

Time span of Malani Igneous Suite, NW India: Constraints from mineral and wholerock Sm-Nd isotope studies

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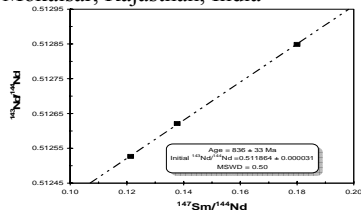
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Malani is an important Neoproterozoic igneous suite, covering an area of approximately 51,000 sq km in Northwestern Indian shield which shows Bimodal volcanism. The Malani consists mainly of volcanic, granite and dyke phases. Crawford and Compston (1970) determined Rb-Sr age of ~ 745 Ma for the volcanics and granites. Rathore *et al* (1996, 1999) on the basis of whole-rock Rb-Sr and Ar-Ar studies suggested that Jalore and Siwana granites, which are part of Malani Igneous Suite, were emplaced at 727 ± 8 Ma and 698 ± 10 Ma, respectively and affected by later thermal event ~ 550 Ma ago.

In order to reliably determine age of magmatism of Malani suite of rocks we have initiated Rb-Sr and Sm-Nd isotope studies on mineral separates and wholerock. Amphibole and K-feldspar were separated from a sample of Siwana granite, a major granite phase of the Malani suite. These minerals along with the whole-rock define a collinear array in Sm-Nd isotope evolution diagram (Figure 1) whose age corresponds to 813 ± 13 Ma (MSWD = 0.57). We interpret that this as the age of crystallization of the Siwana granite which is distinctly older than the reported whole rock Rb-Sr age. Further studies are in progress to constrain the time of Malani magmatism as it has important implications to regional stratigraphy and reconstruction of Neoproterozoic events on supercontinent scale.

ϵ_{Nd} calculated for 800 Ma age on a Siwana and two Jalore granite samples range from + 0.8 to - 7.9. The magmas representing these granites could have been derived from different sources or they could have undergone variable extents of assimilation of old, evolved continental crust.

Figure 1: Sm-Nd Mineral isochron on a sample of Siwana granite, near Mokalsar, Rajasthan, India



References

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Experimental determination of the Iridium solubility in silicate melts

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To understand the fractionation of Os, Ir, and Ru during partial anatexis in the Earth's mantle, we investigate experimentally the solubility of Ir in silicate melt and the partitioning of Ir between chromite and melt at high pressure as a function of oxygen fugacity (fO_2). Starting material is a natural picrite doped with 15 wt.% $FeCr_2O_4$ component and 5 wt.% Ir as Ir_2O_3 . Run conditions are 1700°C and 2.5 GPa. Liquidus phases are silicate melt, chromite, and (Ir,Fe) alloy. To promote chromite grain sizes sufficiently large for LA-ICPMS analysis we add several percent Li tetraborate. fO_2 at run conditions are derived from Fe activities in the alloys. fO_2 is varied between FMQ-4 and FMQ+3 using different capsule materials and pressure assemblies. Reduced conditions are imposed with talc-pyrex assemblies and graphite capsules, oxidized conditions are generated with anhydrous materials and olivine capsules embedded in hematite.

It is found that Cr^{2+} is about ten times more soluble in silicate melts than Cr^{3+} . Based on Cr concentration in silicate glasses, the switch from predominantly trivalent to predominantly divalent chromium is observed at an fO_2 of around FMQ-2.5. Chromite compositions appear to be less sensitive to the valence state of Cr, in that Cr/(Cr+Al) ratios show little variation with fO_2 . Apparently, Cr^{2+} is rather incompatible with the chromite lattice.

The combination of high temperature, chromite oversaturation, and Li tetraborate flux in the silicate melt allows to grow chromite up to 200 μm in diameter, appropriate in size for quantitative LA-ICP-MS analysis. Iridium analyses of glasses and chromites are carried out with an ArF excimer laser coupled to a single-collector magnetic sector ICPMS. Isotopes recorded in addition to ^{191}Ir and ^{193}Ir are ^{29}Si , ^{52}Cr , ^{53}Cr , and ^{57}Fe . Count rates are normalized to the isotope ^{57}Fe and the FeO content of each phase.

Preliminary results of two charges synthesized at FMQ-2 show that under reduced conditions, Ir concentrations in the chromites and the picritic melts are below detection of the laser probe, i.e. around 15 ppb. Hence, it is not possible to calculate partitioning coefficients for Ir between chromite and melt. The low Ir solubility, even at 1700°C, in the picrite melt suggests that sulfide-undersaturated primitive basalts are generally saturated with the refractory PGE (Os, Ir, Ru), hence capable of crystallizing discrete PGE-Fe alloys. It is expected though that, as more oxidized experiments become available, Ir solubilities will turn out higher in silicate melts more oxidized than FMQ-2. Refractory Os-Ir-Ru-alloys exhibit strong epitaxial preferences to chromite surfaces. Hence, the refractory PGE may be fractionated relative to Pt and Pd whenever a silicate melt is saturated with chromite.