Appendix C:
Geology and Field Characterisation

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C1. Introduction

This appendix provides details of the site geology and subsurface investigations undertaken on behalf of the ITRB and other parties in the vicinity of the NTSF embankment failure.

C2. Site Geology

C2.1 Stratigraphy

The geology of the Cadia region is shown on Figure C2-1. This map is based on published Geological Survey of New South Wales maps supplemented by Newcrest geological mapping.

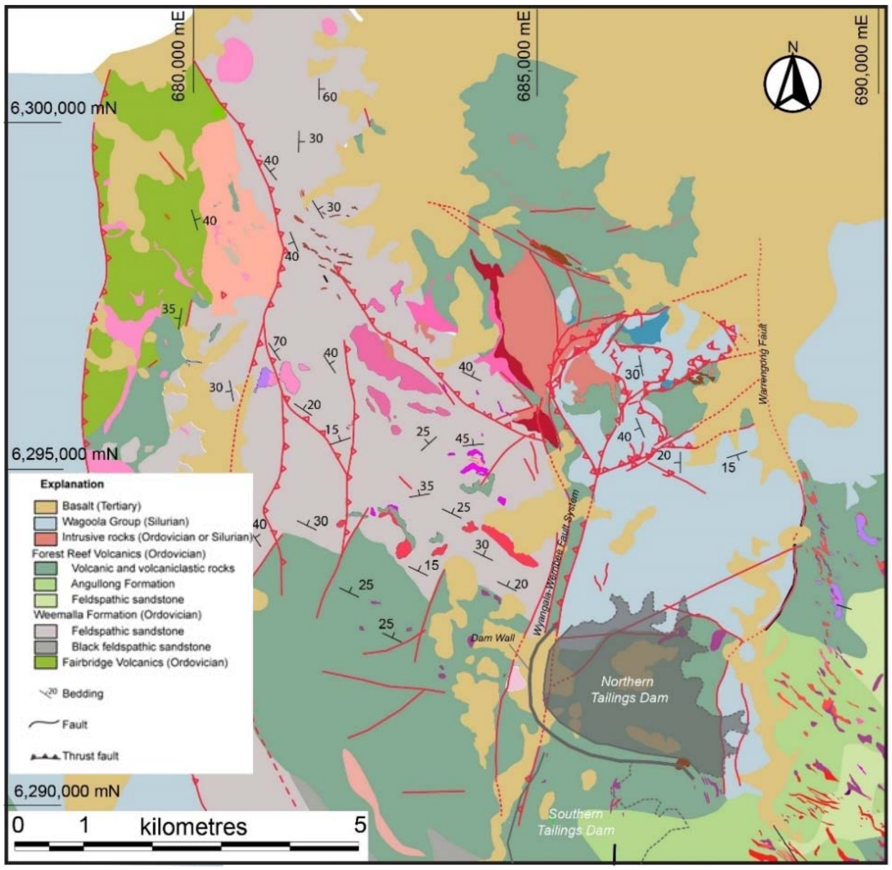


Figure C2-1: Cadia regional geology

Basement rocks in the vicinity of the tailings storage facilities are Ordovician rocks of the central Lachlan Fold Belt. The oldest rocks in the project area are the Ordovician rocks of the Carbonne Group which include the Weemalla Formation and Forest Reef Volcanics. To the north these strata are unconformably overlain by sedimentary rocks of the Silurian Waugoola Group (Harris, et al., 2014).

The youngest rocks in the region are the Tertiary basalts of the Canobolas Volcanic Complex. These obscure large areas to the north of the CVO, while remnants outcrop along elevated ridge lines in the project area.

Formations outcropping in the immediate vicinity of the tailings storage facilities are described in the following sections.

C2.1.1 Weemalla Formation

In the Cadia District the minimum observed thickness of the Weemalla Formation is between 1300 m and 3500 m thick and comprises laminated siltstone and lesser siliceous siltstone, mudstone and feldspathic sandstone (Harris, et al., 2014). The basal section of the Weemalla Formation includes ~500 m of pillow basalts, while the upper contact is gradational with and inter-fingers with the Forest Reef Volcanics and is marked by a progression to felspathic sandstone and volcanically derived conglomerate.

The fine grained and well sorted nature of the Weemalla Formation and presence of abundant volcanic detritus is consistent with deposition in deep low relief, marine sedimentary basin on the flank of an eroding volcanic arc.

Although the regional contact between the Weemalla Formation and overlying Forest Reef Volcanics is gradational, the contact in the vicinity of the NTSF is faulted, with the Weemalla Formation lying to the west of the NTSF

C2.1.2 Forest Reef Volcanics

The Forest Reef Volcanics (FRV) is the dominant rock type in the vicinity of the NTSF and STSF. The FRV comprise a thick (2.5 km) sequence of mafic to intermediate volcanic derived sedimentary breccias and lesser sandstones intercalated with basaltic andesite and andesitic lavas. Deposition of the FRV spanned the Late Ordovician to Early Silurian.

Volcanic eruptions appear to have occurred from a low relief, submarine volcanic complex with multiple vents, producing thickly stacked lava sequences. Explosive volcanism occurred during the later stages of the FRV resulting in ash fall deposits in a shallow water environment.

Petrographic analysis of rocks undertaken as part of the ITRB investigations indicates that the FRV are comprised of altered andesite and pyroxene andesites that were potentially extruded into shallow water.

C2.1.3 Waugoola Group

The Silurian Waugooloa Group lies to the north and east of the NTSF, of which the gently dipping Cadia Coach Shale is the dominant Formation in the NTSF environs. The Cadia Coach Shale consists of feldspathic siltstone, mudstone, poorly sorted sandstone and limestone (2000-003), characteristic of deposition in a deep, low energy environment. A sandstone unit at the top of the Cadia Coach Shale may reflect a shallowing depositional environment.

The Cadia Coach Shale was intersected in the north western foundation area of the NTSF. In BH108, material identified as Silurian sediments was extremely weathered to in excess of 20m depth.

C2.1.4 Tertiary Basalt

Tertiary basalt crops out along elevated ridgelines adjacent to both the NTSF and STSF. The basalts are typically olivine basalt and are part of the now dissected Canobolas Volcanic Complex. The basalts are up to 80m thick at Cadia East and comprise at least six separate flows (Wilson, 2003). Potassium-Argon dating of the Canobolas Basalt (Gibson, 2007) provides a Middle Miocene age of 12.7 to 11.2 Ma.

The basalts were extruded over a paleo terrain and initial flows would have been along paleo drainage channels which now occupy the thickest accumulations of basalt. The paleo terrain over which the basalts were extruded could be expected to be similar to the current terrain and include both alluvial and residual soils developed over older basement rocks.

C2.1.5 Paleosoils

Paleosoils are soils developed under a past geological environment preserved by overlying materials. At Cadia basalts overlie paleosoils comprising alluvium and residual soils developed over both the Forest Reef Volcanics and Weemalla Formation.

In the context of this report, paleo residual soils are included as part of the residual profile of their respective formations while alluvial paleosoils are referred to as paleo alluvium.

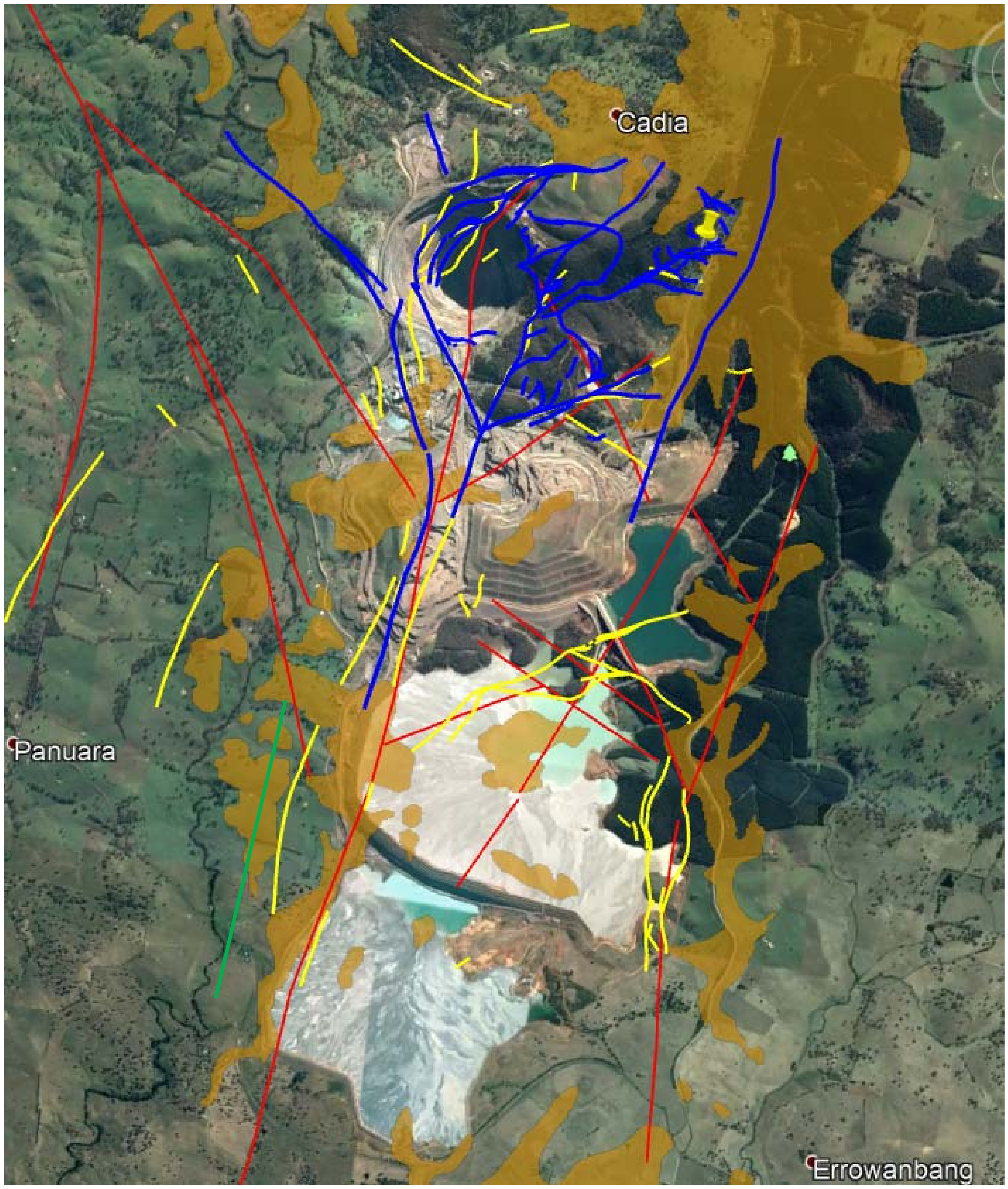
Poorly preserved organic matter (root?), observed within the paleo alluvium, places the paleo alluvium at an age much younger than the residual soils developed over the Silurian / Ordovician bedrock strata. Although dating of the paleo alluvium using palynology (Annexure CH) was inconclusive, the paleo alluvium most likely belongs to the early Miocene Epoch (23.3 to 16.3 Ma).

C2.2 Geological Structure

The most prominent fault in the vicinity of the TSF is the roughly north-south striking Wyangala-Werribee Thrust Fault system also known as the Werribee – Cadiangullong Fault Zone (Wilson, 2003). The faults are located to the west of Rodds Creek and traverse the western side of both the NTSF and STSF. The faults extend over 30km and appear as a series of two or three parallel westward dipping thrust faults.

To the south of the STSF, the position of the Werribee – Cadiangullong Fault Zone has been confirmed by geological mapping, while in the vicinity of the NTSF where it is overlain by basalt, it has been largely inferred from early (1997) aeromagnetic surveys.

North of the NTSF, detailed mapping completed for the Cadia East and Cadia Hill areas in 2007, places the Werribee – Cadiangullong Fault Zone to the west of its original position as shown in Figure C2-2. This latter position is consistent with the position of a major fault zone intersection in drillholes CE380 and CE396 which is shown in green on Figure C2-2 and discussed more fully in Section C9.1.



LEGEND

green line	2018 location based on drilling
blue line	2007 surface mapping (ground tested).
yellow line	2000 surface mapping (ground tested).
red line	1997 aeromagnetic mapping
brown box	Basalt

Figure C2-2: Cadia fault architecture showing historical development

C3. Previous Investigations

C3.1 Foundation Investigations

Previous investigations undertaken at the NTSF are detailed in Appendix B.

Foundation investigations completed in the vicinity of the NTSF and STSF are summarised in Table C3-1.

Table C3-1: Summary of previous foundation investigations

Year	Consultant	Drillholes	Test Pits	Comments
1995	WC	9	64	NTSF Foundations & Storage
1997	PSM	10	23	NTSF Foundations & Storage
1997	PSM	-	31	NTSF Stage 1 Core Trench
2000	WC	7	41	STSF Foundations & Storage
2017	ATCW	-	9	Buttress Foundations
2018	ATCW	5	-	NTSF & STSF Clay Foundations

Notes:

PSM Pells Sullivan & Meynink
WC Woodward Clyde
ATCW ATC Williams

The locations of previous investigations in the vicinity of the NTSF are shown on Figure C3 (Annexure CA). Table C3-2 provides a summary of the drillholes located in the vicinity of the NTSF embankment failure, while geotechnical logs of these drillholes (reproduced in gINT format) are included in Annexure CK.

Table C3-2: Summary of drillhole information

Hole ID	Embankment Chainage	By	Total Depth (m)	Soil (m)	Basalt (m)	Paleo Alluvium (m)	Forest Reef Volcanics	Sedimentary Strata
BH107	1470	PSM	20.0	5.2	0.9	1.8		12.0
BH106	1750	PSM	15.8	4.3	7.9	1.9	1.7	
BH020	1950	WC	15.0	1.0	14.0 (1)			
BH101	2090	PSM	20.6	3.3			17.3	
BH102	2330	PSM	14.8	2.6			12.3	
BH017	2480	WC	32.2	5.0			27.2	
BH103	2690	PSM	21.3	2.9			18.4	

Notes:

(1) Although basalt was recorded for the full depth of this hole it is considered that this hole was either incorrectly located or incorrectly logged, in which case it is most likely Forest Reef Volcanics.

C3.2 Tailings Investigations

C3.2.1 CPT 2004

Prior to the Stage 3 design URS completed three cone penetration tests (CPT) to a maximum depth of 16 m. The tests were supplemented by hand vane shear tests. The aim of the tailings investigation was to provide a tailings strength profile for use in the stability analyses of Stage 3-6 upstream raises.

The location of these tests are not known and data is in hard copy format only.

C3.2.2 CPTu 2013

In 2013 URS commissioned CPTS of Brisbane to complete penetration tests with pore pressure measurement (CPTu) at three locations where fingers were constructed onto the tailings surface. The locations of the CPTu are shown on Figure E1 (Appendix E, Annexure EA), while a summary of the type and number of tests is provided in Table C3-3.

Two CPTu were completed at each location, with the second mostly being used to conduct pore water pressure dissipation tests (PWPD) at specified depths. At the time, the CPTu data was used to assess the liquefaction potential of the tailings.

Table C3-3: Summary of 2013 Tailings Investigation

Investigation Type	Test Location					
	N1/1	N1/2	N2/1	N2/2	N3/1	N3/2
CPTu Depth (m)	31.5	27.9	39.5	39.5	39.5	39.5
CPTu Dissipation Tests	-	4	2	1	-	3

Cone data was provided in an un-corrected format. Interpreted CPTu profiles are provided in Appendix E.

Specific details of the cone used for the 2013 CPT testing is:

Manufacturer: AP van den Berg

Type: Compression Cone – 100 MPa / 10 cm^2

Pore Pressure: 2,000 kPa

Area Ratio: 0.75

C3.2.3 Thickener Sample Testing 2016

In 2016 CVO commissioned Golder Associates to conduct a suite of laboratory tests on samples taken from the thickener underflow. Tests completed included index, settling, consolidation and triaxial tests. The results of these tests are reported in Appendix E.

C3.2.4 CPTu 2017

As part of the Stage 10 design ATC Williams (ATCW) completed eleven CPTu tests with dissipation testing, vane shear testing and seismic shear wave testing as well as disturbed and undisturbed sampling. Piezometers were also installed in some CPTu locations as part of this work. Field testing and sampling was undertaken in January and February 2017 and subcontracted to IGS of Brisbane.

Seven CPTu tests were carried out approximately 25 m upstream of the Stage 9 embankment, one CPTu was carried out approximately 45 m upstream of the Stage 9 embankment and three tests were carried out through the Stage 5 embankment crest. At the latter locations, holes were pre-drilled through the Stage 5 and 4 embankments

Investigation locations are shown on Figure E1 (Appendix E, Annexure EA), whilst a summary of the type and number of field tests is provided in Table C3-4. Interpreted CPTu profiles are provided in Appendix E.

Table C3-4: Summary of 2017 NTSF Tailings Investigation

Investigation Type	Test Location (Prefixed by N)										
	01	02	02A	03	04	05	06	07	08A	09	10
Stage 9 Fingers	✓	✓	✓	✓	✓	✓	✓	✓			
Stage 5 Crest									✓	✓	✓
CPTu Depth (m)	38.4	39.4	15.0	51.6	58.7	65.5	51.8	28.6	24.4	25.0	23.6
CPTu Dissipation Tests	2	2	1	3	4	4	3	2	2	-	1
Shear Wave Velocity Depth (m)	36	38		48	57	63	45	27			
Vane Shear Tests	5				4			6			
Undisturbed Samples (63mm)	1			2	2	2		4			
Piezometer Depth (m)	10	10		10	16	16	16	16			

Cone data was provided in both un-corrected and corrected format. Re-interpreted CPTu profiles are provided in Appendix E.

Specific details of the cone used for the 2017 CPT testing are provided below. Pre and post calibration certificates were provided for the cone:

Manufacturer: Geomill

Type: Subtraction Cone – 100MPa / 15 cm^2

Pore Pressure: 3,500 kPa

Area Ratio: 0.621

CPT were undertaken using a 'subtraction cone' rather than the more accurate 'compression cone' which could potentially affect the accuracy of the friction measurements. This introduces some uncertainty when using this data with standard CPT evaluation charts as friction is an input for assessing soil behaviour.

Vane shear testing was carried out adjacent to three of the CPTu, and recorded both peak undrained strength and the residual undrained strength after large deformations. Tests were undertaken using either a 50 x 100 mm or 75 x 150 mm vane and a constant rotation of 12 degrees / min. These were used to provide a correlation between cone resistance and undrained shear strength.

An unusual and important aspect of this investigation was recovery of undisturbed tailings using a piston-pneumatic-injection (PPI) sampler, with subsequent careful sample handling and density measurement. Disturbed tailings samples were recovered using a Vertek Sampler.

Shear wave velocity measurements were made separately to the CPTu using a seismic dilatometer (SDMT) with a sensor spacing of 0.5m.

A suite of laboratory tests was undertaken on the samples including soil moisture content, Atterberg Limits, specific gravity, bulk density, particle size distribution and triaxial shear testing.

C3.3 Construction Materials Investigations

A number of investigations were completed around the NTSF to identify suitable clay for low permeability sections of the embankments. These investigations identified materials ranging from high plasticity residual basaltic and andesitic clays to low plasticity Tertiary and Quaternary sandy clays, all of which were considered appropriate for use in the TSF.

The source of the Zone A material was indicated as the excavation beneath the downstream shoulder of the dam and borrow areas within 2 km of the embankment.

Two rounds of laboratory tests were conducted on the clayey soils before construction. The first was by Woodward-Clyde as part of the Feasibility Study (1995-001) and the second by Pells Sullivan Meynink (1997-001) as part of a supplementary site investigation for detailed design.

The samples taken by Pells Sullivan Meynink were combined to create bulk samples as follows;

- TP100 to TP104 - upper right abutment, above RL705 m
- TP105 to TP107 - plateau area on right abutment at ~ RL 705 m
- TP108 to TP112 - central right abutment
- TP113 to TP115 - lower right abutment, below about RL686 m
- TP118 to TP121 - left abutment (all residual andesite)

Triaxial shear strength tests were completed on four remoulded samples from the NTSF. These included TS12, TS6 and TD38 from the Woodward Clyde investigations and TP100 to TP107 from the PSM investigations.

Subsequent to the initial construction of the NTSF, triaxial tests were completed on samples from TP4, TP6 and TP26 as part of the 2000 STSF investigation. These tests were incorporated into the database of tests for the NTSF construction materials. The results of the triaxial tests on all construction materials are included in Appendix D.

C4. Current Investigations

C4.1 Overview

C4.1.1 Objectives

Following the ITRB site visit in April 2018, Hatch prepared a Scope of Works (SOW) for Geotechnical Field Investigations in the vicinity of the NTSF embankment failure. The SOW was endorsed by the ITRB and was subsequently executed by Hatch.

The subsurface Investigations endorsed by the ITRB had a number of objectives. These included:

- Obtaining representative samples of tailings from both upstream of the NTSF failure and within the slump for advanced laboratory testing;
- Confirming the geological model for the foundations, in particular the distribution of Tertiary basalt and presence of paleosoils beneath the basalt;
- Assessing the hydraulic gradient within the foundation bedrock, in particular the Tertiary basalt;
- Obtaining undisturbed samples of foundation soils for advanced laboratory testing to determine their strength and deformation parameters;
- Obtaining undisturbed samples of the embankment clay core for advanced laboratory testing to determine their strength and deformation parameters; and
- Identifying the depth of tailings and potential embankment remnants in the NTSF failure zone.

C4.1.2 ITRB Investigations

Subsurface investigation undertaken on behalf of the ITRB spanned between May 5, 2018 and September 11, 2018, and included a range of geotechnical investigation methods, including; drilling, hand auguring, test pitting, and geophysics. With the exception of geophysical investigations, investigations were undertaken under the direction of Hatch.

Over the course of the investigations, the SOW was amended and included some additional drillholes, as the risks associated with working in the vicinity of the slump became better understood and were able to be more effectively managed.

The investigations completed on behalf of the ITRB consisted of the following:

- Four test pits with undisturbed block sampling;
- One hand auger hole and one hand sample;
- Fourteen sonic drillholes with a total depth of 618 m;
- VWP installation in ten drillholes, and
- Electrical Resistivity Imaging (ERI) traverse, total length 650 m.

With the exception of one test pit (TP405), the location of the ITRB investigations are shown on Figure C1, Annexure CA.

C4.1.3 GHD Investigations

Following the NTSF embankment failure, GHD were retained by Ashurst to undertake geotechnical investigations to confirm the adequacy of the STSF to receive tailings discharge. This investigation also included four drillholes in the immediate vicinity of the NTSF.

Investigations completed by GHD included:

- Nineteen (19) drillholes numbered CE382 to 393 and CE398 to 404;
- Seismic refraction traverses (SRT) ~ 10 km; and
- Electrical resistivity traverses ~ 10 km.

The location of drillholes CE398, CE399, CE400, CE401, CE403 and CE404 are shown on Figure C1, Annexure CA, whilst geotechnical logs and core photographs are included in Annexure CF.

C4.1.4 Newcrest Investigations

Newcrest drilled four inclined holes and one vertical hole, with a total length of 2095 m, to assist in resolving the location of faulting in the vicinity of the NTSF embankment failure. Drillholes CE380, CE381, and CE396 were located approximately 600 m west of the slump and confirmed the location of the Wyangala-Werribee Fault. Drillholes CE409 and CE431 were a pair of 'scissor holes' angled beneath the slump and did not identify the presence of bedrock faulting.

The location of these holes is shown on Figure C1, Annexure CA, and core photographs are provided in Annexure CG. All of this information led to the view that the presence of bedrock faulting was not consequential to the Event.

C4.2 ITRB Investigation Methods

C4.2.1 Hand Samples

In January 2018, as part of the foundation excavation for the Stage 2 Buttress, extremely weathered Forest Reef Volcanics was exposed at the toe of the NTSF embankment in the vicinity of Ch2000. As the material continued to degrade and a suitable foundation could not be achieved, a sample was taken by Peter Lord.

At the time of the failure the sample remained in a sealed 20 litre container and although it was a bulk sample it contained a number of relatively undisturbed blocks which had been wrapped in bubble wrap. As this was the only evidence of the pre-failure condition of the insitu foundation material, the sample was split between GHD and the ITRB for testing. The ITRB sample is designated as PL1 BS1 0 – 0.5m.

Due to delays in mobilizing suitable drilling equipment and gaining access to the NTSF embankments for drilling, two bulk samples were collected from the tailings runout on the slump. These samples were required to fast track critical state testing of the tailings.

Two samples were collected on 9th May 2018 in the vicinity of Chainage 1980. Sample HA401 was recovered by using a 75mm diameter hand auger to 2 m depth. Three holes were required to fill a 10 litre plastic pail which was subsequently sealed. The material recovered using the hand auger was a low plasticity, clayey silt and was considered to represent the bulk of the tailings that had liquefied and flowed on 11th March 2018.

The second sample, HA402, was taken by carefully scraping the surface of a number of randomly selected sand boils using a small hand shovel. Sand boils typical of those sampled can be seen in Figure C4-1. To provide sufficient sample for testing, a number of sand boils were 'scraped', a task that proved difficult as the tailings were still saturated and prone to liquefaction. This sample was taken as it represented the coarsest phase of the tailings and material more prone to liquefaction.

Figure C4-1: Sand boils on slumped surface sampled as HA402

As the tailings needed to be air dried and then reconstituted for sample preparation by moist tamping, two 20 litre containers of decant water were taken from the STSF for use in testing. This was to ensure that the pore fluid of the reconstituted sample was as close as possible to the original chemistry.

The details of the three hand samples are provided in Table C4-1.

Table C4-1: Hand sample details

Sample ID	Depth	Easting	Northing	Level
PL1 BS1	0 – 0.50m	685253.0	6291074.0	676.00
HA401	0 – 2.00m	685283.5	6291047.2	706.35
HA402	0 – 0.01m	685317.8	6291100.8	708.53

C4.2.2 Test Pits

Test pits were excavated at four locations, principally to obtain undisturbed block samples of residual soil and extremely weathered rock for initial advanced laboratory testing.

At each test pit location, material was progressively excavated using a 35 tonne tracked hydraulic excavator fitted with a 2.1 m wide trimming bucket. When material suitable for block sampling was identified, a slot one bucket width wide and approximately 0.6m deep was excavated on either side of the test pit, leaving a 'pillar' approximately 1 m wide. In some test pits, several attempts were required to create a satisfactory 'pillar'.

Using hand digging tools the 'pillar' was progressively excavated to leave a neatly trimmed column approximately 300 mm square and 450 mm high (Figure C4-2a). The column was then wrapped with plastic wrap and aluminium foil to preserve the in situ moisture content. A box constructed of 17 mm thick ply was placed around the column and the annulus between the sides and lid of the box and the soil column was filled with and expanding polyurethane foam (Figure C4-2b). Once the foam had set, the sample was then undercut, inverted, trimmed, sealed with plastic wrap and aluminium foil, filled with foam and the base of the box screwed on.

Three test pits were initially proposed to sample the range of materials anticipated, namely, extremely weathered basalt (TP401), residual basalt (TP402) and extremely weathered andesitic volcanics (TP403). Due to the rocky nature of TP403, a fourth test pit (TP405) was excavated. This test pit was excavated near the toe of the STSF, where a previous GHD drillhole indicated that less rocky andesitic volcanics could be expected.

Details of the test pit locations are provided in Table C4-2, while logs and photographs of test pits are included in Annexure CC.

Table C4-2: Test pit details

Test Pit ID	Depth (m)	Easting	Northing	Level (mAHD)
TP401	2.1	685075.0	6291180.2	686.42
TP402	1.6	684984.8	6291160.5	680.74
TP403	2.0	685302.0	6290903.0	679.30
TP405	3.5	685146.3	6288996.5	652.41

(a) (b)

Figure C4-2: Excavated (a) and partially boxed undisturbed block sample (b)

C4.2.3 Drilling

The main component of the drilling for the ITRB field investigations was completed between June 1, 2018 and September 11, 2018, using a rubber track-mounted Boart Longyear LS250 MiniSonic sonic drill rig which was cable of both sonic and rotary drilling. The drill rig was operated by Groundwave Drilling Services Pty Ltd, Melbourne Australia. The final hole in the drilling program (CE431) was drilled by Deepcore using a rotary drill.

The sonic operation was essential to quickly penetrate the substantial depths of coarse rockfill and obtain large diameter samples of the underlying residual soils and weathered rock through the 150 mm diameter sonic casing. However, HQ diamond coring required that the rig head be changed; an operation that would take a minimum of 2 hrs to change over and a further 2 hrs to change back. In the interests of productivity this constrained the coring in some holes.

Drilling progress was much slower than anticipated and resulted from:

- Difficult access to the eastern side of the NTSF;

- Equipment breakages / loss;
- Availability of equipment and consumables;
- Availability of drillers and offsiders; and
- Availability of equipment for rig re-location and water supply.

The following sampling methods were employed during the drilling operations:

- Undisturbed thin wall samples were recovered in residual soils, paleo alluvium, extremely weathered rock and clay core. 500 mm long, 63 mm diameter thin walled steel tubes were sealed with wax and fitted with plastic caps taped in place. If present, voids at either end were filled with polystyrene beads.
- Piston samples. 450 mm long, 75 mm diameter thin walled stainless steel tubes were taken in tailings using a custom built 'mechanical' piston sampler. Once sampled, the thin-walled tubes were sealed with plastic caps and tape. Off-site the tape and caps were removed and the samples waxed before recapping and taping for transport. Any voids remaining at either end of the tube were filled with polystyrene beads. The tubes were transported in purpose built boxes and were maintained in an upright position during road freight.
- Lexan samples. Samples of tailings, soils and extremely to highly weathered rock were recovered in a clear polycarbonate Lexan liner using a 1.5 m long sonic split barrel sampler. Lexan liners had dimensions 108 OD mm x 1521 mm length with a 3.2 mm wall thickness and were sealed with plastic end caps taped in place. In less weathered rock, rotation to advance the split barrel was not possible and in rare cases the Lexan liner melted.

  To facilitate handling of the long Lexan samples, all but the tailings samples were cut into 500 mm lengths using a hand saw and were given a suffix A, B, C from the top to the bottom. These sub-samples were sealed with a tight-fitting plastic cap taped in place.

  It was originally planned to obtain a continuous profile of the tailings using the Lexan liners, however, the number and weight of samples made this an unrealistic task. As a consequence, sampling intervals were selected based on adjacent CPTu profiles, with CE413 located adjacent to CPTu N03 and CE408 located approximately 100 m from CPTu N05. CE412 and CE407 were located on the Stage 1 Buttress, aligned with CE413 and CE408 respectively.

  Although the split barrel containing the Lexan liner could be pushed into the tailings without vibration, it was necessary to use some vibration to advance the sonic casing over the split barrel. As a consequence, the Lexan tailings samples can be only viewed as semi undisturbed.

  Lexan tailings samples were maintained in a vertical position on site (Figure C4-3a) and during transport to the CVO core processing facility (CPF). At the CPF a selected number of Lexans were split longitudinally using a jigsaw and 'torn' apart to exposed any structure or layering. One half of the Lexan was sub-sampled and sealed in a plastic sleeve while the other was air died (Figure C4-3b) to expose sandier horizons (if present).

(a) Lexan samples stored at drill site

(b) Lexan samples split and air dried

Figure C4-3: Lexan tailings samples

Five bulk samples of the 'insitu tailings' were taken by placing selected portions of the sleeved split tubes into 10 litre plastic pails which were subsequently sealed. Details of theses samples are provided in Appendix E.

HQ triple tube coring using a split steel inner tube recovered 61 mm diameter core. Coring was undertaken in materials ranging from paleo alluvium and extremely weathered to fresh rock. HQ core was placed into PVC core boxes 1m in length.

On completion of drilling, vibrating wire piezometers (VWP) were installed at the depths indicated in Table C4-3 using the 'fully grouted method'. Where the drillhole penetrated rockfill, the VWP cable was run on the inside of 40 mm PVC to prevent damage to the wires.

Access to the upper surface of the slump for drilling was gained from a rockfill ramp built from the containment bund to the western edge of the slump. This ramp also served as a drilling platform for CE416, located on the edge of the slump. The drilling platform for the two holes located within the slump (CE433 and CE435) was formed by dozer (CAT D6) pushing a 1m thick layer of 40 mm gravel over four parallel sheets of Tensar TriAX geogrid cable tied together (Figure C4-4). Design of the platform was based on hand vane shear tests.

A Geotechnical Engineer from Hatch Pty Ltd (Hatch), or a nominated representative, supervised the field investigations and completed the geotechnical logging. The description of soils as detailed on the geotechnical logs was based on field visual classifications and confirmatory laboratory testing in accordance with AS 1726-2017 – Geotechnical Site Investigation. Explanatory Notes are included as Annexure CB.

Details of the drillholes are provided in Table C4-3, while geotechnical logs and photographs are included in Annexure CD

Figure C4-4: Drilling platform on slump with Boart Longyear LS 250 drill rig

Table C4-3: ITRB drillhole details

Drillhole ID	Location	Easting	Northing	Elevation	Total Length	VWP Depth
CE405	Stage 2 Buttress East	685666.1	6290859.7	687.83	30.5	30.25
CE406	Stage 2 Buttress East	685494.5	6290951.9	688.04	31.8	30.15
CE407	Stage 1 Buttress East	685700.4	6290945.1	731.80	61.6	51.00
CE408	Stage 10 Crest East	685736.5	6291005.9	743.80	57.0	56.95
CE411	SW of Slump	685116.3	6290998.1	690.02	13.5	-
CE411A	SW of Slump	685115.0	6290997.8	690.00	23.0	-
CE412	Stage 1 Buttress West	685129.3	6291369.4	732.14	67.5	56.50
CE413	Stage 10 Crest West	685171.4	6291414.3	743.85	58.4	57.35
CE415	West of Slump	685059.2	6291148.8	686.16	31.3	25.00
CE416	Western edge of Slump	685215.8	6291170.3	704.98	39.0	-
CE417	Containment Berm	685120.2	6291199.9	701.00	39.0	12.40
CE430	Containment Berm	685045.1	6291328.1	706.32	44.5	26.15
CE432	Stage 2 Buttress East	685499.9	6290949.4	688.00	39.5	-
CE433	Slump	685310.8	6291091.2	709.15	46.3	-
CE435	Slump	685280.0	6291117.3	708.33	45.0	38.48

At the commencement of the investigations, the ITRB holes were assigned a number, with the sequence commencing DH401. Due to the similarity of this numbering with the Newcrest numbering (also a 400 series), the ITRB numbering was abandoned in lieu of the Newcrest numbering. Some laboratory test results may indicate both the CE and DH numbers.

C4.2.4 Electrical Resistivity Imaging (ERI)

ERI was completed across the slump to provide an indication of the distribution of remnant sections of embankment and the depth of slumped material. In total, four transverse traverses (NW-SE) and four longitudinal traverses (NE-SW) with a total length of 1260 m were completed and results are included in Annexure CE.

It was originally proposed to use CPT probing to provide confirmation of the ERI, however this was abandoned when it was possible to gain access to the slump for drilling.

The field survey took place between 31 July and 05 August 2017, and was carried out by GHD, subcontracted to Newcrest.

An ABEM Terrameter LS multi-channel resistivity system with smart cable electrode system was used to acquire data along a linear array. The short available traverse length constrained the electrode spacing of 2 m. Stainless-steel electrodes were connected via smart electrodes, or electrodes switches, on a multicore cable to the resistivity meter. Resistivity measurements were taken using a modified multiple gradient array.

The raw resistivity data was processed using the RES2DINV finite-difference inversion software which is based on an iterative routine involving determination of a two dimensional simulated model of the subsurface, which is then compared to the observed data. Convergence between theoretical and observed data is achieved by non-linear least squares optimisation and is stopped when the root-mean-square (RMS) error between the current and previous iterations is <0.1%.

Although it was intended to model the slump using the 3D inversion software RES3DINV, site access constraints limiting data point density and the pronounced lateral variability in resistivity resulted in the generation of an anomalous resistivity model. As a consequence, the 3D model was developed by interpolation between the 2D lines.

C4.3 GHD Investigation Methods

Fourteen (14) of the 19 holes drilled by GHD were drilled using the track mounted Boart Longyear LS250 operated by Groundwave Drilling Services Pty Ltd. Holes were advanced using a combination of sonic and HQ rotary diamond methods. The remaining five holes were drilled by Deepcore Drilling Pty Ltd, using a truck mounted McCullochs DR950 drilling rig with holes being advanced using PQ rotary drilling from the surface.

Drillholes CE398, CE399, CE400, CE401, CE403 and CE404 were drilled in the vicinity of the NTSF. Details of these drillhole locations are provided in Table C4-4, while geotechnical logs and photographs are included in Annexure CF.

Table C4-4: GHD drillhole details

Drillhole ID	Location	Easting	Northing	Elevation	Total Depth
CE398	STSF – West Wall	685023.3	6290925.3	684.6	26.4
CE399	NTSF – South of Slump	685088.8	6291019.1	689.3	30.1
CE400	STSF – West Wall	684953.7	6290720.5	682.2	30.1
CE401	STSF – West Wall	684906.9	6290611.8	682.3	32.1
CE403	NTSF Toe - East	686069.7	6290734.1	688.0	30.8

CE404	NTSF Toe - East	686154.4	6290713.9	687.9	29.1

GHD were engaged by Newcrest to complete a geophysical investigation in the vicinity of the NTSF and STSF which comprised six ERI traverses and twelve Seismic Refraction Tomography (SRT) traverses. The SRT and ERI sections prepared by GHD are included in Appendix J, while the location of traverses in the vicinity of the NTSF are shown on Figure C4-5 and the start and end point of traverses are provided in Table C4-5:.

