Geophysical Research Abstracts
Vol. 18, EGU2016-15412-1, 2016
EGU General Assembly 2016

Lake evolution during the Early Danian Dan-C2 hyperthermal, Boltysh impact crater, Ukraine

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Lacustrine facies record complex relationships between lake evolution and environmental conditions and provide proxies for climate changes. However, lacustrine successions formed during past hyperthermals as recorded from negative carbon isotope excursions (CIEs) are of limited availability and thus less well understood. Here, we present a complete lacustrine record of the Early Danian Dan-C2 hyperthermal at c. 65.2 Ma from a core drilled in the K-Pg Boltysh impact crater, Ukraine. This borehole allows a detailed facies analysis and reconstruction of lake evolution and associated plant ecosystem in correspondence with rapid climate change.

The Boltysh borehole reveals a c. 400 m thick siliciclastic and organic-rich succession overlying impact melt-breccia dated at 65.17 $\pm$ 0.64 Ma. Based on detailed core logging, 8 distinctive facies associations are identified, including 1) littoral mudstones, 2) siliciclastic shoreline deposits, 3) siliciclastic littoral to sublittoral deposits, 4) mudstone laminites, 5) organic-rich mudstones, and deposits of 6) coarse-grained, 7) fine-grained density currents, and 8) debris flows.
Based on the occurrence of these facies associations 3 major phases of lake evolution are distinguished: 1) an initial pre-CIE rising clastic-dominated lake phase characterised by the presence of coarse-grained density and debris flow deposits, 2) an organic-rich fluctuating shallow lake phase during the main phase of the CIE, characterised by alternating packages of the mudstone laminites and organic-rich mudstones; and 3) a rising clastic-dominated lake during and post-CIE recovery phase, which shows a high presence of siliciclastic shoreline and littoral to sublittoral deposits.

This study provides a full record of lacustrine response to climate change during the Dan-C2 hyperthermal, and subsequently allows us to infer lake formation and environmental conditions at different stages during climate warming. The high resolution sedimentary record together with present palynological data will allow us to analyse the effects and timing of short-term and long-term climatic variations during the hyperthermal. This has important implications for our understanding of response patterns of ancient terrestrial environments and ecosystems to climate changes, but will also help to better understand environmental changes derived from modern climate warming.