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ORE DEPOSITS AND RELATED PETROLOGY OF MAFIC – ULTRAMAFIC SUITES

PREFACE

A special session entitled "Ore Deposits in Mafic – Ultramafic Suites" was held at the GAC–MAC Joint Annual Meeting in Winnipeg, May 17–19, 1982. The venue was deemed a timely opportunity for new accounts of these types of mineral deposits and of models to explain their formation. As session chairmen, we were asked by the Executive Committee of the Mineralogical Association of Canada to invite participating speakers to submit manuscripts for publication in a special issue on the same topic in *The Canadian Mineralogist*. Of the original 13 papers presented, 5 appear in this issue, together with an additional dozen papers whose fruition happily coincided with the preparation of this special issue. The increased range of subject matter occasioned by the new contributions is reflected in the expanded title of this issue.

The papers fall into five groups: nickel-copper deposits, host rocks of nickel-copper deposits, platinum-group elements (PGE), chromite, and asbestos and serpentinites. In the first group, Paterson and Watkinson, in two companion papers on the unusual high-copper, low-nickel Thierry mine in northwestern Ontario, provide welcome new documentation of this previously little-described Archean deposit in the Pickle Lake greenstone belt. In the first paper, they propose that after amphibolite-grade regional metamorphism, the gabbro intrusive body and its disseminated magmatic sulfides were subjected to cataclasis and metasomatism of the resulting mylonite. In the second paper, they present evidence that the cataclasis preferentially mobilized copper sulfides to produce the mylonite and breccia ores. Tyson and Chang supplement previous work on mineralization in the Duluth Complex with new petrological and stratigraphic descriptions of the lower, mineralized part of the Partridge River troctolite, and present evidence suggesting a footwall source (rocks of the Virginia Formation) for some of the S, Cu and Fe of the mineralized rocks. The study by Pasteris of Cu–Ni sulfides from both the Partridge River troctolite and the South Kawishiwi intrusion of the Duluth Complex indicate that the sulfides are products of an immiscible sulfide melt at an early magmatic stage, and a later Cu-sulfide-bearing, low-H_2O fluid. Thompson, Barnes and Duke have calculated mean distribution-coefficients for Ni–Fe between sulfide and olivine in four nickel–copper–PGE deposits (Katahdin, Maine, Moxie pluton, Maine, Dumont, Quebec and Stillwater Pt Reef, Montana). They conclude that their values, ranging from 5 to 11, are consistent with most experimentally determined values, and that "normal" magmatic values probably fall in the range from 5 to 20.

The second group of papers deals with primarily petrological aspects of the host rocks of nickel–copper deposits. In the first of these, Scribbins, Rae and Naldrett document the range of compositions of dunite to gabbro inclusions in the igneous ore-bearing sublayer of the Sudbury Igneous Complex; they suggest the derivation of the inclusions from hidden layered intrusive complexes in the crust, possibly related to the Sudbury norite. Paktunç studied an unusually fresh, weakly mineralized ultramafic body in the Thompson Nickel Belt and concluded that, after partial serpentinization, it was metamorphosed at 700°C, then deformed, and subsequently recrystallized to an equigranular mosaic before experiencing late shearing and retrograde hydration. The Kanichee intrusion in the Archean Temagami greenstone belt has been shown by James and Hawke to be layered and to consist of five Ni–Cu-sulfide-bearing cycles of mainly dunite to clinopyroxenite cumulate rocks, formed from repeated pulses of high-magnesium basalt. The first

of these cycles contained a small tonnage of Ni–Cu–PGE ore, now mined out. Lightfoot and Naldrett have thrown new light on the compositional affiliation of the Cu-Ni-mineralized Insizwa Complex in southern Africa; the composition of the olivine and of the marginal gabbro indicates a low-MgO parentage rather than the high-MgO parentage previously proposed.

The third group of papers focuses on PGE mineralization. Talkington and Watkinson conclude that the PGE in the Archean Lac-des-Iles mafic complex have been mobilized by late fluids, which led to partial separation from Cu-Ni sulfides; they now occur as tellurides, arsenides and sulfides associated with secondary sulfides and silicates. Page and Talkington demonstrate that chondrite-normalized PGE ratios from several ophiolite complexes in Newfoundland have Pt–Pd-depleted patterns similar to those of many other ophiolite complexes, perhaps representing a mantle residue from single or multistage partial melting events. In an important paper on modeling of processes of PGE concentration, Campbell and Barnes found that differences in apparent partition-coefficients for PGE between sulfides and silicate melt in different magmatic environments may be controlled mainly by the silicate-to-sulfide mass ratio. They demonstrate why this result occurs when equilibrium partition-coefficients are large relative to the silicate-to-sulfide mass ratio, and show that this appears to be the case for the PGE.

The single paper on chromite by Whittaker and Watkinson reports new documentation on chromitites in the allochthonous serpentinized peridotite of the Mitchell Range, B.C. They recognize two types of podiform chromitite, mostly containing at least 55% Cr_2O_3. The first comprises deformed layers and is related to magmas formed by partial melting in the upper mantle, whereas the second is unrelated to layering. Pargasite and fluid inclusions in chromite suggest the presence of a contemporaneous sodium-bearing fluid.

The last group of four papers concerns serpentine minerals. Cogulu and Laurent have contributed to an understanding of the formation of asbestos by documenting the systematic compositional variation in serpentines from fresh peridotitic wall rocks through serpentinized halos into cross-fibre chrysotile veins in asbestos deposits from the Eastern Townships of Quebec. In the following three companion papers, Wicks has focused on the interplay between deformation and serpentinization. He recognized deformation prior to serpentinization in the Glen Urquhart peridotite in Scotland, in the form of serpentine pseudomorphically replacing plastically deformed olivine and enstatite, and uncovered a complex history of plastic and brittle deformation interspersed with retrograde mineral formation. In his second paper, Wicks reports that natural antigorite serpentinites appear to have failed in the same brittle or ductile manner under various P–T conditions as those deformed experimentally, whereas in lizardite and chrysotile serpentinites the lack of correspondence between natural and experimental deformation may be due in part to transformations to antigorite in the natural case. In the third paper, Wicks cautions that fracture patterns in olivine are well preserved pseudomorphically by mesh-textured serpentine but are commonly mistaken as a recrystallization texture of olivine.

Finally, we thank the authors for their stimulating submissions, the Mineralogical Association of Canada for the opportunity to publish this collection of papers in a special issue of *The Canadian Mineralogist,* and the editor, Dr. Robert Martin, for his encouragement and guidance. Financial support from the Geological Survey of Canada in the form of a publication grant is gratefully acknowledged.

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