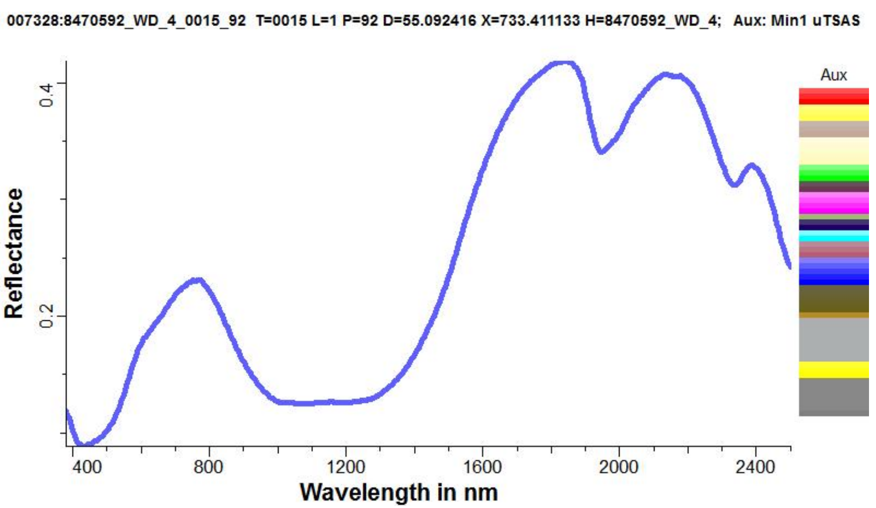
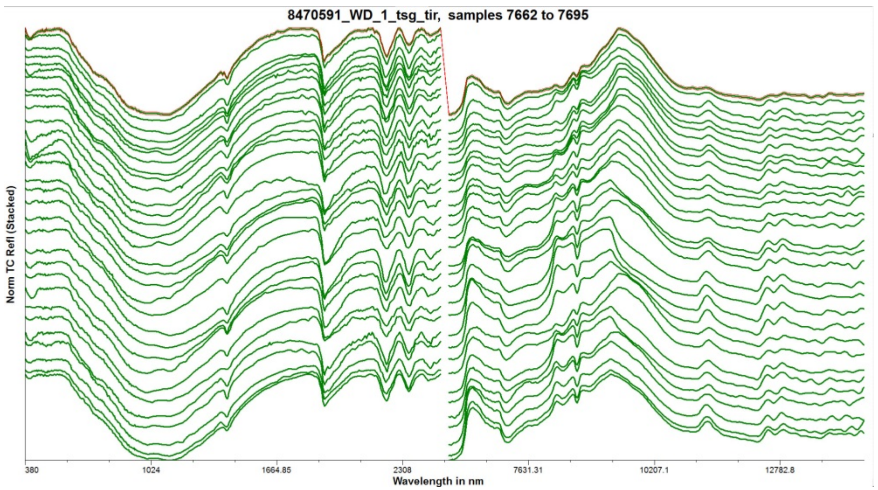
Summary of mineralogy matches from HyLogger™ data, Walker Gossan WD series holes, Walker Fault Zone, McArthur Basin

Belinda Smith





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Northern Territory Geological Survey
3rd floor Paspalis Centrepoint Building
Smith Street Mall, Darwin
GPO Box 4550
Darwin NT 0801, Australia

Arid Zone Research Institute
South Stuart Highway, Alice Springs
PO Box 8760
Alice Springs NT 0871, Australia

For further information contact:
Minerals and Energy InfoCentre
Phone: +61 8 8999 6443
Website: **http://www.minerals.nt.gov.au/ntgs**
Email: geoscience.info@nt.gov.au

Walker Gossan drillholes – Introduction

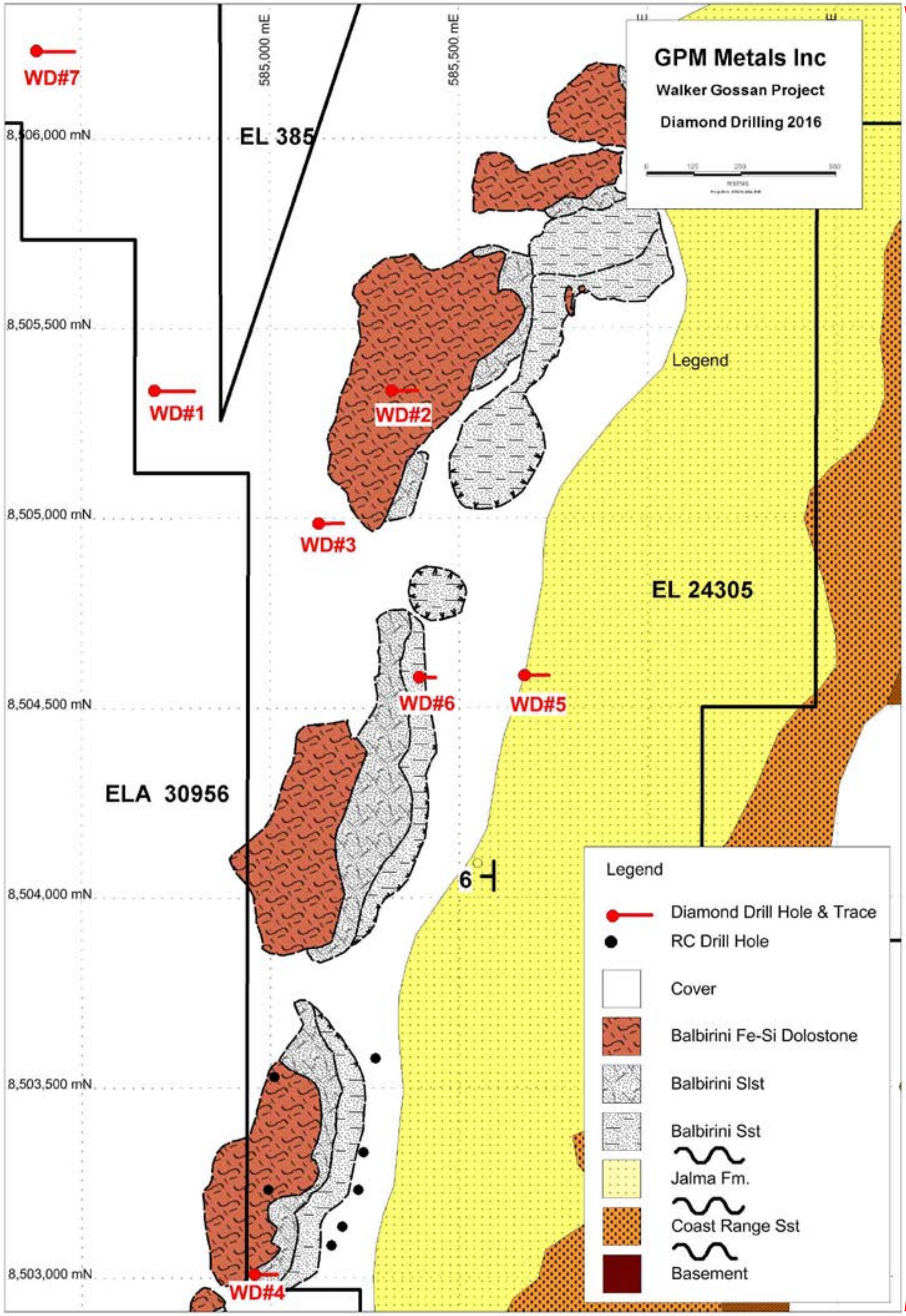
DPG Resources successfully applied for funding to drill the WD-series holes in Round 9, NTGS *Geophysics and Drilling Collaborations Programme* in 2016-2017. Results are reported in CR2017-0031 (DPG Resources 2017).

