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# LAYERED INTRUSIONS

## PREFACE

Four of the papers in this special issue (Boudreau, Morse, Thy *et al.*, Young *et al.*) were presented at a symposium entitled "Layered Igneous Rocks" held during the 1986 Geological Association of Canada/Mineralogical Association of Canada meetings in Ottawa. During the symposium eighteen papers and ten poster sessions were presented. The three additional papers (Cawthorn *et al.*, Brown *et al.*, Augé) address questions of determining initial magma compositions using evidence from ilmenite compositions, the nature of a layered complex in Tasmania, and processes of concentration of platinum-group elements in chromites of dunites and chromitites in ophiolites.

Layered igneous rocks have fascinated petrologists for many years and remain among the most controversial topics of the discipline. From the time of Darwin, to relatively recently, most igneous layering was widely regarded as the product of crystal settling in magmas. The role of crystal settling as the process of overriding importance in the formation of igneous layering has been cast into doubt in recent years. Whereas certain layering features are still attributed to gravitative settling, many others are now thought to result from processes such as bottom crystallization, double diffusive convection, magmatic density currents and so on. The increased interest in exploration for economic concentrations of platinum-group elements places a timely and special emphasis on understanding processes in magma chambers that produce the variety of layered structures observed in layered intrusions.

Cawthorn *et al.*, in their study of the Mount Ayliff Intrusion, Transkei, examine whether the magma from which the picrite-hosted sulfides formed was more magnesian than normal basalt, or whether there was physical accumulation of olivine from a low-magnesian basalt. Ilmenite of contrasting compositions suggests derivation from magmas of different compositions.

Brown *et al.* have identified numerous primary structures in layered sequences of the Serpentine Hill complex, Tasmania. The intrusion has physical characteristics of Alaskan zone complexes, but the rocks contain relatively abundant orthopyroxene. Platinum-group-element chondrite-normalized profiles from chromitites have patterns that resemble those from ophiolitic chromitites.

Augé proposes that platinum-group minerals (PGM) and base-metal sulfides in chromites of two ophiolitic complexes (Tiebaghi and Vourinos) were trapped during chromite growth, the PGM acting as nuclei for chromite crystallization. He relates the enrichment in PGM in massive chromitite to the process of chromite concentration where chromite is a mechanical collector for Os, Ir and Ru-bearing PGM.

Boudreau has examined the role of volatiles in the petrogenesis of the J-M Reef of the Stillwater Complex. The abundance of Cl-rich hydrous phases and the common occurrence of pegmatitic textures suggest extensive activity of Cl-rich aqueous fluids in the genesis of olivine-rich rocks of olivine-bearing zone I of the complex. A lithologic discontinuity within the cumulus sequence acted as a trap to the upward migration of PGE-bearing, volatile-rich fluids. The result is a regionally stratabound zone of pegmatitic rocks with sulfides and chromite.

Morse suggests that, in a magma chamber, removal of heat and growth of crystals are promoted by two-phase convection of crystal-bearing plumes. Magmatic dynamic patterns involve both two-phase and compositional convection. The growth of mafic minerals in cumulates or feldspar cotectic cumulates releases either light feldspar-enriched rejected solute or dense rejected solute. These rejected solutes either rise or descend in the gravity field, causing retardation of nucleation or dissolution of the consolidated floor. Morse states that the main premise of the study of layered intrusions has presumably been that they teach us how magmas crystallize and evolve within the crust.

Young *et al.* propose that the peridotite–troctolite cyclic units of the Eastern Layered Series of the Rhum Intrusion were formed through contemporaneous crystallization of peridotite and troctolite layers from stratified picritic and basaltic magmas.

Thy *et al.* address the problem of the origin of modally graded layers. These layers are commonly thought to originate through the action of density currents. Alternatively they may form as a result of heterogeneous nucleation on various substrates in magma chambers. The study of fine-scale modal layering in the Fongen-Hyllingen Complex, Norway, indicates that oscillating chemical processes along an advancing front of solidification on the floor of the chamber produced the fine-scale modal layering observed.

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