2022 IMEKO TC-4 International Conference on
Metrology for Archaeology and Cultural Heritage
University of Calabria, Italy, October 19-21, 2022

Paleogeographic reconstruction of the Tuscan coastal area nearby Grotta dei Santi (Monte Argentario, Italy) during the Neandertal occupation

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***Abstract* – The mobility of hunter-gatherer groups is crucial in understanding Palaeolithic settlement dynamics. The concept of mobility cannot be separated from the space in which it occurs, including landscape components, localization of critical resources and of other sites, and routes between them. Nevertheless, the landscape is not constant in time due to the geomorphological changes that occurred in the long timescale of Prehistory. Here we present a paleogeographic reconstruction of the coastal area around Grotta dei Santi during the Neandertal occupation. A GIS-based approach, combining geological, bathymetric, and sea-level fluctuations data, allows us to reconstruct the landscape around the cave at about 45 ky BP. The cave today opens onto a cliff facing the sea. The Neandertal occupation occurred with a sea-level 74 m lower than present-day. Consequently, the cave faced a vast coastal plain, playing a strategic role due to its position, allowing both proximity and control of essential resources.**

Keywords: Palaeolithic mobility; Neandertal; Landscape archaeology; Paleogeography; GIS; Central Italy

I. INTRODUCTION

Each monocausal approach to the analysis of human societies is invariably destined to fail. Human societies are not a simple sum of abstract and independent elements. On the contrary, their structure is shaped by a complex entanglement of co-dependent components (e.g., social relations, demography, economy, exchanges, physical and biological environment, resources) [1]. Metric and relational properties can describe the reciprocal interactions of these components (e.g., density, connectivity, centrality, cohesion), highlighting their relative ranking and roles in a given context and at a given scale. Reading these dialectical relations in the frame of spatial analysis allows catching the dynamism behind the staticity of the archaeological record. Consequently, a contextual, multivariate and integrated approach is the fundamental prerequisite for a proper understanding of human society. This is particularly true for the Past due to the residuality of archaeological records [2]. From this perspective, Spatial Archaeology [3] plays a pivotal role, given its interdisciplinary, contextual and multi-scale approach [4]. The space is not only a passive box of "resources", which van be reduced to mere geometric properties. It plays an active role in bounding, dividing, connecting and catalysing people, "resources" and their relationships [5].

The reconstruction of past mobility cannot be abstracted from the idea of moving from the geographical, informational and relational context in which it occurred. At the landscape scale (or macro-level *sensu* [3]), the reconstruction of mobility patterns significantly contributes to reveal the contextual framework of the economic sphere. This is particularly relevant for Palaeolithic hunter-gatherers, given the crucial role of mobility for the economy and social structures of nomad groups [6], [7], [8], [9]. Recently, the developments of geomatics applications to landscape and economic archaeology returned exciting results, significantly implementing our knowledge of Palaeolithic mobility patterns [10], [11], [12], [13], [14], [15], [16], [17]. The reconstruction of Palaeolithic mobility cannot be adequately addressed without a paleogeographic framing. The landscape, indeed, is not an invariable component. A preliminary geomorphological assessment is fundamental to recognize the changes in the long timescale of Prehistory. Eustatic fluctuations of sea level, tectonics, fluvial and glacial dynamics, and climate changes, along with other geomorphological agents, determine a difference in the aspect of past landscapes which gets greater and greater as one goes back in time [18].

II. MATERIAL AND METHODS

This paper focuses on the paleogeographic reconstruction of a 45km wide area around the Middle Palaeolithic site of Grotta dei Santi (Monte Argentario, Southern Tuscany, central Italy). This study area extends along the coastline between Punta Ala (facing the Elba island) to the north and the Lido di Tarquinia to the south [19].

