Chevkinite and perrierite: Significant hosts of LREE in tholeiitic intrusive rocks

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Chevkinite-(Ce) and perrierite-(Ce) are the most common members of the chevkinite group of minerals. They are dimorphs, and both have the general formula $A_4BC_2D_2Si_4O_{22}$, where A = REE, Y, Ca, Sr, Th; B = Fe^{2+}, (Mn, Mg); C = Ti, Al, Fe^{3+}, Fe^{2+}, Cr, Mn, Mg, Zr, Hf, Nb; and D = Ti. Both have been reported from a wide range of igneous, metamorphic and hydrothermal rocks types, but occurrences in mafic igneous rocks are rare, with minimal chemical and crystallographic documentation.

Chevkinite-(Ce) and perrierite-(Ce) are more abundant than has been recognized previously in mafic igneous rocks and occur with other Ti-, Zr- and REE-bearing accessory phases in eight suites of tholeiitic dolerite from Western Australia. They crystallize late in the paragenetic sequence and occur as inclusions in igneous amphibole rimming pyroxene, or intergrown with quartz, orthoclase and other accessory phases in patches of late-crystallizing mesostasis. They are significant hosts of incompatible elements, particularly LREE, in mafic rocks being more abundant than monazite or allanite.

Chevkinite-(Ce) and perrierite-(Ce) from mafic rocks have distinctive chemical compositions with higher Zr than recorded in examples from most other common rock types. Among mafic rocks, two chemical groups are recognized based on total Fe contents: one with >8 wt% FeO* and one with <8 wt% FeO*. While the FeO contents of individual crystals are generally constant, the contents of other elements, particularly Ca, are more variable. No regular zoning patterns are visible in backscattered electron images to account for the compositional heterogeneities.

Crystal structural analysis by electron diffraction indicates that the high-Fe group is chevkinite-(Ce) while the low-Fe group is perrierite-(Ce). Both minerals can occur within a single hand specimen and have the same texural setting, i.e. both may be inclusions in amphibole, and both may be intergrown with late-stage mesostasis. Minor differences in composition between pockets of late melt may explain why both polymorphs are found in identical textural settings within single rock samples.