In situ terrestrial cosmogenic nuclide (TCN) dating of 'La falaise de la Mine d'Or' at Pénestin (SW Brittany, France) within the cron-BRET Project

Carlos Arce-Chamorro[1,2], Benjamin Sautter[3], Guillaume Guerin[4], Steve Binnie[5], Tibor Dunai[5], David Menier[1]

[1] UMR 6538 Geo-Ocean, Université de Bretagne Occidentale, CNRS, IFREMER
[2] Instituto Universitario de Geología Universidade da Coruña (Spain)
[3] Commission de la Carte Géologique du Monde, Paris
[4] UMR 6118 Géosciences Rennes, Université de Rennes, CNRS
[5] Institute of Geology and Mineralogy, University of Cologne (Germany)
Contact : carlos.arce@udc.es

The sedimentary units overlying the so-called 'Falaise de la Mine d'Or' at Pénestin (SW Morbihan, Brittany, France) have been studied for decades (see historical references in Guillocheau et al., 1998) to reconstruct the evolution of fossil fluvial valleys in Brittany during the Pliocene and Quaternary (Bonnet et al., 2000, Proust et al., 2001; Menier et al., 2006). However, published numerical data are insufficient to provide a precise age of each of the units described, being mostly correlations with ESR dating of fluvial sediments from the interior of Central Brittany (Laurent et al., 1996). Some authors (Van Vliet-Lanöe et al., 1997) associate these dates (ie, 455 and 317 ky) with the formation of the lower and upper units of this outcrop. Thanks to the cron-BRET Project of the COFUND-Bienvenüe Bretagne Programme carried out by the Geo-Ocean Laboratory of the Université de Bretagne Sud in collaboration with the Cosmogenic Nuclide Laboratory of the University of Cologne (Germany), it has been possible to date the lower unit (U1), mainly composed of quartzite gravels and pebbles. In situ 10Be and 26Al concentrations produced within the quartz of these clasts become controlled by differential rates of decay when shielded from production at the surface (Dunai, 2010). The fact that the sediments are buried under a sedimentary shield of more than three metres, allows for the calculation of a burial age from the concentration of 10Be and 26Al by using the isochron method (Balco and Rovey, 2008). Preliminary results provide numerical data that place the formation of this unit 2.72 ± 0.19 million years ago, at the Plio-Quaternary boundary. The next step being taken within this geochronological project focusing on the Brittany Coast is the optically stimulated luminescence (OSL) dating of the upper units at the RenDaL Luminescence Laboratory (CNRS- Géosciences-Rennes) of the University of Rennes1, as an active partner within the project to extend the available dates and the knowledge of this site.

Références

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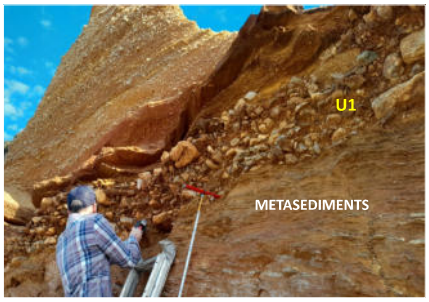
Carlos Arce-Chamorro[1,2,3], Benjamin Sautter[2], Guillaume Guèrin[3],Steven Binnie[4], Tibor J. Dunai[4], David Menier[2].

[1]Institute of Geology - University of Coruña, ESCI-Campus de Elviña, 15071, A Coruña, Spain. carlos.arce@udc.es
[2]CNRS, Geo-Ocean Lab., University of Bretagne Sud, UMR6538, 56000, Vannes, France
[3]CNRS, Géosciences, University Rennes1, UMR 6118, 35000, Rennes, France
[4]Institute of Geology and Mineralogy, University of Cologne, Zülpicher Str. 49b, 50674 Cologne, Germany

