



HAL
open science

U-series dating at Nerja cave reveal open system. Questioning the Neanderthal origin of Spanish rock art

Edwige Pons-Branchu, José Luis Sanchidrián, Michel Fontugne, M. Ángeles Medina-Alcaide, Anita Quiles, François Thil, Hélène Valladas

► To cite this version:

Edwige Pons-Branchu, José Luis Sanchidrián, Michel Fontugne, M. Ángeles Medina-Alcaide, Anita Quiles, et al.. U-series dating at Nerja cave reveal open system. Questioning the Neanderthal origin of Spanish rock art. *Journal of Archaeological Science*, 2020, 117, pp.105120. 10.1016/j.jas.2020.105120 . hal-02514905

HAL Id: hal-02514905

<https://hal.science/hal-02514905>

Submitted on 20 May 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial 4.0 International License

U-series dating at Nerja cave reveal open system. Questioning the Neanderthal origin of Spanish rock art

Edwige Pons-Branchu¹, Josè-Luis Sanchidrian², Michel Fontugne^{1,3}, M^a Angeles Medina Alcaide⁴, Anita Quiles⁵, François Thil¹, H  l  ne Valladas¹

¹Laboratoire des Sciences du Climat et de l'Environnement, LSCE/IPSL, CEA-CNRS-UVSQ, Universit   Paris-Saclay, F-91191 Gif-sur-Yvette, France.

²University of Cordoba, Geography and Territory Sciences Cardenal Salazar, 14071 Cordoba, Spain.

³LAMPEA - UMR 7269, Maison M  diterran  enne des Sciences de l'Homme. 5 rue du Ch  teau de l'Horloge, 13094 Aix-en-Provence, France

⁴University of the Basque Country UPV/EHU Geography, Prehistory and Archaeology, Tom  s y Valiente, 01006 Vitoria-Gasteiz, Spain

⁵Institut Fran  ais d'Arch  ologie Orientale, P  le Arch  om  trie, 37 al-Cheikh Aly Youssef, B.P Qasr al-Ainy 11562, 11441 Cairo, Egypt

Keywords: Rock art dating, U-series, open system

Abstract

U/Th data obtained on CaCO₃ layers covering rock art at Nerja Cave (Spain) evidence erroneous ages and an inverse relation between uranium concentration and apparent ages. This open system behavior could be due to a mechanism causing uranium mobility, resulting in apparent ages being too old with respect to their real age. This article also questions recently published U/Th data on samples from Ardales, Maltravieso and La Pasiega caves (Spain) where a few U/Th ages older than 40 ka BP, suggested that cave art could be attributed to Middle Palaeolithic population (Hoffmann et al., 2018). For these caves, U/Th data also display an inverse relation between U content and ages, indicating possible uranium mobility and erroneous ages.

1. Introduction

Cave art dating is a key issue for the knowledge of human artistic development. Uranium series dating (or uranium-thorium or U/Th) of secondary CaCO₃ layers underlying or overlying rock art has been used when no direct radiocarbon (¹⁴C) dating is applicable in order to give a limit age to the artistic representations (e.g. Bischoff et al. 2003). U/Th data obtained on Spanish decorated caves proposed a significantly older chronology for rock art than the one previously established using archaeological and ¹⁴C studies, and suggested that the Neanderthals may be the authors of the cave art (Pike et al., 2012, Hoffmann et al., 2016, 2018). These data have been intensely discussed from an archaeological and chronometric point of view (e.g. Bednarik et al., 2012, Clottes 2012, Pons-Branchu et al., 2014, Aubert et al. 2018, Slimak et al. 2018, Pearce and Bonneau 2018, White et al., 2019).

In order to test the reliability of U/Th ages obtained on CaCO₃ layers covering rock art, some authors suggested the use of two dating radiometric methods (U/Th and ¹⁴C) on the same samples (e.g. Plagnes et al., 2003, Fontugne et al., 2013). This approach has been done on a few samples from the Lower galleries of Nerja Cave (Spain). In some cases, it revealed age concordance and in other cases age disagreement, interpreted as the consequence of an open

46 system behavior of the sample (unreliable ages, see Valladas et al., 2017) but without
47 determination of mechanism causing it. In this article, we present U/Th data obtained on
48 CaCO₃ samples from the Upper gallery of Nerja Cave, with evidence of open system behavior
49 resulting in erroneous U/Th ages. The recently published old ages obtained for rock art from
50 Spanish caves are also discussed, since the same phenomena could have occurred.

