Science Advanced* 8, 3766, 1-10.

Prasolov, L. I. (1933).

Zemel'niy fond dl'a rastenievodstva v SSSR s tochki zreniya geographii pochv, *Rastenievodstvo SSSR*, vol. 1. Moskva-Leningrad: Sel'khozgiz, 70-84.

Preusser, F., Meru M., Rosentau A. (2014).

Comparing different Post-IR IRSL approaches for the dating of Holocene Coastal foredunes from Ruhnu Island, Estonia, *Geochronometria* 41 (4), 342–351.

Prinsen, G. F., Becker B. P. J. (2011).

Application of SOBEK hydraulic surface water models in the Netherlands hydrological modelling instrument, *Irrigation and Drainage* 60, 35–41.

Pumpelly, R. (ed) (1908).

Explorations in Turkestan. Expedition 1904, Prehistoric Civilizations of Anau, 2, Washington.

Puschnigg, G. (2020).

Merv and Margiana, in Mairs R. (ed), *The Graeco-Bactrian and Indo-Greek World*, New York: Routledge, 335-356.

P'yankova, L.T. (1989).

Pottery complexes of Bronze Age Margiana (Gonur and Togolok 21), *Information Bulletin of the International Association for the Study of the Cultures of Central Asia* 16, 27-54.

P'yankova, L.T. (1993).

Pottery of Margiana and Bactria in the Bronze Age, *Information Bulletin of the International Association for the Study of the Cultures of Central Asia* 19, 109–27.

P'yankova, L.T., (1994).

Central Asia in the Bronze Age: sedentary and nomadic cultures, *Antiquity* 68, 355–372.

Railsback, L. B., Liang F., Brook G. A., Riavo N., Voarintsoa G., Sletten H. R., Marais E., Hardt B., Cheng H., Edwards R. L. (2018).

The timing, two-pulsed nature, and variable climatic expression of the 4.2 ka event: a review and new high-resolution stalagmite data from Namibia, *Quaternary Science Review* 186, 78–90.

Rashidian, E. (2021).

Rivers in the making; the definition of "Nahr" as a hybrid watercourse based on geoarchaeological evidence from Southwestern Iran, *Water History* 13, 235–259.

Rayne, L. (2015).

Imperial irrigated landscape in the Balikh Valley, *Water History* 7, 419-440.

Rayne, L., Donoghue D. (2018).

A remote sensing approach for mapping the development of ancient water management in the Near East, *Remote Sensing* 10 (2042), 1-21.

Ricketts, R. D., Johnson T. C., Brown E. T., Rasmussen K. A., Romanovsky V. V. (2001).

The Holocene paleolimnology of Lake Issyk-Kul, Kyrgyzstan: Trace element and stable isotope composition of ostracodes, Palaeogeography, Palaeoclimatology, *Palaeoecology* 176 (1), 207–227.

Riehl, S. (2008).

Climate and agriculture in the ancient Near East: a synthesis of the archaeobotanical and stable carbon isotope evidence, *Vegetation History and Archaeobotany* 17 (1), 43–51.

Riehl, S., Bryson R., Pustovoytov K. (2008).

Changing growing conditions for crops during the Near Eastern Bronze Age (3000–1200 BC): the stable carbon isotope evidence, *Journal of Archaeological Science* 35, 1–12.

Risbøl, O., Gustavsen, L. (2018).

LiDAR from drones employed for mapping archaeology – Potential, benefits and challenges, *Archaeological Prospection*, 25(4), 329-338.

Rost, S. (2015).

Watercourse Management and Political Centralization in Third-Millennium B.C. Southern Mesopotamia: A Case Study of the Umma Province of the Ur III Period (2112–2004 B.C.). Ph.D Thesis, Stony Brook University, New York, USA.

Rost, S. (2017).

Water management in Mesopotamia from the sixth till the first millennium B.C., *WIREs Water* 4: 1-23.

Rossi-Osmida, G. (ed) (2002).

Margiana. Gonur-depe Necropolis. 10 years of excavations by Ligabue Study and Research Centre, Vicenza: Il Punto.

Rossi-Osmida, G. (2007).

Citadella delle Statuette Vol I, Vicenza: Il Punto.

Rossi-Osmida, G. (2011).

Citadella delle Statuette Vol II, Vicenza: Il Punto.

Rouse, L. M. (2015).

A Line in the Sand: Archaeological Evidence for the Interactions of Settled Farmers and Mobile Pastoralists in the Late Bronze Age (1950 - 1500 BC) Murghab alluvial fan, Turkmenistan. Ph.D Thesis, Washington University in Saint. Louis, Saint. Louis, USA.

Rouse, L. M. (2020).

Silent partners: archaeology insights on mobility, interaction and civilization in Central Asia's past, *Central Asian Survey*, 1-22.

Rouse, L. M., Cerasetti B. (2014).

Ojakly: A Late Bronze Age mobile pastoralist site in the Murghab Region, Turkmenistan, *Journal of Field Archaeology* 39, 1, 32-50.

Rouse L. M., Cerasetti B. (2017).

Micro-dynamics and macro-patterns: exploring new archaeological data for the late Holocene human-water relationship in the Murghab alluvial fan, Turkmenistan, *Quaternary International* 437, 20-34.

Rouse, L. M., Cerasetti B. (2018).

Mixing metaphors: sedentary-mobile interactions and local-global connections in prehistoric Turkmenistan, *Antiquity* 92, 363, 674-689.

Rouse, L. M., Grillo K. M., Piermartiri R., Rotondaro E., Cogo-Moreira H., Bargossi G. M., Cerasetti B. (2019).

Not just "nomadic jars": the Late Bronze Age ceramic assemblage from the mobile pastoralist site of Ojakly, Murghab region, Turkmenistan, *Archaeological Research in Asia* 18, 100-119.

Rouse, L. M., Woldekiros H. S., Cerasetti B. (2022a).

Faunal remains from Ojakly, a Late Bronze Age mobile pastoralist campsite in the Murghab region, Turkmenistan, *Journal of Archaeological Science: Reports* 44, 1-12.

Rouse, L. M., Doumani Dupuy P. N., Brite E. B., (2022b).

The Agro-pastoralism debate in Central Eurasia: arguments in favor of a nuanced perspective on socio-economy in archaeological context, *Journal of Anthropological Archaeology* 67, 1-18.

Rudaya, N., Tarasov P., Dorofeyuk N., Solovieva N., Kalugin I., Andreev A., Daryin A., Diekmann B., Riedel F., Tserendash N., Wagner M. (2008).

Holocene environments and climate in the Mongolian Altai reconstructed from the Hoton-Nur pollen and diatom records: a step towards better understanding climate dynamics in Central Asia, *Quaternary Science Reviews* 28, 540–554.

Rühl, L., Herbig C., Stobbe A. (2015).

Archaeobotanical analysis of plant use at Kamennyi Ambar, a Bronze Age fortified settlement of the Sintashta culture in the southern Trans-Urals steppe, Russia, *Vegetation History and Archaeobotany* 24, 413–426.

Rust, B. R. (1978).

A classification of alluvial channel systems, in Miall, A.D. (ed), *Fluvial Sedimentology*, Calgary: Canadian Society of Petroleum Geologists Memoir, 187–198.

Rustamov, I. G. (1994).

Vegetation of the deserts of Turkmenistan, in Fet V., Atamuradov K. I. (eds), *Biogeography and Ecology of Turkmenistan*, Dordrecht: Springer Science and Business, 77–104.

Rychagov, G. I. (1997).

Holocene oscillations of the Caspian Sea, and forecasts based on palaeogeographical reconstructions, *Quaternary International* 41-42, 167–172.

Sabori, H., Talai H., Garazhian O., Bolandi R., Bayani N. (2018).

The reviews of post depositional processes: case study of Tepe Ferizi in the Sabzevar plain, North-Eastern Iran, *Journal of Historical Archaeology and Anthropological Science* 3 (3), 456–465.

Sala, R. (2014).

Methodological problems concerning the correlation between paleoclimatic and archaeological data, in Lamberg-Karlovsky C.C., Genito B., Cerasetti B. (eds), *My Life is like the Summer Rose. Maurizio Tosi e l'Archeologia como modo di vivere*, Oxford: BAR, 677–684.

Sallaberger, W., Ur J.A. (2004).

Tell Beydar: Nabada in its regional setting, in Milano L., Sallaberger W., Talon P., Van Lerberghe K. (eds). *Third Millennium Cuneiform Texts from Tell Beydar (Seasons 1996-2002)*, Turnhout: Brepols Publisher, 51-71.

Salvatori, S. (1998).

Margiana Archaeological Map: the Bronze Age settlements pattern, in Gubaev A., Koshelenko G., Tosi M. (eds) *The Archaeological Map of the Murghab Delta: Preliminary Reports 1990-1995*, Roma: IsIAO, 57-65.

Salvatori, S. (2000).

Bactria and Margiana seals: a new assessment of their chronological position and a typological survey, *East and West* 50, 97–145.

Salvatori, S. (2002).

The project for the archaeological map of the Murghab Delta (Turkmenistan): stratigraphic trial trenches at Adzhi Kui 1 and 9, *Ancient Civilizations from Scythia to Siberia: an international journal of comparative studies in history and archaeology* 1-2 (7), 107–178.

Salvatori, S. (2008a).

The Margiana settlement pattern from the Middle Bronze Age to the Parthian-Sasanian Period: a contribution to the study of complexity, in Salvatori S., Tosi M., Cerasetti B. (eds), *The Bronze Age and Early Iron Age in the Margiana Lowlands: Facts and Methodological Proposals for a Redefinition of the Research Strategies*, Oxford: BAR, 57–74.

Salvatori, S. (2008b).

Cultural variability in the Bronze Age Oxus Civilisation and its relations with the surrounding regions of Central Asia and Iran, in Salvatori S., Tosi M., Cerasetti B. (eds), *The Bronze Age and Early Iron Age in the Margiana Lowlands: Facts and Methodological Proposals for a Redefinition of the Research Strategies,* Oxford: BAR, 75–98.

Salvatori, S. (2010).

Thinking around Grave 3245 in the 'Royal Graveyard' of Gonur (Murghab Delta, Turkmenistan), in Kozhin P. M., Kosarev M. F., Dubova N. A. (eds), *Na puti otkrytija tsivilizatsii* [On the track of uncovering a civilization]. Trudy Margianskoj Arkheologicheskoj Ekspeditsii, vol. 3, St. Petersburg: Aletejja, 244–257.

Salvatori, S. (2016).

Bactria-Margiana Archaeological Complex: How Terminology Hides Historical Processes, in Dubova N. A. (ed), *Trudy Margianskoj Arkheologicheskoj Ekspeditsii, vol. 6*, Moskva: Staryj Sad, 449–460.

Salvatori, S., Tosi, M., Cerasetti B. (2008).

The Bronze Age and Early Iron Age in the Margiana Lowlands: Facts and Methodological Proposals for a Redefinition of the Research Strategies, Oxford: BAR.

Salvatori, S., Tosi M. (2008).

