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Wagnerite in a cordierite-gedrite gneiss: Witness of long-term fluid-rock interaction in the continental crust (Ile d'Yeu, Armorican Massif, France)

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Abstract

We describe the first occurrence in the Variscan Belt of Western Europe of the relatively rare phosphate wagnerite, ideally Mg_2PO_4F. It occurs in albite-rich, cordierite-gedrite-bearing gneisses on the island of Ile d'Yeu, southern Armorican Massif, France. These gneisses are associated with a network of shear zones that crosscut granitoid orthogneisses of calc-alkaline affinity. Wagnerite is zoned and displays a rimward decrease of Fe/(Fe + Mg) from 0.16 to 0.08 and a concomitant increase in F. The F content ranges 0.46–1.05 apfu, but critically depends on the choice of the analytical standard. Based on phase diagrams calculated with THERMOCALC, we infer that the wagnerite-bearing orthoamphibole + cordierite + biotite + chlorite paragenesis equilibrated at ca. 550 °C, and pressures lower than 4 kbar. The presence of staurolite relics requires similar temperatures, but pressures higher than 4 kbar, implying an evolution dominated by decompression. On the basis of whole-rock chemistry and stable isotopes, we suggest that superimposed periods of metasomatic alteration throughout the metamorphic history led to the prograde stabilization of the cordierite-gedrite gneiss at the expense of the orthogneiss. This alteration involved aqueous fluids in isotopic equilibrium with local rocks and caused significant loss of Ca, K, and Si, and gain of Mg and Na. We argue that the Na-enrichment is the most significant difference between wagnerite-bearing and wagnerite-free Mg-rich, Ca-poor rocks on Ile d'Yeu. This emphasizes the possible importance of Na metasomatism for the formation of wagnerite. In light of comparisons with other wagnerite occurrences, we conclude that a long-term fluid-rock interaction, typically associated with shear-zones, may be the rule rather than the exception for the formation of wagnerite in metamorphic rocks unaffected by anatexis.

Keywords: Wagnerite, cordierite-gedrite gneiss, fluid-rock interaction, metamorphism, phase diagrams, *P-T* and *P-X* pseudosections