51

52 **2. U/Th dating of CaCO₃ samples from the pisciform chamber at Nerja cave**

53 Nerja cave (Malaga, Spain) is a large cave, developed in Triassic dolomitic marble. It contains
54 important archaeological remains and graphic manifestations including animals and signs
55 (Sanchidrián 1994). ¹⁴C analyses of charcoal fragments indicate human occupation from
56 40,695 to 5,970 yr cal BP (Medina-Alcaide et al., 2015). In the Upper Galleries, the Pisciform
57 Chamber displays a decorated panel with six red paintings, the “Focas”, interpreted as seals
58 (Sanchidrián 1994). From this room, small fragments of CaCO₃ removed from the decorated
59 panel (GN12-10, GN13-20 and GN13-21, GN14-16 see fig. 1a for location of the samples), an
60 active soda straw (GN12-12), two samples (GN13-15 and GN 13-17) taken below and above
61 a charcoal mark, which was already dated by ¹⁴C (Sanchidrian et al., 2017) and a piece of
62 stalactite from the same sector (GN13-18) were studied for U/Th. Sample GN14-16 was
63 separated into two adjacent fractions: GN14-16I (internal part) and GN14-16E (external part).
64 A more detailed samples description is given in SI. Bulk mineralogy of 4 samples has been
65 determined using Fourier Transform Infrared spectroscopy (FTIR).

66

67 U/Th analyses were performed at LSCE (see Sup. Material SI for details on the method and
68 for the table of results), and revealed in the case of the archaeological parietal samples
69 variable uranium (U) contents scattered between 0.15 (GN14-16E) and 9.16 ppm (GN13-20),
70 U isotopic composition close to equilibrium and ²³⁰Th/²³⁸U ratios from 0.014 (GN13-18) up to
71 2.30 (GN14-16E) corresponding to ages ranging from 1.39 ka to out of the U/Th range, and in
72 two cases, no age calculation possible (too high ²³⁰Th/²³⁸U ratios see fig. S3). As expected, the
73 active soda straw (U content of 7.6 ppm) gave a recent age (0.03±0.01 ka). The most striking
74 feature is the inverse relation between ²³⁰Th/²³⁸U ratios and U content (fig. 1b), and the very
75 large U content variability for samples collected in a same area of the cave.

76

77 GN13-15 and GN13-17 (see fig. S1a and b) sampled under and above the charcoal black mark
78 dated from ca 20 to 18 ka cal BP (Sanchidrian et al., 2017) display U/Th ages that are
79 inconsistent with their stratigraphic position (ca. 87 ka BP for the deepest ca 119 ka BP for
80 the surface sample), and with the ¹⁴C age of the charcoal mark indicating biased U/Th ages.

81 For the whole set of data, the inverse relation between U concentrations and ²³⁰Th/²³⁴U ratios
82 indicates a possible U loss for some samples, resulting in an increase of the ²³⁰Th/²³⁴U ratio
83 and consequently of the apparent age. U natural variability (due to water pathways, U source,
84 climate variation, or prior calcite precipitation ...), may in certain cases lead to different U
85 concentrations within secondary CaCO₃ in the same cave. This natural variability could
86 however not explain either the wrong ages obtained for samples GN13-15 and GN13-17
87 (stratigraphic inversion) or the impossibility of conducting an age calculation for samples
88 GN14-16e and GN13-21 (²³⁰Th/²³⁴U >> 1). Mineralogical investigation shows that samples
89 GN13-15, GN13-18 and GN14-16 are mostly composed of calcite crystals while GN12-12 is

90 made of aragonite. The age of this aragonitic sample is the youngest, sub-actual as expected
91 for an active soda straw and has the highest U content of the 4 samples.

92 Such a U loss could be due to leaching by flowing water, mineral alteration, or to
93 mineralogical transformation. In fact, Nerja cave develops in a dolomitic host rock,
94 favourable to the formation of aragonitic speleothems (e.g. Duan et al. 2012). This mineral,
95 with high U contents, has been identified in this cave (de Cisneros et al. 2003, Drugat 2018).
96 Aragonite is a metastable polymorph of CaCO₃ in surface conditions, and tends to transform
97 into calcite, causing U loss and too old apparent U/Th age (e.g. Railsback et al. 2002,
98 Lachniet et al. 2012, Domínguez-Villar et al., 2017, Martín-García et al. 2019). This
99 transformation is likely at Nerja cave and could explain both the inverse relation between U
100 content and ²³⁰Th/²³⁴U ratios and the wrong U/Th ages obtained even if other more complex
101 mechanisms leading to open system behaviour cannot be excluded.

102 **3. Questioning the Neanderthal origin of Iberian rock art**

103 Hoffmann et al, 2016, 2018 and Pike et al. (2012, with U content published in Pike et al.,
104 2017) presented data from La Pasiéga, Ardales and Maltravieso Caves (north, south and
105 central Spain). The conclusions of these studies were intensely debated (Bednarik et al., 2012,
106 Clottes 2012, Pons-Branchu et al., 2014, Aubert et al., 2018, Slimak et al., 2018, Pearce and
107 Bonneau, 2018, White and al., 2019). Indeed, as some of the U/Th ages were older than 40
108 kyr, the authors suggested that the rock art in these caves was realized by Neanderthal people.
109 But as shown in figure 2, data from La Pasiéga, Ardales and Maltravieso Caves also display
110 an inverse relation between U content and ²³⁰Th/²³⁴U ratios or U/Th ages. The oldest ages
111 always corresponding to low U content.