The drillholes were designed to test a large Pb-Zn soil and rock chip anomaly in the Walker Fault Zone that was interpreted to indicate economic lead-zinc mineralisation beneath the weathered profile of the Balbirini Dolostone. The original exploration concept was to test targets at depth (4 holes of 500 m depth) due to an interpreted down-faulted block to the west. However, the intersected geology was much shallower than expected, so DPG Resources drilled more holes than planned, to shallower depths (7 holes for 953.5 m).

Three of the 7 holes (WD 2, WD 4 and WD 6) were collared on mapped Balbirini Dolostone (as indicated on the BLUE MUD BAY 250 000 scale mapsheet (Haines *et al* 1999). One hole (WD 1) is reported as intersecting basement (CR2017-0031; page 12) although the imagery from the HyLogger data indicates that WD 4 also intersected basement (Smith 2017). The drillholes are logged as intersecting Balbirini Dolostone, Jalma Formation, Coast Range Sandstone and basement. Haines et al (1999) described the stratigraphy as:

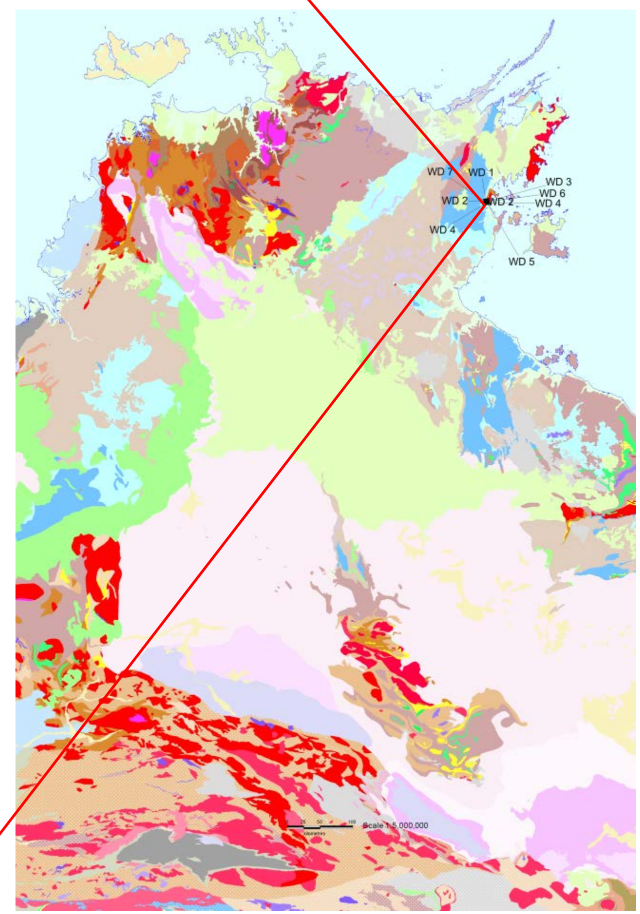
> Balbirini Dolostone (previously Dolomite): 'chert, altered carbonate containing stromatolites, locally common ooids, evaporites and intraclast breccia. Local basal sandstone and conglomerate.'
>
> Jalma Formation: 'brown to purple medium-grained sandstone, bedded, ferruginous, lower basal conglomerate; upper recessive laminated claystone unit'.
>
> Coast Range Sandstone: 'white medium- to coarse-grained sandstone, thick bedded, possibly pebbly'.

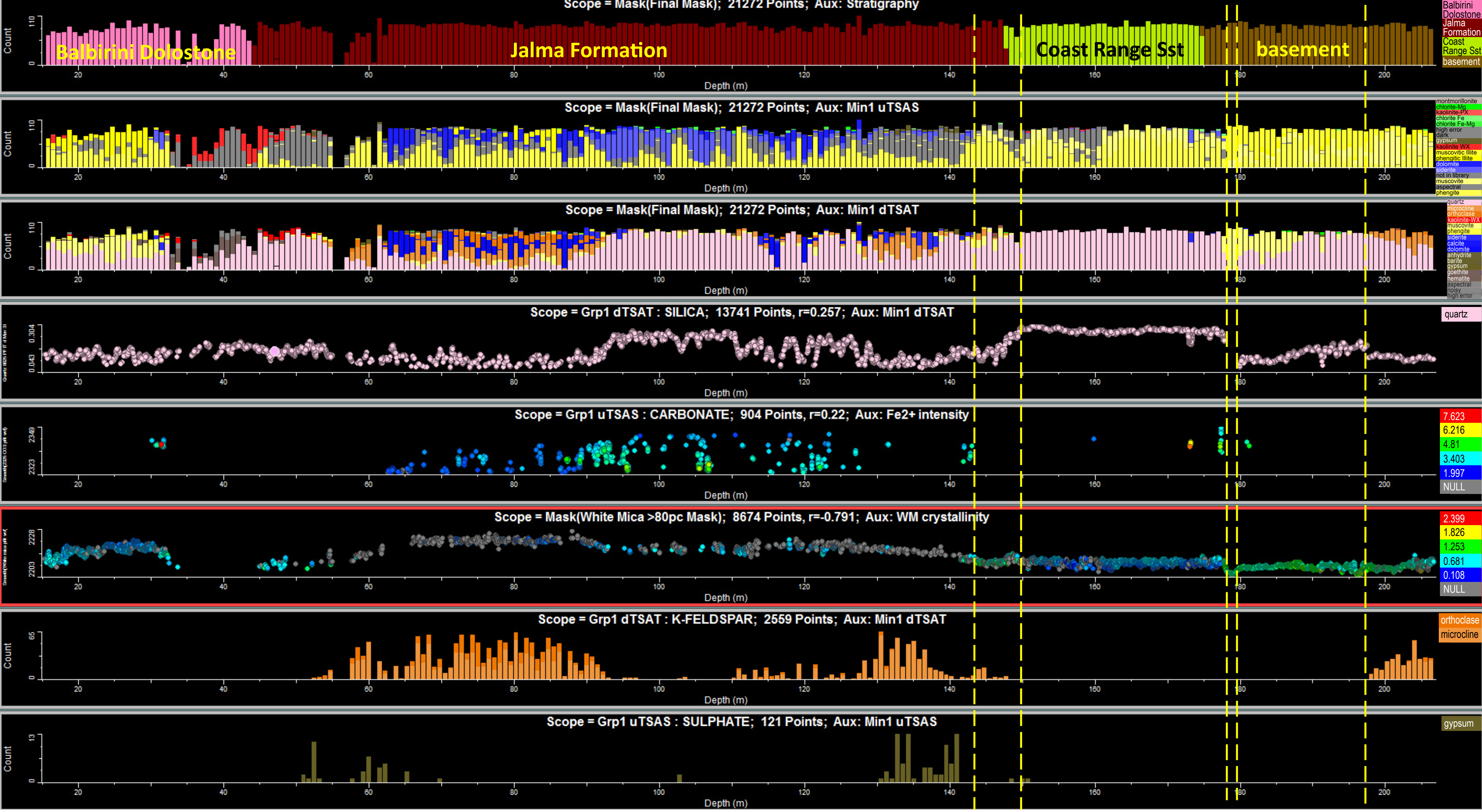
The purpose of this publication is to document the mineralogy and textures of the WD-series holes for use as a guide in characterising the stratigraphy of this area. The basement is not assigned to any stratigraphic unit. The stratigraphic picks currently assigned to the drillholes came from estimated depths from the interpreted sections rather than from text files in the report. This means that the stratigraphic depths are approximate and could be further refined based on mineralogy and textures in the HyLogger data.



