High-pressure gneiss with pseudomorphs after jadeite from the Variscan Erzgebirge in Saxony

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The Erzgebirge in Saxony is known for occurrences of various ultrahigh-pressure (UHP) rocks (Massonne, 2001, 2003), but gneiss, the major rock type there, was rarely addressed in scientific studies (e.g., Willner et al. 1997). A paragneiss (sample E98-36), rich in quartz and white mica, was sampled very close to an eclogite body of the Gneiss-Eclogite Unit (GEU) c. 5 km north of the Saidenbach reservoir where UHP rocks were found.

Millimetre-sized garnet grains in this gneiss can be zoned with a relatively Ca-poor core (XCa = Ca/(Ca+Fe^{2+}+Mg+Mg) around 0.04, XMg = 0.16, XMn = 0.005) surrounded by a mantle with XCa = 0.07-0.09, XMg = 0.13-0.18, and XMn = 0.01. The contact between these two garnet generations is sharp. Large oriented white mica flakes are phengite with Si contents around 3.42 per formula unit (pfu) in the core and slightly decreasing Si contents towards the rim. A new generation of potassic white mica with lower Si contents formed at the rim of these flakes. A peculiar feature of the studied paragneiss is the occurrence of mm-sized clusters of small albite grains with thin potassic white mica flakes in between. The Si contents of these flakes is between 3.23 and 3.31 pfu and, thus, similar to those of the rim generation of large flakes. The observed elongated clusters, being oriented in the same direction as the large mica flakes, are interpreted as former jadeite grains, which decomposed during exhumation of the rock under infiltration of K-bearing hydrous fluids.

Thermodynamic modelling with PERPLE_X (Connolly, 2005: version 6.6.6) was applied to decipher the metamorphic evolution of the paragneiss. According to the calculated pressure-temperature (P-T) pseudosection contoured with various isopleths for garnet and potassic white mica, an early metamorphic stage (Ca-poor garnet core) occurred at P-T conditions of 0.9±0.1 GPa and 635±25 °C (Fig. 1). The conditions of the high-pressure (HP) stage (garnet mantle) were difficult to determine precisely because compositions of the early garnet mantle and phengite can coexist over a wider P-T range. Thus, a temperature increase from 580-600 °C to 660 °C can be accompanied by a slight pressure decrease from 1.8 to 1.7 GPa, but also by a clear one from ca. 2.4 to 1.7 GPa. This not well determinable portion of the P-T path is compatible with the presence of jadeite and absence of primary biotite. Further decompression without deformation resulted in the formation of pseudomorphs after jadeite. The obtained conditions of 660 °C at 1.7 GPa are similar to those of 715 °C at 1.8 GPa determined for the adjacent eclogite (Massonne 2011).

In-situ U-Th-Pb dating of monazite with the electron microprobe (e.g., Rahimi & Massonne, 2018) yielded an average age of 338.4 ± 2.3 (2σ) Ma (40 of 44 monazite analyses). This age was assigned to the HP event according to previous studies of rocks from the GEU (e.g., Hallas et al. 2021). A small monazite grain enclosed in garnet yielded an age of 386.4 ± 10.5 (2σ) Ma, which was related to the garnet core-forming event (Fig. 1).

Based on the here presented data and those gathered from the literature, the following conclusions are drawn: (1) An Early Carboniferous continent-continent collisional scenario was responsible for the HP event in the GEU. Evidence for metamorphism at UHP is lacking in metasediments and metagranitoids. Diamondiferous rocks in the Erzgebirge in Saxony are crystallization products of melts, which ascended from great Earth's depths and intruded the

Early Carboniferous HP rocks. (2) These HP rocks of the GEU, including eclogites, originally experienced Late Devonian medium-pressure, medium-temperature metamorphism and were constituents of a medium to lower portion of the downgoing plate in the Early Carboniferous collisional scenario. (3) Jadeite should characterize medium-temperature metasediments and metagranitoids that had experienced lithostatic pressure in excess of 1.6 GPa. This study demonstrates that jadeite can be recognized in corresponding HP rocks even after complete decomposition. This means that previously suggested UHP terranes worldwide, lacking relics and pseudomorphs of jadeite and coesite, have never experienced UHP.

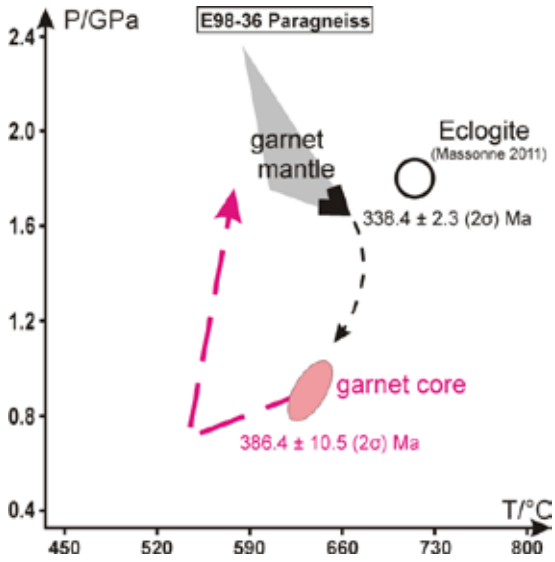

Figure 1. P-T evolution of paragneiss E98-36 developed by thermodynamic modelling. The broken paths were estimated. The given ages resulted from monazite dating using the electron microprobe. The open circle refers to P-T conditions derived by Massonne (2011) for eclogite adjacent to E98-36.

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