The scientific discovery of Grotta dei Santi dates back to the middle of the last century [20]. Nevertheless, logistical difficulties hindered further research until 2007, when the systematic excavation campaigns started under the direction of the Research Unit of Prehistory and Anthropology – Department of Physical Science, Earth and Environment of the University of Siena (Italy) [21], [22], [23], [24], [25], [26]. The extraordinary importance of this site to study Neandertal behaviour diversity with a high-resolution perspective immediately arose with recent interdisciplinary studies [19], [27], [28], [29], [30], [31]. Recent geological fieldwork, founded by the National Geographic Society, allowed the collection of a large amount of sedimentological data. This will contribute to a high-resolution reconstruction of the archaeological stratigraphy formation processes and cave environmental changes.

Grotta dei Santi currently opens on a cliff facing the sea. This was not the situation during the Neandertal occupation. The combined contribution of eustasy and tectonics produced a continuous process of large-scale regression/transgression of the sea over time [32], [33], [34], [35].

Consequently, the Digital Elevation Models of both the Terrain (DTM) and Bathymetry (DBM) are required for an accurate palaeogeographical reconstruction of the territory around this key site during the Palaeolithic. This is a challenging task, mainly due to the absence of high-resolution models of the bathymetry. The most accurate open-source DBM covering this area, indeed, is the EMODNET, with a grid resolution of 1/16 * 1/16 arc minutes (~ 115 * 115 meters) [36].

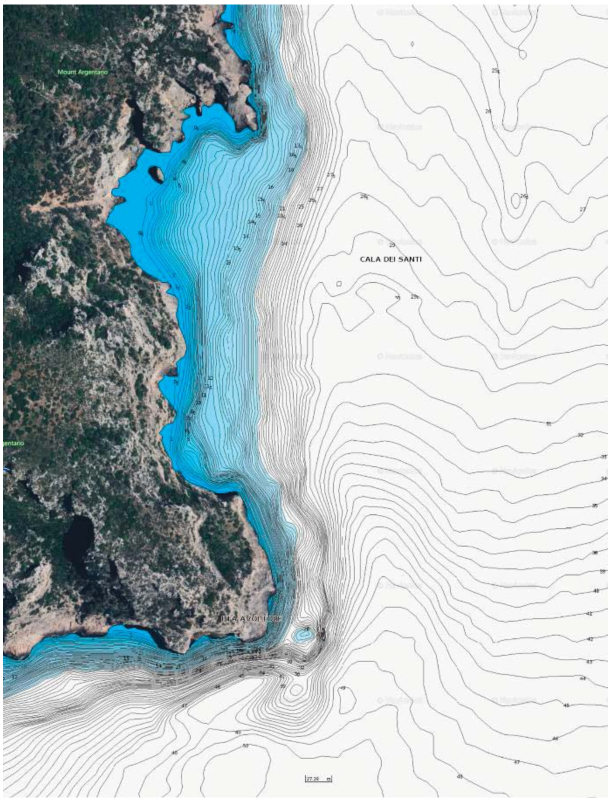

Figure 1: Screenshot of the Navionics SonarChart™ in the area in front of the Grotta dei Santi site.

For this reason, a new model has been created by interpolation. Raw data have been collected by the HD SonarChart™ of Navionics [37]. The Navionics raster map of the study area includes high-resolution seafloor contours and high-resolution satellite world imagery (common to ArcGIS®) (Figure 1). This map has been georeferenced (with 84 control points and an estimated error of about 10m). The contours have been vectorized into a purposely-designed geodatabase (set on the UTM WGS 84 zone 32 projection system), with an accuracy of 4m down to the bathymetric -148m. A more accurate step has been used in the presence of particular seabed morphologies. Along the coastline, modern dock features have been excluded. Given its computational efficiency, the Topogrid interpolation algorithm has been used to build the bathymetric model [38], [39], taking into account the contours mentioned above and a polygon mask of the submerged study area (used as a boundary). The obtained DBM has been set with a 10m cell size grid. Currently, it is the most accurate model available for this area (with a resolution significantly higher than the EMODNET). As far as the continental elevation model is concerned, the TINITALY/01 has been used. It is freely downloadable and shares with the DBM mentioned above the same grid resolution (10m) and projection system [40], [41]. The interest area has been extracted with a mask by five frames (W47060, W47065, W47070, W46565, W46570).