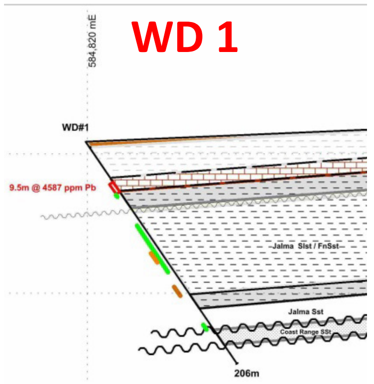
Walker Gossan drillhole map

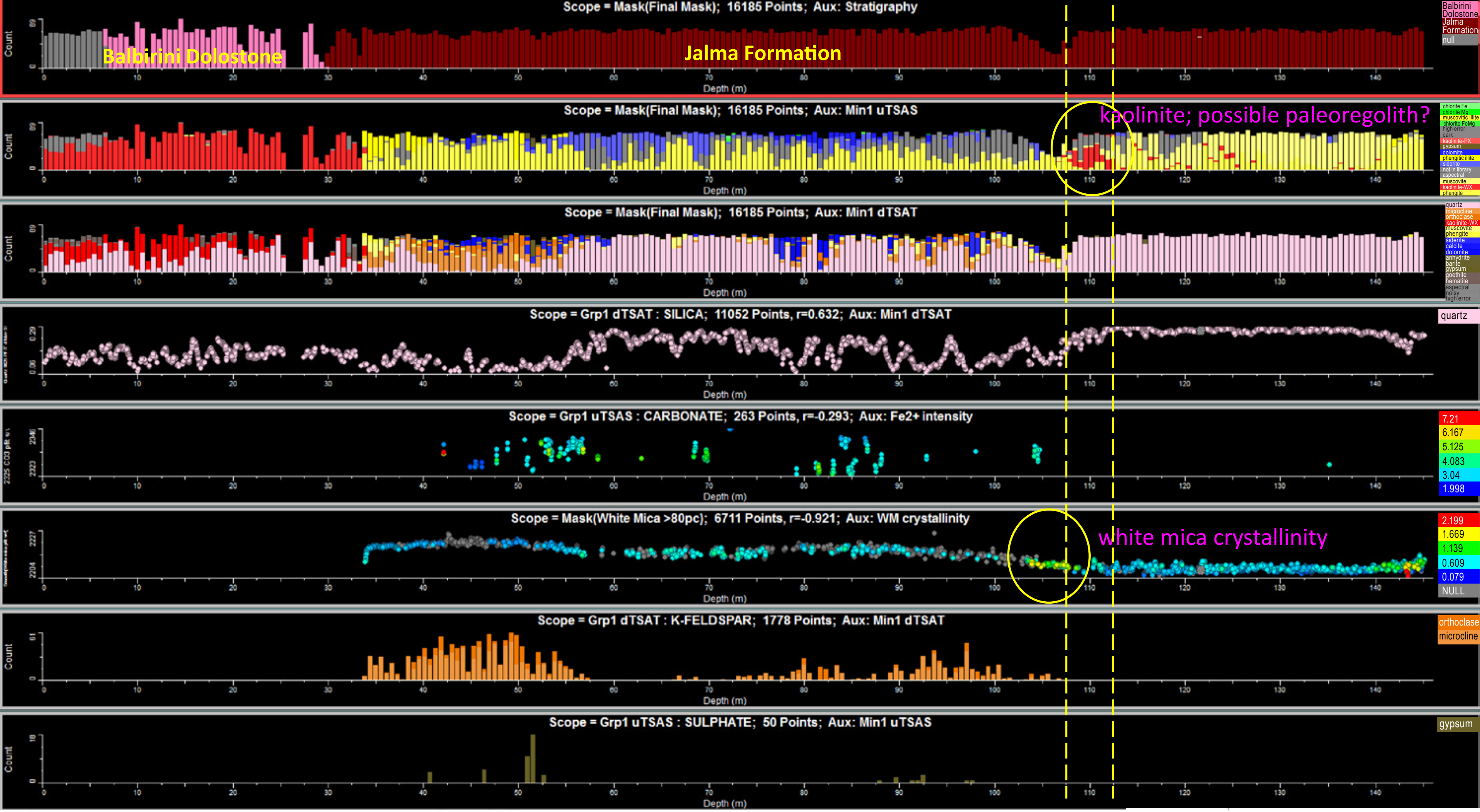
Map showing the location of the NTGS *Geophysics and Drilling Collaborations* drillholes (WD-series). Note that drillholes WD 2, WD 4 and WD 6 are collared in mapped Balbirini Dolostone. WD 7 is furthest west, and the upper part of the hole is different to the other WD-series holes.



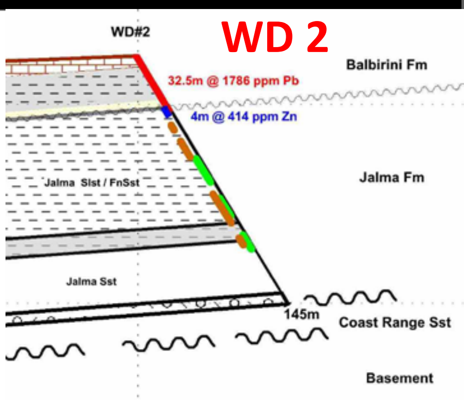


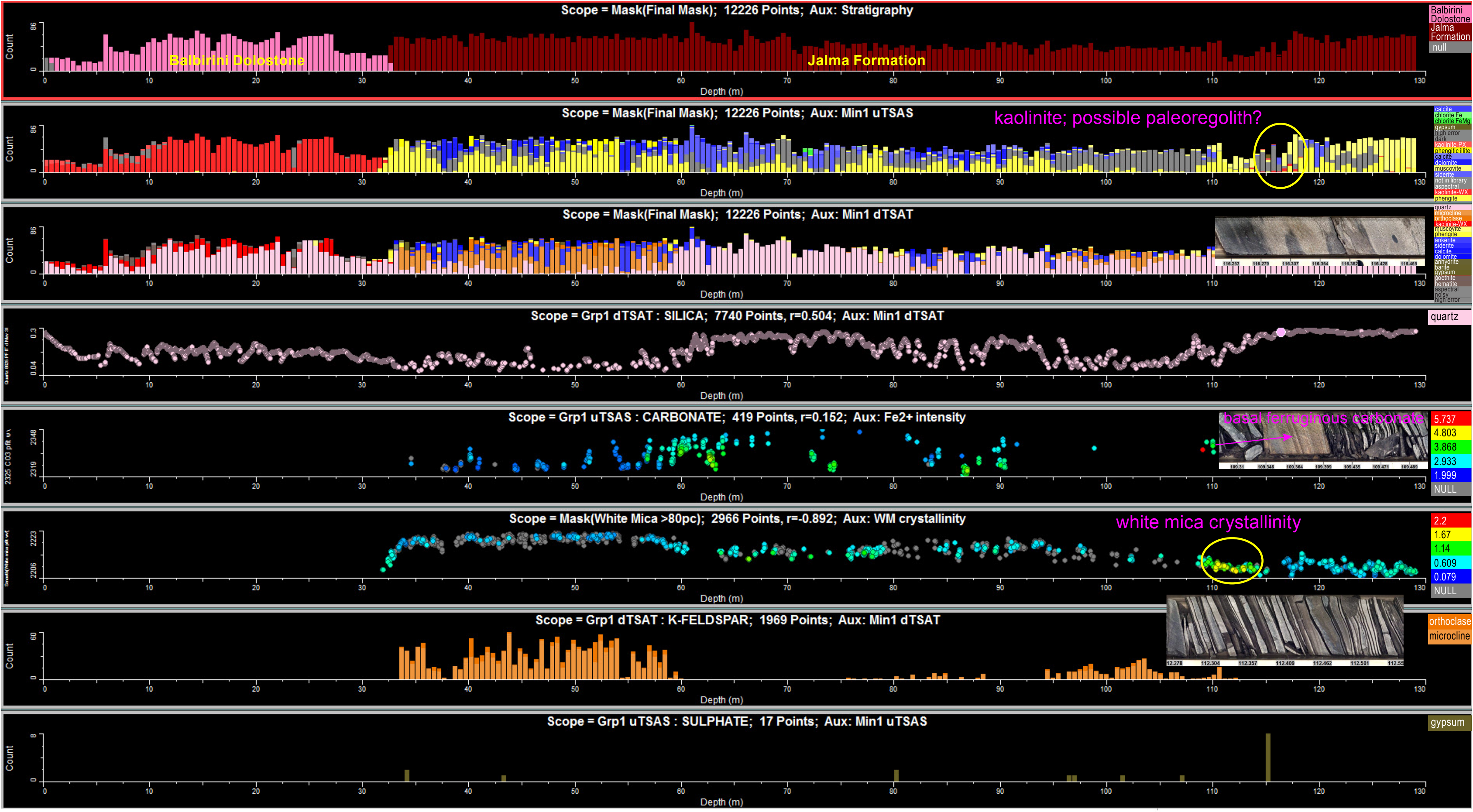
HyLogged results from WD 1, with stratigraphy taken from cross section (inset right; DPG Resources 2017). Dotted lines show zones of mineralogical change. Row 7 shows feldspars in 2 zones in the Jalma Formation, which roughly matches sulfates (row 8). Note the feldspars in the lower half of the basement (which corresponds with a drop in quartz abundance). Middle quartz zone (elevated quartz in row 4) also has Fe-rich carbonate (warmer colours in row 5). Logged Balbirini Dolostone contains no carbonate; the log noted anomalous mineralisation in gossanous material. The change in white mica crystallinity and wavelength correlates with logged stratigraphic changes. Based on quartz abundance (rows 3 and 4), the Coast Range Sandstone may continue at depth (to 177 m). The basement changes about 198.8 m, with a decrease in quartz and corresponding increase in K-feldspar.



