



BOREHOLE DATA WITH A PURPOSE

Downhole Rock Properties and Televiewers Applied to Mining & Minerals Exploration

BCGS 2019 Fall Symposium



STRUCTURAL GEOLOGY

- Oriented digital core
- Contacts, veins & foliation true orientation



RESOURCE EXPLORATION

- Map lithology, mineralization & alteration
- Constrain geophysical inversions



MONITORING & HYDROGEOLOGY

- Monitor paste & shot lines
- Fluid flow & hydraulic conductivity



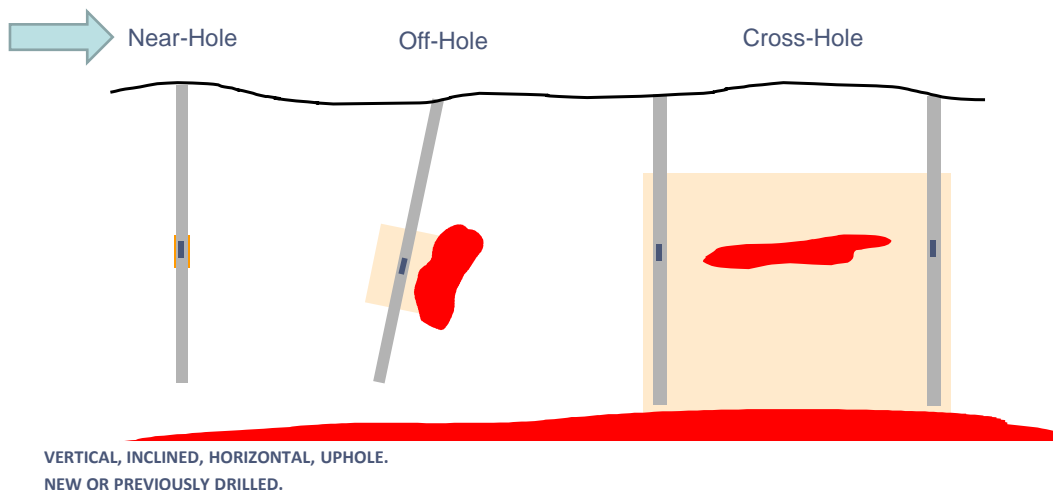
GEOTECHNICAL

- Fractures, joints & fault zone true orientation
- Breakout orientation & far field stress analysis

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BOREHOLE DATA WITH A PURPOSE

Types of Downhole Measurements


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What Can We Actually Measure?

Physical Rock Properties

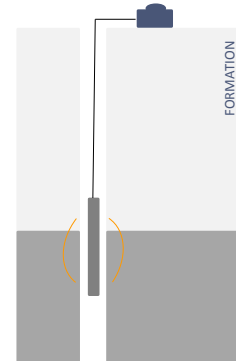
- Natural Gamma
- Neutron (Porosity)
- Magnetic Susceptibility
- Conductivity
- Acoustic Velocity (P and S Wave)
- Electrical Resistivity
- Spontaneous Potential
- Induced Polarization
- Density (Cesium-137/Cobalt-60)

Directional and Hydrogeology

- Gyro
- Caliper
- Fluid Flow
- Borehole Magnetic Resonance (Porosity, Permeability and Hydraulic Conductivity)

Borehole Imaging

- Acoustic Televiwer
- Optical Televiwer
- Dipmeter
- Downhole Camera



VERTICAL, INCLINED, HORIZONTAL, UPHOLE.
NEW OR PREVIOUSLY DRILLED.



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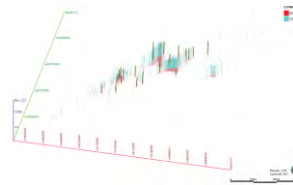
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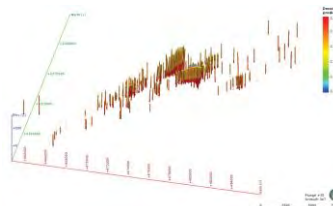

BOREHOLE DATA WITH A PURPOSE

Lithology, Alteration and Mineralization Characterization

- Given:
 - Downhole PRP Data
 - Geochemistry, Lithology, Mineralization, etc
- Can use statistical methods to characterize different elements of a deposit and make predictions.
- Quick example:
 - Density on a subset of holes, with co-located geochemical results.
 - Predict the density on boreholes where you only have geochemistry.
 - Training and testing datasets allow you to validate prediction.



