A new approach to precise Pb dating of CAI's by thermal extraction and thermal ionization in silica melt

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Calcium-aluminum-rich inclusions (CAIs) from carbonaceous chondites are known to contain primary Pb that is highly radiogenic but at very low concentrations (0.3 – 0.01 ppm). The challenge to precise dating of these refractory phases by $^{207}Pb/^{206}Pb$ chronometry is an efficient removal of terrestrial contaminant Pb. Presently, this is done through leaching, dissolution and chromatographic separation in clean-lab environments (Amelin *et al*. 2002). A novel method is described here that embeds whole CAIs in silica glass on a Re filament for thermal Pb-isotope extraction and efficient ionization in a mass spectrometer (TE-TIMS). CAI fragments were obtained from Allende (Royal Ontario Museum, specimen #M29173 and Dr. O. Bogdanovski) by freeze-thaw disaggregation. After washing in clean H_2O and acetone, whole-chips were mixed directly with clean concentrated silicic acid + H_3PO_4 on rhenium filaments. The mix was slowly fused to a glass under vacuum, taking care to fully embed the CAI fragments inside the glass. Pb/Pb-ratios were measured on a VG354 thermal ionization mass spectrometer (TIMS) in ion-counting mode using a Daly detector.

Initial results on two ca. 0.1 mg samples yielded mostly thorogenic Pb ($^{208}Pb/^{204}Pb = 160$ and 260). ^{208}Pb emission began to increase at 1580C and attained between 16 – 30 kcps over about about 40 min. Thus, the presence of a whole CAI in the melt does not appear to have significantly reduced the ionization efficiency of the Pb and precise ratios can be measured if sufficient sample can be embedded on the filament. The low concentration of uranogenic Pb combined with significant common-Pb ($^{206}Pb/^{204}Pb = 19$; $^{207}Pb/^{204}Pb = 16$) precludes precise dating of these samples. BSE imaging and EDS analysis of the embedded sample after melting showed extremely high concentration of Re in the CAI. Dissolved Re from the filament may have been efficently partitioned into a molten Fe phase. No detectable Re could be found in the glass or unheated CAIs.

Aside from initial washing of the specimen, no clean chemical separation is required. In addition, thermal pre-treatment may prove useful for differential evaporation of contaminant Pb from meteoritic materials, as shown with zircon (Kober 1987 and Davis, this volume).

References

Amelin, Y., Krot, A.N., Hutcheon, I.D., Ulyanov, A.A. (2002) *Science* **297** (5587): 1678-1683

Kober, B. (1987) *Contr. Min. Pet.* **96**: 63-71

Early saturation of ilmenite and plagioclase buoyancy in Fe-Ti deposits associated with Proterozoic anorthosites

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The igneous origin of Fe-Ti deposits associated with Proterozoic massif-type andesine anorthosites is unanimously accepted but magmatic processes responsible for these oxides concentrations are still debated. New data on the trace element content of ilmenite from various Fe-Ti ores are modelled by a fractional crystallization process of a Fe-Ti-rich ferrodioritic melt. The sequence of crystallization has ilmenite as an early liquidus phase after plagioclase and before ferromagnesian silicates. Cotectic proportions of ilmenite calculated from linear trends in log-log diagrams are in the range 15-20 wt.%, which is commonly lower than the modal proportions of ilmenite observed in Fe-Ti deposits. The mechanism responsible for the ilmenite enrichment is removal of plagioclase through segregation by flotation. Indeed, the plagioclase has a lower density (2.61-2.65 $g.cm^{-3}$ for An_{60-40}) than ferrodioritic melts from which it crystallizes (ca. 2.75 $g.cm^{-3}$). Direct evidences for plagioclase buoyancy are found in the Tellnes (SW Norway) and Lac Tio (Quebec) deposits where anorthositic rocks outcrop close to Fe-Ti deposits and commonly at a higher stratigraphic level. These grey anorthosites significantly differ from their host pink massif-type anorthosite and represent the complementary liquidus phases to the non-cotectic cumulates of the ore bodies. Flotation of plagioclase is also described in the Grader layered intrusion (Quebec) where the saturation of apatite is reached after that of plagioclase and ilmenite. Ilmenite-apatite rocks (nelsonites) thus occur in plagioclase-free layers. This thus implies that nelsonites actually represent cumulates rather than Fe-Ti-P-rich immiscible melts. The cumulate origin is thus largely documented for different types of Fe-Ti ores in anorthosites and related rocks. It is accompanied by plagioclase floatation which is responsible for the relative enrichment of Fe-Ti oxides and may be a major controlling factor in the genesis of Fe-Ti deposits.