

# Apatite Compositional Constraints on the Magmatic to Hydrothermal Evolution of Lamproites from Raniganj Basin, Eastern India [EGU25-1988]

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### INTRODUCTION

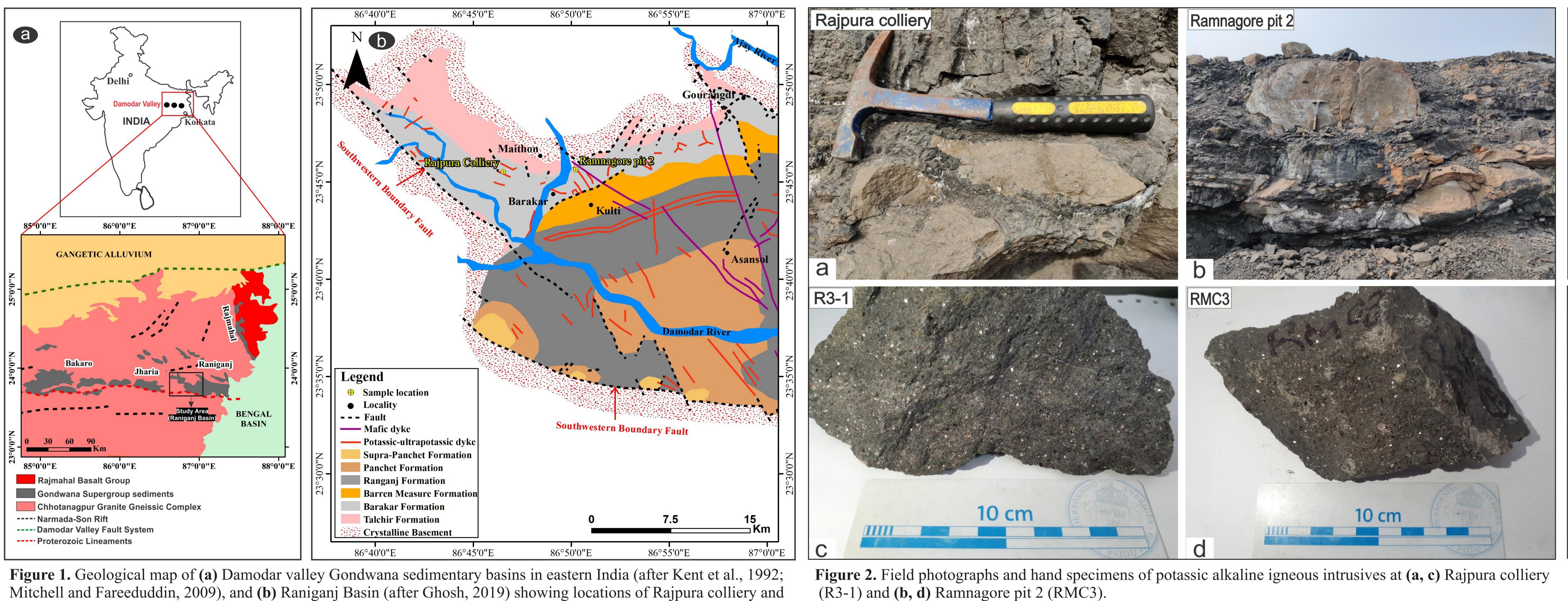
- Lamproites: Mantle-derived, volatile-rich, distinct group of potassic-ultrapotassic alkaline igneous rocks with complex mineralogy.
- Apatite (Ca5[PO4]3[F,Cl,OH]): Ubiquitous mineral in Lamproites, exhibiting variable modal abundance.
- Apatite Composition: Incorporates minor & trace elements like REE, Ba, Mg, Na, and Si via various substitution mechanisms.
- · Compositional Variability: Zoning in apatite tracks fluid-driven magmatic and hydrothermal processes.

## **STUDY AREA**

- · K-rich Rajpura and Ramnagore sills intruding the Barakar Formation of the Raniganj Basin, sampled from open-cast coal mines.
- · Rajpura and Ramnagore sills classified as "phlogopite-diopside-K-feldspar-apatite olivine lamproite" (Saini et al., 2022).

#### **OBJECTIVES**

- · To identify different growth stages of apatite based on textural and compositional variations.
- · To assess compositional variations in terms of possible substitutional schemes.
- · To reconstruct apatite crystallization sequence from magmatic to hydrothermal stages.



Rajpura Apatite Ramnagore Apatite

(R3-1) and **(b, d)** Ramnagore pit 2 (RMC3).

