Pb-Sr-Nd isotope data from 30 and 300 Ma collision zone carbonatites in Northwest Pakistan

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Virtually all known carbonatites have been intruded within plates by anorogenic processes, usually in rift zones, and can provide information on the chemical characteristics of the under-lying mantle(e.g. Bell *et al.*, 1982). The carbonatites of Pakistan are especially interesting because they cropout within the Himalayan collision zone, and include both syn-orogenic and pre-orogenic plutons, offering unique opportunities to study the effects of the orogenic process upon the isotope data. We present isotope data for two syn-orogenic Sillai Patti and Loe Shilman (30 Ma) and two pre-orogenic Koga and Jhambil (300 Ma) carbonatites, of the Indus Suture Zone. The younger carbonatites are foliated/banded sheet-like bodies emplaced along thrust faults in the metamorphosed belts of the Higher and Lesser Himalaya, within the Indus Suture Zone. They appear to be collision-related and have no relationship to the silicate rocks in the complex. The initial isotope ratios are given in Table 1 and plotted in a Nd-Pb correlation diagram in Fig. 1. The pattern for the 30 Ma samples is atypical given that carbonatites generally yield positive ε_{Nd} (and negative E_{Sr}). In a compilation of analyses for 128 carbonatites from around the world with ages less than 200 Ma (Harmer and Gittins, 1998), 28 plutons yield negative E_{Nd}, of which 9 are from E. Africa, and 9 others are from a single complex, the Amba Dongar carbonatite of NW India (Simonetti *et al.*, 1995). Significantly, the Pakistan Nd, Sr, and least radiogenic Pb isotope ratios also fit the pattern of carbonatites from the East African Rift, as shown in Fig. 1. Although all Nd and Sr data fit the East African Rift pattern, Pb in some samples appears to have been contaminated as a result of the collision process. The similarities between the East African Rift and the Pakistan carbonatite isotope data suggest similar sources. We suggest that a lithospheric source for the 30 Ma Pakistan carbonatites was transported with the Indian plate during migration from East Africa to the collision with the Asian continent. Intrusion of the carbonatites into rocks of the Himalayan orogenic zone affected only the Pb isotopes in some of the plutons. The anomalies in both terrains are probably somehow related to the presence of the East African Rift.

The 300 Ma Koga and Jhambil carbonatites exhibit a very different pattern, with positive E_{Nd}(and negative E_{Sr}), similar to that for the majority of world carbonatites, showing that the conditions that led to the anomalous features in the 30 Ma carbonatites did not exist 300 m.y. ago in the future Pakistan terrain. The tectonic settings must have differed greatly from present conditions. The Koga

TABLE 1. Nd, Sr and Pb isotope data for Pakistan carbonatites[1]

Sample	Age, Ma	$^{143}Nd/^{144}Nd$	E_{Nd}	$^{87}Sr/^{86}Sr$	$^{206}Pb/^{204}Pb$	$^{207}Pb/^{204}Pb$
Loe Shilman	30	0.512403	−3.8	0.70463	19.429	15.541
Loe Shilman	30	0.512440	−3.1	0.70467	19.008	15.572
Sillai Patti	30	0.512416	−3.6	0.70486	20.455	15.632
Sillai Patti	30	0.512455	−3.2	0.70475	21.354	15.672
Koga	300	0.512440	+3.7	0.70349	18.633	15.600
Jhambil	300	0.512418	+3.2	0.70355	18.693	15.605

[1] All ratios are initial values corrected for *in situ* decay

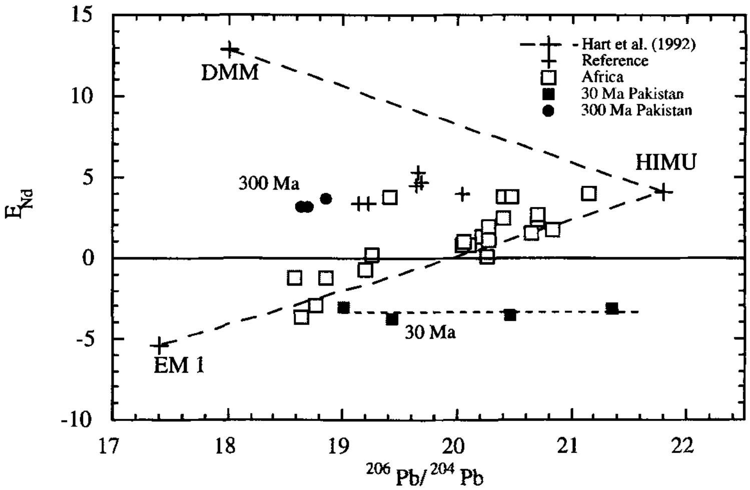

FIG. 1. E_{Nd}-$^{206}Pb/^{204}Pb$ for young (<300 Ma) carbonatites. Data sources for African and other reference carbonatites after Titlton *et al.* (1998).

and Jhambil plutons must have survived the transport and collision processes experienced by the Indian plate without losing their isotopic or compositional identity.

References

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