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Symplectite in spinel lherzolite xenoliths from the Little Hungarian Plain, Western Hungary: A key for understanding the complex history of the upper mantle of the Pannonian Basin

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Abstract

Two spinel lherzolite xenoliths from Hungary that contain pyroxene–spinel symplectites have been studied using EPMA, Laser ablation ICP-MS and universal stage. Based on their geochemical and structural characteristics, the xenoliths represent two different domains of the shallow subcontinental lithospheric mantle beneath the Pannonian Basin. The occurrence of symplectites is attributed to the former presence and subsequent breakdown of garnets due to significant pressure decrease related to lithospheric thinning. This implies that both mantle domains were once part of the garnet lherzolitic upper mantle and had a similar history during the major extension that formed the Pannonian Basin.

Garnet breakdown resulted in distinct geochemical characteristics in the adjacent clinopyroxene crystals in both xenoliths. This is manifested by enrichment in HREE, Y, Zr and Hf towards the clinopyroxene porphyroclast rims and also in the neoblasts with respect to porphyroclast core compositions. This geochemical feature, together with the development and preservation of the texturally very sensitive symplectites, enables us to determine the relative timing of mantle processes. Our results indicate that garnets had been metastable in the spinel lherzolite environment and their breakdown to pyroxene and spinel is one of the latest processes that took place within the upper mantle before the xenoliths were brought to the surface.
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Keywords: Lherzolite; Xenolith; Symplectite; Garnet breakdown; Pannonian Basin

1. Introduction

Upper mantle peridotite xenoliths in the Pannonian Basin (PB) have been the focus of extensive petrologic and geochemical research mainly on depletion and enrichment processes (e.g., Szabó and Taylor, 1994; Downes and Vaselli, 1995; Szabó et al., 1995a,b; Vaselli et al., 1995, 1996; Dobosi et al., 1999; Embey-Isztin et al., 2001; Bali et al., 2002; Szabó et al., 2004 and

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references therein). Deformation and recrystallization of lithospheric mantle xenoliths in response to basin formation have also been investigated (e.g., Szabó et al., 1995b; Falus et al., 2000, 2004; Falus, 2004). A strong link between deformation/recrystallization state and geochemical features of the mantle xenoliths has been established (e.g., Downes et al., 1992; Szabó and Taylor, 1994; Szabó et al., 1995a; Falus, 2004).

The Little Hungarian Plain Volcanic Field (LHPVF) is well-known for xenoliths in the PB (Embey-Isztin et al., 1989; Szabó et al., 1995b). Mantle xenoliths found here are generally porphyroclastic, equigranular and rarely secondary recrystallized (called 'poikilitic' by Embey-Isztin, 1984). The xenoliths are generally spinel lherzolites, but some harzburgites were also found (Embey-Isztin et al., 1989, Kurat et al., 1991; Downes et al., 1992). Our recently collected mantle xenoliths from the Gérce location in the LHPVF are porphyroclastic spinel lherzolites. Some of them contain, however, relatively large (2–5 mm in diameter) symplectites, consisting of pyroxene and spinel. Such symplectites may have formed during garnet breakdown like other symplectites in mantle rocks worldwide (e.g., Van Der Wal and Vissers, 1996; Medaris et al., 1997; Morishita and Arai, 2003). Symplectites in two geochemically different LHPVF xenoliths are the subject of this study. We propose that the peridotites were originally derived from the garnet lherzolite stability field and carry valuable information on the deep lithosphere beneath the central portion of the PB. Detailed microstructural fabric and geochemical analysis of these mantle rocks enable us to date deformation, metasomatism and partial melting relative to garnet breakdown and symplectite formation.

2. Geological background

The Pannonian Basin is a back-arc basin of the Carpathian arc with anomalously thin lithosphere (40–60 km) formed at a late stage in the Alpine orogeny (e.g., Tari et al., 1993; Cavazza et al., 2004; Schmid et al., 2004). The major driving forces for basin formation were continuous subduction and roll back on its northern and eastern boundaries and synchronous eastward extrusion of

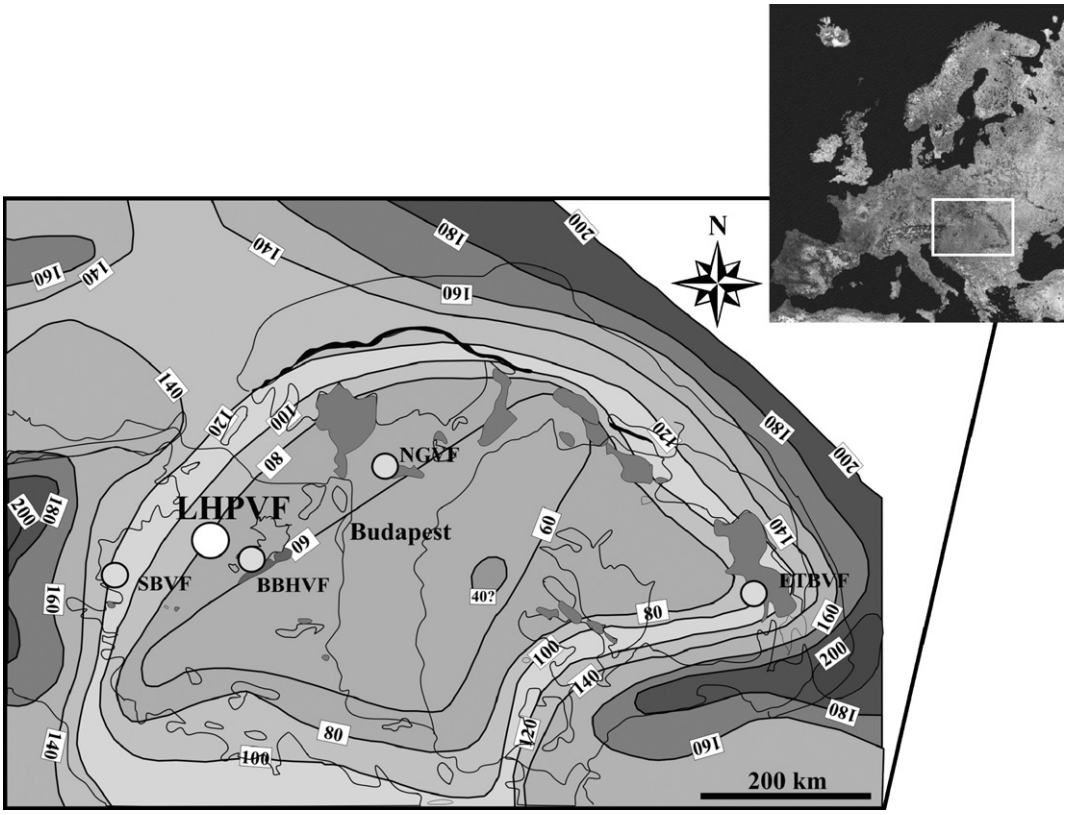

Fig. 1. Geological sketch map of the Pannonian Basin with lithospheric thickness (Horváth, 1993) and its position in Europe. Mantle xenolith locations are also indicated: SBVF — Styrian Basin Volcanic Field; LHPVF — Little Hungarian Plain Volcanic Field; BBHVF — Bakony-Balaton Highland Volcanic Field; NGVF — Nógrád-Gömör Volcanic Field; ETBVF — Eastern Transylvanian Basin Volcanic Field.

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