**Figure 3.** Photomicrographs (**a**, **b**) and BSE images (**c**–**f**) of Rajpura (R3-1) and Ramnagore (RMC3) samples. (**a**) Apatite inclusions (Ap) in mica phenocryst. (**b**) A microphenocryst of apatite. (**c**) Groundmass apatite grains with Ap-I core, Ap-II inner rim and Ap-III outer rim. Ap-I inclusions in mica. (**d**) Ap-II microphenocryst with oscillatory zoning. (**e**) Microphenocryst with Ap-I core and Ap-II rim. (**f**) Groundmass apatite with Ap-I core, oscillatory-zoned Ap-III inner rim and locally developed Ap-III outer rim.

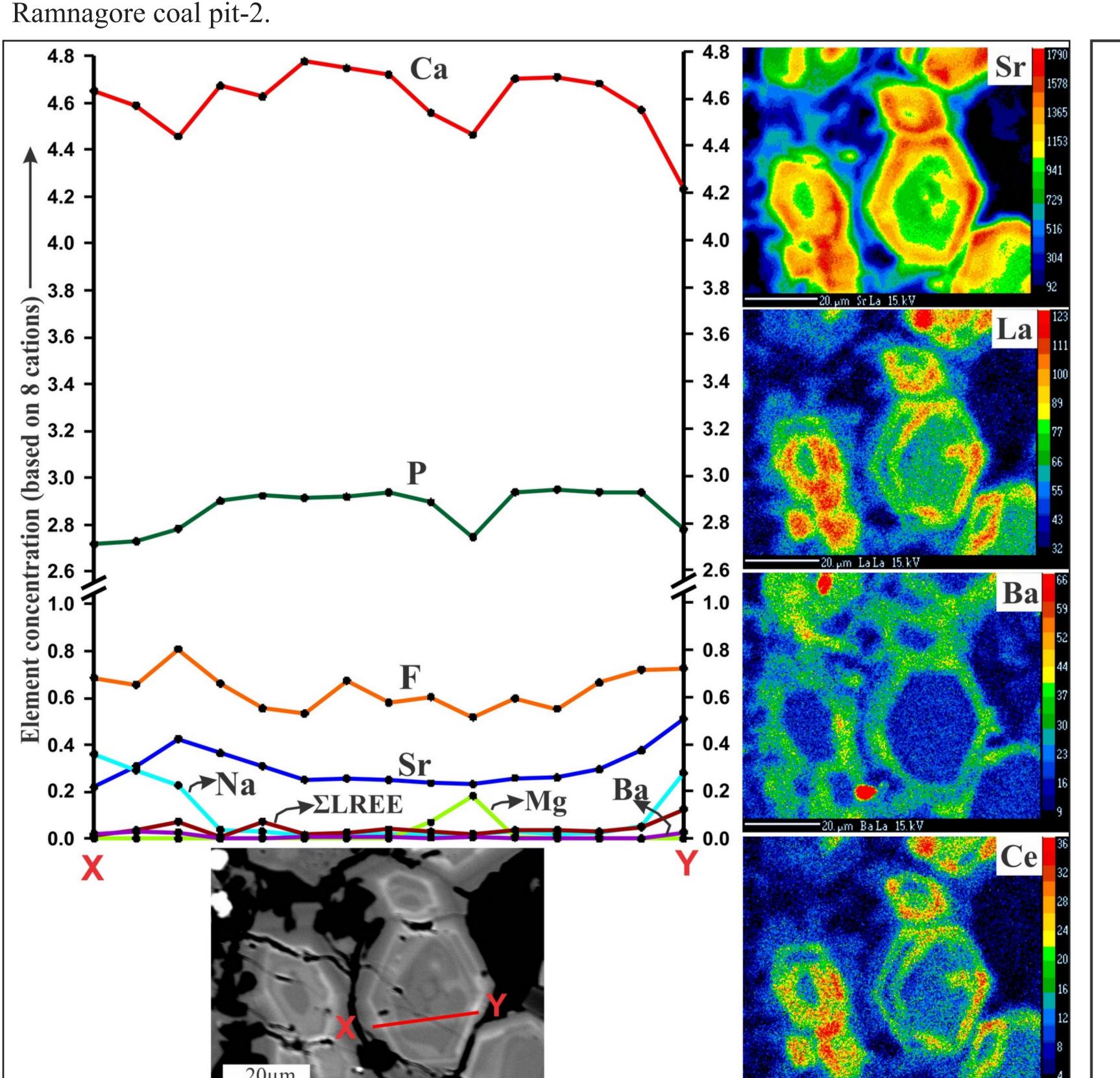


Figure 4. Rim-to-core-to-rim compositional profile for oscillatory zoned Ramnagore apatite along with BSE image and false colour X ray elemental maps of Sr, La, Ba and Ce.