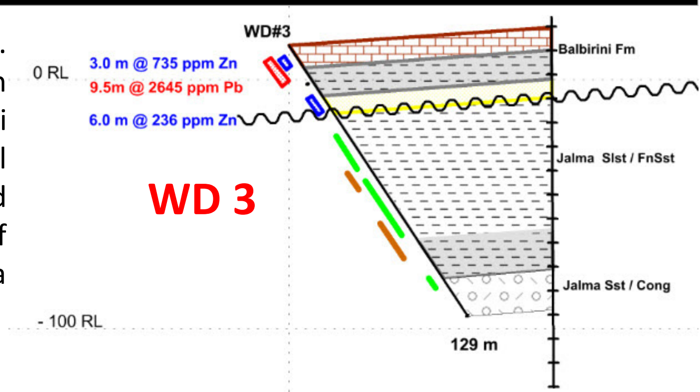


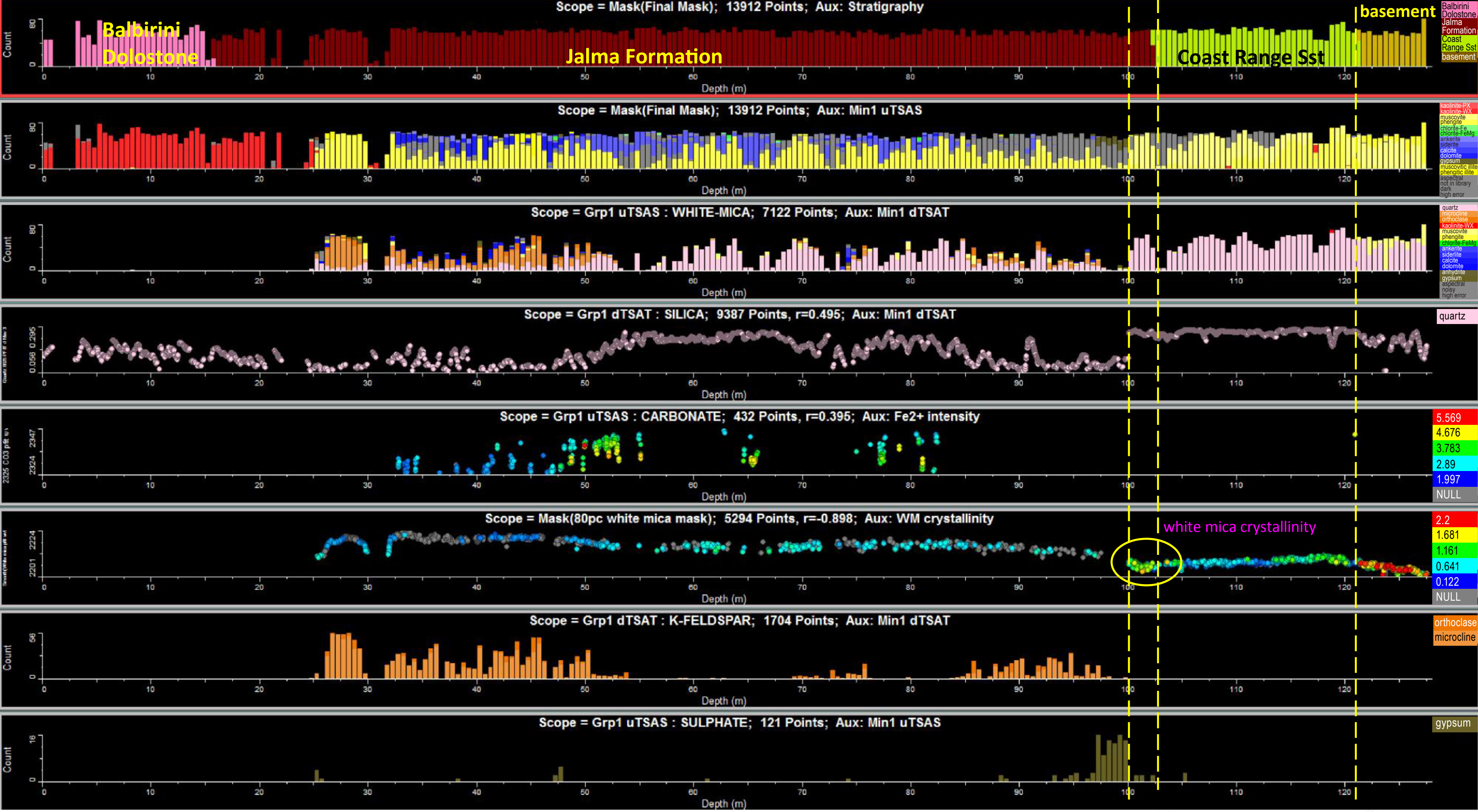
HyLogged results from WD 2, with cross section (inset right) from DPG Resources (2017). As with WD 1, there are feldspars in 2 zones (row 7) which roughly matches sporadic sulfates (row 8). Middle quartz zone also has Fe-rich carbonate (warm coloured dots, row 5) in Jalma Formation. There is less carbonate than in WD 1. Logged Balbirini Dolostone has no carbonate; the log noted anomalous mineralisation in gossanous material near top of hole. It comprises kaolinite with minor quartz, although this extends down into the logged Jalma Formation. Circled area is higher white mica crystallinity (row 6) in the zone at the base of feldspars. Zone below is uniform 2207nm white mica and quartz composition (row 6), which corresponds with uniform high quartz abundance (row 4). Note the kaolinite (circled; row 2) that precedes the high abundance quartz zone. In WD 1 this was identified as Coast Range Sandstone, and it is possible that this is also Coast Range Sandstone.