112 The inverse link observed between U concentration and the age (or the ²³⁰Th/²³⁴U ratios) for
113 the three caves is similar to the one observed at Nerja Cave and can hardly be explained by
114 environmental change. We thus suggest that the oldest published ages for CaCO₃ layers
115 covering rock art from three Spanish caves could be altered by U loss (due to aragonite to
116 calcite transformation, as already observed at Maltravieso Cave by Mancha Flores, 2011, or
117 due to other phenomenon). Further studies in these caves, including mineralogical studies or
118 cross dating could be important for the knowledge of the rock art chronology.

119

120

121 **4. Conclusion**

122 This article highlights the complexity of the dating of parietal carbonate deposits in caves and
123 shows that it is essential to study in more details their formation and evolution in order to get
124 reliable results and establish a robust chronological framework for parietal art.

125 Further analysis should include when possible i) the use of a second chronometer for discrete
126 sampling, ii) mineralogical study in order to identify possible dissolution processes and
127 mineralogical transformations, iii) the analysis of the CaCO₃ layers not only in the part
128 covering rock art, but also laterally in order to understand its variability and check for its
129 preservation, iiiii) analysis of present day CaCO₃ formation.

130

131 **Acknowledgments**

132 The authors warmly thank J. Nouet for IR measurement and J. Barbarand for discussion, and
133 E Rowley Jolivet for language improvement.

134 The authors thank: Proyecto General de Investigación Interdisciplinar de la Cueva de Nerja,
135 (fundacion Cueva de Nerja), the ANR (ANR-18-CE27-0004) and the Spanish Science
136 Ministry HAR2017-87739-P. MAMA is a researcher of the PATHFINDER project
137 (HAR2017-82483-C3-1-P) and the prehistoric research team of the University of the Basque
138 Country (IT-622-13).

139

140 **Figure Caption**

141 Figure 1: Location of the CaCO₃ samples on the “Panel de las Focas” from Nerja Cave (left,
142 a). Relation between U content and ²³⁰Th/²³⁸U ratios for the studied samples (right, b). Dots:
143 data from the decorated panel; Squares: samples from the room, near the panel.

144 Figure 2: Relation between U content and ²³⁰Th/²³⁴U ratios (a) or ages (b) for La Pasiega Cave
145 data (Hoffmann et al., 2016: dots; Hoffman et al., 2018: squares). b) relation between U
146 content and ages for Maltravieso (c) and Ardales Caves (c), data from Hoffman et al. (2018).

147

148 **References**

149 -Aubert M, Brumm A, Huntley J (2018). Early dates for 'Neanderthal cave art' may be wrong.
150 *J. of human evolution*.

151 -Bednarik, R. G. (2012). U-Th analysis and rock art: a response to Pike et al. *Rock Art*
152 *Research: The Journal of the Australian Rock Art Research Association (AURA)*, 29(2), 244.

153 -Bischoff J et al. 2003. Aplicación del método de series de Uranio al grafismo rupestre de
154 estilo paleolítico : el caso de la cavidad de Covalanas (Ramales de la Victoria, Cantabria).
155 *Veleia* 20:143–50.

156 -Clottes J (2012) – Datations U-Th, évolution de l’art et Néandertal, *Inter. Newslet. on Rock*
157 *Art*, 64, pp. 1– 6.

158 -de Cisneros CJ et al. (2003). A record of Pleistocene climate from a stalactite, Nerja Cave,
159 southern Spain. *Pal., Pal., Pal.*, 189(1-2), 1-10.

160 -Domínguez-Villar, D., Krklec, K., Pelicon, P., Fairchild, I. J., Cheng, H., & Edwards, L. R.
161 (2017). Geochemistry of speleothems affected by aragonite to calcite recrystallization–
162 Potential inheritance from the precursor mineral. *Geochimica et Cosmochimica Acta*, 200,
163 310-329.

164 -Drugat L. (2018) Géochimie des spéléothèmes du sud-ouest de l'Europe (chronologie U-Th
165 et 14C, éléments traces, ⁸⁷Sr/⁸⁶Sr, δ¹⁸O, δ¹³C) appliquée aux reconstitutions climatiques et
166 environnementales à l'Holocène. PhD Dissertation, UVSQ.

167 -Duan WH et al. 2012, The growth mechanism of the aragonitic stalagmite laminae from
168 Yunnan Xianren Cave, SW China, revealed by cave monitoring. *Boreas*, v. 41, no. 1, p. 113–
169 123.