Introduction, in Salvatori S., Tosi M., Cerasetti B.(eds), *The Bronze Age and Early Iron Age in the Margiana Lowlands: Facts and Methodological Proposals for a Redefinition of the Research Strategies*, Oxford: BAR, 57–74.

Salvini, R., Guastaldi E., Coscini N., Del Seppia N. (2006).

Ricostruzione del Peleoalveo del Fiume Serchio (Lucca, Italia) tramite rilivei LIDAR, Foto aeree ed immagini Quick Bird, *Italian Journal of Quaternary Sciences* 19 (2), 299–310.

Sarianidi, V. I. (1975).

Stepnye plemena epokhi bronzy v Margiane, *Sovietskaya Arkheologia* 2, 20–29.

Sarianidi, V. I. (1981).

Margiana in the Bronze Age, in Kohl, Ph. L. (ed), *The Bronze Age Civilization of Central Asia. Recent Soviet Discoveries*, New York: M. E. Sharpe Inc, 165–193.

Sarianidi, V. I. (1982).

Ob odnoj gruppe drevnebaktrijskoj gliptiki, Drevnjaja Indija i nauka, Moskva: Nauka, 297–306.

Sarianidi, V. I. (1986).

Le complexe cultuel de Togolok 21 en Margiane, *Arts Asiatiques* 41, 5–21.

Sarianidi, V. I. (1990a).

Drevnosty Strany Margush, Ashgabad: Sily.

Sarianidi, V. I. (1990b).

Togolok 21, an Indo-Iranian Temple in the Karakum, *Bulletin of the Asia Institute* 4, 159–165.

Sarianidi, V. I. (1991).

Temples of Ancient Margiana, *Pakistan Archaeology* 26, 175–187.

Sarianidi, V. I (1994).

Temples of Bronze Age Margiana: traditions of ritual architecture, *Antiquity* 68, 388–397.

Sarianidi, V. I. (1998a).

Myths of Ancient Bactria and Margiana on its Seals and Amulets, Moscow: Pentagraphic Limited.

Sarianidi, V. I. (1998b).

Margiana and Protozoroastrianism, Athens: Kapon Editions.

Sarianidi, V. I. (2002).

The fortification and palace of northern Gonur, *Iran* 40, 75-87.

Sarianidi, V. I. (2005).

Gonur Depe: City of Kings and Gods, Ashgabat: Miras.

Sarianidi, V. I. (2006).

"Tsarskij nekropol" na Severnom Gonure, *Vestnik Drevnej Istorii* 2 (257), 155–192.

Sarianidi, V. I. (2007).

Necropolis of Gonur, Athens: Kapon Edition.

Sarianidi, V. I. (2008a).

The palace –temple complex of North Gonur, *Anthropology & Archeology of Eurasia* 47(1), 8–35.

Sarianidi, V. I. (2008b).

Margush: Mystery and True of the Great Culture, Ashgabat: Türkmend övlethabarlary.

Sarianidi, V. I. (2009).

Margus. Mistery and True of the Great Culture, Asgabat: Turkmen dowlet nesiryat gullugy.

Sarianidi, V. I. (2010a).

On the Track of Uncovering a Civilization, St. Petersburg: Aletheia.

Sarianidi, V.I. (2010b).

Long Before Zaratushtra: Archaeological Evidences of Protozoroastrianizm in Bactria and Margiana, Moscow: Staryi Sad.

Sarianidi, V.I., Dubova N.A. (2012).

Goňurdepe suw üpjüçiligi we onuň dolandyrylyşy, *Türkmenistanda Ylym we Tehnika* 2, 115-121.

Sarianidi, V. I., Boroffka N., Dubova N. A. (2012).

Cultural contacts of Margiana, Turkmenistan, in the 3rd Millennium BC: new evidence from Gonur Depe, burial 4150, *Gandhāran Studies* 6 (1), 1–17.

Sarianidi, V. I, Boroffka N., Dubova N. A. (2014).

Kul'turnye kontakty Margiany (Turkmenistan) v III tys. do n.e. Novye dannye po Gonur- Depe (pogrebenie no. 4150) [Margiana (Turkmenistan) cultural contacts in the 3rd millennium BC: new data from Gonur Depe (tomb no. 4150)], in Sarianidi V.I., *Trudy Margianskoj Arkheologicheskoj Ekspeditsii*, vol. 4, Moskva: Staryj Sad, 127–137.

Sataev, R. M. (2008).

Raskopki drevnego irrigatsionnogo kanala [Excavations of an ancient irrigation canal], in Sarianidi, V. I., Kozhin, P. M., Kosarev, N. A., Dubova, N. A. (eds), *Trudy Margianskoj Arkheologicheskoj Ekspeditsii* Vol. 2, Moskva: Staryj Sad, 65–66.

Sataev, R. M. (2018).

Predvaritel'nye itogi izuchenija stratigrafii dvortsa Severnogo Gonura, in Dubova N. A. (ed), *Trudy Margianskoj Arkheologicheskoj Ekspeditsii* vol. 7, Moskva: Staryj Sad, 80–86.

Sataev, R. M. (2021a).

Animal Exploitation at Gonur Depe, in Lyonnet B., Dubova N.A. (eds), *The World of the Oxus Civilization*, New York: Routledge, 438-456.

Sataev, R. M. (2021b).

Animal burials at Gonur Depe, in Lyonnet B., Dubova N.A. (eds), *The World of the Oxus Civilization,* New York: Routledge, 386-404.

Sataev, R.M., Sataeva, L. (2014).

Results of archaeozoological and archaeobotanical researches at the Bronze Age site Gonur Depe (Turkmenistan), in Bieliński P., Gawlikowski M., Koliński R., Ławecka D., Sołtysiak, A., Wygnańska, Z. (eds), *Proceedings of the 8th International Congress on the Archaeology of the Ancient Near East: 30 April - 4 May 2012*, Warsaw: University of Warsaw, 367-370.

Sataev, R. M., Sataeva L. (2012).

Arkheobotanicheskiye issledovaniya na Gonur Depe, in Sarianidi V. I., Kozhin P. M., Kosarev M. F., Dubova N. A. (eds), *Transactions of Margiana Archaeological Expedition, Gonur Depe studies 2008-2011*, Vol 4, Moscow: Russian Accademy of Science, 159-162.

Sataeva, L., Sataev R. M. (2014).

Wood using at the Bronze Age site Gonur-Depe. (Ancient Margiana, South Turkmenistan), in Stucky R. A., Kaelin O., Mathys H.P. (eds), *Proceedings of the 9th International Congress on the Archaeology of the Ancient Near East: June 9-13,* 3, Basel: University of Basel, 643–645.

Schacht, R. M. (1984).

The contemporaneity problem, *American Antiquity* 49 (4), 678–695.

Schawartz, G., Falconer S. (1994).

Rural Approaches to Social Complexity. Archaeological Views from the Countryside, Washington: Smithsonian Institution Press, 1-9.

Schmidt, E. F. (1937).

Excavations at Tepe- Hissar Damghan, Philadelphia: University of Pennsylvania Press.

Schmitt, R. (1990).

Bisotun III. Darius's inscription, *Encyclopedia Iranica* Vol. IV (3), 299-305.

Schumm, S.A. (1963).

Sinuosity of alluvial rivers on the Great Plains, *Bulletin of the Geological Society of Americas* 74, 1089-100.

Schumm, S.A. (1968).

Speculations concerning paleohydraulic controls on terrestrial sedimentation, *Geological Society of America Bulletin* 79, 1573–1588.

Schumm, S.A., (1985).

Patterns of alluvial rivers, *Annual Review of Earth and Planetary Sciences* 13, 5–27.

Schwerin von, S., Richards-Rissetto H., Remondino F., Spera M. G., Auer M., Billen N., Loos L., Stelson L., Reindel M. (2016).

Airborne LiDAR acquisition, post-processing and accuracy-checking for a 3D WebGIS of Copan, Honduras, *Journal of Archaeological Science* 5, 85-104.

Seely, M., Henderson J., Heyns P., Jacobson P., Nakale T., Nantanga K., Schachtschneider K. (2003).

Ephemeral and endoreic river systems: relevance and management challenges, in Truton A., Ashton P., Cloete E. (eds), *Transboundary rivers, sovereignty and development Hydropolitical drivers in the Okavango River basin*, Pretoria:University of Pretoria, 187–212.

Seminara, G., Tubino M. (1989).

Altrernate bars and meandering: free, forced and mixed interactaions, in Ikeda S., Parkers G. (eds), *River Meandering*, Hoboken: Wiley, 267-320.

Seo, S. N., Mendelsohn R. (ed) (2006).

*Climate Change Impacts on Animal Husbandry in Africa: A Ricardian analysi*s, CEEPA Discussion Paper No. 9. Centre for Environmental Economics and Policy in Africa, Pretoria: University of Pretoria.

Shaikh Baikloo Islam, B., Chaychi Amirkhiz A., Al-Din Niknami K. (2020).

Late Holocene climatic events, the main factor of the cultural decline in North Central Iran during the Bronze Age, *Documenta Praehistorica* 470, 446-460.

Sharifi, A., Pourmand A., Canuel E. A., Ferer-Tyler E., Peterson L. C., Aichner B., Feakins S. J., Daryaee T., Djamali M., Naderi Beni A., Lahijani H. A. K., Swart P. K. (2015).

Abrupt climate variability since the last deglaciation based on a high-resolution, multi-proxy peat record from NW Iran: the hand that rocked the Cradle of Civilization?, *Quaternary Science Reviews* 123, 215-230.

Smith, D.G., Smith N.D. (1980).

Sedimentation in anastomosed river systems: examples from alluvial valleys near Banff, Alberta, *Journal of Sedimentary Petrology* 50, 157–164.

Sohn, H. G., Kim G. H., Yom J. H. (2004).

Mathematical modelling of historical reconnaissance CORONA KH-4B imagery, *The Photogrammetric Record* 19, 105, 51-66.

Spengler, R. N. (2015).

Agriculture in the Central Asian Bronze Age, *Journal of World Prehistory* 28, 215–253.

Spengler, R. N. (2019a).

Fruits from the Sand: The Silk Road Origins of the Foods We Eat, Oakland: University of California Press.

Spengler, R. N. (2019b).

Dung burning in the archaeobotanical record of West Asia: where are we now?, *Vegetation History and Archaeobotany* 28, 215–227.

Spengler, R. N., Willcox G. (2013).

Archaeobotanical results from Sarazm, Tajikistan, an Early Bronze Age village on the edge: agriculture and exchange, *Journal of Environmental Archaeology* 18 (3), 211–221.

Spengler, R. N., Frachetti M.D., Fritz G.J. (2013).

Ecotopes and herd foraging practices in the Bronze and Iron Age, steppe and mountain ecotone of Central Asia, *Journal of Ethnobiology* 33, 125–147.

Spengler, R. N., Cerasetti B., Tengberg M., Cattani M., Rouse L. M. (2014).

