

Applications of state of the art downhole logging for hard-rock

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Downhole logging has been one of standard measurements in scientific drilling. Its basic data are gamma-ray, spectral gamma-ray, electrical resistivity, density, porosity, sonic velocity, seismic velocity, and borehole image. These data has being applied to physical properties, lithology, sedimentology, structural geology, rock mechanics, hydrogeology, mineralogy, geochemistry etc. State of the art downhole logging leads us higher resolution, more data variation and volume, and then to new scientific results. We here discuss basics of wireline logging and LWD (Logging While Drilling), their standard/extensive applications, drilling strategy, potential applications for hard rocks with new technology with some case studies.

One of the advantages of downhole logging over coring is continuous data. Poor core recovery is one of the major issues in hard rock drilling. Continuous logging data covers the missing core intervals. Another advantage is in-situ measurement in downhole. It is important to measurements physical properties like electrical resistivity, sonic velocity, density, porosity, before physical changing and developing contamination of cores with drilling fluid. New geochemical fluid analyzer allows us to measure fluid compositions, for example optical spectrometer (20ch), C1, C2-C5, C6+, CO₂, pH, fluorescence, density, viscosity, flowline pressure, temperature, electrical resistivity, gas-oil ratio. Downhole fluid sampler allows us to sample formation fluid with less contamination. In addition, large diameter side-wall coring tool allows us to take 3.8 cm diameter and 6.3 cm length cores from borehole wall.

New sensor technology brings us higher accuracy/resolution and more data volume. Latest borehole image tools give us much higher resolution than previous generations. It helps to descript small structure and fractures. New gamma-ray spectral tools allows us to identify minerals: Al, Ba, C, Ca, Cl, Fe, Gd, K, Mg, Mn, Na, S, Si, Ti, Cu, Ni. Some of these new tools require larger guide pipes to low the tools into borehole. Chikyu's riser drilling gives more chances to use new tools with large diameter riser pipes.

Chikyu's riser drilling allows us to approach deeper in safer approach. While it expands our leading edge of science, it requires longer days and huge cost. It drives us to consider spot coring (at selected intervals) from coring of the whole interval. Under this situation, it is more important for downhole logging to compensates the missing coring intervals. While wireline logging is carried out after coring, LWD before coring suggests us best spot coring intervals or best position for observatory installation. New LWD technology provides various high resolution data same as those of wireline logging. These above change paradigm of drilling strategies.

Riser drilling circulates cuttings (small pieces of formation rocks during drilling) and formation gas to surface with drilling fluid. They are valuable samples and information from subsurface, too, and utilized oil and gas industries long time, but we just have started our studies for science researches. Integration analysis with core, logging, seismic, and cuttings must maximize our science products.

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