Table C4-5: Geophysical traverse start and end points

Traverse	Location	Start Chainage		End Chainage		Length (m)
		Easting	Northing	Easting	Northing	
ERI #4	NTSF NW	685235	6292805	684894	6291477	1491
ERI #6	NTSF / STSF West	684900	6291410	684670	6290310	1190
ERI #5	NTSF East Toe	685707	6290837	687730	6290252	2153
SRT #10	NTSF NW	685037	6292820	684890	6291497	1405
SRT #11	NTSF / STSF West	684900	6291410	684670	6290310	1190
SRT #7	NTSF East Toe	685716	6290810	687296	6290366	1702

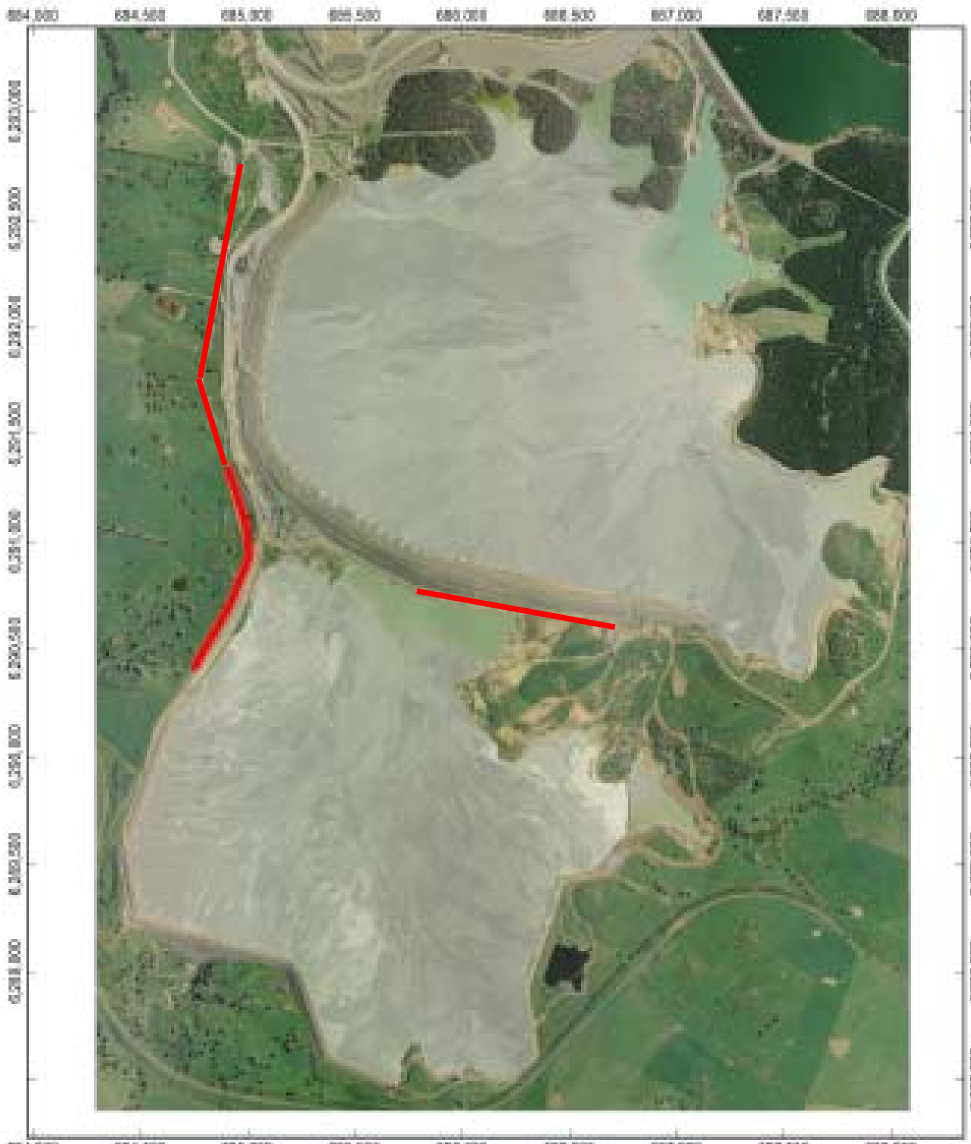


Figure C4-5: GHD geophysical traverses

C4.4 Newcrest Investigation Methods

The five holes drilled by Newcrest as part of the NTSF embankment failure investigation were completed by Deepcore Drilling Pty Ltd, using a truck mounted McCullochs DR950 drilling rig with holes being advanced using PQ rotary drilling from the surface.

Details of the Newcrest drillholes are provided in Table C4-6, while selected photographs of core are included in Annexure CG.

Table C4-6: Newcrest drillhole details

Drillhole ID	Easting	Northing	Elevation	Dip	Azimuth (True Nth)	Length Drilled (m)
CE380	684836.6	6291480.9	697.8	60	122	800
CE381	684836.6	6291480.9	697.8	90	-	50
CE396	684815.2	6291500.6	697.1	60	122	244
CE409	685088.8	6291019.1	689.3	60	124	500
CE431	685504.1	6290946.7	688.0	55	304	501

C4.5 Laboratory Testing

During the field investigations, disturbed and undisturbed samples were recovered from within test pits and drillholes. A selected number of these samples were submitted to various organizations for testing. Table C4-7 provides a list of the type and number of ‘advanced’ laboratory tests undertaken according to material type.

To assist with site characterisation, a summary of Atterberg Limit, Particle Size Distribution (PSD) and density tests completed on samples tested as part of the ITRB investigations is included as Annexure CM.

Table C4-7: Advanced Laboratory Tests

Material	Direct Simple Shear	Cyclic Direct Simple Shear	Direct Shear	Consolidated Undrained TX	Consolidation Tests	Critical State Tests	Bender Element Tests	X-Ray Diffraction Analysis	Scanning Electron Microscopy
Embankment Core				2	1				
Insitu Tailings	2	10			4	19	1	1	2
Slumped Tailings						21		1	
Basaltic Soil	6				2			1	
Paleo Alluvium	5			3	4				
FRV Volcanics	18		7	16	6			5	

C5. Results of Investigations

C5.1 Overview

The thickness of materials intersected in the ITRB holes are listed in Table C5-1, while the thickness of materials intersected in GHD and Newcrest holes drilled in close proximity to the NTSF are listed in Table C5-2 and Table C5-3 respectively.

It should be noted that the thickness of Basalt and Forest Reef Volcanics reported in these tables includes residual soils and weathered materials developed over the parent rock. In holes CE433 and CE435, the tailings thickness is the thickness of slumped tailings and includes remnant portions of embankment fill.

A detailed discussion of the physical characteristics of the materials intersected is provided in the following sections.

Table C5-1: Material intersections in ITRB drillholes

Hole ID	Location	Total Depth (m)	Fill (m)	Tailings (m)	Basalt (m)	Paleo alluvium (m)	Forest Reef Volcanics	Weemalla Formation
CE405	Stage 2 Buttress -East	30.5	26.7				3.8	
CE406	Stage 2 Buttress -East	31.8	18.1				13.7	
CE407	Stage 1 Buttress -East	51.6	27.0	24.6				
CE408	Stage 10 Crest – East	57.0	5.5	51.5				
CE411 (1)	South of Slump	36.5	3.2		9.1	3.7	7.0	
CE412	Stage 1 Buttress - West	67.5	11.8	26.0	21.2	2.4	6.1	
CE413	Stage 10 Crest – West	58.5	4.3	48.9	5.2			
CE415	South West of Slump	31.3	3.4				27.9	
CE416	Western edge of slump	39.0	18.2		3.0	1.2	16.6	
CE417	Containment Berm	39.0	9.0		6.7	5.6	17.7	
CE430	Containment Berm	44.5	14.4		14.0	0.9	15.2	
CE432	Stage 2 Buttress - East	39.5	19.0				20.5	
CE433	Slump – Ch1970	46.3	1.5	30.5 (2)			14.3	
CE435	Slump - Ch1930	38.5	1.0	28.6 (2)			8.9	

Notes:

(1) Includes CE411A drilled adjacent to CE411

(2) Includes disturbed tailings and embankment fill

Table C5-2: Material intersections in GHD drillholes

Hole ID	Location	Total Depth (m)	Fill (m)	Tailings (m)	Basalt (m)	Paleo alluvium (m)	Forest Reef Volcanics	Weemalla Formation
CE398	STSF – West Wall	26.4	1.1			4.3	21.0	
CE399	NTSF – South of Slump	30.1			18.0	0.4	11.7	
CE400	STSF – West Wall	30.1	1.4		6.5	3.6	18.6	
CE401	STSF – West Wall	32.1	1.3		4.9	1.0	24.9	
CE403	NTSF Toe - East	30.8	10.3				20.5	
CE404	NTSF Toe - East	29.1	10.7				18.4	

Table C5-3: Material intersections in Newcrest drillholes

Hole ID	Location	Total Depth (m)	Fill (m)	Tailings (m)	Basalt (m)	Paleo alluvium (m)	Forest Reef Volcanics	Weemalla Formation
CE380	West of slump (1)	800.0			7.5	7.1	599.7	185.8
CE381 (2)	West of slump	50.0	0.3		7.4	8.3		34.0
CE396	West of slump (1)	243.5	0.1		7.2	10.5	70.4	155.3
CE409 (3)	South of slump (1)	57.5	0.4		14.0	1.5	39.3	
CE431 (4)	Stage 2 Buttress – East (1)	501.2	22.0				479.2	

Notes:

(1) Material intersections have not been corrected for drillhole inclination.

(2) Located adjacent to CE380.

(3) Located adjacent to CE399.

(4) Drilled adjacent to CE432

C6. Foundation Characteristics

C6.1 Tertiary Basalt

Downstream of the NTSF the residual soil profile developed over the Tertiary basalt has been largely modified by earthfill borrow areas, haul road construction or is obscured by the STSF embankment construction or tailings.

Residual basaltic soil was encountered in 16 drillholes at the NTSF and STSF and ranged in thickness up to 4.3 m with an average thickness of 1.6 m.

A full profile of residual basaltic soil was intersected upstream of the NTSF embankment in CE412 (3 m) and CE413 (2 m). The basaltic soil in this area comprised dark brown, high plasticity Gravelly CLAY and SILT. Atterberg Limits of LL = 81 and PI = 44 (CE412 39.50 – 39.72) represent some of the more plastic materials encountered in the NTSF and STSF foundations.

The residual basaltic soil typically graded into extremely weathered basalt. Figure C6-1 shows residual, red brown basaltic soil (high plasticity CLAY with some sand and gravel) with 50-100 mm diameter corestones of grey, extremely weathered basalt. A further 0.6 m below this sample, the basalt transitioned to highly weathered, then slightly weathered to fresh basalt a further 0.5 m below.

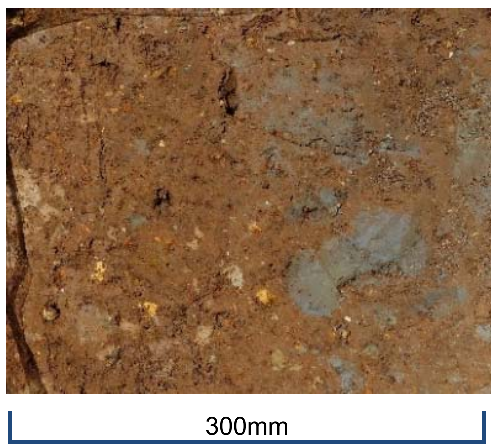


Figure C6-1: TP401 BL01 @ 1.0m

As there was a requirement to recover undisturbed soil and extremely weathered materials from below the basalt in ITRB holes, the basalt was mostly drilled using non-core sonic methods. The basalt was diamond cored in CE430 and a number of GHD holes where it was typically slightly weathered to fresh but highly fractured (Figure C6-2).

Figure C6-2: Slightly weathered, high strength, Basalt (CE430 – 20.4 – 20.9)

Basalt was intersected in 19 holes at the STSF and NTSF with an average thickness of 8.4 m. In the vicinity of the NTSF, the maximum basalt thickness was 18.2 m (CE412), while thicknesses greater than 13.0 m were recorded in CE399, CE402 and CE430.

C6.2 Paleo Alluvium

Paleosoils underlying the basalt show considerable variation in thickness and physical characteristics, ranging from alluvial soils (paleo alluvium) to residuals soil. Residual paleosoils will be considered as part the underlying bedrock profile, while paleo alluvium will be the focus of this section.

In the vicinity of the NTSF embankment failure alluvial paleosoils range in thickness from 0.4 m (CE399 and CE430) to 5.6 m (CE417).

Paleo alluvium immediately underlying the basalt is typically medium to high plasticity, light grey Sandy SILT, Clayey SILT or Silty CLAY, with red and orange mottling. The layer is up to 1.3 m thick (CE417), but it is often less than 0.5 m thick. Where the layer is particularly thin some workers have considered it to be weathered basalt at the base of a flow.

In CE417 the paleo alluvium is typical of a low energy environment, possibly lacustrine, or fluvial overbank and is comprised of three distinct layers, namely;

Upper 1.3 m	Clayey SILT, high plasticity, light grey with red brown staining, block structure.	Figure C6-3
Centre 3.0 m	Silty CLAY, high plasticity, black, organic matter and sulphurous odour indicate anaerobic conditions. Organic content 7%.	Figure C6-4
Bottom 1.3 m	Silty CLAY, high plasticity, light grey with orange mottling, fissured.	

Figure C6-3: CE417 16.50 - 17.00m- low energy paleo alluvium

Figure C6-4: CE417 18.00 – 18.50m – low energy paleo alluvium (anaerobic conditions)

To aid in the understanding of the geological model, an attempt was made to use palynology to determine the geological age of two specimens from CE417 (Annexure CH). Although fungal spores and pollen were recovered in one specimen, there was insufficient material recovered to provide a reliable geological age.

In CE416, the paleo alluvium is 1.2 m thick and comprised brown Clayey SILT and light grey, high plasticity Silty CLAY with organic matter along some fissures. Material underlying the paleo alluvium is red orange high plasticity Silty CLAY with yellow white and white veining and has been interpreted as a residual paleosoil.

In contrast to the low energy, lacustrine or fluvial overbank deposits, seen in drillholes CE416 and CE417, paleo alluvium in CE402 is comprised of subrounded gravels in a sandy matrix (Figure C6-5) and are characteristic of a high energy environment. The gravelly alluvium in CE402 is both overlain and underlain by light grey Silty CLAY, resulting in a thickness in excess of 3 m.

Figure C6-5: CE402 15.80 – 18.60 m - high energy paleo alluvium

Atterberg Limit tests on paleo alluvium are plotted on a plasticity chart as Figure C6-6.

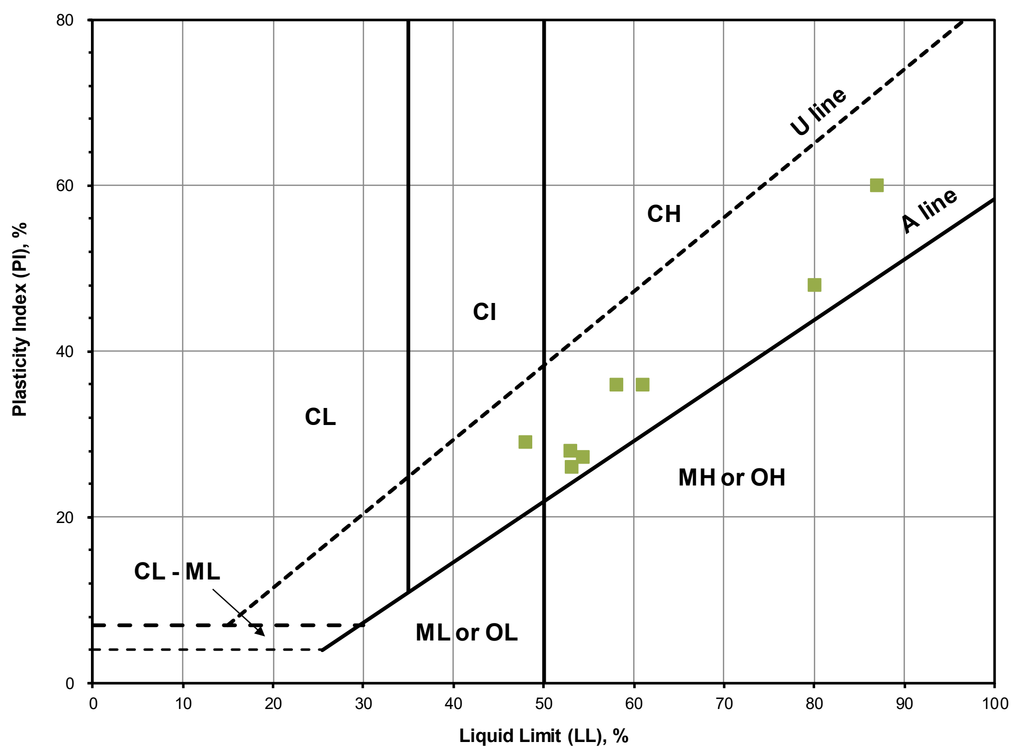


Figure C6-6: Atterberg Limit tests on paleo alluvium

C6.3 Forest Reef Volcanics

C6.3.1 Bedrock

The Forest Reef Volcanics (FRV) in the vicinity of the NTSF have been variously described as andesite, altered andesite, andesitic volcanics and volcaniclastics. In hand specimen, the Forest Reef Volcanic displays the colour and textural heterogeneity (Figure C6-7) of a volcaniclastic (tuff or agglomerate). However, this description is not always supported by petrographic analyses (Table C6-1) where some specimens have been interpreted as andesite or pyroxene andesite lava flows that have erupted in shallow water. Notwithstanding this, the FRV has been described as volcaniclastic in drillhole logs for consistency.

Table C6-1: Summary of FRV petrographic analyses (Annexure CI)

Drillhole	Depth (m)	Description	Inferred Genesis
CE405	29.7	Altered andesite	Lava flow into shallow water
CE409	42.3	Altered andesite	Pyroclastic flow into water
CE415	26.1	Altered pyroxene andesite	Pyroclastic flow from numerous vents
CE416	38.8	Altered pyroxene andesite	Lava flow into sea water
CE433	42.0	Altered hornblende-pyroxene andesite	Ash fall tuff

Figure C6-7: CE432 (38.80 – 39.04) - Fresh FRV showing textural heterogeneity

C6.3.2 Weathering Products

The FRV is typically deeply weathered, and although the depth to moderately weathered rock can be as little as 2.0 m, the average depth is close to 10 m and the maximum is 22 m (based on 33 holes at the NTSF and STSF). For the ten holes where moderately weathered FRV was encountered in the vicinity of the NTSF failure, the minimum depth to moderately weathered rock was 8 m and the average was 13.2 m.

Early in the ITRB investigations it was recognised that the insitu dry density of some weathered FRV in the vicinity of the NTSF embankment failure was particularly low and this material exhibited brittle behaviour. As a consequence, considerable time and effort was expended in identifying the distribution of, and reasons for, the low density material. Testing included common physical testing undertaken on soils, semi-quantitative X-Ray Diffraction (XRD) analysis and petrographic analysis of parent material.

For the purpose of this report, low insitu dry density material is designated as Unit A, while material with higher insitu dry density is designated as Unit B. Unit A materials were typically intersected immediately beneath the paleo alluvium and Tertiary basalt or in close proximity to the Tertiary basalt.

XRD analyses were completed on six specimens, five taken from FRV soils and one taken from residual Tertiary basalt. Detailed results are included in Annexure CJ, whilst a summary of the FRV results consolidated into the principal mineral group assemblages is presented as Figure C6-8. Also shown on Figure C6-8 are the measured dry density of samples.

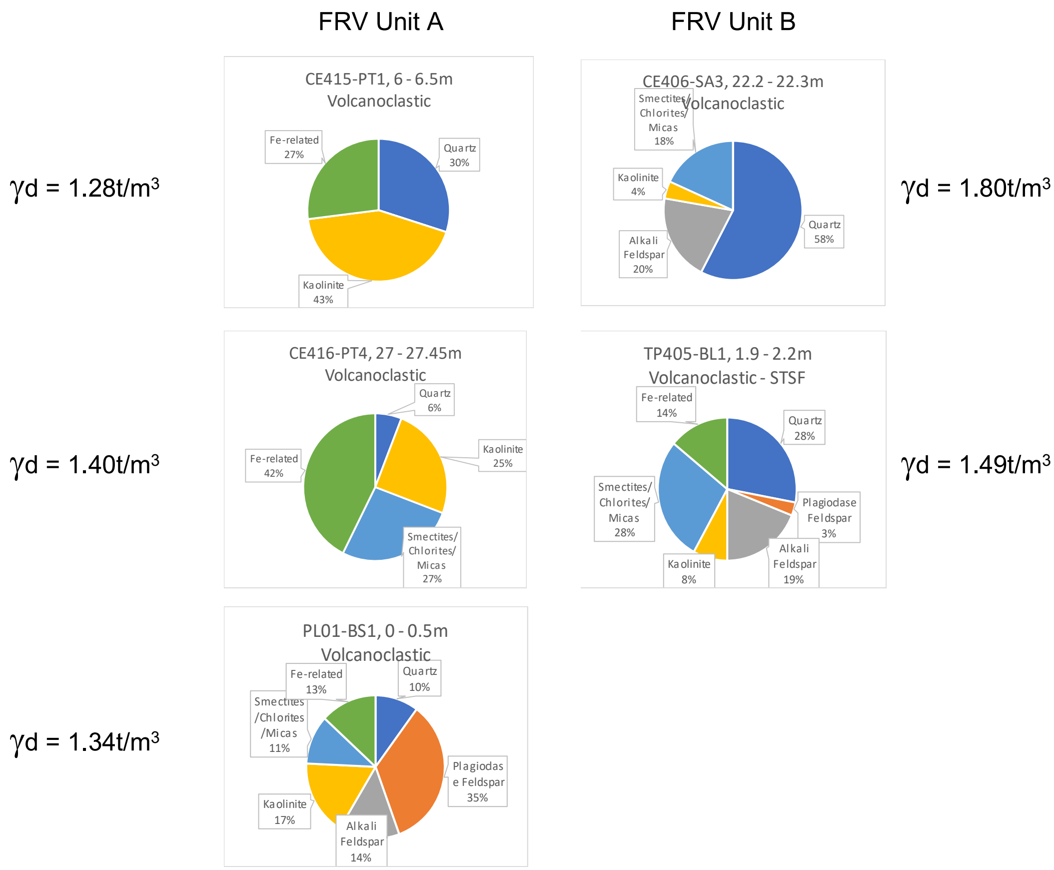


Figure C6-8: Summary of XRD analyses completed on FRV weathering products

Although there is considerable variability between samples, the analyses do indicate the following trends:

- The strong purple colouring of Unit A materials (CE415 & CE416) is most likely directly related to the iron oxide mineral content of these samples.
- The percentage of Kaolinite in Unit A materials is higher than Unit B materials.
- Kaolinite comprises 100 to 48% of the total clay minerals in Unit A materials but less than 22% of clay minerals in Unit B materials.
- Feldspars are absent in CE415 and CE416.

Fookes et al. (1988) proposes that chemical weathering results in four major components, resistates, solutions, gels and secondary minerals as indicated in Figure C6-9. High concentrations of kaolinite and a reduced concentration of smectites and chlorites indicates increased leaching and a more advance state of chemical weathering. The XRD analyses indicate that Unit A is at a more advanced state of chemical weathering compared to Unit B.

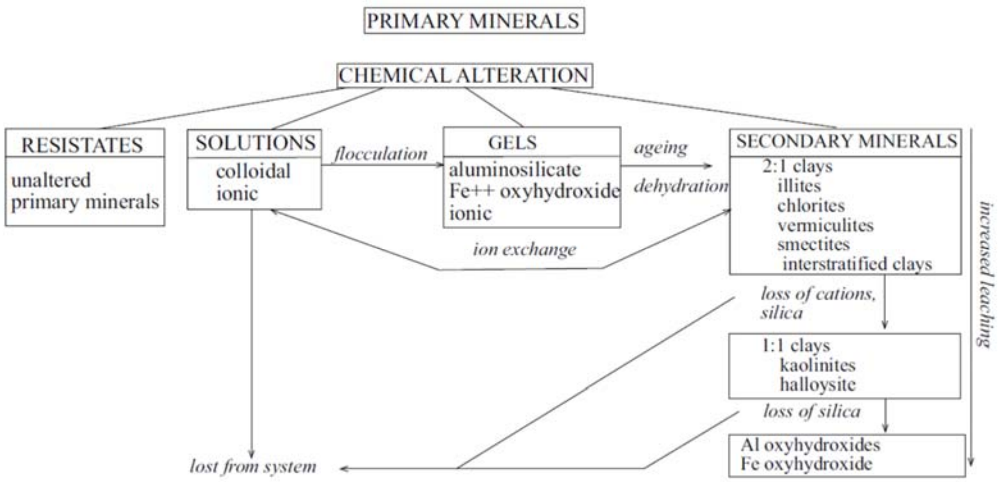


Figure C6-9: Chemical weathering process, Fookes et al. (1988)

C6.3.3 FRV Unit A

Unit A is typically a Clayey SILT or Silty CLAY, with a trace of sand, medium to high plasticity and red orange to brown with white speckling, commonly with purple staining.

The transition from residual paleosoil to extremely weathered FRV can be seen in drillhole CE416, where residual red orange clayey SILT with white (kaolinite?) veining is evident in Figure C6-10 and white speckled and white veined extremely weathered FRV can be seen in Figure C6-11.

Figure C6-10: CE416 24.50 – 25.00m – residual paleosoil developed over FRV

Figure C6-11: CE416 26.00 – 26.50m – extremely weathered FRV

C6.3.4 FRV Unit B

Unit B is typically Sandy CLAY or Silty CLAY with some sand and weathered rock fragments, medium to high plasticity and red orange to yellow brown as indicated in Figure C6-12.

TP403 BL01, 1.5 – 1.8 m

TP405 BL01, 1.9 - 2.2 m

Figure C6-12: FRV Unit B; Block samples recovered from test pits TP403 and TP405.

C6.3.5 FRV Index Properties

Plasticity data, void ratio and density relationships for both Unit A and Unit B are provided as Figure C6-13 and Figure C6-14.

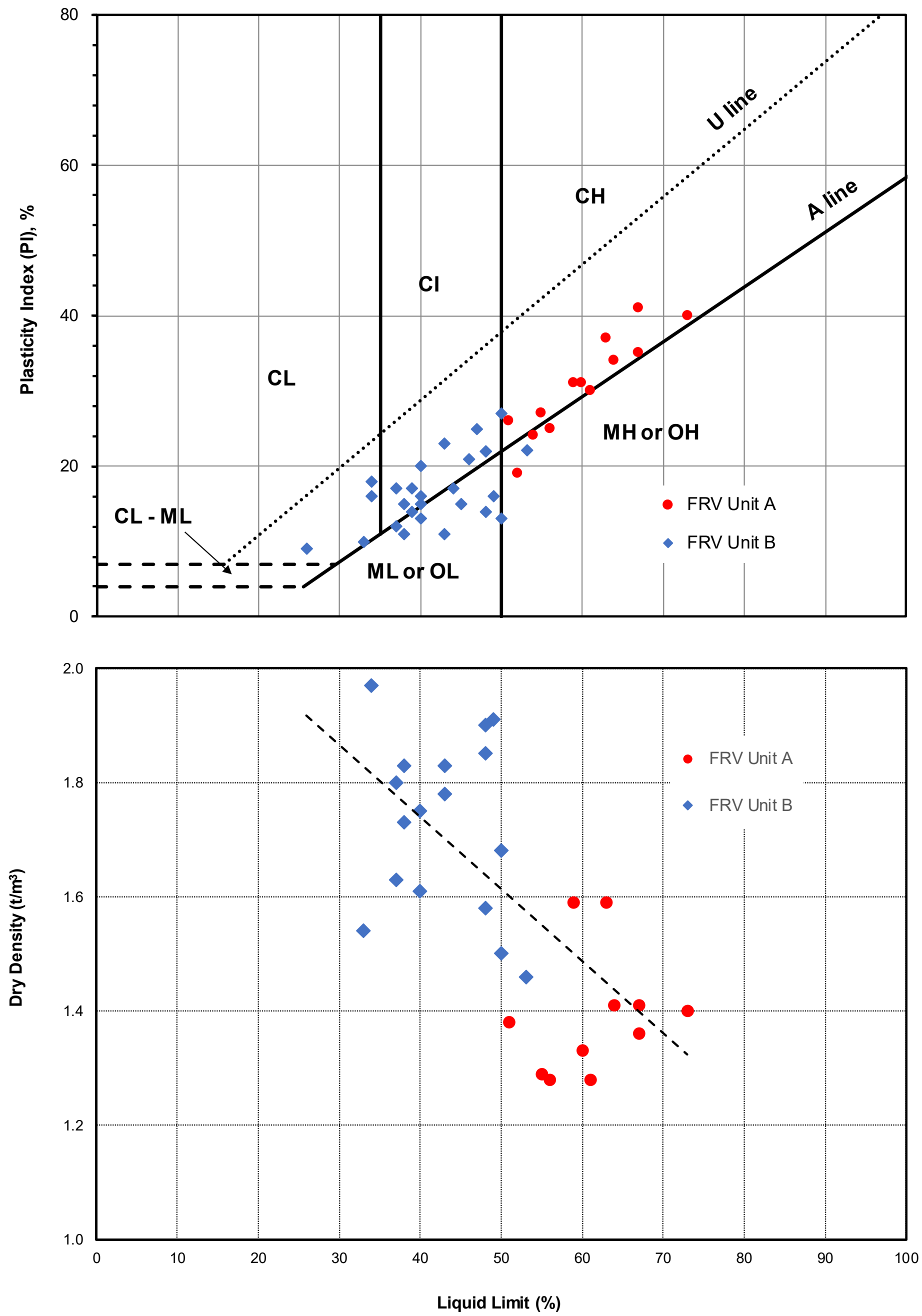


Figure C6-13: Forest Reef Volcanics – Atterberg Limits and Dry Density vs Liquid Limit

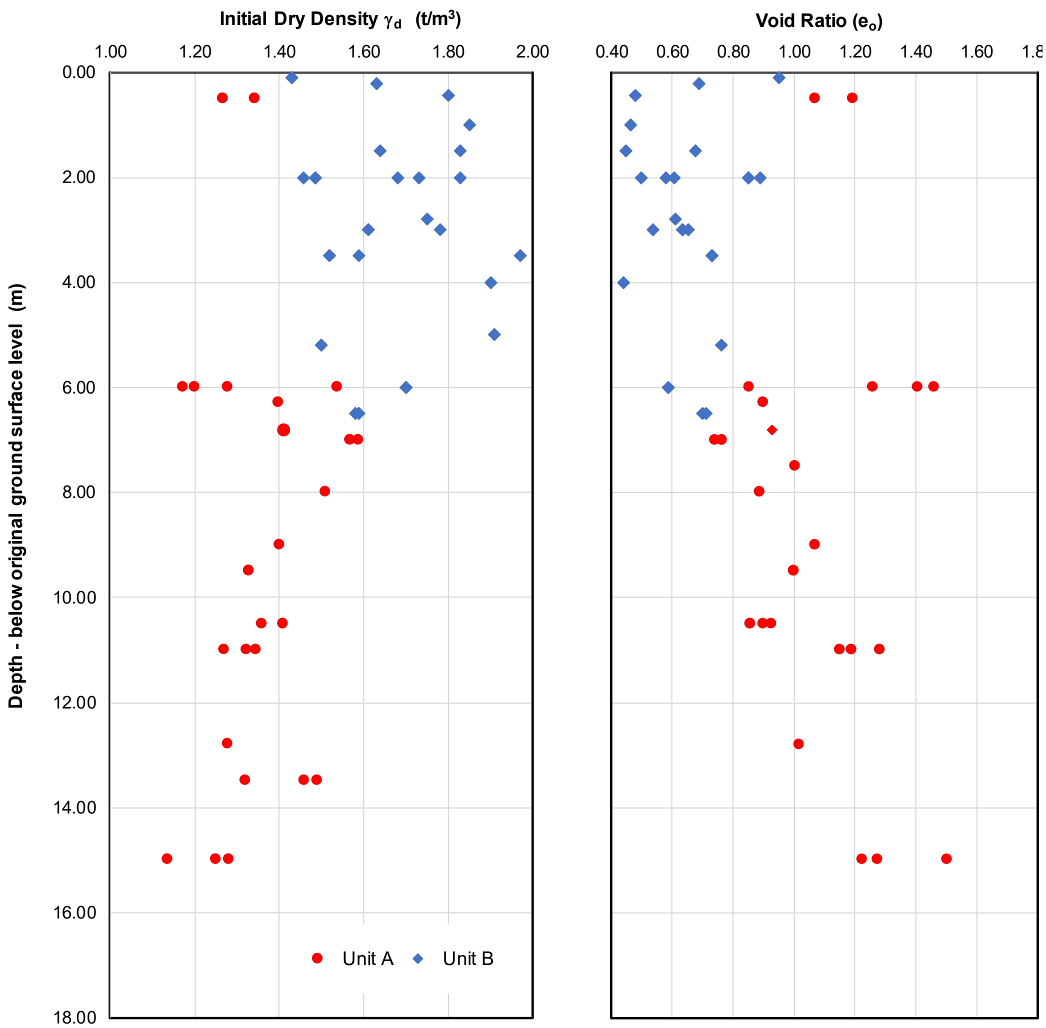


Figure C6-14: Forest Reef Volcanics – void ratio & dry density vs depth

C6.4 Weemalla Formation

The Weemalla Formation was not intersected in ITRB holes drilled as part of the subsurface investigations for the NTSF embankment failure. However, the Weemalla formation was intersected in GHD holes drilled along the western and southwestern sides of the STSF and three Newcrest holes (CE380, CE381 and CE396) collared to the west of the Wyangala-Werribee Thrust Fault.

In the GHD holes along the western side of the STSF, the Weemalla Formation is comprised of banded siltstone and felspathic sandstone. The siltstone is typically steeply dipping (45° to 60°) and highly to moderately weathered.

C6.5 Water Level Measurements

Vibrating Wire Piezometers (VWP) were installed in holes at the depths indicated in. Installation details together with the results of subsequent water level measurements are included in Annexure CL.

VWP measurements at Section A (east of the slump) are plotted on Figure C6-15, while those at Section C and D (west of the slump) are plotted on Figure C6-16 and Figure C6-17, respectively. For locations of Sections A, C and D refer Figure C6 (Annexure CA).

