Geochemistry, paleoenvironment and timing of Lower Aptian organic rich beds of Paja Formation (Eastern Cordillera, Colombia)

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Lower Aptian organic-rich marine sediments are interpreted with respect to anoxic episode, "Oceanic Anoxic Event 1a" (OAE-1a), coeval with $\delta^{13}C$ segments C3 to C6, of duration between 1.0 and 1.3 MA [1,2].

A 115m section of the Lower Aptian Arcillolitas Abigarradas Member of the Paja Fm at Villa de Leiva (Tunja-Villa de Leiva road) includes a prominent 4m-thick interval of black shale 10 meters below the base of the lowest Upper Aptian (Gargasian) *Dufrenoyia sanctorum-Stoyanowiceras treffryanus* ammonite assemblage zone [3]. Similarly, at the Curití Quarry (San Gil-Curití road), a 12m section includes 8m-thick organic-rich shale at the base of the Paja Fm, which overlies Barremian-age carbonate ramp deposits of the Rosablanca Fm. The base of the Paja Fm yielded reworked and phosphatized middle Barremian to lowest Aptian ammonites: *Pulchellia*, *Gerhardtia*, *Toxancycloceras*, *Karsteniceras* and *Prodeshayesites*. High-resolution analyses of these sections, including TIC (wt% $CaCO_3$), TOC (wt% C), and stable carbon isotope values ($\delta^{13}C_{org}$), characterize the stratigraphic relationship of these organic-rich levels of the Paja Fm and OAE-1a.

At Villa de Leiva, the organic-rich interval includes laminae associated with gypsum, pyritic concretions, absence of bioturbation and benthic fossils, and yielded increased TOC values (1.17% to 5.33%). These sediments accumulated under anoxic conditions in a subtidal, hypersaline environment [4]. C- isotope data show $\delta^{13}C_{org}$ values from -19.79‰ to -24.65‰. At Curití, the organic-rich sediments are devoid of benthic fossils and bioturbation, and TOC values are up to 8.4%, also indicative of oxygen-depleted conditions. C- isotope data yielded $\delta^{13}C_{org}$ values between -22.05‰ and -20.47‰. In both sections the range of $\delta^{13}C_{org}$ values, and the trend of the $\delta^{13}C_{org}$ curve are compatible with the Lower Aptian interval C7 [1, 2]. Therefore, both organic-rich intervals of the Paja Fm are subsequent to OAE-1a, which is known to occur between isotopic levels C3 and C6.

[1] Menegatti et al. (1998) *Paleoceano*. **13**, 530-545. [2] Li, Y-X. et al. (2008) *Earth Planet. Sci. Lett*. **271**, 88-100. [3] Etayo-Serna (1979) *Pub. Geol. Esp., INGEOMINAS* **2**, 186 pp. [4] Forero & Sarmiento (1985) *Pub. Geol. Esp., INGEOMINAS* **16**, XVII.1-XVII.16.

Beach placer, a proxy for the average Nd-Hf isotopic composition of a continental area

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Beach placer deposits concentrate detrital heavy minerals which are the erosion products of large areas of continental crust. Here, we report the first analyses of Nd-Hf isotopic ratios and trace element concentrations that we measured in a beach placer from Camargue, France and in its pure mineral separates. Both the bulk composition of the placer and those of its pure mineral separates were determined. We also report mineral proportions obtained using observations under a binocular microscope and X-ray microfluorescence cartography.

Our results indicate that monazite totally controls the placer Nd isotopic composition (ε_{Nd} = -9.3) while zircon dominates its Hf isotopes (ε_{Hf} = -13.0) even though both mineral phases represent only a small proportion of the heavy mineral assemblage (3.5 and 10% respectively). We demonstrate that the Camargue placer provides a good estimate of the average Nd and Hf isotopic composition of the continental area drained by the Rhone River in western Europe ($\varepsilon_{Nd} \approx$ -9 and ε_{Hf} = -13). Using these values, we calculate two-stages model ages and show that almost all the placer minerals are derived from Proterozoic crustal protoliths. This provides valuable information on the history of the continental crust drained by the Rhone River. In particular, it suggests that little juvenile crust was created during the recent geological events that formed the Alps and the Massif Central, the two main massifs from which the placer minerals originate.

More generally, we propose that similar measurements made on other worldwide beach placer deposits could provide estimates of the present-day Nd and Hf isotopic composition of large continental areas, values that are difficult to obtain due to the well-known heterogeneity of continental material but are essential to model the growth of continental crust through Earth history or to model the impact of crustal material when recycled into the mantle.