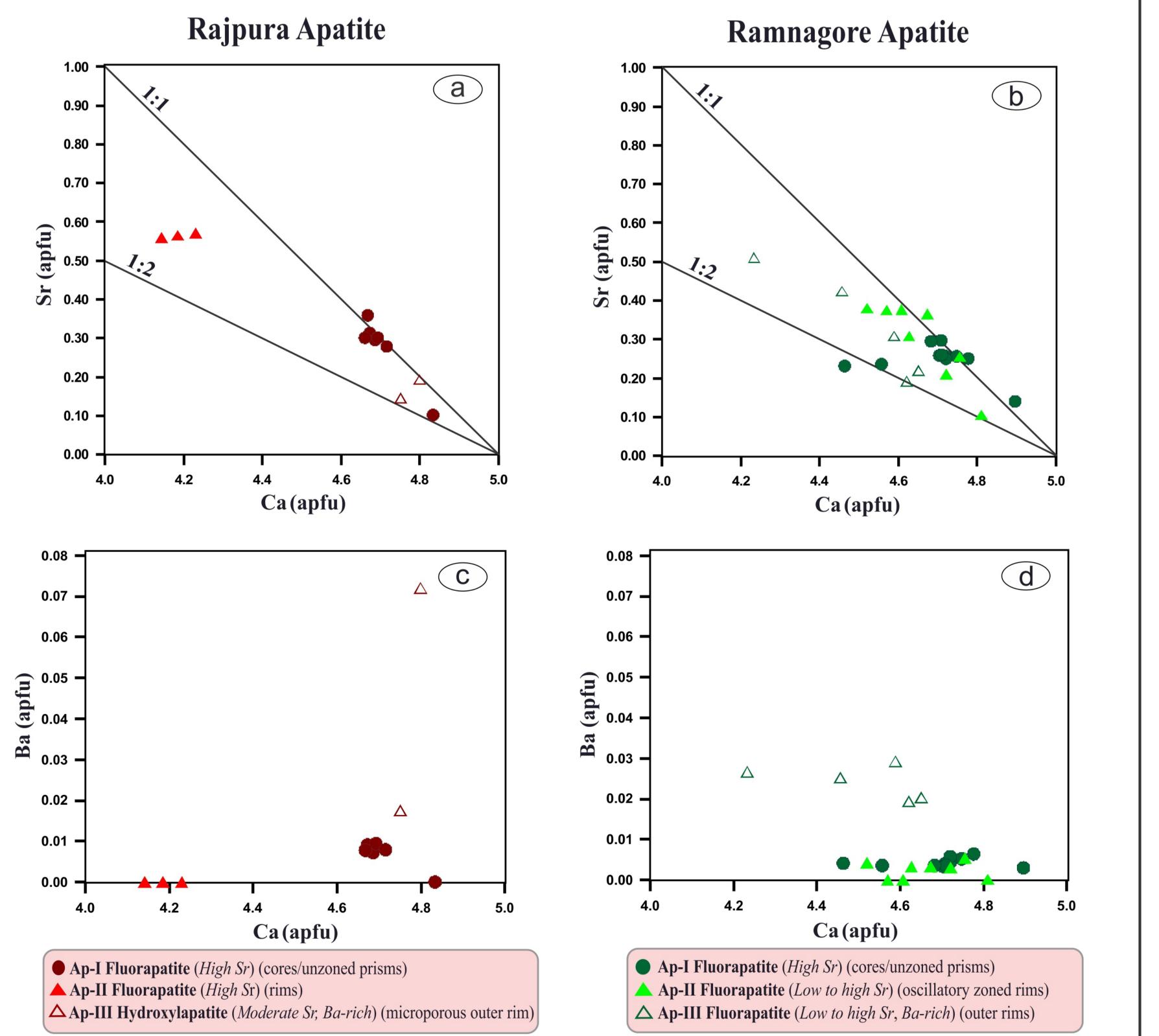


Figure 5. Compositional variation diagrams of Rajpura and Ramnagore apatites: (a) Sr vs. Ca, (b) Ba vs. Ca. All variables represent cations in atoms per formula unit (apfu).

