REE geochemical exploration in magmatic felsic rocks and carbonatites of the Fuerteventura Island (Canary Islands, Spain)

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INTRODUCTION

Demand for Rare Earth Elements (REE) by industrialized countries in recent decades is high due to the increasing requirements for high-tech industries. Currently, China dominates the 90 % of the REE market and so, industrialised countries focus on finding RE resources in their own territories to avoid external dependency. REE deposits mainly occur on complexes of alkaline magmatic rocks and carbonatites. In this sense, this work focuses on the geochemical exploration of REE in the complexes of alkaline igneous rocks and carbonatites from different periods, which emerge on the island of Fuerteventura (Fig. 1). Indeed, these rocks appear both in the Oligocene (34 to 23 Ma, group of submarine volcanic rocks, ultra-alkaline and plutonic complex of the basal complex), in the Miocene (23 to 12 Ma, shield volcanic complexes) and in the Pliocene-Quaternary (< 5.3 Ma, volcanic rejuvenation group).

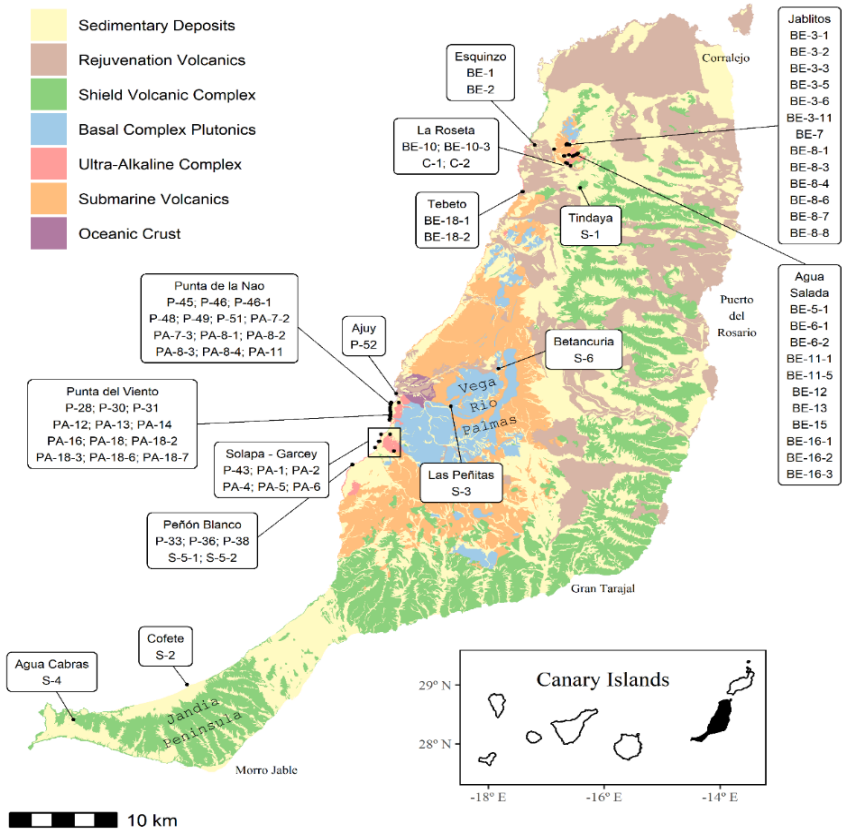

***Fig 1**. Geological map (simplified) of Fuerteventura Island with sample location. Situation map in the Canary archipelago (inset).*

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A total set of 72 collected samples of alkaline igneous rocks and carbonatites, and 2 sedimentary calcretes from Fuerteventura was analysed for geochemistry. Samples were prepared in the IOCAG geological facilities and sent to the Activation Laboratories Ltd. in Canada. Whole-rock composition data of 69 chemical elements were gained for every sample (ICP and INAA techniques) including major, minor and trace elements (eight REE included).

