HETEROGENEITY IN THE LITHOSPHERIC MANTLE BENEATH THE EUROPEAN PLATE: A CONTINENT-WIDE REVIEW

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ABSTRACT

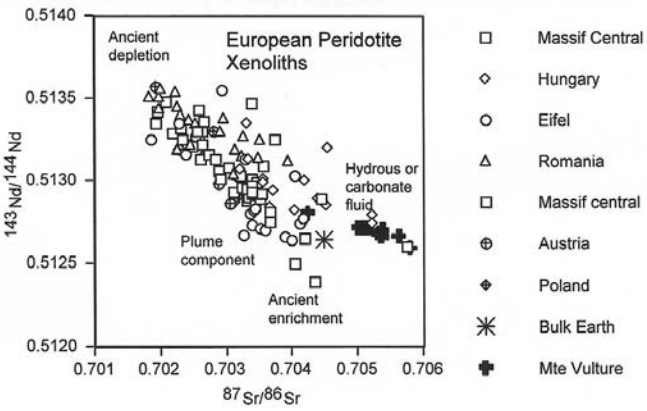
Heterogeneity in the shallow subcontinental lithospheric mantle (SCLM) can occur over a wide range of length scales, from kilometers down to microns. If the SCLM is examined on a continent-widescale (following the approach of Menzies and Bodinier, 1993), numerous similarities emerge in lithology, mineralogy, isotopic and trace element compositions, and age of the SCLM. Significant differences among spinel-facies xenolith suites are also highlighted by this method and can be attributed to a variety of major mantle processes. In this review, I will discuss examples of shallow SCLM xenolith suites from different tectonic settings across the European continent, and will compare them with examples from well-established tectonic settings from elsewhere in the world.

The most obvious observation is the consistency of modal mineralogical abundances in spinel peridotite xenolith suites from the European SCLM and worldwide, which must be related to a first order process, probably partial melting. Thus, it is relatively simple to identify regions of anomalous SCLM in which the observed rock-types deviate from the norm, implying significantly different mantle processes. These processes include alkali silicate metasomatism, interaction with carbonatite fluids (s.l.) and/or subduction zone enrichment. However, alkali silicate melt metasomatism and subduction zone enrichment do not always produce significant deviations in modal abundances of minerals, although the introduction of amphibole and/or phlogopite can be observed. In contrast, interaction between carbonatite melt and SCLM almost always induces strong modal changes in mantle mineralogy towards that of wehrlite.

An example of alkali-silicate melt metasomatism of previously depleted lithospheric mantle is well documented in the French Massif Central (Zangana et al., 1997; 1999). Prior to the metasomatism, the lithospheric mantle was largely LREE-depleted, similar to the depleted mantle represented in the ultramafic massifs of the eastern Pyrenees (Downes et al., 1991). The effect of metasomatism by silicate magmas derived from an upwelling asthenospheric plume beneath the region (Hoernle et al., 1995) is mainly one of increasing LREE-enrichment and offsets in the Sr and Nd isotope composition towards that of the plume component (see Figure). Pb isotopes also show similar shifts from depleted mantle to plume component (Wilson et al., in prep).

An area in Europe that displays typical depleted mantle geochemistry is the Eastern Transylvanian Basin (Vaselli et al., 1995). Despite the apparent proximity to recent subduction in the Carpathian arc, the vast majority of the SCLM xenoliths are LREE-depleted and their bulk rock chemistry shows no evidence of interaction with subduction-zone fluids. In contrast, xenoliths from the central part of the neighbouring Pannonian Basin display strong evidence of interaction with subduction-related fluids and melts (Downes et al., 1992; Wilson et al., 1997). This enrichment affects Pb isotopes in constituent clinopyroxenes, with consistent high $^{207}Pb/^{204}Pb$ ratios at a given value of $^{206}Pb/^{204}Pb$ (i.e. deviation from the NHRL towards the field of sea-floor sediments). $^{87}Sr/^{86}Sr$ isotope ratios are also elevated during this interaction.

Carbonatite metasomatism has been documented in xenoliths from Spitsbergen by Ionov et al. (1993). We present evidence for similar metasomatic activity in peridotite xenoliths from Monte Vulture in Italy (Jones et al., submitted) and the Kola peninsula (Beard et al., in prep). The xenoliths were originally harzburgitic in composition but have become wehrlitic due to the interaction with carbonatite fluids. $^{87}Sr/^{86}Sr$ ratios in the constituent clinopyroxenes are higher than in other regions of the European SCLM (see Figure) and trace elements patterns are also strongly affected.



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