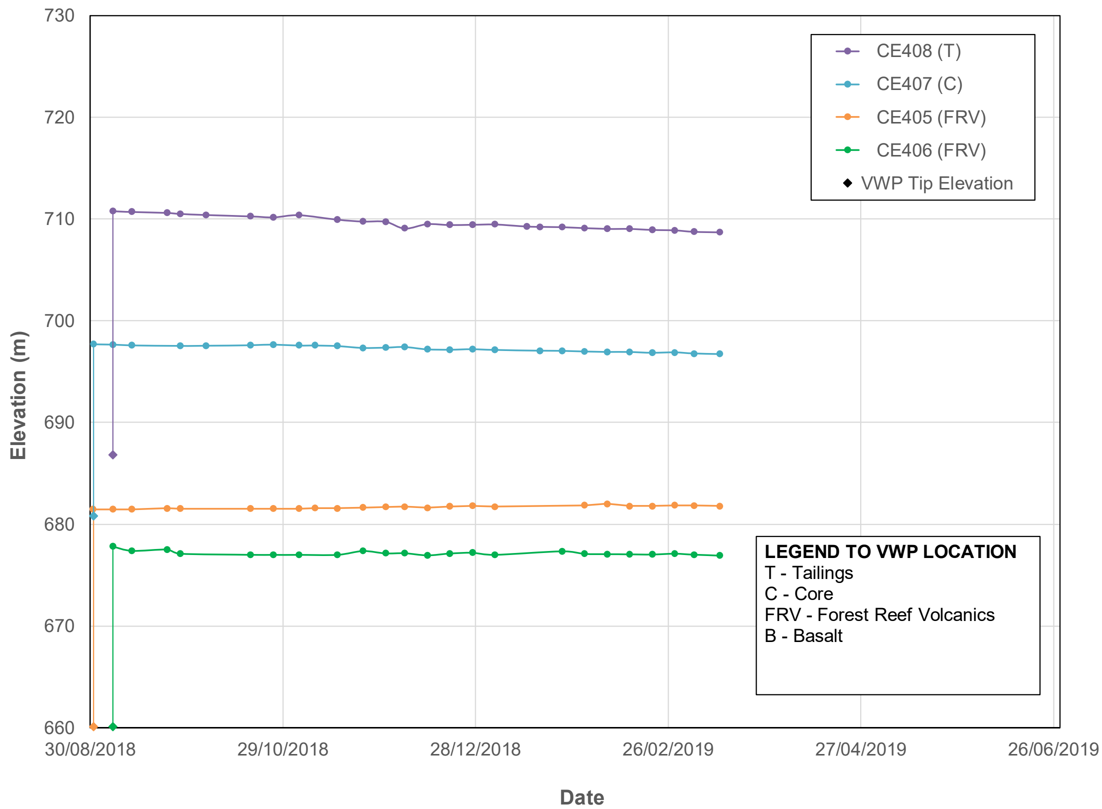


Figure C6-15: VWP measurements Section A (east of slump)

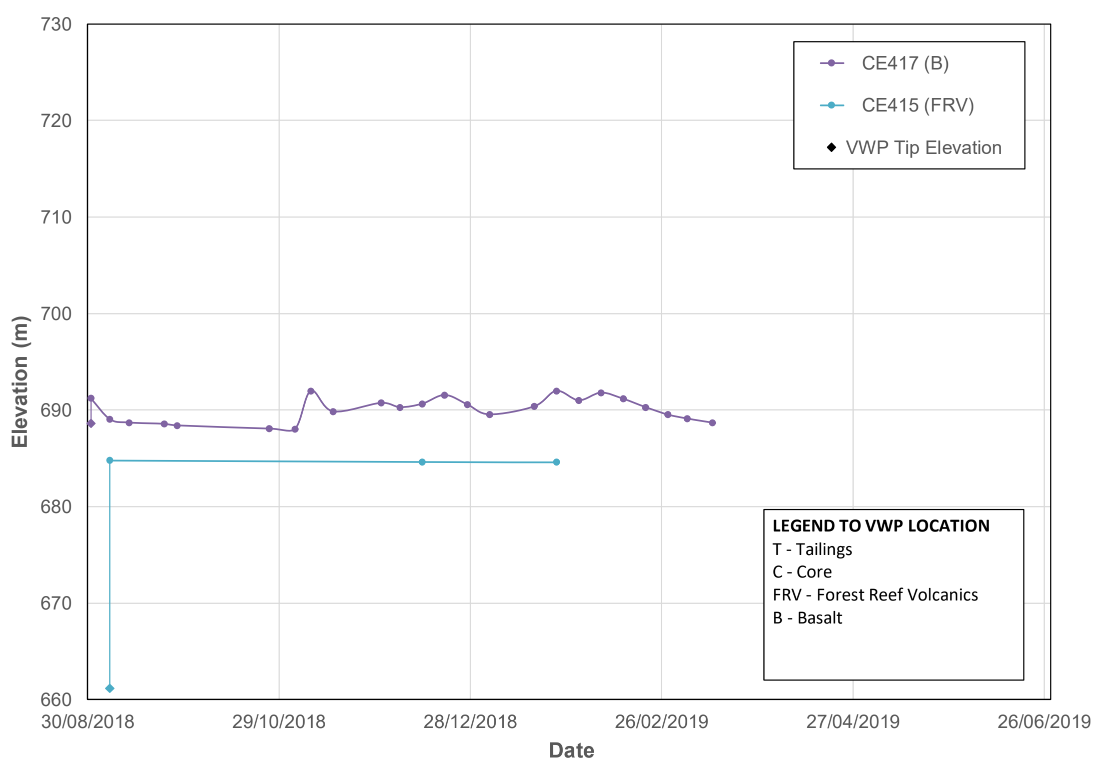


Figure C6-16: VWP measurements at Section C (west of slump)

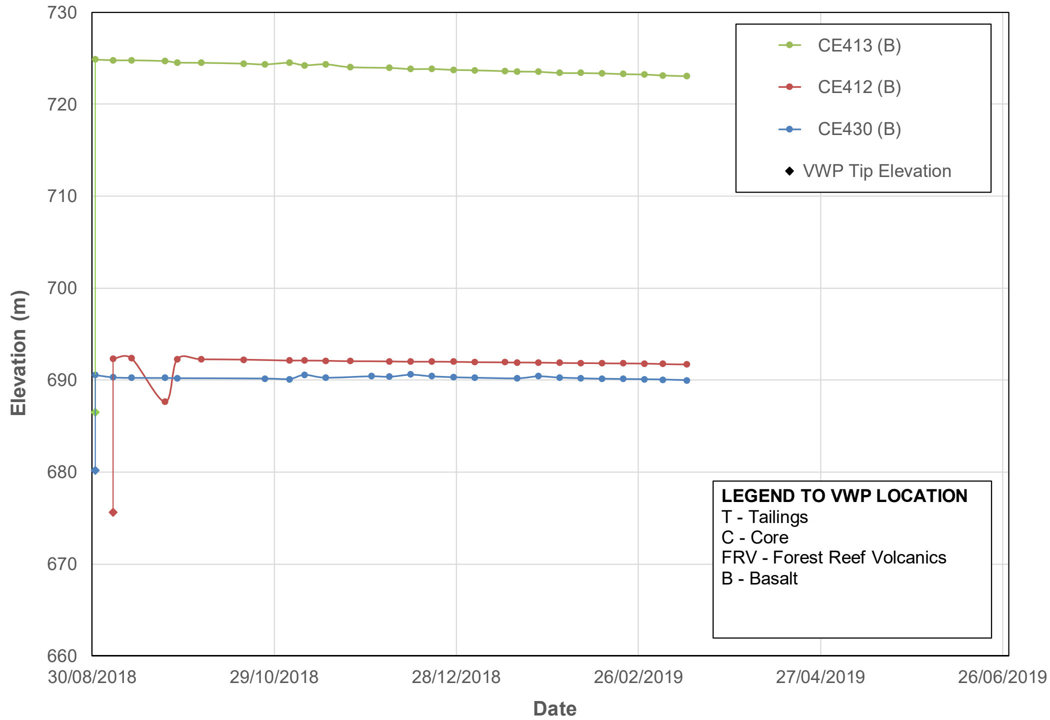


Figure C6-17: VWP measurements at Section D (west of slump)

C7. Fill Materials

Nine of the fourteen ITRB holes were collared in fill materials belonging to either the Stage 10 embankment, the Stage 1 Buttress, the Stage 2 Buttress or the Containment Berm constructed on the western side of the slump. Drillhole CE416 was collared in a rockfill ramp constructed between the western Containment Berm and the western side of the slump and drillholes CE433 and CE435 were collared in the rockfill drilling platform constructed across the slump.

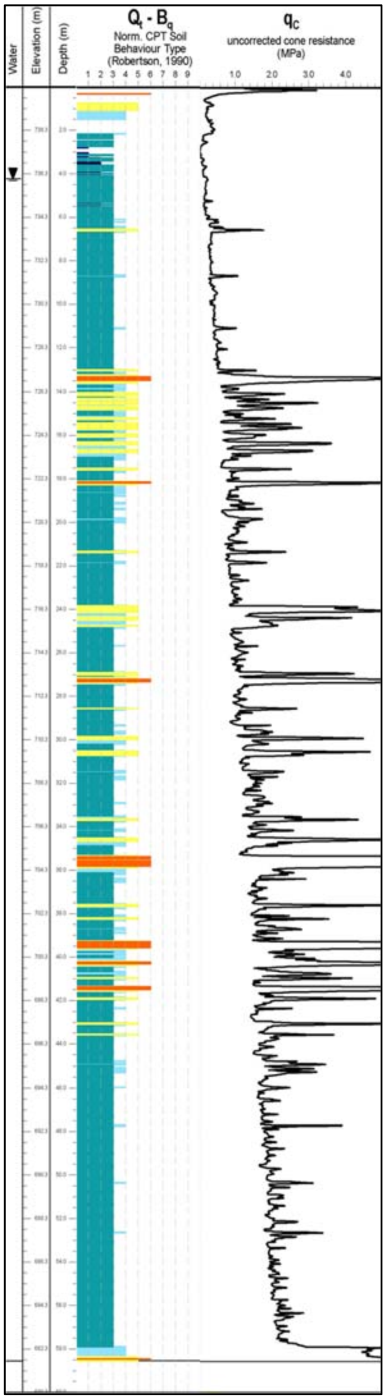
Sonic drilling proved to be an effective method for penetrating the high strength rockfill used in the NTSF, however the highly disturbed nature of materials recovered from the sonic drilling did not permit characterisation of the rockfill or differentiation between the various phases of filling (or slumped rockfill in the case of CE416). Clay fill and working platform rockfill, used in the various embankment stages intersected, were able to be identified and these are recorded on the relevant geotechnical logs.

Where drillholes were collared in fill materials, the underlying materials (tailings, residual soils or weathered bedrock) were generally of prime interest. The exception to this was CE407, which was drilled specifically to intersect and sample the Stage 1 embankment clay core. The clay core intersected, over a depth of 3.5 m, was high plasticity brown clay and three undisturbed samples were recovered. Details of testing on the clay core are provided in Appendix D.

In CE405, the lower 3.5 m of fill was not typical rockfill but included clayey sand, gravelly sand and sandy gravel with some boulders, overlying strongly organic topsoil. From topographic records it would appear that a sediment control / farm dam at this location had been backfilled by placing mixed fill materials without adequate ground preparation.

C8. Tailings

C8.1 Insitu Tailings



ITRB holes that intersected tailings (CE408 and CE413 collared on the Stage 10 embankment crest and CE407 and CE412 collared on the Stage 1 Buttress) were drilled to obtain both bulk and undisturbed samples of tailings.

Field characterisation of the tailings has relied upon analysis of both 2013 and 2017 CPTu using the normalized Soil Behaviour Type (SBTn) relationship of (Roberston, 1990).

Figure C8-1 shows the interpreted SBTn and uncorrected cone resistance plots for CPTu N04, the closest 2017 CPTu to the slump prior to the failure.

Based on the SBTn, the tailings profile has been divided into three units.

Zone A – above RL 727; predominantly CLAY and Silty CLAY.

Zone B – between RL697 and RL727; predominantly CLAY and Silty CLAY with thin (0.1 to 0.2 m thick) layers of Silty SAND and Sandy SILT and lesser SAND, more frequent above RL723.

Zone C – below RL697; predominantly CLAY and Silty CLAY

The water table at the time of testing was 4.2 m below the tailings surface.

Reinterpreted logs of all CPTu are provided in Appendix E.

Figure C8-1: CPT N04 showing stratigraphy

C8.2 Slumped Tailings

The tailings in the vicinity of the NTSF embankment failure liquefied and slumped in two phases.

The initial phase occurred at the time of the slump, late in the afternoon of 9th March 2018. At the time the liquefied tailings were contained within a buttress of failed rockfill as shown on Figures B6 and B7 (Annexure BA). The maximum elevation of the slumped tailings was at ~RL707. A composite drone photograph taken on 10th March 2018 indicated a line of sand boils near the centre of the slump.

The second phase of tailings liquefaction occurred at 19:21 on the 11th March 2018 when tailings above and behind the initial failure slumped. This phase of slumping is attributed to dissipation of negative pore pressures generated in the tailings behind the initial failure. The second event was captured on video and consisted of a highly fluid jet / flow of tailings which overflowed the initial failed rockfill buttress in a number of locations (Figures B8 and B9 Annexure BA) and raised the general surface of the slumped tailings by 3 m to ~ RL710. A composite drone photograph taken on 14th March 2018 shows sand boils covering a larger portion of the rear of the slumped tailings.

Near surface samples, representing clayey (HA401) and sandy (HA402) portions of the second phase of tailings slumping were taken in May 2018. Laboratory testing on these samples is included in Appendix E.

Holes CE433 and CE435 were drilled near the centre of the slump and intersected tailings with some remnant portions of embankment fill to 32.0 m depth (RL677.2) and 29.6 m depth (RL678.7) respectively. Remnant sections of fill recovered by the sonic drilling were mostly clay with some rock pieces, with intersections typically 0.5 to 1.0 m in length. Although rock fill was not recovered by the sonic drilling it is most likely that the rock pieces would have been pushed to the side in the soft tailings by the sonic drilling.

Although the lateral extent and depth of penetration (25 m) of the ERI traverses completed across the slumped surface (Annexure CE) was constrained by the space available, the analysis indicates that the majority of the sections have low apparent resistivity values (<20 ohm.m) consistent with conductive tailings materials. Higher resistivity values (>100 ohm.m) are observed in the south and southeast of the sections likely indicating the failed embankment sections consisting mostly of rockfill. The higher apparent resistivity zone (green) at the base of the 3D inversion model most likely indicates the ground surface prior to the failure, and would suggest that the surrounding tailings do not extend much deeper than a RL of 676 m. Although errors in depth calculations using ERI are commonly in the range 10% to 20%, the depths indicated are reasonably consistent with the drilling results and the toe of the NTSF embankment in the vicinity of the slump.

Annotated sections through the slump showing the location of drillholes and resistivity interpretations are provided as Figure C2 (Annexure CA).

C9. Geological Model

C9.1 Geological Mapping

Geological mapping in the vicinity of the NTSF (Newcrest, 2000) is reproduced in part on Figure C3 and in the vicinity of the slump on Figure C4 (Annexure CA). Also shown on Figure C4 are previous and current investigation locations, colour coded on the basis of near surface materials; namely basalt (orange) or volcaniclastics (green). At a number of previous investigation locations, particularly test pits, the type of bedrock was not recorded and these investigation locations are shown in black.

Except for three locations (BH20, TP220 and TP224), materials intersected in drillholes are consistent with the geological mapping. At these three investigation locations bedrock has been described as basalt. After review of all available information it is considered that the bedrock was either described incorrectly or the locations were recorded incorrectly.

The most significant departure from the previous geological mapping is the position of the Wyangala-Werribee Thrust fault, which placed the fault beneath the Tertiary Basalt and passing through the NTSF near the slump. The current interpretation, based on drillholes CE380 and CE396 places Wyangala-Werribee Thrust approximately 350m to the west of its original position.

Drillholes CE380 and CE396 were located about 500 m to the north west of the slump and inclined at 60° towards the south east. Both drillholes intersected a 5 m wide zone of fracturing and shearing between 191.5 and 200.3 m in drillhole CE380 and between 218.8 and 226.6 m in drillhole CE396. The zone of shearing and fracturing has been inferred to be the Wyangala-Werribee Thrust fault. Bedrock to the west of the fault has been logged as Weemalla Formation, while that to the east has been logged as Forest Reef Volcanics. The inferred surface expression of the Wyangala-Werribee Thrust fault (Figures C3 and C4 Annexure CA) is based on a projection of the CE380 and CE396 drillhole intersections and a prominent anomaly in ERI traverse Line 6 (Appendix J). On the basis of the information available, the fault dips at approximately 60° to the west, with the western side (Weemalla Formation) thrust upwards.

C9.2 FRV Weathering

During chemical weathering of rocks, geochemically mobile elements such as alkali and alkali-earth elements (Si_2O, Na_2O, K_2O, CaO and MgO) are leached leaving the residual elements to combine with components from the atmosphere to form new minerals.

In tropical areas where high rainfall continually flushes the weathering profile with unsaturated fluids for hydrolysis and quickly removes the products of ion exchange, weathering is more rapid and complete and is characterised by particularly low material densities. As a consequence, bulk density is commonly used as a means of assessing the effectiveness of chemical weathering indices which rely on incorporating bulk major element oxide chemistry into a single value (Price & Velbel, 2003).

Although the bulk (dry) density of Unit A is low, only one XRD sample from this unit shows complete conversion to kaolinite. Although kaolinite is the dominant clay mineral in other Unit A samples, the presence of some 2 : 1 clay minerals (smectite etc) and some residual orthoclase and muscovite and an absence of gibbsite, indicates that Unit A is best described as a ferrisol which most probably developed under a sub-tropical environment (Fookes & Ed, 1997). A sub-tropical environment is also consistent with global paleo-geographic reconstructions for the early Tertiary.

As Unit A materials were intersected immediately beneath the paleo alluvium or in close proximity to the Tertiary basalt, it is most likely that the basalt has prevented or inhibited the physical erosion of Unit A under the current climatic regime. Away from the basalt, it is most likely that Unit A has been eroded or modified to some degree under the current climatic regime exposing the underlying Unit B.

As clastic sedimentary rocks are composed of the end product of either physical or chemical weathering (or both) of other rocks, they are not as susceptible to the leaching that occurs in igneous or metamorphic rocks and as a result the change in density that occurs during chemical weathering is not as pronounced as in igneous and metamorphic rocks.

Figure C9-1 to Figure C9-4 are sketches that show a possible paleo-geographic reconstruction of the NTSF area and have been prepared to explain the distribution of low density weathering products on the Forest Reef Volcanics.

Figure C9-1 shows the Silurian and Ordovician basement rocks at the NTSF that have been exposed by weathering. Sedimentary strata, the Weemalla Formation in the west and Cadia Coach Shale in the east, have been faulted against the Forest Reef Volcanics. Deep weathering and low density soils developed over the FRV in a subtropical environment and drainage channels were broadly aligned along the eastern and western faults. Low density soils did not develop on the adjacent sedimentary strata.

Prior to the Miocene, possibly in response to a cycle of increased erosion, alluvium was deposited along paleo-valleys as depicted in Figure C9-2. It is possible that a number of cycles of deposition and erosion may have occurred as the paleo alluvium ranges from low energy lacustrine (lake) deposits to high energy fluvial (stream) deposits. Erosion of ridges adjoining the paleo alluvium most probably reduced the thickness of low density FRV in these areas.

During the Middle Miocene a volcanic centre developed in the Mount Canobolas area and basalt flowed to the south filling valleys and burying the paleo alluvium and underlying low density soil developed on the FRV (Figure C9-3). The total thickness of the basalt was up to 80m so it is likely that higher intervening ridges were not covered by the basalt.

A deeply weathered profile and an absence of basalt in the former ridge areas allowed streams to develop and a new phase of down-cutting occurred; Rodds Creek being one of these streams and Cadiangullong Creek another. With continued erosion and stream down-cutting basalt was eroded where it is thin, together with the underlying paleo alluvium and low density residual soils.

The current situation is depicted in Figure C9-4, where remnants of Tertiary remain where it is thickest along the former paleo- valleys. The basalt in these areas overlies paleo alluvium and low density FRV protecting it from further erosion except around the periphery. The location of the NTSF centreline and position of the embankment slump is shown on Figure C9-4.

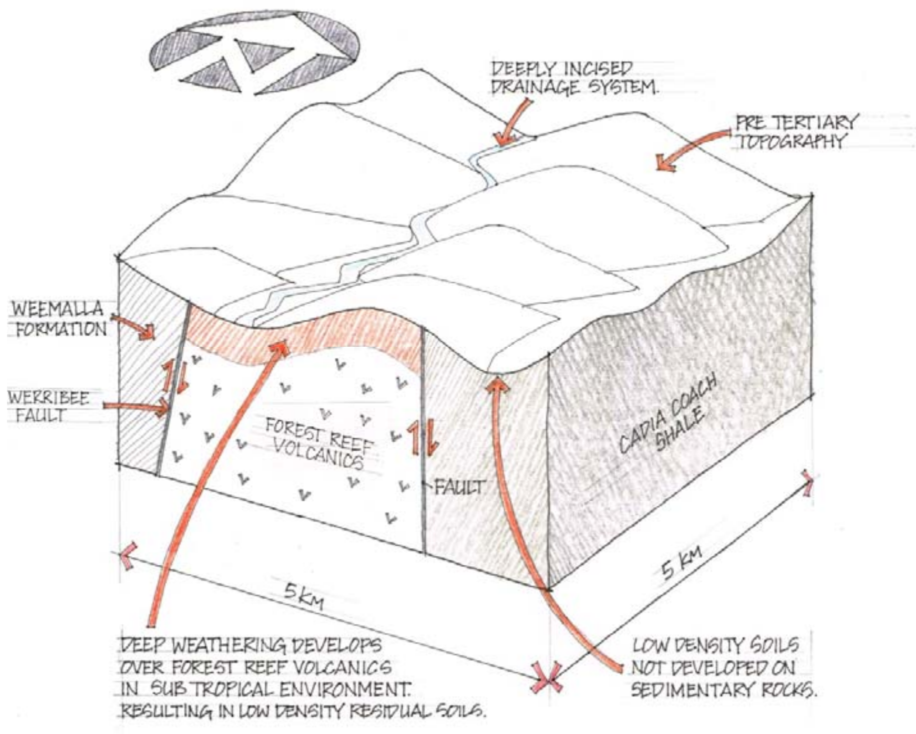


Figure C9-1: Low density soils develop on FRV under a sub-tropical climate.

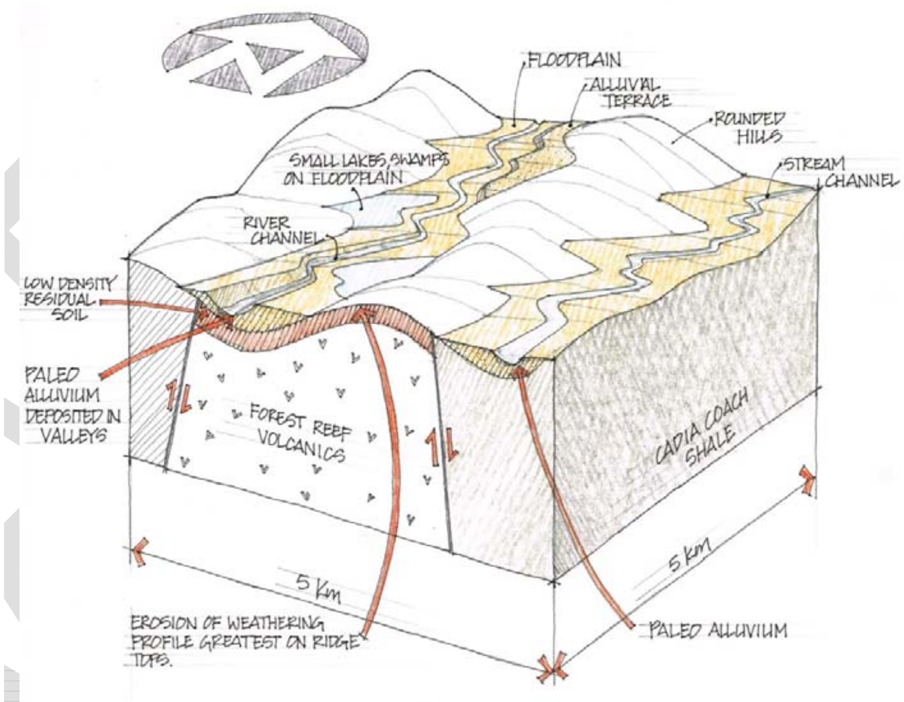


Figure C9-2: Alluvium is deposited along paleo valleys.

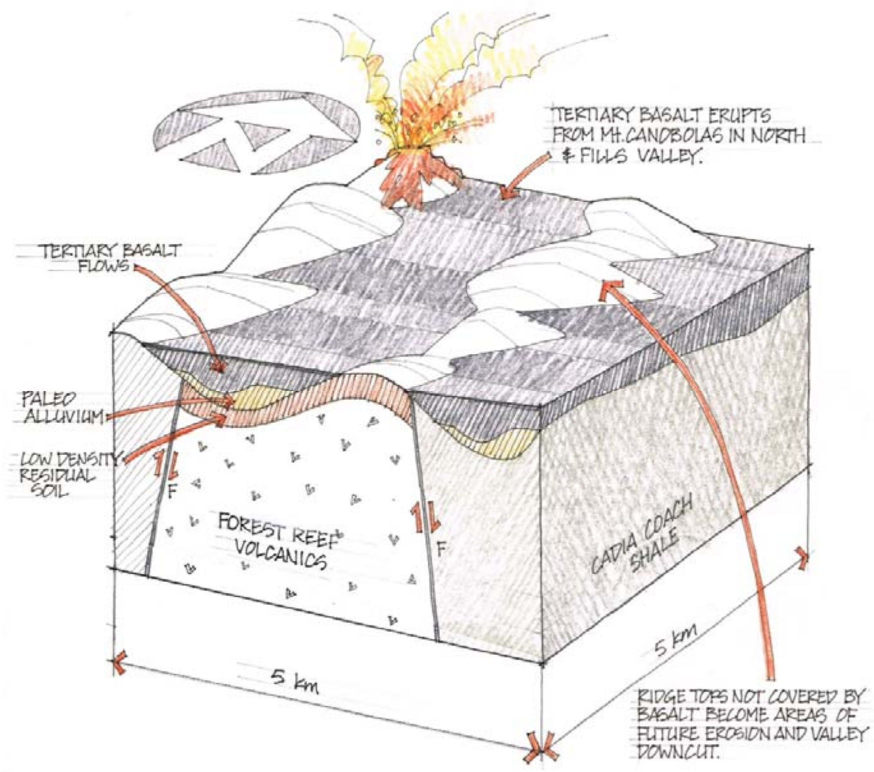


Figure C9-3: Basalt flows down valleys and covers paleo alluvium.

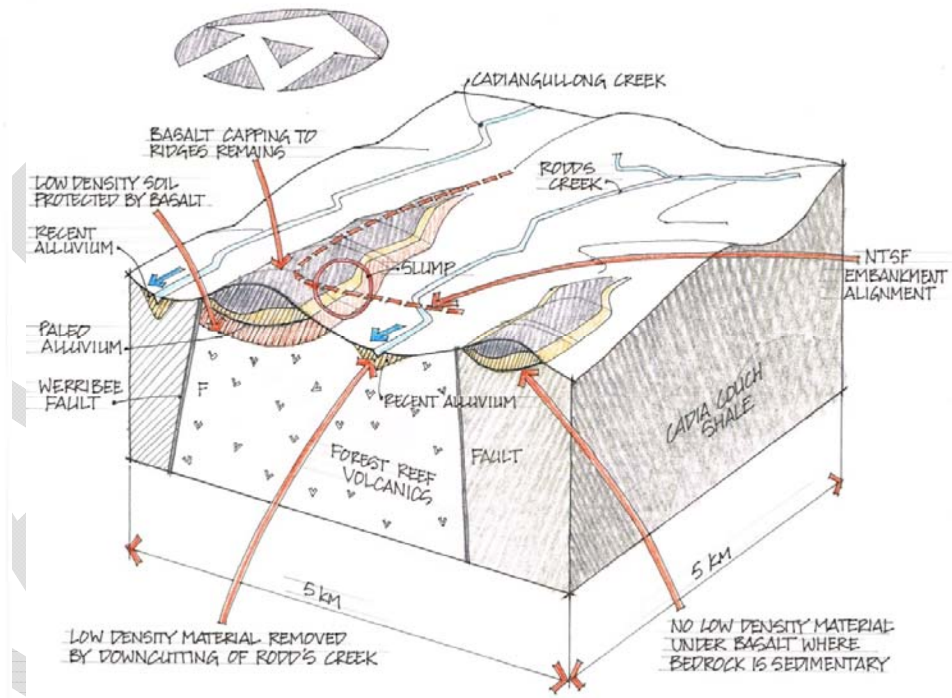


Figure C9-4: Stream downcutting results in the formation of Rodds Creek.

C9.3 Basalt Basal Contours

Contours of the base of the Tertiary basalt have been developed using the results of the current and previous investigations. The extents of the basalt and basal contours are shown on Figure C5 (Annexure CA). The following principals were used in developing the contours:

- The maximum depth of the basalt was intersected (CE399);
- Current geomorphic principals were applied;
- Where practical a linear interpolation was adopted between drillhole intersections;
- Available geological mapping of the basalt was honoured (except where noted above); and
- Basal contours were terminated at the preconstruction ground surface even though any evidence of basalt at this point may have been obscured by weathering, alluvium or colluvium.

C9.4 Geological Sections

The location of geological sections in the vicinity of the NTSF slump are shown on Figure C6 (Annexure CA), while the geological sections are shown on Figures C7 through to C11 (Annexure CA).

The following points should be noted in relation to the geological sections;

- Shading for basalt and FRV applied to the sections includes residual soil and weathering products developed over each of the materials.
- As some drillholes are offset from the sections, drillhole intersections may not completely agree with boundaries such as the base of basalt.

C9.5 Geological Model at Slump

The geological model at the NTSF slump is complex, with basalt partially removed by weathering, paleosoils beneath the basalt appearing to either lens out or be removed by erosion and the underlying volcaniclastic materials being variably weathered.

Notwithstanding the above, the geological section at the NTSF slump is best described by drillhole CE416, located on the western edge of the slump. This hole, together with the hole at the centre of the slump (CE435) and the hole immediately east of the slump (CE432) are summarised in Table C9-1.

Detailed results of laboratory tests undertaken on materials listed in Table C9-1 are included Appendix D.

Table C9-1: Geological section at NTSF slump

	CE416		CE435		CE432	
	RL	Th	RL	Th	RL	Th
Original Ground Surface	689.0		684.0		671.0	
Material Removed		2.2		5.30		2.0 (2)
Residual Basalt	686.8 685.7	1.10				
HW to MW Basalt	685.7 683.8	1.9				
Paleo Alluvium	683.8 682.6	1.2				
Unit A - FRV	682.6 676.0	6.6				
Unit B - FRV	676.0 671.5	4.5	678.7 (1) 674.3	4.2	669.0 660.5	8.5
MW - FRV	671.5 668.0	3.5	674.3 671.5	2.8	660.5 653.0	7.5
SW to Fresh - FRV	668.0 666.0	+2.0	671.5 669.8	+1.7	653.0 652.5	+0.5

Notes:

RL Level (m)

Th Layer Thickness (m)

(1) Base of slump recorded at RL677.15 in CE433

(2) Topsoil noted at base of rockfill; original ground surface level may be in error.

Key features of the geological model at the slump are:

- The base of rockfill, in drillholes CE416 and CE432 is ~2 m below the original ground surface level (implying a 2m depth of excavation). However, topsoil was logged in CE432 indicating a lesser depth of excavation.
- Approximately 1 m of high plasticity, residual basaltic clay remained on the western side of the slump.
- Two metres of high to moderately weathered basalt was intersected in CE416, with the base of the basalt at RL683.8m. Basalt was not recorded in TP113 (80 m SE of CE416), where the original ground surface level was RL683.9. At TP113, it would appear that the basalt has been removed by erosion.
- Paleo alluvium in CE417 (100 m W of CE416), was 6 m thick and contained organic black clay. At CE416 the paleo alluvium had thinned to 1.2 m and only comprised high plasticity, grey Silty CLAY. As the paleo alluvium was not observed in TP113, it would appear that it had either lensed out before TP113, or had been removed by erosion.

- Residual soil, extremely and highly weathered FRV were intersected in both CE416 and CE432. However, the weathering profile beneath the Tertiary basalt is deeper than that where the basalt has been removed by erosion.
- Unit A to the west of the slump includes both residual soil and extremely weathered FRV.
- Unit B to the east of the slump includes both residual soil and highly weathered FRV, while to the west of the slump it is only highly weathered FRV.
- Pink / purple colouring and white mottling characteristic of Unit A and similar to that observed at the toe of the NTSF embankment (PL1 BS1), can be seen in photographs of TP113, excavated into residual soil and extremely weathered FRV.
- The depth of weathering in CE435 is less than that which could be reasonably inferred from adjacent drillholes.
- Depending on the depth of stripping below the downstream shell of the NTSF, the NTSF slump has removed between 3m and 5m of residual volcaniclastic soil.

The geological model in the vicinity of the NTSF slump is summarized in Figure C9-5.

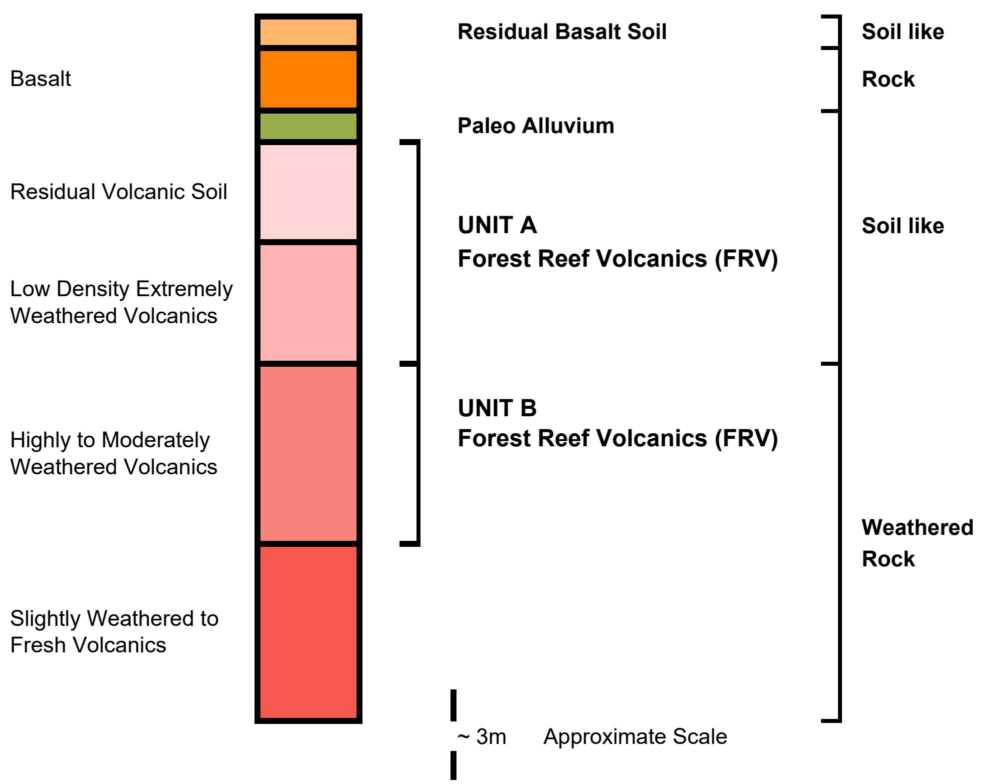


Figure C9-5: Geological model at NTSF slump.

C10. References

Fookes, P., & Ed. (1997). Tropical Residual Soils. *A Geological Society Engineering Group working party revised report. Geological Society Professional Handbooks.*

Fookes, P., Gourley, C., & Ohikere, C. (1988). Rock weathering in engineering time. *Quarterly Journal of Engineering Geology and Hydrogeology, 21*, 33-57.

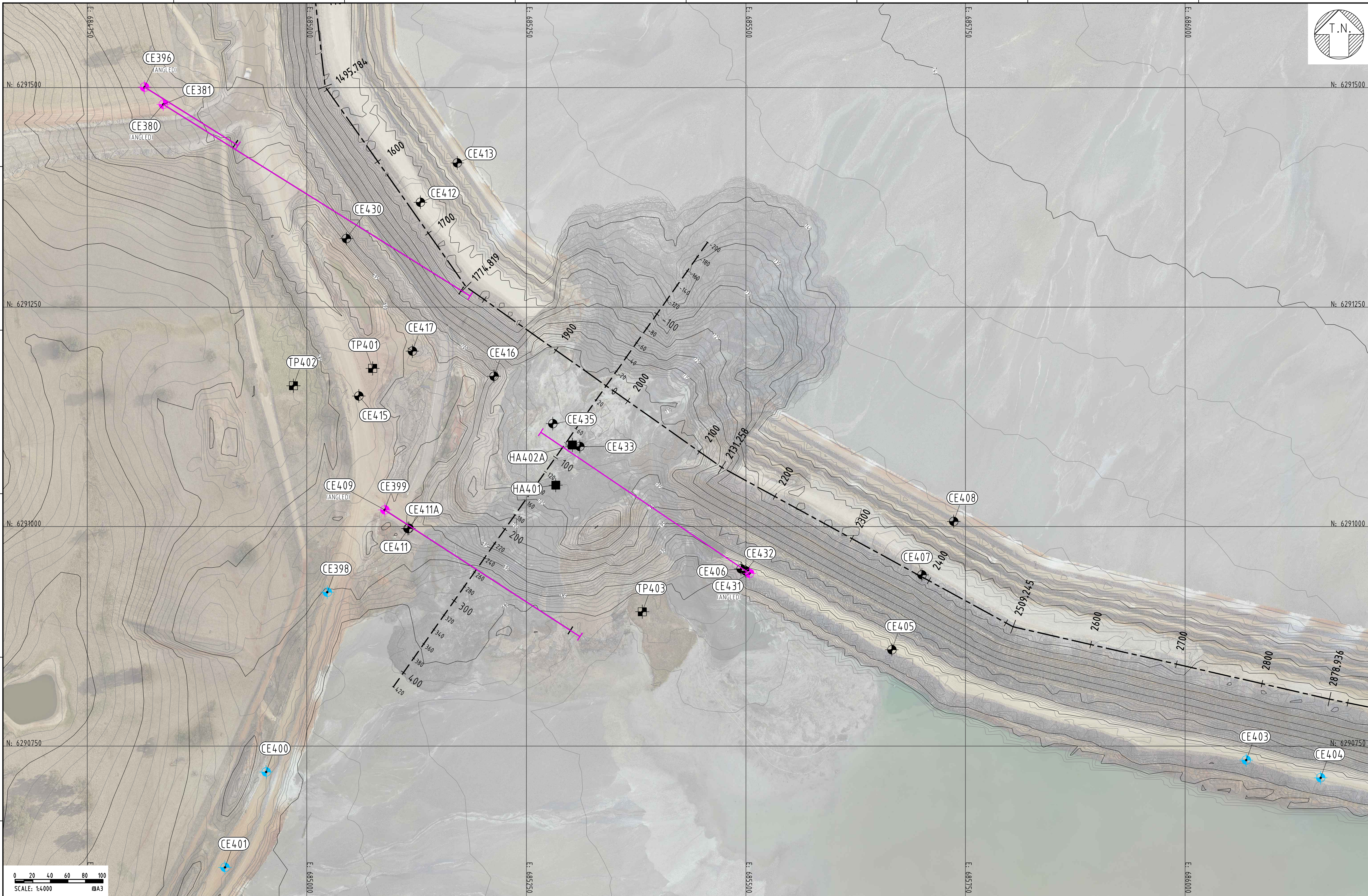
Harris, A., Percival, I., Cooke, D., Tosdal, R., Fox, N., Allen, C., . . . Collet, D. (2014). Marine Volcanosedimentary Basins Hosting Porphyry Au-Cu Deposits, Cadia Valley, New South Wales, Australia. *Economic Geology, V109*, 1117-1135.

