GEOTECHNICAL INVESTIGATION OF KARIBA DAM PLUNGE POOL

SUMMARY

The Kariba Dam plunge pool has experienced erosion due to water flow through spill gates, prompting a rehabilitation project to reshape and protect the plunge pool. A detailed geotechnical investigation using advanced imaging technologies was conducted to understand the rock mass characteristics essential for the project's success.

PROBLEM

Over the years, water flowing through the spill gates of the Kariba dam has eroded the natural rock floor of the plunge pool. The Kariba Dam Rehabilitation Project (KDRP) was created to reshape and rebuild the plunge pool to limit the erosion of the riverbed directly beneath the dam wall to secure the dam's future operations in accordance with international standards.

The works to reshape the plunge pool involve the excavating of 300 000m3 of rock in the current pool and the construction of a concrete slab to protect the weakest areas. Work commenced in 2017 and is expected to be completed by end of 2024.

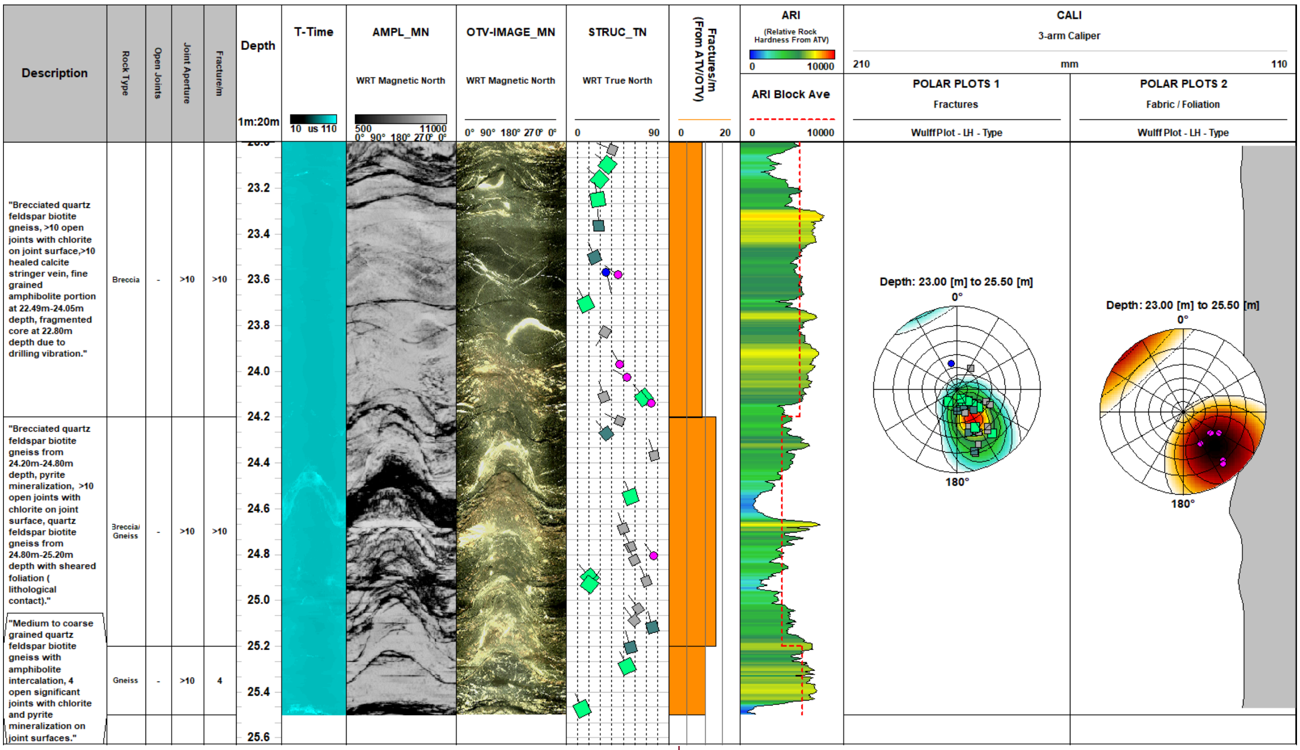
SOLUTION

As part of the project a geotechnical investigation was conducted to help give answers to the engineering questions related to the excavation and rehabilitation of the plunge pool. These investigations were intended to verify the geomechanical characteristics of the rock mass, in terms of fracturing, weathering, alteration, rock hardness, strength and deformability. The geomechanical characteristics have a direct bearing on project scope, cost and overall success.

A watertight coffer dam was constructed to enable the drilling of a series of short, cored holes into the biotite gneiss bed rock. Core retrieved from these holes could be analyzed in a laboratory while in-situ measurements could be conducted in the now open hole.

An important component of the in-situ testing was the ability to analyze the fracture distribution and orientation, along with bedding / foliation orientations within the bedrock. This was accomplished by deploying both Optical Televiewer (OTV) and Acoustic Televiewers (ATV) downhole to capture high-resolution, orientated, images of the undisturbed borehole wall.

Safety | Range of Services | Depth of Service | Training | Experience & Knowledge



IMPACT

These in-situ high-resolution images from both ATV and OTV tools, when in the hands of an experienced interpreter can yield a highly

Above is a typical Tech-Log plot from the project which includes the ATV and OTV images along with interpreted data products.

detailed digital point data set in a shorter time than it traditionally takes for core logging results to be published. This speeds up the decision-making process and can assist in the siting of extra boreholes where required or highlight areas of concern faster.

With the images being captured directly from the relatively undisturbed wall rocks, the possibility also exists to measure fracture openness as part of the interpretation classifications / data. This is not always possible, or carries a higher degree of uncertainty, when done from core samples alone.

Other inherent attributes in the images can also make useful data when extracted. The acoustic reflectance (ARI) can be extracted for the acoustic amplitude image for example. The ARI although uncalibrated can still be useful metric to map the variability in rock hardness within the wall rocks.

TECHNOLOGY

Acoustic Televiewer: (ATV) generates images of the borehole wall by transmitting ultrasound pulses from a fixed transducer, with a rotating

acoustic mirror and recording the amplitude and travel time of the signals reflected at the interface between the borehole fluid and the formation (borehole wall). The reflection amplitude is controlled by the acoustic impedance of the formation. Variations of the acoustic impedance both vertically and radially are mapped in the

generated image. Changes in borehole diameter result in variations in acoustic travel-time and these variations are used to generate a second image of the travel time data.

Optical Televiewer: (OTV) uses high-resolution optical scanning of the borehole wall and measures the intensity and colour of the reflected light. OTV results are presented as a continuous and oriented true colour image of the borehole wall enabling mapping of litho-structural features. OTV requires optically transparent fluid inside the borehole (air or clear water). The quality of the image is reduced by tool decentralization, muddy water or dust on the borehole wall. The OTV log can be used as a replacement for litho-structural core logging.