Producing high-performing foundry sands from ophiolite chromitites: an arduous challenge?

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Chromite foundry sands are employed in the industry to form molds for high demanding casting of metal and steel (e.g., automotive casting, filler in steel production…). They have high melting point (2090°C), low thermal expansion and neutral chemical behavior, making them difficult to replace for high performing materials casting. Chrome sand is also used in the production of magnesite chrome refractory bricks providing resistance to abrasion and high temperature.

Because the sintering behavior of chromite sand influences the casting process, the quality parameters of the sands are quite strict. The main parameters are: i) fineness index (FI), depending on the grain size distribution, ii) SiO_2 content and iii) Acid Demand (AD), which measures the reactivity of the sand with binding resins.

Chromite foundry sands in the EU market mainly come from South Africa ore deposits. For this reason, the present study aims to evaluate ophiolite chromite deposits in the European territory as possible new sources for the foundry industry (Bussolesi et al., 2020).

For the study, four chromite sands from different enrichment plants were evaluated and confronted with two different South African products. The four sands are from Neyriz (Iran), Vourinos (Greece), Kalimash and Balleja (Albania).

The grain size distribution shows that all the sands fit into the Fineness Index range (between 40 and 75), making them suitable candidates. The SiO_2 content, which should normally lie below 2 wt%, is below 1.4 wt% for the South African samples, below 2.0 wt% for Neyriz, 3.5 wt% for Balleja, 7.0 wt% for Vourinos and 10 wt% for Kalimash.

The high SiO_2 content is directly connected to the AD, a titration method used as a proxy for sand-resin reaction potential, and calculated at pH 3, 4 and 5 for all the sands. South Africa samples have AD values below 10 (the upper limit for foundry sands). Ophiolite chromite samples show much higher values: 21 for Neyriz, 40 for Vourinos, 30 for Balleja and 31 for Kalimash.

The high values for Vourinos and Kalimash can be easily correlated to the high SiO_2 content in the sands, indicating a bad separation efficiency in the enrichment plants, but Neyriz and Balleja AD values cannot be explained through their high SiO_2 content.

Further analyses revealed that the silicate mineralogy strongly influences the AD values. Pyroxene, the main silicate mineral within the South Africa sands, is the lowest reactive, while serpentine, widespread in ophiolite contexts, is highly reactive with the binding resins. Intermediate results are to be attributed to olivine, which shows higher reactivity than pyroxene but much lower than serpentine.

The use of ophiolite chromitites for foundry purposes is limited to serpentine-poor (e.g., unaltered) deposits, and only after careful studies of the enrichment processes, in order to increase the separation efficiency of the plant and lower the SiO_2 content in the final chromite concentrate.

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