Pb and Hf isotope composition of hornblende-bearing lavas (Central European Volcanic Province): a lithospheric mantle source?

BERNHARD MAYER[1*], STEFAN JUNG[1], ROLF L. ROMER[2], CARSTEN MÜNKER[3]

[1] Universität Hamburg, Mineralogisch-Petrographisches Institut, Hamburg, Germany, Bernhard.Mayer@uni-hamburg.de (* presenting author)
[2] Deutsches GeoForschungsZentrum, Potsdam, Germany
[3] Universität zu Köln, Institut für Geologie und Mineralogie, Köln, Germany

Primitive alkaline mafic volcanic rocks – like the hornblende-bearing basanites from the Rhön area (Central European volcanic Province; CEVP) – provide important information about the chemical composition in the Earth's mantle. The presence of amphibole requires wet melting conditions; hence the source for the hornblende-bearing lavas is thought to be located in the lithospheric mantle. Strontium and Nd isotope compositions are well within the range commonly observed in CEVP magmas (εNd: +3.4 to +4.4; $^{87}Sr/^{86}Sr$: 0.7034-0.7041) and, although moderately evolved, are not indicative of crustal contamination.

Beside some differences in major and trace element geochemistry and Sr and Nd isotopes relative to other primitive volcanic rocks in CEVP, the Pb isotope composition is broadly similar to lavas from other volcanic centers located in the eastern part of the CEVP (i.e., Vogelsberg, Hessian Depression) in having $^{206}Pb/^{204}Pb$ ratios < 19.5, which contrasts to the Pb isotope composition of volcanic centers in the west (Eifel, Siebengebirge, Westerwald) with $^{206}Pb/^{204}Pb$ ratios > 19.5. The Rhön lavas have Pb isotope compositions ($^{206}Pb/^{204}Pb$: 19.1-19.4, $^{207}Pb/^{204}Pb$: 15.61-15.64, $^{208}Pb/^{204}Pb$: 38.9-39.2) that plot slightly above the NHRL (Northern Hemisphere Reference Line) in the $^{206}Pb/^{204}Pb$-$^{207}Pb/^{204}Pb$ and $^{206}Pb/^{204}Pb$-$^{208}Pb/^{204}Pb$ diagram, indicating that the source of the western CEVP must have a slightly higher U/Pb and Th/Pb ratio than the source of the eastern CEVP. In general, the Pb isotope compositions of the lavas plot at the unradiogenic end of Pb isotope range obtained on mantle xenoliths from the CEVP.

The hornblende-bearing lavas have initial εHf values ranging from +4.6 to +6.6, which is at least one εHf unit lower than in other lavas from the CEVP having similar εNd values and Pb isotope compostions. Since the Lu/Hf ratios of the hornblende-bearing lavas are similar to other lavas from the CEVP, the Hf isotope composition must be a source feature which is related to distinct Lu/Hf ratios in the mantle. The less radiogenic Hf isotope composition requires a source with a time-integrated lower Lu/Hf ratio relative to the mantle that produced other CEVP lavas with more radiogenic Hf isotope compositions. This inferred lower Lu/Hf ratio is compatible with a mantle with less or even no garnet, i.e. the spinel-bearing lithospheric mantle. Alternatively, participation of metasomatism-related minerals with low Lu/Hf ratios can explain the inferred slightly lower Lu/Hf ratios of the mantle source.

Sources and Seasonal Transformations of Nitrate in Lake Winnipeg (Manitoba, Canada)

BERNHARD MAYER[1]* AND LEONARD I. WASSENAAR[2]

[1] University of Calgary, Calgary, Alberta, Canada, bmayer@ucalgary.ca (* presenting author)
[2] Environment Canada, Saskatoon, Saskatchewan, Canada, current e-mail: L.Wassenaar@iaea.org

Lake Winnipeg (Manitoba, Canada) is in an eutrophic state from a century of increased riverine loadings from agricultural and urban nitrogen (N) and phosphorus (P) sources. This study investigated seasonal patterns of the isotopic composition of nitrate (NO_3^-) in Lake Winnipeg and its contributing rivers to gain insight into current N nutrient sources and in-lake N dynamics. Elevated NO_3^- concentrations in Lake Winnipeg tributaries between 0.36 and 2.44 mg/L NO_3^--N were associated with high $\delta^{15}N$ values between +5.0 and +13.9 ‰, while $\delta^{18}O_{NO3}$ values were <+15.0 ‰. The three major riverine inputs had distinctive mean $\delta^{15}N_{NO3}$ values of +8.1 ‰ for the Red River, -0.6 ‰ for the Winnipeg River, and +5.0 ‰ for the Saskatchewan River. The isotopic composition of NO_3^- in Lake Winnipeg was partly controlled by the isotopic composition of the riverine nitrate for instance via the predominant nitrate input to the South basin from the Red River. Nitrate assimilation and late season mineralization of phytoplankton and N_2 fixing cyanobacteria were identified as important additional processes affecting the isotopic composition of lake NO_3^- resulting in low $\delta^{15}N_{NO3}$ values, especially in the North basin. In the South basin, elevated $\delta^{15}N_{NO3}$ values in spring that changed to lower values by summer indicated a dynamic N cycle within the lake. This study demonstrates the need for sesoanlly resolved concentration and isotope analyses on samples from a large number of sampling sites to assess the highly dynamic in-lake fate of nitrogen inputs to Lake Winnipeg.