Eclogites of the Western Carpathians revisited

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Abstract: An overview and new investigations of eclogites from the crystalline basement of the Western Carpathians are presented. On examples from the Low Tatra Mts. (Veporic Unit) and the Western Tatra Mts. (Tatric Unit) thermodynamic modelling of pseudosections constrained the stability of the observed mineral assemblages in terms of compositions and P–T conditions. The new data show that these rocks, in spite of strong retrogression, reached eclogite facies conditions thus supporting previous investigations.

Introduction

Eclogite facies rocks are vestige of deep crustal subduction during an orogenic cycle, providing important information about the depth of subduction. The term *eclogite* as a petrographic rock name is restricted to rocks of broadly basaltic composition which lack primary plagioclase and have a predominant assemblage of jadeite-bearing clinopyroxene (omphacite) and garnet. True eclogites have previously been unknown in the Western Carpathians. However, microtextures indicating former eclogite facies stage have been observed in the amphibolite facies metabasites (garnet–clinopyroxene amphibolites) in several places of the pre-Mesozoic basement of the Central Western Carpathians, mainly in the core mountains of the Tatric Unit, e.g. Tribeč Mts. (Hovorka & Méres 1990), Malá Fatra Mts. (Hovorka et al. 1992 ; Janák & Lupták 1997), Western Tatra Mts. (Janák et al. 1996), Low Tatra Mts. (Méres et al. 2008; Janák et al. 2009) and Branisko Mts. (Faryad et al. 2005). In these rocks a high-pressure stage is indicated by sympletite textures characteristic for breakdown of omphacite to dopside and plagioclase.

Low Tatra Mts. eclogite (Veporic Unit)

First finding of omhacite-bearing eclogite (Fig. 1) in the Western Carpathians was reported from the Low Tatra Mts. in the Veporic Unit near Heľpa village (Janák et al. 2007). Here, eclogites together with garnet-bearing ultramafic rocks (Grt+Ol+Opx+Sp) occur as lenses and boudins in the kyanite-bearing ortho- and paragneisses derived from Cambro–Ordovician protoliths. Omphacite with the highest jadeite content (~40 mol. %) occurs as inclusions in the garnet whereas omphacite with lower jadeite content (20–30 mol. %) occurs in the matrix. Most of clinopyroxene has jadeite content below 19 mol. %, forming the symplectites with plagioclase, amphibole and quartz. Conventional geothermobarometry on eclogite facies assemblage garnet+omphacite +phengite+quartz (Ravna & Terry 2004) constrained the maximum pressure and temperature conditions of around 2.5 GPa and 700 ^{o}C (Janák et al. 2007).

Western Tatra Mts. eclogite (Tatric Unit)

In the Western Tatra, strongly retrogressed eclogites form lenses in banded amphibolites being accommodated in a hangingwall (Upper unit) of an inverted metamorphic sequence, above the micaschists in the footwall (Lower unit). Exhumation of eclogites was facilitated by ductile extrusion and mid-crustal thrusting during the Variscan orogeny. In eclogites, primary omphacite (Cpx I) has been wholly converted to symplectites of diopside (Cpx II) and plagioclase and therefore these rocks have been described as garnet–clinopyroxene amphibolites (Janák et al. 1996). The attainment of the eclogite facies stability field was inferred from the composition of a "reconstructed" omphacite

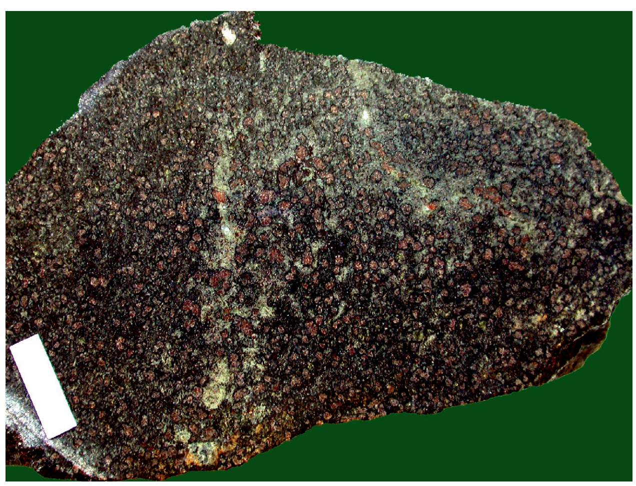

Fig. 1. Eclogite from the Low Tatra Mts. (Veporic Unit). Scale bar (white rectangle) is 1 cm (Janák et al. 2007).

(Jd36 mol. %), implying a minimum peak-pressure of 15–16 kbar. The Sm/Nd dating of garnet from eclogite in the Western Tatra yields 342 Ma age, which likely records cooling during exhumation (Moussallam et al. 2012).

Thermodynamic modelling

Isochemical phase diagrams (P–T pseudosections) have been calculated using the Perple_X thermodynamic software (Connolly 1990, 2005: version 6.8.6) with the internally consistent thermodynamic dataset (hp11 version) of Holland & Powell (2011). Solid-solution models for garnet, white mica (White et al. 2014), omphacite (Green et al. 2007), plagioclase (Holland & Powell 2003), amphibole (Dale et al. 2005) were used. The bulk rock composition was determined from the whole-rock XRF analysis.

The pseudosection for Helpa eclogite (VV-40) from the Veporic unit of the Low Tatra Mts. shows that the calculated isopleths of clinopyroxene and white mica match the measured compositions of omphacite and phengite in the stability field of garnet+omphacite+ phengite+rutile+quartz, in spite of partial re-equilbarion of garnet due to retrogression. The compositions of omphacite (Jd ≥30 mol. %) and phengitic white mica (≥ 3.45 Si a.p.f.u) thus constrain the pressure values to 2.2–2.4 GPa at 650–700 °C. These conditions are consistent with previous P–T estimates obtained from conventional geothermobarometry) implying subduction to depths of around 80 km (Janák et al. 2007).

The pseudosection for Baranec eclogite (ZT-17) from the Western Tatra Mts. (Tatric Unit) shows that model compositional isopleths of clinopyroxene corresponding to composition of "reconstructed" omphacite (Jd36 mol. %) and measured clinopyroxene (Jd10 mol. %) constrain the pressure conditions from 1.7–1.0 GPa during exhumation. The peak-pressure assemblage stable at ≥17 GPa would be garnet+omphacite+rutile+quartz. These results are in agreement with the previous P–T estimates and interpretations that the garnet–clinopyroxene amphibolites of the Western Tatra Mts. are in fact retrogressed eclogites (Janák et al. 1996).

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