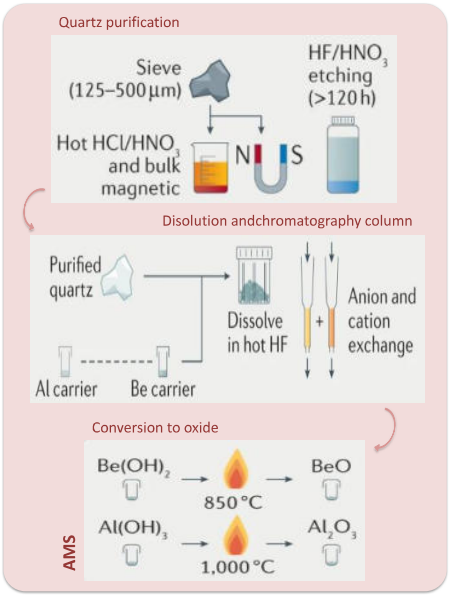


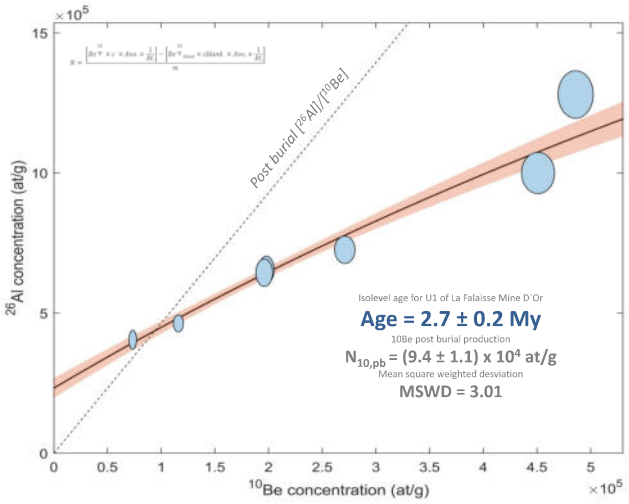
La Falaise de la Mine d'Or at Pénestin (SE Morbihan, Brittany) have been studied for decades to reconstruct the evolution of fluvial valleys in Brittany (Fig.1) during the Quaternary (Guillocheau et al., 1998). However, numerical data are insufficient to provide an age of the units described, being mostly correlations with fluvial sediments dated at the interior of Brittany (Laurent et al., 1998). Thanks to the cron-BRET Project (MSCA-Bienvenüe 2023) carried out by the Geo-Ocean Laboratory of the Université de Bretagne Sud in collaboration with the Cosmogenic Nuclide Laboratory of the University of Cologne (Germany), it has been possible to date the lower unit (U1), mainly composed of quartzite gravels and pebbles. As a consequence of the interaction of secondary cosmic rays with quartz minerals (mainly by spallation processes), in situ production of ^{10}Be and ^{26}Al takes place and their concentration increases proportionally to the time of exposure (Dunai, 2010). Furthermore, based on the differential decay of these unstable cosmogenics and the isolation of unit U1 from cosmic rays by the overlying sedimentary units (about 3-4 m), the isochron method (Balco & Rovey, 2008) allows estimating a burial age and post-burial production by deeply penetrating muons.

For each of the 8 quartz pebbles (5-10 cm approx.) analysed from unit U1, the accepted standard protocols (Dunai, 2010) were carried out for the purification and dilution of quartz, as a target mineral to estimate the in situ production of ^{10}Be and ^{26}Al. This includes crushing, milding, sieving, physical separation, chemical treatment (HCL/HF20%) and quartz dilution (HF 40%). ICP analysis for checking [Al], chromatography extraction and stable isotopes spiking (^{9}Be and ^{27}Al carriers) has been also carried out before AMS procedures. Ideally, the best isochrone fit between the [^{26}Al/^{10}Be] concentrations of clasts belonging to the same sedimentary unit, as an isolevel from which the same history could be assumed, would describe a relation that depends only on burial time (the slope), the known decay constants and post-burial production, the latter as a parameter that can be calculated on the basis of the depth (300 cm) and the density (1.9 g/cm^3) of the covering materials, being null when the [^{26}Al/^{10}Be] ratio starts from the origin.

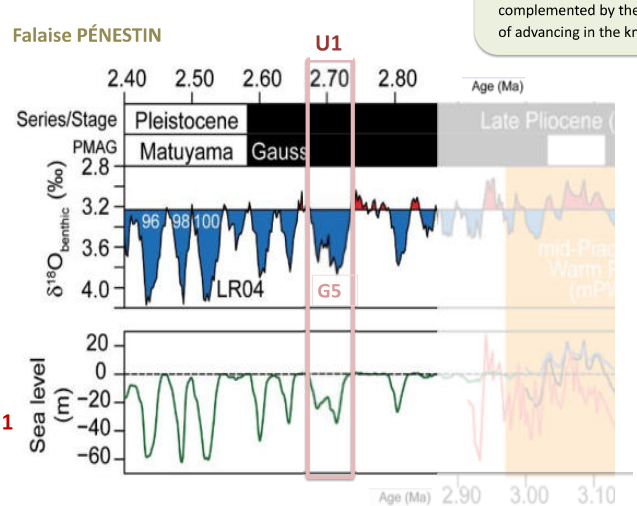
Magnetic separation for Qz

ICP: [^{27}Al/ ^{26} Al] ≈ 200 ppm





Considering a constant production rate and a known decay constant of ^{10}Be and ^{26}Al (Dunai, 2010), the slope of the best isolevel fit of the clasts analysed within the unit U1 yields and age of 2.72±0.19 My (1σ analytical error) with a mean square weighted deviation (MSWD) of 3.01 (Granger et al., 2022). This indicates that the data are fairly well spread along the line and a reliable age estimate. The isochron predicts a post-burial ^{10}Be production of 9.4±1.1x10^4 (at/y), which is slightly lower than expected during this time (3.5x10^5 at/y). This small discrepancy would indicate that the sedimentary cover above the U1 would be a few metres thicker (<200 cm). A variable depth of the upper units could therefore be assumed as a consequence of different erosion and sedimentation processes over more than 2.5 My. Optically Stimulated Luminescence (OSL) of quartz grains from the upper sedimentary units being carried out at the RenDaL Luminescence Laboratory (Géosciences-Rennes) within the project, will provide a better understanding of these processes. Based on this preliminary solution, unit U1 was deposited at the Plio-Quaternary boundary during the cold episode G5 (Lisiecki and Raymo, 2005), for which a glacioeustatic variation about -30 m (below present sea-level) is described. This first chronological approach will be complemented by the dating of other coastal sediments in South Brittany, also as part of the cron-BRET project, with the aim of advancing in the knowledge of the evolution of the Loire and Vilaine Basins (Menier et al., 2006) during the Quaternary.



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