



Testing the Alpine provenance of heavy minerals in the Rhine: New results from single grain geochemical analyses of detrital garnets and amphiboles

Julian Hülscher and Heinrich Bahlburg

Westfälische Wilhelms-Universität Münster, Institut für Geologie und Paläontologie, Münster, Germany
(j_huel07@uni-muenster.de)

The Upper Rhine Graben (URG) is a major continental rift system in central Europe. At its flanks the metamorphic Black Forest and Vosges Mountains rise. Since the opening of the URG in the late Eocene a repeated input of alpine detritus is registered. From 2.9 Ma onward the Swiss Molasse Basin was drained into the URG. In sediments > 2.9 Ma in the URG the heavy mineral assemblage was dominated by zircon, rutile and tourmaline, upsection this changes to a dominance of garnet, epidote and green hornblende. This so-called “Alpine Spectrum” is recorded along the Rhine from the URG to the North Sea but maybe is not delivered exclusively from the Alps. Potential sources are also located along the URG, including Black Forest and Vosges. We test the question of whether the Alpine Spectrum is exclusively derived from the Alps and whether sources in Black Forest and Vosges need to be considered as well. Toward this end we have performed a single grain geochemical provenance analysis for garnets and amphiboles.

We have sampled recent sediments from three rivers of the Swiss Molasse Basin, one river from the Vosges Mountains and three from the Black Forest to characterise the heavy mineral suites derived from these sources. This we combine with samples from the Rhine which represent the sink and which we obtained from drill cores near Freiburg and Pfungstadt. We added a sample from the Heidelberg Nord drill core to account for input from the Neckar. Main element geochemistry of ~330 amphiboles and ~850 garnets grains were analysed via electron microprobe. The results were used to perform a linear mixing model in order to quantify the influence of the different source areas.

This is the first data set of this kind in the area. Garnets from the sources and the sinks are mostly dominated by almandine and show a varying content of pyrope, spessartine and grossular. The garnets from the Black Forest and the Vosges Mountains are enriched in pyrope and depleted in almandine, compared to the garnets from the Alps. Both sinks show similar garnet chemistry, which can be correlated to both sources but seems to be dominated by alpine garnets.

The amphiboles from both sources and sinks are dominated by Mg-Hornblende (52-86%) and show a varying amount of Fe-Hornblende, actinolite, hastingsite, tschermakite and sadanagite. In the sinks, $\text{TiO}_2/\text{SiO}_2$ values of the amphiboles show a trend from low values in the drill core close to Freiburg to high values in the drill core Pfungstadt. The amphiboles from the Black Forest show homogeneous values comparable to the values from Pfungstadt amphiboles. Amphiboles from the Alps are heterogeneous in their $\text{TiO}_2/\text{SiO}_2$ values.

The results from the geochemical analyses of the amphiboles are difficult to reconcile with the hypothesis of a heavy mineral spectrum derived exclusively from the Alps. If our results are confirmed by ongoing analysis, the system of sediment derivation and its routing to the URG in the Quaternary may have to be reconsidered.