

Discussion

Reply to: Comment on “Depleted and enriched mantle sources for Paleo- and Neoproterozoic carbonatites of southern India: Sr, Nd, C-O isotopic, and geochemical constraints”

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Accepted 28 May 2004

We thank A. Kumar, K. Gopalan, and D. Macdougall for their interest in our paper, published after peer reviews and editorial scrutiny. Our justification of a depleted source for older carbonatites is based on simultaneous consideration of all relevant parameters (Rare Earth Element geochemistry, C-O isotopic characteristics, and Sr- and Nd-isotopic signatures) and not just because the same observation can be made for the Canadian Shield (Bell and Blenkinsop, 1987). The geochemical and isotopic characteristics have led us to clearly discriminate two different mantle sources for Hogenakal and Neoproterozoic carbonatites.

We would like to clarify that analytical uncertainties are different for REEs and Sr- and Nd-isotopic ratios, and have been mentioned in the text at appropriate place.

Our Paleoproterozoic carbonatites plot as a tight cluster within the primary carbonatite field (Fig. 6 of our paper) while the younger carbonatites show a wide scatter. The older ones have lower $\delta^{13}\text{C}$ values (-6.2 to -6.0%) while the Neoproterozoic ones are relatively enriched in ^{13}C [$\delta^{13}\text{C}$ values between -5.3% and -3.3% , barring a single Sevattur sample

(SVT/4)]. Our usage of ‘enriched’ is meant to describe ^{13}C enrichment alone in Neoproterozoic carbonatites relative to Hogenakal carbonatites, and this statement must not be confused with ‘depleted’ or ‘enriched’ mantle source. We have also incorporated the data of Kumar et al. (1998) in Fig. 6 of our paper and have found a close similarity in C-isotopic results.

The stated confusion of Kumar and others is due to the interchange of elemental Sm/Nd ratios and isotopic characteristics, which are used differently by us. Our statement that the Sm/Nd ratios for carbonatites are lower relative to bulk earth composition should be understood in this context. To emphasize, we state that Neoproterozoic carbonatites have higher $^{87}\text{Sr}/^{86}\text{Sr}$ ratios and lower ϵ_{Nd} values, suggesting an ‘enriched’ source for them.

The main objection of Kumar and others seems to be about our recognition of a depleted mantle source for the Paleoproterozoic carbonatites, which is different from their interpretation (Kumar et al., 1998). Our identification of a ‘depleted’ mantle component for Hogenakal carbonatites is based on the consistency of the data (REE, C-O, Sr- and Nd-isotopes). The Sr- and Nd-isotopic data for Paleoproterozoic carbonatites are significantly different from the younger carbonatites (please see our Tables 2 and 3) and point towards chemically discrete mantle sources for them.

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We have calculated $\epsilon_{\text{Nd}}(\text{T})$ values for Paleo- and Neoproterozoic carbonatites for emplacement ages of 2.5 and 0.8 Ga, respectively, and this explains the difference, although insignificant, in our $\epsilon_{\text{Nd}}(\text{T})$ values and the ones recalculated by Kumar and others (please see Table 1 of comments). The $\epsilon_{\text{Nd}}(\text{T})$ values recalculated from our data also support our conclusion. These recalculated $\epsilon_{\text{Nd}}(\text{T})$ values, which they claim not to differ significantly from Kumar et al. (1998), also show that the Hogenakal carbonatites represent an isotopically distinct group ($\epsilon_{\text{Nd}}(\text{T}) - 0.4$ and -0.56) compared to Neoproterozoic ones (-16.9 to -6.6). This distinction is further reflected in the initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratios (0.70174 and 0.70175 for Hogenakal carbonatites and 0.70488 to 0.70658 for Neoproterozoic ones) and also manifested in the data of Kumar et al. (1998), but they have not appreciated the significance. The isotopic differences clearly indicate two chemically distinct mantle reservoirs, a relatively depleted one for Paleoproterozoic carbonatites and an enriched one for the younger ones.

We agree that our ϵ_{Sr} values appear slightly off in Fig. 7. This shifting appears to have occurred while

drafting the figure. We regret this oversight. Nevertheless, it does not affect our interpretation as the distinction between Hogenakal and Neoproterozoic carbonatites is clearly demonstrated in the Sr-isotopic ratios.

We have proposed two alternative possibilities to explain the geochemical characteristics of carbonatites in question; mantle inhomogeneity—such mantle reservoirs existed from Late Archean through to Neoproterozoic, or the mantle after extraction of the Archean crust was subsequently enriched through metasomatism.

References

- Bell, K., Blenkinsop, J., 1987. Archean depleted mantle: evidence from Nd and Sr initial isotopic ratios of carbonatites. *Geochim. Cosmochim. Acta* 51, 291–298.
- Kumar, A., Nirmal Charan, S., Gopalan, K., Macdougall, J.D., 1998. A long-lived enriched mantle source for two Proterozoic carbonatite complexes from Tamil Nadu, southern India. *Geochim. Cosmochim. Acta* 62, 515–523.