Mineral systems revealed: hyperspectral insights from exploration drilling at Yeneena, Speewah, and Hercules deposits

by

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Introduction

The HyLogging™ system is a suite of spectroscopic and imaging tools developed by CSIRO as part of its Minerals Down Under Flagship program, for logging rock-forming and alteration mineralogy in drillcore and chips, (Huntington et al., 2007). It uses rapid reflectance spectroscopy in the visible-near infrared (VNIR), short-wave infrared (SWIR) and — since May 2011 — thermal infrared (TIR) wavelength ranges to identify a broad suite of hydrous and anhydrous minerals. The Geological Survey of Western Australia's HyLogger has been successfully used by academic, government and industry geologists, and has scanned more than 60 000 m of core from 250 holes since commissioning in July 2009.

One of the major avenues for collaboration between GSWA and mineral and petroleum exploration companies is via the Co-funded Drilling Program, one of the pillars of the Western Australia Government's Exploration Incentive Scheme (EIS). Diamond drillcore generated as part of this program is delivered whole or in part to the Perth or Kalgoorlie core libraries, and is then routinely scanned with the HyLogger on a requested priority basis. Processed data are initially provided to the participant companies as graphic images, spreadsheets, and The Spectral Geologist (TSG) software files, and the results discussed with company staff. All data are then released to the public domain upon expiry of the brief confidentiality period.

Three successful EIS drilling projects are chosen here to demonstrate the value of the HyLogger for objective logging of drillcore, hence providing insights into mineral systems.

Yeneena Base Metals project

The Yeneena project is located in the Paterson Province, 40 km southeast of the Nifty copper mine. Mineralization is associated with regionally extensive faults in Neoproterozoic shales and dolomites of the Broadhurst Formation, a constituent of the Yeneena Basin (Bewick et al., 2010).

Encounter Resources Limited (ERL) was a successful recipient of EIS Co-funded Drilling grants in 2009, 2010, and 2012. ERL subsequently announced that this diamond drilling had intersected significant mineralization — a broad zone of hydrothermal copper within dolomitic shale (12 m @ 3.2% Cu) at the BM1 prospect, and a thick zone of zinc mineralization (188 m @ 0.35% Zn) as sphalerite in quartz–siderite–pyrite veins overprinting brecciated argillite/shales at the BM2 prospect. There is also secondary copper enrichment in the oxidation zone of the BM2 prospect.

Six drillholes totalling 1800 m of core were analysed using the GSWA HyLogger at Perth Core Library. Carbonate–quartz–sericite+/–chlorite+/–hematite alteration is widespread throughout fresh argillite/shale host rocks and the clay-rich weathering zone. But some lateral and vertical variations in the distribution of alteration in the area might be useful as vectors to mineralization (Fig. 1):

- The carbonate composition changes from pervasive dolomite at the BM1 prospect, associated with Cu mineralization, to abundant Ca–Mn-rich siderite and calcite veining at the BM2 prospect, associated with Zn (and Pb) mineralization.
- Secondary (supergene) copper in clays and brecciated argillite is accompanied by muscovite, quartz, goethite, and Fe/Mg chlorite. Hypogene copper-rich zones in dolomitic shales at the BM1 prospect are instead associated with phengite alteration.

Speewah Ti–V–PGE–Au–Cu–fluorite project

The Speewah Dome is an anticline structure exposing Paleoproterozoic sediments and intrusive Hart Dolerite in the East Kimberley region. The dome is host to several commodities. Vanadium–titanium–iron mineralization with minor platinum group elements and gold is hosted in vanadiferous titanomagnetite gabbro of the Hart Dolerite. Fluorite occurs with minor copper and gold in epithermal, sub-vertical quartz–fluorite veins up to 10 metres thick and stockworks of smaller veins, along major north- and north-northeast-trending faults cutting Speewah Group sedimentary rocks (King River, Pentecost and Central Faults). Carbonate veins also occur locally along these faults (Ramsay et al., 2011).

