INTEGRATION OF BOREHOLE GEOPHYSICAL LOGS INTO A HAZARD INDEX

SUMMARY

Borehole geophysical logging has gained momentum and formed a part of detailed investigations to structurally and geotechnically characterize formations. A comparison of geotechnical stress-strain tests with downhole geophysical data enabled the development of a robust workflow and the derivation of a local hazard index.

PROBLEM

The Bushveld Igneous Complex (BIC) in Limpopo Province, South Africa contains major structures which are known to pose a threat to mining operations.

The Tumela Mine is a large underground and open cast mine with mining rights that cover a total area of 111km^2. Due to depletion of shallow MR resources, mining has advanced downdip to exploit both pyroxenite Merensky (MR) and chromitite Upper Group 2 (UG2) Reefs resulting in the mine currently operating at depths of 1.3km. MR and UG2 reefs are narrow tabular orebodies which extend for hundreds of sq. km and dip at 18°-27° south-east in the immediate Amandebult area.

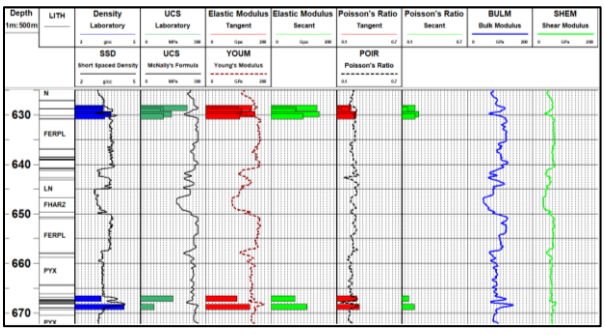
Mine planning and developments suffer from cost and scheduling impacts of intersecting high geohazard zones. Health and safety risk, directly associated with geohazard, is a critical parameter in the design and execution of hard-rock mining, both in open cast and underground environments, and is often difficult to evaluate.

SOLUTION

Borehole televiewer tools are routinely used to capture structural and geotechnical data, providing accurate, fully oriented structural parameters for features intersected by boreholes. In-situ rock strength can be derived from sonic velocity and density data. For hydrogeological applications, analysis of impeller flowmeter, borehole magnetic resonance (bMR), fluid temperature, fluid conductivity and associated fractures, aquifers or fluid passageways can be located. These information are compared with laboratory stress-strain test work.

The majority of the information obtained from logging is limited to the surface of the borehole wall. In order to detect the lateral extent of major structures, low frequency radar is employed with the capacity to map structures in excess of 50m from the borehole (formation dependent).

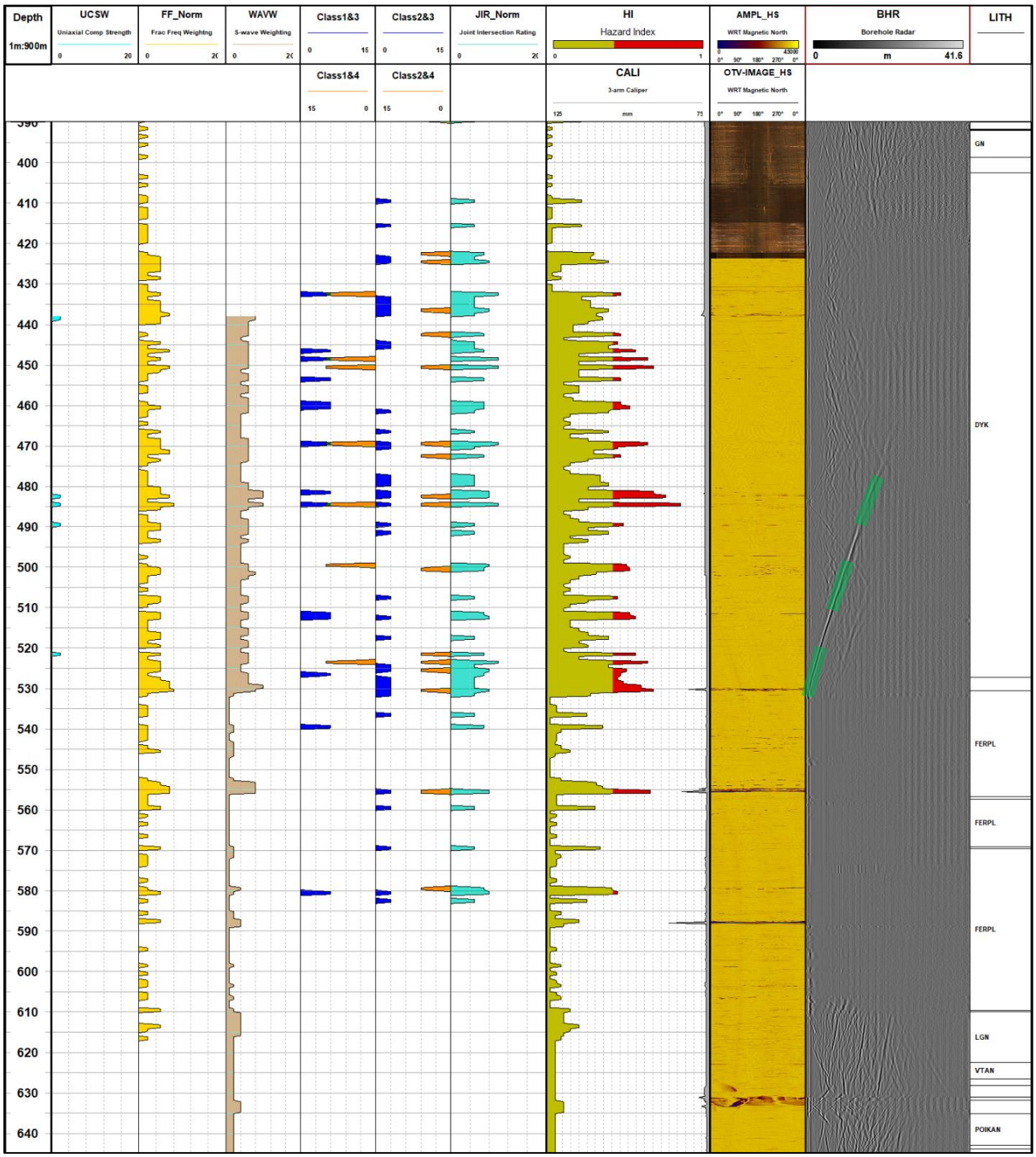
The Hazard Index (HI) log is a risk assessment tool used to inform shaft sinking, slope stability, hydrogeology and ahead of mining studies. HI is the linear combination of multiple borehole parameters or logs into one log, similar to standard rock mass classification schemes that are well known and is used to flag zones of potential hazard.



Comparison of borehole geophysical logs (traces) with stress-strain laboratory test work (bars).

IMPACT

The robust local hazard index, derived from borehole geophysical logs, identifies zones of potential hazard. These information are integrated into shaft sinking, slope stability, hydrogeology and ahead of mining studies, increasing confidence in plans and de-risking developments, ultimately reducing cost and fast tracking mining.



Hazard Index log with zones of elevated hazard (red), acoustic televiewer and radargram mapping associated structural element (green dash).