Finally, the obtained models have been merged with a mosaic to a new raster procedure. The resulting elevation model includes the current continental and submerged relief, down to the depth of -148m. The slope map and the hillshade model have also been produced to improve the reading of this landscape in Prehistory. In order to enhance the realism of landscape reading, the value of eustatic sea-level at 47ky BP (73m) has been added to the obtained model, by the raster calculator tool.

III. RESULTS AND DISCUSSION

The High-Resolution model of landscape and seafloor returned by this study is a fundamental precondition for palaeogeographical reconstructions. Nevertheless, this is not the only condition. The proper rendering of the palaeolithic landscape stems from the intersection of multiple information.

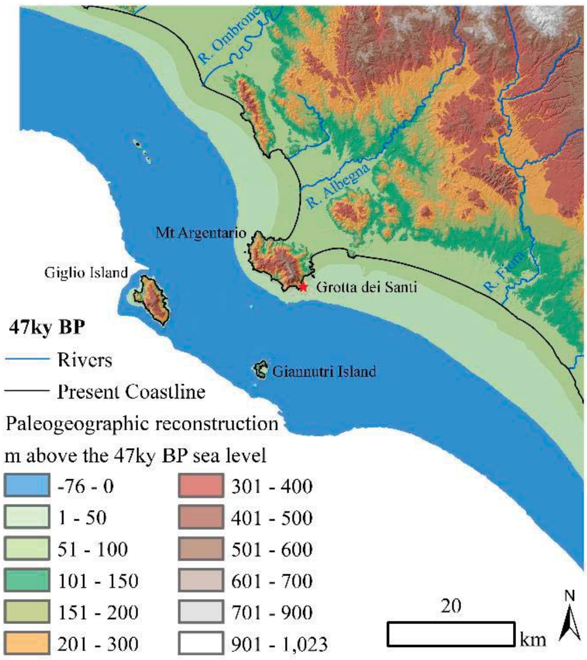

Figure 2: Palaeogeographical reconstruction of the study area at 47ky BP.

Firstly, a chronological framing as accurate as possible is needed. Eustatic fluctuations of the sea level follow a characteristic pattern anchored in time. Radiocarbon dates from Grotta dei Santi allow for framing the Neandertal occupation of the cave between about 50-40 ky BP [29]. The new INTCAL20 calibration curve [42] on the only reliable radiometric dates allows constraining the occupation at about 47-45ky BP (straddling the end of Heinrich Event 5 and the Greenland Interstadial GI-12). According to the foraminifera isotopic records, the sea level in this interval was about -73m (± 13m) [32], [35].

Secondly, the analysis of local geomorphological proxies points to modest uplift rates, highlighting the relative tectonic stability of the area [33] [34]. In a radius of 25km from the cave, indeed, the vertical displacement computable from the last 47ky tends to be less than 1m (with values between -0.016 and 0.048 mm/yr). Only in the southern part of the study area (corresponding to the mouth of the Fiora River) are some higher uplift rates recognizable. Nevertheless, the estimated vertical displacement is around 8m (with values between 0.112 and 0.192 mm/yr). These tectonic displacements appear negligible considering that the sea-level estimate standard error is significantly higher [32], [35].

Finally, the recent contributions of fluvial transport and coastal dynamics have been taken into account to assess the reliability of each part of the reconstructed model. The Argentario promontory is characterized by a rocky coastline with a null sedimentary apport by fluvial distribution systems. As a result, this area is suitable for paleogeographic reconstructions. More problems affect both the northern and southern coastline sectors. In particular, the Holocene inputs from the Ombrone river significantly changed the assets of the coast, with high sedimentation rates. Sediments transported by the Albegna river in the last 10ky contributed to the formation of narrow dune belts, connecting the Argentario to the peninsular area (influencing the formation of the Orbetello lagoon). In the south, the area near the Fiora river is affected by the sedimentation rate of fluvial transport and the higher uplift rates.

