FINE-SCALE CRYPTIC LAYERING IN THE PERIDOTITE MEMBER OF THE STILLWATER COMPLEX, MONTANA.

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The Stillwater Complex is an Archean basic layered intrusion that outcrops along the northern margin of the Beartooth Mountains in south-central Montana. In this abstract, we report preliminary results of a microprobe study of mineral compositions in a detailed sampling traverse (100 samples collected over a stratigraphic interval of ≃ 33 meters) from outcrops near the Gish Mine, in the Boulder River Valley. This traverse samples a small portion of the peridotite member of the Ultramafic Series. Previous studies of cumulate mineral compositions in the Stillwater Complex have shown a narrow range of variation, with frequent resets to more primitive compositions (e.g. Raedeke and McCallum, 1984; Page et al., 1985). Many of the previous studies have utilized sampling intervals of tens of meters between samples. Coherent trends in mineral compositions with stratigraphic height often are not observed with this coarse sampling interval. We have collected several fine-scale traverses from a variety of levels in the complex in order determine whether the narrow range of compositions found in previous studies is a result of the coarse sampling interval.

The Gish Mine traverse consists of bronzitites, olivine bronzitites, harzburgites and dunites. The samples contain cumulus bronzite, olivine, disseminated chrome-spinel and sulfides (pyrrhotite, pentlandite and chalcopyrite), with minor intercumulus clinopyroxene.

The range of compositions for the cumulus minerals in this traverse follows: Mg-number of orthopyroxene: 82.2-85.5, Cr_2O_3=0.33-0.56 wt.%, Al_2O_3=1.1-1.7 wt.%; Fo in olivine=79.9-84.1, NiO in olivine=0.19-0.37 wt. %; Chrome-number of spinel=55.1-61.4, Mg-number of spinel=26.4-37.7. Mg-number in bronzite, forsterite in olivine and TiO_2 in spinel are plotted versus stratigraphic height in the traverse in Fig. 1. The section has been divided into a series of cryptic units, A, B, C, and D. The boundaries between these units have been selected based on major reversals in Mg-number in orthopyroxene. Bronzite is a major phase in all samples, whereas olivine is rare or absent in the lower part of the section where gaps are shown in the olivine data. Units A and C show trends of increasing Mg-number in OPX with stratigraphic height. This behavior is believed to be related to mixing between evolved and more primitive liquids. It is uncertain whether the more primitive end member in this mixing represents a new input of fresh magma into the chamber or whether it is due to a resident magma, already present in the chamber, once quasi-isolated but now mixing with the local magma due to convective overturn in the chamber or due to breakdown of a double-diffusive interface. Unit B shows decreasing Mg-number with height, indicating that this zone represents normal fractionation of an isolated magma batch. Unit D shows little variation with height. The scale of these magmatic resets, with brief stratigraphic zones in units A, B, and C could indicate the presence and quasi-isolation of small magma batches in the chamber. Unit D appears to represent a much larger magma batch, with removal of > 10 meters of cumulates producing very little change in mineral compositions.

Other chemical factors in these samples, such as Mg-number and Cr-number in spinel, and Cr and Al in pyroxene do not display well defined trends versus stratigraphic height and are not shown in Fig. 1. It is believed that these factors have been modified by sub-solidus reequilibration. Olivine-spinel geothermometers (Engi, 1983; Fabries, 1979; and Fujii, 1977) indicate temperatures of equilibration in the range 500-800 ° C. The geothermometer of Sachtleben and Seck (1981), based on aluminum solubility in orthopyroxene, also yields sub-solidus temperatures, most of which fall in the range 800-1150 ° C.

References: Engi, M. (1983), Am. J. Sci., 283A, 29-71. Fabries, J. (1979), Contrib. Mineral. and Petrol., 69, 329-336. Fujii, T. (1977), Yrbk. Carnegie Inst. Wash., 76, 563-569. Page, N. et al. (1985), in Montana Bureau of Mines and Geology Spec. Pub. 92, pp. 147-209. Raedeke, L. D. and I. S. McCallum (1984), J. Petrol., 25, 395-420. Sachtleben, T. and H. A. Seck (1981), Contrib. Mineral. Petrol., 78, 157-165.

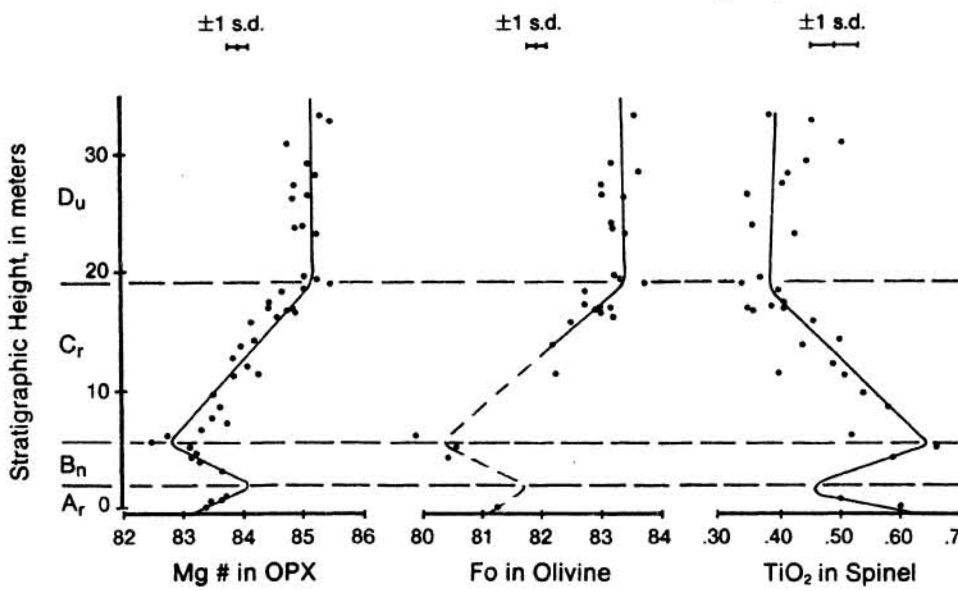

Figure 1. Fine-scale cryptic trends in mineral compositions for the Gish Mine traverse. Units showing reverse trends are labelled 'r', 'n' is for normal trend and 'u' is for uniform, as in unit D, which shows near constant orthopyroxene and olivine compositions with height.