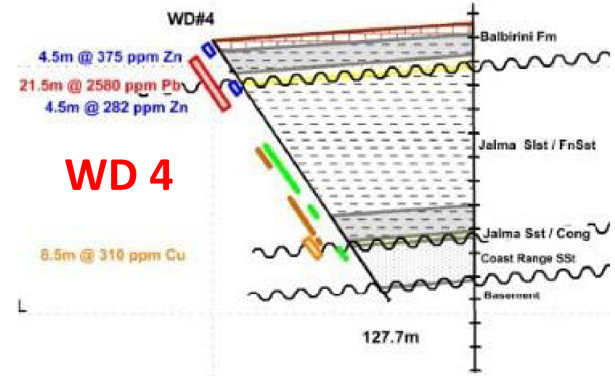


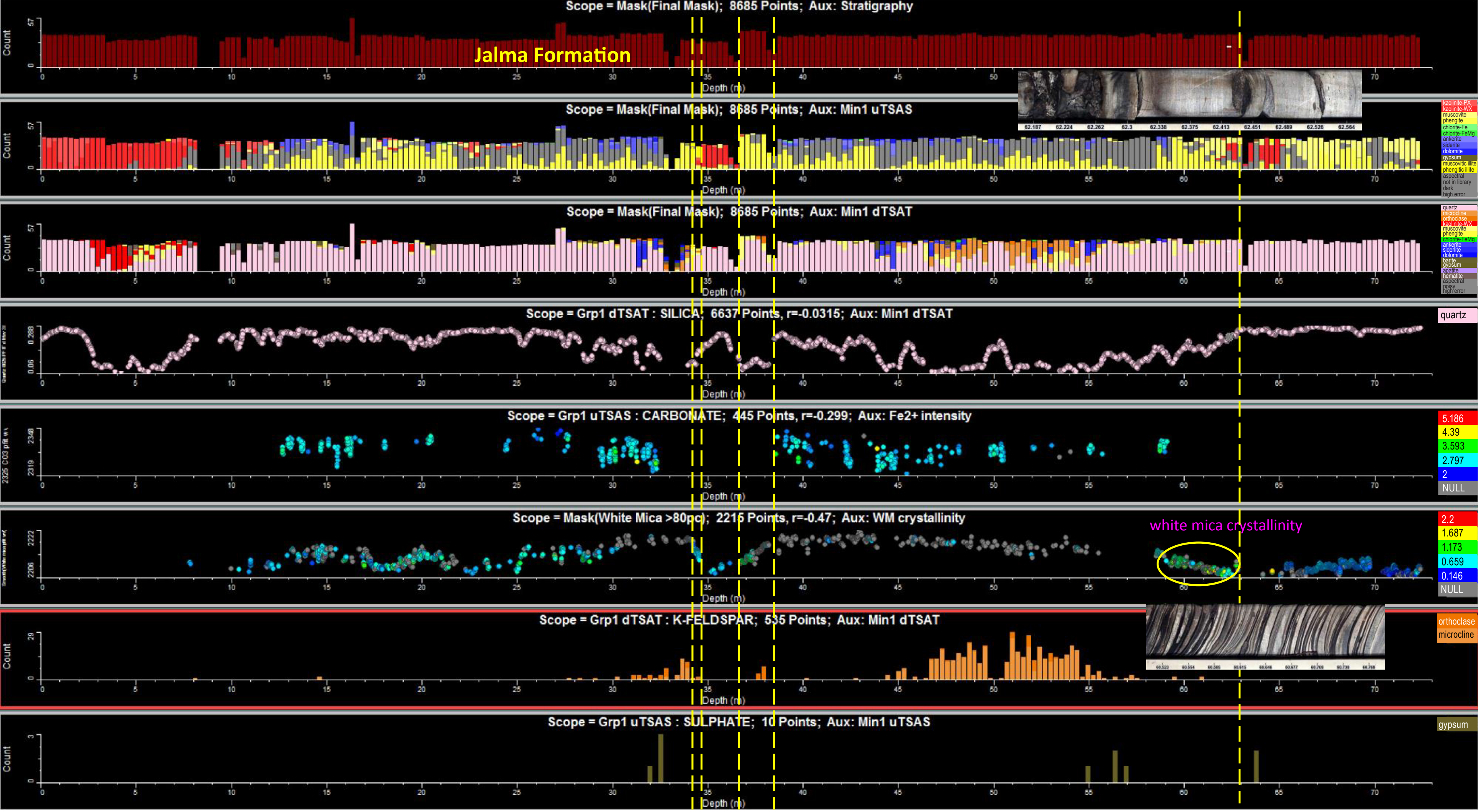
HyLogged results from **WD 3**, with section (inset right) taken from DPG Resources (2017). Feldspars in 2 zones; roughly matches sulfates. Middle quartz zone also has Fe-rich carbonate. More carbonate than WD 2, WD 3 but less than WD 1. Logged Balbarini Dolostone has no carbonate; the log noted anomalous mineralisation in gossanous material near top of hole. There is greater development of kaolinite in this hole. Well-developed hematite 4-13 m (row 2). Circled area is higher white mica crystallinity zone at base of feldspars. Zone below is white mica and quartz composition but unlike WD 2, the white mica ranges between 2207 and 2211nm. In WD 1 was this identified as Coast Range Sandstone?



