# GS-19 STRATIGRAPHY, GEOLOGY AND MINERALIZATION OF SELECTED PARTS OF THE PAGE PROPERTY, BIRD RIVER SILL (PART OF NTS 52L/5)

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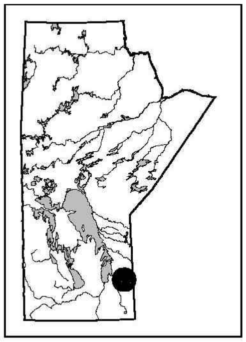

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## SUMMARY

The Bird River Sill has been explored for chromite, Ni-Cu and platinum-group elements (PGEs). Past studies focussed on the Dumbarton–Maskwa Ni-Cu mine and the well-exposed and accessible Chrome property. Three PGE-bearing stratabound layers, two of them intimately associated with chromitite layers, were defined on the Chrome property in previous studies. A sulphide-bearing layer associated with chromitite layers, thought to be equivalent to the ‘Disrupted Chromitite’ layer on the Chrome property, was defined this summer on the Page property. This approximately 6 m thick sulphide-bearing layer, recognized on most of the Page property, is a conspicuous, easily traced marker horizon containing disrupted chromitite layers and a vast number of chromitite pebbles. These pebbles are thought to be the product of episodic disruption and fragmentation of solid chromitite layers. The chromitite fragments were abraded and rounded during transport and eventually deposited on a semisolid substratum of olivine crystals.

This model requires a magma chamber that is at least periodically dynamic and characterized by magmatic surges of sufficient momentum to fragment solid chromitite layers and transport the fragments over an undetermined distance that was sufficient to abrade and round the fragments. Such surges would generate turbulence in at least part of the magma. Periodic magmatic turbulence during emplacement of the Bird River Sill is highly significant for guiding the search of PGE-bearing layers. It is widely believed that many ‘reef-type’ PGE deposits were formed as a result of magmatic interaction due to the injection of a batch of sulphide-rich primitive magma into a chamber containing PGE-bearing magma. The ensuing turbulence of the magmatic reservoir is assumed to facilitate thorough mixing of both magmas, resulting in the efficient scavenging and concentration of chalcophile elements, including the PGEs. Resulting sulphide droplets are thought to concentrate in discrete layers or reefs.

## INTRODUCTION

The Page property, approximately 2.5 km long, is located within the Bird River Sill in southeastern Manitoba, 2.3 km northeast of the Chrome property (Fig. GS-19-1). The Bird River Sill is a south-facing, ultramafic to mafic layered body that intruded Archean supracrustal rocks of the Bird River greenstone belt in the Superior Province. It consists of a lower, modally and cryptically layered ultramafic rock sequence, including dunite, peridotite, chromite and pyroxenite, overlain by anorthositic (and, in places, glomeroporphyritic) gabbro and anorthosite. Although disseminated chromite is ubiquitous throughout the ultramafic sequence, layers of chromitite (>80% chromite) are restricted to the upper section of the ultramafic sequence. Timmins et al. (1985) gave a U-Pb zircon age date of 2745 ± 5 Ma for the Bird River Sill.

Mineral deposit studies in the Bird River Sill traditionally focussed on chromite and Ni-Cu resources. Geological studies regarding the PGE potential were initiated by Theyer (1982). Geological mapping and research that centred on the well-exposed and accessible Chrome property identified three reef-type, PGE-bearing layers in the ultramafic part of the sill.

Part of the 2001 field season was spent documenting the geology of the Page property in order to:

- ascertain the degree of lithological and stratigraphic continuity between the Page and the Chrome properties; and
- identify, map and sample rock layers on the Page property considered to be analogous to PGE-bearing rock units on the Chrome property.

Investigations of the stratigraphy of the chromitite layers were especially emphasized, because two PGE-bearing layers on the Chrome property are closely associated with chromitite layers.