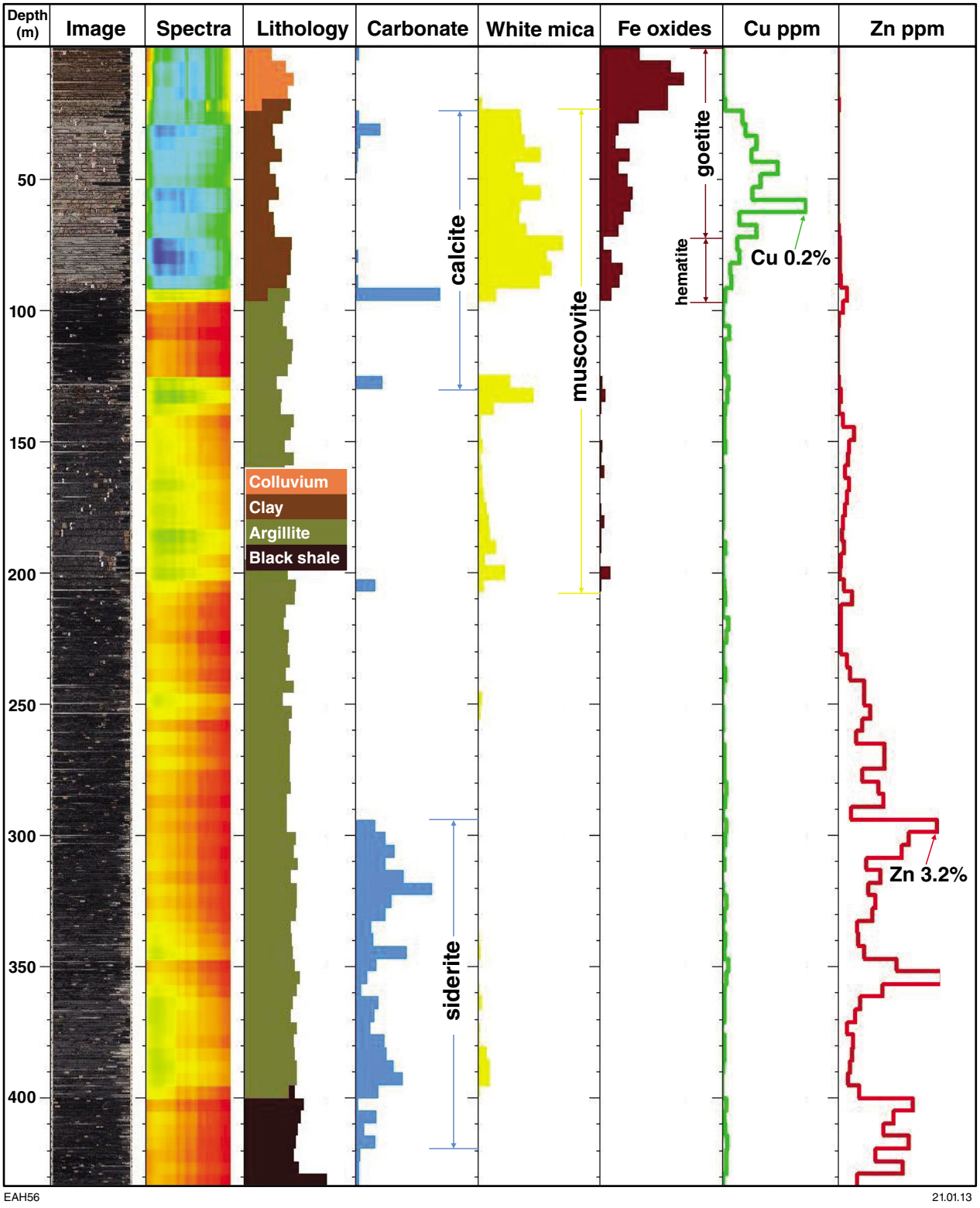

Figure 1. TSG graphic logs for core (drillhole EPT1174) of the BM2 Prospect at the Yeneena: distribution of carbonate, muscovite, Fe oxides, and Cu–Zn mineralization