Agriculturalists and pastoralists: Bronze Age economy of the Murghab alluvial fan, southern Central Asia, *Journal of Vegetation History and Archaeobotany* 23 (6), 805- 820.

Spengler, R. N., Ryabogina N., Tarasov P. E., Wagner M. (2016).

The spread of agriculture into northern Central Asia: Timing, pathways, and environmental feedback, *The Holocene* 26 (10) 1527– 1540.

Spengler, R. N., de Nigris I., Cerasetti B., Carra M. L., Rouse L. M. (2018).

The breadth of dietary economy in Bronze Age Central Asia: Case study from Adji Kui 1 in the Murghab region of Turkmenistan, *Journal of Archaeological Science Reports* 22, 372–381.

Spengler, R. N., Ventresca Miller A., Schmaus T., Motuzaitė Matuzevičiūtė G., Miller B. K., Wilkin S., Treal Taylor W. T., Li Y., Roberts P., Boivin N. (2021).

An imagined past? Nomadic narratives in Central Asian archaeology, *Current Anthropology* 62 (3), 251-286.

Staubwasser, M., Sirocko F., Grootes P.M., Segl M., (2003).

Climate change at the 4.2 ka BP termination of the Indus valley civilization and Holocene south Asian monsoon variability, *Geophysical Research Letters* 30, 1425–1425.

Stein, A. (1921).

Air photography of ancient sites, *The Geographical Journal* 54 (3), 200.

Stein, A. (1938).

An Archaeological journey in Western Iran, *The Geographical Journal* 92 (4), 313-342.

Stein, A. (1940).

Surveys on the roman frontier in 'Iraq and Trans-Jordan, *The Geographical Journal* 95 (6), 428-438.

Steinkeller, P. (2001).

New light on the hydrology and topography of Southern Babylonia in the Third Millennium, *Zeitschrift für Assyriologie* 91, 22–84.

Steinkeller, P. (2006).

New Light on Marhaši and Its Contacts with Makkan and Babylonia, *Journal of Magan Studies* 1, 1– 17.

Steinkeller, P. (2007).

City and countryside in third-millennium southern Babylonia, in Stone E. C. (ed), *Settlement and Society: Essays Dedicated to Robert McCormick Adams*, Chicago: Oriental Institute of the University of Chicago, 185–211.

Steinkeller, P. (2016).

The role of Iran in the inter-regional exchange of metals: tin, copper, silver and gold in the second half of the Millennium BC, in Maekawa K. (ed), *Ancient Iran: New Perspectives from Archaeology and Cuneiform Studies, Proceedings of the International Colloquium held at the Center for Eurasian Cultural Studies, Kyoto University, December 6-7, 2014*, Kyoto: Kazuya Maekawa, 127– 150.

Stewart, C. E. (1881).

The Country of the Tekke Turkomans, and the Tejend and Murghab Rivers, Proceedings of the Royal Geographical Society and Monthly Record of Geography, Sep., 1881, 3 (9), 513-546.

Stokes, H., Mülder G., Jenkins E. (2011).

An investigation into the archaeological application of carbon Stable isotope analysis used to establish crop water availability: solutions and ways forward, in Mithen S., Black E. (eds), *Water, Life and Civilization: Climate, Environment, and Society in the Jordan Valley*, Cambridge: Cambridge University Press, 373–80.

Sumner, W. M. (1990).

An Archaeological sstimation of population trends Since 6000 BC in the Kur River Basin, Fars Province, Iran, in Taddei M., Callieri P. F. (eds), *South Asian Archaeology 1987*, Vol. I. Roma: IsMEO, 3–16.

Suslov, S. P. (1961).

Physical Geograpy of Asiatic Russia, San Francisco: W.H. Freeman and Company.

Tamburrino, A. (2010).

Water technology in ancient Mesopotamia, in Mays L. W. (ed), *Ancient Water Technologies*, Heidelberg: Springer, 29-52.

Taylor, C. (1973).

The Cambridgeshire Landscape: Cambridgeshire and the Southern Fens, London: Hodder & Stoughton.

Taylor, J., (2000).

Cultural depositional processes and post-depositional problems, in Franchovich R., Patterson H. (eds), *Extracting Meaning from Ploughsoil Assemblages*, Oxford: Oxbow Books, 16-28.

Tianduowa, Z., Woodson K.C., Ertsen M.W. (2018).

Reconstructing ancient hohokam irrigation systems in the middle gila river valley, Arizona, United States of America, *Human Ecology* 46, 735–746.

Tieszen, L. (1991).

Natural variations in the carbon isotope values of plants: implications for archaeology, ecology, and paleoecology, *Journal of Archaeological Science* 18: 227–48.

Tinney, S. (1999).

Ur-Namma the canal-digger: context, continuity and change in Sumerian literature, *Journal of Cuneiform Studies* 51, 31–54.

Tirsch, D. (2014).

Barchanoid ridge, in Hargitai H., Kereszturi Á. (ed), *Encyclopedia of Planetary Landforms*, Heidelberg: Springer, 2-14.

Tolstov, S. P. (1948).

Drevniy Khorezm, *Opyt istoriko-arkheologicheskogo issledovaniya*, Moskva: Sad, 73-82.

Tolstov, S. P. (1952).

Khorezminskaya arkheologo-etnograficheskaya ekspeditsiya AN SSSR (1945-1948 gg.), *Trudy Khorezmskoy arkheologo-etnograficheskoy ekspeditsii. To, 1 Arkheologicheskeie Etnograficheskeie Roboty Khorezmskoy Ekspeditsii* 1945-1948, Moskva: I T.A. Jdanko

Tolstov, S. P. (1960).

Result of the work of the koresmian archaeological and ethonographic expedition of the USSR Accademy of Science 1951-1956, *Journal of the Asia Society of Bombay* 33, 1-24.

Tolstov, S.P., Kes A.S. (1960).

Nizov'ja Amudari, Sarykamysh, Uzboj: istorija formirovanija i zaselenija. Materialy Khorezmskoj Ekspeditsii [Lower Amu Darya, Sarykamysh, Uzboi: history of their formation and of settlement], vol. III. Moscow: Nauka.

Toonen, W. H. J., Macklin M. G., Dawkes G., Durcan J. A., Leman M., Nikolayev Y., Yegorov A. (2020).

A hydromorphic revaluation of the forgotten river civilizations of Central Asia, *PNAS* 117 (52), 32982-32988.

Tosi, M., Cerasetti, B. (2010).

Once Upon a Time...a brief reflection on the History of "The Archaeological Map of the Murghab Delta (AMMD)" Project in relation to the fundamental role of V.I. Sarianidi, in Kozhin P. M., Kosarev M. F., Dubova N. A. (eds), *On the Track of Uncovering a Civilization. A volume in honour of the 80th-anniversary of Victor Sarianidi, Transactions of the Margiana Archaeological Expedition*, Sant Petersburg: Aletheia, 86-103.

Tsvetsinskaya, E. A., Vainbergw B.I., Glushkoz E.V. (2002).

An integrated assessment of landscape evolution, long-term climate variability, and land use in the Amudarya Prisarykamysh delta, *Journal of Arid Environments* 51, 363–381.

Udeumuradov, B. N. (1993).

Altyn-Depe i Margiana, *Svyazi, khronologiya, proiskhozhdenie,* Ashgabat: Ylym, 22-38.

Udeumuradov, B.N. (2002).

Ceramic Material from Gonur Depe Necropolis, in G. Rossi Osmida (ed), *Margiana: Gonur Depe Necropolis: 10 Years of Excavations by Ligabue Study and Research Centre,* Venice: Il Punto, 133–143.

Ur, J. A. (2002).

Settlement and landscape in northern Mesopotamia: the Tell Hamoukar Survey 2000-2001, *Akkadica* 123, 57-88.

Ur, J. A. (2003).

Corona satellite photography and ancient road networks: a northern Mesopotamian case study, *Antiquity* 77, 102–115.

Ur, J. A. (2005).

Sennacherib's northern Assyrian canals: new insights from satellite imagery and aerial photography, *Iraq* 67 (1), 317-345.

Ur, J. A. (2013).

CORONA Satellite imagery and ancient Near Eastern landscapes, in Comer D.C., Harrower M. J. (eds), *Mapping Archaeological Landscapes from Space,* Heidelberg: Springer, 21-31.

Ur, J. A., Wilkinson T.J. (2008).

Settlement and economic landscapes of Tell Beydar and its hinterland, in Lebeau M., Suleiman A. (eds), *Beydar Studies* I, Turnhout: Brepols, 305-327.

Ur, J. A., Reade, J. (2015).

The hydraulic landscape of Nimrud, *Mesopotamia* 50, 25-51.

Varushchenko, S. I., Varushchenko A. N., Klige R. K. (1987).

Izmenenija rezhima Kaspijskogo morja i besstochnikh vodoemov v paleovremeni, Moskva: Nauka.

Vepraskas, M. J., Lindbo D. L., Stolt M. H. (2018).

Redoximorphic features, in Stoops G., Marcelino V., Mees F. (eds), *Interpretation of Micromorphological Features of Soils and Regoliths*, Amsterdam: Elsevier, 425-445.

Vervoort, R.W.A., Annen Y.L. (2006).

Paleochannels in northern New South Wales: inversion of electromagnetic induction data to infer hydrologically relevant stratigraphy, *Australian Journal of Soil Research* 44, 35–45.

Vickery, R. (1995).

A Dictionary of Plant Lore, Oxford: Oxford University Press.

Vidale, M. (2017).

Treasures from the Oxus, London: I.B. Tauris & Co.

Vidale, M. (2018).

Irrigation and canals in ancient Iran, resurrecting Wittfogel?, in Calieri P., Rossi A. (eds), *Civiltà dell'Iran, Atti del Convegno Internazionale Roma 22-23 febbraio 2013*, Roma: Scienze e Lettere, 27-53.

Vinogradov, B. V. (1962).

Geograficheskie zakonomernosti dalneyshey ekstrapolyatsii priznakov deshifrirovaniya landshaftovanalogov, *Primenenie aerometodov dlya izucheniya gruntovykh vod*., Moskva: Sad.

Vinogradov, A. V., Mamedov E. D. (1975).

Pervobytnyj Ljavljakan, etapy drevnejshego zaselenija i osvoenija vnutrennikh Kyzylkumov, in Itina M.A (ed) *Materialy Khorezmskoj Ekspeditsii*, Vol. 10. Moskva: Nauka, 20-33.

Vinogradova, N. M. (2021).

The formation of the Oxus Civilization/BMAC in Southern Tajikistan, in Lyonnet B., Dubova N. A. (eds), *The World of the Oxus Civilization*, New York: Routledge, 535-664.

Vinogradova, N. M., Kuz'mina E. E. (1996).

Contacts between the steppe and agricultural tribes of Central Asia in the Bronze Age, *Anthropology & Archeology of Eurasia* 34, 29–54.

Vitkovskaya, T. P. (1990).

Takyrs as geomorphological elements of local runoff and their role in water balance of deserts, *Problems of Desert Development*, 6, 54–59.

Wallace, M., Charles M. (2013).