## PREVIOUS WORK

Most geological studies of the Bird River Sill focussed on the well-exposed and readily accessible Chrome property. The Bird River greenstone belt and the Bird River Sill were mapped by Trueman (1971, 1980). Bannatyne and Trueman (1982) and Cerny et al. (1981) summarized these studies. Geological investigations in the 1940s and early 1950s concentrated on chromite (Bateman, 1943). From the 1950s on, interest switched to the exploration for Ni-Cu mineralization (Karup-Møller and Brummer, 1978), but the focus reverted to chromite in the early 1980s. Investigation of the PGE potential of the sill started in 1982, when the principal author chemically analyzed a channel sample sawed across the exposed mafic and ultramafic

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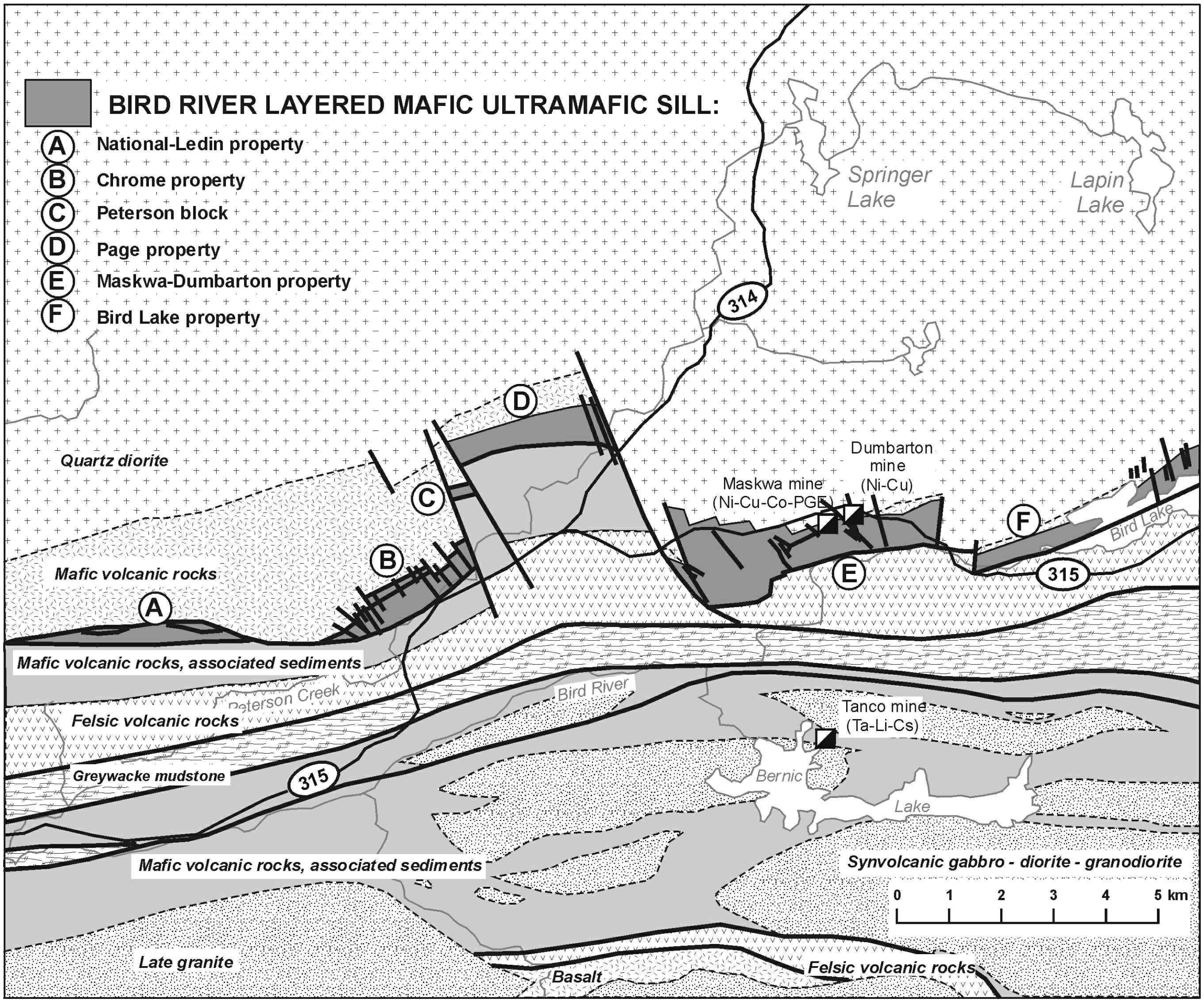

*Figure GS-19-1: Location map of the Bird River Sill, showing the Chrome and Page properties.*

portions of the sill on the Chrome property (Theyer, 1982). Platinum-group element inclusions in chromite from the Bird River Sill were described by Talkington et al. (1983). Theyer (1985) described two, metre-thick sulphide layers in the ultramafic portion of the intrusion, and Scoates et al. (1989) published maps and descriptions of two additional PGE-bearing layers, one associated with the 'Lower Group' chromitite and the other associated with the 'Disrupted Group' chromitite.

