

Relationship among metamorphic grade, vesuvianite “rod polytypism,” and vesuvianite composition

EDWIN GNOS^{1,*} AND THOMAS ARMBRUSTER²

¹Institut für Geologie, Universität Bern, Baltzerstrasse 1-3, CH-3012 Bern, Switzerland

²Laboratorium für chemische und mineralogische Kristallographie, Universität Bern, Freiestrasse 3, CH-3012 Bern, Switzerland

ABSTRACT

Single-crystal X-ray study of different vesuvianite samples of known origin shows that different metamorphic grade results in different arrangements of structural rods oriented parallel to the vesuvianite *c* axis, interpreted as “rod polytypism.” There is a systematic dependence of space-group symmetry and rod arrangement on crystallization temperature: *P4nc*-dominant < 300 °C, *P4/n*-dominant ~300–500 °C, and *P4/nnc* > 500 °C. Partial occupancy of the T sites (B, Al, Fe³⁺) and increased F-content seem to stabilize rod disorder causing *P4/nnc* space-group symmetry. All studied vesuvianites in calcsilicate rocks and marbles from regional- and contact-metamorphic upper amphibolite facies have disordered rods (*P4/nnc* symmetry). Electron-microprobe analyses of metamorphic vesuvianites from alpine and non-alpine occurrences, supported by structural investigation, showed that in addition to homo- and heterovalent substitution, partial occupancy of the commonly vacant T sites by B, Al, or Fe³⁺, and the (O₄H₄)⁴⁻ → SiO₄⁴⁻ (hydrogarnet-type) substitutions are significant in nature. With few exceptions, T-site occupancy seems to be restricted to high-grade metamorphic rocks whereas the “hydrovesuvianite” substitution is only found in vesuvianites formed at very low metamorphic grade. The cell parameters of vesuvianite with empty T sites increase with increasing Ti + Mg → 2 Al substitution, and this increase is even more pronounced with increasing “hydrovesuvianite” component. An increase in boron on T sites leads to a decrease of *c* but an increase in *a*. Fluorine incorporation and T-site substitution (B, Al, Fe³⁺) in vesuvianite are coupled with a decrease in hydroxyl groups. This causes vesuvianites to be stable under higher *X*_{CO₂} conditions, and in an assemblage with quartz at conditions above the experimentally determined upper stability of quartz + T site vacant, F-free vesuvianite. Optically anomalous vesuvianites have ordered rods and are generally characterized by an intergrowth of *P4/n* and *P4nc* domains. In addition to B-rich vesuvianite and wiluite, *P4nc*-dominant vesuvianites are also commonly optically positive.

Keywords: Analysis, chemical (vesuvianite), crystal structure, metamorphic petrology, polytypism