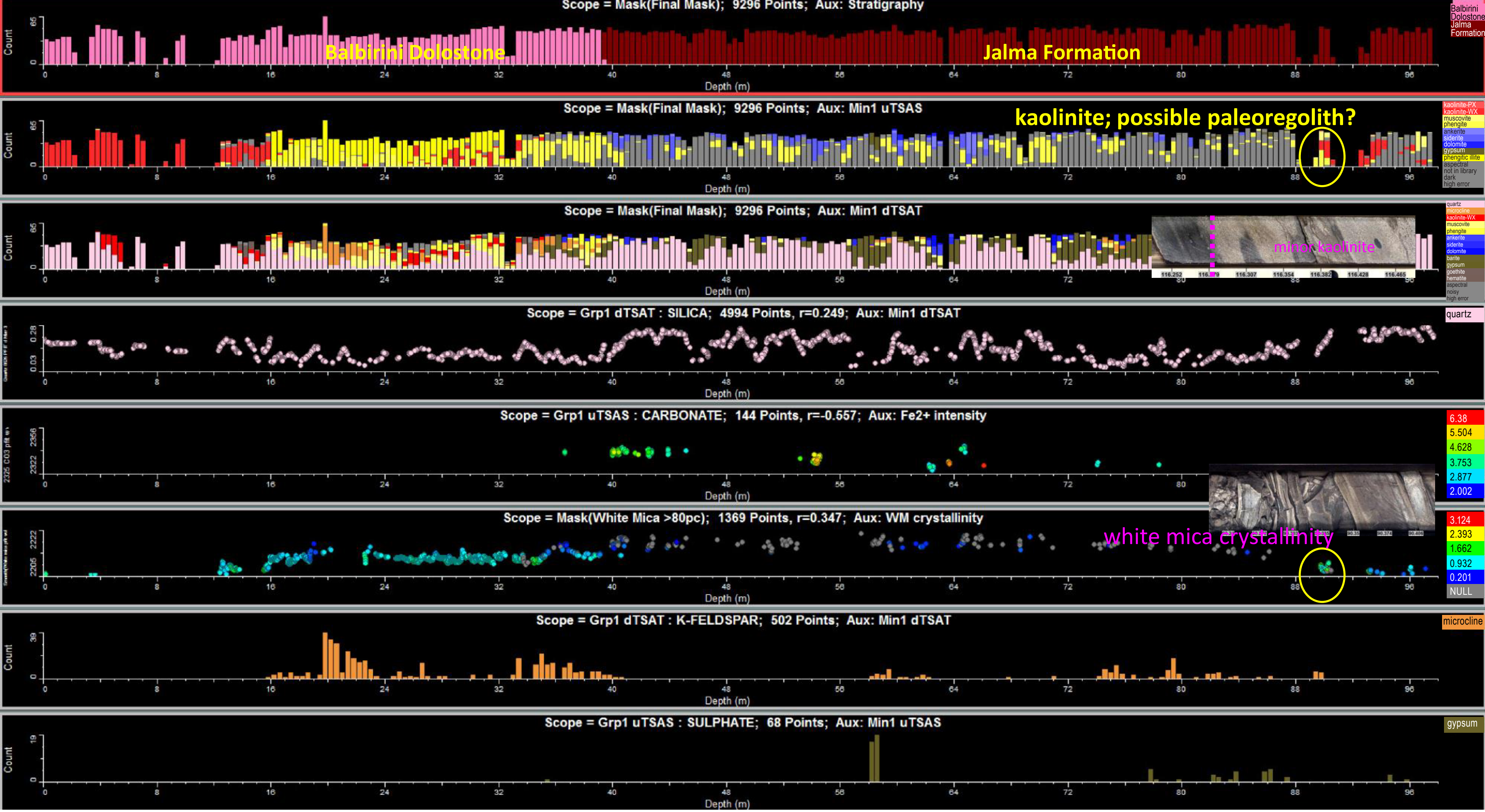


HyLogged results from **WD 4**, with section (inset right) taken from DPG Resources (2017). Feldspars in 2 zones; roughly matches sulfates. Middle quartz zone also has Fe-rich carbonate. Less carbonate than in WD 1. Logged Balbarini Dolostone has no carbonate; the log noted anomalous mineralisation in gossanous material near top of hole. Basal Jalma Formation contact is sharp (carbonaceous siltstone to grey sandstone) but would make the contact about 3 m higher than that logged. Difference in white mica crystallinity and wavelength (composition) matches basement/Coast Range Sandstone contact.

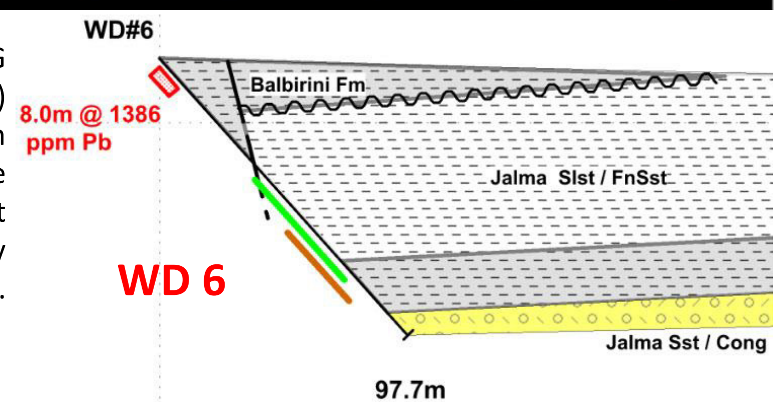


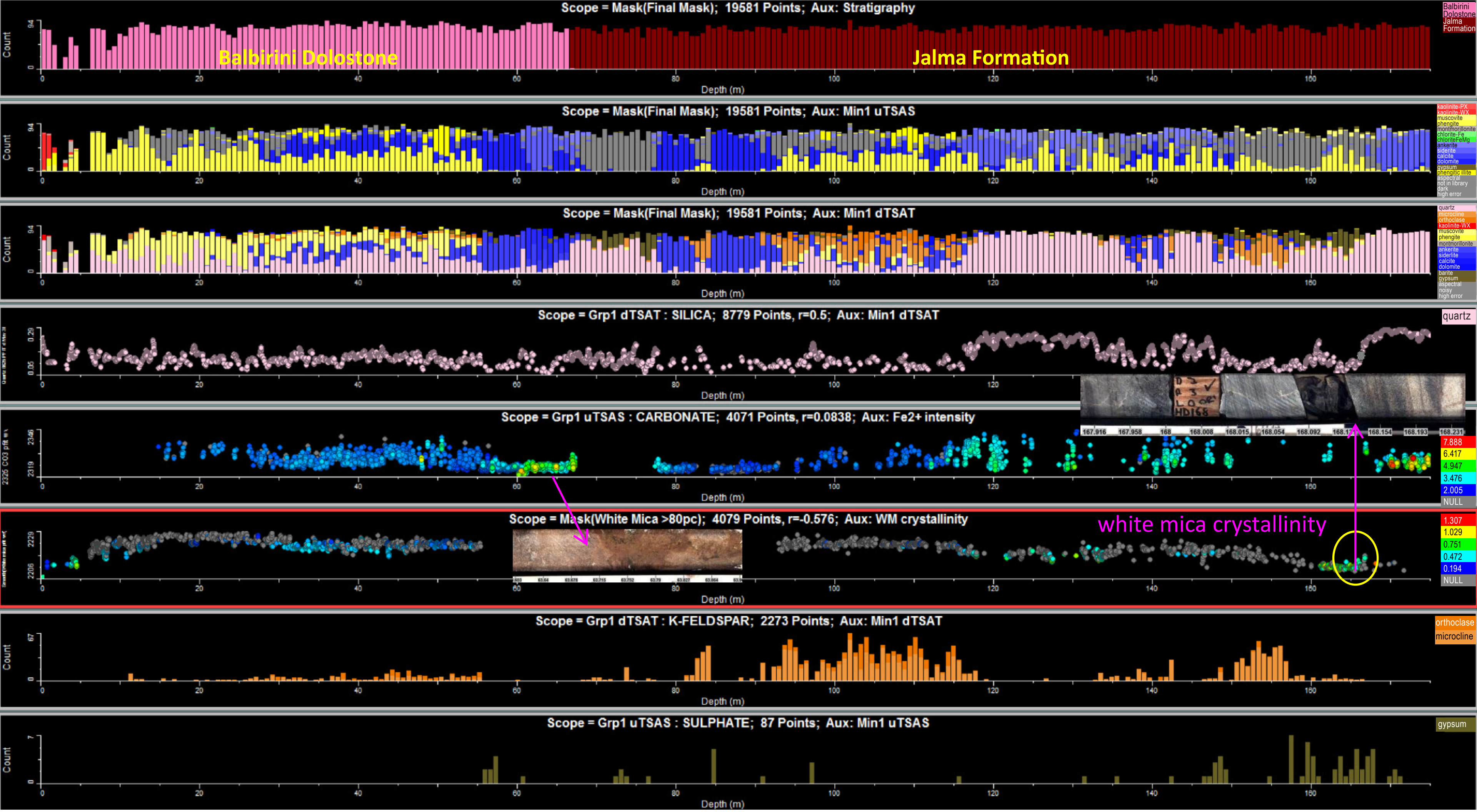


HyLogged results from **WD 5,** logged as being within the Jalma Formation from surface. There are feldspars in 2 zones; but less feldspar, gypsum than other holes. More variable middle zone; shows kaolinite and has clay zone (fault gouge?). Note also change in white mica composition and quartz abundance. This is possibly faulted and repeated lithology (?). There is another kaolinite zone (about 63 m), which is at the base of a higher white mica crystallinity zone. The inset at top shows change in lithology from siltstone to sandstone (which has trace kaolinite) with depth. The inset below is the white mica crystallinity zone; this is similar to WD 3.