What goes in doesn't always come out: the impact of the ruminant digestive system of sheep on plant material, and its importance for the interpretation of dung-derived archaeobotanical assemblages, *Environmental Archaeology* 18,18–30.

Wallace, M., Jones G., Charles M., Fraser R., Halstead P., Heaton T. H., Bogaard A. (2013).

Stable carbon isotope analysis as a direct means of inferring crop water status and water management practices, *World Archaeology* 45 (3), 388-409.

Walling, D. E., Quine T.A., He Q. (1992).

Investigating contemporary rates of floodplain sedimentation, in Carling P.A., Petts G.E. (eds), *Lowland floodplain Rivers*, Chichester: Wiley, 165-184.

Wang, X., Guo Z., Wu L., Zhu C., He H. (2012).

Extraction of palaeochannel information from remote sensing imagery in the east of Chaohu Lake, China, *Frontiers of Earth Science* 6, 75–82.

Weiss, H. (2016).

Global megadrought, societal collapse and resilience at 4.2– 3.9 ka BP across the Mediterranean and West Asia, *Climate Change and Cultural Evolution* 24, 62–63.

Wendrich, W., Barnard H. (2008).

The archaeology of mobility: definition and research approache, in Barnard H., Wendrich W. (eds), *The Archaeology of Mobility: Old World and New World Nomadism*, Los Angeles: Cotsen Institute of Archaeology at UCLA, 1-21.

Widdel, M., Hritz C., Ur J., Wilkinson T. J. (2013).

Land use of the model communities, in Wilkison T. J., Gibson M., Widell M. (eds). *Models of Mesopotamian Landscapes. How Small-Scale Processes Contributed to the Growth and Early Civilizations*, Oxford: Archeopress, 56-80.

Widera, M., Kowalaska E., Fortuna M. (2017).

A Miocene anastomosing river system in the area of Konin Lignite Mine, central Poland, *Annales Societatis Geologorum Poloniae* 87, 157–168.

Widera, M., Chomiak L., Zielińsky T. (2019).

Sedimentary processes and paleochannel pattern of an anastomosing river system: an example from the upper Neogene of Central Poland, *Journal of Sedimentary Research* 89, 487–507.

Wilkinson, T. J. (1982).

The Definition of ancient manured zones by means of extensive sherd sampling techniques, *Journal of Field Archaeology* 9, 323-33.

Wilkinson, T. J. (1989).

Extensive sherd scatters and land-use intensity: some recent results, *Journal of Field Archaeology* 16, 31-46.

Wilkinson, T. J. (2003).

Archaeological Landscapes of the Near East, Tucson: University of Arizona Press.

Wilkinson, T. J. (2014).

A perspective on the "continuous landscape" of the Murghab Region, in Lamberg-Karlowsky C. C., Genito B., Cerasetti B. (eds), *'My Life is like the Summer Rose' Maurizio Tosi e l'Archeologia come Modo di Vivere: Papers in Honour of Maurizio Tosi for his 70th birthday*, Oxford: BAR, 105-114.

Wilkinson, T. J., Tucker, D. J. (1995).

Settlement Development in the North Jazira, Iraq. A study of the Archaeological Landscape, Warminster: Aris Phillips.

Wilkinson, T. J., Ur J. A., Casana J. (2004).

From nucleation to dispersal: trends in settlement pattern in the northern fertile crescent, in Cherry J., Alcock S. (eds), *Side-by-Side Survey: Comparative Regional Studies in the Mediterranean World*, Oxford: Oxbow Books, 198-205.

Wilkinson, T. l, Gibson M., Christians J. H., Widen M., Schloen D., Kouchoukos N., Woods C., Sanders l., Simunich K.L., Altaweel M., Ur J. A., Hritz C., Lauinger J., Paulette T., Tenney J. (2007).

Modelling settlement systems in a dynamic environment: case studies from Mesopotamia, in Kohler T. A., van der Leeuw S. E. (eds), *The Model-Based Archaeology of Socionatural Systems*, Santa Fe: School for Advanced Research Press, 175-208.

Wilkinson, T. J., Rayne L. (2010).

Hydraulic landscapes and imperial power in the Near East, *Water History* 2 (2), 115–144.

Wilkinson, T.J., French C., Ur, J., Semple M. (2010).

The geoarchaeology of route systems in northern Syria, *Geoarchaeology* 25, 745–771.

Wilkinson, T. J., Boucharlat R., Ertsen M.W., Gillmore G., Kennet D., Magee P., Rezakhani K., De Schacht T. (2012).

From human niche construction to imperial power: long-term trends in ancient Iranian water systems, *Water History* 4, 155–176.

Wilkinson, T. J., Christiansen J., Altaweel M., Widell M. (2013a).

Output from the agent-based modelling program, in Wilkinson T. J., Gibson M., Widell M. (eds), *Model of Mesopotamian Landscapes: How Small-Scale Processes Contributed to the Growth of Early Civilizations*, Oxford: Archeopress, 177-203.

Wilkison, T. J., Gibson M., Widell M. (2013b).

Models of Mesopotamian Landscapes. How Small-Scale Processes Contributed to the Growth and Early Civilizations, Oxford: Archeopress.

Wilkinson, T. J., Rayne L., Jotheri J. (2015).

Hydraulic landscapes in Mesopotamia: the role of human niche construction, *Water History* 7, 397–418.

Willcox, G. (1989.)

Étude archéobotanique, in Francfort H-P (ed) *Fouilles de Shortughaï, recherches sur l'Asie Centrale protohistorique (Mémoires de la Mission Archéologique Française en Asie Centrale 2*) vol. 1, Paris: Editions de Boccard, 175–185.

Williams, T. J. (2012).

Unmanned aerial vehicle photography: exploring the medieval city of Merv, on the Silk Roads of Central Asia, *Archaeology International* 15, 54-68.

Williams, T. J. (2018).

Flowing into the city: approaches to water management in the early Islamic city of Sultan Kala, Turkmenistan, in Zhuang Y., Altaweel M. (eds), *Water Societies and Technologies from the Past and Present*, London: UCL Press, 157-179.

Winkelmann, S. (2014).

Trading religions from Bronze Age Iran to Bactria, in Wick P., Rabens V. (eds), *Religion and Trade. Religious Formation, Transformation and Cross-Cultural Exchange between East and West*, Leiden: Brill, 199-232.

Winterhalder, B. (1980).

Environmental analysis in human evolution and adaptation research, *Human Ecology* 8 (2), 135–70.

Witzel, M. (2015).

Water in Mythology, *Dædalus, the Journal of the American Academy of Arts & Sciences*, 18-26.

Wossink, A. (2009).

Challenging Climate Change: Competition and Cooperation among Pastoralists and Agriculturalists in Northern Mesopotamia (c. 3000-1600 BC), Leiden: Sidestone Press.

Wright, J. (2008).

Non-graphic information systems and diachronic transnformations in Margiana, in Salvatori S., Tosi M., Cerasetti B. (eds) *The Bronze Age and Early Iron Age in the Margiana Lowlands: Facts and methodological proposals for a redefinition of the research strategies*, Oxford: BAR, 47-56.

Xu, Q., Shi W., Xie X., Zhang C., Manger W. L., Wang J., Rao S. (2019).

Multichannel systems in an ancient river-dominated delta: case study of the lower Yanchang Formation, southwest Ordos Basin, China, *Canadian Journal of Earth Sciences* 56 (10), 1027-1040.

Yacoub, S. (2011).

Geomorphology of the Mesopotamia floodplain, *Iraqi Bulletin of Geology and Mining* 4, 7-32.

Yoffee, N. (1997).

Robert McCormick Adams: An archaeological biography, *American Antiquity* 62 (3), 399-413.

Yonechi, F., Maung W. (1986).

Subdivision on the anastomosing river channel with a proposal of the irrawaddy type, *The Science Reports of the Tohoku University* 36 (2), 102–113.

Zaina, F. (2019).

A risk assessment for cultural heritage in southern Iraq: framing drivers, threats and actions affecting archaeological sites, *Conservation and Management of Archaeological Sites* 21, 184-206.

Zonn, I. S. (2014).

Karakum canal: artificial river in a Desert, in. Zonn I. S., Kostianoy A. G. (eds), *The Turkmen Lake Altyn Asyr and Water Resources in Turkmenistan*, Heidelberg: Springer, 96-106.

Appendices

- *Appendix 1*

Table 1.1. Paleochannel traces in the Ojakly area were identified through remote sensing analysis. When these traces are likely part of the same channel, they have been grouped under a single paleochannel number (Paleochannel #).

Paleochannel Traces #	**Paleochannel #**	**Characteristics:** RA (Research Area)
OJK_Ch_IXa OJK_Ch_IXb	Paleochannel 1	The paleochannel traces are located to the east of the RA. Additionally, OJK_Ch_IXb is situated next to OJK_Ch9, just a few meters away. It is likely that OJK_Ch_IXb represents the result of an avulsion process.
OJK_Ch_X	Paleochannel 2	
OJK_Ch_XIa OJK_Ch_XIb OJK_Ch_XIc	Paleochannel 3	The paleochannel traces of OJK_Ch_XIa, OJK_Ch_XIb, and OJK_Ch_XIc are located in the central-eastern part of the RA. They are interconnected and likely represent different stages of the same channel.
OJK_Ch_XIIIa	Paleochannel 4	The paleochannel trace is located 100 m west of OJK_Ch_XIIIb on the center-north of the RA.
OJK_Ch_XIIIb OJK_Ch_XIIIc	Paleochannel 5	The paleochannel traces OJK_Ch_XIIIb and OJK_Ch_XIIIc are located in the north-central part of the RA. Both traces likely represent the same channel.
OJK_Ch_XIV	Paleochannel 6	The small paleochannel trace is located in the center-north of the RA. Considering its flow direction, it may have been connected to OJK_Ch_XXIV.
OJK_Ch_XXIV	Paleochannel 7	The paleochannel traces are located in the center-north of the RA. Their position just north of OJK_Ch_XIV might suggest that they were part of the same paleochannel.
OJK_Ch_I	Paleochannel 8	The paleochannel trace, OJK_Ch_I, is located in the

		center-east of the RA. It is one of the main channels east of Ojakly
OJK_Ch_IIa OJK_Ch_IIb OJK_Ch_IIc	Paleochannel 9	The paleochannel trace OJK_Ch_IIa is located in the center of the RA. Traces OJK_Ch_IIb and OJK_Ch_IIc could be interpreted as resulting from the avulsion process. Considering the flow direction, it might be possible that they were part of the same paleochannel, along with OJK_Ch_XXVII to the north.
OJK_Ch_IVa	Paleochannel 10	The paleochannel trace of OJK_Ch_IVa represent the largest paleochannel trace in the RA and is located in the central area.
OJK_Ch_IIII	Paleochannel 11	The paleochannel trace OJK_Ch_IIII represents an isolated meander trace located south of Ojakly in the central area of the RA.
OJK_Ch_IVb OJK_Ch_IVc	Paleochannel 12	The paleochannel traces of OJK_Ch_IVb and OJK_Ch_IVc are located in the central-south area of the RA, partially crossing OJK_Ch_IVa. it is likely they were part of the same paleochannel representing an avulsion process.
OJK_Ch_Va OJK_Ch_Vb	Paleochannel 13	The paleochannel traces OJK_Ch_Va and OJK_Ch_Vb are located in the center-west area of the RA. Their position and the continuity of the traces suggest that they were part of the same paleochannel.
OJK_Ch_Vc	Paleochannel 14	The paleochannel trace OJK Ch5c is a small trace east of OJK_Ch_Va.
OJK_Ch_VI	Paleochannel 15	Paleochannel trace OJK_Ch_VI, together with OJK_Ch4, is one of the longest paleochannel traces detected in the RA. It is considered one of the channels

