Characterization of Red Muds as valuable resource for sustainability

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AIM

Red mud (RM) is an industrial waste generated during the production of alumina from bauxite through the Bayer process. RM represents an environmental challenge due to the high alkalinity and storage issues.

A geochemical and mineralogical characterization of RM samples stored at Porto Vesme (Sardinia, Italy) disposal sites (Fig. 1) was carried out to gain insights into the processes promoting the concentration of critical metals (CMs) in such matrixes.

Figure 1. Satellite image of the Sardinian Bauxite Residue Disposal Area, 39°10′53″ N 8°24′30″ E (Dentoni et al. 2021).

METHODS

Ten samples of red muds (in Fig.2 a selection is shown) were provided by EurAllumina S.p.A, leader company in the metallurgical sector for the production of aluminum oxide. The samples underwent Inductively Coupled Plasma Mass Spectrometry (ICP-MS) and X-ray powder diffraction (XRPD).

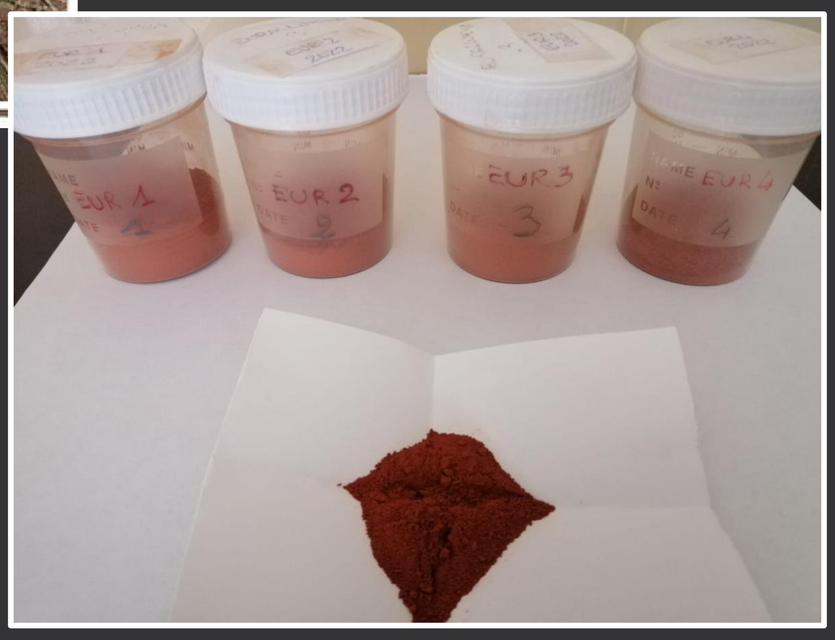
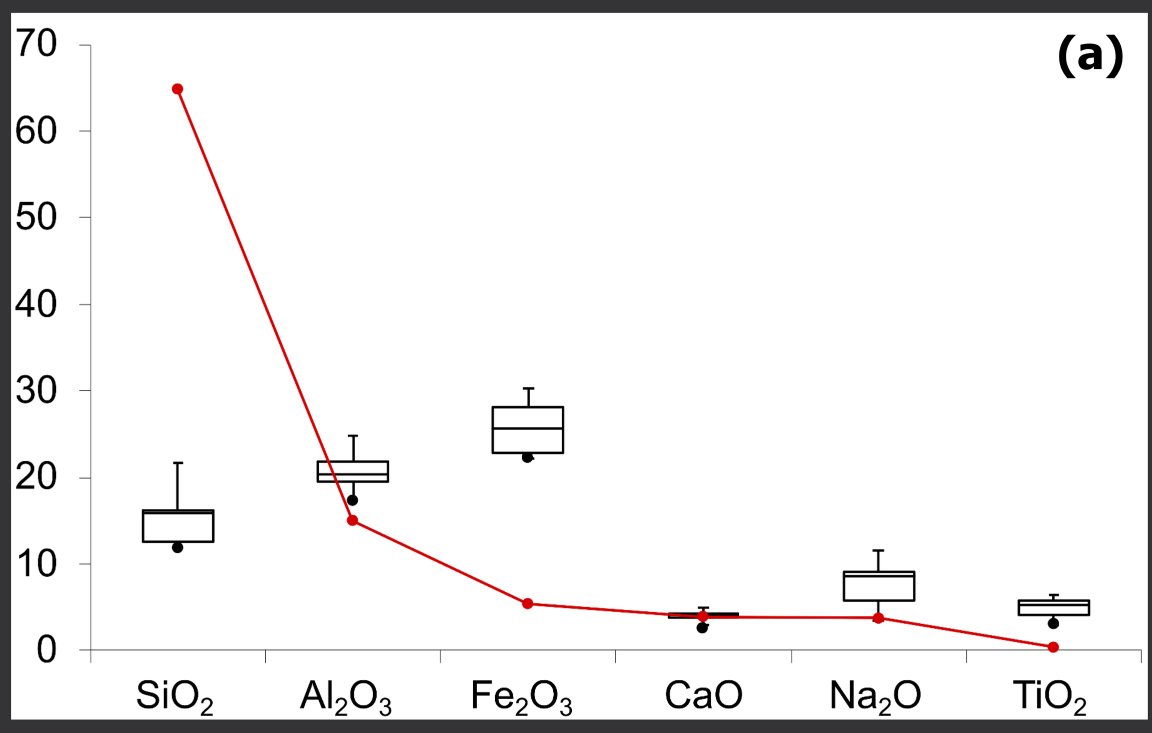


