Characterization of REE(+/-Ba)-bearing Minerals from Granitic Rocks (Central Portugal) and Metassomatic Rocks (Bayan Obo, China)

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1. INTRODUCTION

The REE have great importance in present-day economics (*e.g.* in high-tech technology) and science, such as in understanding the different sources and evolution of parental magmas and distinguishing post-magmatic hydrothermal alteration.

The main focus of this paper is to interpret REE distribution patterns in granitic rocks from the Castelo-Branco and Oledo-Idanha-a-Nova plutons (Central Portugal; Antunes, 2006) and in metasomatic rocks from Bayan Obo (Inner Mongolia, China; Fan *et al*., 2015), comparing them with the individual REE distribution pattern of their REE-bearing minerals.

2. METHODOLOGY

After preliminary petrography, samples containing REE-bearing minerals were analyzed on a JEOL JXA 8200 electron microprobe (Geology Department, FCUL), using probe diameter of 5 µm and 9 µm, accelerating voltage 15kV, beam current 10nA and measuring time was 20s in the analytical peaks and 5s in the backgrounds (-/+). Elements were measured against natural and synthetic mineral standards: REE 1 (Eu, Gd, Tb, Tm), REE 2 (Sm, Yb, Lu), REE 4 (Dy, Ho, Er), REE 6 (Nd) monazite (La, Ce, Pr, Th), apatite (F, P), $LiNbO_3$ (Nb), $LiTaO_3$ (Ta), zirconia (Zr, Y), m32 (Hf), benitoite (Ba, Ti), pyrope (Mg), almandine (Fe, Al), bustamite (Mn), diopside (Ca.Si), jadeite (Na), sanidine (K), celestite (Sr), Vmetal (V), galena (Pb), stibnite (S), Ga arsenate (As), UO_2 (U) and tugtupite (Cl).

3. RESULTS AND DISCUSSION

3.1. REE-rich rocks from Bayan Obo (Inner Mongolia, China)

All *monazites* are enriched in LREE (Fig.1) and show positive $(La/Lu)_N$ fractionation (0.7-115) and negative Eu-anomalies. It is interesting to note that monazite patterns are rather more regular for the LREE than for the HREE, either because HREE occur in much lower concentrations (occasionally close to detection limits) or because of specific fractionation features. The monazite REE-patterns are very similar to the whole-rock pattern suggesting that monazite may be the main contributor to the whole-rock pattern. Two *fluorcarbonates* occur frequently in these Bayan Obo rocks (bastnäsite and cebaite), both also displaying REE-patterns very similar to the rock patterns (Fig.1). Naturally, REE concentrations in cebaite are lower than in bastnäsite because of its very high Ba contents (23-44% BaO). Just as monazite, fluorcarbonates are important in controlling the general shape of the Bayan Obo whole-rock REE patterns.

Pyrochlore occurs only in a few samples (Fig.1) and shows enrichment in Sm instead of Nd, unlike monazites and fluorcarbonates. It is also important to notice that pyrochlore has less La than the other REE-bearing minerals present in these rocks, implying a lower degree of LREE fractionation for this mineral, or even lower whole-rock La contents.

3.2. Granitic rocks from Central Portugal

Monazites from these granitic rocks are also enriched in LREE, show a positive $(La/Lu)_N$ fractionation (0.6-164) and a negative Eu-anomaly, though they show relatively higher La contents. As in the Bayan Obo rocks, monazite seems to be the main mineral controlling the granite REE-patterns.

Unlike monazite, *zircons* are enriched in HREE showing a HREE pattern similar to monazite but with slightly lower contents, with the possible exception of Tb and Lu. Zircons usually display an overall irregular REE-pattern, presenting a marked negative Nd-anomaly due to the extreme fractionation of this element in monazite, negative $(La/Lu)_N$ fractionation (0-0.7) and positive Eu-anomalies (Fig.2). Taking these data into account, zircons seem to contribute in much smaller way than monazite to these granitic rock patterns, implying that they are probably less abundant than monazite in these rocks.

Fig.1 (sample BO-20)

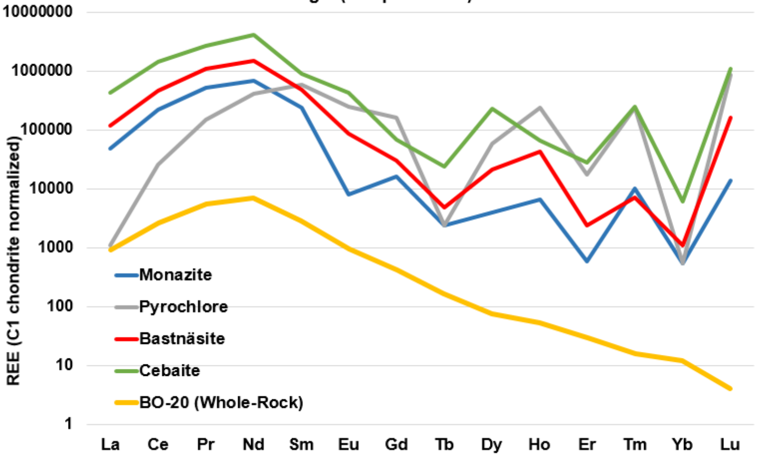
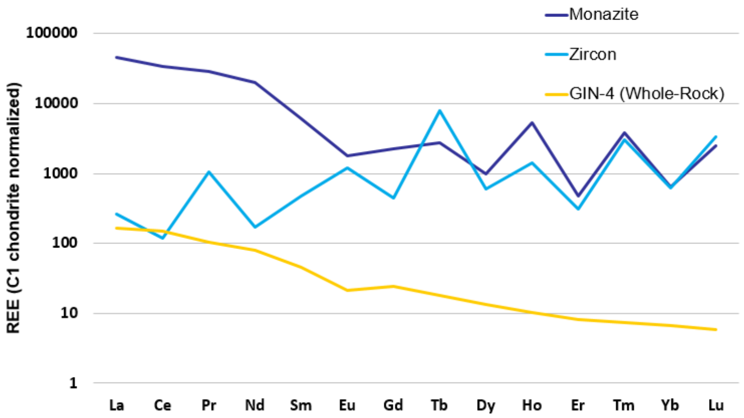


Fig. 2 (sample GIN-4)



4. CONCLUSIONS

Generally, monazite is an important mineral in both rock types, conditioning in a significant way the whole-rock REE pattern.

In the Bayan Obo metasomatic rocks, fluorcarbonates also contribute to the general whole-rock REE-pattern, whereas zircon in the granitic rocks from Central Portugal does not seem to have a marked contribution in the bulk REE pattern.

5. ACKNOWLEDGMENTS

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6. REFERENCES

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