		that supplied water to the Late Bronze Age site of Auchin 1. Considering its position and flow direction, it might have been connected with OJK_Ch_Vb, forming a single paleochannel.
OJK_Ch_VIIa OJK_Ch_VIIb OJK_Ch_VIIc	Paleochannel 16	The paleochannel traces of OJK_Ch_VIIa, 7b, and 7c are located in the center-northwest of the RA. The flow direction of the paleochannels and their close proximity suggest that they were part of the same channel, likely formed through an avulsion process. Moreover, considering their positions, they may have been part of the same channel as OJK_Ch_VIIIa and 8b to the south.
OJK_Ch_VIIIa OJK_Ch_VIIIb	Paleochannel 17	The paleochannel traces of OJK_Ch_VIIIa and 8b are located in the center-northwest of the RA. The flow direction of the paleochannels and their close proximity suggest that they were part of the same channel, likely formed through an avulsion process. Moreover, considering their positions, they may have been part of the same channel as OJK_Ch_VIIa and 7b to the north.
OJK_Ch_XVIII	Paleochannel 18	The meandering paleochannel trace of OJK_Ch_XVIII is located to the east of the RA. Considering its flow direction, it might have been connected with OJK_Ch_XVII, forming part of the same channel.
OJK_Ch_XVII	Paleochannel 19	The paleochannel trace of OJK_Ch_XVII is located to the east of the RA, and it is north of OJK_Ch_XVIII. Both traces, OJK_Ch_XVII and OJK_Ch_XVIII, might have been part of the same channel.

OJK_Ch_XIX	Paleochannel 20	The small trace, OJK_Ch_XIX, is located southwest of the RA. However, a long trace of what appears to be a paleochannel to the south is visible on CORONA images, though it is of modern origin.
OJK_Ch_XXa OJK_Ch_XXb OJK_Ch_XXc	Paleochannel 21	The paleochannel trace OJK-Ch20 is located on the north-east of the RA.
OJK_Ch_XXI	Paleochannel 22	The paleochannel trace OJK_Ch_XXI is located in the northeast of the RA. Considering the flow direction, this channel likely supplied water to the Late Bronze Age site of Auchin 1.
OJK_Ch_XXIIa OJK_Ch_XXIIb	Paleochannel 23	The two small paleochannel traces, OJK_Ch_XXIIa and OJK_Ch_XXIIb, are located in the northeast of the RA. OJK_Ch_XXIIa is situated to the north of OJK_Ch_XXIIb, and considering the flow direction, they may have been part of the same channel. Moreover, the flow direction of the paleochannel traces suggests that they carried water to the Late Bronze Age site of Auchin 1. Interestingly, OJK_Ch_XXIIa presents the only possible traces of small artificial canals used for irrigation.
OJK_Ch_XXIII	Paleochannel 24	The paleochannel trace of OJK_Ch_XXIII is located north-east of the RA. Its flow direction suggests it was taking water to the Late Bronze Age site of Auchin 1.
OJK_Ch_XXIV	Paleochannel 25	The paleochannel trace of OJK_Ch_XXIV is located on the north-west of the RA.
OJK_Ch_XXVI	Paleochannel 26	The paleochannel trace OJK_Ch_XXVI is a trace locate on the north-east of the RA.
OJK_Ch_XXVII	Paleochannel 27	The paleochannel trace of

		OJK_Ch_XXVII is located in the center of the RA and is the closest paleochannel trace east of Ojakly. Considering the flow direction, it might have been connected with OJK_Ch_XIIa and OJK_Ch_XIIb.
OJK_Ch_XIIa OJK_Ch_XIIb	Paleochannel 28	The paleochannel traces OJK_Ch_XIIa and OJK_Ch_XIIb are located in the center of the RA. The location and flow direction of these traces suggest that they were part of the same paleochannel, possibly formed through an avultion process. Moreover, the flow direction suggests that this paleochannel may have been connected with OJK_Ch_XXVII.

Table 1.2 The table presents the sites recorded in the Ojakly Area by this project.

Site number and Type	Survey Area	Paleochannel	Distance from the paleochannel	Chronology	Size
1747 Large Cluster	Area 11	Paleochannel 10 and Paleochannel 27	650 meters	LBA	0.5–1 ha

Description

Site 1747 lies equidistant between Paleochannel 10 and Paleochannel 27, approximately 650 meters from each. This site, spanning roughly 1 hectare, stands out for its slightly elevated terrain hosting a concentration of pottery, marking it as a Large Cluster site. Notably absent is any sign of a takyr surface, with the area characterized by sparse vegetation featuring small shrubs and saxsaul trees. In contrast to nearby Site 1748, no kiln fragments remnants were uncovered, nor were there any traces of architectural structures. Its position atop a modest rise suggests a potentially more enduring or seasonally occupied settlement.

Photo

Site number and Type	Survey Area	Paleochannel	Distance from the paleochannel	Chronology	Size
1748 Large Cluster	Area 11	Paleochannel 10	310 meters	LBA	0.5–1 ha

Description

Site No. 1748 is designated as a Large Cluster site situated atop a gently elevated terrain. A distinct feature of this site is the presence of kiln fragments scattered across its expanse, indicating a zone of pottery production. Additionally, both ICW (Andronovo) pottery and BMAC pottery have been found here. These findings strongly suggest a more enduring occupation, likely associated with its proximity to the channel.

Photo

Site number and Type	Survey Area	Paleochannel	Distance from the paleochannel	Chronology	Size
1749 Small Cluster	Area 11	Paleochannel 10	190 meters	LBA	0.1–0.5 ha

Description

Site 1749, classified as a Small Cluster site, sits across from Site 1750 on the left bank of Paleochannel 10, approximately 190 meters from its former bank. Encompassing around 0.1-0.5 hectares, the site features a flat sand-takyr surface. Notably, the assemblages found here exhibit less fragmentation compared to other sites, potentially indicating less erosional processes. It has been suggested elsewhere that the presence of small fragmented materials may signal significant aeolian processes (Markofsky 2010:172).

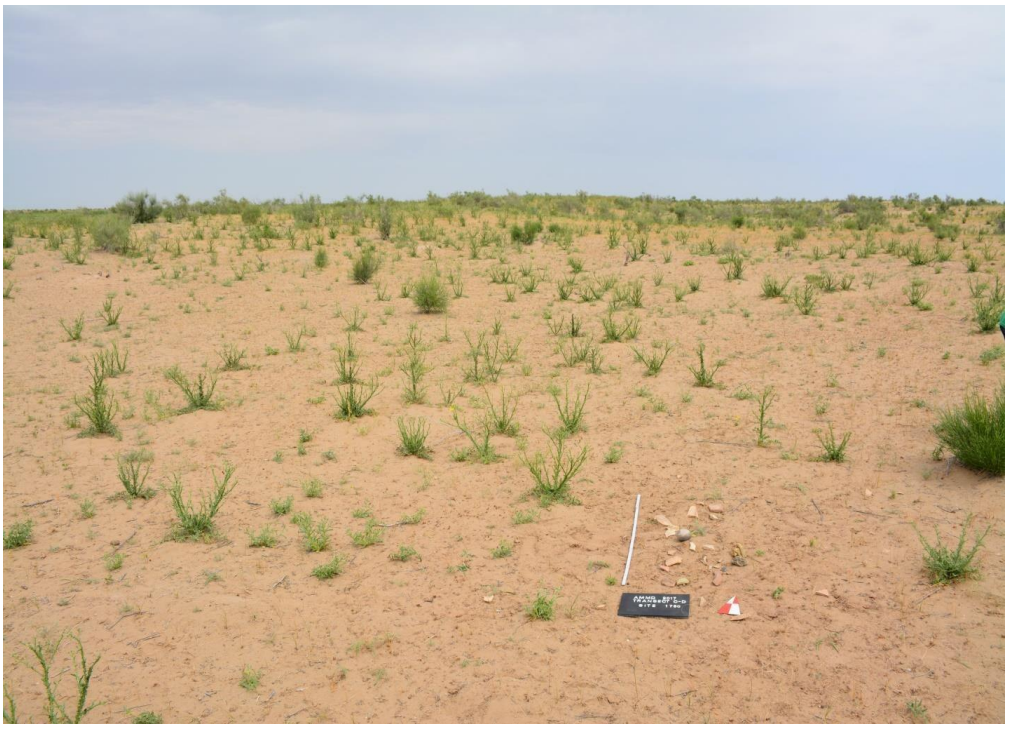
Photo

Site number and Type	Survey Area	Paleochannel	Distance from the paleochannel	Chronology	Size
1750 Large Cluster	Area 11	Paleochannel 10	150 meters	MBA-LBA	0.5–1 ha

Description

Site 1750 was discovered on the right bank of Paleochannel 10, around 150 meters from its former bank. Positioned on a slightly elevated terrain, this site was designated as a Large Cluster. It is distinguished by the concentration of pottery within an area with sparse vegetation. Notably, there are no takyr surfaces present, and no signs of potential permanent structures were observed.

Photo



Site number and Type	Survey Area	Paleochannel	Distance from the paleochannel	Chronology	Size
1751 Small Cluster	Area 11 Area 10	Paleochannel 13	300 meters	LBA	0.1–0.5 ha

Description

Site 1751 is a Small Cluster site situated roughly 300 meters to the left of Paleochannel 13. The pottery is predominantly scattered across a flat takyr surface, sparsely vegetated and covering an area of approximately 0.1-0.5 hectares. Apart from the pottery cluster, no other evidence was discovered. It is noteworthy that Site 1751, along with sites 1753 and 1752, are all located within 500 m from Paleochannel 13. Interestingly, this site also features ICW (Andronovo) pottery.

Photo

Site number and Type	Survey Area	Paleochannel	Distance from the paleochannel	Chronology	Size
1752 Small Cluster	Area 11 Area 10	Paleochannel 13	90 meters	LBA	0.1–0.5 ha

Description

Site 1752 is a Small Cluster site positioned in a gently elevated and sparsely vegetated region, approximately 90 m to the left of the paleomeander of Paleochannel 13. A notable concentration of pottery was found within small interdunal depressions at this site. Remarkably, there were no takyr surfaces linked to this area.

