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Assessing the mineral prospectivity of the Beja Layered Gabbroic Sequence, Portugal

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The Beja Layered Gabbroic Sequence (LGS) was emplaced in the southern border of the Ossa Morena Zone in Portugal during the Variscan orogeny climax. With an area of 315 km^2 it remains one of the largest synorogenic intrusions worldwide, being chiefly preserved from postmagmatic tectono-metamorphic events. The intrusion hosts potentially economic oxide mineralization and ore showings developed at different evolution stages intrusion. It overlaps in time the Ni-Cu-PGE Aguablanca deposit (Spain), sharing also similarities in the geological setting, which led to an in-depth revaluation of LGS in the scope of HEU SEMACRET project (www.semacret.eu).

From W to E, the LGS comprises olivine leucogabbros and chromite bearing troctolites+wehrlites (SB I Series, Fo_{88}) that formed from high-Mg, high-alumina parental melts. SB II Series represents a secondary chilled margin that is parental to polybaric assemblages of ferrodiorites and ferrogabbro, the latter hosting massive Fe-Ti-V oxide mineralisation at Odivelas (ODV I). A voluminous sequence with narrow compositional ranges formed under steady state replenishment/crystallization conditions (ODV II-ODV-III-BRG I-BRG II-BJA), locally showing evidence for large-scale channelled melt flow. The E block at Serpa (SRP) represents an isolated domain, forming a zoned lopolith with distinctive features, such as cumulus Opx, a primary hydrous character and a strong N-dipping foliation instead of the modal layering common to other Series.

The Nd-Sr-Os isotope compositions for LGS indicate derivation from a source slightly more enriched than the Depleted Mantle. Most Series follow typical AFC paths however troctolites show contaminated compositions due to the higher assimilating capability of most primitive melts. Modelling shows that marble and amphibolite country rocks cannot be the main contaminants for LGS magmas, thus implying a main contamination stage prior to their emplacement. The enriched components, increasing from W to E of LGS with SRP closing into the field of Aguablanca, suggest a progressive contamination of the magma source zones at the scale of the orogen.

Median V_2O_3 concentrations in spinel (> 1 wt%) are comparable to those reported for tholeiitic intrusions (e.g. Bushveld, Skaergaard) and significantly higher than in calk-alkaline-derived magmas. The synorogenic character can favour effective mechanical sorting of oxide-rich magma slurries, with BJA and SRP Series displaying multiple magnetic anomalies that require further investigation. While the assessment is very positive for oxide mineralization, indicators for

magmatic Ni-Cu-PGE are mixed. The high-Mg chromite-bearing rocks include both depleted and undepleted olivine (Ni <2200 ppm) and indicate moderately positive fertility for sulfide mineralization. The ubiquitous presence of accessory sulfide blebs suggests sulfur saturation at an early evolving stage. The evidence for deep seated/source contamination increases the likelihood of sulfur saturation at lower crustal levels. This would have led to a decrease of the chalcophile budget in the magmas, as corroborated by the systematically high base/noble metal ratios and very low PGE abundances. The fertile ultramafic rocks at the LGS southern border are therefore the primary targets for magmatic sulfides as they may represent dismembered portions of the intrusion conduits.

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