Peck and Theyer (1998) re-analyzed the material of Theyer's channel samples and presented further evidence of 'reef-type' PGE mineralization.

Young (1992) produced a (1:2000 scale) geological map and a report of the Page property, in which he noted that the stratigraphy of the chromitite layers is comparable with that of the Chrome property, which was defined by Scoates (1983).

## STRATIGRAPHY OF THE CHROMITIFEROUS LAYERS

This year's investigations concentrated on the stratigraphy of the chromitite units on the Page property. Exposures on a hill near the eastern end of the Page property (Fig. GS-19-2) show a complex array of chromitite fragments derived from tectonically disrupted chromitite layers. The fragments range from 1 cm to several metres in length and are offset by faults. The magnitudes of displacement range from a few millimetres to more than 1 km. The faults are mainly dextral, but sinistral and wrench faulting were also observed.

The stratigraphy of the chromitite layers on the Page property is very similar to that established by Scoates (1983) for the chromitite units of the Chrome property.

### Disrupted Chromitite Layer with Chromitite Pebbles and Sulphide Minerals (Part of Section A–A')

Section A–A' (Fig. GS-19-3A and -3B) presents a detailed view of the exposed rock types from north to south (i.e., from the stratigraphically lower to the stratigraphically higher units).

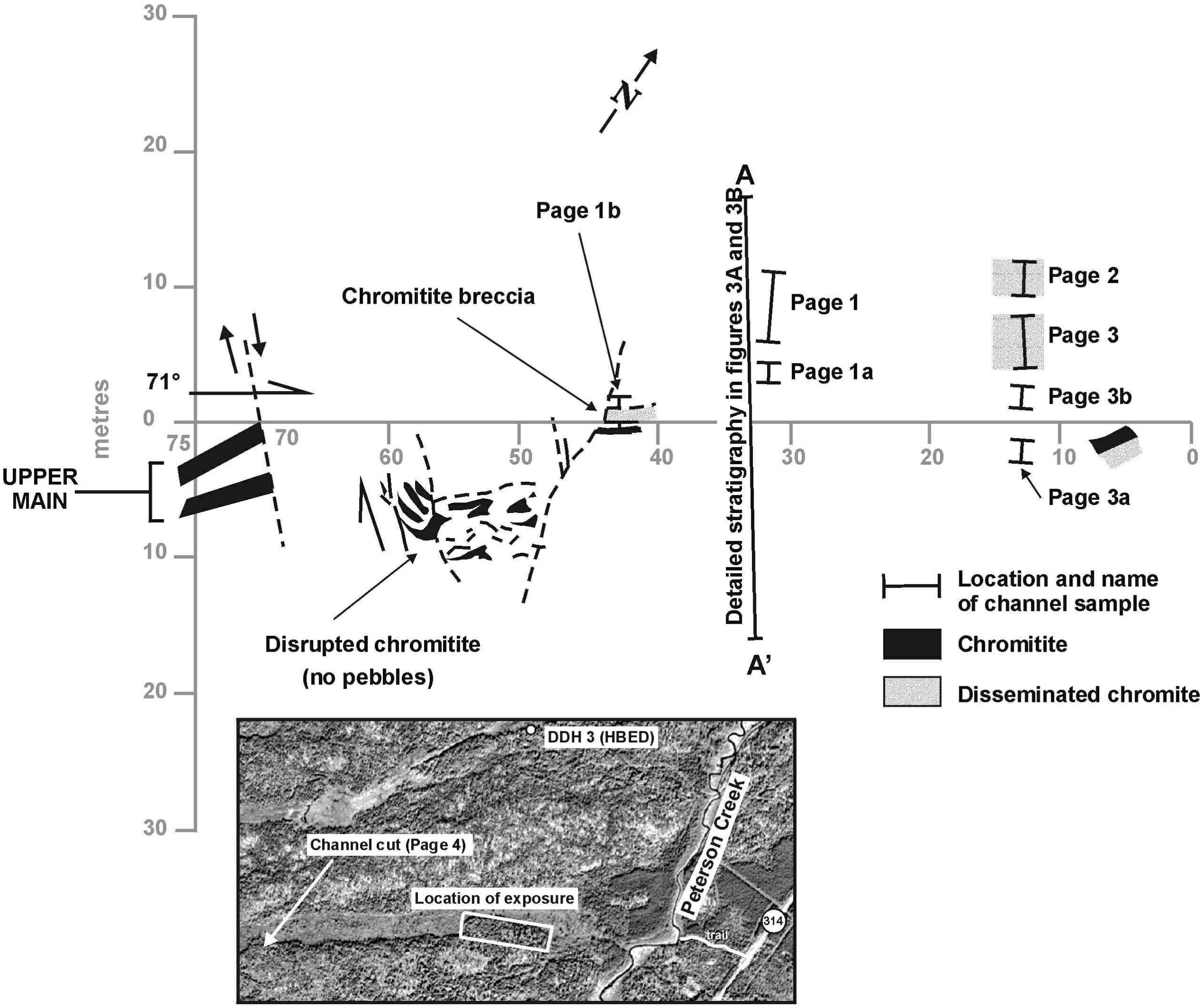

*Figure GS-19-2: Schematic geology of part of the Page property and location of detailed cross-section. Insert map shows location of chromitite exposures, channel sample 'Page 4' and diamond-drill hole 3 (Hudson Bay Exploration and Development).*

The northern 9 m of this section (Fig. GS-19-3A) includes olivine cumulate (dunite) containing ubiquitous disseminated chromite and numerous randomly arrayed, centimetre-thick, elongated chromitite layers ranging from 10 cm to a metre in length. These layers are characterized by typical soft-sediment deformation, including slumping and load casts, and evidence of deformed bedding, including truncation and folding. Many of the chromitite folds are truncated and bevelled, implying that they formed and were partially eroded before deposition of the overlying bed.

