Prospecting for Rare Earth Elements in Plio-Pleistocene Sands of the Cenozoic Mondego Basin, Portugal

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Rare earth elements (REEs) are critical to a wide range of applications, including several key technologies for the generation of clean and sustainable energy. Sedimentary placer deposits are a proven commercially viable source of REEs. Existing placer exploration efforts have focused on monazite and xenotime, which are common REE-bearing minerals in such deposits, particularly where sediment has been sourced from crystalline basement. Consequently, understanding sediment provenance is an important part of characterising a prospective placer deposit play. Demand for REEs in Europe is growing. Geologically recent, poorly consolidated placer sands within Europe are energy efficient to extract, offer geopolitical security, and could, at least in part, help to meet demand; however, such deposits are presently under-researched. This project was conceived in an attempt to address this by developing a low-cost, field-driven workflow to characterise heavy mineral and REE concentrations using Pliocene to Pleistocene sands of the Cenozoic Mondego Basin as an example. Poorly consolidated Pliocene to Pleistocene sands in the Mondego Basin are up to 70 m thick, unconformably overlie Mesozoic strata of the Lusitanian Basin and the Iberian Massif, and span a range of depositional environments from shallow marine to alluvial fan. Field-based geophysical analysis (magnetic susceptibility and gamma radioactivity) was conducted to attempt to detect heavy mineral concentrations by exploiting the natural radioactivity of several common heavy minerals (e.g., apatite, monazite, zircon) and the strong magnetic signatures of others (e.g., ilmenite, magnetite). Sand samples were collected for laboratory-based analysis of their heavy mineral assemblages using scanning electron microscopy-energy dispersive spectroscopy, whole-rock geochemistry, and U-Th-Pb geochronology. The sands contain monazite and xenotime and were derived from the adjacent Iberian Massif. The data collected so far reveal striking variations in monazite content, which is likely linked to subtle changes in sediment provenance through time.