The paleogeographic analysis, net of the delineation of the margins mentioned above of error, brings out a very different landscape outlook from the present one (figure 2).

The first evident difference is the large coastal plain extending in front of the cave and along the northern sector of the study area. In particular, the stretch of coastline facing the cave was expected to have an average slope of ~1% and a width of about 8.5km (directly connecting Grotta dei Santi with part of the coast in front of it). Given the morphology and acclivity (~4%) of the southwestern face of Punta Avoltore, bordering Grotta dei Santi, we infer that the sea was quite close to this stretch (~2.5km). In this frame, Mt Argentario was a prominent element of the landscape. Other minor but significant prominent elements on the plain were expected to be what are now the rocks of Isolotto, Argentarola and the Formica di Burano. These morphological features make the Grotta dei Santi an ideal hunter-gatherers' camp, given its potential close access to diversified environments and resources. The cave's position could potentially implement Neandertals' control of the territory.

In summary, this work offers a helpful tool to frame

Neandertal mobility patterns. The elevation model can be used to visualize the landscape aspect during the occupation of Grotta dei Santi and other phases of prehistory (e.g., from the Tyrrhenian Interglacial to the Last Glacial Maximum). This can allow to follow the evolution of the landscape through time. Nevertheless, some criticisms can also be focused on the contribution of tectonics and Holocene sedimentation rates driven by fluvial dynamics. The latter issue can help, focusing on specific areas for in-depth geological investigations to improve the accuracy of paleogeographic reconstructions.

ACKNOWLEDGEMENTS

For their logistic support we are grateful to the local Heritage Office (SABAP – Siena, Arezzo e Grosseto), the Firemen of Grosseto, the Coast Guard of Porto Ercole, the Red Cross of Porto Ercole, La Venta, AOG Industries di Luciano Chelli, Accademia Mare Ambiente di Porto Santo Stefano and Argentario Divers.

For their financial support we are grateful to the National Geographic Society/Exploration Grant Program (grant NGS-61617R-19 to I. Martini), the Comune di Monte Argentario, the UniCoop Tirreno of Orbetello and the Banca di Credito Cooperativo di Castagneto Carducci.

We extend special thanks to all the people who have made the fieldwork possible, despite the many difficulties.

REFERENCES

[1] I. Hodder, A. Mol, “Network analysis and entanglement,” Journal of Archaeological Method and Theory, vol. 23(1) (2016), pp. 1066-1094. DOI: 10.1007/s10816-015-9259-6.

[2] M.B. Schiffer, “Archaeological context and systemic context,” American Antiquity, vol. 37, (1972), pp.156-165. DOI: 10.2307/278203.

[3] D.L. Clarke, “Spatial Archaeology,” Academic Press. Inc., London, UK, (1977)

[4] V. Spagnolo, G. Marciani, D. Aureli, I. Martini, P. Boscato, F. Boschin, A. Ronchitelli, Martini, I., “Climbing the time to see Neanderthal behaviour’s continuity and discontinuity: SU 11 of the Oscurusciuto Rockshelter (Ginosa, Southern Italy),” Archaeological and Anthropological Sciences, vol. vol. 12(2), (2020), pp. 1-30. DOI: 10.1007/s12520-019-00971-9.

[5] V. Spagnolo, E.A.A. Garcea. “Persistent settlement patterns reveal memory of place of Early/Middle Holocene hunter-gatherers on Sai Island in the Middle Nile Valley,” In preparation.

[6] L.R. Binford, “Willow smoke and dogs’ tails: hunter-gatherer settlement systems and archaeological site formation,” American Antiquity, vol. 45 (1980), pp. 4-20. DOI: 10.2307/279653.

[7] L.R. Binford, “The Archaeology of Place,” Journal of Anthropological Archaeology, vol. 1 (1982), pp. 5-31. DOI: 10.1016/0278-4165(82)90006-X.

