



High-pressure granulites of the Podolsko complex, Bohemian Massif: An example of crustal rocks that were subducted to mantle depths and survived a pervasive mid-crustal high-temperature overprint



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ABSTRACT

The Podolsko complex, Bohemian Massif, is a mid-crustal migmatite–granite dome exposed along a tectonic boundary separating the upper crust from the deeply eroded interior of the Variscan orogen, referred to as the Moldanubian Zone. This study examines metamorphic history of mafic and felsic granulites that occur in this complex as minor lenses or layers hosted in pervasively anatectic rocks. The mafic granulite contains garnet with preserved high-Ca cores, which based on pseudosection modelling indicates pressure conditions near the coesite stability field at temperatures of ca. 550–600 °C. The relicts of an earlier eclogite-facies stage have been overprinted by a later granulite-facies assemblage consisting of ternary feldspar, orthopyroxene, and spinel in the mafic granulite and sillimanite and spinel in the felsic granulite. Composition of younger garnet (in rims and as smaller grains) in both granulites suggests that a near isothermal decompression of these rocks was followed by heating that reached temperature of ca. 900 °C at pressure of ca. 0.5 GPa. It is thus concluded that the granulites underwent at least two temporally separate tectonometamorphic events: they were first subducted to mantle depths and exhumed rapidly at relatively low temperatures and then near isobarically heated at mid-crustal levels. The preservation of earlier eclogite-facies garnet in the mafic granulite indicates that the latter event was short-lived and was followed by near isobaric cooling. The geologically brief granulite-facies metamorphism was previously explained as a result of slab break-off and mantle upwelling after the main phase of microplate convergence in the Bohemian Massif. To put the Podolsko complex into a broader tectonic context, we synthesize the available petrologic and structural data from the correlative (U)HP assemblages of the Moldanubian Zone to suggest that they typically do not preserve structural record of the subduction stage, only rarely preserve an early exhumation phase to the middle crust, and most, if not all, have been extensively overprinted by late-stage processes at shallower crustal levels. This synthesis also reveals that kinematics and thus tectonic processes driving the final exhumation of the (U)HP rocks were diverse and may vary from one location to another. These local settings include exhumation in the footwall of major extensional detachments, due to folding and subsequent lateral extrusion, and along crustal-scale strike-slip shear zones. The extensive late-stage overprint masking the earlier (pre-340 Ma) subduction history is greatly exemplified in the Podolsko complex where the granulites are only small relicts in pervasively anatectic rocks melted at mid-crustal conditions and then rapidly exhumed along extensional detachments to upper-crustal levels.

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1. Introduction

Recent progress in petrologic research showed that many collisional orogens (even those with pervasive Barrovian metamorphic overprint) preserve evidence for an earlier subduction history (e.g., Dobrzhinetskaya, 2012; Dobrzhinetskaya and Faryad, 2011; Liou et al., 2009, 2014; and references therein). Mineral reactions in relict, less overprinted assemblages may thus reveal an early stage of decompression and cooling resulting from exhumation of high-pressure (HP)

rocks. The near-isothermal decompression P–T paths have been commonly explained as reflecting a low-temperature gradient and fast exhumation along the subduction zone (e.g., Baziotis et al., 2009; Chopin, 1984; Ernst, 1979, 1988, 2006; Maruyama et al., 1996; Peacock, 2003). It has been well established that the significance of such even volumetrically minor and sparse relicts of HP rocks for reconstructing the tectonic evolution of collisional orogens is enormous: they provide hints on location of oceanic sutures and thus former plate boundaries and can be used to constrain the subduction polarity and to test competing tectonic models of orogenic development. Unfortunately, the exhumed HP rocks may be significantly displaced and reworked during the late-orogenic, medium- to low-pressure and

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high-temperature metamorphism and deformation, leaving the exact mechanisms and timing of their exhumation and incorporation into mid-crustal units enigmatic.

An excellent case example of an ancient large hot collisional orogen which preserves relics of HP rocks and where the above issues have been vigorously debated is the Bohemian Massif, the easternmost inlier of the Variscan belt in Europe (Fig. 1). The Bohemian Massif is a mosaic consisting of several principal lithotectonic units amalgamated during the Devonian to Carboniferous convergence of the Gondwana and Laurussia supercontinents (Fig. 1; e.g., Edel, 2001; Kroner and Romer, 2013; Nance et al., 2010; Tait et al., 1997; Winchester, 2002; Winchester et al., 2006; and references therein). These units in the Bohemian Massif have been variously correlated with broadly similar units across the Western Europe to define three main zones of the orogen: Rhenohercynian, Saxothuringian, and Moldanubian (Fig. 1a). However, the plate-tectonic significance of these units, whether they represent microplates or lithospheric blocks once separated by oceanic domains, and thus also the location, polarity, and timing of Variscan subductions have been a matter of long-standing

controversy. To date, several competing plate-tectonic reconstructions have been proposed for the Variscan orogenic development of the Bohemian Massif (e.g. Franke, 2006; Edel et al., 2003; Finger et al., 2007; Schulmann et al., 2009, 2014; Babuška and Plomerová, 2013; Faryad et al., 2013a, 2015). In this context, any new piece of information from HP rocks may add to the vigorous debate and may help to test and refine the existing tectonic models.