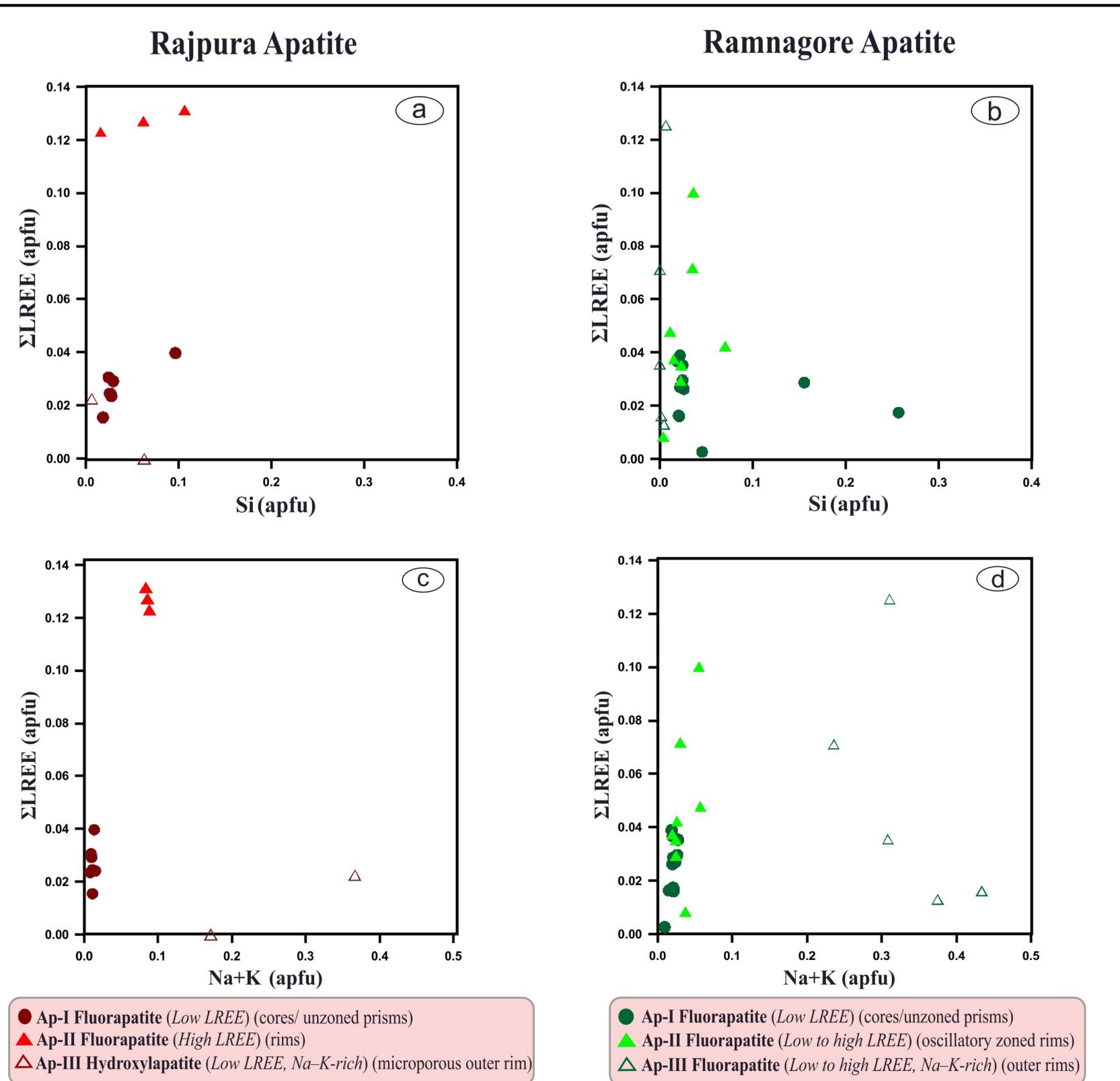


Figure 6. Compositional variation diagrams of Rajpura and Ramnagore apatites: (a)  $\Sigma$ LREE vs. Si (b) ΣLREE vs. Na+K. All variables represent cations in atoms per formula unit (apfu).

## DISCUSSION AND CONCLUSIONS

- · Three compositional zones identified in the Rajpura and Ramnagore lamproites:
  - 1. Ap-I (early magmatic): Sr-rich, LREE-poor
  - 2. Ap-II (mid-magmatic): Sr-LREE-rich
  - 3. Ap-III (hydrothermal-metasomatic alteration): LREE-poor, Na-rich
- · Ap-II exhibits higher LREE than Ap-I, via substitutions:

$$(Na,K)^{+} + \sum LREE^{3+} = 2Ca^{2+}$$
 and  $[2\sum LREE^{3+} + \Box] = 3Ca^{2+}]$ 

Ap-III shows enrichment in alkali and carbonation via substitutions:

$$(Na,K)^{+} + CO_{3}^{2-} = Sr^{2+} + PO_{4}^{3-}$$
 and  $[(Na,K)^{+} + (F,OH)^{-} = \Box + \Box]$ 

- · Microporous texture in Ap-III (Rajpura lamproite): Dissolution-reprecipitation induced by CO<sub>3</sub><sup>2</sup>-bearing fluid, served to release LREE
- · Results relevant to lamproites and other igneous systems influenced by deuteric fluids rich in alkalis and carbonates.

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