

## **Ti- and Zr-minerals in calcite-dolomite marbles from the ultrahigh-pressure Kimi Complex, Rhodope mountains, Greece: Implications for the *P-T* evolution based on reaction textures, petrogenetic grids, and geothermobarometry**

**ALEXANDER PROYER<sup>1,\*</sup>, IOANNIS BAZIOTIS<sup>2</sup>, EVRIPIDIS MPOSKOS<sup>3</sup> AND DIETER RHEDE<sup>4</sup>**

<sup>1</sup>Department of Earth Sciences, University of Graz, Universitätsplatz 2/II, A-8020 Graz, Austria

<sup>2</sup>Department of Mineralogy, Petrology and Economic Geology, School of Geology, Aristotle University of Thessaloniki, 54124, Thessaloniki, Greece

<sup>3</sup>Department of Mining and Metallurgical Engineering, Section of Geological Sciences, National Technical University of Athens, Heroon Polytechniou 9, 15780 Athens, Greece

<sup>4</sup>Section 4.2 Anorganic and Isotope Geochemistry, Deutsches Geoforschungszentrum (GFZ), Telegrafenberg, D-14473, Potsdam, Germany

### **ABSTRACT**

Rutile, titanite, and zircon formed as relatively coarse-grained accessory minerals in several samples of high-grade calcite-dolomite marble with an early ultrahigh-pressure history. These minerals decomposed to a texturally complex set of secondary minerals during subsequent stages of retrograde metamorphism. The reactions involve several generations of geikielite-ilmenite as well as zirconolite [(Ca, Th, U)Zr(Ti, Fe, Nb, Ta)<sub>2</sub>O<sub>7</sub>], kassite/cafetite [CaTi<sub>2</sub>O<sub>4</sub>(OH)<sub>2</sub>/CaTi<sub>2</sub>O<sub>5</sub>·H<sub>2</sub>O], Ti-bearing humite group minerals, thorianite, and sometimes euxenite [(Ca, U, Th, REE)(Nb, Ta, Ti)<sub>2</sub>(O, OH)<sub>6</sub>]. Stable coexistence of zircon and olivine is observed and stably coexisting titanite with olivine and/or humite-group minerals is reported here for the first time outside of carbonatites, kimberlites, or lamprophyres. Petrogenetic grids constructed for Ti- and Zr-bearing olivine/antigorite-saturated calcite-dolomite marbles show that geikielite is stable at highest pressures, followed by titanite and rutile, and that baddeleyite + diopside replaces zircon + calcite to higher pressures. The observed reaction textures are consistent with an earlier derived *P-T* path for the Kimi Complex. They corroborate a period of heating during decompression from 25 to 20 kbar and ca. 800 °C, where the assemblage olivine-diopside-spinel-rutile-zircon formed. This assemblage partially re-equilibrated during subsequent decompression and cooling, thus forming the observed reaction textures. Even though no memory of the UHP path is preserved in the accessory minerals, their reaction relationships turn out to be potentially very useful for geothermobarometry over a large range of metamorphic conditions.

**Keywords:** Ti-minerals, zirconolite, kassite, cafetite, impure calcite-dolomite marbles