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Stability of high-Al titanite from low-pressure calcsilicates in light of fluid and host-rock composition

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ABSTRACT

Titanite of variable Al and F content was found in granulite- to amphibolite-facies calcsilicates in Central Dronning Maud Land, Antarctica. The highest observed Al content corresponds to an X_{Al} [= Al/(Al + Ti)] of 0.53. Previously, such high values of X_{Al} were reported from high-pressure rocks, but the titanite of this study is from a low-pressure terrain. The compositional variations in titanite can be described for all samples by a set of three linearly independent exchange vectors added to the $CaTiSiO_5$ end-member titanite. In most rocks, these vectors are $Al_1F_1Ti_{-1}O_{-1}$, $Ti_{-0.25}\square_{0.25}O_{-1}OH_1$, and OH_1F_{-1}; in one sample, the $Ti_{-0.25}\square_{0.25}O_{-1}OH_1$ vector is replaced by a $Si_{-0.25}\square_{0.25}O_{-1}OH_1$ vector. The actual amount of exchange along these vectors and, therefore, the amount of Al in titanite, depends on *P* and *T*, on the composition of the coexisting fluid phase in terms of its H_2O/HF fugacity ratio, and on host rock composition in terms of Al_2O_3/TiO_2 activity ratio. It is inferred that, in suitable chemical environments, high-Al titanite is stable over a wide *P-T* range. Therefore, the Al content of titanite should not be used in geothermobarometry, even qualitatively. Additionally, because of the coupled substitutions $Al_1F_1Ti_{-1}O_{-1}$ and $Al_1OH_1Ti_{-1}O_{-1}$, the concentration of F in titanite is strongly dependent on the host rock chemistry. This rules out the easy use of titanite as a monitor of fluid composition.