A prominent characteristic of this layer, so far recognized only on the Page property, is the inclusion of countless chromitite pebbles in ill-defined layers (Fig. GS-19-4). The pebbles are generally subrounded to rounded but, in places, are subangular and highly irregular in shape, ranging from a few millimetres up to 8 cm in diameter. Each pebble is characterized by a thin (<1 mm) ‘crust’ of conspicuously large chromite crystals that contrast with the smaller crystals in the interior of the pebble. Polished pebble cross-sections also show differences between the reflectance of the core and the crust, believed to be caused by differences in the chemical composition. These ‘crusts’ are more resistant to weathering and abrasion than the chromite in the interior of the pebble. As a result, the chromitite pebbles are conspicuous on weathered surfaces, due to their intense black colour, lensoid shape and rough weathering outlines. The pebbles are generally randomly distributed but, in places, are sorted into concordant zones and vaguely arcuate trains commonly demarcated by a layer of chromitite granules, several millimetres thick, that is interpreted to be the debris of ground chromitite pebbles (Fig. GS-19-5).

The chromitite pebbles are interpreted to be autoliths derived from the debris of rigid chromitite layer(s) that were disrupted and fragmented in a turbulent magmatic environment. Turbulence in the magma, resulting in differing transport velocities of the chromitite pebbles, is suggested by a chromitite pebble that indented and partially adhered to a second pebble (Fig. GS-19-6). The ubiquitous crust characteristic of the pebbles is interpreted as evidence that, after formation, the pebbles adjusted to conditions that differed from the physicochemical environment in which the chromitite layer was originally deposited. The rigid chromitite layers that disintegrated into fragments (which were subsequently rounded into pebbles) must have been located in a cooler part of the magma chamber. Indentations observed in the substrate of many of the pebbles is interpreted as evidence that the pebbles were deposited onto semiconsolidated cumulate olivine layers.