RESULTS

Geochemical diagrams were plotted for both igneous rocks and carbonatites. Geochemical classification of igneous rocks with binary diagrams (Total Silica-Alkalis, TAS of Le Maître, and R1-R2 of De la Roche) shows the Oligocene ultra-alkaline plutonic complex composed by ultramafic (ijolite, melteigite, theralite and essexite), mafic (syeno-diorite), and intermediate-acid (nepheline-syenite and syenite) rocks, within the subsaturated sub-alkaline magmatic series. Carbonatites are calcium- and ferro-carbonatites (alvikites and sövites) and the last to form. These magmatic rocks derived from fractional crystallisation processes are spatially and genetically related, although some of them have experienced subsequent contact and regional metamorphism, metasomatism, and ductile shear deformation processes. The plutonic formation of the basal complex, a posterior Oligocene intrusion, seems to result from other fractional crystallisation process within a different magmatic chamber, ranging from ultrabasic to acidic members (theralite, essexite, alkali gabbro, gabbro, nepheline-syenite and syenite). Miocene felsic rocks come from different magma chambers too, and only the most evolved rocks (syenite and quartz syenites) were analysed. Highest REE concentrations are related to carbonatites (ΣREE = 511-7372 ppm), felsic plutonic rocks (ΣREE = 51-2290 ppm), in contrast to mafic-ultramafic rocks (ΣREE = 116-357 ppm). Light REE predominate over the heavy counterparts (LREE / HREE > 1) and the most abundant are Ce > La > Nd > Sm > Eu. Thus, mantle source and subsaturated alkaline magmas derived from both Oligocene submarine and Miocene subaerial formations were characterised by high contents of light REE whereas low in Y and heavy REE. Besides, chondrite-normalised (Taylor & McLennan, 1985) REE patterns show high values for carbonatites, followed by felsic plutonic rocks, whereas minimum values occur in both mafic and ultramafic rocks, and sedimentary rocks (Fig. 2).

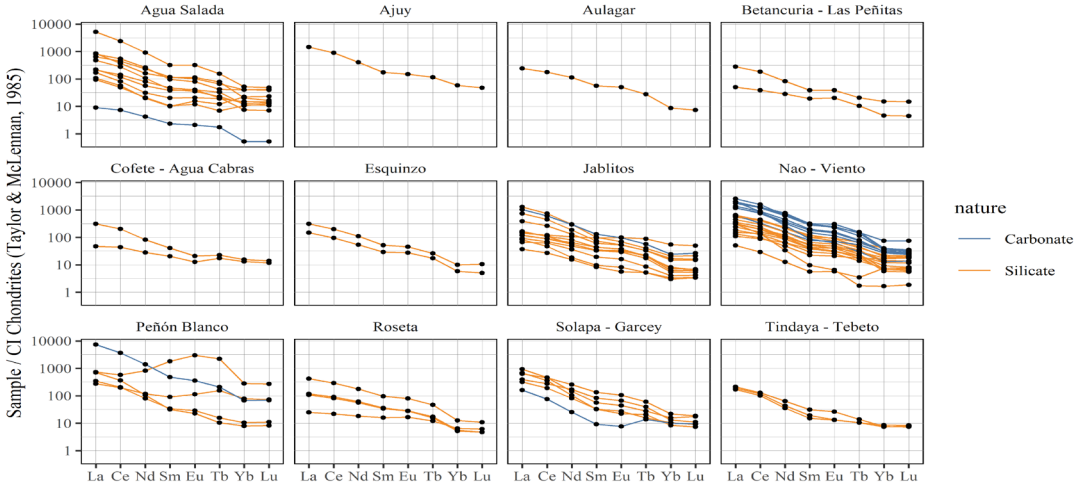

Fig 2. Chondrite-normalised REE diagrams of studied samples from different geographic outcrops of Fuerteventura Island, considering varied rock nature (carbonate rocks in blue/ silicate rocks in dark orange).

CONCLUSION

The search of REE concentration anomalies in different rocks from Fuerteventura Island has confirmed that the carbonatite bodies have the highest REE concentrations, followed by felsic plutonic rocks (intermediate and acidic), and, to a lesser extent, by mafic and ultramafic rocks. In addition, LREE predominate over HREE.

REFERENCES

Taylor, S.R. & McLennan, S.M. (1985): The continental crust: its composition and evolution. Ed. Blackwell. Oxford, 312 p.