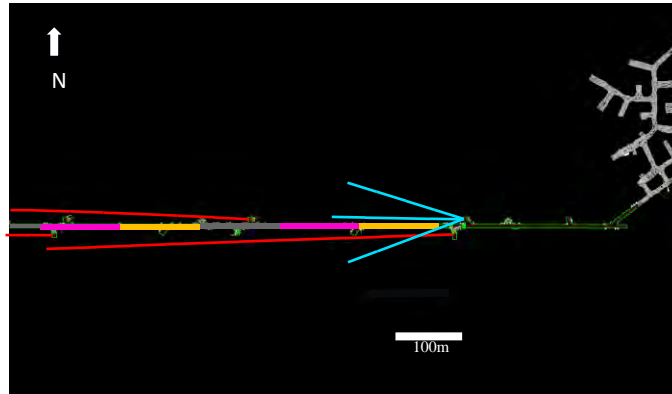
Highlighted boreholes logged with density. Co-located geochem data available on all boreholes.



Modelled density.

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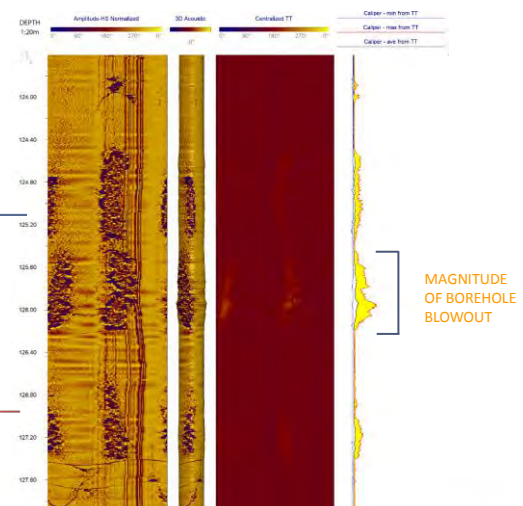
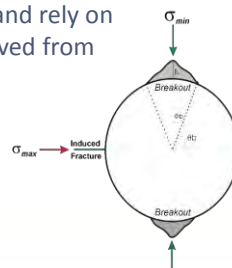
Acoustic Televiewer Applications: Geotechnical Hazard Assessment



New innovations allow for the acquisition of televiewer data in horizontal boreholes subparallel to development.

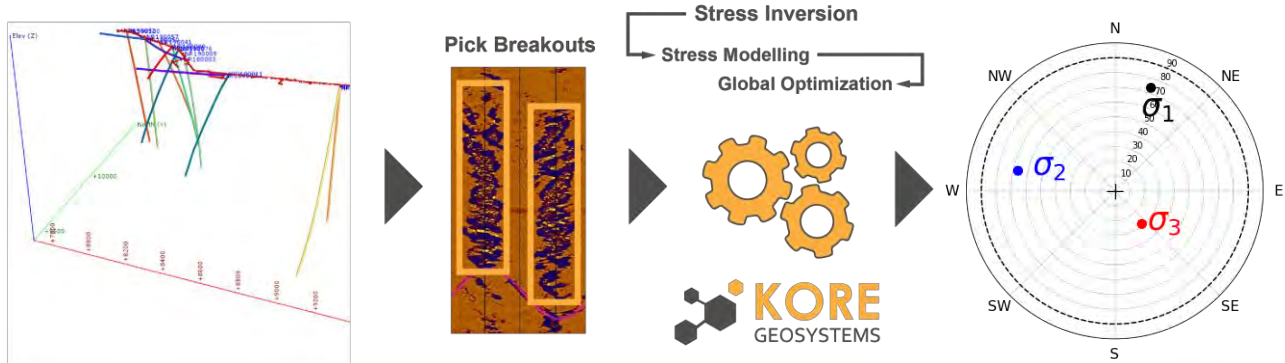
Acoustic Televiewer Applications: Geotechnical Hazard Assessment

- When a borehole is drilled the surrounding rock is no longer supported.
- If stress is great enough, the borehole will become elongated in one direction.
- Traditional methods of obtaining stress orientation are expensive and rely on sparse measurements derived from testing sections of core.



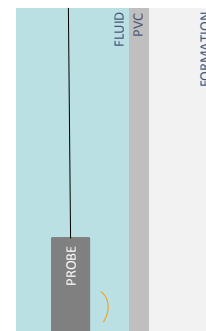
Acoustic Televiewer Applications: Stress Regime Quantification

ATV Breakout Data



Acoustic Televiewer & BMR: Logging Through PVC

- Obtain fracture orientations through PVC casing in situations where the borehole would not remain open long enough to survey.
- Multi-echo acoustic televiewer records multiple arrivals, allowing the tool to record an image through PVC.



First Reflector: edge of tool.

Second Reflector: PVC.

Third Reflector: borehole wall.





BOREHOLE DATA WITH A PURPOSE

**Presents**

Using borehole magnetic resonance to
detect free and bound water in tailings
and estimate hydraulic conductivity to
predict resistance to static liquefaction
failure in upstream tailings

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