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Heterogeneous sources of marlstone in a piggy-back basin: the Neogene Lopare basin in Dinarides

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The chemical composition of marlstones is commonly not used to investigate to provenance of the sedimentary basin fill because of variable dilution by authigenic carbonate and the assumed uniformity of the clay fraction. Here, we report geochemical compositions of marlstone from the Neogene Lopare basin in Internal Dinarides, which have an unusual chemical composition reflecting at least two different sources. The Lopare basin formed as a piggy-back basin on top of the growing Dinaric orogenic wedge. Much of its Miocene evolution, this basin represented a partly hypersaline lake in a warm climate likely formed during the Miocene Climatic Optimum during Early Miocene. Several lithofacies of marlstone reflect basin center deposits and the chemical composition could be considered as well mixed from external siliciclastic input (clay fraction) and internal carbonate precipitation. Sandstone layers are very thin and are not considered here.

A total of 46 samples from two boreholes POT-3 (depth to 344 m) and POT-1 (depth to 193 m) were selected for geochemical investigation. The contents of major, minor and trace including rare earth elements were determined by inductively coupled plasma atomic emission spectrometry (ICP-AES). The qualitative composition of the mineral part was determined by means of X-ray diffractometry.

The main chemical features of the Lopare basin marlstone are variable but high contents of most metals like Fe (5.36 $\pm$ 1.05 wt%), Cr (215 $\pm$ 34 ppm), Ni (183 $\pm$ 36 ppm), Pb (173 $\pm$ 43 ppm), but also of some alkalies like Li (340 $\pm$ 123 ppm). Particularly the heavy metal contents like Cr, Ni, Fe are much higher than for average continental mudstones (e.g., Taylor and McLennan, 1985). These contrasting compositions may result from two geochemically different sources: (1) Ophiolites (oceanic source) occurring in the neighborhood are responsible for high Cr, Ni, Fe contents, while (2) the increased alkali contents (e.g., Li; continental source) likely results from continental sources enriched by evaporation of the lake water.

When weathered to soils, the high heavy metal contents represent a significant geogenic hazard and could potentially represent a hazard for surface and groundwater, too.