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Landscape response to Early-Eocene hyperthermals: a record of climate-controlled deltaic progradation in the Roda formation, South-Pyrenean foreland basin, Spain

Andres Nowak (1), Charlotte Laeuchli (1), Teodoro Hunger (1), Cai Puigdefabregas (2), Julian Clark (3), Miquel Poyatos-Moré (4), Thierry Adatte (5), Jorge Spangenberg (5), Emmanuelle Chanvry (6), and Sébastien Castelltort (1)

(1) Earth and Environment sciences, University of Geneva , Switzerland (andres.nowak@etu.unige.ch), (2) Universitat de Barcelona, Barcelona, Spain, (3) Statoil ASA, Stavanger, Rogaland, Norway, (4) University of Oslo, Oslo, Norway, (5) University of Lausanne, Lausanne, Switzerland, (6) Total SA, Pau, France

The Early Eocene Roda Sandstone Formation is a shallow marine deltaic depositional system composed of mixed siliciclastic and carbonate sediments deposited in the NE margin of the Tremp-Graus Basin, Southern Pyrenees, Spain. The Early Eocene was punctuated by important climate variations and carbon cycle perturbations (hyperthermals) superimposed on a long-term warming trend starting at the end of the Paleocene and culminating in the Early Eocene Climatic Optimum. The aim of this study is to document the links between these prominent early Eocene climatic signals and the stratigraphic evolution of the Roda formation in order to explore landscape response to hyperthermals.

We collected samples of fine-grained material at 1-3 meters resolution in two coeval sections of the Roda formation, one proximal section in the deltaic segment of the system (“Roda section”), and one distal section (“Las Colladas section”) in the shelfal area. We generated carbon and oxygen stable isotope profiles as well as major and trace elements for both section. Thanks to existing magnetostratigraphic constraints, the obtained isotopic profiles are correlated with target curves from ODP site 1258, which allow us to identify the presence of five hyperthermals corresponding to the I1, I2, J, ETM 3 and L events. We observe that deltaic progradation is systematically correlated with these hyperthermals, while carbonate deposition systematically occurs at the end of hyperthermals or in between. Based on analogy with similar observations in New Zealand (Slotnick and al., 2016), these results suggest that deltaic progradation of the Roda formation could be related to increased sediment transport and continental weathering due to enhanced hydrology during hyperthermals. Conversely, carbonate deposition could result from simple unavailability of sediment after hyperthermal “clearing events”. If this is correct, unlike classical sequence stratigraphic models, our results imply that deltaic progradation is primarily driven by climate-controlled sediment supply in a background of rising and high sea-level, while carbonate deposition represents maximum flooding because of a lack of available clastic material in generally lower sea-level stands. These findings also highlight the dominant role of climate on landscape evolution and stratigraphic records even in an active foreland basin.