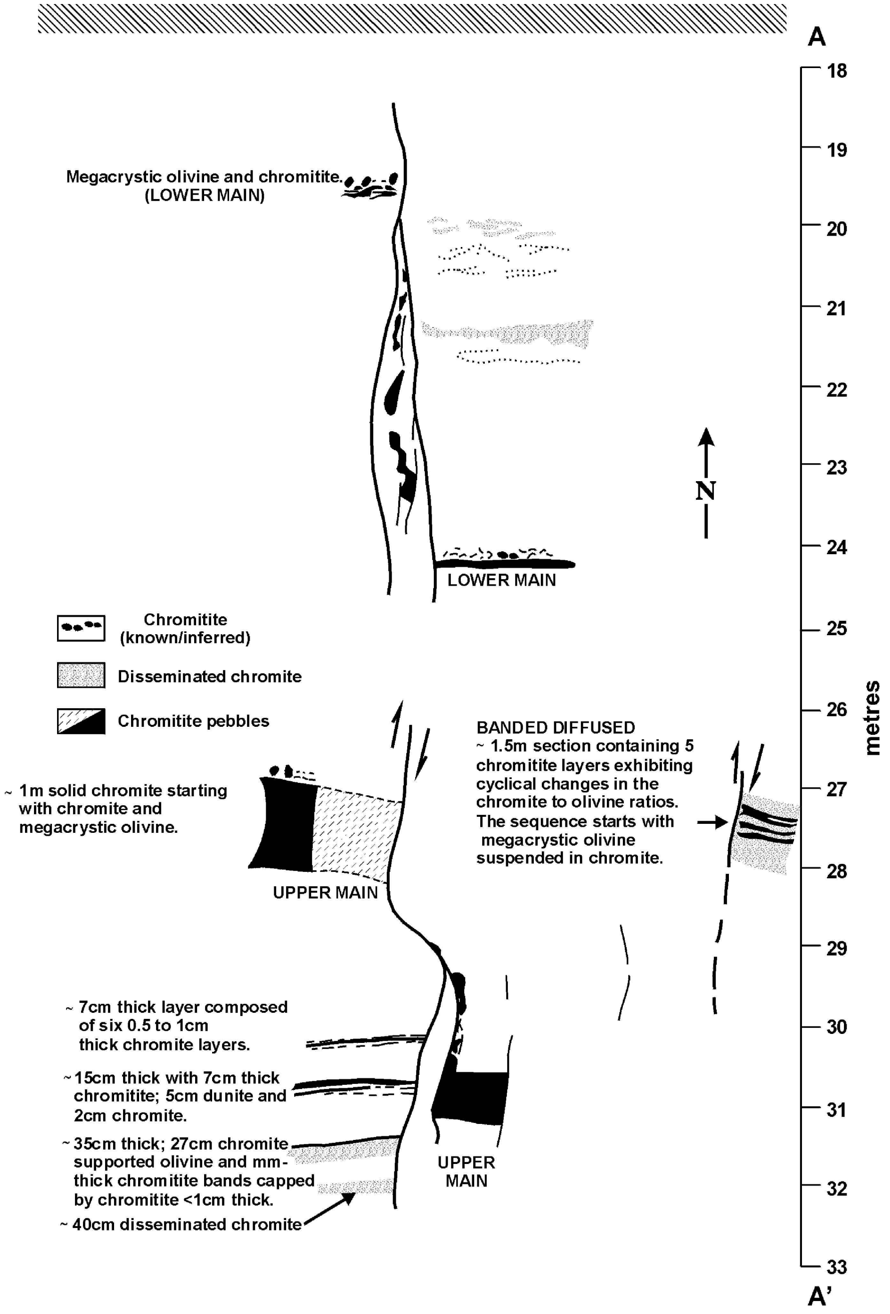

*Figure GS-19-3A: Detailed geological section A-A', northern part. Note that true widths of the lithological units are less than portrayed, because the sill dips south at angles ranging from 55° to almost vertical and the outcrop surface slopes up to 30° toward the north.*

Lithic fragments stoped from the top of a magma chamber by convecting magma, followed by deposition of the fragments on a crystal mush at the bottom of the chamber, has been described in the Skaergaard intrusion of Greenland (Irvine et al., 1998). This mechanism is considered as a possible model to explain the formation of the pebble-bearing layers.

The balance of the section consists of fragmented exposures of the 'Lower Main', 'Banded Diffuse', 'Upper Main' and 'Upper Paired' chromitite layers. The Lower Main chromitite layer is intensely fragmented along an approximately 5 m dextral fault trace.