Price, J., & Velbel, M. (2003). hemical weathering indices applied to weathering profiles developed on heterogenous felsic metamorphic parent material. *Chemical Geology, V202*, 397-416.

Roberston, P. (1990). Soil classification using the cone penetration test. *Canadian Geotechnical Journal, Vol. 27*.

Wilson, A. (2003). *The geology, genesis and exploration context of the Cadia gold-copper porphyry deposits, New South Wales, Australia.* Submitted in fulfillment of the requirements for the degree of Doctor of Philosophy, University of Tasmania.

Annexure CA
Figures



NOTES

1. ALL DIMENSIONS, ELEVATIONS AND COORDINATES ARE IN METERS, EXCEPT WHERE INDICATED OTHERWISE.
2. HORIZONTAL DATUM CORRESPONDS TO GDA 94 MGA ZONE 55.
3. VERTICAL DATUM CORRESPONDS TO AHD.
4. LIDAR SURVEY COMPLETED BY AAM ON THE 19TH OF MARCH 2018.

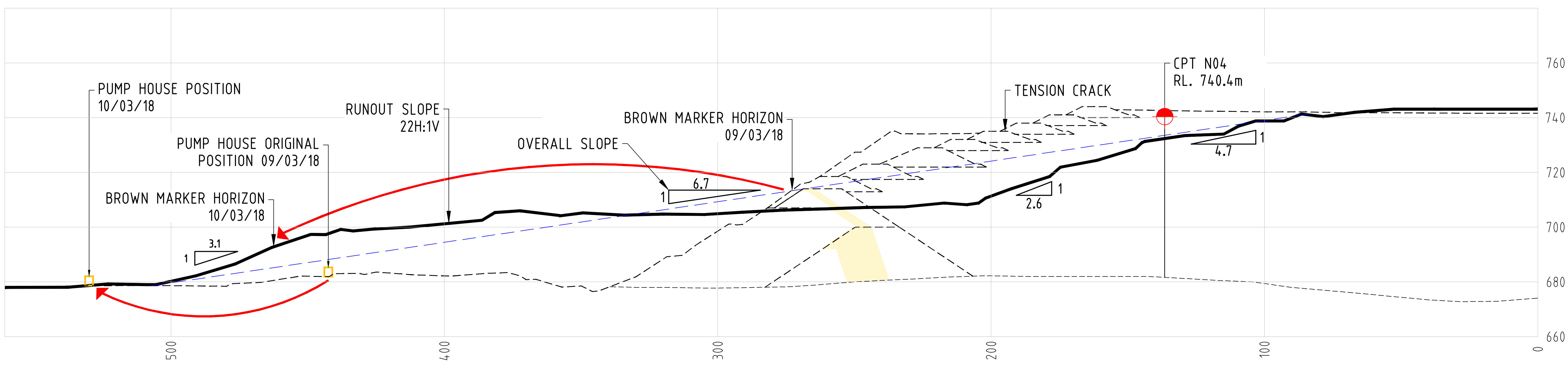
LEGEND

- ITRB DRILLHOLE
- ITRB TEST PIT
- ITRB HAND AUGER
- GHD DRILLHOLE
- NEWCREST DRILLHOLE
- NTSF SETOUT LINE
- SLUMP CENTRELINE
- HORIZONTAL PROJECTION OF INCLINED DRILLHOLE

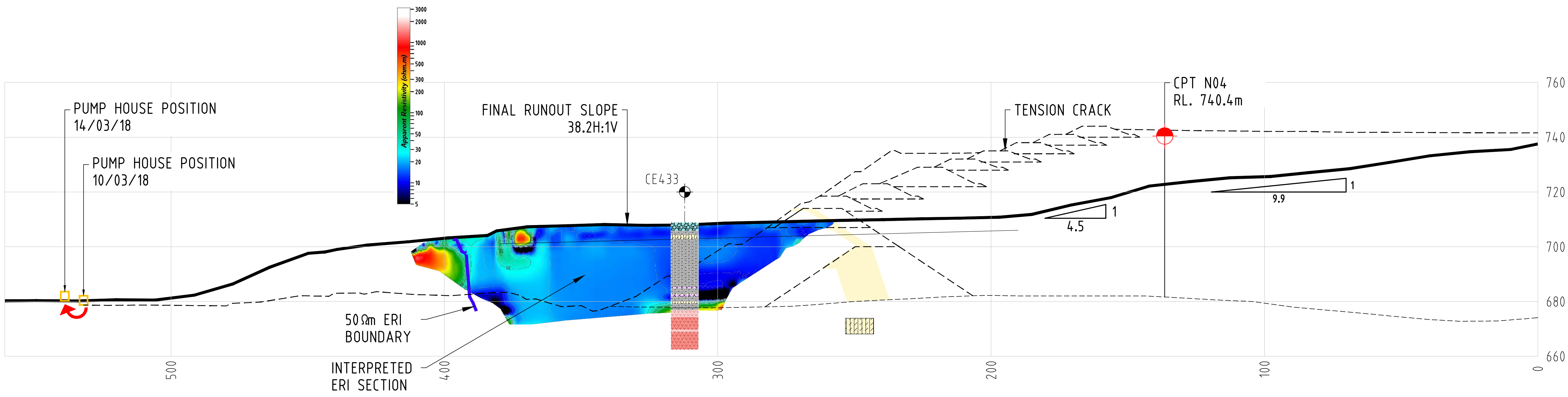
2018 INVESTIGATION LOCATIONS

CADIA NTSF FAILURE INDEPENDENT TECHNICAL REVIEW BOARD

FIGURE C1		
DESIGNED IG	DRAWN PK	APPROVED
DATE 13-02-2019	DWG. No. H356804-00000-22A-270-0101	



ANNOTATED SECTION THROUGH SLUMP - MARCH 10, 2018



ANNOTATED SECTION THROUGH SLUMP - MARCH 14, 2018

0 7.5 15.0 22.5 30.0 37.5
SCALE: 1:1500 @A3

NOTES

1. ALL DIMENSIONS, ELEVATIONS AND COORDINATES ARE IN METERS, EXCEPT WHERE INDICATED OTHERWISE
2. VERTICAL DATUM CORRESPONDS TO AHD

LEGEND

- DRILLHOLE FROM HATCH (2018)
- CPT FROM ATCW TAILINGS INVESTIGATION (2017)
- PRE-CONSTRUCTION SURFACE
- NTSF AS-BUILT
- TOPOGRAPHY ON DATE OF LIDAR

UNIT	DESCRIPTION
	TAILINGS
	CLAY FILL
	ROCKFILL
	MIXED FILL
	NO SAMPLING
	EW/HW VOLCANICLASTIC
	SW/F VOLCANICLASTIC

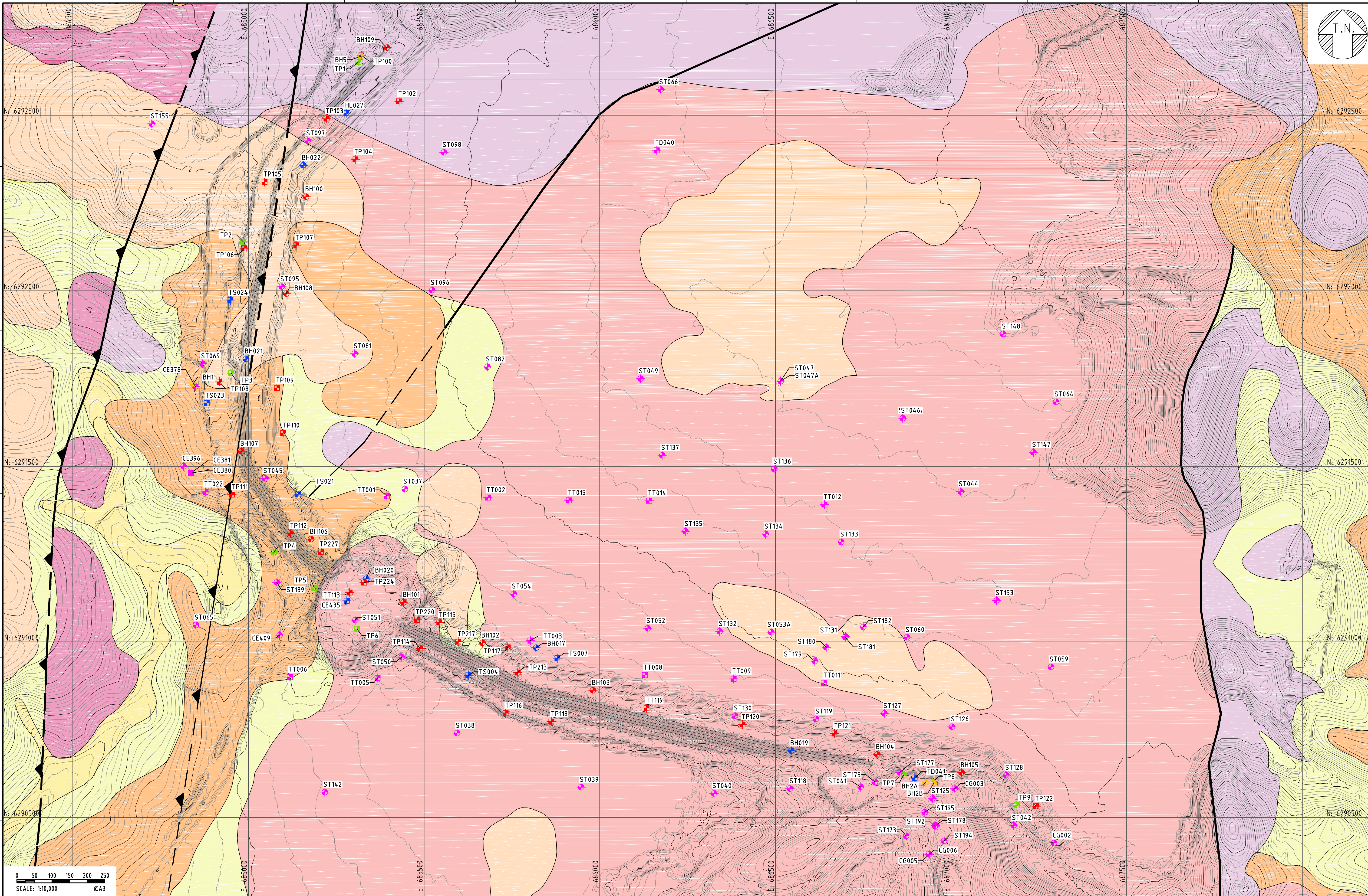
ANNOTATED SECTION THROUGH SLUMP

CADIA NTSF FAILURE INDEPENDENT TECHNICAL REVIEW BOARD

FIGURE C2

DESIGNED	DRAWN	APPROVED
IG	PK	

DATE	DWG. No.
13-02-2019	H356804-00000-22A-273-0100



NOTES

1. ALL DIMENSIONS, ELEVATIONS AND COORDINATES ARE IN METERS, EXCEPT WHERE INDICATED OTHERWISE.
2. HORIZONTAL DATUM CORRESPONDS TO GDA 94 MGA ZONE 55.
3. VERTICAL DATUM CORRESPONDS TO AHD.
4. LIDAR SURVEY COMPLETED BY AAM ON THE 19TH OF MARCH 2018.
5. GEOLOGY BASED ON NEWCREST GEOLOGICAL MAP DATED 24/05/2000.

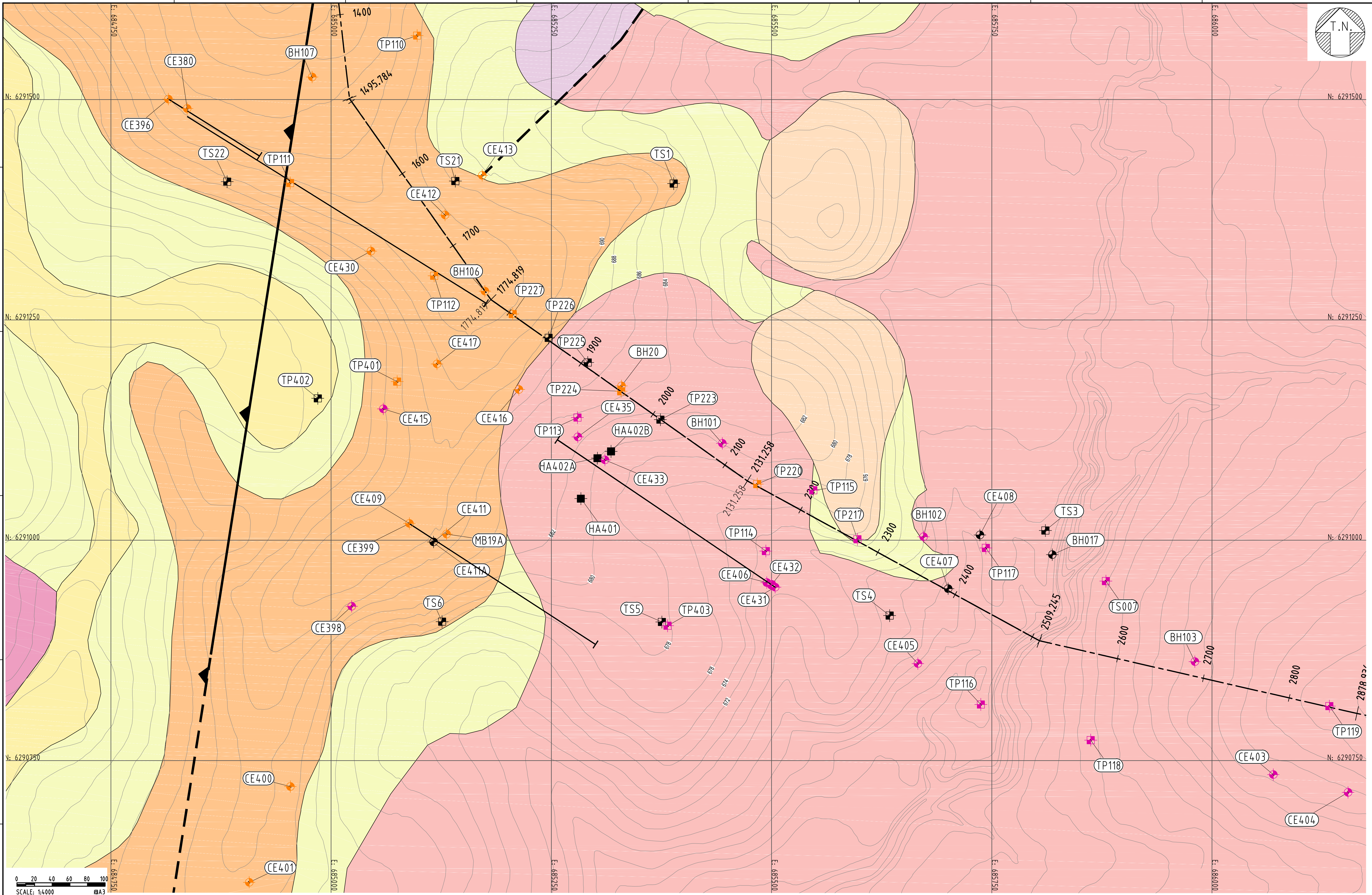
LEGEND

- PELLS SULLIVAN MEYNINK (DECEMBER, 1996) DRILLHOLE
- PELLS SULLIVAN MEYNINK (DECEMBER, 1996) TEST PIT
- WOODWARD-CLYDE (SEPTEMBER, 1995) DRILLHOLE
- WOODWARD-CLYDE (SEPTEMBER, 1995) TEST PIT
- NEWCREST DRILLHOLE
- NEWCREST TEST PIT
- ATCW (APRIL, 2017) DRILLHOLE
- ATCW (MARCH, 2018) TEST PIT
- ALLUVIUM (QUATERNANY)
- COLLUVIUM (QUATERNANY)
- GRAVELS (TERTIARY)
- BASALT (TERTIARY)
- CADIA COACH SHALE (SILURIAN)
- FOREST REEF VOLCANIC (ORDOVICIAN)
- WEEMALLA FORMATION (ORDOVICIAN)
- FAULT (MAPPED)
- FAULT (INFERRED)
- THRUST FAULT

NTSF GEOLOGY AND PREVIOUS INVESTIGATION LOCATIONS

CADIA NTSF FAILURE INDEPENDENT TECHNICAL REVIEW BOARD

FIGURE C3		
DESIGNED IG	DRAWN PK	APPROVED
DATE 13-02-2019	DWG. No. H356804-00000-22A-274-0002	



NOTES

1. ALL DIMENSIONS, ELEVATIONS AND COORDINATES ARE IN METERS, EXCEPT WHERE INDICATED OTHERWISE.
2. HORIZONTAL DATUM CORRESPONDS TO GDA 94 MGA ZONE 55.
3. VERTICAL DATUM CORRESPONDS TO AHD.
4. GEOLOGY BASED ON NEWCREST GEOLOGICAL MAP DATED 24TH MAY 2000.
5. CONTOURS DEPICT PRE-CONSTRUCTION TOPOGRAPHY.

LEGEND

NTSF SETOUT LINE
SLUMP CENTRELINE
PRE-CONSTRUCTION CONTOURS

TEST PIT, DRILLHOLE } ROCK TYPE NOT SPECIFIED OR NOT INTERSECTED
TEST PIT, DRILLHOLE } BASALT REPORTED
TEST PIT, DRILLHOLE } FRV REPORTED

ALLUVIUM (QUATERNANY)
COLLUVIUM (QUATERNANY)
GRAVELS (TERTIARY)
BASALT (TERTIARY)
CADIA COACH SHALE (SILURIAN)
FOREST REEF VOLCANIC (ORDOVICIAN)
WEEMALLA FORMATION (ORDOVICIAN)

FAULT (MAPPED)
FAULT (INFERRED)
THRUST FAULT
HORIZONTAL PROJECTION OF INCLINED DRILLHOLE

SLUMP GEOLOGY

CADIA NTSF FAILURE INDEPENDENT TECHNICAL REVIEW BOARD

FIGURE C4

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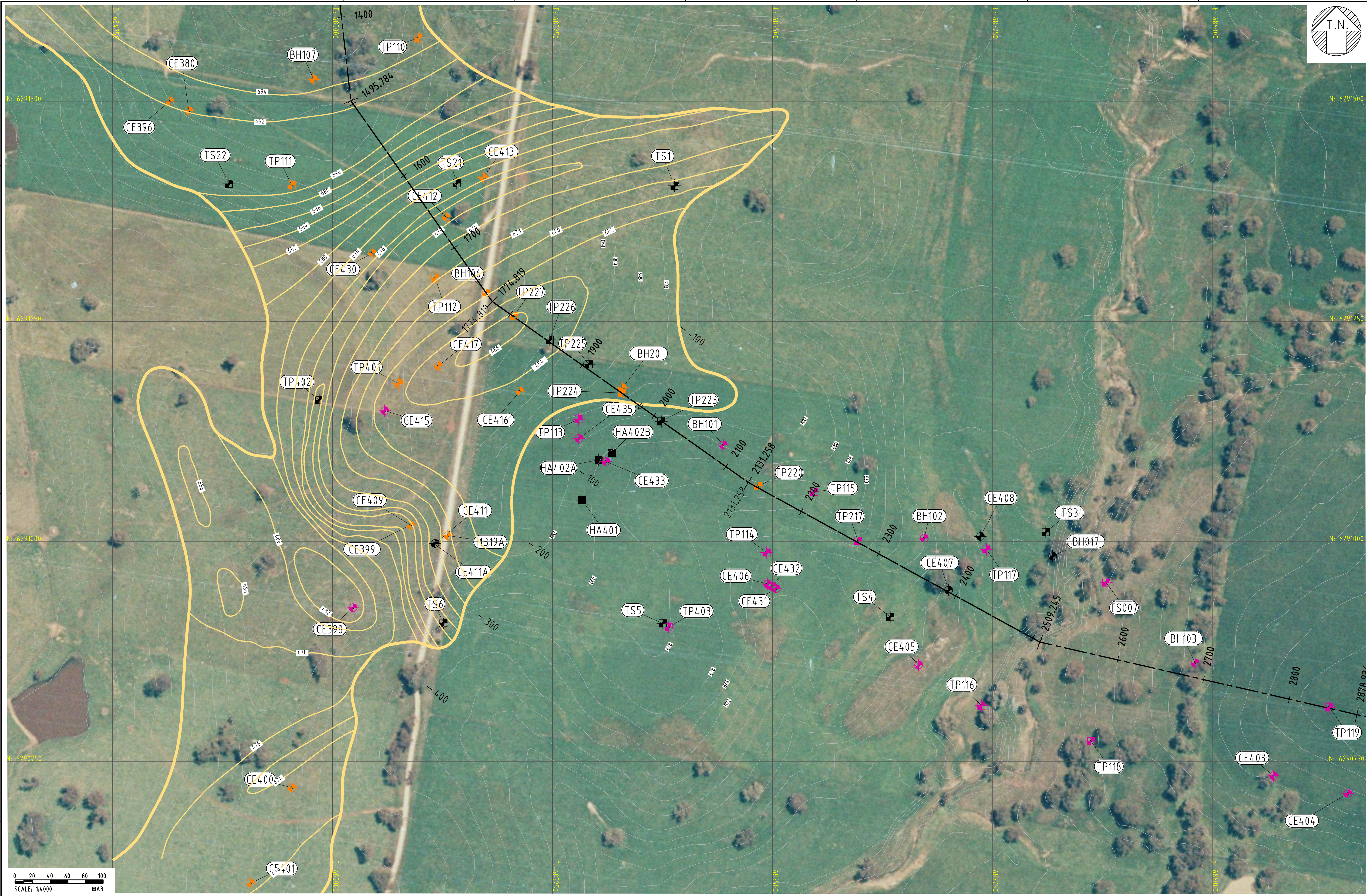
IG	PK	
DATE	DWG. No.	
13-02-2019	H356804-00000-22A-274-0003	



NOTES

1. ALL DIMENSIONS, ELEVATIONS AND COORDINATES ARE IN METERS, EXCEPT WHERE INDICATED OTHERWISE.
2. HORIZONTAL DATUM CORRESPONDS TO GDA 94 MGA ZONE 55.
3. VERTICAL DATUM CORRESPONDS TO AHD.
4. AERIAL PHOTO PROVIDED FROM THE NSW SPATIAL SERVICES, DATED 29TH OCTOBER 1993.
5. CONTOURS DEPICT PRE-CONSTRUCTION TOPOGRAPHY.

LEGEND

- NTSF SETOUT LINE
- SLUMP CENTRELINE
- BASALT CONTOURS
- PRE-CONSTRUCTION CONTOURS
- TEST PIT / DRILLHOLE } ROCK TYPE NOT SPECIFIED OR NOT INTERSECTED
- TEST PIT / DRILLHOLE } BASALT REPORTED
- TEST PIT / DRILLHOLE } FRV REPORTED

INFERRED BASE OF BASALT CONTOURS

CADIA NTSF FAILURE INDEPENDENT TECHNICAL REVIEW BOARD

FIGURE C5		
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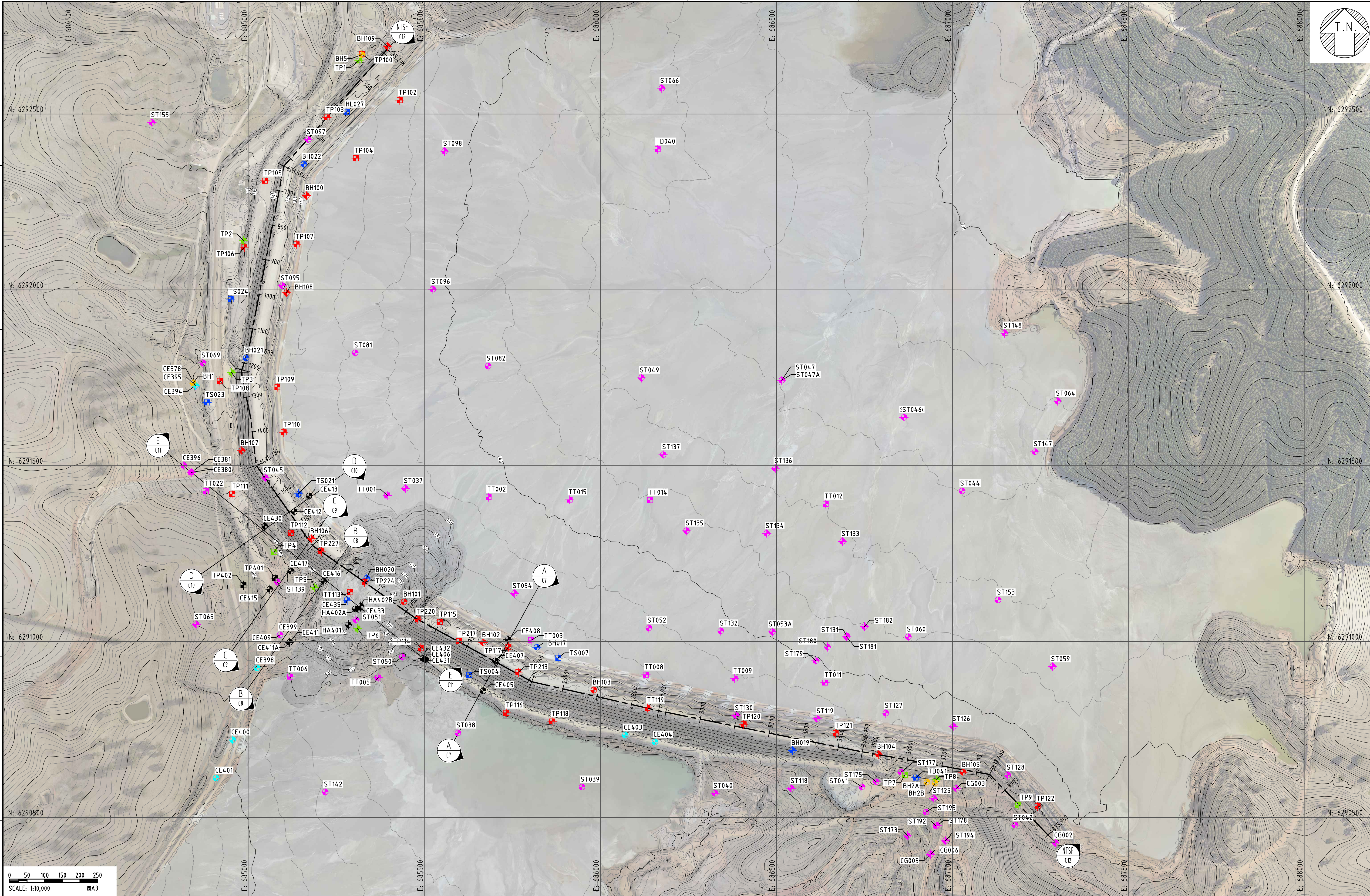
DATE 13-02-2019	DWG. No. H356804-00000-22A-274-0004	



NOTES

1. ALL DIMENSIONS, ELEVATIONS AND COORDINATES ARE IN METERS, EXCEPT WHERE INDICATED OTHERWISE.
2. HORIZONTAL DATUM CORRESPONDS TO GDA 94 MGA ZONE 55.
3. VERTICAL DATUM CORRESPONDS TO AHD.
4. LIDAR SURVEY COMPLETED BY AAM ON THE 19TH OF MARCH 2018.

LEGEND

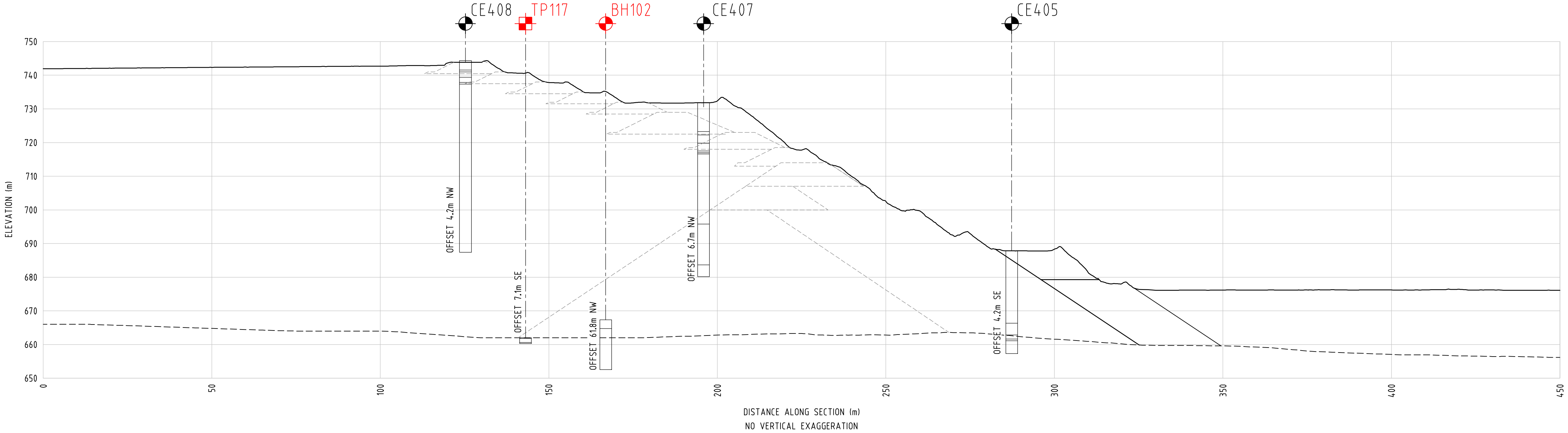
- ITRB DRILLHOLE
- ITRB TEST PIT
- ITRB HAND AUGER
- GHD DRILLHOLE
- PELLS SULLIVAN MEYNINK (DECEMBER, 1996) DRILLHOLE
- PELLS SULLIVAN MEYNINK (DECEMBER, 1996) TEST PIT
- WOODWARD-CLYDE (SEPTEMBER, 1995) DRILLHOLE
- WOODWARD-CLYDE (SEPTEMBER, 1995) TEST PIT
- NEWCREST DRILLHOLE
- NEWCREST TEST PIT
- ATCW (APRIL, 2017) DRILLHOLE
- ATCW (MARCH, 2018) TEST PIT
- NTSF SETOUT LINE

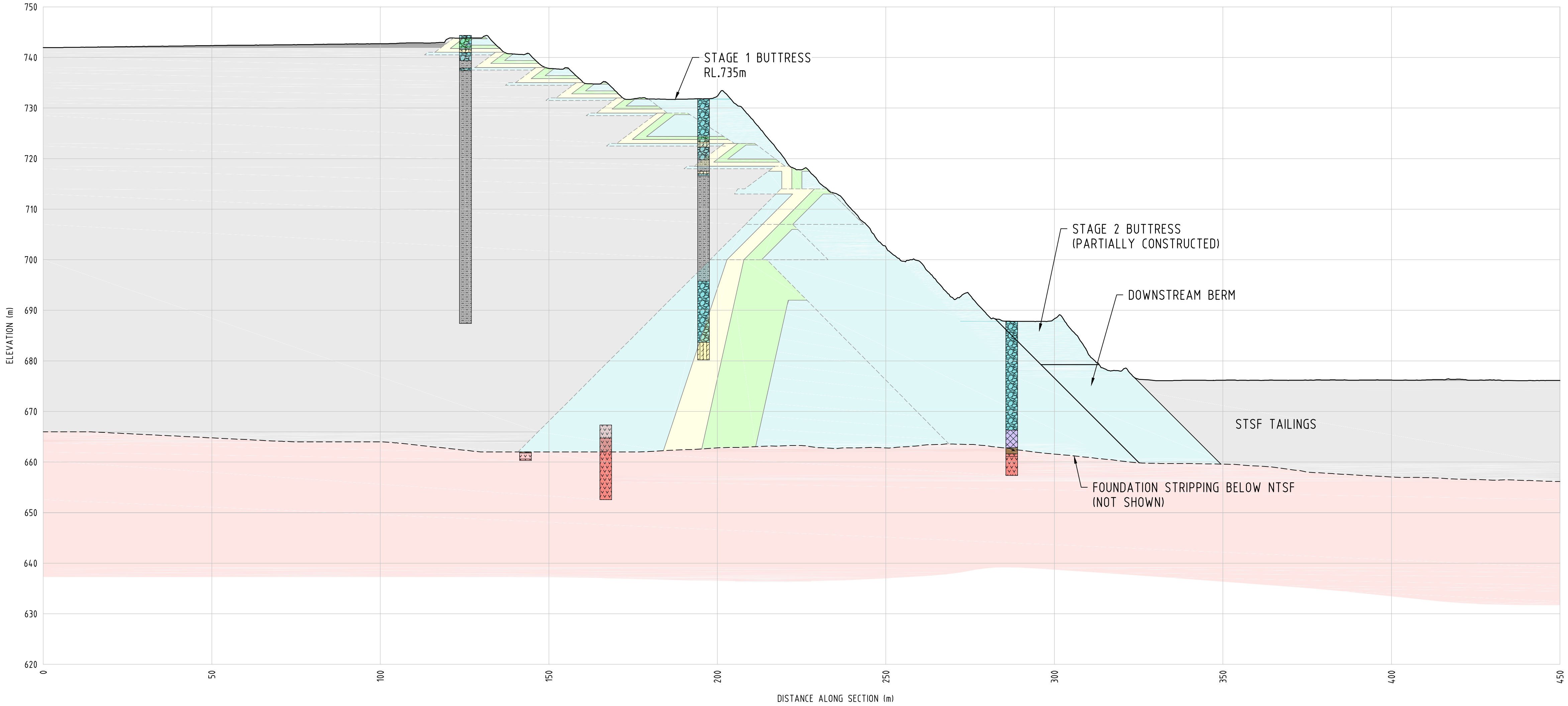
LOCATION OF GEOLOGICAL SECTIONS

CADIA NTSF FAILURE INDEPENDENT TECHNICAL REVIEW BOARD

FIGURE C6

DESIGNED	DRAWN	APPROVED
IG	PK	
DATE	DWG. No.	
13-02-2019	H356804-00000-22A-270-0201	





GEOLOGY (AGE)	UNIT	DESCRIPTION
ENGINEERED FILL (RECENT)		TAILINGS
		CLAY FILL
		FILTER / TRANSITION FILL
		ROCKFILL
		MIXED FILL
		SLUMP MATERIAL
(QUATERNARY)		TOPSOIL/COLLUVIUM/ ALLUVIUM
(TERTIARY)		RESIDUAL BASALT
		BASALT
		PALEO ALLUVIUM
CADIA COACH SHALE (SILURIAN)		INTERBEDDED SEDIMENTARY ROCKS
FOREST REEF VOLCANICS (ORDOVICIAN)		RESIDUAL VOLCANICLASTIC
		EW/HW VOLCANICLASTIC
		MW VOLCANICLASTIC
		SW/F VOLCANICLASTIC
WEEMALLA FORMATION (ORDOVICIAN)		INTERBEDDED SEDIMENTARY ROCKS

0 7.5 15.0 22.5 30.0 37.5
SCALE: 1:1500 @A3

SECTION A
SCALE H
VERTICAL EXAGGERATION 1.5:1
FIG C6

NOTES

1. ALL DIMENSIONS, ELEVATIONS AND COORDINATES ARE IN METERS, EXCEPT WHERE INDICATED OTHERWISE
2. HORIZONTAL DATUM CORRESPONDS TO GDA 94 MGA ZONE 55
3. VERTICAL DATUM CORRESPONDS TO AHD
4. LIDAR SURVEY COMPLETED BY AAM ON THE 19TH OF MARCH 2018

LEGEND

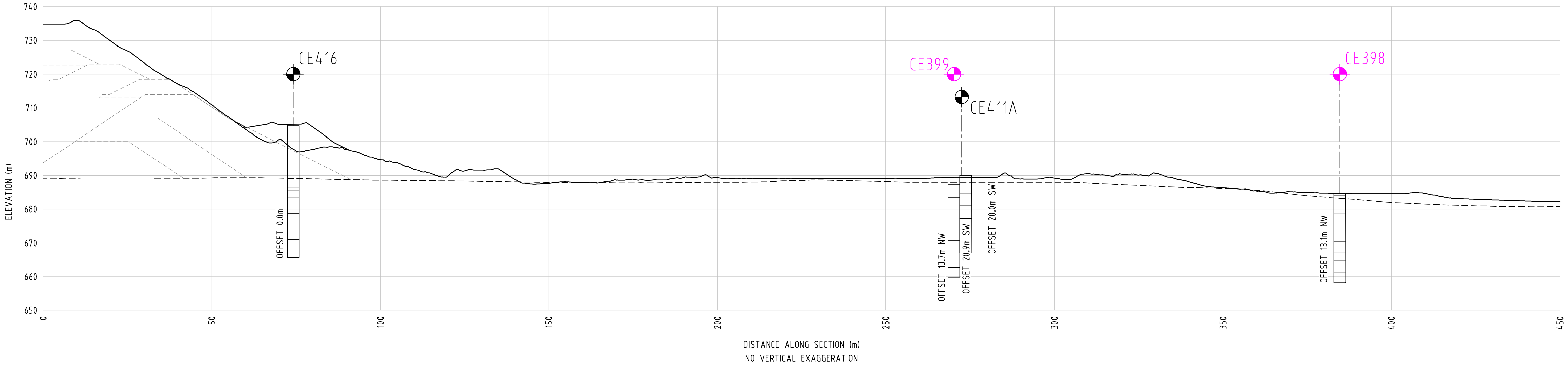
- ITRB DRILLHOLE (2018)
- ITRB TEST PIT (2018)
- ITRB HAND AUGER (2018)
- DRILLHOLE FROM GHD
- DRILLHOLE FROM PELLS SULLIVAN MEYNINK (DECEMBER, 1996)
- TEST PIT FROM PELLS SULLIVAN MEYNINK (DECEMBER, 1996)
- DRILLHOLE FROM WOODWARD-CLYDE (SEPTEMBER, 1995)
- TEST PIT FROM WOODWARD-CLYDE (SEPTEMBER, 1995)
- DRILLHOLE FROM NEWCREST
- TEST PIT FROM NEWCREST
- LIDAR COMPLETED ON 19TH OF MARCH 2018
- PRE-CONSTRUCTION SURFACE
- ? INFERRED BOUNDARY

