2021 Howard Street Robinson Medalist: Dr James Mungall (Carleton University)

How do layers form in layered intrusions? (and why should we care?)

When: Feb 17, 2022 at 1pm AST,
12pm EST
Virtual

Mafic-ultramafic layered intrusions are among the most fascinating and economically important phenomena in igneous petrology, hosting globally important reserves of metals, notably Pt, Pd, Cr, Ti, and V, as stratiform ore deposits within their complexly layered internal structures. The mode of formation of these layers remains astonishingly poorly understood - there is a general lack of agreement regarding even the most fundamental aspects of their genesis after a century of dedicated research effort and countless descriptions of outcrop, drill core, and mine exposures. We cannot even agree whether the layer-forming crystals form in situ on the hard floors of vast magma chambers or are formed as suspended crystal cargoes in strongly porphyritic magma batches. In this talk, I use some basic physical and chemical constraints and examples found in the Bushveld Complex of South Africa and the Stillwater Complex of Montana to address these issues. I argue that most (but not all) of the silicate and oxide mineral layers in both complexes, including chromitites, Pt-Pd sulfide-bearing silicate layers, and Ti-V-rich magnetitites, formed as crystal mushes delivered to their current locations as cargoes of crystals entrained in strongly porphyritic magma batches. These inferences are consistent both with the widely accepted concept of the "big tank" magma chamber dominated by melt with upward-accumulating layers formed at the base, or with more controversial recent suggestions that many layers were emplaced as individual intrusive sheets between existing solid layers of the intrusions. This rather arid-sounding controversy has profound ramifications for mineral exploration. If the mineralized layers can only form from vast underground seas of magma, then exploration must be confined to large layered intrusions. If, on the other hand, the layers are collections of mush that was generated en route to their current locations, then the shape of the mineralized body is not constrained to be a layer in a layered intrusion and similar concentrations of minerals might be found in a wide range of tectonic and structural settings. The latter option opens a world of possibilities to mineral exploration targeting worldwide.

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