## ECONOMIC GEOLOGY

There is a correlation between the pebble-bearing disrupted chromitite layers of the Page property and sulphide content of the Bird River Sill. Concentrations of up to 5% pyrrhotite, with traces of pyrite and chalcopyrite, were observed on slabs of channel sample1-2001 (Fig GS-19-3B). Similar concentrations of pyrrhotite, with traces of pyrite and chalcopyrite, were observed approximately 450 m west at the site of channel sample Page 4 (Fig. GS-19-2). This channel sample intersected pebble-bearing 'Disrupted Chromitite' layer and sulphide minerals, in amounts and distribution similar to those encountered in channel sample 1-2001. The discovery and tracing of a sulphide-bearing layer, associated with chromitite layers and

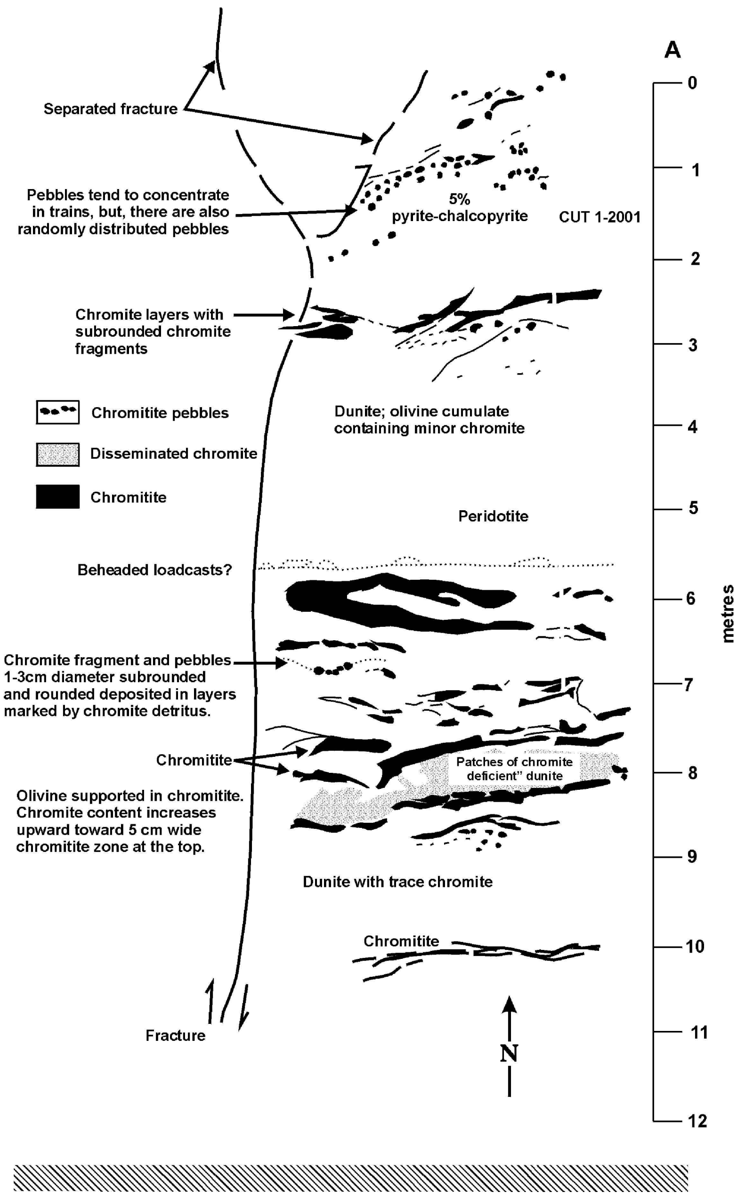

*Figure GS-19-3B: Detailed geological section A-A', southern part. Note that true widths of the lithological units are less than portrayed, because the sill dips south at angles ranging from 55° to almost vertical and the outcrop surface slopes up to 30° toward the north.*