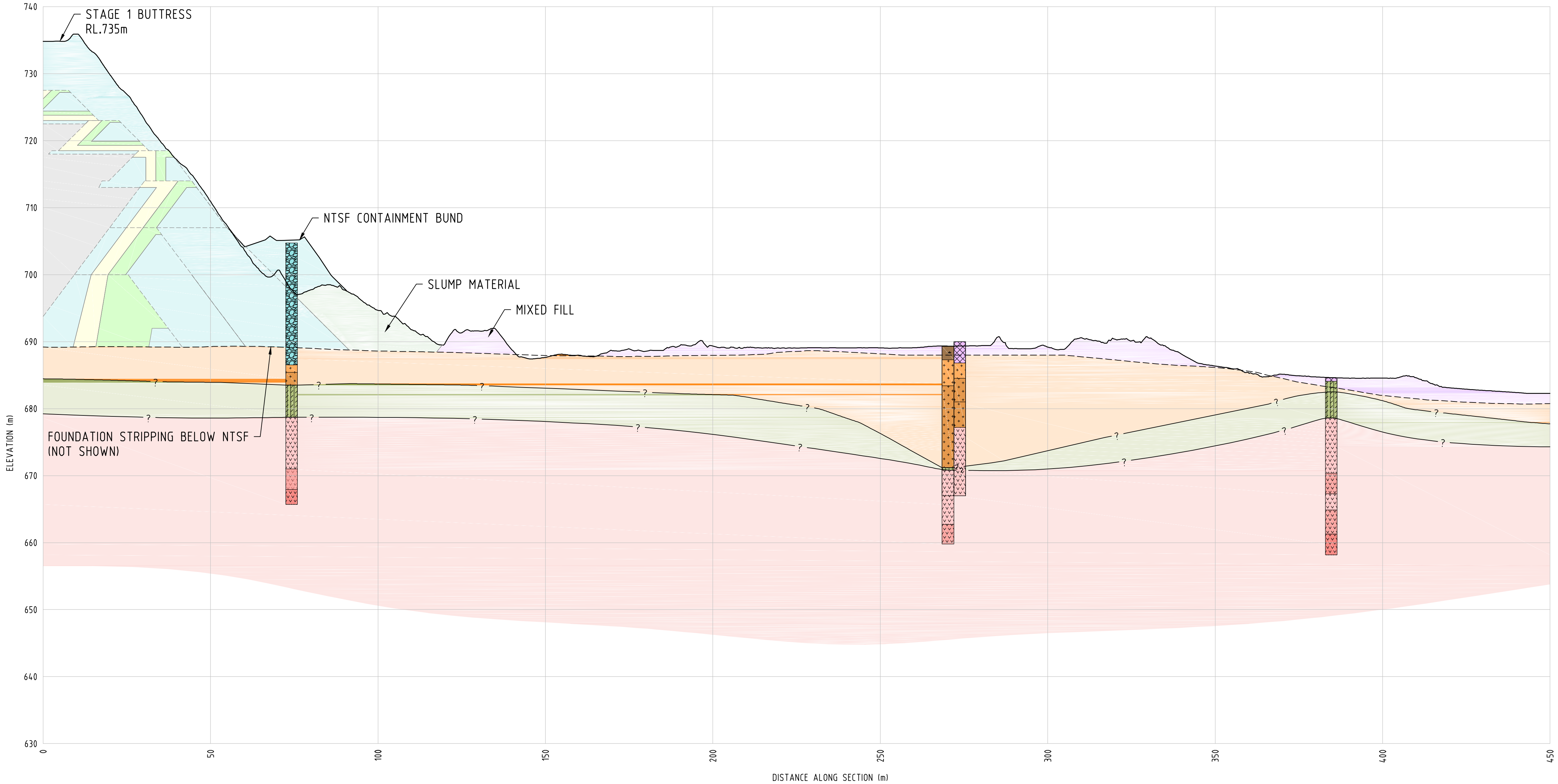
GEOLOGICAL SECTION A

CADIA NTSF FAILURE INDEPENDENT TECHNICAL REVIEW BOARD

FIGURE C7

DESIGNED	DRAWN	APPROVED
IG	PK	
DATE	DWG. No.	
13-02-2019	H356804-00000-22A-273-0201	





SECTION B
SCALE H
VERTICAL EXAGGERATION 2:1
FIG C6

GEOLOGY (AGE)	UNIT	DESCRIPTION
ENGINEERED FILL (RECENT)		TAILINGS
		CLAY FILL
		FILTER / TRANSITION FILL
		ROCKFILL
		MIXED FILL
		SLUMP MATERIAL
(QUATERNARY)		TOPSOIL/COLLUVIUM/ ALLUVIUM
(TERTIARY)		RESIDUAL BASALT
		BASALT
		PALEO ALLUVIUM
CADIA COACH SHALE (SILURIAN)		INTERBEDDED SEDIMENTARY ROCKS
FOREST REEF VOLCANICS (ORDOVICIAN)		RESIDUAL VOLCANICLASTIC
		EW/HW VOLCANICLASTIC
		MW VOLCANICLASTIC
		SW/F VOLCANICLASTIC
WEEMALLA FORMATION (ORDOVICIAN)		INTERBEDDED SEDIMENTARY ROCKS

0 7.5 15.0 22.5 30.0 37.5
SCALE: 1:1500 @A3

NOTES

1. ALL DIMENSIONS, ELEVATIONS AND COORDINATES ARE IN METERS, EXCEPT WHERE INDICATED OTHERWISE
2. HORIZONTAL DATUM CORRESPONDS TO GDA 94 MGA ZONE 55
3. VERTICAL DATUM CORRESPONDS TO AHD
4. LIDAR SURVEY COMPLETED BY AAM ON THE 19TH OF MARCH 2018

LEGEND

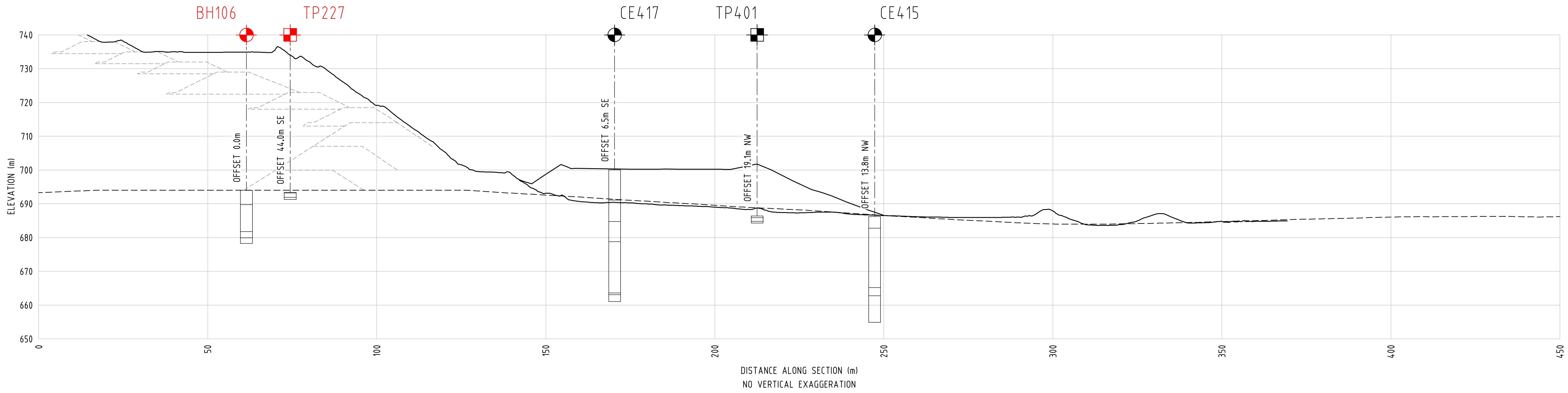
- ITRB DRILLHOLE (2018)
- ITRB TEST PIT (2018)
- ITRB HAND AUGER (2018)
- DRILLHOLE FROM GHD
- DRILLHOLE FROM PELLS SULLIVAN MEYNINK (DECEMBER, 1996)
- TEST PIT FROM PELLS SULLIVAN MEYNINK (DECEMBER, 1996)
- DRILLHOLE FROM WOODWARD-CLYDE (SEPTEMBER, 1995)
- TEST PIT FROM WOODWARD-CLYDE (SEPTEMBER, 1995)
- DRILLHOLE FROM NEWCREST
- TEST PIT FROM NEWCREST
- LIDAR COMPLETED ON 19TH OF MARCH 2018
- PRE-CONSTRUCTION SURFACE
- ? INFERRED BOUNDARY

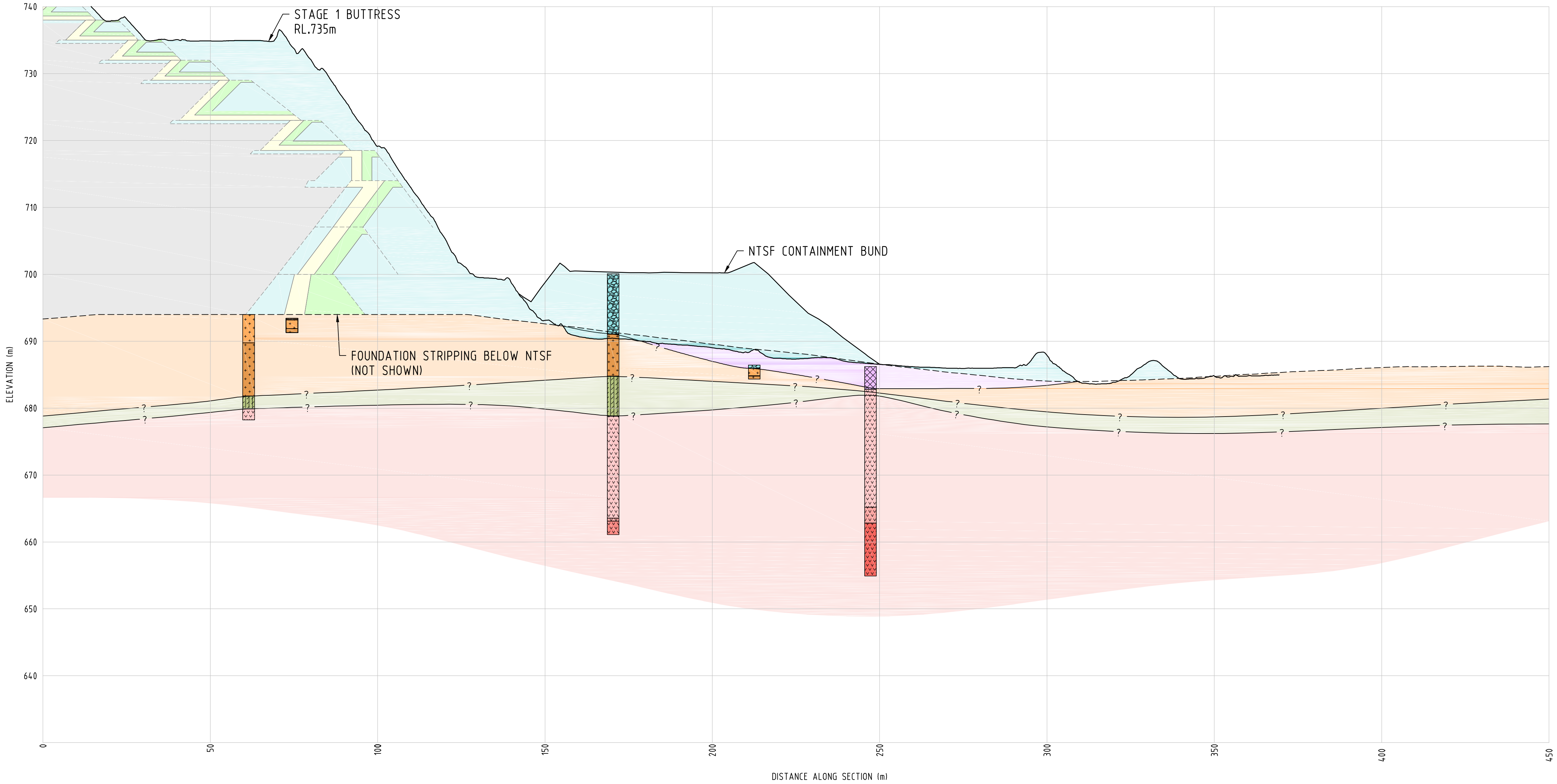
GEOLOGICAL SECTION B

CADIA NTSF FAILURE INDEPENDENT TECHNICAL REVIEW BOARD

FIGURE C8

DESIGNED	DRAWN	APPROVED
IG	PK	
DATE	DWG. No.	
13-02-2019	H356804-00000-22A-273-0202	





SECTION C
SCALE H
VERTICAL EXAGGERATION 2:1
FIG C6

GEOLOGY (AGE)	UNIT	DESCRIPTION
ENGINEERED FILL (RECENT)		TAILINGS
		CLAY FILL
		FILTER / TRANSITION FILL
		ROCKFILL
		MIXED FILL
		SLUMP MATERIAL
(QUATERNARY)		TOPSOIL/COLLUVIUM/ ALLUVIUM
(TERTIARY)		RESIDUAL BASALT
		BASALT
		PALEO ALLUVIUM
CADIA COACH SHALE (SILURIAN)		INTERBEDDED SEDIMENTARY ROCKS
FOREST REEF VOLCANICS (ORDOVICIAN)		RESIDUAL VOLCANICLASTIC
		EW/HW VOLCANICLASTIC
		MW VOLCANICLASTIC
		SW/F VOLCANICLASTIC
WEEMALLA FORMATION (ORDOVICIAN)		INTERBEDDED SEDIMENTARY ROCKS

0 7.5 15.0 22.5 30.0 37.5
SCALE: 1:1500 @A3

NOTES

1. ALL DIMENSIONS, ELEVATIONS AND COORDINATES ARE IN METERS, EXCEPT WHERE INDICATED OTHERWISE
2. HORIZONTAL DATUM CORRESPONDS TO GDA 94 MGA ZONE 55
3. VERTICAL DATUM CORRESPONDS TO AHD
4. LIDAR SURVEY COMPLETED BY AAM ON THE 19TH OF MARCH 2018

LEGEND

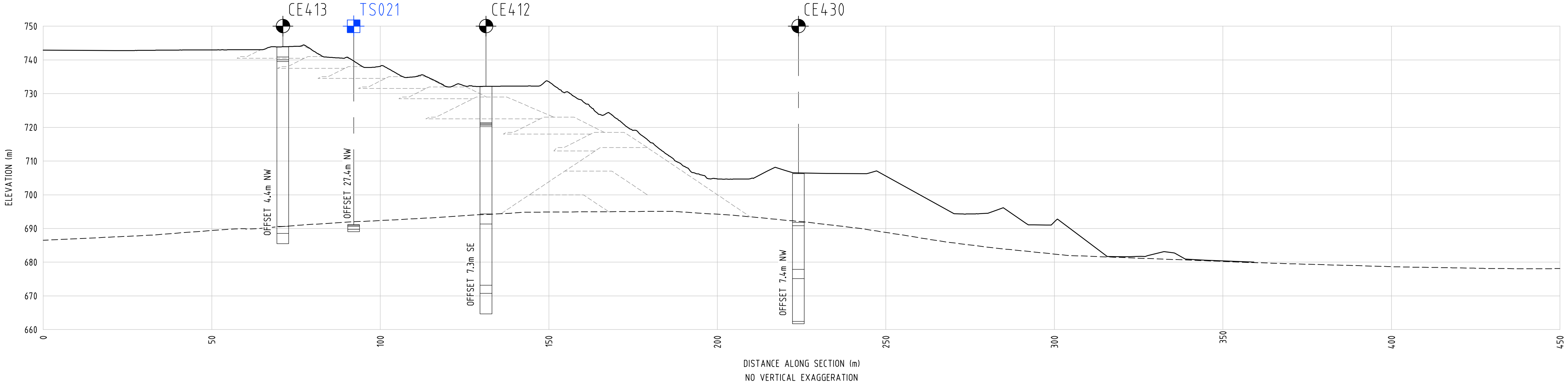
- ITRB DRILLHOLE (2018)
- ITRB TEST PIT (2018)
- ITRB HAND AUGER (2018)
- DRILLHOLE FROM GHD
- DRILLHOLE FROM PELLS SULLIVAN MEYNINK (DECEMBER, 1996)
- TEST PIT FROM PELLS SULLIVAN MEYNINK (DECEMBER, 1996)
- DRILLHOLE FROM WOODWARD-CLYDE (SEPTEMBER, 1995)
- TEST PIT FROM WOODWARD-CLYDE (SEPTEMBER, 1995)
- DRILLHOLE FROM NEWCREST
- TEST PIT FROM NEWCREST
- LIDAR COMPLETED ON 19TH OF MARCH 2018
- PRE-CONSTRUCTION SURFACE
- ? INFERRED BOUNDARY

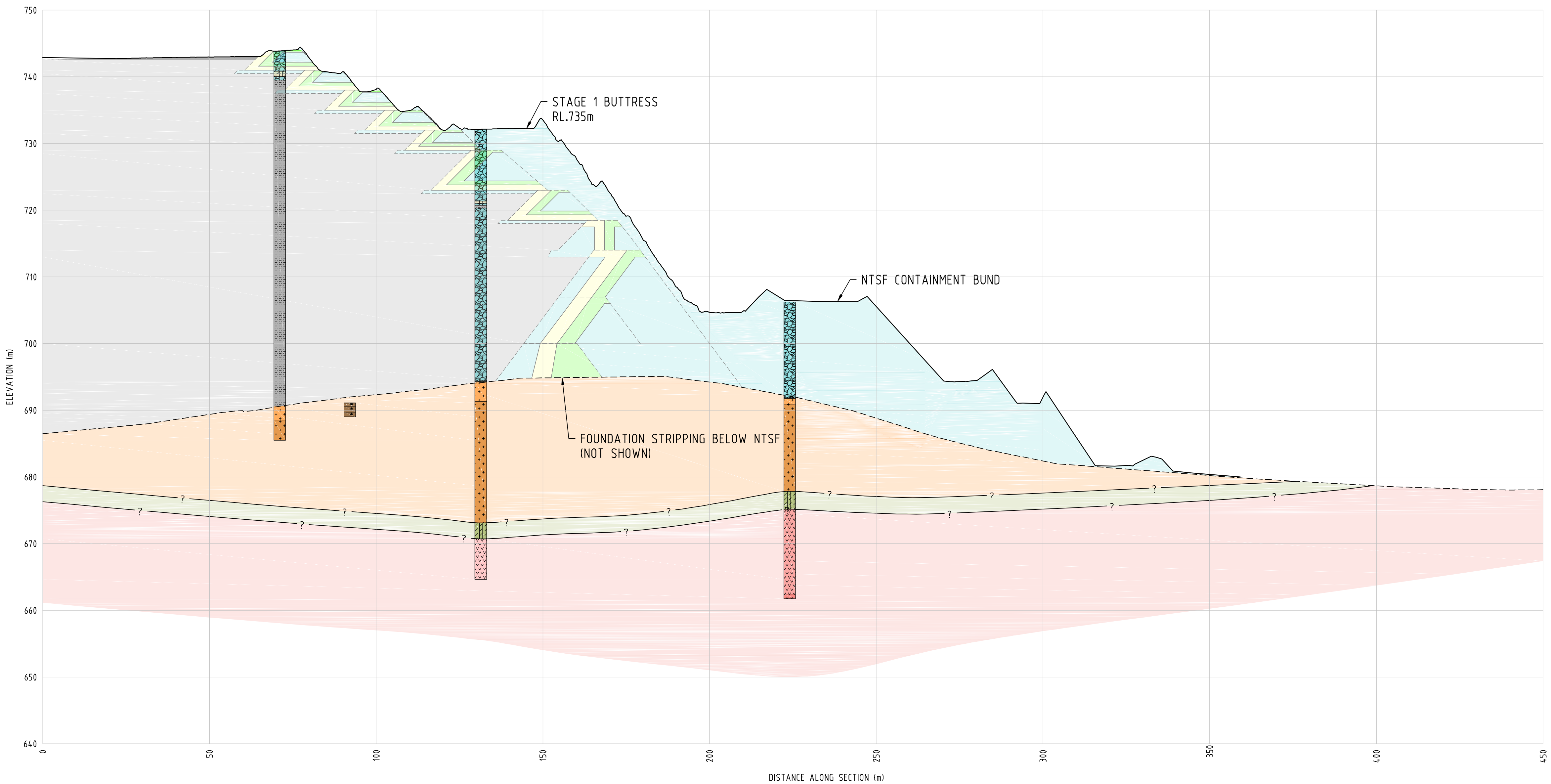
GEOLOGICAL SECTION C

CADIA NTSF FAILURE INDEPENDENT TECHNICAL REVIEW BOARD

FIGURE C9

DESIGNED	DRAWN	APPROVED
IG	PK	
DATE	DWG. No.	
13-02-2019	H356804-00000-22A-273-0203	





SECTION D
SCALE H
VERTICAL EXAGGERATION 2:1
FIG C6

GEOLOGY (AGE)	UNIT	DESCRIPTION
ENGINEERED FILL (RECENT)		TAILINGS
		CLAY FILL
		FILTER / TRANSITION FILL
		ROCKFILL
		MIXED FILL
		SLUMP MATERIAL
(QUATERNARY)		TOPSOIL/COLLUVIUM/ ALLUVIUM
(TERTIARY)		RESIDUAL BASALT
		BASALT
		PALEO ALLUVIUM
CADIA COACH SHALE (SILURIAN)		INTERBEDDED SEDIMENTARY ROCKS
FOREST REEF VOLCANICS (ORDOVICIAN)		RESIDUAL VOLCANICLASTIC
		EW/HW VOLCANICLASTIC
		MW VOLCANICLASTIC
		SW/F VOLCANICLASTIC
WEEMALLA FORMATION (ORDOVICIAN)		INTERBEDDED SEDIMENTARY ROCKS

0 7.5 15.0 22.5 30.0 37.5
SCALE: 1:1500 @A3

NOTES

1. ALL DIMENSIONS, ELEVATIONS AND COORDINATES ARE IN METERS, EXCEPT WHERE INDICATED OTHERWISE
2. HORIZONTAL DATUM CORRESPONDS TO GDA 94 MGA ZONE 55
3. VERTICAL DATUM CORRESPONDS TO AHD
4. LIDAR SURVEY COMPLETED BY AAM ON THE 19TH OF MARCH 2018

LEGEND

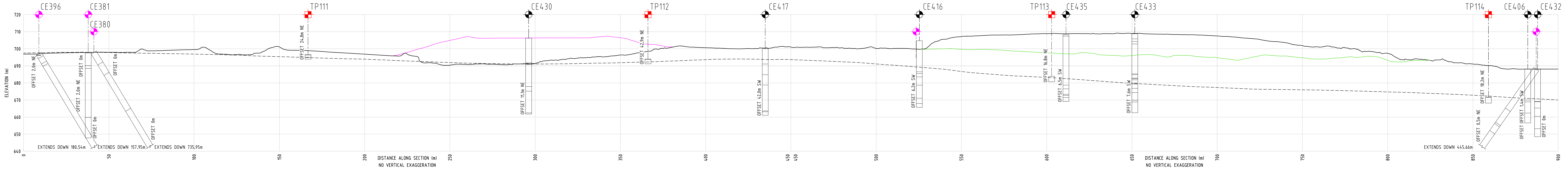
- ITRB DRILLHOLE (2018)
- ITRB TEST PIT (2018)
- ITRB HAND AUGER (2018)
- DRILLHOLE FROM GHD
- DRILLHOLE FROM PELLS SULLIVAN MEYNINK (DECEMBER, 1996)
- TEST PIT FROM PELLS SULLIVAN MEYNINK (DECEMBER, 1996)
- DRILLHOLE FROM WOODWARD-CLYDE (SEPTEMBER, 1995)
- TEST PIT FROM WOODWARD-CLYDE (SEPTEMBER, 1995)
- DRILLHOLE FROM NEWCREST
- TEST PIT FROM NEWCREST
- LIDAR COMPLETED ON 19TH OF MARCH 2018
- PRE-CONSTRUCTION SURFACE
- ? INFERRED BOUNDARY

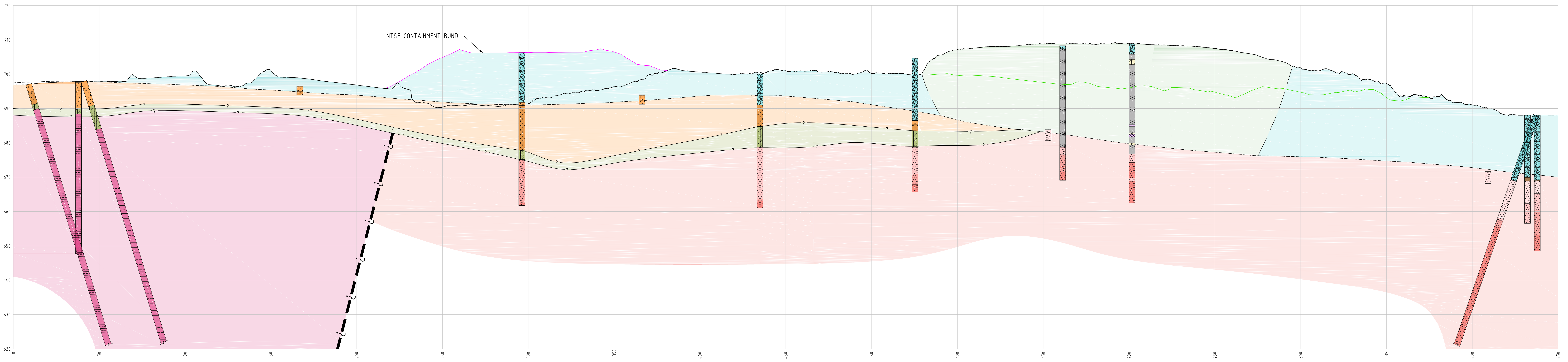
GEOLOGICAL SECTION D

CADIA NTSF FAILURE INDEPENDENT TECHNICAL REVIEW BOARD

FIGURE C10

DESIGNED	DRAWN	APPROVED
IG	PK	
DATE	DWG. No.	
13-02-2019	H356804-00000-22A-273-0204	





SECTION E
SCALE H
VERTICAL EXAGGERATION 2:1
FIG C6

SECTION E
SCALE H
VERTICAL EXAGGERATION 2:1
FIG C6

GEOLOGY (AGE)	UNIT	DESCRIPTION
ENGINEERED FILL (RECENT)		TAILINGS
		CLAY FILL
		FILTER / TRANSITION FILL
		ROCKFILL
		MIXED FILL
		SLUMP MATERIAL
(QUATERNARY)		TOPSOIL/COLLUVIUM/ ALLUVIUM
(TERTIARY)		RESIDUAL BASALT
		BASALT
		PALEO ALLUVIUM
CADIA COACH SHALE (SILURIAN)		INTERBEDDED SEDIMENTARY ROCKS
FOREST REEF VOLCANICS (ORDOVICIAN)		RESIDUAL VOLCANICLASTIC
		EW/HW VOLCANICLASTIC
		MW VOLCANICLASTIC
		SW/F VOLCANICLASTIC
WEEMALLA FORMATION (ORDOVICIAN)		INTERBEDDED SEDIMENTARY ROCKS

0 7.5 15.0 22.5 30.0 37.5
SCALE: 1:1500 @A3

NOTES

1. ALL DIMENSIONS, ELEVATIONS AND COORDINATES ARE IN METERS, EXCEPT WHERE INDICATED OTHERWISE
2. HORIZONTAL DATUM CORRESPONDS TO GDA 94 MGA ZONE 55
3. VERTICAL DATUM CORRESPONDS TO AHD
4. LIDAR SURVEY COMPLETED BY AAM ON THE 19TH OF MARCH 2018

LEGEND

- ITRB DRILLHOLE (2018)
- ITRB TEST PIT (2018)
- ITRB HAND AUGER (2018)
- DRILLHOLE FROM GHD
- DRILLHOLE FROM PELLS SULLIVAN MEYNINK (DECEMBER, 1996)
- TEST PIT FROM PELLS SULLIVAN MEYNINK (DECEMBER, 1996)
- DRILLHOLE FROM WOODWARD-CLYDE (SEPTEMBER, 1995)
- TEST PIT FROM WOODWARD-CLYDE (SEPTEMBER, 1995)
- DRILLHOLE FROM NEWCREST
- TEST PIT FROM NEWCREST
- LiDAR NOVEMBER 2016
- LiDAR COMPLETED ON 19TH OF MARCH 2018
- NTSF CONTAINMENT BUND
- PRE-CONSTRUCTION SURFACE
- ? INFERRED BOUNDARY
- ? INFERRED FAULT

GEOLOGICAL SECTION E

CADIA NTSF FAILURE INDEPENDENT TECHNICAL REVIEW BOARD

FIGURE C11

DESIGNED	DRAWN	APPROVED
IG	PK	
DATE	DWG. No.	
13-02-2019	H356804-00000-22A-273-0205	

NOTES

1. ALL DIMENSIONS, ELEVATIONS AND COORDINATES ARE IN METERS, EXCEPT WHERE INDICATED OTHERWISE
2. HORIZONTAL DATUM CORRESPONDS TO GDA 94 MGA ZONE 55
3. VERTICAL DATUM CORRESPONDS TO AHD
4. LIDAR SURVEY COMPLETED BY AAM ON THE 19TH OF MARCH 2018

LEGEND

- DRILLHOLE FROM HATCH (2018)
- TEST PIT FROM HATCH (2018)
- ITRB HAND AUGER (2018)
- DRILLHOLE FROM GHD
- DRILLHOLE FROM PELLS SULLIVAN MEYNINK (DECEMBER, 1996)
- TEST PIT FROM PELLS SULLIVAN MEYNINK (DECEMBER, 1996)
- DRILLHOLE FROM WOODWARD-CLYDE (SEPTEMBER, 1995)
- TEST PIT FROM WOODWARD-CLYDE (SEPTEMBER, 1995)
- DRILLHOLE FROM NEWCREST
- TEST PIT FROM NEWCREST
- PRE-CONSTRUCTION SURFACE
- ? INFERRED BOUNDARY
- ? INFERRED FAULT

LONGITUDINAL GEOLOGICAL SECTION OF THE NTSF

CADIA NTSF FAILURE INDEPENDENT TECHNICAL REVIEW BOARD

FIGURE C12		
DESIGNED IG	DRAWN PK	APPROVED
DATE 13-02-2019	DWG. No. H356804-00000-22A-273-0206	

Annexure CB
Explanatory Notes

HATCH

BASIS FOR SOIL DESCRIPTION

(Based on AS1726-2017 - Geotechnical Site Investigations, with modifications)

UNIFIED CLASSIFICATION (in order of description)

Soil Name (BLOCK LETTERS);
Plasticity or grading characteristics for major compontents,
Plasticity or grading characteristics for secondary compontents,
Colour of soil,
Other minor components - name, plasticity or particle characteristics and colour,
Moisture condtions,
Consistency,
Structure, and
Additional observations such as ORIGIN or other significant features not relating to the composition, condition or structure of the soil.

The terms used in the unified classification are discribed below:

PARTICLE SIZE DISTRIBUTION

Term	Clay	Silt	Sand			Gravel			Cobble	Boulder
			Fine	Medium	Coarse	Fine	Medium	Coarse		
Size	0.002mm	0.075mm	0.21mm	0.6mm	2.36mm	6.7mm	19mm	63mm	200mm	

CLASSIFICATION OF SOILS

The Classification of soils is based on particle size distribution and plasticity, in general accordance with AS1726-2017.

SOIL NAME

The Soil Name is based on the grain size characteristics and plasticity. As most soils are a combination of a range of constituents, the primary soil is described and modified by minor components, as follows:

Coarse Grained Soil (<35% Clay and Silt content)				Fine Grained Soil (>35% Clay and Silt content)	
% Fines	Modifier	% Co. fraction	Modifier	% Coarse	Modifier
≤ 5%	Omit, or use 'trace'	≤15%	Omit, or use 'trace sand/gravel'	≤15%	Omit, or use 'trace'
> 5% ≤12%	Describe as 'with clay/silt'	>15% ≤30%	Describe as 'with sand/gravel'	>15% ≤30%	Describe as 'with sand/gravel'
>12%	Prefix soil as 'silty/clayey'	>30%	Prefix soil as 'sandy/gravelly'	>30%	Prefix soil as 'sandy/gravelly'

PLASTICITY

Plasticity of clay and silt, both alone and in mixtures with coarser material, are described as:

Descriptive Term	Range of liquid limit (percent)
Of **low** plasticity	≤35%
Of **medium** plasticity	>35% ≤50%
Of **high** plasticity	>50%

GRADING CHARACTERISTICS

For coarse grained soils only and are as follows:

Descriptive Term	Characteristics
Well Graded	Having good representation of all particle sizes
Poorly Graded	With one or more intermediate sizes poorly represented
Gap Graded	With one or more intermediate sizes absent
Uniform	Essentially of one size

PARTICLE SHAPE

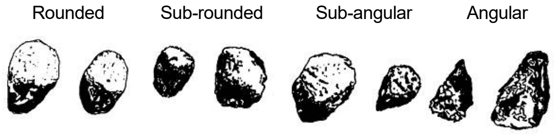
The particle shape of equidimensional particles may be described as **'rounded', 'sub-rounded', 'sub-angular'** or **'angular'** as shown in the sketches overleaf. Two-dimensional particles with the third dimension small by comparison may be described as **'flaky'** or **'platy'**. One-dimensional particles with the other two dimensions small by comparison may be described as **'elongated'**.

Continue overleaf...

BASIS FOR SOIL DESCRIPTION

(Based on AS1726-2017 - Geotechnical Site Investigations, with modifications)

PARTICLE SHAPE (continued...)



COLOUR

The soil colour is described for soil in the 'moist' condition, using simple terms such as **'black', 'white', 'grey', 'brown', 'red', 'orange', 'yellow', 'green'** or **'blue'**. These may be modified as necessary by **'pale', 'dark'** or **'mottled'**. Borderline colours may be described as red-brown. Where a soil colour consists of a primary colour with a secondary mottling it should be described as:

(primary colour) mottled **(secondary colour)** , eg. **grey** mottled **red-brown** clay.

MOISTURE CONDITION

Descriptive Term	General	Granular Soil	Cohesive Soil
'Dry' **(D)**		Cohesionless and free running	Hard and friable or powdery, well dry of plastic limit (<PL,< < PL)
'Moist' **(M)**	Soil feels cool, darkened in colour	Particles tend to cohere	Soil may be moulded by hand (~ PL)
'Wet' **(W)**	Soil feels cool, darkened in colour	Soil particles tend to cohere, free water forms when squeezed	Soil usually weakened and free water forms when handled (>PL,> >PL)

CONSISTENCY (Cohesive soils)

The consistency of cohesive soil is based on the undrained shear strength and is generally estimated, with or without the aid of a pocket penetrometer or shear vane test.

Descriptive Term	Undrained Shear Strength (kPa)		Field Guide to Consistency
'Very Soft' **(VS)**		≤ 12	Exudes between the fingers when squeezed in hand
'Soft' **(S)**	> 12	≤ 25	Can be moulded by light finger pressure
'Firm' **(F)**	> 25	≤ 50	Can be moulded by strong finger pressure
'Stiff' **(St)**	> 50	≤ 100	Cannot be moulded by fingers
'Very Stiff' **(VSt)**	> 100	≤ 200	Can be indented by thumb nail
'Hard' **(H)**	> 200		Can be indented with difficulty by thumb nail

DENSITY (Granular soils)

The density of a non-cohesive soil is described via the Density Index (relative density), which is generally assessed using a penetration test and published correlations.

Descriptive Term	Density Index (%)		SPT N-Value	DCP blows per 100mm	CPT q_c (MPa)*
'Very Loose' **(VL)**		< 15	< 4	0 - 1	< 2.5
'Loose' **(L)**	> 15	≤ 35	4 - 10	1 - 3	2.5 - 5
'Medium Dense' **(MD)**	> 35	≤ 65	10 - 30	3 - 8	5 - 10
'Dense' **(D)**	> 65	≤ 85	30 - 50	8 - 15	10 - 20
'Very Dense' **(VD)**	> 85		> 50	> 15	> 20

* At an effective overburden pressure of 100kPa.

