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A novel approach for the geospatial modelling and resource assessment of tailings storage facilities

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Tailings are the fine-grained residues of ore processing operations, typically stored in dedicated tailings storage facilities (TSFs). Despite being viewed as 'waste' materials, tailings can contain significant amounts of valuable metals which were not recovered by original processing techniques or were previously not of economic interest. Re-processing of tailings deposits for the recovery of remaining metals has the additional benefits of mitigation of environmental hazards posed by the TSFs, such as Acid Mine Drainage (AMD). The estimation of mineral resources requires the construction of accurate and reproducible geospatial models. However, the sedimentary-style deposition and subsequent weathering of tailings results in a complex internal structure which is challenging to model, with a laterally and vertically heterogeneous distribution of the minerals comprising the residues. The present study investigates a novel approach for the geospatial modelling of a TSF case study. The surface of the tailings deposit was densely sampled in order to assess the intrinsic horizontal variability. Drill core samples were taken from a depth of 1-3 m, on a 30 m grid and nested grids of 15 m and 7.5 m, with additional random and twin holes. The entire depth of the TSF was sampled in 2 m intervals with a total of 10 drill holes to assess vertical variability. All drill core samples were analysed with x-ray fluorescence spectrometry and inductively coupled plasma mass spectrometry. The compositional data was log-ratio-transformed and variography and subsequent ordinary kriging and co-kriging were performed on the surface samples. The variogram models obtained for the surface samples were then applied for kriging of the deeper layers. Historical photographs of the surface of the TSF were used to improve estimates with co-kriging for the corresponding layers. The entire data set will be used to determine the most efficient sampling approach for the resource estimation of TSFs.