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Identification and expression of the hyperthermal "U" in continental settings of the early Eocene Pyrenean foreland basin, Spain

Louis Honegger (1), Thierry Adatte (2), Jorge Spangenberg (3), Jeremy K. Caves Rugenstein (4), Miquel Poyatos-Moré (5), Cai Puigdefabregas (6), Emmanuelle Chanvry (7), Julian Clark (8), Andrea Fildani (8), Eric Verrechia (2), and Sébastien Castelltort (1)

(1) University of Geneva, Genève, Switzerland (louis.honegger@etu.unige.ch), (2) Institut des Sciences de la Terre, Université de Lausanne, Lausanne, Switzerland, (3) Institute of Earth Surface Dynamics, Université de Lausanne, Lausanne, Switzerland, (4) Geologisches Institut, ETH Zürich, Zürich, Switzerland, (5) Department of Geosciences, University of Oslo, Oslo, Norway, (6) Departament de Dinàmica de la Terra i l'Oceà, Universitat de Barcelona, Barcelona, Spain, (7) Institut de Chimie des Milieux et des Matériaux de Poitiers, Université de Poitiers & CNRS, Poitiers, France, (8) Equinor Research Center, Austin, Texas, USA

During the late Palaeocene to the middle Eocene (57.5 to 46.5 Ma) a total of 39 hyperthermals—periods of rapid global warming recorded by prominent negative carbon isotopic excursions as well as peaks in iron content—have been recognized in marine cores. Hyperthermals are recognized as periods during which the Earth system responded to rapid warmings and they could be reliable analogues for ongoing anthropogenic modifications. However, while hyperthermals are readily identified in the marine realm, only six have been recognized and described in continental deposits, thereby limiting our ability to understand the effect and record of global warming in terrestrial depositional systems. Identifying hyperthermal in the continental record is of fundamental importance to effectively study the correlations between marine and continental successions thus understanding signal propagation from land to sea. In this study, we use the well-exposed and time constrained fluvial sedimentary succession of the early Eocene Castissent Formation, South Central Pyrenees (Spain), to propose a new stable isotopic record of an early Eocene hyperthermal. Profiles of δ13C from pedogenetic carbonate nodules reveal the hyperthermal event "U" at ca 50 Ma and a robust correlation with the global δ13C profile. We document a stepped δ13C negative excursion and a relative enrichment in immobile elements (Zr, Ti, Al) in red beds and an iron-barite nodule layer, interpretable as product of more intense weathering and/or longer exposed soils that we associate with landscape stability during a short-lived climatic peak. Results of this study yield insights into the recognition of hyperthermal events in continental successions as well as in the preservation potential of such deposits, and highlight the need to use multi-proxy studies to adequately identify and characterize extreme climatic events in the stratigraphic record.