Continue overleaf...

HATCH

BASIS FOR SOIL DESCRIPTION

(Based on AS1726-2017 - Geotechnical Site Investigations, with modifications)

GRAPHIC SYMBOLS FOR SOILS

GRAVEL
- poorly graded -
- well graded -

SAND
- poorly graded -
- well graded -

SILT
- of low plasticity -
- of high plasticity -

CLAY
- of low plasticity -
- of high plasticity -

FINE GRAINED TAILINGS -

COBBLES AND BOULDERS -

ORGANIC/ PEATY SOIL -

FILL/ MADE GROUND -

Composite soil types are presented using combined symbols, eg. **Gravelly Sandy CLAY**

GROUNDWATER OBSERVATIONS

Permanent Water Level

Temporary Water Level

Inflow into Pit or Borehole

Outflow/ Water Loss in Borehole

Slow Inflow/ Seepage into Pit or Borehole

SAMPLE TYPES

Disturbed bag sample

Bulk Disturbed

Hollow Stem Auger Core

Hollow Stem Auger Core

Auger Flight Cuttings

Standard Penetration Test (SPT), with Disturbed Split-Spoon Sample

SPT (no recovery)

Lexan Tube Sample 108 mm OD

Thin walled "undisturbed" push tube sample eg. U60, U100 etc

Thin walled "undisturbed" piston sample eg. U75, U100 etc

Sample attempted with no recovery

HATCH

BASIS FOR ROCK DESCRIPTION

(Based on AS1726-1993 - Geotechnical Site Investigations, with modifications)

ROCK CLASSIFICATION (in order of description)

Rock Name (BLOCK LETTERS);
Grain Size,
Texture and Fabric,
Colour,
Other minor components - name, particle characteristics and colour,
Strength,
Weathering,
Structure of the rock,
Defects - type, orientation, sapcing, roughness, waviness and persistency, and
Additional rock mass observations noted from larger exposures.

WEATHERING

The Rock material weathering terms are deined in the Table below. The terms have been adopted from a combination of those used in AS1726-1981 and 1993.

Term	Symbol	Description
Residual Soil	RS	Soil developed on extremely weathered rock. The mass structure and substance fabric are no longer evident. There is a large change in volume but the soil has not been significantly transported.
Extremely Weathered Rock	XW	Rock substance affected by weathering to the extent that the rock exhibits soil properties, ie. it can be remoulded and classified in accordance with the Unified Soil Classification System.
Highly Weathered Rock	HW	Rock is weathered to such an extent that it shows considerable change in appearance and loss in strength. Chemical or physical decomposition of individual minerals are usually evident. The colour and strength of the original fresh rock is no longer recognisable.
Moderately Weathered Rock	MW	Rock is affected by weathering to the extent that staining extends throughout the whole of the rock substance and the original colour of the fresh rock is no longer recognisable. There is usually a significant loss in rock strength.
Slightly Weathered Rock	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh Rock	Fr	Rock shows no sign of decomposition or staining.

ROCK STRENGTH

The rock strength terms defined in AS1726-1993 and generally based on Point Load index testing. In weaker rocks Unconfined Compressive Strength testing may provide a better estimate for the rock strength. In the absence of either Point Load or Unconfined Compression Strength testing, the rock strength may be based on field estimates as discribed in the Table below.

Term	Symbol	Point load index (MPa) Is_{50}	Unconfined Compression (MPa) UCS	Field guide to strength
Extremely Low	EL	$\leq$ 0.03	$\leq$ 0.7	Easily remoulded by hand to a material with soil properties.
Very Low	VL	> 0.03 $\leq$ 0.1	> 0.7 $\leq$ 2.4	Material crumbles under firm blows with sharp end of pick, can be peeled with knife, too hard to cut a triaxial sample by hand, pieces up to 30mm thick can be broken by finger pressure.
Low	L	> 0.1 $\leq$ 0.3	> 2.4 $\leq$ 7.0	Easily scored with a knife, indentations 1mm to 3mm show in the specimen with firm blows of the pick point, has dull sound under hammer. A piece of core 150mm long by 50mm diameter may be brocken by hand. Sharp edges of core may be friable and break during handling.
Medium	M	> 0.3 $\leq$ 1.0	> 7.0 $\leq$ 24	Readily scored with a knife, a piece of 150mm long by 50mm diameter can be broken by hand with difficulty.
High	H	> 1.0 $\leq$ 3.0	> 24 $\leq$ 70	A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow, rock rings under hammer blows.
Very High	VH	> 3.0 $\leq$ 10	> 70 $\leq$ 240	Hand specimen break with pick after more than one blow, rock rings under hammer blows.
Extremely High	EH	> 10	> 240	Specimen requires many blows with geological pick to break through intact material, rock rings under hammer blows.

Continue overleaf...

BASIS FOR ROCK DESCRIPTION

(Based on AS1726-1993 - Geotechnical Site Investigations, with modifications)

RUN AND RECOVERY

Every time the core barrel is lifted to recover a sample of the core one run is completed. The core recovery represents the ratio of core recovered to the length drilled for the corresponding core run and is expressed as a percentage. Intervals where no core is recovered are described as Core Loss and are denoted by CL.

ROCK QUALITY DESIGNATION (RQD)

Rock Quality Designation (RQD) is an index or measure of the quality of a rock mass. RQD is determined by the ratio of sound core recovered in pieces over 100mm to the length of the core run drilled. Mechanical breaks are discounted in the calculation. RQD is not determined for extremely to highly weathered rock.

The descriptive terms assigned to RQD are as follows:

RQD (%)	Rock Description
< 25	Very Poor
25 to 50	Poor
50 to 75	Fair
75 to 90	Good
90 to 100	Excellent

DEFECT SPACING

The defect spacing is a measure of the distance between natural discontinuities (drilling breaks are ignored), and is generally expressed in millimeters. The descriptive terms assigned to defect spacing are as follows:

Defect Spacing (mm)	Term
> 2,000	Extremely Wide
600 - 2,000	Very Wide
200 - 600	Wide
60 - 200	Moderately Wide
20 - 60	Moderately Narrow
6 - 20	Narrow
< 6	Very Narrow

DEFECT LOG

The defect log provides a graphical description of each defect in the recovered core sample observed during logging.

DEFECT DESCRIPTION AND COMMENTS

The defect description is an annotated description of rock defects including inclination/ dip, type, infill type and amount, apaerture, planarity, roughness and frequency of the defect. Other comments are also included under the defect description title.

The description format of an individual defect is as follows:

Inclination	*Type*	*Infill*	*Amount*	*Aperture*	*Planarity*	*Roughness*	*Frequency*
30°	Jt	Fe	Fi	Mw	Pl	Sm	C

Inclination

For specific defects, the inclination of each individual defect is noted in degrees and is measured perpendicular to the core axis. For example, in a vertically drilled borehole, an inclination of 0° corresponds to a horizontal defect and an inclination of 90°corresponds to a vertical defect.

Continue overleaf...

BASIS FOR ROCK DESCRIPTION

(Based on AS1726-1993 - Geotechnical Site Investigations, with modifications)

DEFECT DESCRIPTION AND COMMENTS (Continued)

Type

A list and description of the main defect types is included below:

Defect Type	Symbol	Description
Joint	Jt	A single fracture across which rock has little to no tensile strength and is not obviously related to rock fabric.
Contact	CN	Surface between two separate lithologies.
Bedding	BG	An arrangement in layers of mineral grains or crystals parallel to a surface of deposition along which a continuous observable parting occurs.
Bedding Shear	BSH	A shear formed along a bedding plane.
Shear	SH	A fracture along which movement has taken place but no displacement is recognisable. Evidence of movement may be slickensides, polishing and/or clay gouge.
Fractured Zone	FZ	A zone of closely spaced defects (mainly joints, bedding, cleavage and/or schistosity) comprised in core lengths in the order of 50mm or less.
Decomposed Zone	DZ	A zone of any shape but commonly with parallel planar boundaries containing moderately to gradational boundaries into fresher rock.
Crushed Seam	Cs	A zone with roughly parallel, planar boundaries (commonly slickensided) containing disoriented usually angular rock fragments of variable size often in a soil matrix.
Sheared Zone	SZ	A zone of multiple closely spaced fracture planeswith roughly parallel planar boundaries usually forming a blocks of lenticular or wedge shapes intact material. Fractures are typically smooth, polished or slickensided, and curved.
Fault	FL	A fracture along which displacement is recognisable.
Cleavage	CV	A plane of mechanical fracture in a rock normally sufficiently closely spaced to form parallel sided slices.
Schistosity	SC	A plane formed by the preferred orientation of the constituent minerals in a paralle arrangement in a coarse grained rock which has undergone regional metamorphism (schist).
Foliation	Fo	A near parallel alignment of specific minerals within a rock.
Dyke	DK	An igneous intrusion, often weathered and altered to a clay like material.
Vein	VN	A fracture in which a tabular or sheet like body of mineral has been intruded.
Drilling Break	DB	A fracture caused by drilling. Usually smooth (if core has spun) or irregular to serrated (if rock has broken in tension).

Infill

A list and description of some general and site specific infill materials is included below:

General Infill Materials

Infill Symbol	Description
CL	Clean
CA	Calcium
CB	Carbonaceous
CH	Chlorite
CT	Carbonate
Fe	Iron Oxide
Lm	Limonite
Qz	Quartz
SU	Sulphides
RF	Rock Fragments
g	Gravelly
s	Sandy
m	Silty
c	Clayey
G	GRAVEL
S	SAND
M	SILT
C	CLAY
hp	High Plasticity
lp	Low plasticity

Site Specific Infill Materials

Infill Symbol	Description
MgO	Magnesium Oxide
Cy	Chrysotile (White Asbestos)
ST	Serpentine
Tl	Talc

Continue overleaf...

HATCH

BASIS FOR ROCK DESCRIPTION

(Based on AS1726-1993 - Geotechnical Site Investigations, with modifications)

DEFECT DESCRIPTION AND COMMENTS (Continued)

Infill Amount

The amount of infilling is desribed as follows:

Infill Amount	Description
sn	Surface Stain
Sp	Spotty/ Patchy
Pa	Partially Filled
Fi	Filled
Op	Open/ none

Defect Aperture or Thickness

The aperture is an estimate of the open-ness of a defect and is descriped as follows:

Symbol	Width (mm)	Term
T	0	Tight
En	0-2	Extremely Narrow
Vn	2-6	Very Narrow
N	6-20	Narrow
Mn	20-60	Moderately Narrow
Mw	60-200	Moderately Wide
W	>200	Wide

Planarity

The planarity of a defect is described as follows:

Symbol	Term
Un	Undulating
St	Stepped
Ir	Irregular
Pl	Planar
Cu	Curved (Concave/ Convex)

Roughness

The surface roughness of a defect is desribed in accordance with the following:

Symbol	Term	Description
Sl	Slickensided	Visual evidence of striations.
Sm	Smooth	Surface appears and feels smooth.
Sr	Slightly Rough	Asperities on the defect surface are distinguishable and can be felt.
Ro	Rough	Some ridges and agled steps are evident. Asperities are clearly visible and surface feels very abrasive.
Vr	Very Rough	Near right angle steps and ridges occur along the defect surface.

Frequency or Spacing

The frequency or spacing is described in more detail under the Defect Spacing section in Basis for Rock Description Page 2.

Annexure CC
Geotechnical Logs of ITRB Test Pits

TEST PIT LOG

HATCH

Test Pit No: **TP401**

Sheet 1 of 1

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Haul Road - West of Slump		

Easting:	685,075.0 m
Northing:	6,291,180.2 m
Coord.System:	GDA94
Elevation:	686.42 m
Total Depth:	2.1 m

Contractor:	Newcrest	**Equipment:**	Cat 350	**Date Logged:**	15-May-18	**Logged By:**	IAG/TMY
Operator:	T. Dickerson	**Bucket Size:**	2.1m	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Water	Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	**Soil Description** TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Sample Type	Additional Observations
				GW	FILL; grey rockfill up to 0.5m, well-graded, sub-angular		VD		
	685.9	0.5		CH	Silty CLAY; high plasticity, red-brown, trace fine ironstone and gravel	<PL	H		pp>600 (kPa)
									Bulk Sample taken from 0.7-1m. Undisturbed Block Sample
	685.4	1.0			BASALT core stones, 50-150mm, extremely weathered to fresh	D			
	684.9	1.5			becoming highly weathered grey basalt with vesicles				
	684.4	2.0			Excavator Refusal. **Test Pit TP401 terminated at 2.10m.**				
	683.9	2.5							
	683.4	3.0							
	682.9	3.5							
	682.4	4.0							
	681.9	4.5							
	681.4	5.0							

Notes:

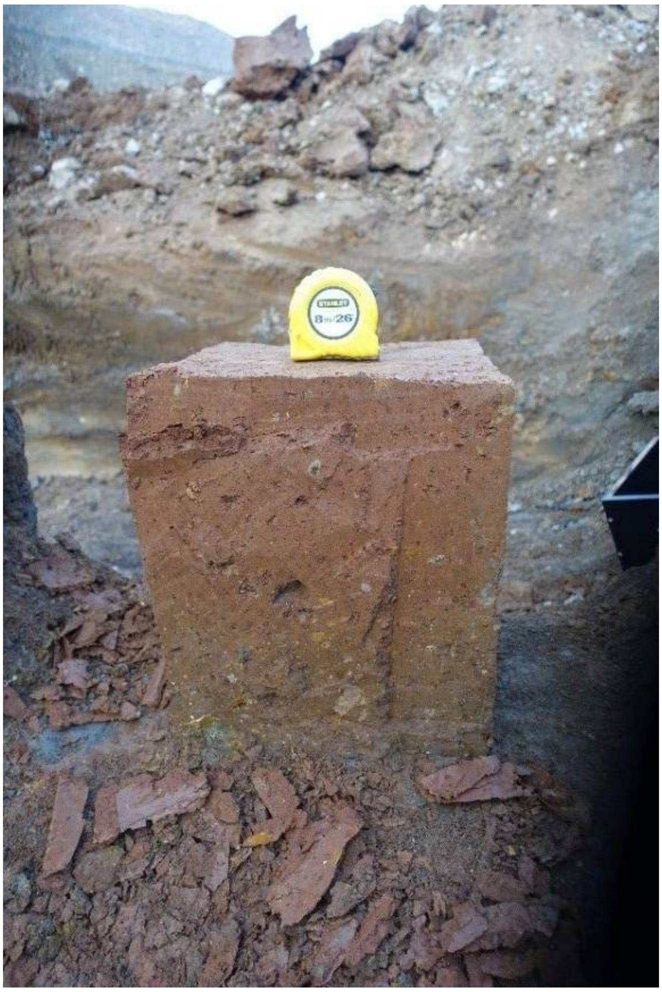
TEST PIT LOG
PHOTOGRAPH

Test Pit No:	**TP401**
Sheet 1 of 1	

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Haul Road - West of Slump		

Easting:	685,075.0 m
Northing:	6,291,180.2 m
Coord.System:	GDA94
Elevation:	686.42 m
Total Depth:	2.1 m

Contractor:	Newcrest	**Equipment:**	Cat 350	**Date Logged:**	15-May-18	**Logged By:**	IAG/TMY
Operator:	T. Dickerson	**Bucket Size:**	2.1m	**Date Checked:**	04-Oct-18	**Checked By:**	IAG



Notes:

TEST PIT LOG

Test Pit No: **TP402**

Sheet 1 of 1

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Field - West of Slump		

Easting:	684,984.8 m
Northing:	6,291,160.5 m
Coord.System:	GDA94
Elevation:	680.74 m
Total Depth:	1.6 m

Contractor:	Newcrest	**Equipment:**	Cat 350	**Date Logged:**	15-May-18	**Logged By:**	IAG/TMY
Operator:	T. Dickerson	**Bucket Size:**	2.1m	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Water	Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	**Soil Description** TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Sample Type	Additional Observations
	680.2	0.5		MH	Clayey SILT; some fine gravel	W	L		
	679.7 679.2	1.0 1.5		CH	Silty CLAY; high plasticity, grey with orange banding, fissured, trace gravel	>> PL	St - VSt		Bulk Sample taken from 1.2-1.5m. Undisturbed Block Sample
	678.7 678.2 677.7 677.2 676.7 676.2 675.7	2.0 2.5 3.0 3.5 4.0 4.5 5.0			To Target Depth. **Test Pit TP402 terminated at 1.60m.**				

Notes:

TEST PIT LOG

PHOTOGRAPH

Test Pit No:

TP402

Sheet 1 of 1

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Field - West of Slump		

Easting:	684,984.8 m
Northing:	6,291,160.5 m
Coord.System:	GDA94
Elevation:	680.74 m
Total Depth:	1.6 m

Contractor:	Newcrest	**Equipment:**	Cat 350	**Date Logged:**	15-May-18	**Logged By:**	IAG/TMY
Operator:	T. Dickerson	**Bucket Size:**	2.1m	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Notes:

TEST PIT LOG

HATCH

Test Pit No: **TP403**

Sheet 1 of 1

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	STSF - South of Slump		

Easting:	685,382.0 m
Northing:	6,290,903.0 m
Coord.System:	GDA94
Elevation:	679.30 m
Total Depth:	2.0 m

Contractor:	Newcrest	**Equipment:**	Cat 350	**Date Logged:**	16-May-18	**Logged By:**	IAG/TMY
Operator:	T. Dickerson	**Bucket Size:**	2.1m	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Water	Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	**Soil Description** TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Sample Type	Additional Observations
				CH	Silty CLAY; high plasticity, red-brown, fine sand and gravel	>PL	St		pp=150 (kPa)
	678.8	0.5							
					VOLCANICLASTIC; moderately weathered, slightly weathered to fresh sub angular cobbles of andesite with yellow-brown bands and seams of sandy silt, some clay				
	678.3	1.0							
	677.8	1.5							Bulk Sample taken from 1.5-1.8m. Undisturbed Block Sample
Inflow in Pit Floor	677.3	2.0			To Target Depth. **Test Pit TP403 terminated at 2.00m.**				
	676.8	2.5							
	676.3	3.0							
	675.8	3.5							
	675.3	4.0							
	674.8	4.5							
	674.3	5.0							

Notes:

HATCH_LIBRARY_REVB.GLB Log BOREHOLE/TESTPIT H356804_CADIA_VALLEY R2.GPJ <<DrawingFile>> 13-12-2018 11:19

TEST PIT LOG

PHOTOGRAPH

Test Pit No:

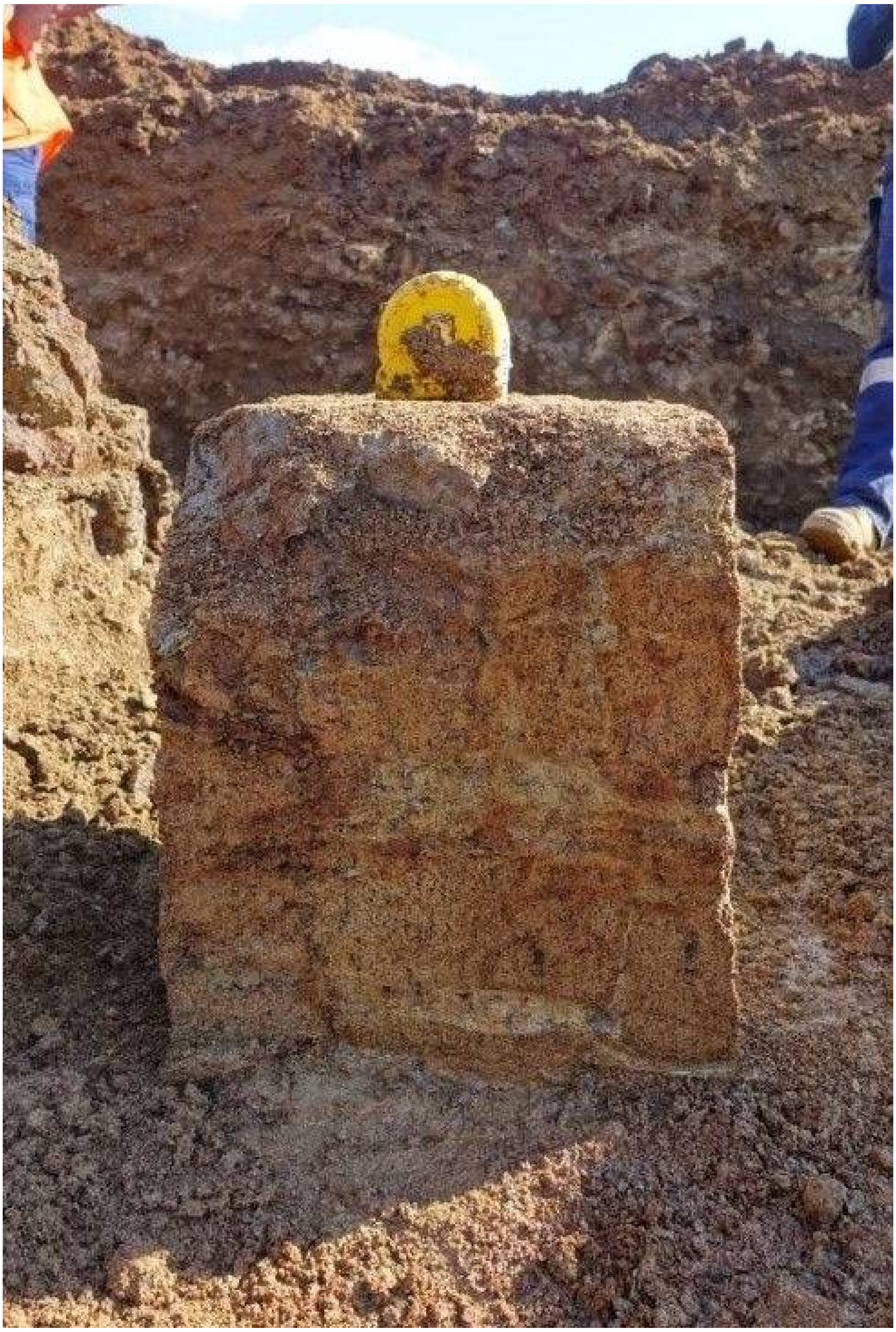
TP403

Sheet 1 of 1

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	STSF - South of Slump		

Easting:	685,382.0 m
Northing:	6,290,903.0 m
Coord.System:	GDA94
Elevation:	679.30 m
Total Depth:	2.0 m

Contractor:	Newcrest	**Equipment:**	Cat 350	**Date Logged:**	16-May-18	**Logged By:**	IAG/TMY
Operator:	T. Dickerson	**Bucket Size:**	2.1m	**Date Checked:**	04-Oct-18	**Checked By:**	IAG



Notes:

TEST PIT LOG

Test Pit No: **TP405**

Sheet 1 of 1

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	STSF South Wall		

Easting:	685,146.3 m
Northing:	6,288,996.5 m
Coord.System:	GDA94
Elevation:	652.41 m
Total Depth:	3.5 m

Contractor:	Newcrest	**Equipment:**	Cat 336D	**Date Logged:**	31-May-18	**Logged By:**	TMY/BM
Operator:	DM	**Bucket Size:**	2.1m	**Date Checked:**	06-Jun-18	**Checked By:**	BM

Water	Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	**Soil Description** TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Sample Type	Additional Observations
	651.4 (at 1)	0–1.5		MH	Clayey SILT; trace gravel, high plasticity, brown, some roots [TOPSOIL]	PL	F		
	650.4 (at 2); 649.4 (at 3)	1.5–3.5		CL	VOLCANICLASTIC; Extremely weathered, sandy clay with some gravel, yellow-brown to orange	M; W	MD	Bulk / Block (1.9–2.2m)	pp=140 (kPa) Bulk Sample taken from 1.9-2.2m. Undisturbed Block Sample pp=300 (kPa)
Inflow in Pit Floor	648.4 (at 4); 647.4 (at 5); 646.4 (at 6); 645.4 (at 7); 644.4 (at 8)	3.5			To Target Depth. **Test Pit TP405 terminated at 3.50m.**				

Notes:

TEST PIT LOG
PHOTOGRAPH

Test Pit No:	**TP405**	Sheet 1 of 1	
Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	STSF South Wall		

Easting:	685,146.3 m
Northing:	6,288,996.5 m
Coord.System:	GDA94
Elevation:	652.41 m
Total Depth:	3.5 m

Contractor:	Newcrest	**Equipment:**	Cat 336D	**Date Logged:**	31-May-18	**Logged By:**	TMY/BM
Operator:	DM	**Bucket Size:**	2.1m	**Date Checked:**	06-Jun-18	**Checked By:**	BM

Notes:

Annexure CD
Geotechnical Logs of ITRB Drillholes

HATCH

DRILLHOLE LOG

Drillhole No: **CE405**

Client: Newcrest **Project No.:** H356804

Project: Cadia NTSF Failure Review

Location: Stage 2 Buttress - East

Easting:	685,666.1 m
Northing:	6,290,859.7 m
Coord.System:	GDA94
Elevation:	687.80 m
Total Depth:	30.5 m
Logged By:	IAG/TMY
Checked By:	IAG

Contractor: Groundwave **Rig Type/ Mounting:** LS250 Sonic **Date Logged:** 01-Jun-18

Driller: RF **Hole Diameter (mm):** 63 / 115 **Date Checked:** 04-Oct-18

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
	666.8	21.0	Roto Sonic	C		GW	[DOWNSTREAM BERM ROCKFILL] (0.0 - 20.0 m) *(Continued)*					
	665.8	22.0				SC	Clayey SAND: medium grained, some fine gravel, red brown orange [MIXED FILL]	M	D			Disturbed Sample taken from 21.60-21.70m. U63 refusal on cobble (22.5 m)
	664.8 663.8	23.0 24.0				GW	Sandy GRAVEL - Gravelly SAND: some cobbles, angular [MIXED FILL]	M	L			
							BOULDER (Monzonite)	M	D			
	662.8	25.0				GW	Sandy GRAVEL: some clay and cobbles [MIXED FILL]	M	MD			
						CH	Silty CLAY: high plasticity, dark brown, fine gravel [MIXED FILL]	mc ~PL	VSt			
	661.8	26.0				SC	Clayey SAND: orange brown [COLLUVIUM] dark grey, strong organic odour	M	MD			Thin Walled U-Tube taken from 25.50-25.70m. U63-1
							CORE LOSS					
	660.8 659.8	27.0 28.0				-	VOLCANICLASTIC: fresh, blue grey, some purple, feldspar porphry					26.9 m Jt Pl 40 deg 27.2 m Jt Pl 30 deg 27.5 m Jt Pl 30 deg Fe sn 27.9 m Jt Pl 30 deg 28.2 m Jt Pl 30 deg & 80 deg
	658.8 657.8	29.0 30.0					***Start of Coring at 28.3m.*** ***Continued on Rock Core Log sheet.***					

Notes: Vibrating Wire Piezometer installed at 30.3 m (Pressure Rating 350kPa, Serial No. 316-284). Hole grouted to 21.5 m
Standing water level measured at 10.8 m below ground level 3-Jun-19.

HATCH CORED DRILLHOLE LOG

ROCK CORE FORMAT

Drillhole No: **CE405**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Stage 2 Buttress - East		

Easting:	685,666.1 m
Northing:	6,290,859.7 m
Coord.System:	GDA94
Elevation:	687.80 m
Total Depth:	30.5 m
Logged By:	IAG/TMY
Checked By:	IAG

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Bearing:**	N/A	**Date Logged:**	01-Jun-18
Driller:	RF	**Hole Diameter (mm):**	63 / 115	**Plunge:**	Vertical	**Date Checked:**	04-Oct-18

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Geological Unit	Rock Description: ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.	Weathering/ Cementation	Estimated Strength (EH VH H M L VL EL)	$Is_{(50)}$ MPa	Defect Spacing mm (2000 600 200 [100] 60 20)	RQD %	Defect Log	Defect Description: Inclination, type, infill, amount, aperture, planarity, roughness, frequency (Specific / General)
	666.8	21.0												
	665.8	22.0												
	664.8	23.0												
	663.8	24.0												
	662.8	25.0												
	661.8	26.0												
	660.8	27.0												
	659.8	28.0					***Resuming in Rock Core Format 28.3m.***							
			HQ-3 Coring	[28.5]			VOLCANICLASTIC: blue grey, some purple, feldspar to 3 mm	Fr				86		
	658.8	29.0												40° Jt Pl Ro Fe
												72		70° Jt Pl Sm
	657.8	30.0												

Notes: Vibrating Wire Piezometer installed at 30.3 m (Pressure Rating 350kPa, Serial No. 316-284). Hole grouted to 21.5 m

HATCH

CORED DRILLHOLE LOG
ROCK CORE FORMAT

Drillhole No: **CE405**

Sheet 3 of 3

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Stage 2 Buttress - East		

Easting:	685,666.1 m
Northing:	6,290,859.7 m
Coord.System:	GDA94
Elevation:	687.80 m
Total Depth:	30.5 m

Contractor: Groundwave **Rig Type/ Mounting:** LS250 Sonic **Bearing:** N/A **Date Logged:** 01-Jun-18 **Logged By:** IAG/TMY

Driller: RF **Hole Diameter (mm):** 63 / 115 **Plunge:** Vertical **Date Checked:** 04-Oct-18 **Checked By:** IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Geological Unit	Rock Description: ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.	Weathering/ Cementation	Estimated Strength (EH VH H M L VL EL)	Is(50) MPa	Defect Spacing mm (2000 600 200 [100] 60 20)	RQD %	Defect Log	Defect Description: Inclination, type, infill, amount, aperture, planarity, roughness, frequency (Specific / General)
			HQ-3 Coring				VOLCANICLASTIC: blue grey, some purple, feldspar to 3 mm *(Continued)*	Fr				72		70° Jt Pl Sm 30° Jt Pl Sm
							Vibrating Wire Piezometer installed at 30.3 m **Drillhole CE405 terminated at 30.5m.**							
	656.8	31.0												
	655.8	32.0												
	654.8	33.0												
	653.8	34.0												
	652.8	35.0												
	651.8	36.0												
	650.8	37.0												
	649.8	38.0												
	648.8	39.0												
	647.8	40.0												

Notes: Vibrating Wire Piezometer installed at 30.3 m (Pressure Rating 350kPa, Serial No. 316-284). Hole grouted to 21.5 m

HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Stage 2 Buttress - East	Page 1 of 1	

Drillhole No.: CE405

Easting: 685,666.1m

Northing: 6,290,859.7m

Horizontal Datum: GDA94

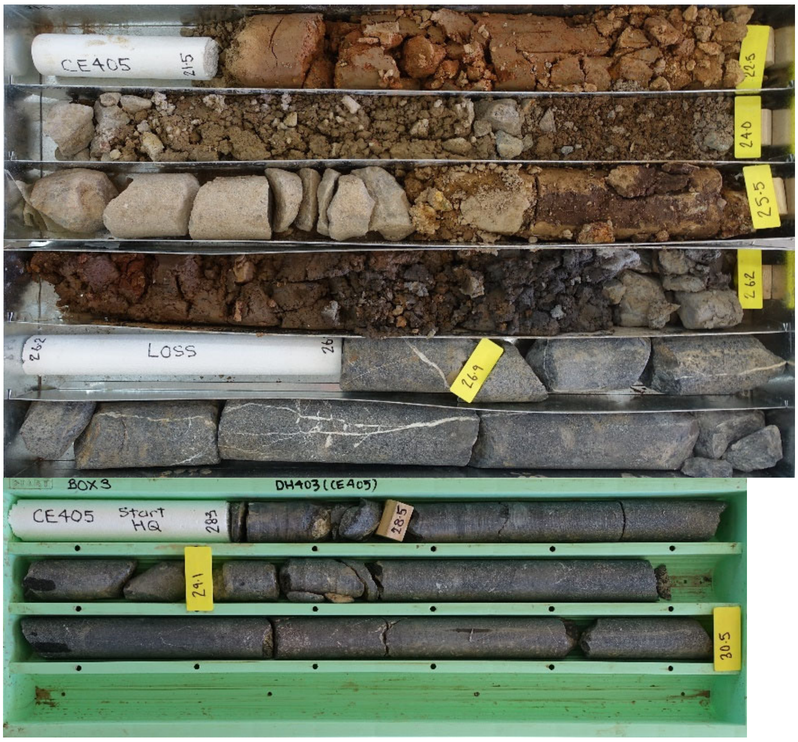
Surface Elevation: 687.83m

0 1m

21.50m

25.50m

28.30m



30.50m EOH

HATCH

DRILLHOLE LOG

Drillhole No: **CE406**

Sheet 1 of 3

Client:	Newcrest
Project No.:	H356804
Project:	Cadia NTSF Failure Review
Location:	Stage 2 Buttress - East

Easting:	685,494.5 m
Northing:	6,290,951.9 m
Coord.System:	GDA94
Elevation:	688.00 m
Total Depth:	31.8 m

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Date Logged:**	14-Jun-18	**Logged By:**	TMY
Driller:	DS	**Hole Diameter (mm):**	115	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
	677.0 – 670.0	11.0 – 18.0	Roto Sonic	C		GW	[DOWNSTREAM BERM ROCKFILL] (0.0 - 10.0 m) *(Continued)*					
	669.0	19.0				CH	CLAY: trace sand, high plasticity, dark brown, angular to sub-rounded andesitic gravel to 50 mm [COLLUVIUM]	mc >PL	VSt-H	300 350 450 300		Disturbed Sample taken from 18.40-18.55m. SA1
	668.0	20.0				ML	Sandy SILT: some clay, orange brown with white speckling, trace of fine gravel and andesite clasts [RESIDUAL VOLCANICLASTIC]			320		Disturbed Sample taken from 19.40-19.50m. SA2 Thin Walled U-Tube taken from

Notes: Vibrating Wire Piezometer installed at 30.2 m (Pressure Rating 350kPa, Serial No. 316-285). Hole grouted to 18.0 m

HATCH — DRILLHOLE LOG

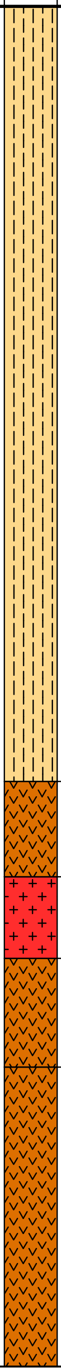
Drillhole No: CE406

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Stage 2 Buttress - East		

Easting:	685,494.5 m
Northing:	6,290,951.9 m
Coord.System:	GDA94
Elevation:	688.00 m
Total Depth:	31.8 m
Logged By:	TMY
Checked By:	IAG

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Date Logged:**	14-Jun-18
Driller:	DS	**Hole Diameter (mm):**	115	**Date Checked:**	04-Oct-18

Method: Roto Sonic. Casing: C



Elevation (m)	Depth (m)	Classification Symbol	Soil Description (TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.)	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
667.0 – 663.0	20.0 – 25.7	ML	Sandy SILT: some clay, orange brown with white speckling, trace of fine gravel and andesite clasts [RESIDUAL VOLCANICLASTIC] *(Continued)*	M; D				19.50-19.65m. U63 refusal, pushed 100 mm recovered 150 mm Disturbed Sample taken from 19.65-20.15m.
662.0	26.0	-	VOLCANICLASTIC: highly weathered, grey brown sandy clay		VSt-H			
		-	MONZONITE (DYKE?): fresh cobbles rounded by drilling		D			
661.0	27.0	-	VOLCANICLASTIC: highly weathered, grey brown sandy clay					
660.0 – 658.0	28.0 – 30.0	CH	VOLCANICLASTIC: extremely weathered, intermediate to high plasticity, brown, sub-rounded iron stained gravel to 5 mm	mc ~PL	VSt-H			

Elevation scale: 667.0, 666.0, 665.0, 664.0, 663.0, 662.0, 661.0, 660.0, 659.0, 658.0. Depth scale: 21.0, 22.0, 23.0, 24.0, 25.0, 26.0, 27.0, 28.0, 29.0, 30.0.