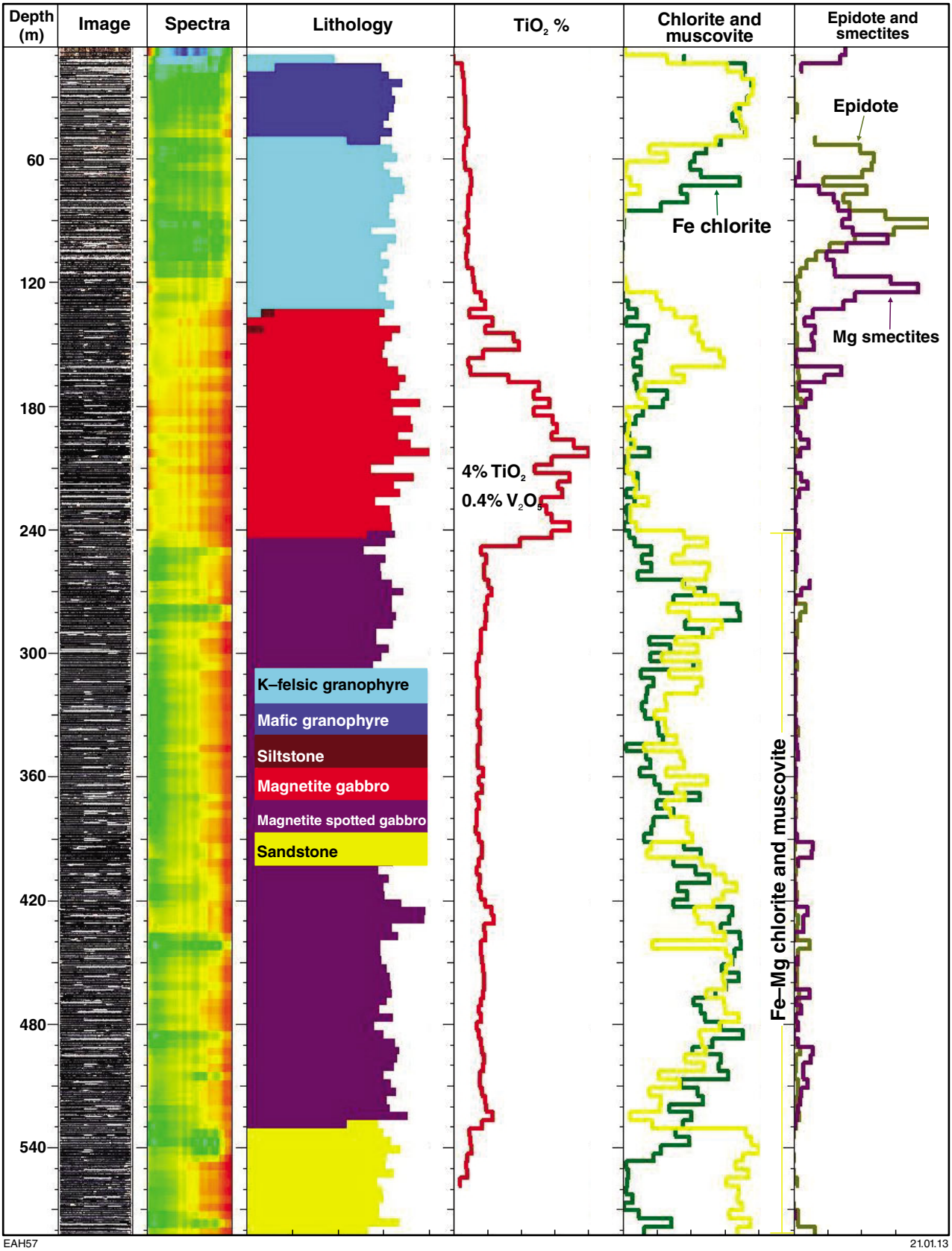

Figure 2. TSG graphic logs for core (drillhole SDH09-01) of the Central V–Ti deposit at Speewah: distribution of lithological units, TiO_2 assays, chlorite–muscovite, and epidote–smectite

