5 Hylogger data

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5.1 HyLogger data acquisition and processing

The Hyperspectral drill core Logging or HyLogging™ system was developed by CSIRO under a national collaborative infrastructure project and comprises:

1) Automated drill core line profiling hardware to acquire hyperspectral mineralogical data
2) Co-registered high-resolution core images (HyLogger 3-5)
3) The Spectral Geologist (TSG™) software for quality control, data interpretation and analysis (Schodlok et al., 2016).

The HyLogging system rapidly, non-destructively measures the reflectance spectra and captures high resolution imagery of drill core in original trays, simultaneously ensuring the quality of the data collected. The mineralogical information about rocks is obtained from diagnostic reflectance features related to the electronic and vibrational properties of their mineral composition. Three spectrometers working in the electromagnetic wavelength range of 400 nm to 1000 nm (visible-near infrared, VNIR), 1000 nm to 2500 nm (shortwave infrared, SWIR) and 6000 nm to 14 500 nm (thermal infrared, TIR), simultaneously collect the characteristic spectra of minerals while the core tray passes below these sensors. The surface of the core is illuminated using a pair of quartz-halogen lamps for the VNIR/SWIR system, disposed along the travel of the core. For TIR, focussed heat sources form the light source. The trays move beneath the sensors at 48 mm/s, reversing the traverse for each tray section, thus covering roughly 1 m per minute. Iron oxides, rare earth minerals, hydrous silicates, carbonates and some sulfates are detected by VNIR and SWIR spectrometers while anhydrous silicates like quartz, feldspar, pyroxene, garnet and olivine, as well as hydrous silicates, sulfates and carbonates, are detected by TIR spectrometer. For more details on this technology see Schodlok et al. (2016).

Prior to HyLogging, drill core from GSQ Cunnamulla 1 was vacuumed and cleaned in the original trays, and depth corrected. Drilling mud and other stains were washed off and the cores were completely dried. The cores were also rotated to face the clean surface towards the sensors. A reflectance calibration was performed before scanning each tray using transfer standards and room radiance measurements following the protocol of Schodlok et al. (2016). After scanning each tray, a quick performance and data quality check was made using The Spectral Geologist (TSG™) QC software and the errors were displayed alongside the image of the core tray, together with the preliminary mineralogical interpretation of the spectral reflectance data. Once all the trays were scanned, the data were further processed using TSG™ Core software, which features tools for characterisation, feature extraction and mineral identification from the measured wavelengths and images, and reports on those minerals present in the drill cores and their relative abundances.

Chip trays containing the washed mud rotary drill chips were treated similarly to the cores. Samples were fully dried and scanned using the HyLogger chip mode, where three individual scans were made within each sample receptacle.
5.2 Results

5.2.1 GSQ Cunnamulla 1 diamond drill core

Hylogger data from the basement in GSQ Cunnamulla 1 (Figure 5.1, Figure 5.2) highlight the relative homogeneity of the rocks as relatively consistent amounts of quartz, muscovite and albite throughout the borehole.

Unweathered rocks in the bottom of the borehole have relatively simple mineralogy, consisting of quartz-muscovite-albite-chlorite and rare phengite. The palaeoweathering profile can be seen as kaolinite group minerals replacing chlorite group in Figure 5.1, and an abundance of poorly crystalline kaolinite (Kaolinite-PX) in Figure 5.2. The base of palaeoweathering is likely to occur at ~ 552 m TVD (~578 m DL), and kaolinite occurring below this length appears to be associated with meteoric water infiltration along shear zones.

5.2.2 GSQ Cunnamulla 1 mud rotary chips

Hylogger data from the mud rotary drilled portion of GSQ Cunnamulla 1 are dominated by clays (Figure 5.3). The upper ~108 m is kaolinite-dominated, with gypsum present sporadically, potentially indicating surface weathering to ~108 m TVD and correlating with relatively low induction conductivity to this depth. In the mud rotary drill chips surface weathering is partially reflected in the colour or tone of mud rotary drilled chips. Strong surface oxidation as red and yellow colours appears to stop at the base of the interpreted Cenozoic section at 31.56 m TVD; below this rocks have light to dark grey tones, with occasional white mottles to ~99 m TVD in the lithological log (see Appendix G) and the correlation is not as strong.

Below ~108 m TVD rocks are completely unweathered and smectite-dominated. There appears to be little mineralogical difference between the fresh rocks of the Wallumbilla Formation, The Wyandra Sandstone Member and the Cadna-owie Formation. In other boreholes drilled as part of the program there are distinct mineralogical variations between these stratigraphic units, perhaps due to the boreholes being drilled closer to the palaeotopographic high of the Eulo Ridge, e.g. GSQ Eulo 4 (Roach et al., 2018a), Milcarpa 1 (Roach et al., 2018c) and Laurelvale 1 (Roach et al., 2018b). The poor mineralogical differences in GSQ Cunnamulla 1 may reflect the more distal nature of the source regions for these rocks, being in a deeper part of the Eromanga Basin.

The Hooray Sandstone is mineralogically distinct, being dominated by kaolinite (in its upper half), smectite and quartz, potentially reflecting more of a locally-derived weathered bedrock mineralogical signature. Correlation with increasing natural gamma signal, and decreasing induction conductivity is also reflective of this, with materials being more radioactive and less electrically conductive with depth towards the basement-cover interface.