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# Petrologic Significance of Allanite and Related Minerals

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Allanite is a common accessory phase in igneous, metamorphic, metasomatic, and sedimentary rocks. Small amounts of REE are present in most epidote-group minerals, but in allanite - and the related minerals dissakisite, ferriallanite, dollaseite, khristovite and androsite - the REE are essential structural constituents. An important characteristic of these minerals is that their octahedrally coordinated M sites contain major amounts of divalent cations.

Existing studies have documented a large number of critical variables affecting the substitutions of various elements into the allanite structure. However, the residence sites and compositional limits of the three petrogenetically significant elements Be, P, and V, are at present poorly understood. The V-richer allanite minerals could add to the conclusion that is suggested by the behavior of Mn and Fe, namely that $f_{O2}$ and $T$, rather than $P$and compositional variations are the most critical variables for determining transition metal and REE ratios in the epidote-group minerals. Our understanding of the trace element characteristics of REE-rich members of the epidote group will be greatly enhanced as SIMS and LA-ICP-MS technology becomes more widely available. Many compositional parameters are poorly understood simply because they cannot readily be analyzed by EPMA.

Moreover, the REE-rich epidote-group minerals typically contain various elements with different valences as well as significant amounts of water. These compositional parameters complicate the characterization of REE-rich epidotes, but at the same time may offer a petrological potential, which can be exploited. It has been demonstrated experimentally that the ratio $Fe^{3+}/Fe_{tot}$ in allanite can be changed via the oxidation-

dehydrogenation reaction (*cf.* oxyallanite). The experimental studies, however, were carried out under metastable conditions. The $Fe^{3+}$, $Fe^{2+}$ and H contents, therefore, need to be accurately measured for epidote-group minerals equilibrated within their stability fields, so that a thermodynamic model applicable to natural samples can be formulated. Such experimental data would be invaluable for a better understanding of igneous rocks, in particular rocks where amphibole, mica, and ferriallananite-allanite-epidote-clinozoisite solid solutions coexist. Where detailed chronological data for zoned allanite are available, one can hope to additionally gain insight into how some petrologically important parameters of a melt (e.g., $T, P, f_{H2O}$) changed with time. Allanite, therefore, could become a powerful geothermobarometer as well as a hygrometer and chronometer for some igneous systems.