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Magmatic evolution of Girnar volcano-plutonic complex of Deccan Traps, India: Sr-Nd-Pb-Hf isotopic evidence of multiple sources

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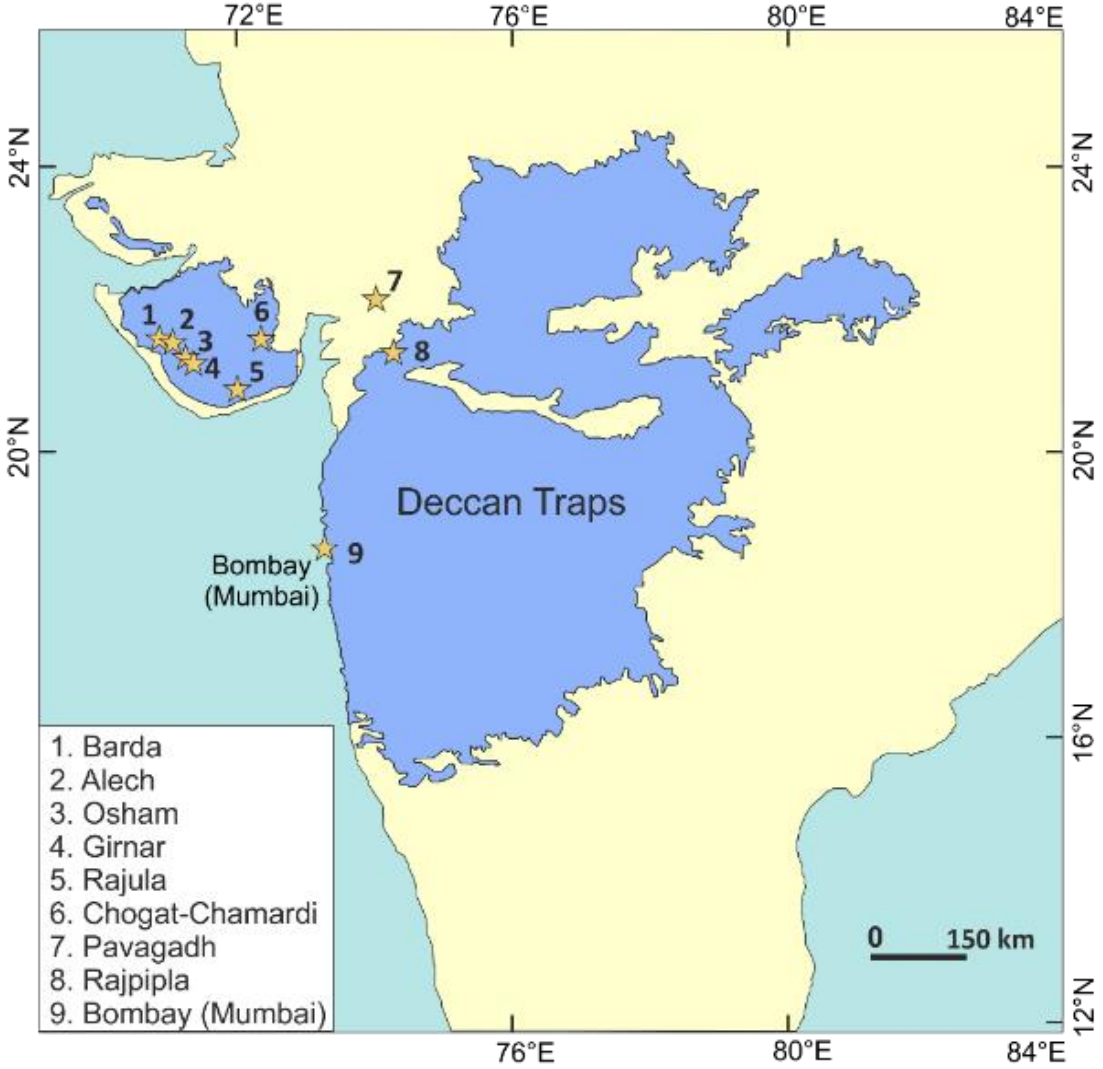
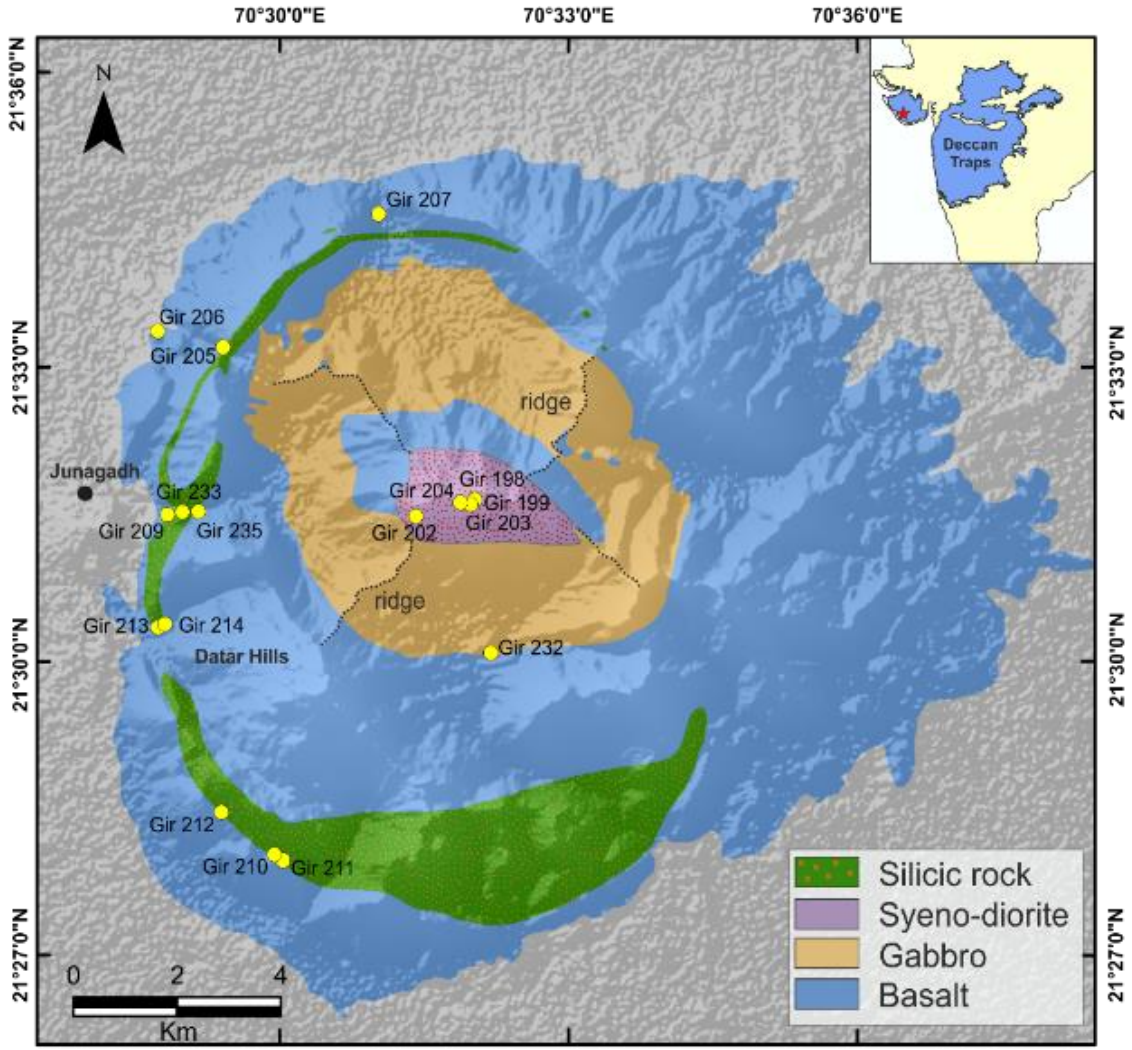
EGU General Assembly 2022
Session: GMPV8.1
Abstract ID: EGU22-446

