

PB ISOTOPIC EVIDENCE FOR REMOBILIZATION OF SULFIDES IN THE STILLWATER COMPLEX M. W. Thurber, B. K. Nelson, and I. S. McCallum, Dept. of Geological Sciences AJ-20, University of Washington, Seattle, WA 98195

Isotopic ratios of Pb in sulfide separates (primarily pyrrhotite, pentlandite, chalcopyrite, pyrite, cubanite, and braggite) from the Archean Stillwater Complex (2.7Ga old) were measured to elucidate the temporal and genetic relationship between sulfide and silicate minerals in the host rocks and to constrain the physical and chemical mechanisms responsible for concentrating sulfides at discrete stratigraphic horizons within the complex (1-5). Our research to date suggests that a component of "post-emplacement" radiogenic Pb (not removable by stepwise leaching techniques) has mixed with common Pb in sulfides. This observation has two important implications: (1) sulfides must have been recrystallized after emplacement, and (2) redistribution of Pb was probably controlled by one or more post-emplacement hydrothermal events which may have affected other isotopic systems in the complex. Small sulfide-rich veins in microfractures within silicates and sulfides associated with quartz veins are consistent with a post-magmatic remobilization of sulfides.

Samples analyzed include surface and subsurface samples collected from the Basal Series, the Platinum Group Element-bearing J-M reef, the Picket-Pin reef and other minor sulfide zones within the Banded Series. We have both a stratigraphic and a lateral sampling of the known occurrences of sulfides. The sulfide separates were progressively leached so that surface contamination and non-crystallographic radiogenic Pb could be preferentially removed. All leaches from the stepwise dissolutions were analyzed.

The least radiogenic Pb isotopic compositions measured for sulfides ($^{206}\text{Pb}/^{204}\text{Pb}$: 14.01-14.75, $^{207}\text{Pb}/^{204}\text{Pb}$: 14.99-15.17, $^{208}\text{Pb}/^{204}\text{Pb}$: 33.731-34.208) fall within the range of values reported for leached plagioclase separates (6), suggesting that Pb in sulfide and in silicate phases was derived from the same reservoir (Figs. 1,2). Given the lateral continuity and conformity with igneous layering of these sulfides (particularly the J-M reef) it is concluded this reservoir was the magma which produced the host rock.

Successive leaches of individual samples yielded more primitive Pb ratios (Fig. 3). The results from most of the acid leaches, as well as sulfides with extremely radiogenic ratios (Fig.1) require a contribution from one or more radiogenic Pb reservoirs. Some of these leaching experiments are well fit by linear regression lines and can be interpreted as mixing lines. The slopes of these lines could have age significance if the radiogenic Pb mixed into the sulfides was derived from within the complex. One particularly well determined sample from the J-M reef falls on a mixing line between the least radiogenic measured isotopic composition and radiogenic Pb internally produced during the interval between emplacement (2.7Ga) and 1.6Ga. The latter date corresponds to a regionally recognized low grade metamorphic event (7).

The least radiogenic $^{208}\text{Pb}/^{204}\text{Pb}$ compositions also fall within the range of plagioclase ratios (Fig. 2). The more radiogenic values, however, are not well correlated with $^{207}\text{Pb}/^{204}\text{Pb}$ ratios. Therefore, the U/Th ratios of the source material that produced the radiogenic Pb must have varied from sample to sample.

The range in "initial" Pb ratios recovered from the leaching experiments shows varying degrees of mixing of common Pb with an unknown source(s) of radiogenic Pb. Only the least radiogenic Pb compositions reflect the initial Pb

REMOBILIZATION OF SULFIDES IN STILLWATER COMPLEX Thurber, M. W. et al.

isotopic compositions of the magma. This conclusion is supported by the fact that sulfides from the same unit exhibit both primitive and radiogenic Pb ratios. There is also evidence for disturbance of the Rb-Sr isotope systematics over the entire complex (8). It is unclear how extensively the major element composition of the sulfides have been affected by this redistribution event, but this possibility should be evaluated in the interpretation of the sulfide compositions.

