# Geological meaning of the REE distribution in zircons from granitoid, aplite and pegmatite bodies of the Panasqueira-Segura area

## Significado geológico da distribuição de ETR em zircões de corpos granitoides, aplíticos e pegmatíticos da área de Panasqueira-Segura

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***Resumo:*** *Na área de Panasqueira-Segura, vários corpos granitoides e diferentes enxames de diques cortam as sucessões metassedimentares que compõem o Grupo das Beiras. Diferentes populações de zircão foram extraídas de: (i) granitoides Câmbrico-Ordovícicos (Batão, Oledo/Idanha-a-Nova, Zebreira e Fundão), (ii) granitos e leucogranitos Variscos (Segura, Penamacor-Monsanto, Orca, Castelo Branco, Argemela e Panasqueira); e (iii) diversos conjuntos de filões aplíticos, pegmatíticos e de pórfiros. Os conteúdos de elementos de terras raras (ETR) em zircão foram analisados com SHRIMP-IIe após análise de imagens SEM-CL. Os resultados obtidos revelam que zircões provenientes de amostras sujeitas a modificações composicionais tardias, geralmente associadas a processos mineralizantes, registam enriquecimento significativo de ETR leves, para além de U e $^{204}$Pb. Tais características composicionais denunciam interação duradoura com fluidos quimicamente reativos, possivelmente exsolvidos de fundidos silicatados em condições de transição magmática-hidrotermal.*

***Key words:*** *REE geochemistry, Zircon, Granites and derived rocks, Panasqueira-Segura area*

**Palavras-chave:** Geoquímica de ETR, Zircão, Granitos e rochas derivadas, Área de Panasqueira-Segura

In the Panasqueira-Segura area, metasediments of the Beiras Group are intruded by voluminous plutons and different dyke swarms. Plutonic rocks can be grouped into 3 main suites (Martins et al., 2022, and references therein). The first one is dominated by weakly per-aluminous I-type granodiorites, biotite quartz-diorites and tonalites forming the Batão, Oledo/Idanha-a-Nova Zebreira and Fundão plutons. This suite represents the magmatic event peaking at the Cambrian-Ordovician transition. The other two plutonic suites are mainly composed of monzonitic granites (often bearing biotite and muscovite, and occasionally porphyroid) but locally including leucogranites. These highly peraluminous S-type rocks provide evidence for multiphase emplacement of melts during the late Carboniferous and comprise several plutons (such as Segura, Penamacor-Monsanto, Orca and Castelo Branco), besides the partly and completely concealed granites related to the Argemela and Panasqueira ore-forming systems, respectively.

Subvertical dykes of fine-grained granodiorites (with azimuth direction 110°±5° to 121°±5°) and micro-gabbros (102°±7°) occur in several locations, often nearby the Cambrian-Ordovician plutons, the most important exception being the cluster of quartz-diorite /granodiorite dykes (beside a small laccolith) labelled as Matos. Subvertical dykes of porphyry mesocratic rocks (148°±5°, 360°±12°, 119°±9°), locally along with minor laccoliths, are common in the SW part of the study area, namely across the W-SW periphery of the Zebreira pluton (e.g. Furão and Marcelina). Aplite dykes, sometimes along with pegmatites, are mostly confined to the margins of the Orca and Penamacor-Monsanto plutons, and to metasediments around the Segura granites, displaying a wide range of directions (dominantly between NE-SW and ENE-WSW) and dips (subvertical to <40°, usually to the NW-WNW).

Different zircon populations were taken from samples representing the above-mentioned plutons and dyke swarms. Several zircon mounts were prepared along with the TEMORA 2 and NIST 610 standards, examined with a SEM-CL Quanta 250 FEI, and further analysed with a SHRIMP-IIe for U, Pb, Th and REE, as reported in Borba et al. (2021). Here, only the results obtained for REE in zircon will be reported and briefly discussed.

The REE contents and their CN-normalised patterns for oscillatory or sector zoned zircons in granitoid rocks lacking effects of late metasomatic or hydrothermal processes are similar, despite of their age (Fig.1). The patterns match those typically revealed by magmatic

zircons (e.g. Pettke et al., 2005), displaying an evident LREE-HREE fractionation together with slight positive Ce-anomalies and pronounced negative Eu-anomalies. In the same rocks, other texturally analogous zircons present REE CN-normalised patterns typified by larger positive Ce-anomalies, possibly denoting consecutive zircon crystallisation stages under conditions of higher oxygen partial pressure. This interpretation could also explain the contrasting Ce- and Eu-anomalies obtained for many zircon grains in porphyry rocks of Furão and Marcelina, although requiring higher LREE saturation, as indicated by the LREE enrichment trend.

Zircons from aplite/pegmatite bodies rarely preserve oscillatory zoning, conceivably due to a significant interaction with fluid-saturated melts. Even so, their REE CN-normalised patterns are indistinguishable from those above described for zircons in contiguous granite facies. On the contrary, evident differences exist when zircons came from aplite/pegmatite or granite samples subjected to strong compositional changes, which are usually related to an increase of mineralisation footprints. In such cases, zircons show complex internal textures in which secondary domains cut across primary growth zones, besides a prominent LREE enrichment along with fading or even loss of the Ce- (and sometimes Eu-) anomalies. As demonstrated in some studies (e.g. Zhong et al., 2018, 2021), part of this LREE enrichment could reflect accidental sampling of sub-micrometre inclusions in zircon (e.g. monazite, apatite). However, the textural and compositional changes recognised for these zircons are irrefutable, being comparable with other well documented case-studies (e.g. Hoskin, 2005; Borba et al., 2021).

Additional evidence for late compositional changes experienced by zircons from highly differentiated rocks or granitic facies affected by mineralising fluids are provided by high U and $^{204}$Pb contents, ranging from 500 to 10000 ppm, and often above 1 wt%, respectively. Future work will explore the geological meaning of this U-enrichment (co-varying with $^{204}$Pb and LREE increase?) in zircons from rocks affected by a long-lasting interaction with chemically reactive fluids, possibly exsolved from melts in transitional magmatic-to-hydrothermal conditions.

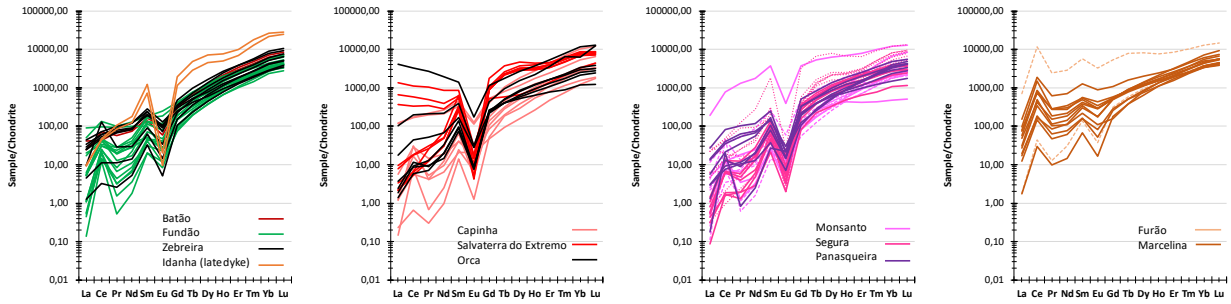


*Fig. 1. REE Chondrite (CN)-normalised patterns for zircons taken from granitoid, aplite/pegmatite and porphyry rocks spread across the Panasqueira-Segura area. For Monsanto and Segura, the dotted and dashed lines discriminate, respectively, pegmatite and aplite bodies.*

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