This paper presents new petrologic data and thermobarometric estimations from the Podolsko complex, a poorly known and largely unexplored migmatite–granite dome that contains relics of (U)HP garnetites and variously retrogressed granulite-facies rocks exhumed along a major lithotectonic boundary in the south-central Bohemian Massif (Fig. 1b). Despite extensive late-stage reworking, mineral assemblages in the granulites preserve two metamorphic events. An earlier event was presumably related to subduction-zone metamorphism of crustal rocks that may even have reached (U)HP conditions; whereas, a younger event was MP–HT granulite-facies metamorphism. Based on the new data and thermobarometry, we compare the P–T paths proposed for the granulites of the Podolsko

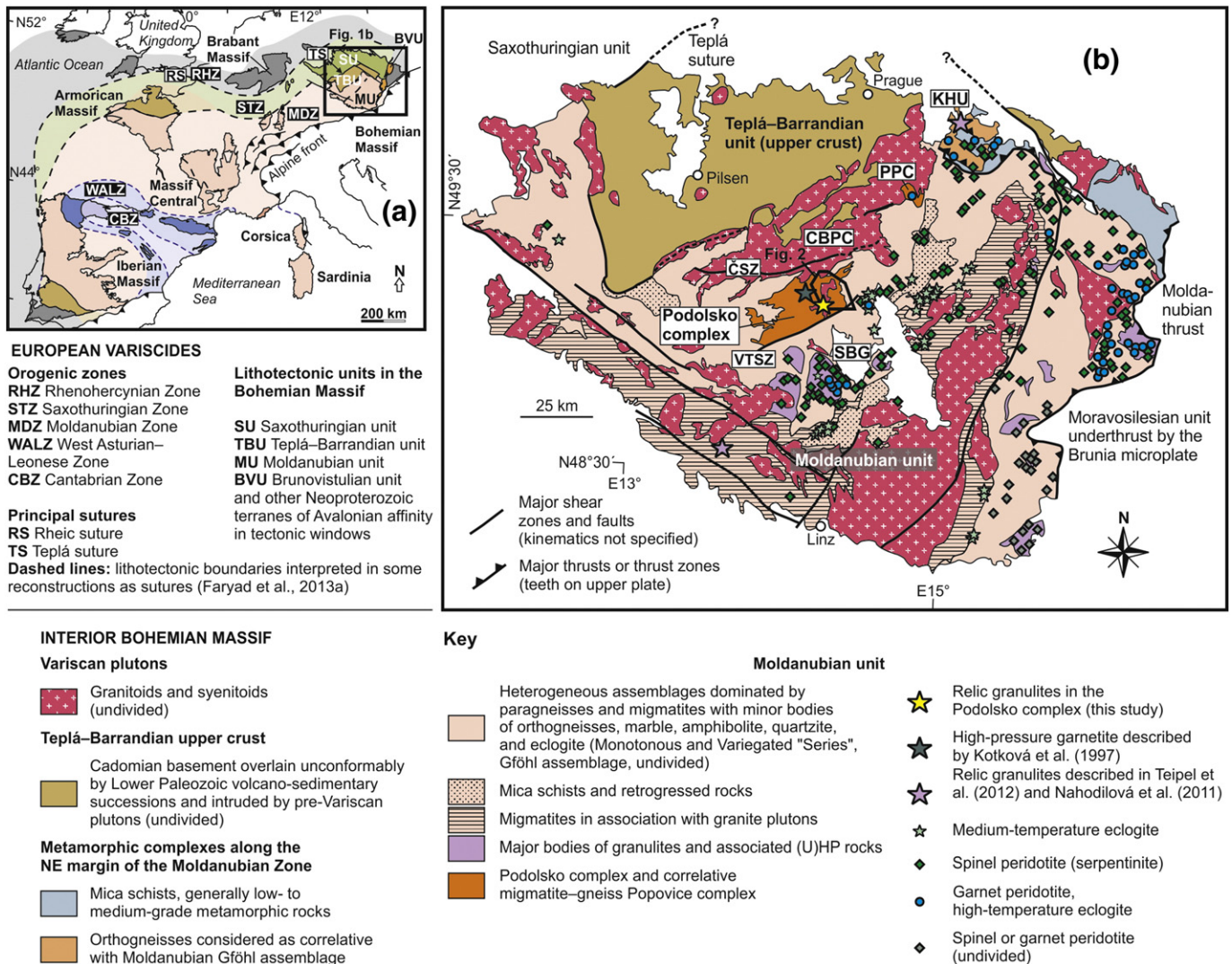


Fig. 1. (a) Overview geologic map showing basement outcrop areas and principal lithotectonic zones and presumed sutures of the Variscan orogenic belt in Europe. Bohemian Massif is the easternmost inlier of the orogen. Compiled from Winchester (2002), Asch (2003), and Martínez Catalán (2011, 2012), presumed sutures redrafted from Faryad et al. (2013a). (b) Greatly simplified geologic map of the interior Bohemian Massif emphasizing geologic units and tectonic features discussed in the text. Coloured symbols show main occurrences of small-sized bodies of HP–UHP rocks (approximate locations, after Vrána et al., 1995 and Faryad et al., 2013a). Compiled from Fusán et al. (1967) and Cháb et al. (2007). CBPC—Central Bohemian Plutonic Complex, ČSZ—Červená shear zone, KHU—Kutná Hora unit, PPC—Popovice complex, SBG—South Bohemian granulites, VTSZ—Vodňany–Týn nad Vltavou shear zone.

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