Chemie der Erde 76 (2016) 299–308

Contents lists available at ScienceDirect

Chemie der Erde

journal homepage: www.elsevier.de/chemer

Melt impregnation phases in the mantle section of the Ślęża ophiolite (SW Poland)

Piotr Marian Wojtulek[a,*], Jacek Puziewicz[a], Theodoros Ntaflos[b]

[a] University of Wrocław, Institute of Geological Sciences, pl. Maksa Borna 9, 50-204 Wrocław, Poland
[b] University of Vienna, Department of Lithospheric Research, Althanstraße 14, 1090 Vienna, Austria

ARTICLE INFO

Article history:
Received 8 December 2015
Received in revised form 18 March 2016
Accepted 20 March 2016
Editorial handling - A. Holzheid

Keywords:
Ophiolite
Harzburgite
Non-serpentine phases
Melt percolation
Variscan orogen

ABSTRACT

The ultramafic member of the Variscan Ślęża Ophiolite (SW Poland) consists of heavily serpentinised, refractory harzburgites. Those located down to 1.5 km below paleo-Moho contain scarce grains or aggregates of olivine, clinopyroxene and spinel. Non-serpentine phases occur in various assemblages: M1—olivine (Fo 90.2–91.0%, NiO 0.38–0.47 wt.%) and rounded or amaeboidal aluminous chromite, rimmed by Al poor chromite and magnetite; M2—olivine (Fo 90.5–91.5, NiO 0.32–0.44 wt.%), olivine with magnetite inclusions (Fo 87.1–92.5, NiO 0.01–0.68 wt.%), rounded, cleavaged clinopyroxene I (Mg# 91.1–93.2, Al_2O_3 3.00–4.00 wt.%, Cr_2O_3 1.00–1.40 wt.%) and elongated clinopyroxene II and clinopyroxene from symplectites with magnetite (Mg# = 92.2–94.1, Al_2O_3 2.20–3.20 wt.% and Cr_2O_3 0.80–1.20 wt.%). Clinopyroxene is depleted in REEs relative to chondrite. The M3 assemblage consists of intergrown olivine (Fo 90.8–92.7, NiO 0.20–0.38 wt.%) and clinopyroxene (Mg# = 96.0–98.1, Al_2O_3 0.00–1.00 wt.% and Cr_2O_3 0.20–0.60 wt.%).

The M1 assemblage contains chromite which records greenschist-facies metamorphism. Textural relationships and chemical composition of clinopyroxene occurring in the M2 assemblage are similar to those formed in oceanic spreading centres by LREE depleted basaltic melt percolation. Olivine occurring in M1 assemblage and part of that from M2 have composition typical of residual olivine from the abyssal harzburgites and of olivine formed in those rocks by melt percolation. The olivine with magnetite inclusions (M2 assemblage) and that from M3 record later deserpentinization event, which supposedly produced also M3 clinopyroxene. The non-serpentine phases from the Ślęża ophiolite mantle member, albeit very poorly preserved, document depleted basaltic melt percolation in the Variscan oceanic spreading centre.

1. Introduction

Ophiolites are remnants of ancient oceanic crust and upper mantle, coming from the various tectonic settings (Dilek and Furnes, 2014), which are included in orogens. They consist of spatially and temporally associated ultramafic, mafic and sedimentary rocks (Dilek and Furnes, 2014). The geological setting of ophiolites is still a matter of debate, although their mostly suprasubduction origin is widely accepted (Nicolas and Boudier, 2003).

Mantle parts of ophiolites consist of peridotites, which typically record polybaric multiple melting episodes, which occur during gradual uplift of the asthenospheric protolith under the spreading centre. The repeated melting events gradually remove the melt-compatible elements from the evolving rock, producing eventually the "depleted" harzburgite composition, from which no or little melt can be extracted under conditions occurring in the oceanic mantle (Walter, 1999).

Melt produced during partial melting of peridotitic protolith is basaltic. In fact its composition varies broadly depending on the composition of peridotite protolith at the onset of melting, on local P and T conditions during succeeding melting episodes and on how much melt was produced in the episodes preceding the current one. This melt is migrating upwards and reacting with the overlying peridotite, which leads to local overprint of melting record by melt-induced metasomatism. The migration of melt may variously affect the peridotitic host, which is visible both in ophiolites and in abyssal peridotites (e.g. Dick and Natland, 1996). The initial stages of the process may be of cryptic nature and lead only to the incompatible-elements enrichment in the relic clinopyroxene (Warren and Shimizu, 2010). The "dunite channels" in peridotitic

* Corresponding author.
E-mail address: piotr.wojtulek@interia.pl (P.M. Wojtulek).

