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Late Pleistocene and Holocene Climatic Variability in the Carpathian-Balkan Region

ABSTRACTS VOLUME

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Rapid shifts in environmental conditions inferred from geochemical analyses of Lake Stiucii lacustrine record, Transylvanian Lowlands, Romania

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Introduction

Extensive proxy data and modeling suggest that the environmental response to climate forcing varied both spatially and temporarily even during the current interglacial (Davis et al., 2003; Davis and Brewer, 2009). The drivers of these short-term shifts in climate are of multiple origins, ranging from solar irradiance, periodic shifts in the regional expression of atmospheric circulation (e.g., NAO phases) to the episodic cold-water forcing of North Atlantic surface waters. Recently Magny et al. (2013) provided a comprehensive overview of regional climate change during the Holocene and its reflection in local hydrological data and water levels. Although these studies suggest a degree of regionalism in the climate signal, which might be expected, the most intriguing hypothesis is the so-called seesaw gradient, expressed as latitudinal and longitudinal differences in climate over relatively short distances (Davis et al., 2003; Davis and Brewer, 2009). In central-eastern Europe it is likely that the distribution of mountain ranges contributed even further to this climate fragmentation, therefore a regional scale perspective of the temporal development of climatic conditions and phase-relationships requires an increasing spatial resolution in proxy records (Drăgușin et al., 2014).

Rationale

Here we reconstruct past environmental conditions based on sedimentological (grain-size, lithostratigraphy, magnetic susceptibility) and geochemical (xrf-derived elemental data, loss-on-ignition parameters) data acquired on a transect of cores from Lake Stiucii, the largest natural

water body in the Transylvanian Lowlands, and whose sedimentary record extends from last glacial to present (Feurdean et al., 2013). We discuss past sediment dynamics and in-lake biogeochemical processes as reflected by sediment geochemical and lithological characteristics, and use this information to shed light on the sedimentological evolution of the basin. Lastly, we provide a multi-proxy perspective on the Holocene palaeoenvironments in the Transylvanian Lowlands through a detailed comparison with other regionally representative palaeoclimatic records.

Results

The lake basin is likely to have formed initially during Marine Isotope Stage 3 and persisted up to the late glacial as a shallow pond characterized by low organic productivity and a mainly clastic sediment input; however, this part of the record is also affected by erosional boundaries and hiati. Deposition of minerogenic sediments during the GS-1 Younger Dryas time interval indicates a phase of increased catchment erosion, whereas the onset of the Holocene warming is reflected in a sharp rise in organic content and a decrease in sediment input into the basin. However, strong insolation forcing, and the postulated regional atmospheric circulation reorganisation during the early-to-mid Holocene, ensured relatively dry and warm conditions, which resulted in low water levels, wetland development and peat formation which persisted until ca. 5-5.5 ka BP. Over this period however, rapid climate change events at 10.4 ka, 9.6 ka, 8.2 ka and 6.5 ka are clearly reflected by our proxy data as periods of slight increases in clastic sediment input, and decreasing overall productivity. Following a gradual increase in water depth from 5.5 ka BP, the lake level rose suddenly at around 4.7 ka BP in line with the sedimentation of clayey materials. The basin-wide deposition of clays effectively sealed the basin bottom and favored the onset of a second stage of lacustrine conditions that have persisted to the present day. As the reconstructed record of lake-level variations suggest, this abrupt change in environmental conditions may indicate the establishment of the currently dominant Atlantic atmospheric circulation patterns, that provide most of the moisture received by this area. However, significant variations in the lake level are seen over this period that also coincides with increasing human impact in the area through land-use management (Feurdean et al., 2013).

Conclusions

Our geochemical and sedimentological study shows that Lake Stiucii preserves a detailed archive of late glacial-Holocene climate change responses. It provides an unprecedented view on the past regional climate dynamics in the Transylvanian Lowlands that controlled variations in catchment stability, lake internal dynamics and productivity. Given the sensitivity of this lake to hydrological forcing, our data provide a robust framework for interpreting past climate changes in this region with respect to both natural climate variations and also to the marked human impacts during Late Holocene. Moreover, our data show that such hydrologically sensitive water bodies reacted closely to threshold changes, including climate boundary conditions such as prolonged droughts, cold spells or episodes of intensive runoff. These attributes suggest that other shallow water basins in Transylvania and the surrounding Carpathian Lowlands may provide sensitive archives for assessing the characteristics of past environments in a region where such data remain very sparse.

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