Funding agency: CSIR, India and Department of Earth Sciences, IIT Kanpur

Distribution of Silicic rocks in the Deccan Traps

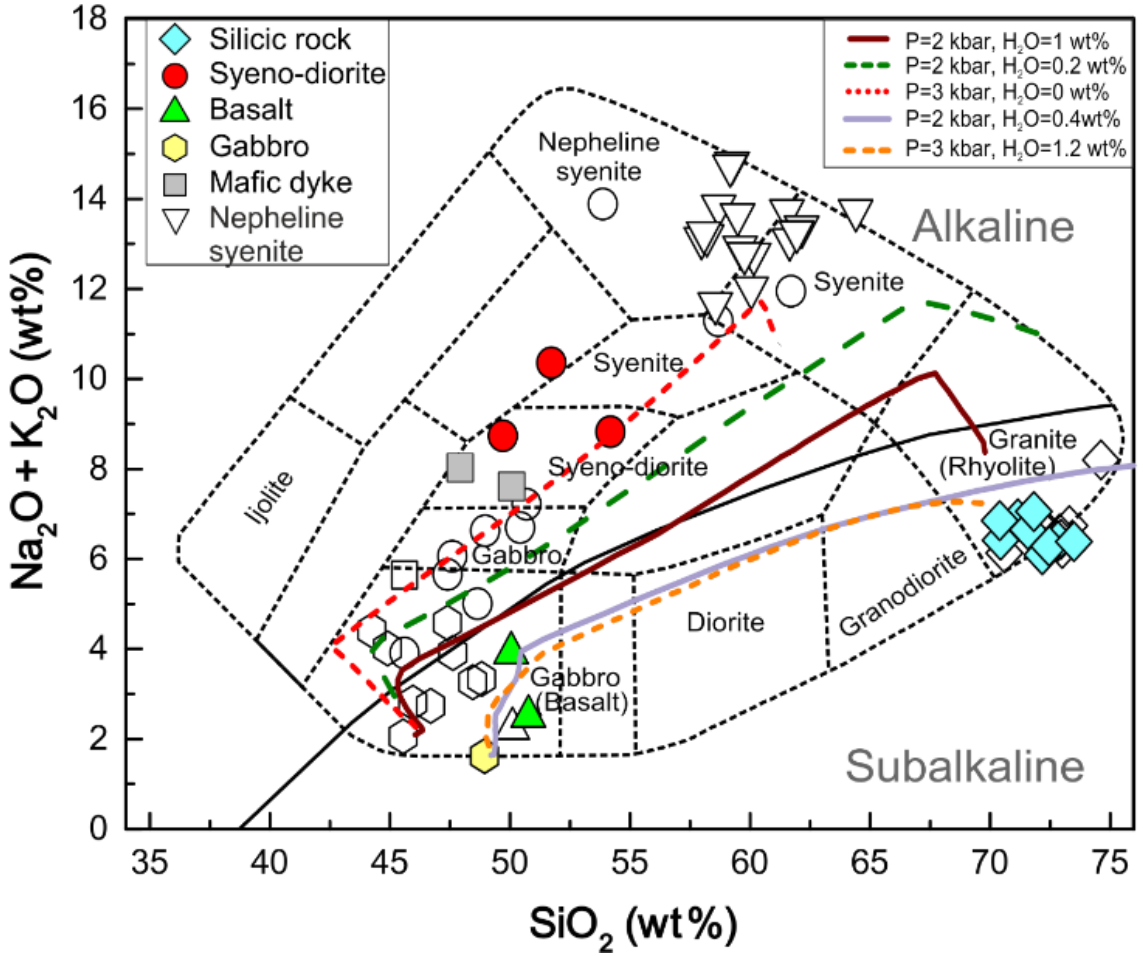


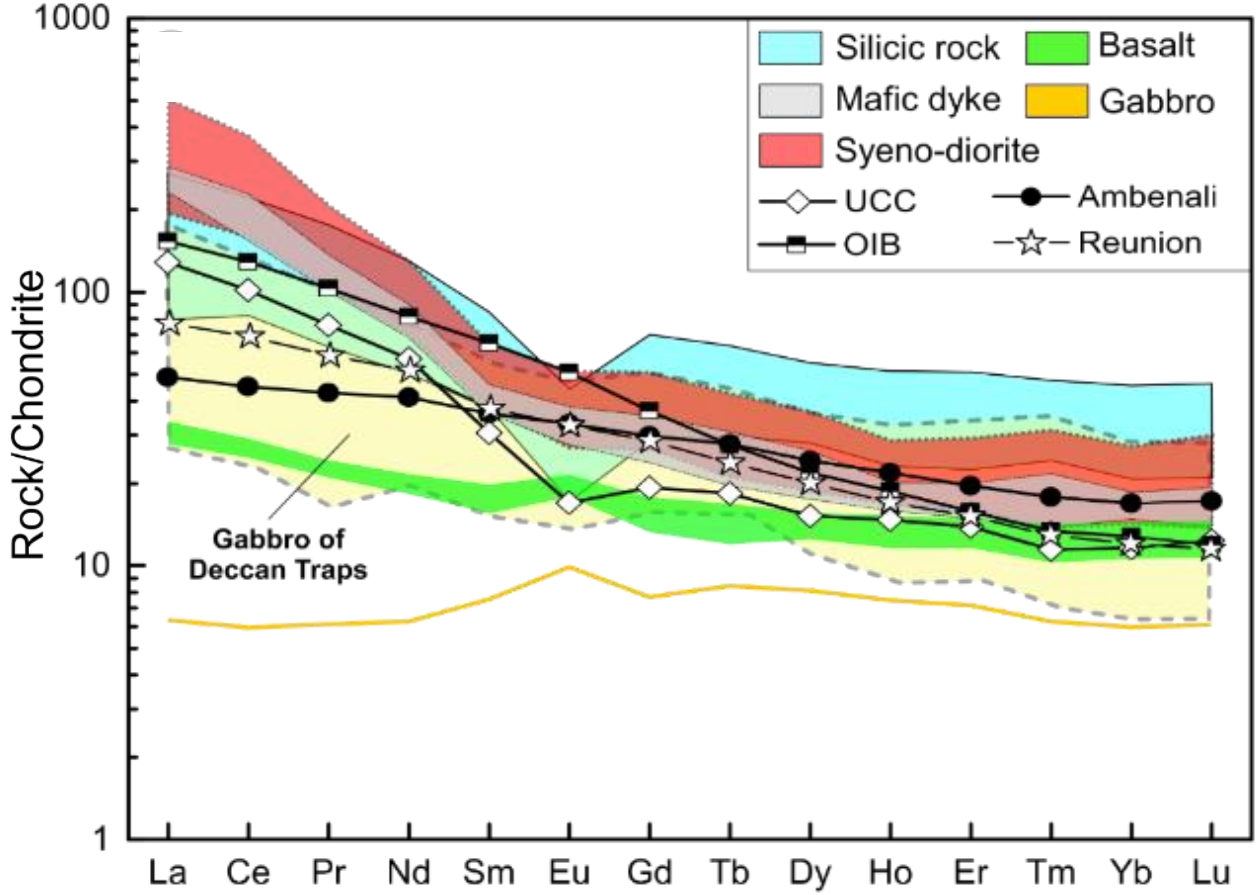
Map of Deccan Traps is showing locations of silicic rocks.