Figure 2. Samples of RM from Porto Vesme (Sardinia) dried at ~ 100 °C for about seven days.

RESULTS

ICP-MS

The chemical composition of the studied samples is illustrated in Fig. 3. High Si/Al ratio (0.75) and iron content (25(3) wt.% on average) as well as relevant concentrations of CMs (Sc, V, Ga, Nb, HREEs, Hf, Ta, W, and Y) and other elements of economic importance (Cr, Pb, Th, U) were measured. Abundance of Ce (93 ÷ 258 ppm) is a notable feature of the analysed samples.



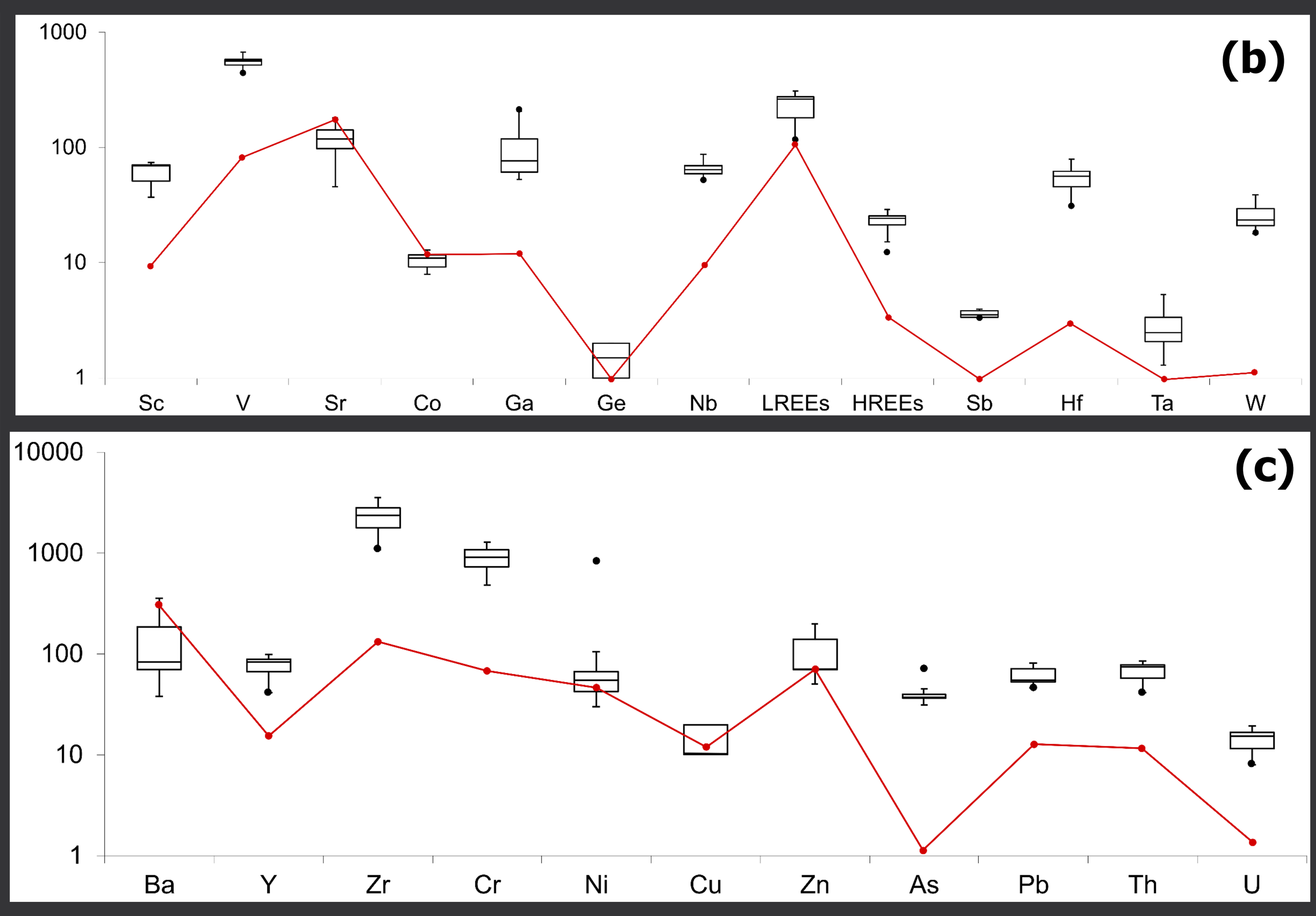


Figure 3. Box plots for (**a**) major elements (wt.%), (**b**) critical metals (ppm), (**c**) trace elements (ppm) in the studied RM. Red circles indicate UCC values.

XRPD

The X-ray diffraction patterns of a selection of the studied samples are shown in Fig. 4. The main phases identified are: hematite, α-Fe_2O_3; gibbsite, $Al(OH)_3$; boehmite, $AlO(OH)$; anatase, TiO_2; cancrinite, $(Na, Ca, \square)_8(Al_6Si_6)O_{24}(CO_3, SO_4)_2{*}2H_2O$; sodalite, $Na_4(Si_3Al_3)O_{12}Cl$; quartz, SiO_2. These results are in keeping with those found in the literature for RM from the same disposal site (Castaldi et al. 2008; Mombelli et al. 2019).