Speewah Mining Ltd (a subsidiary of NiPlats Australia Ltd) has been extensively exploring, and in March 2012 announced a significant increase of 32% in the resource of titanium/vanadium grading 0.3% V_2O_5 and 2% Ti at the Central, Buckman, and Red Hill deposits (Ramsay et al., 2012). The company was granted EIS co-funding for drilling in the Speewah Dome in 2009, 2010, and 2011. Twelve of these drillholes (6850 m) targeted fluorite-bearing mineralization at the ABCE deposit along the King River Fault, and several zones along the Central Fault. Another two holes (746 m) tested the Central and the Red Hill vanadium deposits. All drillholes were scanned using the HyLogger.

Non-mineralized gabbro and granophyres of the Hart Dolerite at the Central Ti–V deposit show widespread chlorite–sericite alteration, and minor prehnite and calcite veining (drillhole SDH09-01; Fig. 2). Fe–chlorite and muscovite are relatively abundant in the hanging wall felsic granophyres and footwall magnetite spotted gabbro, but are more uneven distributed and substantially diminished in the mineralized disseminated magnetite gabbro, where abundances of TiO_2 and V_2O_5 are up to 4% and 0.36%, respectively.

The ABCE fluorite deposits are associated with widespread chlorite and sericite alteration in the surrounding gabbro and sandstone units, and the compositions of these minerals reflect the lithological Fe–Mg variations (drillhole SDH10-01). The B Vein prospect has intense potassic alteration throughout the sandstone and gabbro, highlighted also by pink colouration (drillhole SDH11-02). Unusual spectra from secondary epithermal veins in the gabbro of the Wilmott carbonate prospect (drillhole SDH10-05) indicate the presence of datolite, natroapophyllite, and laumontite.

Hercules gold project

The Hercules project is located 60 km northeast of the Tropicana gold deposit. High-grade gold mineralization occurs in steeply dipping quartz veins associated with biotite–pyrite alteration and silicification. It is contained entirely within the Hercules Shear Zone, which lies along the boundary between the Archean Yilgarn Craton and the Proterozoic Albany–Fraser Province. Mineralization and basement gneisses, granites, and minor schists and meta-arenites are buried beneath a thick cover of Permian and Cenozoic sediments (Copping, 2012).

Beadell Resources Ltd announced the discovery of high-grade gold mineralization at the Atlantis and Hercules Prospects in 2011. Seven diamond drillholes (704 m) were submitted to the Perth Core Library for collaborative research, some of which were co-funded as part of Round 3 of the EIS scheme.

Hyperspectral data from the Hercules prospect (drillhole NLD210) show pervasive quartz, albite, and sericite, and subsidiary, patchily distributed chlorite, amphibole, and carbonate (Fig. 3, see page 18). Two principal lithological units can be interpreted in the core based on varying mineral assemblages:

- granite — characterized by abundant quartz, albite and muscovite, lesser chlorite, epidote and dolomite, and no mineralized quartz veins
- gneiss — dominated by quartz, albite and phengitic white mica, lesser amphibole, calcite/siderite, and phlogopite, and mineralized quartz veins.

The decline in major mineral abundances above ca. 50 m depth may reflect the presence of cover rocks, and weathering.

The mineralized intervals appear to be highlighted by visible pyrite, grunerite, and quartz veins and perhaps an increase in chlorite and calcite–siderite abundance. There is only minor dark mica (<2%).

Conclusion

The spectral range of the new generation HyLogger (encompassing VNIR, SWIR and TIR) now allows us to identify a broad suite of hydrous and anhydrous rock-forming minerals in drillcore. This improves our capacity to objectively characterize the type and distribution of rocks, alteration and ore-hosting mineral assemblages, hence defining potential vectors to mineralization. Mineral exploration companies can benefit from this application of hyperspectral data to their mineral systems by becoming involved in the EIS Co-funded Drilling Program or otherwise engaging with GSWA in collaborative research.