Photo

Site number and Type	Survey Area	Paleochannel	Distance from the paleochannel	Chronology	Size
1753 Low Mound	Area 11 Area 10	Paleochannel 13	125 meters	MBA-LBA	1-2 ha

Description

Site 1753 is located approximately 125 meters to the west of paleochannel 13, and at 250 meters distance from site 1752. Both sites, 1752 and 1753, were located along paleochannel 13. The site cover approximately 1-2 hectares, within an elevated area with a takyr surface at the edges. The site was identified by the large amount of pottery covering almost the entire area. No structures, bricks, or any kiln fragments were recorded that might suggest the presence of a production area. However, the size of the area might suggest a more permanent occupation like farmstead linked to agricultural activities, rather than a very short-term occupation.

Photo

Site number and Type	Survey Area	Paleochannel	Distance from the paleochannel	Chronology	Size
1754 Small Cluster	Area 10	Paleochannel 13	30 meters	LBA	0.1-0.5 ha

Description

Site 1754 is a Small Cluster situated within an interdunal region. It features a small sand-takyr surface and pottery spread across an area of approximately 0.1-0.5 hectares. Located roughly 30 meters from Paleochannel 13, the site likely served as a temporary occupation site, possibly utilized for herding or small-scale agricultural activities.

Photo

Site number and Type	Survey Area	Paleochannel	Distance from the paleochannel	Chronology	Size
1755 Small Cluster	Area 10	Paleochannel 13	200 meters	LBA	0.1-0.5 ha

Description

Site 1755 is a Small Cluster site positioned approximately 200 meters from Paleochannel 13. It is distinguished by the presence of pottery scattered across a vegetated area populated with small shrubs and saxaul trees, covering an area of about 0.1-0.5 hectares.

Photo

Site number and Type	Survey Area	Paleochannel	Distance from the paleochannel	Chronology	Size
1766 Large Cluster	Area 10 Area 11	Paleochannel 13	40 meters	LBA	0.5-1 ha

Description

Site 1766 occupies a slightly elevated terrain roughly 40 meters from Paleochannel 13. It was identified as a Large Cluster spanning approximately 0.5-1 hectare, notable for a substantial pottery concentration similar to Site 1749, albeit with less fragmented pottery. Notably, numerous kiln wasters are scattered throughout the area. Despite this, no discernible kiln structures were identified on the surface. Nevertheless, it is probable that pottery kilns were present in the vicinity.

Photo

Site number and Type	Survey Area	Paleochannel	Distance from the paleochannel	Chronology	Size
1767 Small Cluster	Area 9	Paleochannel 13	190 meters	LBA	0.1-0.5 ha

Description

Site 1767 is a Small Cluster site positioned roughly 190 meters from Paleochannel 13, situated on the edge of an agricultural zone at the time of the survey. This site is marked by a concentration of pottery on an uncultivated takyr surface. While the site covers approximately 0.1-0.5 hectares, it is possible that a portion of it has been impacted by agricultural activities. Notably, Site 1767 exhibits evidence of both ICW (Andronovo) pottery and BMAC pottery assemblage.

Photo

Site number and Type	Survey Area	Paleochannel	Distance from the paleochannel	Chronology	Size
1768 Small Cluster	Area 6	Paleochannel 28	80 meters	LBA	0.1-0.5 ha

Description

Site 1768 is a Small Cluster site positioned roughly 80 meters from Paleochannel 28. It is notable for the dispersion of pottery across a sparsely vegetated takyr surface spanning approximately 0.1-0.5 hectares. Interestingly, the pottery at this site exhibits less fragmentation compared to other sites in the vicinity.

Photo

Table 1.3. The table provides a description of the west and south profiles of the test trench excavated in Paleochannel 13, located in the Ojakly area.

Unit number*	
West Profile Trench (Paleochannel 13) Ojakly Area	
1	The first unit layer is characterized by a clay-silt loam (takyr surface) of grayish color (10YR 6/1) of ca. 15 cm.
2	Between -15 and -50 cm there is a silty-sand layer (10YR 6/3) with visible cross-lamination.
3	Between -24 and -48 cm a small silt unit layer (10YR 8/2).
4	Between -50 and -60 cm there is a small layer of silt (10YR 5/6).
5	Between -60 and -87 cm there is a unit layer of sand (10YR 8/4) with visible ripple cross-bedding.
6	Between -87 and -115 cm there is a unit layer of silt (10YR 7/3)
7	Between -110 and -115 cm, mainly on the north side of the profile there is a unit of reddish silt layer different in color (5YR 6/8) from the preceding one.
8	Between -115 and -140 cm there is a unit layer of silt (10YR 7/3) that shows wave cross-lamination.
9	Between -140 and -170 there is a compact clay unit layer (10YR 7/2) characterized by aggregation of sediments of ca. 2-3 cm.
10	Between -170 and -180 cm there is a small unit layer of silty sand (10YR 7/1).
11	Between -180 and -228 cm there is a compact unit layer of silty clay (10YR 5/6).
South Profile Trench (Paleochannel 13) Ojakly Area	
1	The first unit layer is characterized by a clay-silt loam (takyr surface) of grayish color (10YR 6/1) of ca. 15 cm.
2	Between -15 and -24 cm there is a sloping silty-sand unit layer (10YR 6/3) of ca. 9cm towards the west side of the profile.
3	Between -24 and -49 cm there is a well-sorted silt unit layer (10YR 8/2).
4	Small inclusion unit layer of ca. 3 cm characterized by silty sand (10YR 8/3).
5	Small inclusion unit layer of ca. 5 cm characterized by well-sorted silt layer (10YR 8/2).
6	Small unit layer of ca. 3 cm characterized by very darker silt (5YR 6/6).
7	Between -60 and -85 cm there is a sand unit layer (10YR 6/6) with visible ripple cross-bedding.
8	Between -85 and -165 cm there is a large unit layer of silt (5YR 5/6) with the inclusion of charcoal at about ca. -95 cm.
9	Between -140 and -165 cm there is a compact clay unit layer (10YR 7/2)
10	Between -165 and -175 cm there is a small unit layer of light color silty sand (10YR

	8/3)
11	Between -168 and -175 cm, only on the west side of the profile, there is a small inclusion of silt layer (10YR 7/3).
12	Between -175 and -228 cm there is a compact silty clay unit (10YR 5/6)

*Refer to Figures 5.45 and 5.46 in Chapter 5 for the unite numbers

**From this layer an OSL sample was taken.

- ***Appendix 2***

Table 2. The table present the overview of the OSL results from Ojakly and Togolok trenches.

Sample code	Depth (cm)	Mineral	Grain size (μm)	$n_{accepted}/n_{total}$	D_{total} (Gy ka^{-1})	OD (%)[+]	D_e IR_{50} (Gy)	D_e $pIRIR_{150}$ (Gy)	$D_{e\_corrected}$ IR_{50} (Gy)*	$D_{e\_corrected}$ $pIRIR_{150}$ (Gy)*
OJK18-1	76	F	63-100	12/12	2.9 ± 0.1	27.2 ± 5.7	9.9 ± 0.3	18.8 ± 1.5	12.6 ± 0.3	21.4 ± 1.7
OJK18-2	123	PM	4-11	7/7	3.6 ± 0.2	-	11.3 ± 0.2	19.0 ± 0.4	14.4 ± 0.2	21.7 ± 0.4
OJK18-3	202	PM	4-11	7/7	4.1 ± 0.2	-	12.4 ± 0.2	26.0 ± 0.6	15.9 ± 0.2	30.0 ± 0.5
OJK18-4	255	F	100-150	12/12	3.1 ± 0.2	8.8 ± 2.1	10.1 ± 0.2	17.9 ± 0.5	12.9 ± 0.3	20.3 ± 0.6
TGK18-1	72	F	63-100	12/12	2.9 ± 0.1	8.3 ± 2.1	11.9 ± 0.2	24.3 ± 0.7	16.3 ± 0.3	29.3 ± 0.8
TGK18-2	142	PM	4-11	7/7	4.1 ± 0.2	-	15.3 ± 0.2	54.2 ± 1.4	21.0 ± 0.3	68.6 ± 1.7
TGK18-3	184	F	150-250	12/12	3.1 ± 0.1	6.9 ± 1.8	13.5 ± 0.3	19.3 ± 0.4	18.5 ± 0.4	23.0 ± 0.5

Sample code	Grain size (μm)	D_{total} (Gy ka^{-1})	OD (%)[+]	D_e IR_{50} (Gy)	D_e $pIRIR_{150}$ (Gy)	$D_{e\_corrected}$ IR_{50} (Gy)*	$D_{e\_corrected}$ $pIRIR_{150}$ (Gy)*	Age IR_{50} (ka)	Age $pIRIR_{150}$ (ka)	$Age_{corrected}$ IR_{50} (ka)*	$Age_{corrected}$ $pIRIR_{150}$ (ka)*
OJK18-1	63-100	2.9 ± 0.1	27.2 ± 5.7	9.9 ± 0.3	18.8 ± 1.5	12.6 ± 0.3	21.4 ± 1.7	3.4 ± 0.2	6.4 ±0.6	4.3 ±0.1	7.4 ±0.6
OJK18-2	4-11	3.6 ± 0.2	-	11.3 ± 0.2	19.0 ± 0.4	14.4 ± 0.2	21.7 ± 0.4	3.2 ± 0.2	5.4 ±0.3	4.0 ±0.1	6.1 ±0.2
OJK18-3	4-11	4.1 ± 0.2	-	12.4 ± 0.2	26.0 ± 0.6	15.9 ± 0.2	30.0 ± 0.5	3.0 ± 0.2	6.4 ±0.4	3.9 ±0.1	7.3 ±0.2
OJK18-4	100-150	3.1 ± 0.2	8.8 ± 2.1	10.1 ± 0.2	17.9 ± 0.5	12.9 ± 0.3	20.3 ± 0.6	3.3 ± 0.2	5.8 ±0.4	4.2 ±0.1	6.6 ±0.2
TGK18-1	63-100	2.9 ± 0.1	8.3 ± 2.1	11.9 ± 0.2	24.3 ± 0.7	16.3 ± 0.3	29.3 ± 0.8	4.1 ± 0.2	8.3 ±0.4	5.6 ±0.1	10.1 ±0.3
TGK18-2	4-11	4.1 ± 0.2	-	15.3 ± 0.2	54.2 ± 1.4	21.0 ± 0.3	68.6 ± 1.7	3.8 ± 0.2	13.3 ±0.7	5.1 ±0.2	16.8 ±0.5
TGK18-3	150-250	3.1 ± 0.1	6.9 ± 1.8	13.5 ± 0.3	19.3 ± 0.4	18.5 ± 0.4	23.0 ± 0.5	4.3 ± 0.2	6.2 ± 0.3	6.0 ±0.1	7.4 ±0.2

[+] Overdispersion of $pIRIR_{150}$ D_e values.

* g-values of 3.0 ± 1.0 ($pIRIR_{(50)}$) and 1.6 ± 1.2 ($pIRIR_{150}$) were used for OJK and 2.4 ± 0.9 ($pIRIR_{(50)}$) and 1.2 ± 1.2 ($pIRIR_{150}$) TGK. Correction following Lamothe et al. 2003.

