

Solid Earth Discuss., community comment CC1
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Comment on se-2021-108

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Community comment on "Rare earth elements associated with carbonatite–alkaline complexes in western Rajasthan, India: exploration targeting at regional scale" by Malcolm Aranha et al., Solid Earth Discuss., <https://doi.org/10.5194/se-2021-108-CC1>, 2021

This looks like a great paper and more data-driven methods can definitely benefit the relative young science of exproation targeting for REE deposits, particularly those related to alkaline and carbonatite complexes. Looking forward to reading it when it is published!

I do have some minor comments and corrections regarding the geochemical and petrological aspects of this paper.

line 32: Although IUPAC includes this entire list, Pm is an unstable element and for practical reasons in geology does not exist. It is better to remove it. Scandium also probably does not belong here, as it is not an element that is generally associated with the other REEs, and it not sourced from carbonatites and alkaline complexes.

line 45: Placers are the major source in India, but not globally. The largest operating REE mine is Bayan Obo, which is indeed a high temperature carbonatite.

lines 62-73: Is a list of all approaches necessary? If yes, then I think it would look better in a table. It is challenging to read as it is now, in paragraph text.

line 91: You're saying that "no deposit has been identified in the province so far", but in Table 1 you're showing Kamthai, which has a delineated resource estimate?

line 165: Reactions between carbonatites and country rocks are very common in carbonatites, and it is correct that these reaction remove CO₂. However, it has very little to do with the enrichment in REE. If anything, it allows REE to be deposited into REE-rich silicate minerals, essentially removing REE from the melt. This has been discussed in detail in our own work (Anenburg & Mavrogenes 2018, available <https://doi.org/10.2475/03.2018.03> or open access at <http://hdl.handle.net/1885/143148>)

REE are enriched in carbonatites primarily because they are incompatible elements, and Na+K in the melt allow them to be soluble all the way down to the final stages of magmatic fractionation, causing their enrichment in the last batches of carbonatite melt. See our work (Anenburg et al 2020 available open access at <https://doi.org/10.1126/sciadv.abb6570>)

line 175: These late stage minerals are often in-situ replacement of two minerals: burbankite and carbocernaite, which are probably the two most important primary REE minerals in carbonatites, but because of their solubility, they are rarely preserved. Typically, currently observed REE minerals don't precipitate from hydrothermal fluids as you stage in your line 173, rather they are the result of local redistribution of REE after burbankite and carbocernaite are dissolved, and their REE component remain immobile. See for example the Anenburg et al 2020 paper I referred to earlier, and these two relevant papers by Kozlov et al (<https://doi.org/10.3390/min10010073>) and Andersen et al (<https://doi.org/10.1016/j.oregeorev.2017.06.025>)

Also please correct mineral name from "parasite" to "parisite".

line 185: Something which should be highly relevant for your modelling is the decoupling between LREE and HREE in carbonatites and fenites. Our experimental study (Anenburg et al 2020 above) demonstrated that LREE are retained inside the carbonatite, whereas HREE tend to be mobilised outwards into fenites. This is also observed in nature: see example papers by Andersen et al and Broom-Fendley et al:
<https://doi.org/10.2138/am-2016-5532> <https://doi.org/10.1016/j.oregeorev.2016.10.019>
<https://doi.org/10.2138/am-2016-5502CCBY>