THE PICKET PIN Pt/Pd ZONE, STILLWATER COMPLEX, MONTANA.

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Within the Stillwater Complex several narrow stratabound zones show anomalous enrichment in the platinum group elements (PGE). The main PGE zone occurs in OB I ∿425 m above the base of the Banded Series. The Picket Pin zone is located 3 km stratigraphically higher in the upper 20 - 30 m of AN II, the thickest anorthosite of the Banded Series (1). The thick anorthosite units within the complex present major petrogenetic problems (2,3) and an understanding of the mechanism of concentration of PGE, while of obvious economic significance, may also shed light on the nature of late stage processes operating during the formation of anorthositic cumulates.

The Picket Pin mineralized zone is present for 22 km along strike and consists of meter-size podiform and lenticular concentrations of disseminated PGE-bearing sulfides (1-5%) in anorthosite. Although mineralization is locally present up to the contact with the overlying troctolite (OB V), the majority of the sulfide concentrations are found at and below a horizon in the uppermost 5-10 meters of AN II marked by an abrupt change in texture and mode. Pipe-like bodies of mineralized rock lead up to the ore zone, and are found to a depth of 150 m in the footwall anorthosite. Locally, massive sulfide is found in the cores of plagioclase - pyroxene pegmatites.

It can be seen from fig. 1 that the Picket Pin Zone is of lower grade than the Main Zone and that the ore is notably enriched in Pt and Pd relative to the other PGE's. An inverse correlation between PGE and Ni with stratigraphic height is observed in the Picket Pin area (fig. 3). The stratigraphically uppermost sulfides are devoid of significant PGE's and have a higher Ni/S value (0.233 $\pm$ .053 vs. 0.155 $\pm$ .051 for the PGE-rich samples). This inverse correlation does not support a model of metal concentration involving scavenging by immiscible sulfide droplets as proposed by (4). As shown in fig. 2, the PGE-bearing anorthosites are enriched (relative to unmineralized anorthosites) not only in chalcophile elements but also in LIL incompatible trace elements. The sulfide-bearing zones occur within pyroxene-poor anorthosites (note depletion in Cr and Sc) which contain significant amounts of quartz (up to 10%) and minor fluorapatite, graphite and carbonate. Three-phase fluid inclusions are present in quartz. These CO_2-rich inclusions contain small cubic daughter crystals (?NaCl). It has been proposed by Salpas et al. (2) that the formation of quartz, apatite and the LIL-enriched phase of AN II is the result of crystallization of a very small amount of trapped, volatile-rich melt.

Published petrogenetic models (4,5) for the PGE ore zones emphasize the importance of magmatic processes to concentrate the PGE. However, the typical podiform nature of the mineralization, the presence of pipe-like bodies of ore suggestive of "plutonic fumaroles", the presence of PGE sulfide bearing pegmatites and the presence of briny fluid inclusions are more compatible with a hydrothermal mechanism for ore concentration. We propose that a fluid phase exsolved during the final stages of solidification of the host anorthosite, that this fluid migrated upwards through the largely unconsolidated parts of AN II, thereby permitting interaction with a large volume of rock. The fluid preferentially incorporated ore elements and LIL elements and deposited these components at a zone above which the cumulates had a lower permeability and a higher solidus temperature. The presence of calcite, graphite and fluorapatite and the general absence of primary hydrous phases point to a CO_2-rich briny fluid which is consistent with the expected composition of a juvenile fluid separating from a mafic melt. The high Pt and Pd concentrations relative to the other PGE's also support a hydrothermal origin. As noted by Keays et al. (6), Pt and Pd are more soluble and hence more amenable to hydrothermal transport than are the other PGE's.