D_e values are calculated using the Central Age Model (Galbraith 1999).

Sample code	Depth (cm)	WC field* (%)	WC used* (%)	Radionuclide concentrations U (ppm)	Th (ppm)	K (%)	D_{cosmic} (Gy ka^{-1})	D_{total} F and PM# (Gy ka^{-1})
OJK18-1	76	1.9	5 ± 3	1.7 ± 0.3	6.2 ± 0.4	1.6 ± 0.1	0.19 ± 0.02	2.9 ± 0.1
OJK18-2	123	3.0	5 ± 3	1.8 ± 0.3	7.5 ± 0.5	1.8 ± 0.2	0.18 ± 0.02	3.6 ± 0.2
OJK18-3	202	10.9	10 ± 5	2.3 ± 0.4	9.4 ± 0.6	2.3 ± 0.2	0.17 ± 0.02	4.1 ± 0.2
OJK18-4	255	2.3	5 ± 3	1.9 ± 0.3	6.0 ± 0.4	1.8 ± 0.2	0.16 ± 0.02	3.1 ± 0.2
TGK18-1	72	1.0	5 ± 3	1.9 ± 0.2	6.7 ± 0.4	1.5 ± 0.1	0.20 ± 0.02	2.9 ± 0.1
TGK18-2	142	7.2	10 ± 5	3.0 ± 0.4	9.3 ± 0.6	2.3 ± 0.1	0.18 ± 0.02	4.1 ± 0.2
TGK18-3	184	1.0	5 ± 3	1.7 ± 0.2	6.9 ± 0.5	1.7 ± 0.1	0.17 ± 0.02	3.1 ± 0.1

* Water content as measured in the field and as used for D_e determination.
# Alpha efficiency of 0.05 ± 0.01 and potassium content of 12.5 ± 0.5 % were assumed.

- ***Appendix 3***

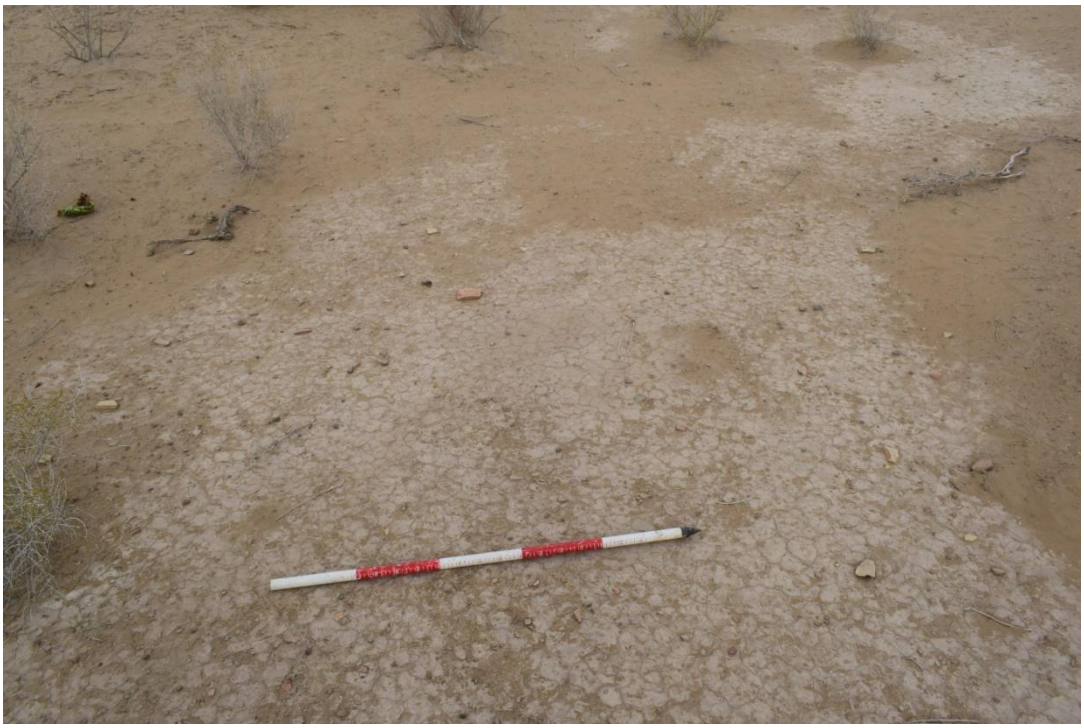
Table 3.1 Paleochannel traces in the Togolok area were identified through remote sensing analysis. When these traces are likely part of the same channel, they have been grouped under a single paleochannel number (Paleochannel #).

Paleochannel Traces #	**Paleochannel #**	**Characteristics:** RA (Research Area)
TGK1_Ch_XIVa TGK1_Ch_XIVb	Paleochannel 1	TGK1_Ch_XIVa is the longest paleochannel trace, located approximately 1.8 km west of Togolok 1. Another small paleochannel trace (TGK1_Ch_XIVb) is situated on the southwest side of TGK1_Ch_XIV and exhibits evidence of a channel bar, suggesting it may have been part of the same paleochannel at an earlier stage.
TGK1_Ch_II TGK1_Ch_III	Paleochannel 2	The paleochannel trace TGK1_Ch_II is approximately 500m from Togolok 1 and is the main paleochannel trace discovered in the RA. The second smallest trace, TGK1_Ch_III, is located 100m east of TGK1_Ch_II. It may represent an old river channel migration.
TGK1_Ch_IV	Paleochannel 3	TGK1_Ch_IV is a small river trace located southwest of Togolok 1. Based on its flow direction, it likely passed on the west side of Togolok 1.
TGK1_Ch_V	Paleochannel 4	The TGK1_Ch_V trace is located 410m southeast of Togolok 1 and was currently part of a cultivated takyr.
TGK1_Ch_VI TGK1_Ch_VIII	Paleochannel 5	TGK1_Ch_VI is located just 50m from TGK1_Ch_V, and its trace passes on the west side of Togolok 1 (Tepe 2) and seems to be connected to TGK1_Ch_VIII.
TGK1_Ch_VII	Paleochannel 6	TGK1_Ch_VII is a small paleochannel trace located 500m south-east of Togolok 1 (Tepe 2).
TGK1_Ch_IX	Paleochannel 7	TGK1_Ch_IX is located 600m from Togolok 1
TGK1_Ch_X*	Paleochannel 8	TGK1_Ch_X is located southeast of TGK1_Ch_IX and intersects the latter. Therefore, it could be a later channel.
TGK1_Ch_XI	Paleochannel 9	TGK1_Ch_XI is located 1300m to the east of Togolok 1.

TGK1_Ch_XII	Paleochannel 10	TGK1_Ch_XII is the eastern paleochannel of the Togolok Area, and it appears to flow towards a modern cultivated area to the northeast.
TGK1_Ch_XIII	Paleochannel 11	TGK1_Ch_XIII is a small paleochannel trace on the south-east of Togolok 1.

*Although the present paleochannel was identified via satellite images, it was not possible to verify its structure on the ground.

Table 3.2. The Tables present the sites recorded in Togolok Area by this project

Site number and Type	Survey Area	Paleochannel	Distance from the paleochannel	Chronology	Size
1756 Large Cluster	Area 2	Paleochannel 7	86 meters	LBA	0.5-1 ha
Description Site 1756 is situated in the central-northern are of Paleochannel 7, along its left former bank. It features a gently flat surface scattered with a significant collection of scattered pottery. The surface is distinguished by takyr, surrounded by sandy soil.					
Photo 					

Site number and Type	Survey Area	Paleochannel	Distance from the paleochannel	Chronology	Size
1757 Low Mound	Area 2	Paleochannel 7	55 meters	LBA	1-2 ha

Description

Site 1757 is situated in the northern section of Paleochannel 7 and stands out for the significant presence of scattered pottery on a small, elevated area. Furthermore, various traces of kiln fragments along with pottery were discovered. The surroundings are marked by sandy takyr surfaces.

Photo

Site number and Type	Survey Area	Paleochannel	Distance from the paleochannel	Chronology	Size
1758 Small Cluster	Area 2	Paleochannel 7	32 meters	LBA	0.1-0.5 ha

Description

Site 1758 given its proximity to the channel trace and its directional flow, it is probable that the site was situated along the right former bank of Paleochannel 7. The site is distinguished by a takyr surface, surrounded by sand, and marked by the presence of small aggregates of pottery.

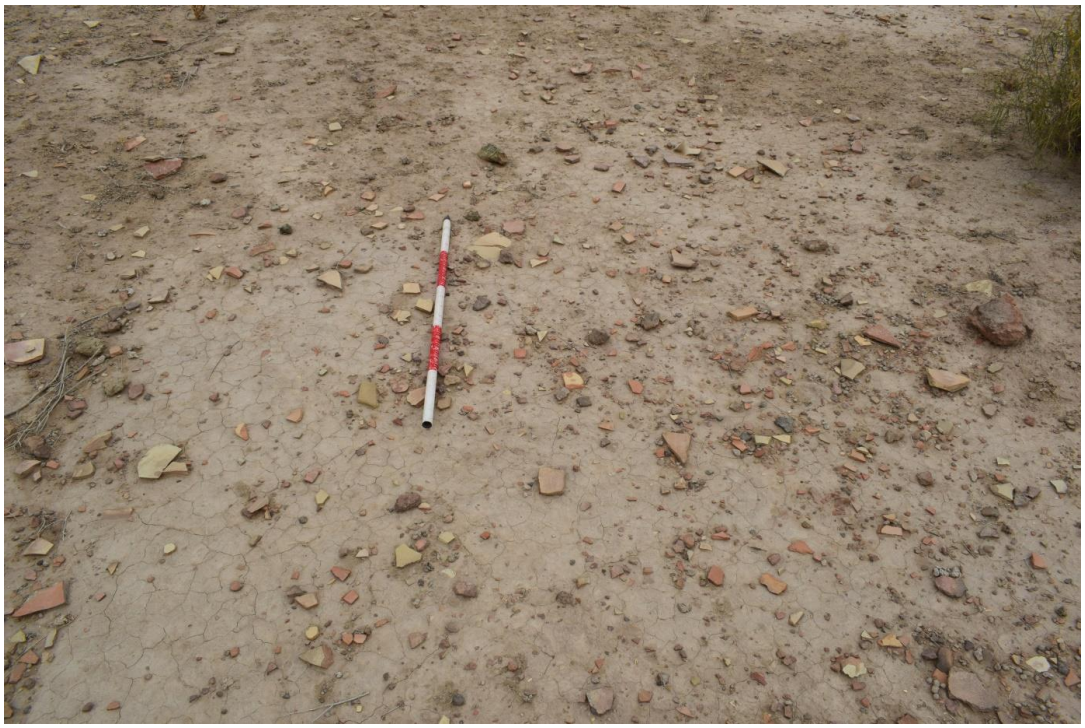
Photo

Site number and type	Survey Area	Paleochannel	Distance from the paleochannel	Chronology	Size
1759 Large Cluster	Area 2	Paleochannel 7	59 meters	LBA/IA1	0.5-1 ha

Description

Site 1759 is positioned on the right paleobank of Paleochannel 2. The site is characterized by a collection of scattered pottery, predominantly on a takyr surface, surrounded by sandy terrain. Particularly noteworthy is the presence of kiln wasters on the surface, similar to Site 1757.