*Figure GS-19-4: Chromitite pebbles arranged in layers.*

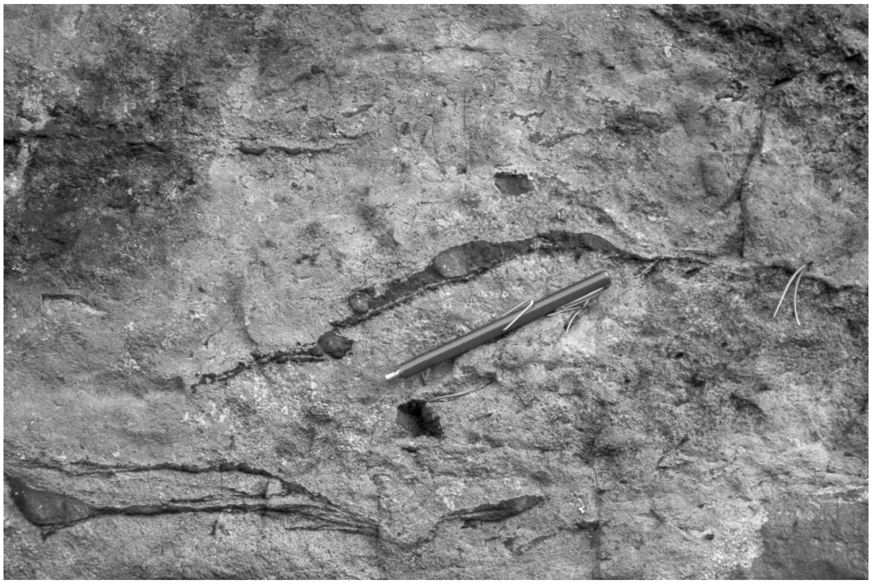

*Figure GS-19-5: Disrupted chromitite layers and chromitite pebbles partially embedded in chromitite debris.*

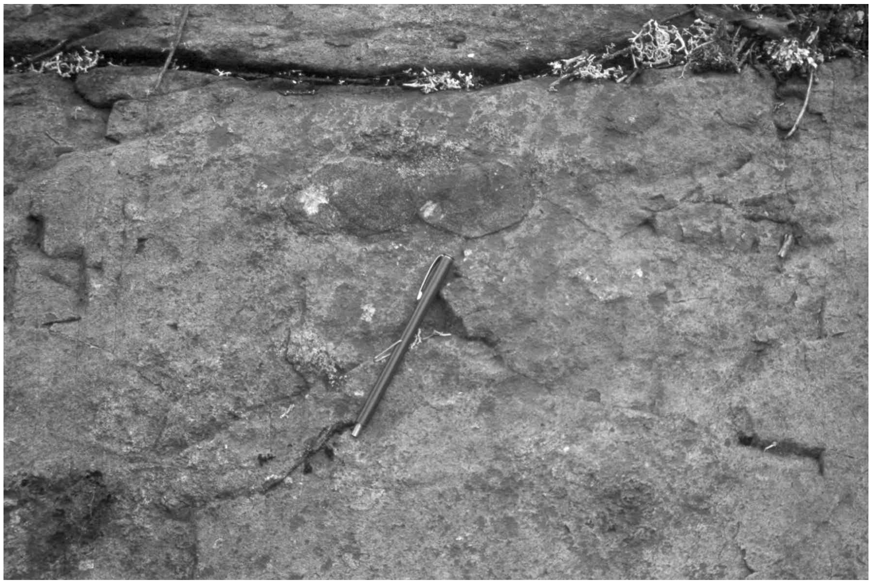

*Figure GS-19-6: Chromitite collision! Note that one pebble indents the other; both pebbles remained welded to each other.*

pebbles, that extends through most of the Page property is thought to be of economic significance. Magmatic turbulence is the hallmark of reef-type PGE concentration models (Naldrett, 1989). Geochemical data from rock units under discussion were not available at the time of writing.

In addition to the above-mentioned potentially PGE-bearing layer associated with the ‘Disrupted Chromitite’ layer, a second possible sulphide- and PGE-bearing layer occurs at the Page property. Diamond-drill hole 3 (Fig. GS-19-2), drilled by Hudson Bay Exploration and Development (HBED) in 1954, intersected what is possibly the equivalent of the PGE- and sulphide-bearing layer at the base of the ‘Layered Zone’ on the Chrome property (Theyer, 2000). This drillhole, which aimed to test an approximately 600 m long, west-striking geophysical anomaly, intersected a 4.6 m thick sulphide zone containing up to 1.43 % Ni and 1.38 % Cu. Combined Pt+Pd content is up to 7.2 g/t over 20 cm.

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