Map of Girnar Hill is showing mafic and silicic rocks.

Major and Trace elements variation and Rhyolite-MELTs modelling

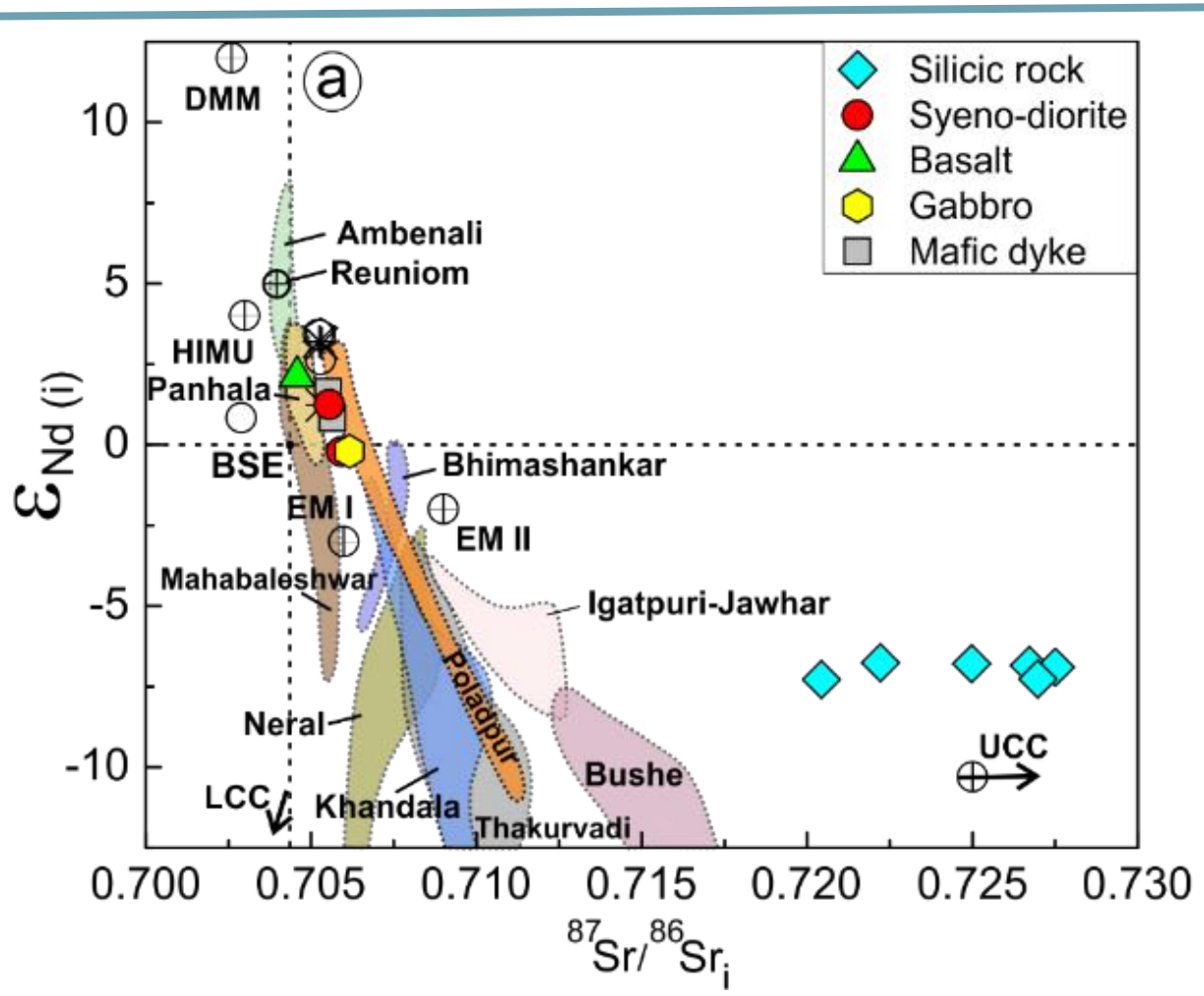


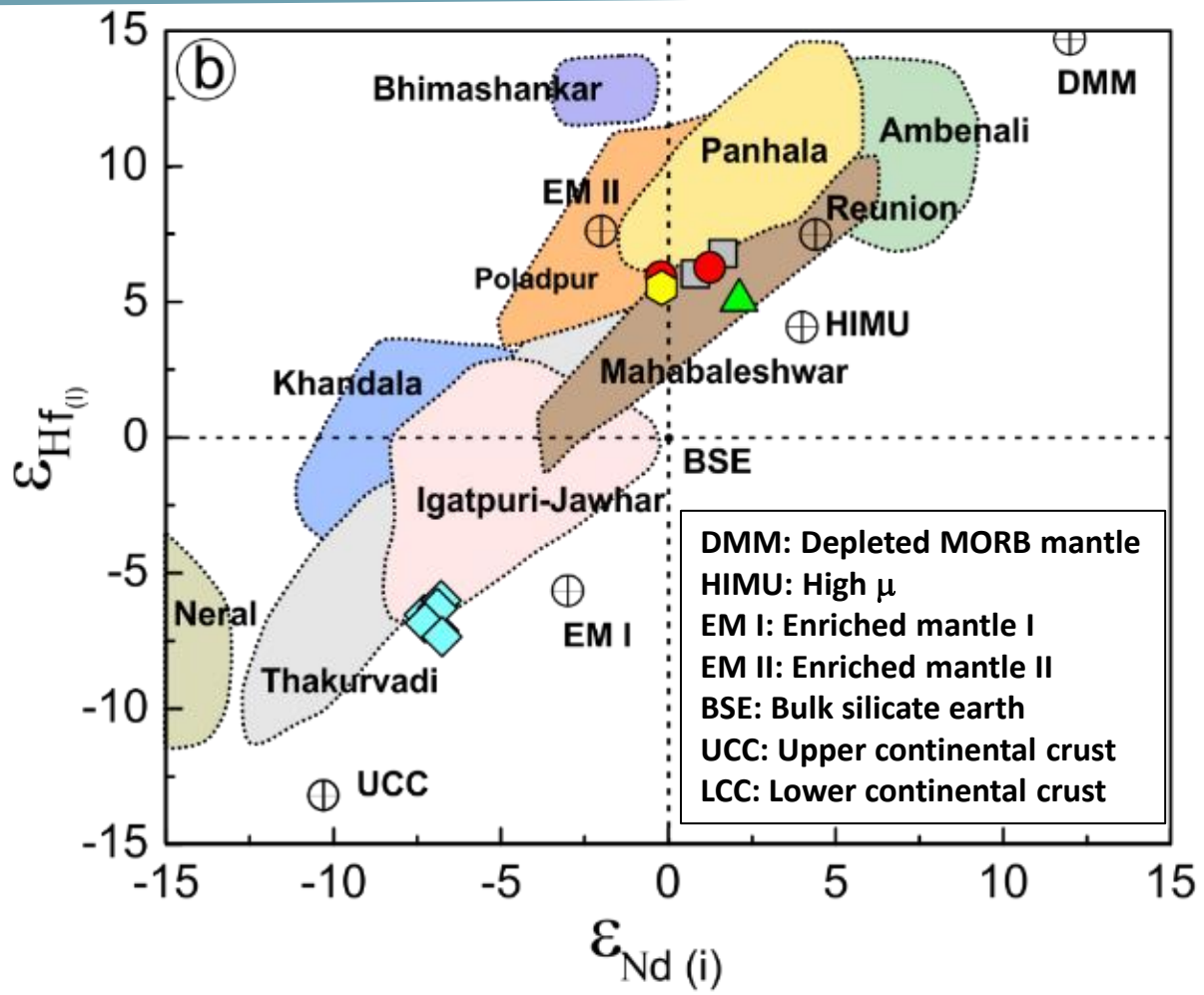


- 74 to 88% fractional crystallization of gabbroic melt under dry conditions can produce melt similar to mafic dykes and syeno-diorites.

- REE pattern of silicic rocks and associated mafic rocks of Girnar Complex of the Deccan Traps.

