TRACE ELEMENT & Pb ISOTOPE STUDIES OF THE KUTCH VOLCANICS OF NW-INDIA

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Introduction

The end of the Mesozoic era was marked by the outpouring of enormous lava flows spreading over vast areas of Western, Central, and Southern India known as the Deccan Volcanic Province (DVP). DVP is thought to be linked to the Re’union plume, which is responsible for the volcanic activity on Re’union Island in the Indian Ocean. All current models of plate reconstruction indicate that the Indian subcontinent drifted northward subsequent to the break up of Gondwanaland, its western margin passing over the newly initiated Re’union hotspot at around 60–66 Ma. Thus Deccan volcanic province records the first magmatism from the plume head of the Re’union hotspot. The alkaline magmatism north of the DVP in Kutch area of Gujarat State, is slightly older (~3 Ma.) compared to the areas further south. The Kutch volcanics nowhere seen to be in direct contact with the Deccan tholeiites. If the alkaline rocks of Kutch represents the initiation of DVP then it would also represent the first melts generated from the Re’union plume head. This study reports trace element,REE and Pb isotope data on 11 samples of alkaline and tholeiitic basalts from Kutch region. Available Nd and Sr isotopic data on the same set of samples (Bizimis, unpublished data) identifies three potential mantle components; Re’union plume, continental lithosphere and asthenosphere (Indian MORB-like). This study intends to illuminate whether or not the trace element and the Pb isotope ratios, in conjunction with the Sr-Nd isotopic ratios can identify the end member components of Kutch lava and will compare and contrast the chemical and isotopic signatures of the Kutch volcanic rocks with the main DVP.

Experimental

Fresh whole rock samples chosen for whole rock analysis of REE and Pb were powdered in an agate mortar and dissolved in a 3:1 mixture of distilled HF:HNO3. Separation of Pb was done using a two-column and run on a single commercial Re filament using MAT 262. Total blanks were better than 0.3 ng for Pb; and repeated (n=18) analysis of isotopic standard NBS 981 yielded $^{206}\text{Pb}/^{204}\text{Pb} = 16.90 \pm 0.02$, $^{207}\text{Pb}/^{204}\text{Pb} = 15.45 \pm 0.02$, $^{208}\text{Pb}/^{204}\text{Pb} = 36.60 \pm 0.04$. Trace elements for the alkali basalts/tholeiites were determined by solution ICP-MS analysis using a ThermoFinnigan Element ICP-MS. The sample solutions were diluted for target concentration of 100 ppm Total Dissolved Solids. 1 ppb of Indium was added as internal standards and drift corrections for each analyzed mass were applied by interpolating with the internal standard. The solution ICPMS analyses were calibrated against a single solution of well-characterized Hawaiian basalt USGS standard BHVO-1 prepared identically to the samples.

Results and Discussion

In the La/Sm vs. Sm/Yb plot the alkali basalt samples plot at a higher ratio than the Re’union plume indicative of a very low degree of partial melting of Re’union type source. Patterns for the Kutch tholeiites show several important features typical of continental crust with negative Nb spikes and strongly positive Pb peaks and either they lack negative Ti spikes or have modest negative Ti anomalies. Mixture of the mantle and granulite and charnockite end-members suggested by trace element calculations also yield appropriate Nd-Sr isotopic values. Alkali basalt samples from Kutch contain Pb isotope ratios that plot on and between the Re’union and Indian MORB fields. The tholeite samples are enriched in $^{207}\text{Pb}$.

Conclusions

Sr-Nd-Pb isotopic ratios and trace element patterns identify three end members: Reunion plume-type alkali basalts, Mahabaleshwar-type alkali basalts and crustally-contaminated tholeiites. The first type of alkali basalts is generated by very low degree of partial melting (1.6-1.8%) of Reunion plume like source in the garnet stability field; the tholeiites can be explained by crustal contamination of Indian-MORB like magma. High $^{207}\text{Pb}/^{204}\text{Pb}$ (15.61-15.83) ratio of the tholeiites agrees well with the Pb isotopes of local Archean crust. The second type of alkali basalts possibly represents the ambient continental lithosphere.