[8] R.L. Kelly, “Hunter-gatherer mobility strategies,” Journal of Anthropological Research, vol. 39 (1983), pp. 277-306.

[9] R.L. Kelly, “The lifeways of hunter-gatherers: The foraging spectrum,” Cambridge University Press, New York, USA, 2013.

[10] M. de Andrés-Herrero, D. Becker, G.C. “Weniger, Reconstruction of LGM faunal patterns using Species Distribution Modelling. The archaeological record of the Solutrean in Iberia,” Quaternary International, vol. 485 (2018), pp. 199-208. DOI: 10.1016/j.quaint.2017.10.042.

[11] B.F. Byrd, A.N. Garrard, P. Brandy, “Modeling foraging ranges and spatial organisation of Late Pleistocene hunter–gatherers in the southern Levant – A least-cost GIS approach,” Quaternary International, vol. 396 (2016), pp. 62-78. DOI: 10.1016/j.quaint.2015.07.048.

[12] R. Ekshtain, C.A. Tryon, “Lithic raw material acquisition and use by early Homo sapiens at Skhul, Israel,” Journal of Human Evolution, vol. 127 (2019), pp. 149-170. DOI: 10.1016/j.jhevol.2018.10.005.

[13] R. Ekshtain, A. Malinsky-Buller, S. Ilani, I. Segal, E. Hovers, “Raw material exploitation around the Middle Paleolithic site of ‘Ein Qashish,” Quaternary International, vol. 331 (2014), pp. 248-266. DOI: 10.1016/j.quaint.2013.07.025.

[14] A.B. Marín-Arroyo, A. Sanz-Royo, “What Neanderthals and AMH ate: reassessment of the subsistence across the Middle - Upper Palaeolithic transition in the Vasco - Cantabrian region of SW Europe,” Journal of Quaternary Science, vol. 37(2), (2022), pp. 320-334. DOI: 10.1002/jqs.3291.

[15] H. Parow-Souchon, C. Purschwitz, “Variability in chert raw material procurement and use during the Upper Paleolithic and Early Neolithic of the southern Levant: A regional perspective from the Greater Petra area,” Journal of Archaeological Science: Reports, vol. 29 (2020), 102087. DOI: 10.1016/j.jasrep.2019.102087.

[16] A. Prieto, M. García-Rojas, A. Sánchez, A. Calvo, E. Domínguez-Ballesteros, J. Ordoño, M.I. García-Collado, “Stones in Motion: Cost units to understand flint procurement strategies during the Upper Palaeolithic in the south-western Pyrenees using GIS,” Journal of Lithic Studies, vol. 3 (1), (2016), pp. 133-160. DOI: 10.2218/jls.v3i1.1310.

[17] A. Prieto, A. Arrizabalaga, I. Yusta, “Lithic raw material in the Cantabrian region: Dialectical relationship between flint and quartzite in the Palaeolithic record,” Journal of Lithic Studies, vol. 8(1), (2021), pp. 1-31. DOI: 10.2218/jls.4334.