References

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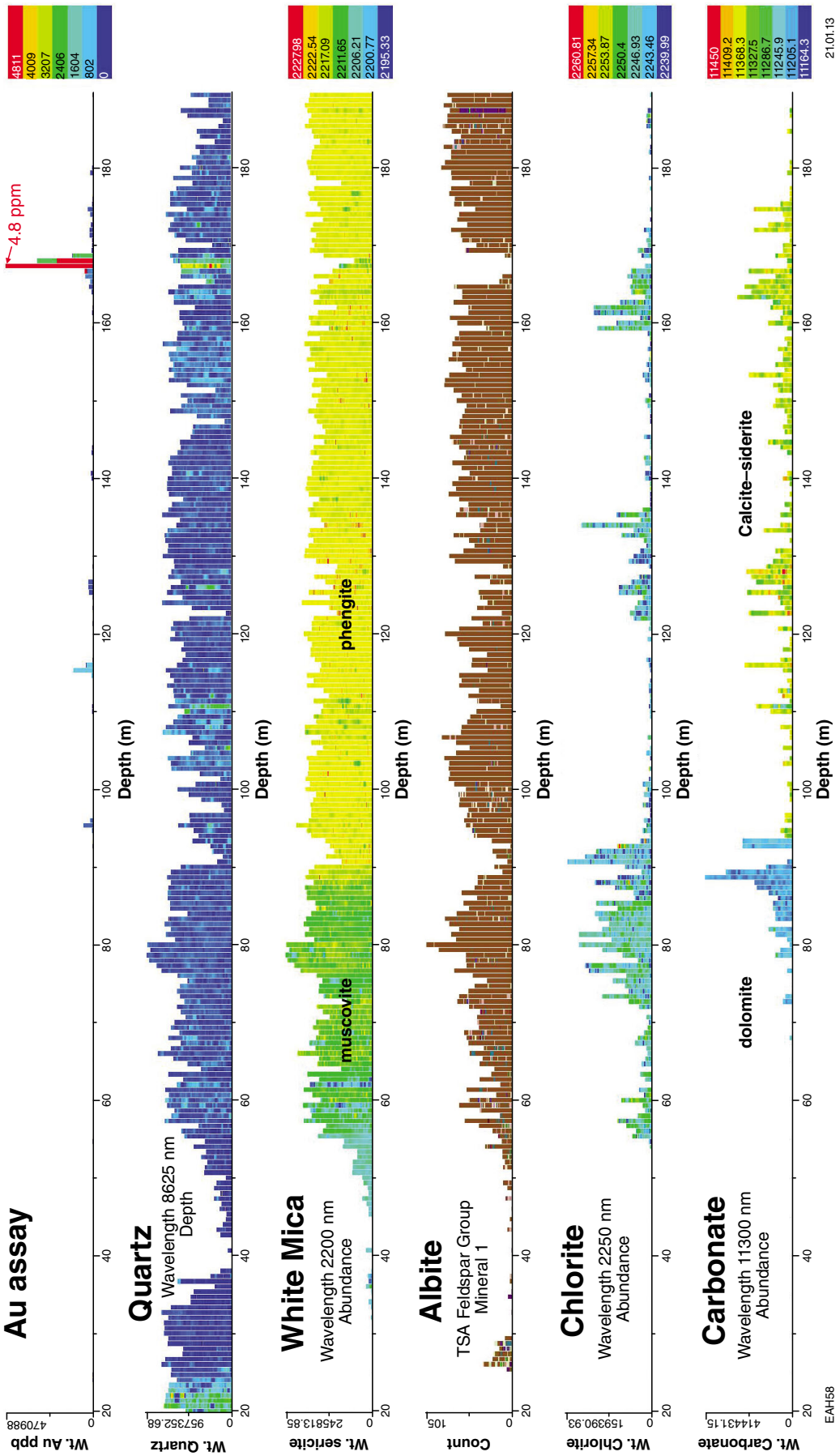

Figure 3. TSG graphic logs for core (drillhole NLD210) of the Hercules: gold assays, distribution of quartz, white mica, albite, chlorites, and carbonate