Reconstruction of dust provenances and environmental conditions from 70-12.5 ka by a combined analysis of geochemical elements and heavy minerals from Dehner dry maar (De3-core; Germany)

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The study presents the results of a combined analysis of heavy minerals, X-ray fluorescence analysis of bulk samples, and grain size analysis from a 84 m long core section of the Dehner dry maar (Eifel, West Eifel Volcanic Field). The core section (De3) ranges from 3 to 87 m depth and encompasses lacustrine sediments which have been supplied by aeolian activity during a period from 12,500 b2k to about 70,000 b2k (Sirocko et al, 2016).

The analysis enabled the distinction of different provenance areas of aeolian material. Local sources are indicated in the content of clinopyroxene and sphene which are supplied mostly from pyroclastic material in the nearer surroundings of the Dehner dry maar. Particularly during the LGM the limestone basins of the Eifeler North-South Zone in the east of the Dehner dry maar represented further local source area (Römer et al., 2016). During this period easterly winds transported carbonate particles to the Dehner dry maar. Zircon, tourmaline and rutile suite minerals (ZRT) indicate regional source areas and were supplied by westerly winds from clastic sedimentary basement rocks of the Eifel, whilst epidote suite minerals and green amphiboles are documenting more remote source areas in the west.

The distribution of heavy minerals (HM) shows a close correspondence particularly to trace elements and heavy metals, not affected by redox transformations. Trace elements such as zirconium are closely associated with HM characterizing regional and more remote dust sources. Heavy metals such as nickel and copper, on the other hand, are mostly associated with clinopyroxene and dark micas (phlogopite, biotite) indicating a supply of pyroclastic material from the nearer surroundings of the Dehner dry maar. The downhole distribution of the heavy minerals (HM) and geochemical elements displays similarities with the “Landscape Evolution Zones” of Sirocko et al.

(2016), with a striking correspondence from the transition of the MIS 3 to the MIS 2 onwards to the LGM. With respect to dust transport, the close parallelism between the Grains Size Index (GSI) after Antoine, et al. (2009), the content of ZRT and epidote and green amphibole group minerals tends to reflect the transporting power of aeolian processes and the availability of deflatable material in the different source areas. This supports the distinction of phases of dust transport/deposition, whilst the increasing degree of mixing of heavy minerals from different source areas during the LGM at times of decreasing GSI suggests the development of a presumably incomplete blanket of
reworked loessic sediments the Eifel. In contrast to the analysis of the HM assemblage geochemical analysis of bulk samples provides further insights on the environmental conditions as several elements reacted on redox conditions in the maar lake. Changes in the concentration of these elements provide a link to environmental and climate reconstruction. The combined analysis of HM, geochemical elements, and grain-size on the other hand, improves the reconstruction of environmental conditions and supports issues related to provenance analyses. The study implies that it may be also possible to determine provenance sensitive geochemical elements. Whilst HM analysis is more sensitive in provenance studies than geochemical element analysis the combined analysis of HM and geochemical elements provides a more comprehensive view on the environmental and climatic conditions.

References

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