[18] G.J. Brierley, “Landscape memory: the imprint of the past on contemporary landscape forms and processes,” Area, vol. 42(1), (2010), pp. 76-85.
[19] E. Conti, “Ricostruzione paleo-geografica della costa grossetana nell’intervallo M.I.S. 2 - M.I.S. 5e,” BA Thesis, Università degli Studi di Siena, Siena, Italy, 2022.
[20] A.G. Segre, “Giacimenti pleistocenici con fauna e industria litica a Monte Argentario (Grosseto),” Rivista di Scienze Preistoriche, vol. XIV (1959), pp. 1-18.
[21] J. Crezzini, A. Moroni, “Archeozoologia. La ricostruzione del comportamento umano dall’esame dei resti faunistici recuperati nei siti archeologici,” Etruria Natura, vol. IX (2012), pp. 36-43.
[22] M. Freguglia, P. Gambogi, L. Milani, A. Moroni Lanfredini, S. Ricci, “Monte Argentario (GR). Cala dei Santi: Grotta dei Santi,” Notiziario della Soprintendenza per i Beni Archeologici della Toscana, vol. 3 (2007), pp. 488-491.
[23] M. Freguglia, F. Bernardini, G. Boschian, C. Capanna, J. Crezzini, P. Gambogi, L. Longo, L. Milani, A. Moroni Lanfredini, F. Parenti, S. Ricci, “Monte Argentario (GR). Cala dei Santi: Grotta dei Santi,” Notiziario della Soprintendenza per i Beni Archeologici della Toscana, vol. 4 (2008), pp. 377-380.
[24] A. Moroni Lanfredini, M. Freguglia, F. Bernardini, G. Boschian, C. Cavanna, J. Crezzini, P. Gambogi, L. Longo, L. Milani, F. Parenti, S. Ricci, “Nuove ricerche alla Grotta dei Santi (Monte Argentario, Grosseto),” In: N. Negroni Catacchio (ed.), L’alba dell’Etruria Fenomeni di continuità e trasformazione nei secoli XII-VIII a.C. Ricerche e scavi, Atti del IX Incontro del Centro Studi di Preistoria e Archeologia (2010), pp. 649-662.
[25] A. Moroni, F. Parenti, A. Araujo, G. Boschian, F. Boschin, G. Capecchi, J. Crezzini, J.J. Hublin, G. Marciani, V. Spagnolo, S. Talamo, P. Gambogi, “Monte Argentario (GR). Grotta di Cala dei Santi (Concessione di Scavo),” Notiziario della Soprintendenza per i Beni Archeologici della Toscana, vol. 10/2014 (2015), pp. 364-366.
[26] V. Spagnolo, G. Boschian, A. Araujo, F. Boschin, G. Capecchi, J. Crezzini, J.J. Hublin, G. Marciani, G. Montanari-Canini, F. Parenti, S. Talamo, A. Moroni, “Monte Argentario (GR). Cala dei Santi: Grotta dei Santi (concessione di scavo),” Notiziario della Soprintendenza per i Beni Archeologici della Toscana, vol. 11/2015 (2016), pp.555-558.
[27] A. Burgassi, “Analisi ad alta risoluzione della suscettività magnetica della Grotta di Cala dei Santi (Monte Argentario, Grosseto),” BA Thesis, Università degli Studi di Siena, Siena, Italy, 2021.
[28] G. Montanari, “Grotta dei Santi, Monte Argentario (GR): i piccoli mammiferi dei livelli musteriani,” MA Thesis, Università degli Studi di Ferrara, Ferrara, Italy, 2014.
[29] A. Moroni, G. Boschian, J. Crezzini, G. Montanari-Canini, G. Marciani, G. Capecchi, S. Arrighi, D. Aureli, C. Berto, M. Freguglia, A. Araujo, S. Scaramucci, J.J. Hublin, T. Lauer, S. Benazzi, F. Parenti, M. Bonato, S. Ricci, S. Talamo, A.G. Segre, F. Boschin, V. Spagnolo, “Late Neandertals in Central Italy. High-resolution chronicles from Grotta Dei Santi (Monte Argentario - Tuscany),” Quaternary Science Reviews, vol. 217 (2019), pp.130-151. DOI: 10.1016/j.quascirev.2018.11.021.
[30] V. Spagnolo, “Studio delle strategie insediative del Paleolitico medio in Italia centro-meridionale,” PhD Dissertation, Università degli Studi di Siena Siena, Italy, 2017.
[31] V. Spagnolo, J. Crezzini, G. Marciani, G. Capecchi, S. Arrighi, D. Aureli, I. Ekberg, S. Scaramucci, L. Tassoni, F. Boschin, A. Moroni, “Neandertal camps and hyena dens. Living floor 150A at Grotta dei Santi (Monte Argentario, Tuscany, Italy),” Journal of Archaeological Science: Reports, vol. 30 (2020), 102249. DOI: 10.1016/j.jasrep.2020.102249.
[32] F. Antonioli, “Sea level change in Western-Central Mediterranean since 300 kyr: comparing global sea level curves with observed data,” Alpine and Mediterranean Quaternary, vol. 25 (2012), pp. 15-23.
[33] L. Ferranti, F. Antonioli, B. Mauz, A. Amorosi, G. Dai Pra, G. Mastronuzzi, C. Monaco, P. Orrù, M. Pappalardo, U. Radtke, P. Renda, P. Romano, P. Sansò, V. Verrubbi, “Markers of the last interglacial sea-level high stand along the coast of Italy: Tectonic implications,” Quaternary International, vol. 145-146 (2006), pp. 19-29. DOI: 10.1016/j.quaint.2005.07.009.
[34] L. Ferranti, F. Antonioli, M. Anzidei, C. Monaco, P. Stocchi, “The timescale and spatial extent of vertical tectonic motions in Italy: insights from relative sea-level changes studies,” Journal of the Virtual Explorer, vol. 36 (2010), pp. 1-34. DOI: 10.3809/jvirtex.2010.00255.
[35] C. Waelbroeck, L. Labeyrie, E. Michel, J.C. Duplessy, K. Lambeck, J.F. Mcmanus, E. Balbon, M. Labracherie, “Sea-level and deep water temperature changes derived from benthic foraminifera isotopic records,” Quaternary Science Reviews, vol. 21 (2002), pp. 295-305. DOI:10.1016/S0277-3791(01)00101-9.
[36] https://www.emodnet-bathymetry.eu.
[37] http://navionics.com/ita.
[38] S. Arrighi, E. Bortolini, L. Tassoni, A. Benocci, G. Manganelli, V. Spagnolo, L.M. Foresi, A.M. Bambini, F. Lugli, F. Badino, D. Aureli, F. Boschin, C. Figus, G. Marciani, G. Oxilia, S. Silvestrini, A. Cipriani, M. Romandini, M. Peresani, A. Ronchitelli, A. Moroni, S. Benazzi, “Backdating systematic shell ornament making in Europe to 45,000 years ago,”