Notes: Vibrating Wire Piezometer installed at 30.2 m (Pressure Rating 350kPa, Serial No. 316-285). Hole grouted to 18.0 m

HATCH DRILLHOLE LOG

Drillhole No: **CE406**

Client:	Newcrest
Project No.:	H356804
Project:	Cadia NTSF Failure Review
Location:	Stage 2 Buttress - East
Easting:	685,494.5 m
Northing:	6,290,951.9 m
Coord.System:	GDA94
Elevation:	688.00 m
Total Depth:	31.8 m
Contractor:	Groundwave
Driller:	DS
Rig Type/ Mounting:	LS250 Sonic
Hole Diameter (mm):	115
Date Logged:	14-Jun-18
Date Checked:	04-Oct-18
Logged By:	TMY
Checked By:	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
	657.0	31.0	Roto Sonic	C [31.8]		CH	VOLCANICLASTIC: extremely weathered, intermediate to high plasticity, brown, sub-rounded iron stained gravel to 5 mm *(Continued)*	mc ~PL	VSt-H			
	656.0	32.0					Vibrating Wire Piezometer installed at 30.15 m **Drillhole CE406 terminated at 31.80m.**					
	655.0	33.0										
	654.0	34.0										
	653.0	35.0										
	652.0	36.0										
	651.0	37.0										
	650.0	38.0										
	649.0	39.0										
	648.0	40.0										

Notes: Vibrating Wire Piezometer installed at 30.2 m (Pressure Rating 350kPa, Serial No. 316-285). Hole grouted to 18.0 m

HATCH

Drill Core Photograph

Client: Newcrest

Project No.: H356804

Project : Cadia NTSF Failure Review

Location: Stage 2 Buttress - East

Drillhole No.: CE406

Easting: 685,494.5m

Northing: 6,290,951.9m

Horizontal Datum: GDA94

Surface Elevation: 688.04m

0 1m

18.00 m

24.50 m

26.40 m

29.00 m

31.80 m EOH

DRILLHOLE LOG

HATCH

Drillhole No: **CE407**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Stage 1 Buttress - East		

Easting:	685,700.4 m
Northing:	6,290,945.1 m
Coord.System:	GDA94
Elevation:	731.80 m
Total Depth:	51.6 m

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Date Logged:**	19-Jun-18	**Logged By:**	BNM
Driller:	DS	**Hole Diameter (mm):**	115	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Roto Sonic	C			[BUTTRESS STAGE 1 ROCKFILL]		D			
	730.8	1.0										
	729.8	2.0										
	728.8	3.0										
	727.8	4.0										
	726.8	5.0										
	725.8	6.0										
	724.8	7.0										
	723.8	8.0										
						CH	Gravelly CLAY: high plasticity, reddish brown, blocky [STAGE 5 CLAY FILL]	mc ~PL	VSt	300		
	722.8	9.0										
							ROCKFILL [STAGE 5 WORKING PLATFORM]	D	D			
	721.8	10.0										

Notes: Vibrating Wire Piezometer installed at 51.0 m (Pressure Rating 700kPa, Serial No. 25009). Hole grouted to 8.0 m

HATCH DRILLHOLE LOG

Drillhole No: **CE407**

Sheet 2 of 6

Easting:	685,700.4 m
Northing:	6,290,945.1 m
Coord.System:	GDA94
Elevation:	731.80 m
Total Depth:	51.6 m
Logged By:	BNM
Checked By:	IAG

Client: Newcrest **Project No.:** H356804

Project: Cadia NTSF Failure Review

Location: Stage 1 Buttress - East

Contractor: Groundwave **Rig Type/ Mounting:** LS250 Sonic **Date Logged:** 19-Jun-18

Driller: DS **Hole Diameter (mm):** 115 **Date Checked:** 04-Oct-18

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Roto Sonic	C			ROCKFILL [STAGE 5 WORKING PLATFORM] *(Continued)*	D	D			
	720.8	11.0				-	LOSS	-	-			
	719.8	12.0				SM	Silty SAND: Poorly graded, loose, wet, grey, max particle size <1mm [TAILINGS]	W	L			
	718.8	13.0								20		Disturbed Sample taken from 13.60-13.70m. SA1
	717.8	14.0				CI	CLAY [STAGE 3 CLAY FILL]	M	VSt	220		
	716.8	15.0				GW	GRAVEL [STAGE 3 ROCKFILL]	M	D			
						SM	Silty SAND with some clay [TAILINGS]	M	MD			
	715.8	16.0				ML	Sandy SILT: coarse, brown, loose, max particle size 2mm [TAILINGS]	M	L			Disturbed Sample taken from 16.00-16.10m. SA2
	714.8	17.0										
	713.8	18.0										
	712.8	19.0	Lexan									Lexan Tube taken from 18.50-20.00m. Recovery 1.0 m
	711.8	20.0										

Notes: Vibrating Wire Piezometer installed at 51.0 m (Pressure Rating 700kPa, Serial No. 25009). Hole grouted to 8.0 m

DRILLHOLE LOG

Drillhole No: **CE407**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Stage 1 Buttress - East		

Easting:	685,700.4 m
Northing:	6,290,945.1 m
Coord.System:	GDA94
Elevation:	731.80 m
Total Depth:	51.6 m

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Date Logged:**	19-Jun-18	**Logged By:**	BNM
Driller:	DS	**Hole Diameter (mm):**	115	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Lexan	C		ML	Sandy SILT: coarse, brown, loose, max particle size 2mm [TAILINGS] *(Continued)*	M	L			Bulk Sample taken from 20.00-21.00m.
	710.8	21.0										Disturbed Sample taken from 20.90-21.00m. SA3 U75 taken from 21.00-21.50m. Piston Sample P1 Lexan Tube taken from 21.50-22.50m. Recovery 1.2 m
	709.8	22.0								20		Disturbed Sample taken from 22.40-22.50m. SA4 Lexan Tube taken from 22.50-24.00m. Recovery 1.3 m
	708.8	23.0								50		
	707.8	24.0										Disturbed Sample taken from 23.90-24.00m. SA5 Lexan Tube taken from 24.00-25.50m. Recovery 1.24 m
	706.8	25.0								70		Disturbed Sample taken from 25.40-25.50m. SA6 Lexan Tube taken from 25.50-27.00m. Recovery 1.28 m
	705.8	26.0										
	704.8	27.0								70		Disturbed Sample taken from 26.90-27.00m. SA7 Lexan Tube taken from 27.00-28.50m. Recovery 1.3 m
	703.8	28.0										Disturbed Sample taken from 28.40-28.50m. SA8 Lexan Tube taken from 28.50-30.00m. Recovery 1.2 m
	702.8	29.0										
	701.8	30.0										

Notes: Vibrating Wire Piezometer installed at 51.0 m (Pressure Rating 700kPa, Serial No. 25009). Hole grouted to 8.0 m

DRILLHOLE LOG

Drillhole No: **CE407**

Client:	Newcrest
Project No.:	H356804
Project:	Cadia NTSF Failure Review
Location:	Stage 1 Buttress - East
Easting:	685,700.4 m
Northing:	6,290,945.1 m
Coord.System:	GDA94
Elevation:	731.80 m
Total Depth:	51.6 m
Contractor:	Groundwave
Rig Type/ Mounting:	LS250 Sonic
Date Logged:	19-Jun-18
Logged By:	BNM
Driller:	DS
Hole Diameter (mm):	115
Date Checked:	04-Oct-18
Checked By:	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description: TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Lexan	C		ML	Sandy SILT: coarse, brown, loose, max particle size 2mm [TAILINGS] *(Continued)*	M	L			Disturbed Sample taken from 29.90-30.00m. SA9 Lexan Tube taken from 30.00-31.50m. Recovery 1.39 m
	700.8	31.0										
												Disturbed Sample taken from 31.40-31.50m. SA10 Lexan Tube taken from 31.50-33.00m. Recovery 1.22 m
	699.8	32.0										
22-Jun-18	698.8	33.0	Roto Sonic									Disturbed Sample taken from 32.90-33.00m. SA11
	697.8	34.0										
	696.8	35.0										
	695.8	36.0				GW	[STAGE 1 ROCKFILL]	-	-			
	694.8	37.0										
	693.8	38.0										
	692.8	39.0										
	691.8	40.0										

Notes: Vibrating Wire Piezometer installed at 51.0 m (Pressure Rating 700kPa, Serial No. 25009). Hole grouted to 8.0 m

HATCH

DRILLHOLE LOG

Drillhole No: **CE407**

Sheet 5 of 6

Easting:	685,700.4 m
Northing:	6,290,945.1 m
Coord.System:	GDA94
Elevation:	731.80 m
Total Depth:	51.6 m
Logged By:	BNM
Checked By:	IAG

Client: Newcrest **Project No.:** H356804

Project: Cadia NTSF Failure Review

Location: Stage 1 Buttress - East

Contractor: Groundwave **Rig Type/ Mounting:** LS250 Sonic **Date Logged:** 19-Jun-18

Driller: DS **Hole Diameter (mm):** 115 **Date Checked:** 04-Oct-18

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Roto Sonic	C		GW	[STAGE 1 ROCKFILL] *(Continued)*	-	-			
	690.8	41.0										
	689.8	42.0										
	688.8	43.0										
	687.8	44.0										
	686.8	45.0										
	685.8	46.0										
	684.8	47.0										
	683.8	48.0										
						CH	CLAY: high plasticity, dark brown [STAGE 1 CLAY CORE]	mc ~PL	VSt			
	682.8	49.0		[49.0]								
										260	U63	Thin Walled U-Tube taken from 49.50-49.95m. U63
	681.8	50.0										

Notes: Vibrating Wire Piezometer installed at 51.0 m (Pressure Rating 700kPa, Serial No. 25009). Hole grouted to 8.0 m

DRILLHOLE LOG

Drillhole No: **CE407**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Stage 1 Buttress - East		

Easting:	685,700.4 m
Northing:	6,290,945.1 m
Coord.System:	GDA94
Elevation:	731.80 m
Total Depth:	51.6 m

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Date Logged:**	19-Jun-18	**Logged By:**	BNM
Driller:	DS	**Hole Diameter (mm):**	115	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
	680.8	51.0	Roto Sonic			CH	CLAY: high plasticity, dark brown [STAGE 1 CLAY CORE] *(Continued)*	mc ~PL	VSt			Thin Walled U-Tube taken from 50.00-50.45m. U63 Thin Walled U-Tube taken from 51.00-51.45m. U63
	679.8	52.0					Vibrating Wire Piezometer installed at 51.0m To Target Depth. **Drillhole CE407 terminated at 51.60m.**					
	678.8	53.0										
	677.8	54.0										
	676.8	55.0										
	675.8	56.0										
	674.8	57.0										
	673.8	58.0										
	672.8	59.0										
	671.8	60.0										

Notes: Vibrating Wire Piezometer installed at 51.0 m (Pressure Rating 700kPa, Serial No. 25009). Hole grouted to 8.0 m

HATCH	Drill Core Photograph			Drillhole No.: CE407	
				Easting:	685,700.4m
Client:	Newcrest	Project No.:	H356804	Northing:	6,290,945.1m
Project :	Cadia NTSF Failure Review			Horizontal Datum:	GDA94
Location:	Stage 1 Buttress - East	Page 1 of 1		Surface Elevation:	731.78m

0 1m

7.90 m

15.00 m

21.00 m

25.50 m

31.50 m

48.70 m

49.50 m

HATCH

DRILLHOLE LOG

Drillhole No: **CE408**

Client:	Newcrest
Project No.:	H356804
Project:	Cadia NTSF Failure Review
Location:	Stage 10 Crest - East
Easting:	685,736.5 m
Northing:	6,291,005.9 m
Coord.System:	GDA94
Elevation:	743.80 m
Total Depth:	57.0 m
Contractor:	Groundwave
Rig Type/ Mounting:	LS250 Sonic
Date Logged:	24-Jun-18
Logged By:	BNM/IAG/TMY
Driller:	DS
Hole Diameter (mm):	115
Date Checked:	04-Oct-18
Checked By:	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Classification Symbol	Soil Description (TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.)	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
		0.0	Roto Sonic	C	GW	GRAVEL: coarse [STAGE 10 ROCKFILL]					
	742.8	1.0									
	741.8	2.0									
	740.8	3.0			CI	CLAY [STAGE 10 CLAY FILL]					
	739.8	4.0			GW	GRAVEL: coarse [STAGE 10 ROCKFILL]					
	738.8	5.0			SM	Sandy SILT, fine grained, poorly graded, grey, homogeneous, rapid dilatency [TAILINGS]	W	F			
26-Jun-18	737.8	6.0									
					GW	[STAGE 9 ROCKFILL]					
	736.8	7.0			ML	Sandy SILT: fine grained, poorly graded, grey [TAILINGS]	M	F			
	735.8	8.0									
	734.8	9.0									
	733.8	10.0									Disturbed Sample taken from

Notes: Vibrating Wire Piezometer installed at 57.0 m (Pressure Rating 700kPa, Serial No. 25012). Hole grouted to 2.8 m

HATCH

DRILLHOLE LOG

Drillhole No: **CE408**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Stage 10 Crest - East		

Easting:	685,736.5 m
Northing:	6,291,005.9 m
Coord.System:	GDA94
Elevation:	743.80 m
Total Depth:	57.0 m

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Date Logged:**	24-Jun-18	**Logged By:**	BNM/IAG/TMY
Driller:	DS	**Hole Diameter (mm):**	115	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description: TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Roto Sonic	C		ML	Sandy SILT: fine grained, poorly graded, grey [TAILINGS] *(Continued)*	M	F			9.80-9.85m.
	732.8	11.0										U75 taken from 11.00-11.50m. Piston Sample Disturbed Sample taken from 11.30-11.35m.
										100		
	731.8	12.0	Lexan									U75 taken from 12.00-12.50m. Piston Sample
									St	150		Lexan Tube taken from 12.50-13.50m. No Recovery Disturbed Sample taken from 12.70-12.75m.
	730.8	13.0										
												Lexan Tube taken from 13.50-15.00m. 0.74 m recovery
	729.8	14.0										Disturbed Sample taken from 14.20-14.25m.
	728.8	15.0										Lexan Tube taken from 15.00-16.50m. 1.25 m recovery Disturbed Sample taken from 15.70-15.75m.
	727.8	16.0								160		Lexan Tube taken from 16.50-18.00m. 1.0 m recovery
	726.8	17.0										Disturbed Sample taken from 17.10-17.15m. Disturbed Sample taken from 17.50-17.55m.
	725.8	18.0										Lexan Tube taken from 18.00-19.50m. no recovery Disturbed Sample taken from 18.60-18.65m. Disturbed Sample taken from 18.90-18.95m.
	724.8	19.0										
			Roto Sonic			SP	Silty SAND: fine grained, grey [TAILINGS]		MD			Lexan Tube taken from 19.50-21.00m. 0.93 m recovery
	723.8	20.0										

Notes: Vibrating Wire Piezometer installed at 57.0 m (Pressure Rating 700kPa, Serial No. 25012). Hole grouted to 2.8 m

HATCH

DRILLHOLE LOG

Drillhole No: **CE408**

Sheet 3 of 6

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Stage 10 Crest - East		

Easting:	685,736.5 m
Northing:	6,291,005.9 m
Coord.System:	GDA94
Elevation:	743.80 m
Total Depth:	57.0 m
Logged By:	BNM/IAG/TMY
Checked By:	IAG

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Date Logged:**	24-Jun-18
Driller:	DS	**Hole Diameter (mm):**	115	**Date Checked:**	04-Oct-18

Depth (m)	Elevation (m)	Method	Casing	Classification Symbol	Soil Description: TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
20.0–21.0		Roto Sonic	C	SP	Silty SAND: fine grained, grey [TAILINGS] *(Continued)*		MD			Disturbed Sample taken from 20.10-20.15m.
21.0	722.8	Lexan								Lexan Tube taken from 21.00-22.50m. 1.32 m recovery
22.0	721.8									
22.5		Roto Sonic								
23.0	720.8									
24.0	719.8			ML	Sandy SILT: trace of clay, low plasticity, fine sand, grey [TAILINGS]		St			U75 taken from 24.00-24.50m. Piston Sample
24.5							F	80		
25.0	718.8									U75 taken from 25.00-25.45m. Piston Sample
25.5							St	100		
26.0	717.8									
27.0	716.8									
28.0	715.8									
28.5		Lexan								Lexan Tube taken from 28.50-30.00m. 1.5 m recovery
29.0	714.8			ML	Sandy clayey SILT: low plasticity, grey, fine sand [TAILINGS]					
30.0	713.8									

Notes: Vibrating Wire Piezometer installed at 57.0 m (Pressure Rating 700kPa, Serial No. 25012). Hole grouted to 2.8 m

DRILLHOLE LOG

Drillhole No: **CE408**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Stage 10 Crest - East		

Easting:	685,736.5 m
Northing:	6,291,005.9 m
Coord.System:	GDA94
Elevation:	743.80 m
Total Depth:	57.0 m
Logged By:	BNM/IAG/TMY
Checked By:	IAG

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Date Logged:**	24-Jun-18
Driller:	DS	**Hole Diameter (mm):**	115	**Date Checked:**	04-Oct-18

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Lexan	C		ML	Sandy clayey SILT: low plasticity, grey, fine sand [TAILINGS] *(Continued)*					Lexan Tube taken from 30.00-31.50m. 1.5 m recovery
	712.8	31.0										
	711.8	32.0	Roto Sonic									
	710.8	33.0										
	709.8	34.0										
	708.8	35.0										
	707.8	36.0										
	706.8	37.0										
	705.8	38.0										
	704.8	39.0										
	703.8	40.0										

Notes: Vibrating Wire Piezometer installed at 57.0 m (Pressure Rating 700kPa, Serial No. 25012). Hole grouted to 2.8 m

DRILLHOLE LOG

Drillhole No: **CE408**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Stage 10 Crest - East		

Easting:	685,736.5 m
Northing:	6,291,005.9 m
Coord.System:	GDA94
Elevation:	743.80 m
Total Depth:	57.0 m

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Date Logged:**	24-Jun-18	**Logged By:**	BNM/IAG/TMY
Driller:	DS	**Hole Diameter (mm):**	115	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Roto Sonic	C		ML	Sandy clayey SILT: low plasticity, grey, fine sand [TAILINGS] *(Continued)*					
	702.8	41.0										
	701.8	42.0										
	700.8	43.0										
	699.8	44.0										
	698.8	45.0										
	697.8	46.0										
	696.8	47.0										
	695.8	48.0										
	694.8	49.0										
	693.8	50.0										

Notes: Vibrating Wire Piezometer installed at 57.0 m (Pressure Rating 700kPa, Serial No. 25012). Hole grouted to 2.8 m

DRILLHOLE LOG

Drillhole No: **CE408**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Stage 10 Crest - East		

Easting:	685,736.5 m
Northing:	6,291,005.9 m
Coord.System:	GDA94
Elevation:	743.80 m
Total Depth:	57.0 m
Logged By:	BNM/IAG/TMY
Checked By:	IAG

Contractor: Groundwave **Rig Type/ Mounting:** LS250 Sonic **Date Logged:** 24-Jun-18

Driller: DS **Hole Diameter (mm):** 115 **Date Checked:** 04-Oct-18

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
	692.8 – 686.8	51.0 – 57.0	Roto Sonic / Lexan	C [57.0]		ML	Sandy clayey SILT: low plasticity, grey, fine sand [TAILINGS] *(Continued)*		VSt	280		U75 taken from 54.15-54.60m. Piston Sample Lexan Tube taken from 55.50-57.00m. 1.5 m recovery
	686.8 – 683.8	57.0 – 60.0					Vibrating Wire Piezometer installed at 57.0m To Target Depth. **Drillhole CE408 terminated at 57.00m.**					

Elevation ticks: 692.8, 691.8, 690.8, 689.8, 688.8, 687.8, 686.8, 685.8, 684.8, 683.8

Depth ticks: 51.0, 52.0, 53.0, 54.0, 55.0, 56.0, 57.0, 58.0, 59.0, 60.0

Notes: Vibrating Wire Piezometer installed at 57.0 m (Pressure Rating 700kPa, Serial No. 25012). Hole grouted to 2.8 m

HATCH

DRILLHOLE LOG

Drillhole No: **CE411**

Sheet 1 of 2

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Haul Road - South West of Slump		

Easting:	685,116.3 m
Northing:	6,290,998.1 m
Coord.System:	GDA94
Elevation:	690.00 m
Total Depth:	13.5 m
Logged By:	MR
Checked By:	IAG

Contractor: Groundwave | **Rig Type/ Mounting:** LS250 Sonic | **Date Logged:** 10-Jul-18

Driller: | **Hole Diameter (mm):** 115 | **Date Checked:** 04-Oct-18

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
	690.0–688.5	0.0–1.5	Roto Sonic	C		GW	GRAVEL: grey, volcanic clasts up to 150mm [HAUL ROAD FILL]					
	688.5–686.8	1.5–3.2	Lexan			GW	Silty GRAVEL: brown grey, volcanic clasts up to 100mm [HAUL ROAD FILL]				Lexan	Lexan Tube taken from 1.50-3.00m. Thin Walled U-Tube taken from 3.00-3.41m. U63, pushed 450 mm recovered 410 mm
	686.8–685.9	3.2–4.1				CH	CLAY: high plasticity, red brown [RESIDUAL BASALT]	mc ~PL	H	450	U63 / Lexan	Lexan Tube taken from 3.41-4.50m.
	685.9–684.5	4.1–5.5	Roto Sonic			ML	Gravelly SILT: red mottled grey, gravel clasts up to 5mm [RESIDUAL BASALT]	mc << PL	H	>600		U63 refusal (4.5 m)
	684.5–680.0	5.5–10.0					BASALT: grey brown, highly weathered BASALT: moderately weathered	D	-			

Notes:

HATCH

DRILLHOLE LOG

Drillhole No: **CE411**

Sheet 2 of 2

Easting:	685,116.3 m
Northing:	6,290,998.1 m
Coord.System:	GDA94
Elevation:	690.00 m
Total Depth:	13.5 m
Logged By:	MR
Checked By:	IAG

Client: Newcrest **Project No.:** H356804

Project: Cadia NTSF Failure Review

Location: Haul Road - South West of Slump

Contractor: Groundwave **Rig Type/ Mounting:** LS250 Sonic **Date Logged:** 10-Jul-18

Driller: **Hole Diameter (mm):** 115 **Date Checked:** 04-Oct-18

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
	679.0	11.0	Roto Sonic	C			BASALT: moderately weathered *(Continued)*	D				
	678.0	12.0				ML	Clayey sandy SILT: low plasticity, grey orange mottled brown, fine to med grained sand with gravel up to 10mm [PALEO ALLUVIUM]	M	H	>600		
						ML	Sandy SILT: low plasticity, orange brown with fine white/red flecks of fine grained sand, with clay	M	H	>600		
	677.0	13.0		[13.5]			changing to light purple				Bulk	Bulk Sample taken from 13.00-13.30m.
	676.0	14.0					**Drillhole CE411 terminated at 13.50m.**					
	675.0	15.0										
	674.0	16.0										
	673.0	17.0										
	672.0	18.0										
	671.0	19.0										
	670.0	20.0										

Notes:

HATCH

Drill Core Photograph

Drillhole No.: CE411

Easting: 685,116.3m

Client: Newcrest

Project No.: H356804

Northing: 6,290,998.1m

Project : Cadia NTSF Failure Review

Horizontal Datum: GDA94

Location: Haul Road - South West of Slump

Page 1 of 1

Surface Elevation: 690.02m

0 1m

0.00 m

5.80 m

8.80 m

12.00 m

13.50 m EOH

HATCH

DRILLHOLE LOG

Drillhole No: **CE411A**

Sheet 1 of 4

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Haul Road - South West of Slump		

Easting:	685,115.0 m
Northing:	6,290,997.8 m
Coord.System:	GDA94
Elevation:	690.00 m
Total Depth:	23.0 m

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Date Logged:**	10-Jul-18	**Logged By:**	MR
Driller:		**Hole Diameter (mm):**	63 / 115	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	**Soil Description** TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
	690.0	0.0	Roto Sonic	C			NO SAMPLING TO 9.0 m					
	689.0	1.0										
	688.0	2.0										
	687.0	3.0										
	686.0	4.0										
	685.0	5.0										
	684.0	6.0										
	683.0	7.0										
	682.0	8.0										
	681.0	9.0					BASALT: grey brown, highly weathered	D	.			
							extremely weathered					
	680.0	10.0										

Notes:

DRILLHOLE LOG

Drillhole No: **CE411A**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Haul Road - South West of Slump		

Easting:	685,115.0 m
Northing:	6,290,997.8 m
Coord.System:	GDA94
Elevation:	690.00 m
Total Depth:	23.0 m
Logged By:	MR
Checked By:	IAG

Contractor: Groundwave **Rig Type/ Mounting:** LS250 Sonic **Date Logged:** 10-Jul-18

Driller: **Hole Diameter (mm):** 63 / 115 **Date Checked:** 04-Oct-18

Water	Elevation (m)	Depth (m)	Method	Casing	Classification Symbol	Soil Description: TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Roto Sonic	C		extremely weathered *(Continued)*					
						highly weathered	M				
	679.0	11.0				moderately weathered, SW-Fr basalt cobbles					
						extremely weathered					
	678.0	12.0									Thin Walled U-Tube taken from 12.00-12.26m. U63, pushed 450 mm recovered 260 mm
					CI	Silty sandy CLAY: intermediate plasticity, grey orange mottled brown, fine to medium grained sand	M	H			Thin Walled U-Tube taken from 12.50-12.95m. U63, pushed 450 mm recovered 450 mm
	677.0	13.0			ML	[PALEO ALLUVIUM]	M	H			
						Clayey sandy SILT: low plasticity, light purple with fine white/ orange flecks, fine grained sand		VSt			
						helical shaped Fe filled fissure		H			Thin Walled U-Tube taken from 13.50-13.73m. U63 refusal, pushed 200 mm recovered 230 mm
	676.0	14.0	Lexan			changing to brown orange sub-rounded to rounded gravel clasts up to 6mm at end of push tube quartz and chert, some angular					Lexan Tube taken from 13.90-15.00m.
	675.0	15.0				sub-rounded to rounded gravel clasts up to 15mm at end of push tube					Thin Walled U-Tube taken from 15.00-15.30m. U63 refusal, pushed 350 mm recovered 300 mm Lexan Tube taken from 15.30-16.50m.
	674.0	16.0			ML	Clayey SILT: low plasticity, yellow orange with purple and orange staining and white speckling [XW VOLCANICLASTIC]			550 550		Thin Walled U-Tube taken from 16.50-16.95m. U63, pushed 450 mm recovered 450 mm
	673.0	17.0	Roto Sonic								
	672.0	18.0				near vertical Fe fissures in base of push tube					Thin Walled U-Tube taken from 18.00-18.45m. U63 refusal, pushed 370 mm recovered 450 mm
	671.0	19.0				***Start of Coring at 18.4m.*** ***Continued on Rock Core Log sheet.***					
	670.0	20.0									

Notes:

HATCH

CORED DRILLHOLE LOG
ROCK CORE FORMAT

Drillhole No: **CE411A**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Haul Road - South West of Slump		

Easting:	685,115.0 m
Northing:	6,290,997.8 m
Coord.System:	GDA94
Elevation:	690.00 m
Total Depth:	23.0 m

Contractor: Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Bearing:**	N/A	**Date Logged:**	10-Jul-18	**Logged By:**	MR
Driller:	**Hole Diameter (mm):**	63 / 115	**Plunge:**	Vertical	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Geological Unit	Rock Description: ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.	Weathering/ Cementation	Estimated Strength (EH VH H M L VL EL)	Is(50) MPa	Defect Spacing mm (2000 600 200 [100] 60 20)	RQD %	Defect Log	Defect Description: Inclination, type, infill, amount, aperture, planarity, roughness, frequency (Specific / General)
	679.0	11.0												
	678.0	12.0												
	677.0	13.0												
	676.0	14.0												
	675.0	15.0												
	674.0	16.0												
	673.0	17.0												
	672.0	18.0					***Resuming in Rock Core Format 18.4m.***							
	671.0	19.0	HQ-3 Coring	[19.0]			VOLCANICLASTIC: fine to medium grained, orange brown, orange phenocrysts 1-3mm	XW						
	670.0	20.0												

Notes:

CORED DRILLHOLE LOG
ROCK CORE FORMAT

Drillhole No: **CE411A**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Haul Road - South West of Slump		

Easting:	685,115.0 m
Northing:	6,290,997.8 m
Coord.System:	GDA94
Elevation:	690.00 m
Total Depth:	23.0 m

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Bearing:**	N/A	**Date Logged:**	10-Jul-18	**Logged By:**	MR
Driller:		**Hole Diameter (mm):**	63 / 115	**Plunge:**	Vertical	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Geological Unit	Rock Description: ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.	Weathering/ Cementation	Estimated Strength (EH VH H M L VL EL)	$Is_{(50)}$ MPa	Defect Spacing mm (2000 600 200 [100] 60 20)	RQD %	Defect Log	Defect Description: Inclination, type, infill, amount, aperture, planarity, roughness, frequency (Specific / General)
							VOLCANICLASTIC: fine to medium grained, orange brown, orange phenocrysts 1-3mm *(Continued)*	XW						
	669.0	21.0					changing to purple brown	HW						
	668.0	22.0					CORE LOSS from 21.90m to 22.25m.							
							VOLCANICLASTIC: fine to medium grained, purple brown, cream/orange phenocrysts 1-3mm	HW						
	667.0	23.0					**Drillhole CE411A terminated at 23.0m.**							
	666.0	24.0												
	665.0	25.0												
	664.0	26.0												
	663.0	27.0												
	662.0	28.0												
	661.0	29.0												
	660.0	30.0												

Notes:

HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Haul Road - South West of Slump	Page 1 of 1	

Drillhole No.:	CE411A
Easting:	685,115.0m
Northing:	6,290,997.75m
Horizontal Datum:	GDA94
Surface Elevation:	690.02m

0 1m

9.00 m

11.20 m

13.50 m

18.00 m

21.10 m

23.00 m EOH

HATCH — DRILLHOLE LOG

Drillhole No: **CE412**

Sheet 1 of 6

Client:	Newcrest
Project No.:	H356804
Project:	Cadia NTSF Failure Review
Location:	Stage 1 Buttress - West
Easting:	685,129.3 m
Northing:	6,291,369.4 m
Coord.System:	GDA94
Elevation:	732.10 m
Total Depth:	67.5 m
Contractor:	Groundwave
Rig Type/ Mounting:	LS250 Sonic
Date Logged:	02-Jul-18
Logged By:	TMY/MR
Driller:	TB / RF / DS
Hole Diameter (mm):	115
Date Checked:	04-Oct-18
Checked By:	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Roto Sonic	C		GW	[BUTTRESS STAGE 1 ROCKFILL] (0.0 - 10.0 m) *(Continued)*					
	721.1	11.0				CH	Gravelly CLAY, high plasticity, brown [STAGE 3 CLAY FILL]	mc >PL	VSt			
						GW	[STAGE 3 ROCKFILL]	M	D			
	720.1	12.0				ML	Sandy SILT: fine grained, grey [TAILINGS]	W	F			
	719.1	13.0										
	718.1	14.0										
	717.1	15.0										
	716.1	16.0										
	715.1	17.0										
	714.1	18.0					TAILINGS: Clayey Silty SAND, fine grained, grey					Disturbed Sample taken from 18.00-18.05m.
	713.1	19.0										
	712.1	20.0										

Notes: Vibrating Wire Piezometer installed at 56.5 m (Pressure Rating 700kPa, Serial No. 25010). Hole grouted to 10.5 m

HATCH

DRILLHOLE LOG

Drillhole No: **CE412**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Stage 1 Buttress - West		

Easting:	685,129.3 m
Northing:	6,291,369.4 m
Coord.System:	GDA94
Elevation:	732.10 m
Total Depth:	67.5 m

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Date Logged:**	02-Jul-18	**Logged By:**	TMY/MR
Driller:	TB / RF / DS	**Hole Diameter (mm):**	115	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Roto Sonic	C			TAILINGS: Clayey Silty SAND, fine grained, grey *(Continued)*					Disturbed Sample taken from 20.20-20.25m.
	711.1	21.0	Lexan									Lexan Tube taken from 21.00-22.50m. 0.8 m recovery
												Disturbed Sample taken from 21.70-21.75m.
	710.1	22.0										
												Disturbed Sample taken from 22.40-22.45m. Lexan Tube taken from 22.50-24.00m. 1.5 m recovery
	709.1	23.0										
									VSt			
	708.1	24.0	Roto Sonic									Disturbed Sample taken from 24.00-24.05m.
	707.1	25.0										
	706.1	26.0										
	705.1	27.0										
	704.1	28.0										
	703.1	29.0										
	702.1	30.0										

Notes: Vibrating Wire Piezometer installed at 56.5 m (Pressure Rating 700kPa, Serial No. 25010). Hole grouted to 10.5 m

DRILLHOLE LOG

Drillhole No: **CE412**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Stage 1 Buttress - West		

Easting:	685,129.3 m
Northing:	6,291,369.4 m
Coord.System:	GDA94
Elevation:	732.10 m
Total Depth:	67.5 m
Logged By:	TMY/MR
Checked By:	IAG

Contractor: Groundwave **Rig Type/ Mounting:** LS250 Sonic **Date Logged:** 02-Jul-18

Driller: TB / RF / DS **Hole Diameter (mm):** 115 **Date Checked:** 04-Oct-18

Water	Elevation (m)	Depth (m)	Method	Casing	Classification Symbol	Soil Description: TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Additional Observations
			Lexan	C		TAILINGS: Clayey Silty SAND, fine grained, grey *(Continued)*				Lexan Tube taken from 30.00-31.50m. 1.5 m recovery
	701.1	31.0								
								S		Lexan Tube taken from 31.50-33.00m. 1.5 m recovery
	700.1	32.0								
	699.1	33.0	Roto Sonic							
	698.1	34.0								
	697.1	35.0								
	696.1	36.0								
	695.1	37.0								
					GW	GRAVEL [STAGE 1 ROCKFILL]	M	-		
	694.1	38.0			CI	CLAY: intermediate plasticity, dark brown, cobbles mixed throughout [RESIDUAL BASALT]	mc >PL	F		Disturbed Sample taken from 38.10-38.15m. Thin Walled U-Tube taken from 38.50-38.85m. U63 refusal, pushed 220 mm recovered 350 mm
	693.1	39.0				cobble, 100mm				U63 refusal on cobble (39.0 m)
			Lexan		ML	Sandy SILT: with some clay, extremely low strength gravel up to 10mm, light to dark brown [RESIDUAL BASALT]	mc ~PL	H		Thin Walled U-Tube taken from 39.50-39.72m. U63 refusal, pushed 190 mm
	692.1	40.0								

Notes: Vibrating Wire Piezometer installed at 56.5 m (Pressure Rating 700kPa, Serial No. 25010). Hole grouted to 10.5 m

HATCH

DRILLHOLE LOG

Drillhole No: **CE412**

Client:	Newcrest
Project No.:	H356804
Project:	Cadia NTSF Failure Review
Location:	Stage 1 Buttress - West
Easting:	685,129.3 m
Northing:	6,291,369.4 m
Coord.System:	GDA94
Elevation:	732.10 m
Total Depth:	67.5 m
Contractor:	Groundwave
Rig Type/ Mounting:	LS250 Sonic
Date Logged:	02-Jul-18
Logged By:	TMY/MR
Driller:	TB / RF / DS
Hole Diameter (mm):	115
Date Checked:	04-Oct-18
Checked By:	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Lexan	C		ML	Sandy SILT: with some clay, extremely low strength gravel up to 10mm, light to dark brown [RESIDUAL BASALT] *(Continued)*	mc ~PL	H			recovered 220 mm Lexan Tube taken from 40.00-41.00m. 0.85 m recovery
	691.1	41.0	Roto Sonic				BASALT: dark grey, fine grained vesicular texture, vesicles up to 5 mm, highly weathered	D	.			
	690.1	42.0										
	689.1	43.0										
	688.1	44.0										
	687.1	45.0										
	686.1	46.0										
	685.1	47.0										
	684.1	48.0										
	683.1	49.0										
	682.1	50.0										

Notes: Vibrating Wire Piezometer installed at 56.5 m (Pressure Rating 700kPa, Serial No. 25010). Hole grouted to 10.5 m

DRILLHOLE LOG

HATCH

Drillhole No: **CE412**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Stage 1 Buttress - West		

Easting:	685,129.3 m
Northing:	6,291,369.4 m
Coord.System:	GDA94
Elevation:	732.10 m
Total Depth:	67.5 m

Contractor: Groundwave	**Rig Type/ Mounting:** LS250 Sonic	**Date Logged:** 02-Jul-18	**Logged By:** TMY/MR
Driller: TB / RF / DS	**Hole Diameter (mm):** 115	**Date Checked:** 04-Oct-18	**Checked By:** IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Roto Sonic	C			BASALT: dark grey, fine grained vesicular texture, vesicles up to 5 mm, highly weathered *(Continued)*	D	.			
	681.1	51.0										
	680.1	52.0										
	679.1	53.0										
	678.1	54.0										
	677.1	55.0										
	676.1	56.0										
	675.1	57.0										
	674.1	58.0										
	673.1	59.0				ML	Sandy SILT: fine grained, low plasticity, grey mottled brown orange, minor clay [PALEO ALLUVIUM]	mc <PL	VSt		Bulk	Bulk Sample taken from 59.00-59.15m.
	672.1	60.0		[60.0]								

Notes: Vibrating Wire Piezometer installed at 56.5 m (Pressure Rating 700kPa, Serial No. 25010). Hole grouted to 10.5 m

DRILLHOLE LOG

Drillhole No: **CE412**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Stage 1 Buttress - West		

Easting:	685,129.3 m
Northing:	6,291,369.4 m
Coord.System:	GDA94
Elevation:	732.10 m
Total Depth:	67.5 m
Logged By:	TMY/MR
Checked By:	IAG

Contractor: Groundwave | **Rig Type/ Mounting:** LS250 Sonic | **Date Logged:** 02-Jul-18

Driller: TB / RF / DS | **Hole Diameter (mm):** 115 | **Date Checked:** 04-Oct-18