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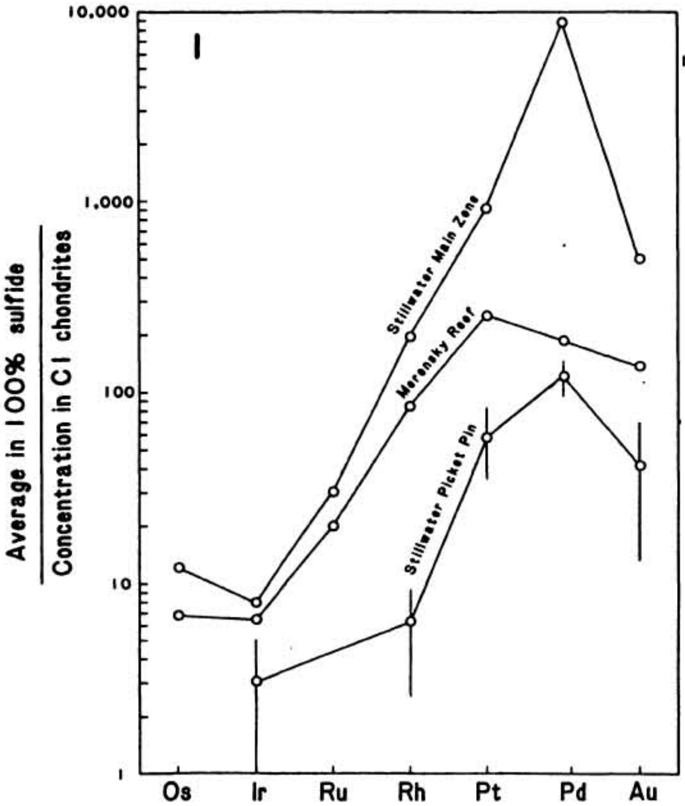
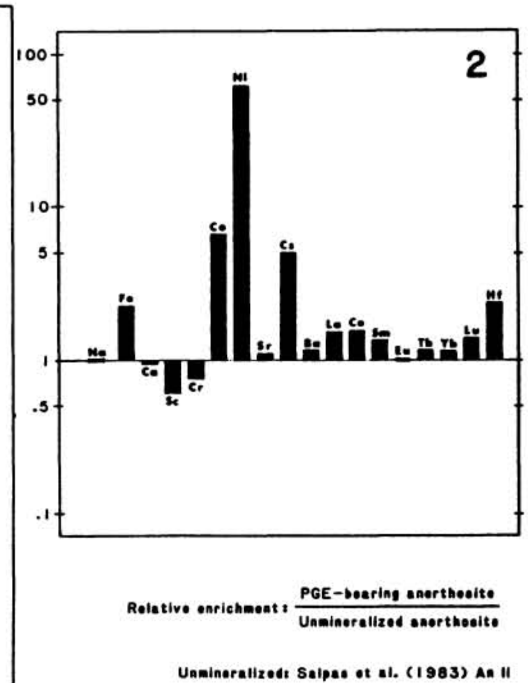
References: (1) McCallum et al. (1980) Am. J. Sci. 280A, 59-87. (2) Salpas et al. (1983) PLPSC 14, in press. (3)Scheidle et al. (1982) EOS, 63, 1143. (4) Campbell et al. (1983) J. Petrol. 24, 133-165. (5) Todd et al. (1982) Ec. Geol. 77, 1454-1480. (6) Keays et al. (1982) Ec. Geol. 77, 1535-1547.





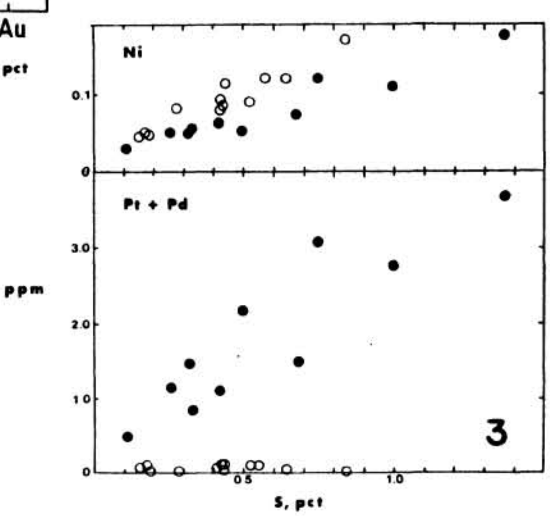


Figure captions: (1) PGE and Au content of Picket Pin sulfide, with comparison with Main Zone and Merensky Reef deposits (data for MZ and MR from 4). (2) Relative enrichment of ore-bearing vs. unmineralized anorthosite. (3) Ni and (Pt + Pd) vs. S. Filled circles are stratigraphically low, podiform ore; open circles are from lenticular zones of sulfide mineralization 2-5 m higher, just below troctolite of OB V.