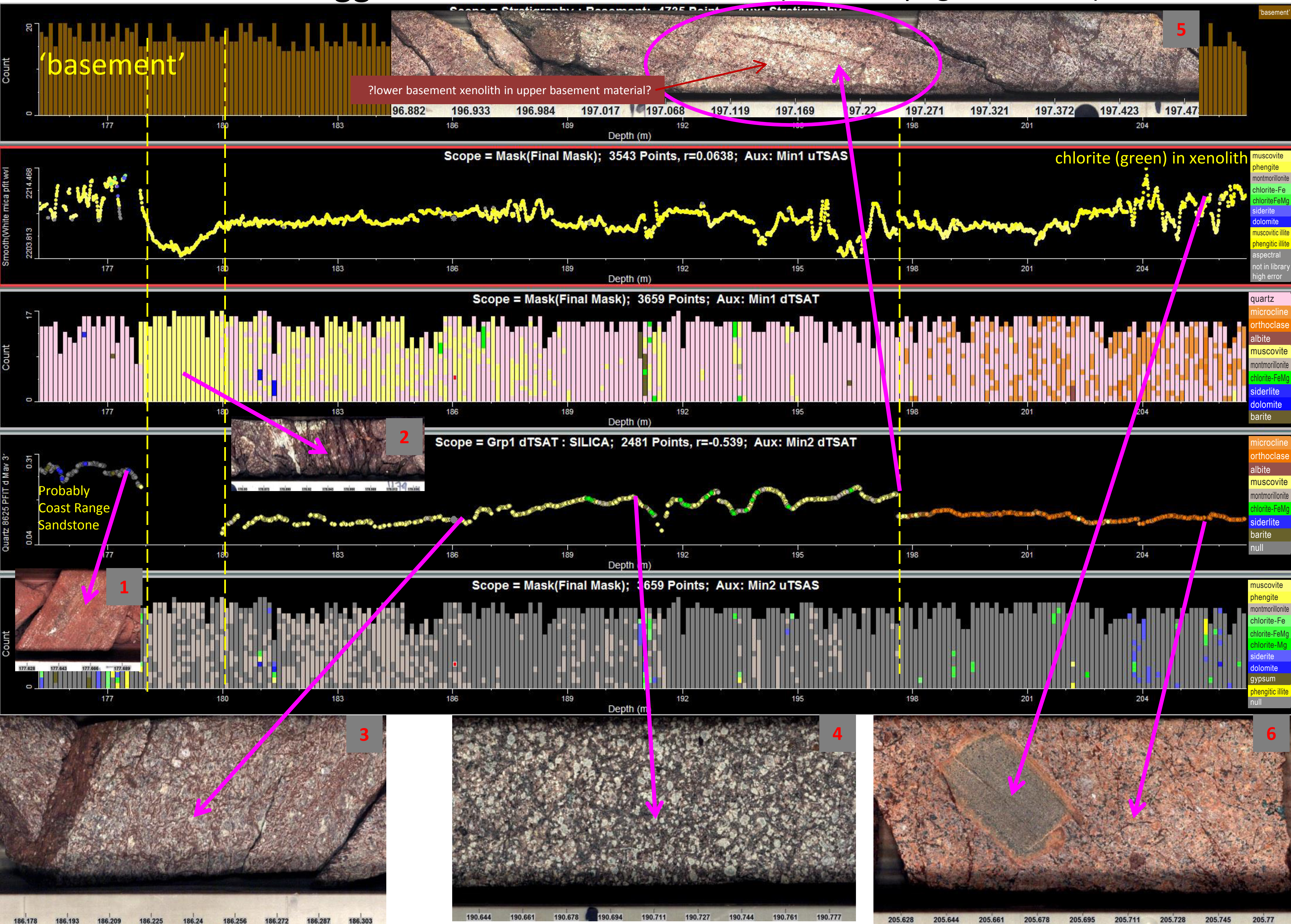
HyLogged results from **WD 6**, with cross section (inset right) taken from DPG Resources (2017). The increased Si alteration (green line on inset map, right) corresponds with increased silica (row 3) at the Balbirini Dolostone/Jalma Formation contact. However, the patterns of increased white mica crystallinity, kaolinite ?paleoregolith at about 90 m, with increased quartz content downhole is consistent with this being Coast Range Sandstone from 90 m to end of hole (EOH). There is very minor carbonate; feldspars are more sporadic but also scattered over a longer interval. Below 16 m is phengitic white mica and feldspars; this is above the carbonate zone.





HyLogged results from **WD 7,** with the top part of the hole (to about 55 m) having different lithology to that noted in other drillholes; it is mainly quartz and white mica > carbonate. There is a strong change to ferruginous carbonate at about 60 m (see inset, centre left). This is the only WD hole with carbonate in the logged Balbirini Dolostone. There is an increase in white mica crystallinity from 161-166 m (row 6; centre right inset image). There is an increase in quartz abundance at about 166 m (row 4). From 166 m to EOH, it is a dolomitic quartz sandstone. The mineralogy pattern of a crystalline white mica zone above a zone of increased quartz abundance would suggest the upper boundary of the Coast Range Sandstone (as noted in WD 4, for example). However, the quartzose sandstone has ferroan dolomite, rather than white mica as the minor (interstitial) component. WD 7 has more carbonate than the other drillholes. The sulfates do not correlate as well with the feldspars as observed in the other WD holes.

WD 1: Logged basement 175.2–EOH (see next page for notes)



WD 1 logged basement 175.2–EOH

The background graphs are enlarged to show logged basement (175.2–206.7 m) mineralogy only. Row 1 is logged basement (brown colour). Row 2 is the dominant SWIR mineral, plotted by the white mica wavelength (as most of the interval is dominantly white mica). White mica wavelength changes are analogous to white mica composition changes although this can be affected by other minerals (in a mineral mix) being present. Row 3 is the dominant TIR mineral. Row 4 shows the TIR spectra that match dominantly to quartz, plotted by a (smoothed) quartz abundance scalar (Quartz 8625PFIT dMav 31; see Guide to Scalars in HDPs). This is coloured by the second most dominant mineral (in a mineral match) in the TIR. Row 5 plots the second most common mineral (in a mineral match) from the SWIR. A NULL match means that there is only one mineral matched, which shows in Row 2. The dotted lines indicate where there are mineralogy changes. Inset images show the textures at the various depths.