http://dx.doi.org/10.1016/j.chemer.2016.03.004

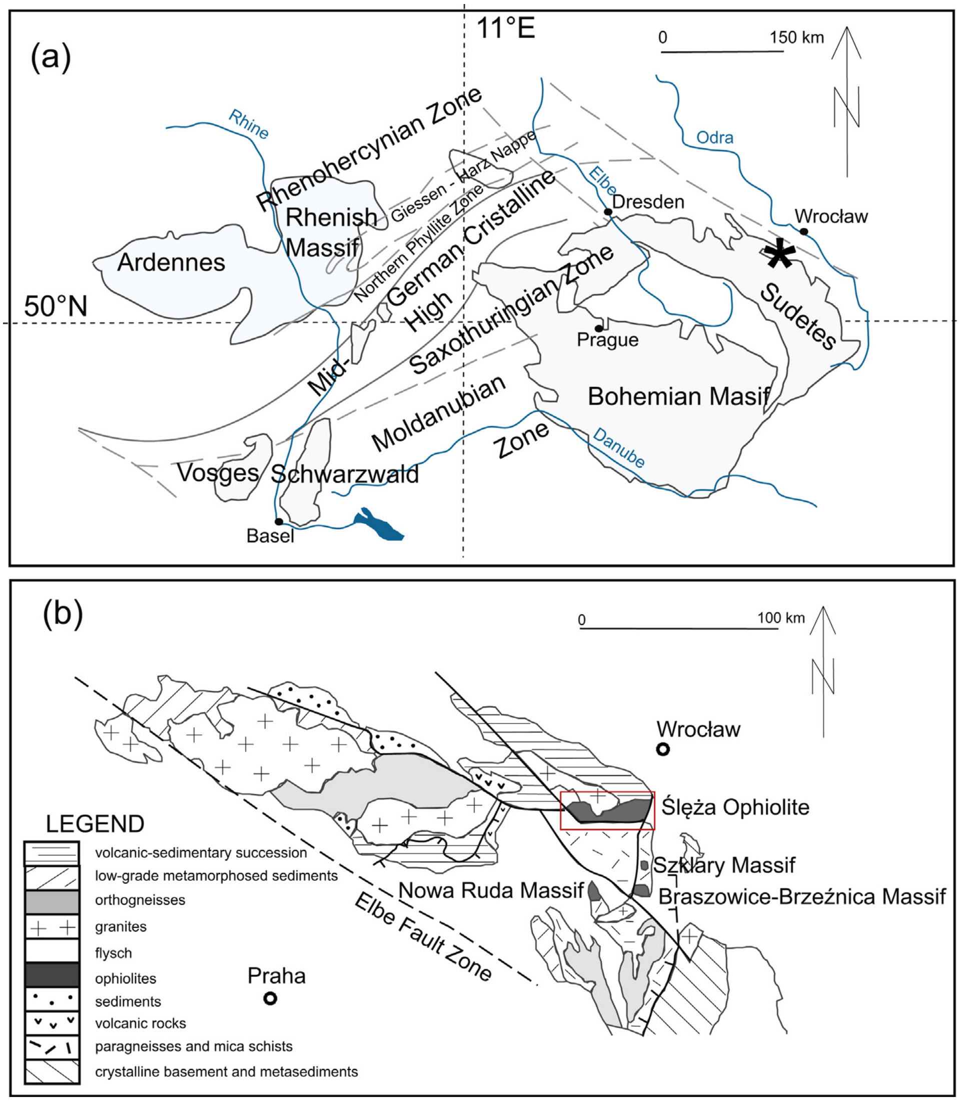

Fig. 1. Location of the Ślęża Ophiolite relative to Variscan basement outcrops in Central Europe (a), modified from Kossmat (1927) and relative to major geological units of Sudetes (b), modified from Aleksandrowski and Mazur (2002).

members of ophiolites originate by replacement of orthopyroxene by olivine in high porosity conduits, in which melt flow was concentrated (Kelemen et al., 1995). Reactive melt percolation is also possible during pre-oceanic rifting in subcontinental setting, as was demonstrated by Piccardo et al. (2007) in Lanzo peridotites. The IAT/boninitic volcanism recorded in ophiolites from supra-subduction settings (e.g. Beccaluva et al., 2005; Dokuz et al., 2011) may also be connected with lava-peridotite reaction in the mantle. Pyroxenite, chromitite and gabbro veins, occurring in the mantle parts of ophiolites also originate due to the basaltic melt migration. Thus, the mantle parts of ophiolites record long and complex history of melting episodes and rock-melt reactions.

The peridotitic members of ophiolites are commonly serpentinised to a different degree. Serpentinization operates because of sea-water circulation in the giant hydrothermal systems generated at spreading centres. The attachment of ophiolitic sequences to the orogen during subduction of the oceanic plate may also lead to local temperature and pressure increase and further serpentinization. The serpentinization obliterates the record of earlier events in the mantellic members of ophiolites. The good example of heavily serpentinised mantle member of ophiolite is that in the Variscan Ślęża ophiolite (NE margin of the Bohemian Massif, SW Poland; Kryza and Pin, 2010 and references therein). The peridotitic protolith of mantle member of ophiolitic sequence is almost completely serpentinized. In this paper we describe sparse relics of olivine and clinopyroxene, as well as the accompanying chromite, occurring in the Ślęża serpentinites. We show that despite strong alteration of their host rock, part of the relics preserve the record of their origin by basaltic melt percolation in the peridotite.

2. Geological setting

The Ślęża Ophiolite is one of the Central Sudetic Ophiolites (Kryza and Pin, 2010). It occurs in the mosaic of allochtonous tectonic units, which were squeezed between the Brunia and Saxo-Thuringia forming the Central Sudetes, and supposedly represent the fragmented accretionary wedge (Mazur et al., 2015). It is located in the Fore-Sudetic Block, part of the Sudetes Mts. in the NE part of the Bohemian Massif (Fig. 1). The Ślęża Ophiolite has preserved a complete ophiolite pseudostratigraphic sequence (Fig. 2) consisting of (from S to N) serpentinites, serpentinized rocks rich in pyroxene and amphibole, metagabbros, amphibolites and metamorphosed radiolarian cherts (Majerowicz, 1979). These rocks are interpreted as (respectively) mantle peridotites, ultramafic cumu-