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HALOGEN VARIATIONS IN THE PALEOPROTEROZOIC LAYERED MAFIC-ULTRAMAFIC INTRUSIONS OF EAST KIMBERLEY, WESTERN AUSTRALIA: IMPLICATIONS FOR PLATINUM GROUP ELEMENT MINERALIZATION

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Abstract

A number of Paleoproterozoic layered mafic-ultramafic intrusions in the central part of the Halls Creek orogen of East Kimberley, Western Australia, have been explored for platinum group elements, chromium, nickel, copper, cobalt, and gold. Here we report on the halogen geochemistry of apatite and biotite in a number of these intrusions. Interstitial apatite is ubiquitous in these intrusions and, in most samples, tends to be relatively enriched in F and OH end members and relatively poor in Cl (<20 mole%). Fluorapatite occurs in the more evolved igneous rocks and in samples from the margins of the intrusions that apparently have been contaminated by metamorphic country rock. Cl/F ratios generally increase with bulk rock molar Mg/(Mg + Fe) ratios, as observed in other intrusions. Only a few samples show Cl enrichment as high as that seen in the Stillwater and Bushveld complexes beneath the major stratabound platinum group element deposits. The most Cl-rich compositions observed occur in the upper part of the Springvale intrusion, where it is associated with troctolite, and in a single sample from the McIntosh intrusion. For the former intrusion, it is suggested that volatiles migrating out of the lower part of the mafic stratigraphy stabilized olivine at the expense of pyroxene. Associated biotite tends to contain little (no more than 10 mole %) Cl or F.

It is concluded that the East Kimberley intrusions contained a low to moderate volatile component that, during the combined processes of crystallization, degassing, and fractionation of interstitial halogen-bearing minerals, produced a late, mobile, interstitial silicate liquid or volatile-rich fluid phase of variable Cl/F content that in turn caused most of the observed variations within any given intrusion. The exceptions include the margins of the intrusions that appear to have been affected by country rocks, either during emplacement (assimilation) or during later metamorphism. Apatite's generally low Cl/F ratio, the lack of primary amphibole, and the high background sulfur concentrations of the East Kimberley intrusions suggest that these magmas were relatively volatile poor. The development of high-grade, platinum group element-enriched horizons by late-stage hydrothermal processes that could have mobilized significant amounts of the platinum group elements and sulfur is considered to be unlikely.

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