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From Sampling to Sustainable Phosphate Recovery from Mine Waste Rock Piles

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Abstract : Phosphate mine waste rock (PMWR) generated during ore extraction is continuously increasing, resulting in a significant environmental footprint. The main objectives of this study consist of i) elaboration of the sampling strategy of PMWR piles, ii) a mineralogical and chemical characterization of PMWR piles, and iii) 3D block model creation to evaluate the potential valorization of the existing PMWR. Destructive drilling using reverse circulation from 13 drills was used to collect samples for chemical (X-ray fluorescence analysis) and mineralogical assays. The 3D block model was created based on the data set, including chemical data of the realized drills using Datamine RM software. The optical microscopy observations showed that the sandy phosphate from drills in the PMWR piles is characterized by the abundance of carbonate fluorapatite with the presence of calcite, dolomite, and quartz. The mean grade of composite samples was around 19.5±2.7% for P_2O_5. The mean grade of P_2O_5 exhibited an increasing tendency by depth profile from bottom to top of PMWR piles. 3D block model generated with chemical data confirmed the tendency of the mean grades' variation and may allow a potential selective extraction according to $\%P_2O_5$. The 3D block model of P_2O_5 grade is an efficient sampling approach that confirmed the variation of P_2O_5 grade. This integrated approach for PMWR management will be a helpful tool for decision-making to recover the residual phosphate, adopting the circular economy and sustainability in the phosphate mining industry.

Keywords : 3D modelling, reverse circulation drilling, circular economy, phosphate mine waste rock, sampling
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