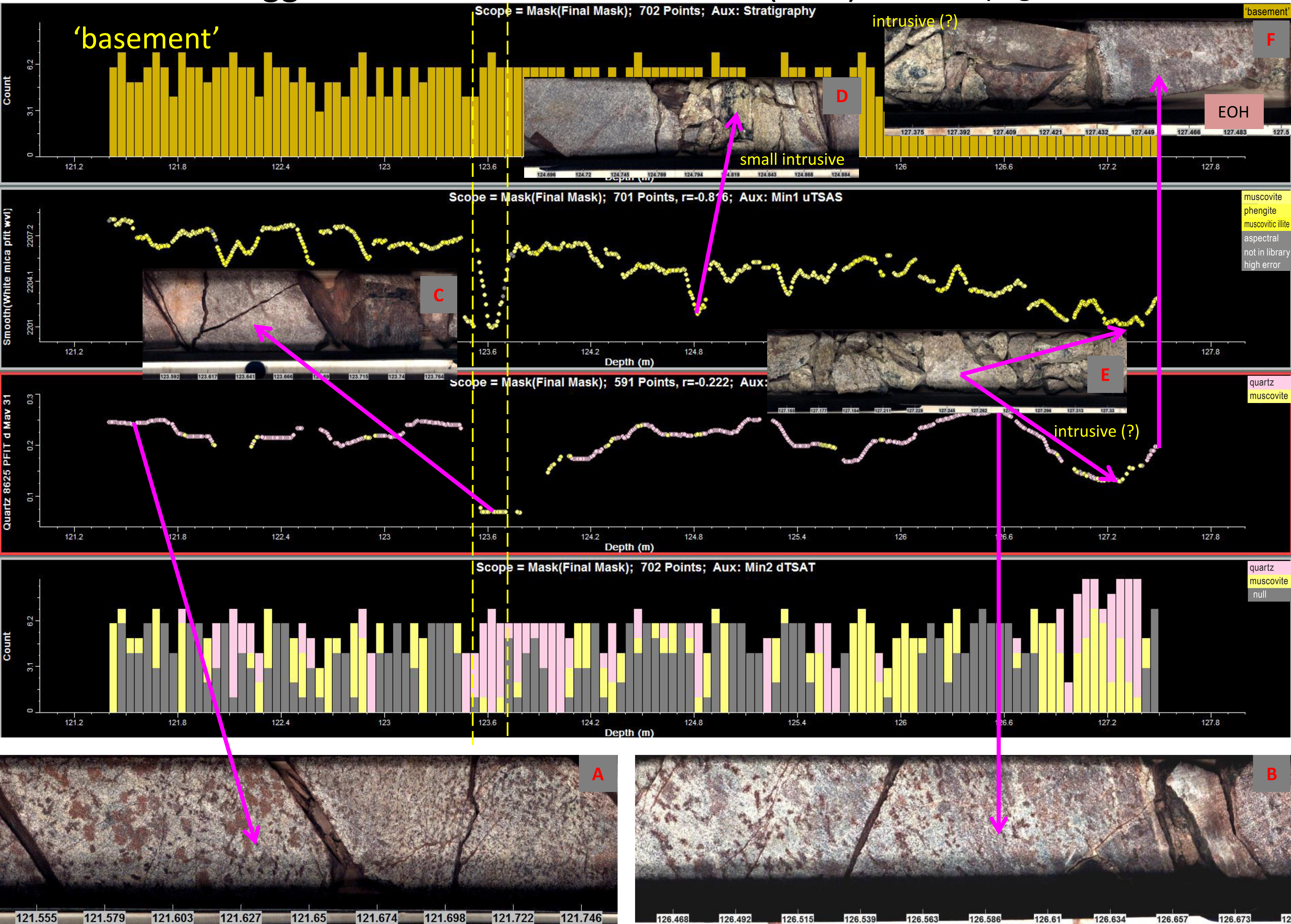
The first interval (175.2–177.9 m) is most likely to be weathered Coast Range Sandstone. It is a ferruginous friable material with a high quartz content (inset image 1).

The second interval (177.9–180 m) has little or no quartz; it is dominantly white mica, with some smectites. The white mica is a different composition, possibly more Al-rich? The imagery (inset image 2) shows some sort of foliation in rubbly core. This may be a fault zone where quartz has been leached and there is only white mica?

The third interval (180–197.5 m) shows increasing quartz with depth but with some variable white mica composition changes from about 191–197.5 m. This ‘upper basement’ (inset image 3) has a different texture to the ‘lower basement’ (inset image 4). There is a sharp mineralogy change at 197.5 m: the quartz abundance drops; there is a local white mica composition change, and this marks the zone where feldspar starts to become more common. The inset image (5) shows what may be a ‘lower basement’ xenolith in the ‘upper basement’ material (?) There is a mineralogy difference between this ‘upper basement’ (180–197.5 m) and ‘lower basement’ (197.5–EOH at 206.7 m).

The ‘lower basement’ has the occasional xenolith (see inset image 6). This is consistent with what has been observed in outcrop (Whelan *et al* 2017). The K-feldspar is pervasive; it might be potassic alteration (?)

WD 4: Logged basement 121.3–127.5 m (EOH) see next page for notes



WD 4 logged basement 121.3–127.5 m (EOH)

The background graphs are enlarged to show logged basement (121.3–127.5 m) mineralogy only. Note this interval is only 6.2 m long (compared with WD 1, which has a logged basement of 31.5 m).

Row 1 is logged basement (mustard colour). Row 2 is the dominant SWIR mineral, plotted by the white mica wavelength (as most of the interval is dominantly white mica). White mica wavelength changes are analogous to white mica composition changes, although this can be affected by other minerals (in a mineral mix) being present. Row 3 shows the TIR spectra plotted by a (smoothed) quartz abundance scalar (Quartz 8625PFIT dMav 31; see Guide to Scalars in HDPs). This is coloured by the most dominant mineral (in a mineral match) in the TIR (which is mainly quartz). Row 4 plots the second most common mineral (in a mineral match) from the TIR. A NULL match means that there is only one mineral matched, which shows in Row 3. The dotted lines indicate where there are mineralogy changes. Inset images show the textures at the various depths.

As with WD 1, the dominant mineralogy is quartz and white mica. Note that there is no feldspar; compare this with the basement intersected in WD 1. Also note the differences in textures in WD 4 (inset images A, B and F; page 14) with WD 1 (inset images 1-6; page 12).

WD 4 has zones of decreased quartz and increased white mica. The first zone is a competent rock at 123.6 m (see inset image C). This is possibly a small intrusive, although it is texturally different from intrusives intersected at 124.8 m and 127.3 m (inset images D, E and left side of F).

Walker Gossan – concluding comments

Balbirini Dolostone: Haines *et al* (1999) noted that outcrops of Balbirini Dolostone are silicified (white to grey chert), commonly displaying relict textures after shallow water carbonates, with scattered interbedded sandstone. Ferruginisation is common. Holes WD 2, WD 4 and WD 6 were collared in mapped outcrops of Balbirini Dolostone. Except in WD 6 and WD 7, the logged Balbirini Dolostone contains no carbonate. Primary sedimentary textures are difficult to determine from the imagery as much of the unit is gossanous or kaolinised. The dominant mineralogy is kaolinite, quartz, goethite, and hematite. There is localised liesegang banding (WD 4). In WD 6, all of the hole is logged as Balbirini Dolostone. The mineralogy indicates similarities to other WD holes logged as Jalma Formation. WD 7 has increasing carbonate to the base of the logged Balbirini Dolostone. Based on the mineralogy and the collar positions of the drillholes, it is possible that WD 7 is the only drillhole that intersected Balbirini Dolostone. Further work examining the textures of the logged intercepts is recommended.

Jalma Formation: DPG Resources (2017) describe the Jalma Formation as 'sandstone, mudstone and minor carbonate with a basal pebble conglomerate'. The local outcrops are described as 'ridges of ferruginous sandstone, interbedded with silicified and leached carbonate and ooidal ironstone'. There is a symmetrical distribution of feldspar and sulfates (gypsum) in most of the WD holes logged as Jalma Formation. There is an upper and lower zone of feldspar-gypsum-quartz-white mica (possibly phengitic white mica) with a middle zone of silicified ferroan carbonate. Does this repeated mineralogical distribution represent a large-scale fold? Or possible sedimentary cyclicity?

Coast Range Sandstone: An increase in quartz abundance characterises the Coast Range Sandstone in WD 1 and WD 4. The SWIR is almost exclusively white mica, with a wavelength range between 2207–2210 nm (muscovite). Just above the upper contact of the Coast Range Sandstone, there is an increase in the white mica crystallinity (at the base of the logged Jalma Formation). Using these mineralogy changes, it seems that WD 2 may have intersected Coast Range Sandstone at about 108 m. This depth also has significant kaolinite at the top of the interval: is this a paleoregolith for the Coast Range Sandstone? Other holes which may have intersected the Coast Range Sandstone include WD 3 (114 m), WD 5 (62.7 m), and WD 6 (97 m?).

Basement: the logged basement in WD 4 is texturally different to that in WD 1. The overall mineralogy in WD 4 is quite consistent (quartz, white mica) with some variations in white mica composition and quartz abundance. In comparison, WD 1 has feldspars at the base of the hole.

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