Archaeological and Anthropological Sciences, vol. 12(2), (2020), pp. 1-22. DOI: 10.1007/s12520-019-00985-3.
[39] J. Conolly, M. Lake, “Geographical Information Systems in Archaeology,” Cambridge University Press, Cambridge, UK, 2006.
[40] https://tinitaly.pi.ingv.it/
[41] S. Tarquini, l. Nannipieri, “The 10 m-resolution TINITALY DEM as a trans-disciplinary basis for the analysis of the Italian territory: Current trends and new perspectives,” Geomorphology, vol. 281 (2017), pp. 108-115. DOI: 10.1016/j.geomorph.2016.12.022.
[42] P.J. Reimer, W.E.N. Austin, E. Bard, A. Bayliss, P.G. Blackwell, C.B. Ramsey, M. Butzin, H. Cheng, R.L. Edwards, M. Friedrich, P.M. Grootes, T.P. Guilderson, I. Hajdas, K.A. Hughen, T.J. Heaton, A.G. Hogg, B. Kromer, S.W. Manning, R. Muscheler, J.G. Palmer, C. Pearson, J. van der Plicht, R.W. Reimer, D.A. Richards, E.M. Scott, J.R. Southon, C.S.M. Turney, L. Wacker, F. Adolphi, U. Büntgen, M. Capano, S.M. Fahrni, A. Fogtmann-Schulz, R. Friedrich, P. Köhler, S. Kudsk, F. Miyake, J. Olsen, F. Reinig, M. Sakamoto, A. Sookdeo, S. Talamo, “The IntCal20 Northern Hemisphere radiocarbon age calibration curve (0–55 cal kBP),” Radiocarbon, vol. 62(4), (2020), pp. 725-757. DOI: 10.1017/RDC.2020.41.