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LEAD ISOTOPIC COMPOSITIONS OF PLAGIOCLASES AND SULFIDES IN THE STILLWATER COMPLEX: EVIDENCE FOR ISOTOPIC DISEQUILIBRIUM AND REMOBILIZATION I. S. McCallum, M. W. Thurber, D. Bosch, and B. K. Nelson, Department of Geological Sciences, AJ-20, University of Washington, Seattle, WA 98195

Variations in crystallization sequences [1] correlated with small differences in initial ratios of Nd isotopes [2] have led to the hypothesis that two chemically and isotopically distinct magmas (U type and A type) were involved in the formation of the layered cumulates of the Stillwater Complex [3]. To test this hypothesis, lead isotopic compositions were measured in samples from the complex. Data were obtained on hand-picked separates of plagioclase and sulfides (primarily pyrrhotite, chalcopyrite, pentlandite with minor braggite) since both sulfides and feldspars have very low U/Pb ratios and might therefore be expected to record any variations in the Pb isotopic ratios which existed at the time of crystallization (2.7 Ga [4]). The data were also used to check the extent of internal isotopic equilibrium in single samples and to provide some constraints on the processes responsible for the concentration of platinum group elements within sulfide-rich zones.

To avoid the effects of chemical weathering, sulfides were separated from samples collected from drill core and subsurface mine/adit exposures; plagioclase was separated from the same samples. Additional plagioclase separates were prepared from fresh surface samples collected from all major stratigraphic units in the complex. To remove radiogenic lead located along grain boundaries and fractures, minerals separates were subjected to a stepwise leaching procedure. For sulfides, an initial leach in 0.5N HNO₃ was followed by several leaches in 6N HCl and a final leach in 16N HNO₃, whereas for plagioclase, an initial leach in 6N HCl was followed by several leaches in a mixture of 0.5N HBr and concentrated HF; residues from plagioclase leaches were dissolved in HF. All leaches and residues from the stepwise dissolutions were analyzed.

The results of two typical leaching experiments are shown in Fig. 1. In general, successive leaches of plagioclase are less radiogenic; the residue may be more or less radiogenic than the leaches. In sulfide samples, successive leaches are also less radiogenic with the exception of the final dissolution which, in several samples, showed a reversion to more radiogenic values, probably due to the dissolution of small silicate inclusions within the sulfide grains. On ²⁰⁷Pb/²⁰⁴Pb versus ²⁰⁶Pb/²⁰⁴Pb plots, data from leaches of plagioclase separates define roughly linear trends (see Fig. 1) corresponding to "ages" ranging from 2.0 to 2.7 Ga. The 2.7 Ga age equals the crystallization age of the complex, suggesting closed system evolution while the younger ages reflect post crystallization disturbances.

The data from all sulfide leaches are plotted in Fig. 2 and the data from all plagioclase leaches and residues are plotted in Fig. 3. The plagioclase data define a band in the Pb-Pb diagram with a slope less than that corresponding to a 2.7 Ga *reference* isochron. The least radiogenic plagioclase values for each sample lie close to a 2.7 Ga *source* isochron (based on parameters for second stage of the Stacey-Kramers model for the evolution of crustal lead) reinforcing our assumption that the most primitive values represent the initial Pb isotopic composition of the complex. Pb isotopic ratios of sulfide leaches show a much wider range and a greater scatter.

Fig. 4 is a plot of the most *primitive* Pb isotopic composition of each plagioclase (solid circles) and sulfide (open squares) relative to the 2.7 Ga Stacey-Kramers source isochron and a 2.7 Ga reference isochron. The plagioclase data points define a tight cluster on or close to the 2.7 Ga S/K source isochron with a ²³⁸U/²⁰⁴Pb value between 11 and 12, which is significantly more radiogenic than the average S/K crust or the average mantle at 2.7 Ga. However, it is not possible to distinguish variations in initial Pb isotopic compositions corresponding to different magma types. The highly radiogenic initial values are consistent with the addition of crustal lead to the source region prior to melting as suggested by [5]. However, crustal contamination during storage of primary komatiitic magmas in lower crustal chambers cannot be ruled out.

The most primitive Pb isotopic ratios for sulfides show a much wider range. Sulfides

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are susceptible to low temperature recrystallization and have incorporated Pb (and other sulfide components) into their structures. The data are consistent with mixing of initial lead and radiogenic lead derived from a hydrothermal source. Textures of sulfide-bearing samples also provide evidence of extensive recrystallization. The data scatter precludes assigning a unique age or source of the hydrothermal event(s) with the possible exception of one sulfide sample from the J-M reef. Pb isotopic values of sulfide minerals from this sample lie on a mixing line between the most primitive isotopic composition and radiogenic Pb *internally* produced during the interval between 2.7 Ga and 1.6 Ga. The latter date corresponds to a regional low grade metamorphic event [6].