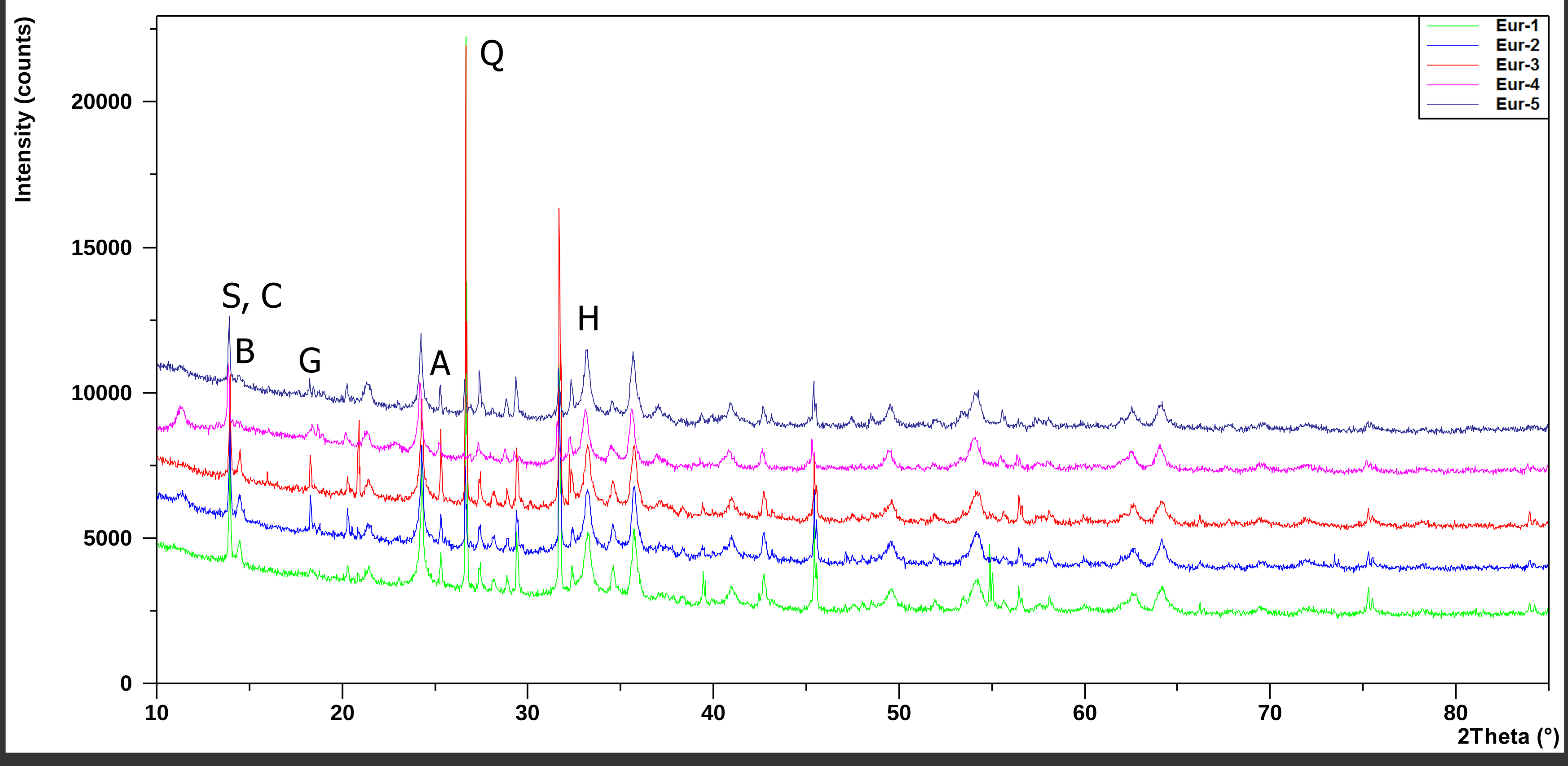


Figure 4. Selected X-ray diffraction patterns of the studied RM. Labels for the main peak of each phase: H = hematite; G = gibbsite; B = bohemite; A= anatase; C = cancrinite; S = sodalite; Q = quartz.

Conclusions

The combination of the preliminary chemical and structural data evidences that the studied RM samples may be used as promising materials for a strategic CMs recovery and for an efficient reuse of the residues obtained from the CMs recovery for the preparation of low cost and environment friendly construction materials. The reuse of RM for the these purposes could provide sustainable and environmental friendly alternative to its mere disposal.

References

Dentoni V., Grosso B., Pinna F. (2021) Minerals, 11(4), 405; Castaldi P., Silvetti M., Enzo S., Deiana S. (2008) Clays and Clay Minerals, 59, 189-199; Mombelli D., Barella S., Gruttadauria A., Mapelli C. (2019) Applied Sciences, 9, 4902.

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