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DECCAN VOLCANISM AND K-T BOUNDARY SIGNATURES. **A. V. Murali[1], B. C. Schuraytz[1], and P. P. Parekh[2], [1]Lunar and Planetary Institute, 3303 NASA Road 1, Houston, TX 77058. [2]Wadsworth Center for Laboratories and Research, N. Y. State Department of Health, Albany, NY 12201.**

The Deccan Traps in the Indian subcontinent represent one of the most extensive flood basalt provinces in the world ($\sim 10^6$ km^3). These basalts occur mainly as flat-lying, subaerially erupted tholeiitic lava flows, some of which are traceable for distances of >100 km. Offshore drilling and geophysical surveys indicate that a part of the Deccan subsided or was downfaulted to the west beneath the Arabian Sea [1,2]. The presence of 1-5 m thick intertrappean sediments deposited by lakes and rivers indicates periods of quiescence between eruptions. The occurrence of numerous red bole beds (thickness <1 m) among the flows suggests intense weathering of flow tops between eruptive intervals [2].

Although the causative relationship of the K-T biotic extinctions to Deccan volcanism is debatable, the fact that the main Deccan eruptions straddle the K-T event (66 ± 2 Ma) appears beyond doubt from the recent ^{40}Ar/^{39}Ar ages of various Deccan flows [3]. This temporal relationship of the K-T event with Deccan volcanism makes the petrochemical signatures of the entire Deccan sequence [basalt flows, intercalated intertrappean sediments, infratrappean Lameta beds (with dinosaur fossils), and the bole beds] pertinent to studies of the K-T event. We present here the results of ongoing study in our laboratory.

Basalt flows

Chemical and isotopic studies of the sequences of basalt flows from the Western Ghats, the Saurashtra peninsula, and the central and eastern Deccan terrains (>150 flows) indicate that these lavas (Mg values 40-65) have undergone crystal fractionation of olivine, clinopyroxene, and plagioclase and that some of them show the effects of crustal contamination prior to eruption. All of these flows are LREE-enriched with no Eu anomalies. The least fractionated flows are present at Girnar, Saurashtra peninsula [$La_N = 15$-25; $(La/Lu)_N = \sim 2$] and the most fractionated in the upper Mahabaleshwar, Western Ghats [$La_N = 60$; $(La/Lu)_N = 4$]. These flows are divisible into three distinct groups, which perhaps indicates eruption in repetitive cycles [4].

Eight samples of Deccan basalts representing different magma batches were analysed for their Ir content employing RNAA. The Ir content varies between 0.02 ± 0.002 to 0.006 ± 0.003 ppb in these basalts, comparable to the iridium content of Columbia river basalt [5].

Red boles

We analysed three red bole samples from the Mahabaleshwar (Western Ghats), Chikaldhara (central India), and Osham Hill (Saurashtra) regions for the INAA suite of elements. All of these boles are LREE-enriched [$La_N = 22$ to 40; $(La/Sm)_N = 1.2$ to 1.7] and show REE patterns similar to the local basalts. However, all three boles, unlike the basalts, show strong negative Ce anomalies ($Ce/Ce^* = 0.4$-0.5).

We examined the REE data of shales and the clay size fraction of these shales, as well as the marine clays and limestones from the Tarapur offshore drill core (38 samples covering ~2500 m depth) in the Arabian Sea, on the west coast of India [6]. These samples include Eocene to Pliocene(45 to 2 Ma) sediments that represent the weathering products of the Deccan terrain. While all of these samples show LREE-enriched patterns and negative Eu anomalies [$(La/Sm)_N = \sim 3$; $Eu/Eu^* = 0.7$) similar to North American Shale Composite [$(La/Sm)_N = 3.5$; $Eu/Eu^* = 0.6$], none show any appreciable Ce anomaly. This suggests to us that the process that produced the Ce anomalies in the red boles was restricted to the time of bole formation.

K-T boundary clays

The REE abundances of various K-T boundary layers (Stevns Klint, Denmark; Caravaca, Spain; DSDP 465A, 577B; Scollard Canyon, Alberta, ref. 7-12) indicate LREE-enriched patterns [$(La/Sm)_N = 1.7$-4] and distinct negative Ce and Eu anomalies ($Ce/Ce^* = 0.1$-0.5; $Eu/Eu^* = 0.4$-0.8).

Discussion

Oxidation of Ce^{3+} to insoluble Ce^{4+}, which precipitates from solution as CeO_2, produces Ce anomalies in the marine environment [13]. The other REE remain in the trivalent state and are removed from seawater without discernible fractionation. It is also known that Ce removal occurs essentially in the open ocean rather than in estuaries or shelf waters and therefore, the estuarine and shelf deposits would not be expected to show Ce anomalies under normal conditions [14]. Considerably less work has been done on REE mobility during chemical weathering of continental rocks and consequently the REE behaviour under different conditions of weathering is not well understood. Available data on chemical weathering of continental rocks indicates that (a) pH is a major factor that controls REE mobility and under acidic conditions REE are easily mobilized; (b) the presence of flouride in hydrothermal solutions significantly increases REE mobility; and (c) hydrothermal fluids provide a means of transporting the elements into and out of the system [14]. It has been suggested that the K-T boundary clays from the DSDP and Stevns Klint, Denmark inherited their REE patterns and Ce anomalies mainly from seawater and from fish debris, respectively [9, 10]. However, both the fish debris and the deep ocean waters [14,15] exhibit slight LREE-enriched trends [$(La/Lu)_N$=2-3] compared with the Stevns Klint and DSDP clays which show significantly more LREE-enriched trends [$(La/Lu)_N$=4-12], indicating that the boundary clays contain LREE-enriched components. The various K-T boundary clays show distinct differences in REE patterns and an order of magnitude variation in their overall REE abundances.

The observation that K-T boundary clays (irrespective of their environment of deposition) and the red boles from the main body of Deccan exhibit Ce anomalies may not be coincidental. There are at least eleven red bole beds in the 1200 m section of Deccan basalts (Mahabaleshwar), and numerous intertrappean beds and infratrappean Lametas in other parts of Deccan, which require careful study (for their chemical signatures including the platinum group element abundances) to evaluate the relationship between Deccan volcanism and the K-T event.

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