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REVIEW

Composition, paragenesis, and alteration of the chevkinite group of minerals

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ABSTRACT

The chevkinite-group minerals (CGM) are dominantly monoclinic REE-Ti-Fe sorosilicates [$(REE, Ca)_4Fe^{2+}(Fe^{2+},Fe^{3+},Ti)_2Ti_2(Si_2O_7)_2O_8$)], with REE_2O_3 contents up to ~50 wt%, but members with predominant Mg, Al, Mn, Cr, Sr, or Zr in one of the cation sites are also known. Twelve members have been approved by the Commission of New Minerals, Nomenclature and Classification International Mineralogical Association (CNMNC-IMA) but more will undoubtedly be identified. Minerals of the group are known from hundreds of terrestrial localities and have also been recorded in lunar and martian rocks. The main occurrences are in igneous rocks ranging from diamond in kimberlites through mafic and intermediate lithologies to metaluminous and peralkaline felsic rocks. They also occur in metamorphic rocks, including granulites, metacarbonates, and jadeitites, and in metasomatic rocks, such as skarns and fenites, and in rare-metal deposits. Chevkinite-group minerals may form over the pressure range 50 to <10 kbar, and over a wide temperature range. Their formation appears to be relatively insensitive to P_{H_2O} and f_{O_2}.

The stability of CGM vis-à-vis other REE-Ti-bearing accessories is poorly understood. They are often the major carriers of REE and actinides, and they have a high potential for fractionating the light lanthanides and Th from U. Very little systematic work has been done in determining CGM-melt partition coefficients, yet such data are critical in, *inter alia*, geochemical modeling. Similarly, CGM are amenable to geochronology due to their high Th abundances, commonly at the several percent level. In common with other REE-bearing accessories, CGM are prone to alteration by hydrothermal fluids. The nature and extent of the alteration are primarily determined by the composition of the fluids. Fluids poor in ligands tend to generate a Ti-enriched phase whose nature is unknown but is probably amorphous. With increasing $F + CO_2$ levels, complex replacement assemblages are formed, usually in more than one step. Although observational evidence of the effects of alteration and element mobility is accumulating and chemical equations can be constructed to approximate the reactions, there is still no firm geochemical basis for understanding element redistribution during these processes.

Keywords: Chevkinite-group, structure, composition, occurrence, alteration, petrogenetic significance