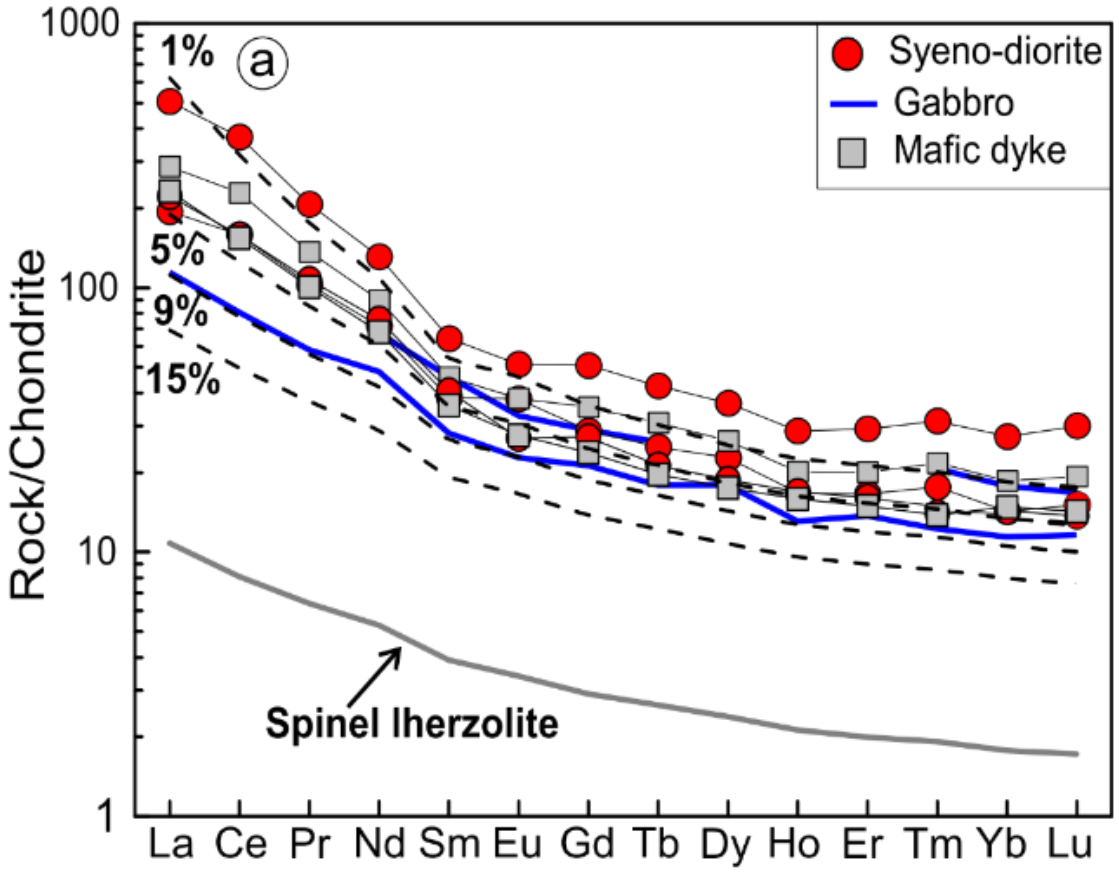
Isotopic composition of Silicic rocks

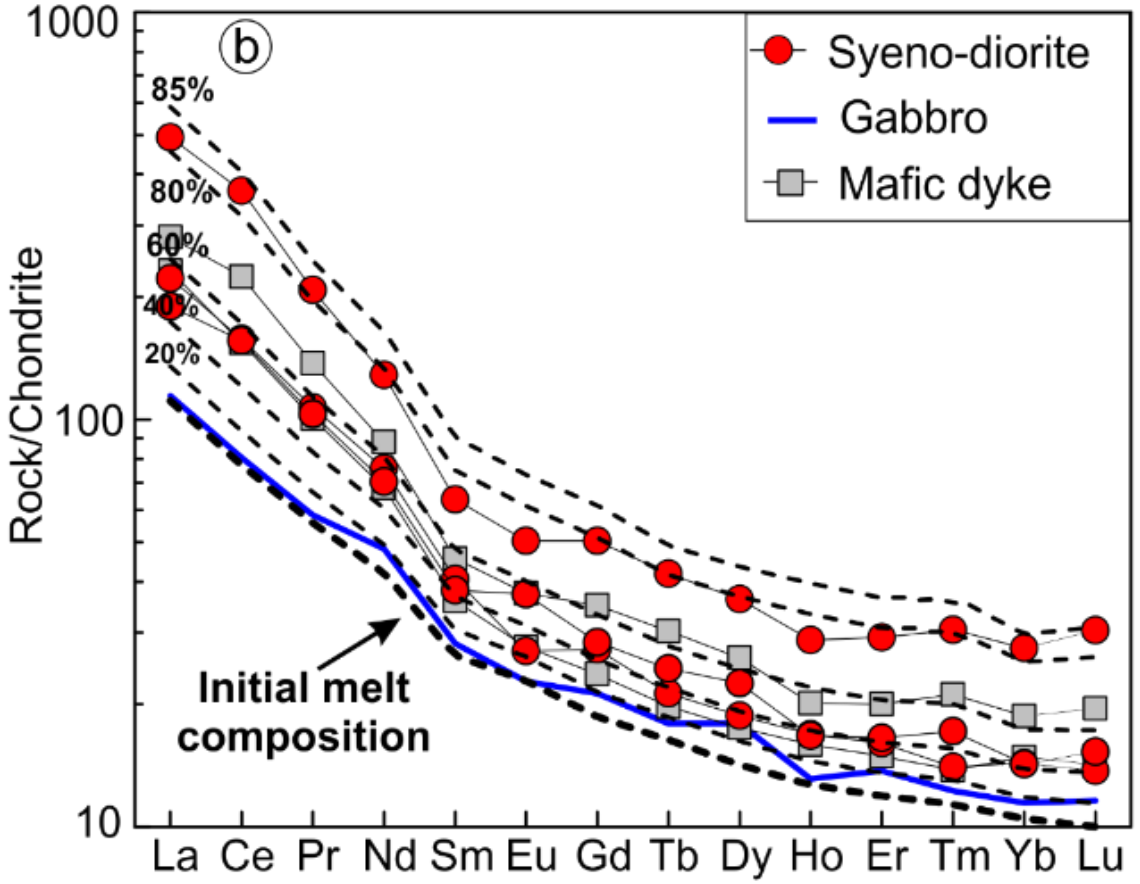




- Mafic rocks plot close to the Bulk Silicate Earth (BSE) or mantle end members composition.
- Isotopic composition of silicic rocks plots close the average Upper Continental Crust (UCC).

