



## **Geochemical features of lithospheric mantle beneath Wilcza Góra (Eger Rift, SW Poland): inferences from noble gases and CO<sub>2</sub> in fluid inclusions of peridotite xenoliths**

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The investigation of mantle-derived products coming from the subcontinental lithospheric mantle (SCLM) is crucial for constraining its geochemical features and evolution. This work investigates a selection of mantle xenoliths from Wilcza Góra (SW Poland), integrating the petrography and geochemistry of minerals with the chemical and isotope composition of fluid inclusions.

These xenoliths were brought to the surface by intraplate alkaline basalts, intensely outpoured a few tens of kilometres outside the northern part of the Eger Rift, a NE branch of the Rhine-Eifel Rift. Nodules are mostly harzburgites with occurrence of amphibole. Olivine crystals are classified in two groups based on forsterite content: 1) Fo<sub>88.9–91.5</sub>, which account for a fertile to depleted mantle; 2) Fo<sub>85.5–88.1</sub>, which testify for a large interaction with circulating (basic) melts. Analogously orthopyroxene and clinopyroxene show two ranges of mg# (molar Mg/Mg+Fe) and clear evidences of recrystallization due to interaction with metasomatic melt/s (Matusiak-Malek et al., 2017).

Fluid inclusions hosted in minerals are dominated by CO<sub>2</sub>, as independently observed in a previous study (Ladenberger et al., 2009), with N<sub>2</sub> as second major species. The carbon isotope composition of CO<sub>2</sub> ( $\delta^{13}\text{C}$  V-PDB) ranges between  $-4.7\%$  and  $-3.1\%$  and is not related to the CO<sub>2</sub> concentration excluding any influence of magmatic degassing. Olivine crystals have a slightly less negative ratios ( $-3.8\pm 0.4\%$  compared to orthopyroxene ( $-4.1\pm 0.4\%$ ), falling within typical MORB range ( $-8\% < \delta^{13}\text{C} < -4\%$ ). At the best of our knowledge, these  $\delta^{13}\text{C}$  data are the first ever reported for European SCLM, representing a reference for evaluating surface emissions. The  $^3\text{He}/^4\text{He}$  corrected for air contamination (Rc/Ra) varies between 5.9 and 6.2 Ra in olivine, between 6.3 and 6.8 Ra in orthopyroxene, between 6.7 and 6.9 Ra in clinopyroxene. These values are within the range proposed for European SCLM ( $6.1\pm 0.9$  Ra). The increase of  $^3\text{He}/^4\text{He}$  from olivine to clinopyroxene is decoupled from helium concentration. The geochemistry of He, Ne, and Ar coupled to that of N<sub>2</sub> and CO<sub>2</sub>, shows systematic differences between olivine and pyroxene crystals in some key ratios (i.e.,  $\text{He}/^{40}\text{Ar}^*$ ,  $\text{He}/\text{CO}_2$ ). These differences are not related to diffusive fractionation of helium from fluid inclusions, because occur at almost constant or even increasing  $^3\text{He}/^4\text{He}$ . Alternatively, the mantle has been modified by variable extents of partial melting, which is in accordance with the main evidences from the host mineral chemistry. Instead, orthopyroxene and clinopyroxene suggest the overprinting of at least one metasomatic event postponing partial melting. As suggested by Matusiak-Malek et al. (2017), clinopyroxene, orthopyroxene, and amphibole have been added to the pristine harzburgite by carbonated hydrous silicate melt related to Cenozoic volcanism. This process allowed the entrapment of CO<sub>2</sub>-rich inclusions resembling the chemical and isotope composition of the metasomatizing fluids. As a result, our data reflect a mixing of two terms: 1) the residuum mantle, modified by partial melting and with  $^3\text{He}/^4\text{He}$  typical of SCLM; 2) the metasomatic agent, strongly He-depleted and characterized by a MORB-like  $^3\text{He}/^4\text{He}$ . These two terms *de facto* represent the main processes occurring with different timing in the mantle beneath Wilcza Góra.