Photo



Site number and Type	Survey Area	Paleochannel	Distance from the paleochannel	Chronology	Size
1760 Large Cluster	Area 2	Paleochannel 7	49 meters	IA1	0.5- 1 ha

Description

Site 1760 is situated on the left paleobank of Paleochannel 2, approximately 49 meters from the paleochannel. The site primarily consists of sandy terrain, with occasional patches of takyr nearby. Despite the abundant presence of scattered ceramics, no evidence of permanent structures was observed on the surface.

Photo

Site number and Type	Survey Area	Paleochannel	Distance from the paleochannel	Chronology	Size
1761 Large Cluster	Area 4	Paleochannel 7	48 meters	IA1	0.5-1 ha

Description

Site 1761 is situated on the southern left paleobank of Paleochannel 7. It occupies a gently flat surface characterized by the presence of pottery and the absence of any permanent structures. While a takyr surface was observed, the area is primarily composed of sandy terrain.

Photo

Site number and Type	Survey Area	Paleochannel	Distance from the paleochannel	Chronology	Size
1762 Small Cluster	Area 5	Paleochannel 8	32 meters	LBA/IA1	0.1-0.5 ha

Description

Site 1762 is the sole site identified in Area 5, situated near Paleochannel 8. It features a Takyr surface with a gentle slope towards the center and sandy terrain surrounding it. Scattered pottery was observed both around the site and within its center.

Photo

Site number and Type	Survey Area	Paleochannel	Distance from the paleochannel	Chronology	Size
1763 Large Cluster	Area 2	Paleochannel 2	65 meters	LBA/IA1	0.5-1 ha

Description

Site 1763 is situated on the right paleobank of Paleochannel 2, positioned approximately 65 meters from the channel itself and 100 meters from Site 1764. Like Site 1764, it is also located 415 meters from Togolok 21. The site features a gently flat surface with minimal indications of a takyr surface. No evidence of permanent structures was identified on the surface.

Photo

Site number and Type	Survey Area	Paleochannel	Distance from the paleochannel	Chronology	Size
1764 Small Cluster	Area 2	Paleochannel 2	20 meters	LBA	0.1-0.5 ha

Description

Site 1764 is positioned in the southern area of Paleochannel 2, situated on its left paleobank at a distance of 20 meters. It is in close proximity to Togolok 21, just 412 meters to the north, and 100 meters from Site 1763. The site occupies a flat terrain with a sparse takyr surface. Notably, no evidence of permanent structures was discerned on the surface.

Photo

Site number and Type	Survey Area	Paleochannel	Distance from the paleochannel	Chronology	Size
1765 Large Cluster	Area 2	Paleochannel 2	93 meters	LBA/IA1	0.5-1 ha

Description

Site 1765 is situated centrally along the left paleobank of Paleochannel 2, at a distance of 93 meters. It occupies a gently flat surface where scattered pottery fragments were discovered. Notably, no takyr surface was evident in the vicinity, and there were no visible structures on the surface.

Photo

Table 3.3. The table provides a description of the west and south profiles of the test trench excavated in Paleochannel 7, located in the Togolok area.

Unit number*	
West Profile Trench (Paleochannel 7) Togolok Area	
1	The first layer of ca. 5 cm is characterized by a compact layer of clay-silt loam (takyr surface) of grayish color (10YR 6/1).
2	Between -5 and -70 cm there is a silty sand compacted unit layer. This layer is darker grey color (10YR 5/1) on the top, until about -50 cm, and lighter grey color (10YR 6/3) from -50 to -70 cm, probably with more sand fraction. This layer was also characterized by the presence of small shells. In addition, there was the presence of a small "root" channel between -50 and -60 cm on the south side of the trench profile.
3**	Between -70 cm and -82cm there is a fine sand unit layer (10YR 7/4) with few laminations visible.
4	Between ca. -82 and -88 cm there is a unit layer of silty clay (10YR 7/4).
5	Between ca. -88 and 95 cm there is a layer of sand (10YR 7/4) with visible small cross-bedding lamination.
6	Between ca. -95 and -100 cm there is a small unit layer of silty-clay (10YR 7/4).
7	Between -100 and -169 cm there is a very cohesive polyhedral unit layer of clay (10YR 6/4). On the top left of this layer there was evidence of small charcoal.
8**	Between -169 and -194 cm there is a unit layer of sand/very fine sand (10YR 5/6) with no particular lamination visible.
South Profile Trench (Paleochannel 7) Togolok Area	
1	The first layer of ca. 5 cm characterized by a compact layer of clay-silt loam (takyr surface) of grayish color (10YR 6/1).
2	Between – 7 and-74 cm there is a compact unit layer of silty sand. The layer is darker grey color (10YR 5/1) on the top and a lighter grey color (10YR 6/2) on the bottom profile with a possible increase in sand fraction.
3	Between -74 and -82 cm there is a fine sand unit layer (10YR 7/3) with visible cross-lamination.
4	Between ca. -85 and -92 cm there is a unit layer of sand (10YR 7/2) within unit layer 5. This layer shows visible cross-laminations
5	Between -82 and – 100 cm there is a unit layer of silty-clay (10YR 7/4). This layer present macro layers of sand in it (units 4,6,7).
6	Between ca. -87 and -92 cm there is a unit layer of sand (10YR 7/2) within unit layer 5. This layer shows visible cross-laminations.
7	Between ca. -94 and -96 cm there is a unit layer of sand (10YR 7/2) within unit layer 5. This layer shows visible cross-laminations.
8**	Between -100 and -170 cm there is a very cohesive polyhedral unit layer of clay

	(10YR 6/4).
9	Between -170 and -194 cm there is a unit layer of sand/very fine sand (10YR 5/6) with no particular lamination visible.

*Refer to Figures 6.42 and 6.43 in Chapter 6 for the unit numbers.

**From this layer OSL sample was taken.

Glossary

The following list aims to offer definitions of selected terms within the thesis. Some definitions may be broad and not exhaustive, as certain fluvial terms are subject to debate (e.g., anabranching). Nonetheless, the purpose is to provide a brief comprehension of the terms.

- **Alluvial fan**: Alluvial fan is a fan-shaped deposit of sediment formed where a stream flattens, slows, and spreads typically onto a plain.
- **Anabranching**: Anabraching is a type of river channel pattern characterized by multiple interconnected channels separated by stable islands or bars, often found in floodplains with a low gradient.
- **Avulsion**: Avulsion refers to a sudden redirection of a channel course to a new path. This typically happens during episodes of flood, resulting in the abandonment of the old channel and the creation of a new one.
- **Bank**: In a river system, the bank refers to the sloping sides of a channel. Riverbanks confine the water within its channel path.
- **Barchanoids**: In arid environments, barchanoids are crescent-shaped sand dunes with an elongated form.
- **Braided**: Braided is a type of river channel pattern characterized by numerous interconnected channels separated by small and often temporary islands or bars, usually found in floodplains with variable discharge.
- **Catchment area**: The catchment area is of land from which water drains into a particular body of water.
- **Channel bar**: A channel bar is a depositional landform typically found within a river channel, often forming inside meanders or in areas of reduced flow velocity. These bars can vary in size and shape
- **Crevasse splays**: Crevasse splays form during periods of high discharge when a river breaches its levee, depositing sediment onto the floodplain. Due to this event, small streams can also form.
- **Cross-lamination**: Lamination consists essentially of parallel stratification, with laminated structures inclined in different directions.
- **Cross-section**: A diagram commonly used in geology and hydrology to depict the structure of landforms or bodies of water, such as a river channel.
- **Discharge**: Discharge is the volume of water flowing through a river channel. This is indicated per unit of time typically measured in cubic meters per second (m^3/s).
- **Furrow irrigation**: A method of irrigation in which water is distributed in small channels or furrows between rows of crops. This method is still used in modern Turkmenistan.
- **Hand auger**: Hand auger is a tool used for drilling small holes in soil in geological and environmental fieldwork. It can be operated by hand or machine.

- **Herringbone canals**: Irrigation canals designed in a herringbone pattern to distribute water across agricultural fields. This structure is common in Mesopotamia.
- **Khak**: In Turkmenistan, 'khak' refers to an artificial structure dug into the Takyr surface to collect water, which can be stored for between 2 and 4 months.
- **Lamination**: Lamination in river sediment refers to the presence of distinct, thin layers or beds of sedimentary material. These laminations are typically the result of changes in sedimentary processes, such as fluctuations in water flow velocity, and they are observable in cross-sections of the channel.
- **Levee**: An embankment built along the banks of a river to prevent flooding and confine the river within its channel.
- **Lithofacies**: In the context of rivers, lithofacies refers to distinctive sedimentary units within a specific formation that share similar characteristics. They represent specific depositional processes within a river system and can vary spatially and temporally along the river channel.
- **Marshes**: Marshes are wetland areas or regions characterized by shallow water with the presence of small vegetation such as grasses and sedges. South Mesopotamia is a typical region known for its marshes.
- **Ostracode shells**: Hard, calcareous shells of tiny aquatic crustaceans called ostracods.
- **Overbank deposition**: Overbank deposition is a process by which sediment carried by a river channel is deposited beyond the confines of its main channel. This happens during periods of high flow regime when a river channel exceeds its channel capacity. In this case, the deposited sediment forms layers of alluvium.
- **Oxbow**: An oxbow is a U-shaped body of water typically formed when a meandering river is cut off from the main channel. This process often occurs during periods of flooding.
- **River ripples**: River ripples are small-scale sedimentary structures that form on the bed of a river channel due to the interaction of flowing water with loose sediment particles. They usually develop perpendicular to the direction of water flow and can vary in size and spacing depending on factors such as flow velocity, sediment grain size, and channel morphology. Typically, they form under relatively low to moderate flow regimes and can be seen in channel sections.
- **Saxaul**: Saxaul is a type of drought-resistant shrub or small tree found in Central Asian deserts, often used for forage and fuel. It can be divided into two main varieties: black saxaul and white saxaul.
- **Takyr:** A takyr is a type of flat, clay-rich desert surface characterized by polygonal crack structures, commonly found in arid regions. In regions other than Central Asia, similar features may be referred to as 'playas' or 'sabkhas.' During periods of high precipitation, water accumulates on takyr surfaces.
- **Tepe or Depe**: Tepe or Depe is a mound formed by the accumulated debris from human occupation. They often represent ancient settlements.

- **Tributary channel**: A tributary channel is a smaller river channel that flows into a larger main one. Tributaries contribute water, sediment, and increase the discharge of the main watercourse, thereby influencing its characteristics
- **Tugai**: Tugai is a typical riparian forest or woodland found along the banks of rivers and streams in Central Asia. It is characterized by a diverse assemblage of trees and shrubs.