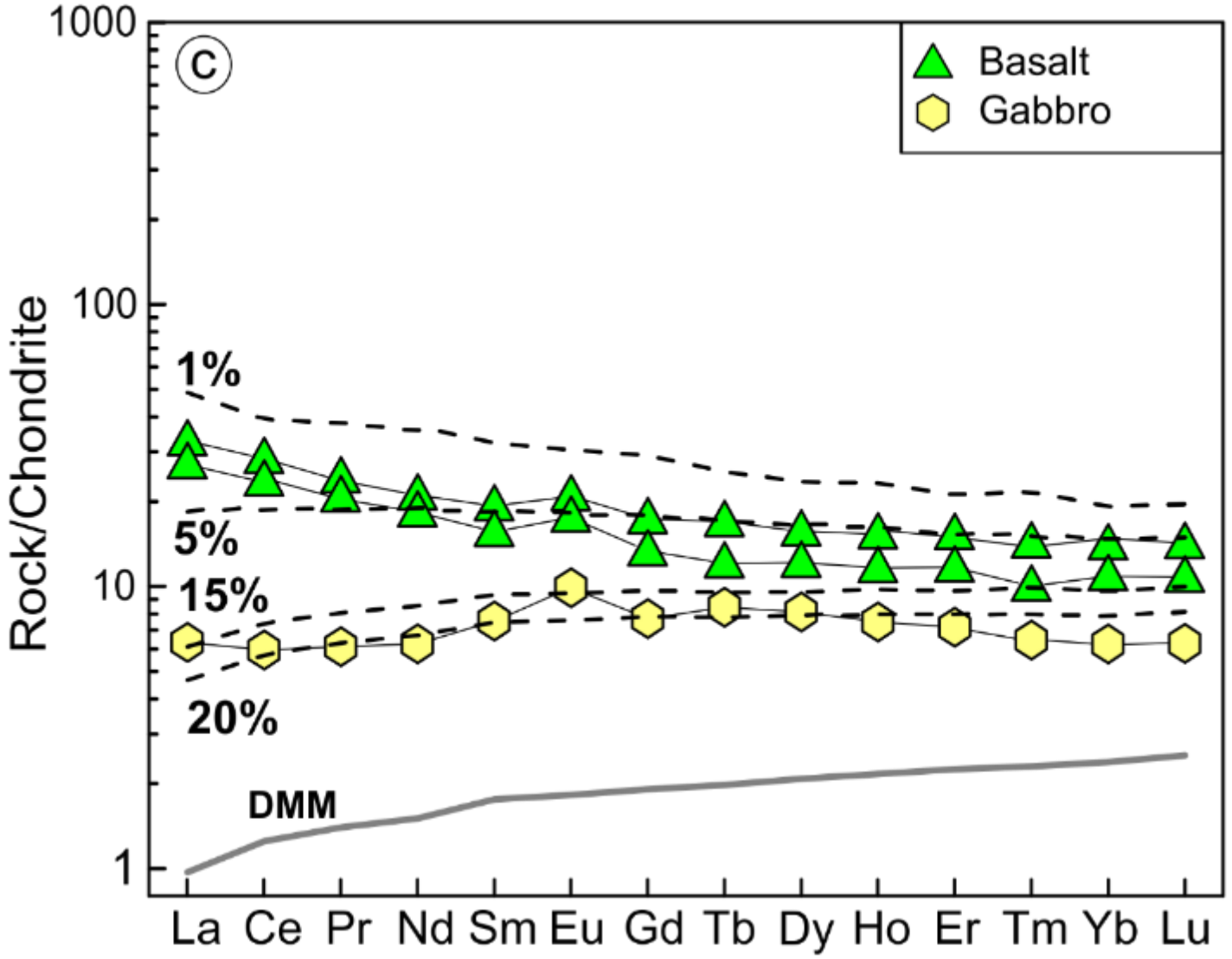
Source of Mafic rocks: Trace elements modelling





- ~9% and ≤5% batch melting of the source can generate patterns of alkaline gabbro and syeno-diorite respectively.
- 50 to 80% fractional crystallization can generate compositional range of syeno-diorite and mafic dykes.