170 -Fernández-Díaz *et al.* 1996, The role of magnesium in the crystallization of calcite and
171 aragonite in a porous medium. *Journal of Sedimentary Research*, 66(3), 482-491.

172 -Fontugne M et al. (2013). Cross-dating (Th/U-14 C) of calcite covering prehistoric paintings
173 at Serra da Capivara National Park, Piauí, Brazil. *Radiocarbon*, 55(3), 1191-1198.

174 -Hoffmann DL et al. (2016). Methods for U-series dating of CaCO₃ crusts associated with
175 Palaeolithic cave art and application to Iberian sites. *Quat. Geochron.*, 36, 104-119.

176 -Hoffmann DL, et al. (2018). U-Th dating of carbonate crusts reveals Neandertal origin of
177 Iberian cave art. *Science*, 359(6378), 912-915.

178 -Lachniet MS, Bernal JP, Asmerom Y, Polyak V (2012). Uranium loss and aragonite–calcite
179 age discordance in a calcitized aragonite stalagmite. *Quat. Geochron.*, 14, 26-37.

180 -Mancha Flores E. (2011) *Geología sedimentaria y lugares de ocupación prehistóricos de la*
181 *cueva de maltravieso (Cáceres, España)* (Doctoral dissertation, Universitat Rovira i Virgili).

182 -Martín-García, R., Alonso-Zarza, A. M., Frisia, S., Rodríguez-Berriguete, Á., Drysdale, R.,
183 & Hellstrom, J. (2019). Effect of aragonite to calcite transformation on the geochemistry and
184 dating accuracy of speleothems. An example from Castañar Cave, Spain. *Sedimentary*
185 *Geology*, 383, 41-54.

186 -Medina-Alcaide MÁ, Sanchidrián Torti JL , Peña LZ (2015). Lighting the dark: wood
187 charcoal analysis from Cueva de Nerja (Málaga, Spain) as a tool to explore the context of
188 Palaeolithic rock art. *C. R. Palevol*, 14(5), 411-422.

189 -Pearce DG, Bonneau A. (2018). Trouble on the dating scene. *Nature ecology & evolution*,
190 2(6), 925.

191 -Pike AW et al., (2012). U-series dating of Paleolithic art in 11 caves in Spain. *Science*,
192 336(6087), 1409-1413.

193 -Pike, A. W., Hoffmann, D. L., Pettitt, P. B., García-Diez, M., & Zilhao, J. (2017). Dating
194 Palaeolithic cave art: Why U–Th is the way to go. *Quaternary international*, 432, 41-49.

195 -Plagnes, V., Causse, C., Fontugne, M., Valladas, H., Chazine, J. M., & Fage, L. H. (2003).
196 Cross dating (Th/U-14 C) of calcite covering prehistoric paintings in Borneo. *Quaternary*
197 *Research*, 60(2), 172-179.

198 -Pons-Branchu E et al. (2014). U-series dating of carbonate formations overlying Paleolithic
199 art: interest and limitations. *Bull. Soc. Préhist. française*, 111 (2) 211-224

200 -Railsback LB, Dabous AA, Osmond JK, Fleisher CJ (2002). Petrographic and geochemical
201 screening of speleothems for U-series dating: an example from recrystallized speleothems
202 from -Wadi Sannur Cavern, Egypt. *J. of Cave and Karst Studies*, 64(2), 108-116.

203 Sanchidrián JL 1994. Arte Rupestre de la Cueva de Nerja. *Fundación Cueva de Nerja Ed.*,
204 Málaga.

205 -Sanchidrián JL et al. (2017) New perspectives for 14C dating of parietal markings using
206 CaCO₃ thin layers: an example in Nerja cave (Spain). *J. of Archaeol. Sci. reports* 12. pp 74-80

207 Shao Q., Pons-Branchu E., Zhu QP., Wei Wang W, Valladas H, Fontugne.M. (2017). High
208 precision U/Th dating of the rock paintings at Mt. Huashan, Guangxi, southern China.
209 *Quaternary research*, 88 (1) 1-13

210 -Slimak L, Fietzke J, Geneste JM, Ontañón R (2018). Comment on “U-Th dating of carbonate
211 crusts reveals Neandertal origin of Iberian cave art”. *Science*, 361(6408), 1371.

212 -Valladas H et al. (2017) U/Th and C-14 cross dating of parietal calcite deposits: application
213 to Nerja cave (Andalusia, Spain) and future perspectives. *Radiocarbon* 59 (6). 1955-1967

214 -White, R., et al. (2019). "Still no archaeological evidence that Neanderthals created Iberian
215 cave art." *Journal of Human Evolution*: 102640.

216
217
218
219



