Novel stratigraphy simulation – a case study for ESG and mine planning application

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ABSTRACT

Characterization of the quantity and location of potentially acid-forming (PAF) material and the embedded tonnage and grade uncertainty is critical to determine and mitigate the impact of handling procedures on operations, project evaluation and ESG compliance and responsibilities. An uncertainty analysis case study was conducted for an open pit operation to characterize the variation of PAF volume on site.

The study details the simulation of sulphur within simulated stratigraphy, integrating domain uncertainty into the result. The relevant subsurface comprises a series of folded pyritic shale strata, intercalated with breccia units. The presence of folding complicated the continuous and categorical simulations as the intended workflow relied on the implementation of an unfolding transformation. However, the relative thickness of the target unit combined with the strength of folding led to artifacts in the unfolding result.

This behaviour led to the development and implementation of a novel stratigraphy simulation workflow that facilitates the reproduction of true strata thicknesses in cartesian space. The workflow, Sequential Surface Offset Simulation (SSOS), proceeds by calculating and simulating the normal distance between a designated reference surface and intersections with the target (simulated) surface. The simulated normal distance is truncated against a gridded reference thickness to generate a contact realization, and surface realizations are extracted where the contact is equal to zero, effectively applying an equality constraint. This process is repeated for each target surface, using previously simulated surfaces as the reference where available.

The integrated SSOS and sulphur simulation workflow is post-processed to calculate PAF tonnage and uncertainty. When compared to deterministic modelling, there is a clear difference in global results, and a notable increase in the possible PAF extents. Comparing to simulation of sulphur within deterministic domains shows the impact of modelling domain uncertainty with the SSOS and highlights greater PAF potential at the top and bottom of the package. This improved understanding of the behaviour of PAF material is being integrated into mine planning, drill hole planning and waste dump management.