Source of Mafic rocks: Trace elements modelling



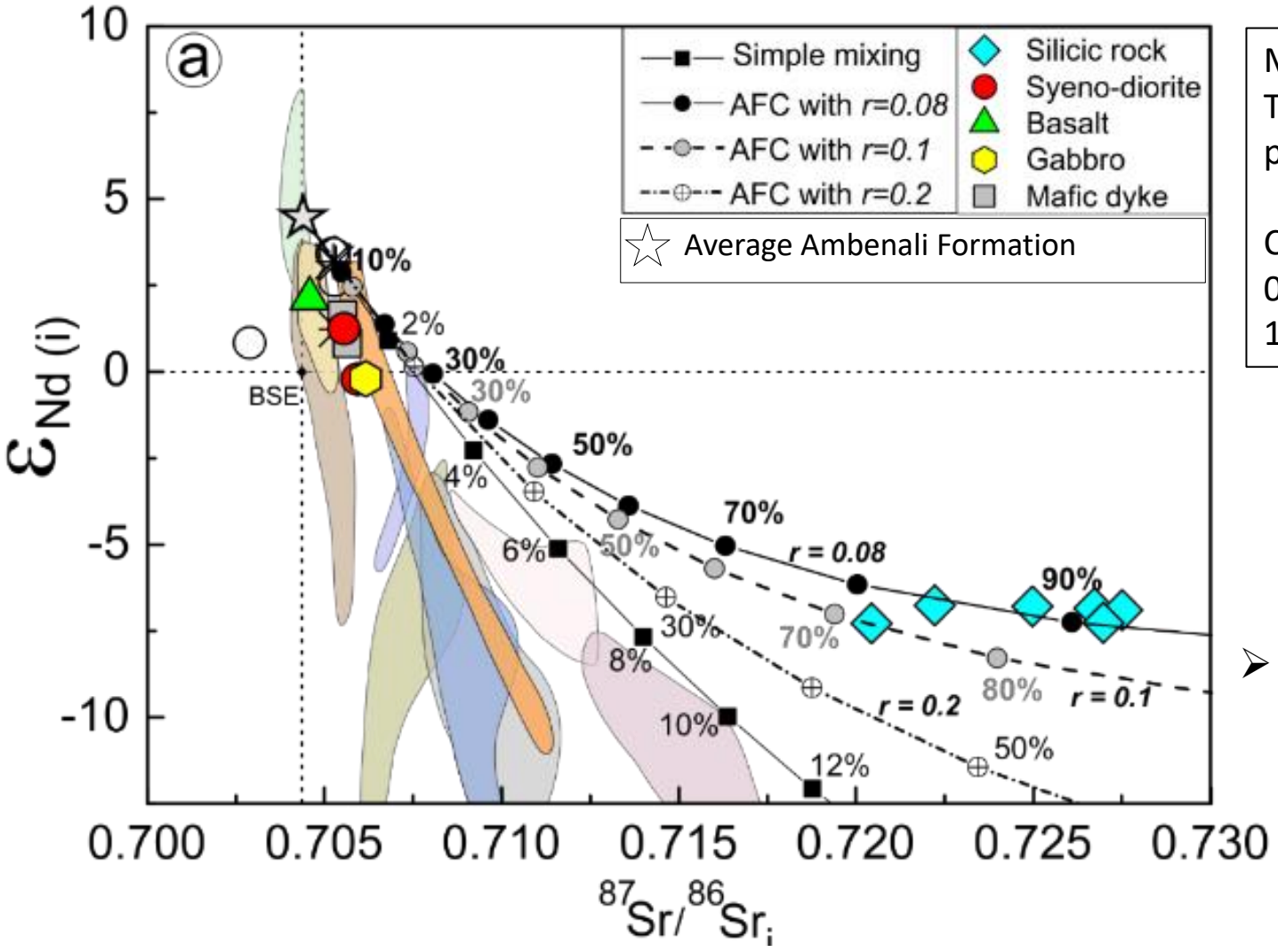
Depleted MORB (DMM): Salters and Stracke (2004).

Mineralogy: 57% olivine, 28% orthopyroxene, 13% clinopyroxene and 2% spinel (Workman and Hart, 2005).

Partition coefficient: Workman and Hart (2005).

- ≤ 5% melting of the DMM source can produce the REEs pattern of basalt.
- ~20% melting of DMM source can produce the gabbro.

Source of Silicic rocks: AFC modelling



Mantle ned member: Ambenali Formation of the Deccan Traps ($^{87}Sr/^{86}Sr_i$ = 0.7044, $\varepsilon_{Nd(i)}$ = +4.5, Sr = 217 ppm, Nd = 20 ppm; Chandra et al., 2019).

Crustal end-member: Granite of Indian Shield ($^{87}Sr/^{86}Sr_i$ = 0.8204, $\varepsilon_{Nd(i)}$ = –41, Sr = 225 ppm, Nd = 84 ppm; Peng et al., 1994). D_{Sr} = 1 and D_{Nd} = 0.068 (Cucciniello et al., 2014).

- Silicic rocks formed due to assimilation of continental crust with mantle-derived melt via AFC process.

Summary and Conclusions

- Alkaline group reveals approximately **9% partial melting of a spinel lherzolite** source with subsequent **74 to 88% fractional crystallization** of olivine, clinopyroxene, plagioclase, spinel, K-feldspar, and amphibole produces the geochemical patterns observed for syeno-diorite and mafic dyke.

- **Tholeiitic basalt and gabbro** could be generated from **5% and 20% melting**, respectively, of a **depleted mantle source**.

- Distinct isotopic composition of silicic rocks and **AFC modelling** indicate **assimilation of continental crust with mantle-derived melt**.

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