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Early Variscan *P-T* evolution of an eclogite body and adjacent orthogneiss from the northern Malpica-Tuy shear-zone in NW Spain

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Abstract: An eclogite and its surrounding gneiss from the Malpica-Tuy zone, northwestern Spain, were studied. In addition to garnet and omphacite, the eclogite contains barroisitic amphibole, quartz, phengite with Si contents between 3.27 and 3.45 per formula unit (pfu), rutile, and accessory talc and (clino)zoisite–epidote. Garnet exhibits a chemical zonation with $Alm_{59}Prp_{13}Grs_{24}Sps_4$, $Alm_{57}Prp_{13}Grs_{27}Sps_3$, $Alm_{56.6}Prp_{12.5}Grs_{30.2}Sps_{0.7}$, and $Alm_{54}Prp_{20}Grs_{25}Sps_1$ as inner core, outer core, inner rim, and outermost rim compositions, respectively. The gneiss is a former granodiorite now mainly composed of quartz, plagioclase, K-feldspar, biotite, garnet, (clino)zoisite–epidote, and phengite with Si contents between 3.27 and 3.38 pfu. Garnet shows inner core, outer core, and rim compositions of $Alm_{26.9}Prp_{0.2}Grs_{70}Sps_{2.9}$, $Alm_{33.8}Prp_{0.7}Grs_{64}Sps_{1.5}$, and $Alm_{42.6}Prp_{1.4}Grs_{54}Sps_2$, respectively. A series of *P–T* pseudosections, calculated with PERPLE_X for the bulk-rock compositions of the studied eclogite and gneiss, were contoured by isopleths of various parameters, including molar fractions of garnet components. Using mainly the variable garnet and phengite compositions and these isopleths, *P–T* paths were derived. After an isothermal burial path the eclogite reached peak pressures of 22.5 kbar at 540°C. The subsequent exhumation path passed through *P–T* conditions of 21 kbar and 575°C and 13.5 kbar and 625°C. The latter data represent the peak *P–T* conditions of the gneiss. These *P-T* data suggest that the protolith of the eclogite, a basic rock of an island-arc setting, underwent high-pressure metamorphism in a subduction zone. During its exhumation it came in contact with the buried metagranodiorite, representing the tip of a descending continental plate, at depths of 45–50 km probably 350–355 Ma ago.

Key-words: continental collision; eclogite; garnet zonation; high-pressure metamorphism; Malpica-Tuy zone; orthogneiss; *P–T* path.

1. Introduction

High-pressure (*HP: P* > 10 kbar) rocks such as eclogite- and blueschist-facies rocks commonly occur in major suture zones of collided continental plates. These rocks are frequently interpreted as the result of continental subduction (*e.g.*, Guillot *et al*., 1997; Jahn, 1999; Pullen *et al*., 2008; Nakano *et al*., 2010; Ravna *et al*., 2010; López-Carmona *et al*., 2014a). However, these interpretations are often based on a few studied rocks only. In addition, *HP* metabasites are the dominant rock-types in these studies although gneisses usually predominate in the field. Studies that considered the pressure-temperature (*P–T*) evolution of both eclogites and adjacent gneissic country-rocks (*e.g*., Krogh, 1981; Willner *et al*., 2000; Godard, 2009) are rare. In general, these studies came to the conclusion that the gneisses experienced *HP* conditions. However, there are examples where the related eclogites had experienced significantly higher pressures than the country rocks (Willner *et al*., 2000; Massonne, 2012). A similar conclusion was drawn by Massonne (2009) for the Triassic Dabie-Sulu collisional belt based on the paucity of garnet in the country-rocks, which proves rather low *P*. Nevertheless, this belt with abundant eclogite bodies, partially with evidence for metamorphism at ultrahigh-pressure (*UHP*) conditions (*e.g*., Xiao *et al*., 2000; Gao *et al*., 2012; Groppo *et al*., 2015), is generally assigned to an extended *HP-UHP* terrane (Xu *et al*., 2006). The Himalayan belt with only three major occurrences of eclogite bodies, partially showing coesite relics, in its central and western part of the Greater Himalayan Sequence, was also related to a *HP-UHP* terrane formed by continental subduction (*e.g.*, Lanari *et al*., 2013), although studies of various gneisses prove peak pressures around 13 kbar only (*e.g*., Liu *et al*., 2007; Iaccarino *et al*., 2015). Such examples for contrasting peak *P* conditions between metabasites, as typical representatives of oceanic crust, and gneisses, representing continental crust, could be continued for so-called *HP-UHP* zones of other continent-continent collisional belts (*e.g*., Massonne, 2016, and references therein). Among the few examples of well-studied *HP* rocks of basic and acidic nature, which seem to have experienced the same *P–T* evolution, those from Ecuador are noteworthy. The occurrence of these rocks is related to the collision of a microcontinent with the South American plate and to peak pressures of only 13 kbar (Massonne & Toulkeridis, 2012).

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