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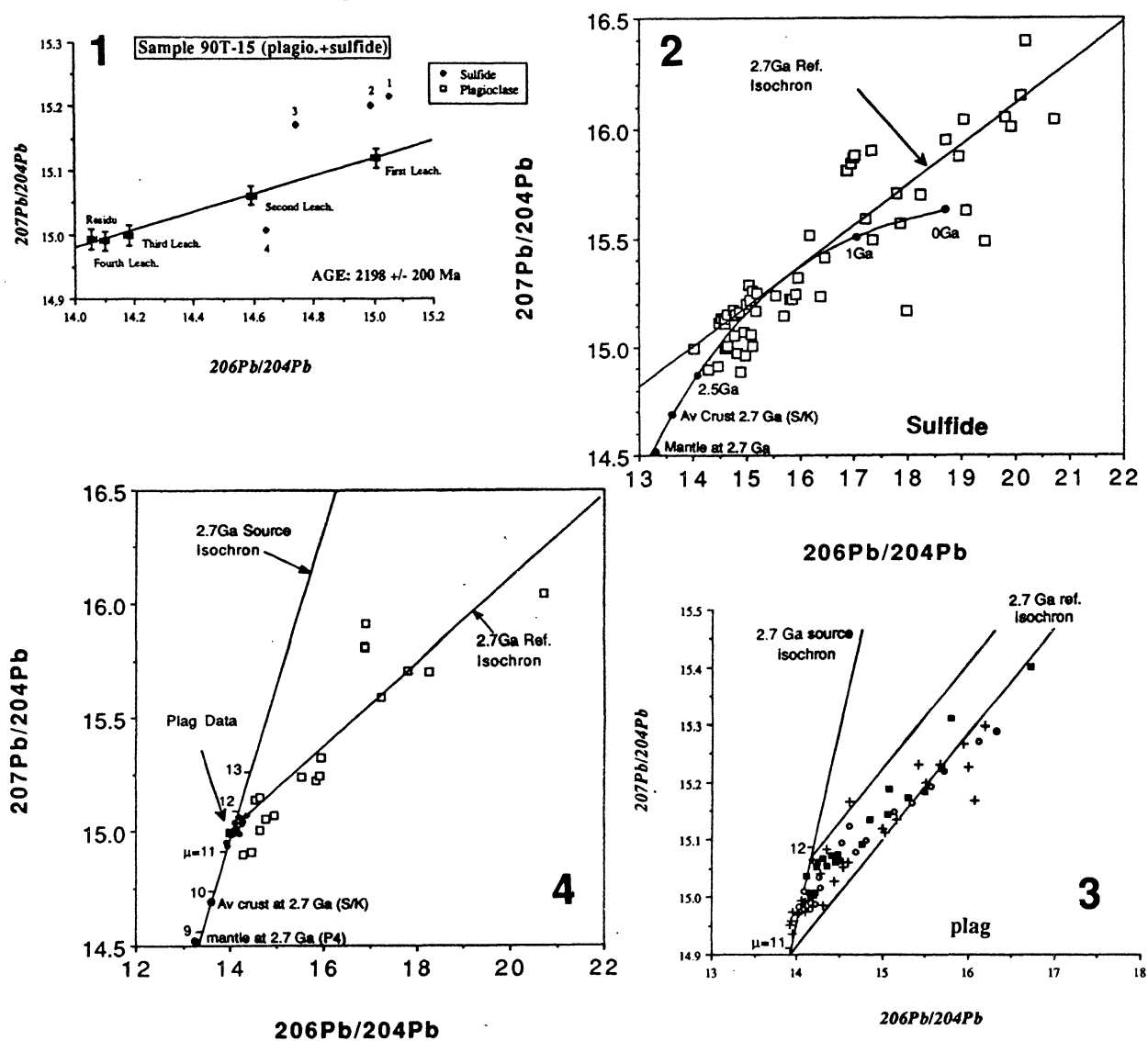


Fig. 1. Results of leaching experiments on sulfides and plagioclase from sample 90T-15. Fig. 2. All sulfide leach data. Stacey-Kramers crustal evolution shown for reference. Fig. 3. All plagioclase leach and residue data. Fig. 4. Least radiogenic Pb isotopic compositions of each sample; plagioclase (solid circles), sulfide (open squares).