Revealing High Geological Spatial Variability at Bench Scale – Implications Upstream and Downstream in the Mining Value Chain

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The development and deployment of BLASTDOG—a semi-autonomous system for acquiring high-resolution, real-time subsurface data from blast holes or grade control holes in open-cut mining—has revealed significantly greater geological variability than previously expected across a range of “bulk” metalliferous deposits, including coal, iron ore, and porphyry copper deposits.

The BLASTDOG probe integrates three primary geophysical sensors—total count natural gamma, magnetic susceptibility, and inductive conductivity—to infer rock type, including lithology and alteration. An eight-arm caliper is also used to identify rock mass defects such as bedding planes, fractures, and joints. Using examples from these deposit types, the spatial variability is revealed through geostatistical variography and with 3D modelling and visualisation. In nearly all deployments to date, this approach has revealed a higher variability of the geology than expected by the site geologists.

We explore the implications of this variability across the mining value chain. Upstream, it affects data acquisition, the transformation of data into actionable geological information, and its integration into mine and processing design during project development, including feedback loops into grade control. Downstream, the observed variability influences operational performance in drilling and blasting, geotechnical assessments, and mineral processing.