REFERENCES: (1) Boudreau, A.E. and McCallum, I.S. (1986) *Economic Geology*, 81, 1953-1975; (2) Campbell, I.H., Naldrett, A.J., and Barnes, S.J. (1982) *J. Petrol.*, 24, 133-165; (3) Barnes, S.J. and Naldrett, A.J. (1986) *J. Petrol.*, (Fig. 3), 27, 791-825; (4) Boudreau, A. (1988) *Canadian Mineralogist*, 26, 193-208; (5) Irvine, T.N., Keith, D.W., and Todd, S.G. (1983) *Economic Geology*, 78, 1287-1334; (6) Wooden, J. et al. (1991) *Contrib. Mineral. Petrol.* (in press); (7) Baadsgaard H. and Mueller P.A. (1973) *Geol. Soc. Am. Bull.*, 84, 3635-3644; (8) DePaolo, D.J. and Wasserburg, G.J. (1979) *Geochim. Cosmochim. Acta*, 43, 999-1008.

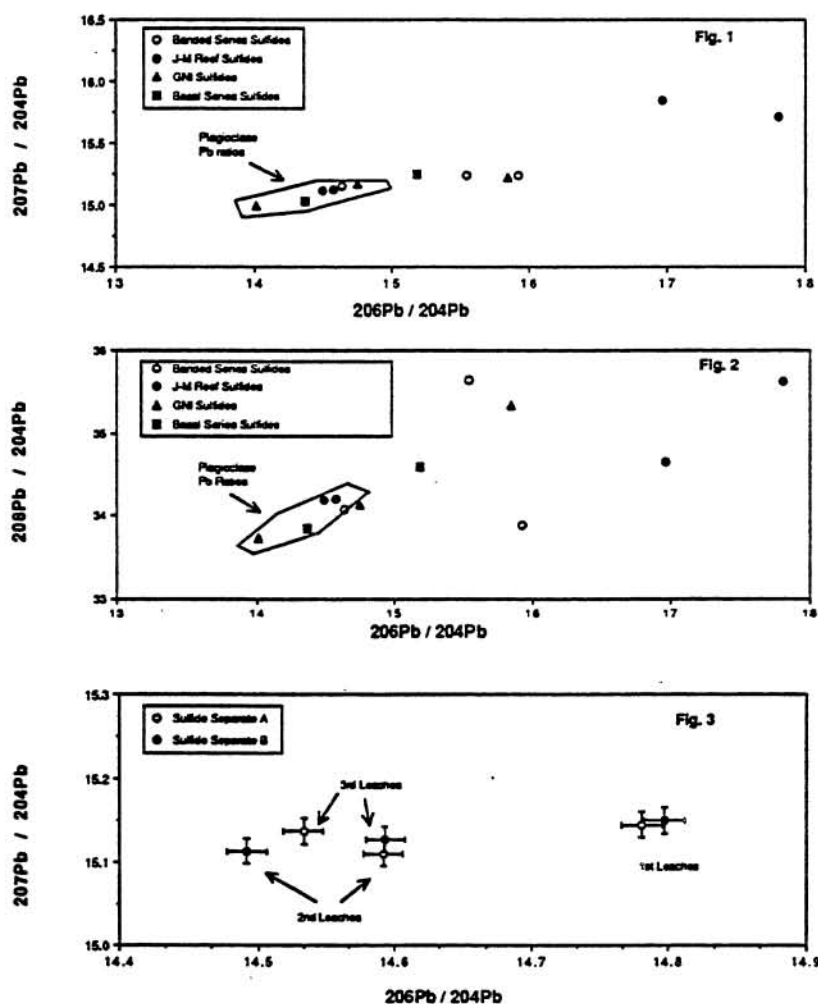


Figure 1: $^{206}\text{Pb}/^{204}\text{Pb}$ - $^{207}\text{Pb}/^{204}\text{Pb}$ plot of most primitive leaches. **Figure 2:** $^{206}\text{Pb}/^{204}\text{Pb}$ - $^{208}\text{Pb}/^{204}\text{Pb}$ plot of most primitive leaches. **Figure 3:** Results on progressive leaching experiments on sulfides from the Frog Pond Adit