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Roto Sonic			CI	Sandy CLAY: intermediate plasticity with mudstone gravel to 20 mm, green brown with brown staining [PALEO ALLUVIUM]	M	H			Bulk Sample taken from 60.00-60.38m. Bulk Sample taken from 60.57-60.89m.
	671.1	61.0										
						CL	Silty CLAY: orange, very fine grained	M	H			
			Lexan			ML	Clayey SILT: low plasticity, greenish grey with some purple grey staining and white speckling, some green grey and purple tuff ? clasts [RESIDUAL VOLCANICLASTIC]	M	H			Bulk Sample taken from 61.70-62.00m. Bulk Sample taken from 62.00-62.35m.
	670.1	62.0								550 550		
	669.1	63.0	Sonic				changing to brown purple					
			Lexan									Lexan Tube taken from 63.50-64.50m. 1.0 m recovery
	668.1	64.0					changing to orange brown					Lexan Tube taken from 64.50-66.00m. 1.5 m recovery
	667.1	65.0										
	666.1	66.0	Roto Sonic									
	665.1	67.0										
	664.1	68.0					Vibrating Wire Piezometer installed at 56.5m **Drillhole CE412 terminated at 67.50m.**					
	663.1	69.0										
	662.1	70.0										

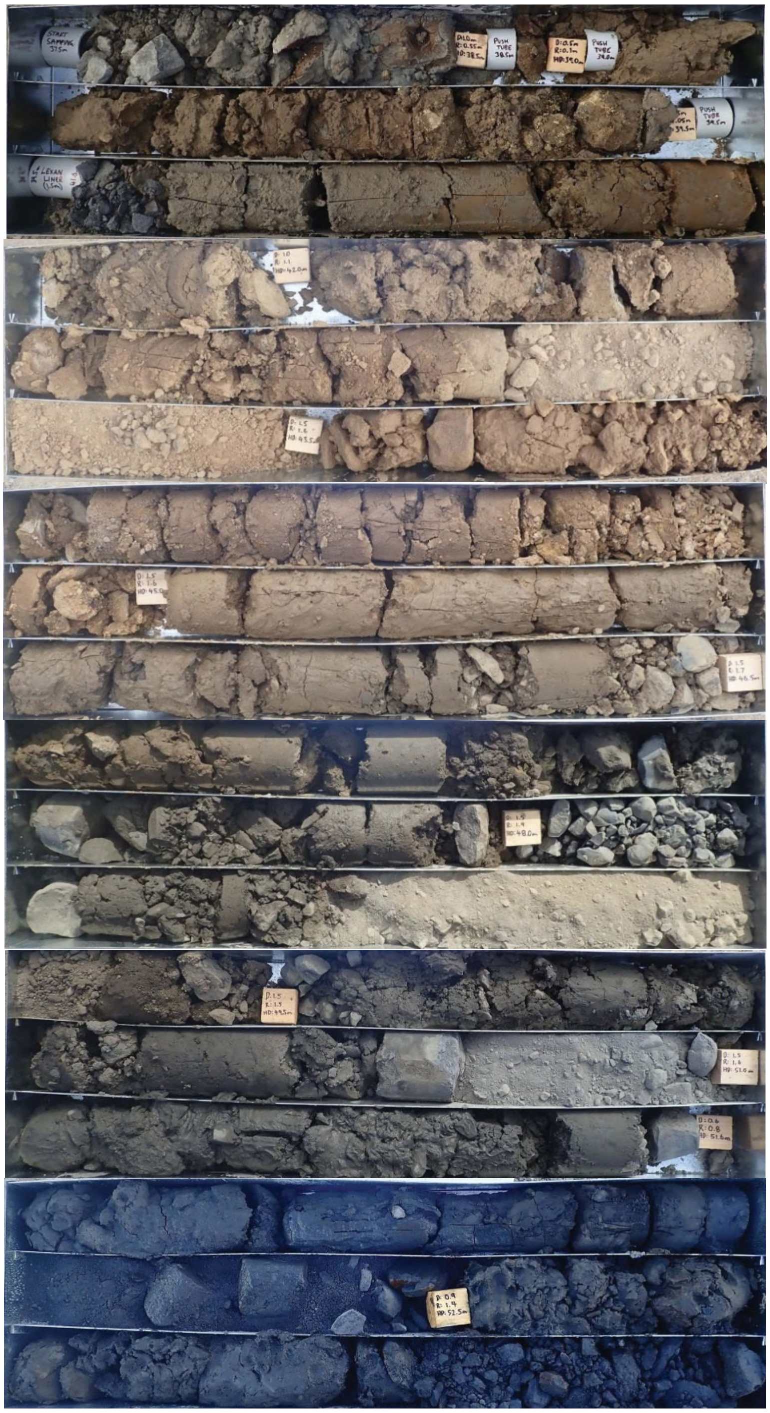
Notes: Vibrating Wire Piezometer installed at 56.5 m (Pressure Rating 700kPa, Serial No. 25010). Hole grouted to 10.5 m

HATCH	Drill Core Photograph	Drillhole No.: CE412
		Easting: 685,129.3m
Client: Newcrest	Project No.: H356804	Northing: 6,291,369.4m
Project : Cadia NTSF Failure Review		Horizontal Datum: GDA94
Location: Stage 1 Buttress - West	Page 1 of 2	Surface Elevation: 732.14m

0 1m

37.50 m

39.50 m



46.50 m

51.00 m

HATCH	**Drill Core Photograph**		Drillhole No.:	CE412
			Easting:	685,129.3m
Client:	Newcrest	Project No.: H356804	Northing:	6,291,369.4m
Project :	Cadia NTSF Failure Review		Horizontal Datum:	GDA94
Location:	Stage 1 Buttress - West	Page 2 of 2	Surface Elevation:	732.14m

0 — 1m

60.89 m

64.50 m

67.50 m EOH

HATCH

DRILLHOLE LOG

Drillhole No: CE413

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Stage 10 Crest - West		

Easting:	685,171.4 m
Northing:	6,291,414.3 m
Coord.System:	GDA94
Elevation:	743.90 m
Total Depth:	58.4 m

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Date Logged:**	27-Jun-18	**Logged By:**	TMY
Driller:	TB	**Hole Diameter (mm):**	115	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Roto Sonic	C		GW	[STAGE 10 ROCKFILL]					
	742.9	1.0										
	741.9	2.0										
	740.9	3.0				CH	CLAY, trace of gravel, high plasticity, brown with orange weathering, some small roots (< 4 mm) [STAGE 10 CLAY FILL]	D	VSt-H	390	Bulk	Bulk Sample taken from 3.65-3.80m.
						GW	[STAGE 10 ROCKFILL]		-			
	739.9	4.0										
						ML	Clayey Sandy SILT: fine grained, grey [TAILINGS]	M-W	F			
	738.9	5.0										
	737.9	6.0										
	736.9	7.0										
	735.9	8.0										
	734.9	9.0										
	733.9	10.0										

Notes: Vibrating Wire Piezometer installed at 57.4 m (Pressure Rating 700kPa, Serial No. 25011). Hole grouted to 3.0 m

HATCH

DRILLHOLE LOG

Drillhole No: **CE413**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Stage 10 Crest - West		

Easting:	685,171.4 m
Northing:	6,291,414.3 m
Coord.System:	GDA94
Elevation:	743.90 m
Total Depth:	58.4 m

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Date Logged:**	27-Jun-18	**Logged By:**	TMY
Driller:	TB	**Hole Diameter (mm):**	115	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	**Soil Description** TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Roto Sonic	C		ML	Clayey Sandy SILT: fine grained, grey [TAILINGS] *(Continued)*	M-W	F			
	732.9	11.0										
	731.9	12.0										
	730.9	13.0										
						CL	Silty CLAY: trace fine reddish sand [TAILINGS]		F			U75 taken from 13.80-14.25m. Piston Sample, recovered 310 mm
	729.9	14.0								90		
	728.9	15.0	Lexan			ML	Clayey sandy SILT [TAILINGS]					Lexan Tube taken from 15.00-16.50m. 1.4 m recovery
	727.9	16.0								70		
						SC	Clayey SAND: grey-brown [TAILINGS]		L			Lexan Tube taken from 16.50-18.00m. 1.4 m recovery
	726.9	17.0										
	725.9	18.0	Roto Sonic									Disturbed Sample taken from 18.00-18.05m.
	724.9	19.0										
	723.9	20.0										

Notes: Vibrating Wire Piezometer installed at 57.4 m (Pressure Rating 700kPa, Serial No. 25011). Hole grouted to 3.0 m

DRILLHOLE LOG

Drillhole No: **CE413**

Client: Newcrest

Project No.: H356804

Project: Cadia NTSF Failure Review

Location: Stage 10 Crest - West

Easting:	685,171.4 m
Northing:	6,291,414.3 m
Coord.System:	GDA94
Elevation:	743.90 m
Total Depth:	58.4 m
Logged By:	TMY
Checked By:	IAG

Contractor: Groundwave **Rig Type/ Mounting:** LS250 Sonic **Date Logged:** 27-Jun-18

Driller: TB **Hole Diameter (mm):** 115 **Date Checked:** 04-Oct-18

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Roto Sonic	C		SC	Clayey SAND: grey-brown [TAILINGS] *(Continued)*		L			
	722.9	21.0										
	721.9	22.0										
▼ 29-Jun-18	720.9	23.0										
	719.9	24.0										
	718.9	25.0										
	717.9	26.0				SM	Silty SAND with trace of clay: fine grained, grey [TAILINGS]			60		U75 taken from 25.95-26.40m. Piston Sample, recovered 420 mm
	716.9	27.0	Lexan									Lexan Tube taken from 27.00-28.50m. 1.5 m recovery
	715.9	28.0								60		
	714.9	29.0	Roto Sonic									Disturbed Sample taken from 28.50-28.55m.
	713.9	30.0										

Notes: Vibrating Wire Piezometer installed at 57.4 m (Pressure Rating 700kPa, Serial No. 25011). Hole grouted to 3.0 m

DRILLHOLE LOG

Drillhole No: **CE413**

Client: Newcrest | **Project No.:** H356804

Project: Cadia NTSF Failure Review

Location: Stage 10 Crest - West

Easting:	685,171.4 m
Northing:	6,291,414.3 m
Coord.System:	GDA94
Elevation:	743.90 m
Total Depth:	58.4 m

Contractor: Groundwave | **Rig Type/ Mounting:** LS250 Sonic | **Date Logged:** 27-Jun-18 | **Logged By:** TMY

Driller: TB | **Hole Diameter (mm):** 115 | **Date Checked:** 04-Oct-18 | **Checked By:** IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Lexan	C		SM	Silty SAND: fine grained, grey [TAILINGS]					Lexan Tube taken from 30.00-31.50m. 1.3 m recovery
	712.9	31.0										
			Roto Sonic									Disturbed Sample taken from 31.50-31.55m.
	711.9	32.0										
	710.9	33.0										
	709.9	34.0										U75 taken from 34.00-34.45m. Piston Sample, recovered 450 mm
	708.9	35.0	Lexan			SC	Clayey Silty SAND: fine grained, grey [TAILINGS]					Lexan Tube taken from 35.00-36.50m. 1.35 m recovery
	707.9	36.0										
										100		Disturbed Sample taken from 36.40-36.45m. Lexan Tube taken from 36.50-38.00m. 1.5 m recovery
	706.9	37.0										
	705.9	38.0	Roto Sonic							120		Disturbed Sample taken from 38.00-38.05m.
	704.9	39.0										
	703.9	40.0										

Notes: Vibrating Wire Piezometer installed at 57.4 m (Pressure Rating 700kPa, Serial No. 25011). Hole grouted to 3.0 m

HATCH DRILLHOLE LOG

Drillhole No: **CE413**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Stage 10 Crest - West		

Easting:	685,171.4 m
Northing:	6,291,414.3 m
Coord.System:	GDA94
Elevation:	743.90 m
Total Depth:	58.4 m
Logged By:	TMY
Checked By:	IAG

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Date Logged:**	27-Jun-18
Driller:	TB	**Hole Diameter (mm):**	115	**Date Checked:**	04-Oct-18

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
	702.9	41.0	Roto Sonic	C		SC	Clayey Silty SAND: fine grained, grey [TAILINGS] *(Continued)*					
	701.9	42.0	Lexan			SM	Silty SAND: fine grained, grey [TAILINGS]			100		Disturbed Sample taken from 41.90-41.95m. Lexan Tube taken from 42.00-43.50m. 0.8 m recovery
	700.9	43.0										Disturbed Sample taken from 42.80-42.85m.
	699.9	44.0	Sonic							70		Lexan Tube taken from 43.50-44.50m. 0.3 m recovery
			Lexan			SP	SAND: poorly graded [TAILINGS]					Disturbed Sample taken from 44.40-44.45m. Lexan Tube taken from 44.50-46.00m. 1.25 m recovery
	698.9	45.0				ML	Sandy Clayey SILT [TAILINGS]		S			
	697.9	46.0	Roto Sonic							30		Disturbed Sample taken from 46.00-46.05m.
	696.9	47.0										
	695.9	48.0										
	694.9	49.0										
	693.9	50.0										

Notes: Vibrating Wire Piezometer installed at 57.4 m (Pressure Rating 700kPa, Serial No. 25011). Hole grouted to 3.0 m

DRILLHOLE LOG

Drillhole No: **CE413**

Sheet 6 of 6

Client:	Newcrest
Project No.:	H356804
Project:	Cadia NTSF Failure Review
Location:	Stage 10 Crest - West
Easting:	685,171.4 m
Northing:	6,291,414.3 m
Coord.System:	GDA94
Elevation:	743.90 m
Total Depth:	58.4 m
Contractor:	Groundwave
Driller:	TB
Rig Type/ Mounting:	LS250 Sonic
Hole Diameter (mm):	115
Date Logged:	27-Jun-18
Date Checked:	04-Oct-18
Logged By:	TMY
Checked By:	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description: TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Roto Sonic	C		ML	Sandy Clayey SILT [TAILINGS] *(Continued)*		S			
	692.9	51.0								160		Disturbed Sample taken from 50.90-50.95m.
	691.9	52.0								170		Disturbed Sample taken from 52.50-52.55m.
	690.9	53.0				CL	Sandy CLAY: low plasticity, grey [TAILINGS]		S	50		
						CH	CLAY: trace sand, high plasticity, dark brown, some small subangular to angular gravel [RESIDUAL BASALT]	mc >PL	VSt	240		Bulk Sample taken from 53.50-53.80m. Sonic Core
	689.9	54.0								360		Thin Walled U-Tube taken from 54.00-54.35m. U63 refusal, recovered 350 mm
				[54.5]			becoming brown, XW-HW basalt gravels and cobbles		H	>600		
	688.9	55.0							VSt	290		
						.	BASALT: extremely weathered, XW-MW basalt gravel and cobbles, brown with orange weathering	D	.			
	687.9	56.0					becoming highly weathered, grey					
	686.9	57.0					highly to slightly weathered basalt cobbles in clay					
							Moderately weathered, orange grey, SW basalt cobbles					
	685.9	58.0										
	684.9	59.0					Vibrating Wire Piezometer installed at 57.35m					
							Drillhole CE413 terminated at 58.40m.					
	683.9	60.0										

Notes: Vibrating Wire Piezometer installed at 57.4 m (Pressure Rating 700kPa, Serial No. 25011). Hole grouted to 3.0 m

HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Stage 10 Crest - West	Page 1 of 1	

Drillhole No.:	CE413
Easting:	685,171.4m
Northing:	6,291,414.3m
Horizontal Datum:	GDA94
Surface Elevation:	743.85m

0 1m

53.20 m

55.85 m

57.00 m

58.35 m EOH

DRILLHOLE LOG

Drillhole No: **CE415**

Sheet 1 of 5

Client:	Newcrest
Project No.:	H356804
Project:	Cadia NTSF Failure Review
Location:	Haul Road - West of Slump
Easting:	685,059.2 m
Northing:	6,291,148.8 m
Coord.System:	GDA94
Elevation:	686.20 m
Total Depth:	31.3 m
Contractor:	Groundwave
Rig Type/ Mounting:	LS250 Sonic
Date Logged:	13-Jul-19
Logged By:	BNM/IAG
Driller:	HF
Hole Diameter (mm):	63 / 115
Date Checked:	04-Oct-18
Checked By:	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
		0.0–3.4	Roto Sonic	C		GW	[ROAD BASE FILL]	D	D			
		3.4–6.5				MH	Clayey SILT: high plascitiy, red brown with white speckling [RESIDUAL VOLCANOCLASTIC]	M	VSt	340 350		
		4.12–4.30										Disturbed Sample taken from 4.12-4.30m. SA-1
									F	100 200		
									St-VSt	250 300		
		5.53–5.76										Disturbed Sample taken from 5.53-5.76m. SA-2
		6.00–6.45										Thin Walled U-Tube taken from 6.00-6.45m. U63 - PT1, recovered 450 mm
		6.5					***Start of Coring at 6.5m.*** ***Continued on Rock Core Log sheet.***					

Elevation / Depth scale: 685.2 / 1.0; 684.2 / 2.0; 683.2 / 3.0; 682.2 / 4.0; 681.2 / 5.0; 680.2 / 6.0; 679.2 / 7.0; 678.2 / 8.0; 677.2 / 9.0; 676.2 / 10.0

Notes: Vibrating Wire Piezometer installed at 25.0 m (Pressure Rating 350kPa, Serial No. 316-280). Hole grouted to 3.4 m

HATCH

CORED DRILLHOLE LOG
ROCK CORE FORMAT

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Haul Road - West of Slump		

Easting:	685,059.2 m
Northing:	6,291,148.8 m
Coord.System:	GDA94
Elevation:	686.20 m
Total Depth:	31.3 m
Logged By:	BNM/IAG
Checked By:	IAG

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Bearing:**	N/A	**Date Logged:**	13-Jul-19
Driller:	HF	**Hole Diameter (mm):**	63 / 115	**Plunge:**	Vertical	**Date Checked:**	04-Oct-18

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Geological Unit	Rock Description ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.	Weathering/ Cementation	Estimated Strength EH VH H M L VL EL	$Is_{(50)}$ MPa	Defect Spacing mm 2000 600 200 [100] 60 20	RQD %	Defect Log	Defect Description Inclination, type, infill, amount, aperture, planarity, roughness, frequency Specific / General
	685.2	1.0												
	684.2	2.0												
	683.2	3.0												
	682.2	4.0												
	681.2	5.0												
	680.2	6.0					***Resuming in Rock Core Format 6.5m.***							
	679.2	7.0	HQ-3 Coring	C [6.7]			VOLCANICLASTIC: low to medium plasticity, light grey with purple and white speckling	XW						
	678.2	8.0						HW						
	677.2	9.0												
	676.2	10.0												

Notes: Vibrating Wire Piezometer installed at 25.0 m (Pressure Rating 350kPa, Serial No. 316-280). Hole grouted to 3.4 m

CORED DRILLHOLE LOG

ROCK CORE FORMAT

Drillhole No: **CE415**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Haul Road - West of Slump		

Easting:	685,059.2 m
Northing:	6,291,148.8 m
Coord.System:	GDA94
Elevation:	686.20 m
Total Depth:	31.3 m

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Bearing:**	N/A	**Date Logged:**	13-Jul-19	**Logged By:**	BNM/IAG
Driller:	HF	**Hole Diameter (mm):**	63 / 115	**Plunge:**	Vertical	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Geological Unit	Rock Description: ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.	Weathering/ Cementation	Estimated Strength (EH VH H M L VL EL)	$Is_{(50)}$ MPa	Defect Spacing mm (2000 600 200 [100] 60 20)	RQD %	Defect Log	Defect Description: Inclination, type, infill, amount, aperture, planarity, roughness, frequency (Specific / General)
			HQ-3 Coring				VOLCANICLASTIC: low to medium plasticity, light grey with purple and white speckling *(Continued)*	HW						
	675.2	11.0												
	674.2	12.0												
	673.2	13.0												
	672.2	14.0												
							CORE LOSS from 14.60m to 14.80m.							
							VOLCANICLASTIC: light grey with purple and white speckling							
	671.2	15.0												
								XW						
	670.2	16.0												
	669.2	17.0												
								HW						
	668.2	18.0												
	667.2	19.0												
	666.2	20.0												

Notes: Vibrating Wire Piezometer installed at 25.0 m (Pressure Rating 350kPa, Serial No. 316-280). Hole grouted to 3.4 m

HATCH CORED DRILLHOLE LOG

ROCK CORE FORMAT

Drillhole No: **CE415**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Haul Road - West of Slump		

Easting:	685,059.2 m
Northing:	6,291,148.8 m
Coord.System:	GDA94
Elevation:	686.20 m
Total Depth:	31.3 m

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Bearing:**	N/A	**Date Logged:**	13-Jul-19	**Logged By:**	BNM/IAG
Driller:	HF	**Hole Diameter (mm):**	63 / 115	**Plunge:**	Vertical	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Column headings: Water | Elevation (m) | Depth (m) | Method | Casing | Graphic Log | Geological Unit | **Rock Description** — ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents. | Weathering/ Cementation | Estimated Strength (EH VH H M L VL EL) | $Is_{(50)}$ MPa | Defect Spacing mm (2000 600 200 [100] 60 20) | RQD % | Defect Log | **Defect Description** — Inclination, type, infill, amount, aperture, planarity, roughness, frequency (Specific / General)

Elevation (m)	Depth (m)
665.2	21.0
664.2	22.0
663.2	23.0
662.2	24.0
661.2	25.0
660.2	26.0
659.2	27.0
658.2	28.0
657.2	29.0
656.2	30.0

Method: HQ-3 Coring

Rock Description:

VOLCANICLASTIC: light grey with purple and white speckling *(Continued)*

yellow brown to brown with white speckling

light to medium grey with white speckling

Weathering/Cementation: HW; MW (from 21.0 m); SW; HW; SW (about 24.0 m); Fr (from about 28.9 m)

Defect Description:

- 65° Jt Ir
- 20° Jt Ir
- 20° Jt Ir
- 20° Jt Ir
- 40° Cs Pl
- 45° Jt Ir Fe sn
- 70° Jt Ir Fe sn
- 70° Jt Ir Fe sn
- 50° Jt Ir Sm
- 45° Jt
- 45° Jt
- 80° Jt Ir
- 60° Jt Ir Fe sn
- 20° Jt
- 20° Jt
- 20° Jt Ir

Notes: Vibrating Wire Piezometer installed at 25.0 m (Pressure Rating 350kPa, Serial No. 316-280). Hole grouted to 3.4 m

CORED DRILLHOLE LOG

ROCK CORE FORMAT

Drillhole No: **CE415**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Haul Road - West of Slump		

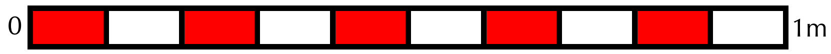
Easting:	685,059.2 m
Northing:	6,291,148.8 m
Coord.System:	GDA94
Elevation:	686.20 m
Total Depth:	31.3 m

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Bearing:**	N/A	**Date Logged:**	13-Jul-19	**Logged By:**	BNM/IAG
Driller:	HF	**Hole Diameter (mm):**	63 / 115	**Plunge:**	Vertical	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Geological Unit	Rock Description: ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.	Weathering/ Cementation	Estimated Strength (EH VH H M L VL EL)	$Is_{(50)}$ MPa	Defect Spacing mm (2000 600 200 [100] 60 20)	RQD %	Defect Log	Defect Description: Inclination, type, infill, amount, aperture, planarity, roughness, frequency (Specific / General)
	655.2	31.0	HQ-3 Coring				VOLCANICLASTIC: light grey with purple and white speckling *(Continued)*	Fr						60° Jt Calcite; 30° Jt Sm; 30° Jt Sm
	654.2	32.0					Vibrating Wire Piezometer installed at 31.3m							
							Drillhole CE415 terminated at 31.3m.							
	653.2	33.0												
	652.2	34.0												
	651.2	35.0												
	650.2	36.0												
	649.2	37.0												
	648.2	38.0												
	647.2	39.0												
	646.2	40.0												

Notes: Vibrating Wire Piezometer installed at 25.0 m (Pressure Rating 350kPa, Serial No. 316-280). Hole grouted to 3.4 m

HATCH	**Drill Core Photograph**		Drillhole No.:	CE415
			Easting:	685,059.2m
Client:	Newcrest	Project No.: H356804	Northing:	6,291,148.8m
Project :	Cadia NTSF Failure Review		Horizontal Datum:	GDA94
Location:	Haul Road - West of Slump	Page 1 of 2	Surface Elevation:	686.20m



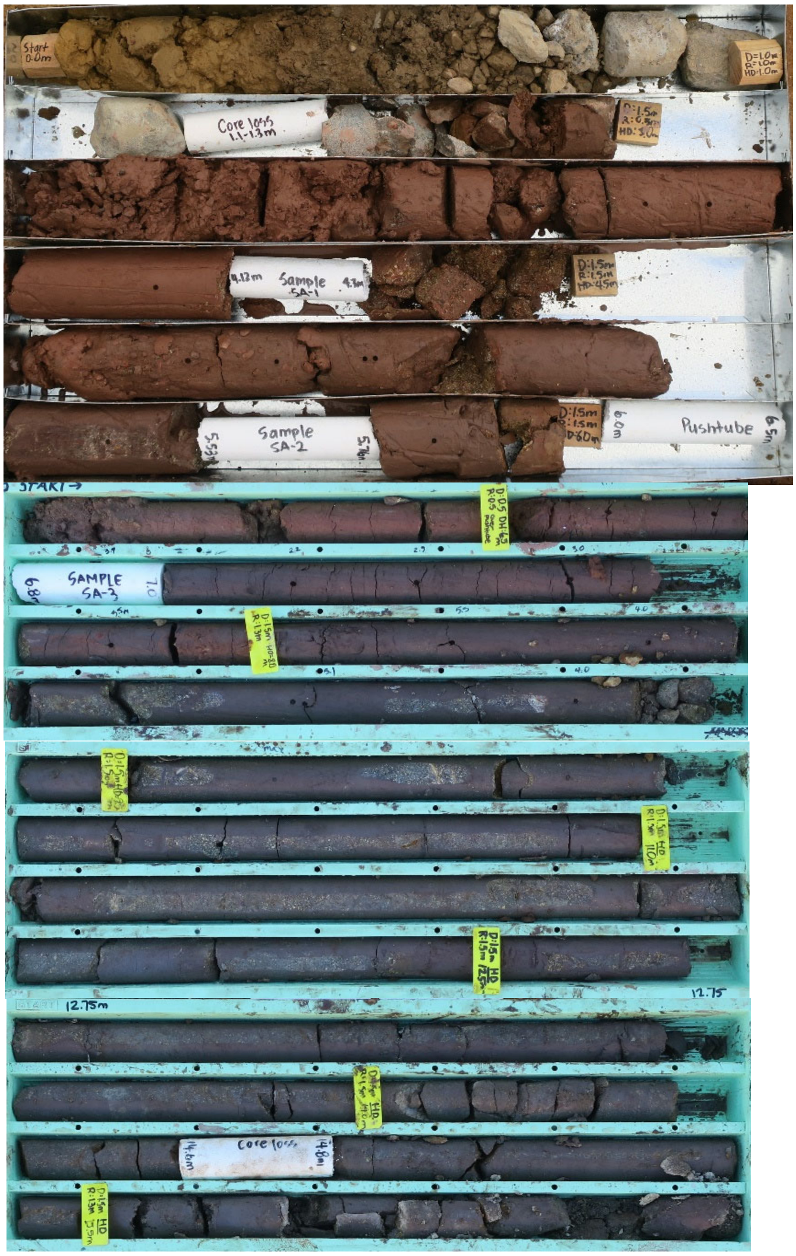
0.00m

4.50m

6.80m

11.00m

12.75m



HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Haul Road - West of Slump	Page 2 of 2	

Drillhole No.:	CE415
Easting:	685,059.2m
Northing:	6,291,148.8m
Horizontal Datum:	GDA94
Surface Elevation:	686.20m

0 1m

24.50m

31.30m EOH

DRILLHOLE LOG

Drillhole No: **CE416**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Western Buttress - Adjacent to Slump		

Easting:	685,213.1 m
Northing:	6,291,171.3 m
Coord.System:	GDA94
Elevation:	704.70 m
Total Depth:	39.0 m

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Date Logged:**	21-Jul-18	**Logged By:**	IAG/TMY
Driller:	HF / TB	**Hole Diameter (mm):**	63 / 115	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
	693.7 692.7 691.7 690.7 689.7 688.7 687.7 686.7	11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0	Roto Sonic	C		GW	[CONTAINMENT BUND ROCKFILL / SLUMP DEBRIS] (0.0 -10.0 m) *(Continued)*	D	L			
	685.7	19.0				CH	CLAY: high plasticity, red brown and grey mottling, some fine sand and gravel below 18.7 m [RESIDUAL BASALT]	mc >PL	VSt F			
	684.7	20.0					BASALT: highly to moderately weathered, grey brown, broken by drill action to silty gravel	M-D	-			

Notes:

HATCH

DRILLHOLE LOG

Drillhole No: **CE416**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Western Buttress - Adjacent to Slump		

Easting:	685,213.1 m
Northing:	6,291,171.3 m
Coord.System:	GDA94
Elevation:	704.70 m
Total Depth:	39.0 m
Logged By:	IAG/TMY
Checked By:	IAG

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Date Logged:**	21-Jul-18
Driller:	HF / TB	**Hole Diameter (mm):**	63 / 115	**Date Checked:**	04-Oct-18

Depth (m)	Elevation (m)	Method	Casing	Classification Symbol	Soil Description: TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Additional Observations
20.0–21.0	683.7 (21.0)	Roto Sonic	C		BASALT: highly to moderately weathered, grey brown, broken by drill action to silty gravel *(Continued)*	M-D	-		
21.0–21.1				ML	Sandy SILT: brown	-	-		
21.1–23.0	682.7 (22.0), 681.7 (23.0)	Roto Sonic		CH	Silty CLAY: high plasticity, yellow white then grey [PALEO ALLUVIUM]]	mc <PL	H		Bulk Sample taken from 21.85-21.90m. SA1
					organic matter along fissure				
					red brown and red staining, some white mottling	mc << PL	H		Thin Walled U-Tube taken from 22.50-22.80m. U63 (PT1), pushed 300 mm recovered 300 mm
23.0–25.0	680.7 (24.0), 679.7 (25.0)	Lexan			becoming yellow brown and brown with red and yellow mottling				Lexan Tube taken from 23.00-23.50m. L1B; Lexan Tube taken from 23.50-24.00m. L1C
					as above with red orange staining and white veining		VSt-H	475 280	Thin Walled U-Tube taken from 24.00-24.33m. U63 (PT2), pushed 330 mm recovered 210 mm; Lexan Tube taken from 24.50-25.00m. L2B
25.0–25.5				MH	Clayey SILT: some fg sand, orange brown with red staining and white veining, fe gravel to 30 mm	mc <PL	VSt	270	Lexan Tube taken from 25.00-25.50m. L2C
25.5–26.0	678.7 (26.0)			CH	[PALEO ALLUVIUM]	mc >PL	VSt		Thin Walled U-Tube taken from 25.50-25.95m. U63 (PT3), pushed 450 mm recovered 450 mm
26.0–27.0	677.7 (27.0)			-	CLAY: medium to high plasticity, red brown, rock structure visible in parts by weathered white mineral grains in purple fine grained matrix with white mottling [RESIDUAL VOLCANICLASTIC]	mc <PL		320 180	Lexan Tube taken from 26.00-26.50m. L3B; Lexan Tube taken from 26.50-27.00m. L3C
27.0–30.0	676.7 (28.0), 675.7 (29.0), 674.7 (30.0)	Roto Sonic			VOLCANICLASTIC: XW, medium plasticity, weathered white mineral grains in red orange matrix, trace of purple, moist white veins	mc >PL	St	190	Thin Walled U-Tube taken from 27.00-27.45m. U63 (PT4), pushed 450 mm recovered 450 mm
							H	400	
					HW, EL strength, light to dark purple with red, orange and brown mottling, gravel to 30 mm, crumbles when handled		VSt	300, 300	

Notes:

Start of Coring at 30.0m.

Continued on Rock Core Log sheet.

CORED DRILLHOLE LOG

ROCK CORE FORMAT

Drillhole No: **CE416**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Western Buttress - Adjacent to Slump		

Easting:	685,213.1 m
Northing:	6,291,171.3 m
Coord.System:	GDA94
Elevation:	704.70 m
Total Depth:	39.0 m
Logged By:	IAG/TMY
Checked By:	IAG

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Bearing:**	N/A	**Date Logged:**	21-Jul-18
Driller:	HF / TB	**Hole Diameter (mm):**	63 / 115	**Plunge:**	Vertical	**Date Checked:**	04-Oct-18

Columns: Water | Elevation (m) | Depth (m) | Method | Casing | Graphic Log | Geological Unit | Rock Description (ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.) | Weathering/ Cementation | Estimated Strength (EH VH H M L VL EL) | $Is_{(50)}$ MPa | Defect Spacing mm (2000 600 200 [100] 60 20) | RQD % | Defect Log | Defect Description (Inclination, type, infill, amount, aperture, planarity, roughness, frequency; Specific, General)

Resuming in Rock Core Format 30.0m.

Elevation (m)	Depth (m)	Method	Casing	Rock Description	Weathering/ Cementation	Defect Description
	30.0	HQ-3 Coring	C	VOLCANICLASTIC: light to dark purple with red, orange and brown mottling	HW	
673.7	31.0		[31.0]			
672.7	32.0					
				light green minerals up to 1 mm		
671.7	33.0					
				matrix discoloured to light red		
						10° Jt Pl Ro sn
				dark purple matrix	MW	
670.7	34.0					
				light pink discolouration	HW	
						45° Jt Ir Ro sn
669.7	35.0					
				dark purple matrix	MW	
						Cs
668.7	36.0					
				quartz veining, little to no discolouration	SW	
						45° Jt Ir Ro sn
667.7	37.0					
					Fr	Jt
666.7	38.0					
665.7	39.0					
664.7	40.0					

Drillhole CE416 terminated at 39.0m.

Notes:

HATCH

Drill Core Photograph

Client: Newcrest

Project No.: H356804

Project : Cadia NTSF Failure Review

Location: Western Buttress - Adjacent to Slump

Drillhole No.: CE416

Easting: 685,215.8m

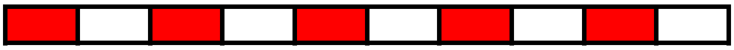
Northing: 6,291,170.3m

Horizontal Datum: GDA94

Surface Elevation: 704.98m

24.50 - 25.00 m

26.00 - 26.50 m



18.00 m

21.00 m

24.00 m

28.00 m

HATCH

Drill Core Photograph

Drillhole No.: CE416

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Western Buttress - Adjacent to Slump	Page 2 of 2	

Easting:	685,215.8m
Northing:	6,291,170.3m
Horizontal Datum:	GDA94
Surface Elevation:	704.98m

0 1m

30.00 m

33.60 m

37.10 m

39.00 m EOH

HATCH

DRILLHOLE LOG

Drillhole No: **CE417**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Western Buttress		

Easting:	685,120.2 m
Northing:	6,291,199.9 m
Coord.System:	GDA94
Elevation:	700.10 m
Total Depth:	39.0 m
Logged By:	BNM/IAG
Checked By:	IAG

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Date Logged:**	18-Jul-18
Driller:	HF / TB	**Hole Diameter (mm):**	115	**Date Checked:**	04-Oct-18

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	**Soil Description** TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Roto Sonic	C			[CONTAINMENT BUND ROCKFILL]					
	699.1	1.0										
	698.1	2.0										
	697.1	3.0										
	696.1	4.0										
	695.1	5.0										
	694.1	6.0										
	693.1	7.0										
	692.1	8.0										
	691.1	9.0				-	BASALT: MW, broken by drill action into sandy gravel with trace of clay, brown black	D				
							HW, red brown					
	690.1	10.0										

Notes: Vibrating Wire Piezometer installed at 12.4 m (Pressure Rating 350kPa, Serial No. 316-518). Hole grouted to 9.0 m

HATCH

DRILLHOLE LOG

Drillhole No: **CE417**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Western Buttress		

Easting:	685,120.2 m
Northing:	6,291,199.9 m
Coord.System:	GDA94
Elevation:	700.10 m
Total Depth:	39.0 m
Logged By:	BNM/IAG
Checked By:	IAG

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Date Logged:**	18-Jul-18
Driller:	HF / TB	**Hole Diameter (mm):**	115	**Date Checked:**	04-Oct-18

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
							BASALT: HW, red brown *(Continued)*	D				
	689.1	11.0										
	688.1	12.0					XW, clayey gravel, red brown	M				
	687.1	13.0					MW, sandy gravel, grey brown	D				Disturbed Sample taken from 12.80-12.90m. SA1
	686.1	14.0					XW, clayey gravel, brown	M				
	685.1	15.0										Disturbed Sample taken from 14.80-14.90m. SA2
						GP	Sandy GRAVEL: with clay, grey and red brown [BASALT]					
	684.1	16.0				ML	Clayey SILT: with sand, low to medium plasticity, light grey with red brown staining [PALEO ALLUVIUM]	mc <PL	H			Disturbed Sample taken from 15.90-16.20m. SA3
			Lexan				some gravel, blocky o/c structure, slickensided					Thin Walled U-Tube taken from 16.50-16.85m. U63 (PT1), pushed 360 mm recovered 350 mm
	683.1	17.0				CH	CLAY: high plasticity, black with iron oxide and white staining along fissures, slight sulphurous smell					Lexan Tube taken from 17.00-18.00m.
	682.1	18.0							VSt	330		Lexan Tube taken from 18.00-19.40m.
	681.1	19.0										
			Sonic									Disturbed Sample taken from 19.40-19.50m. SA4
	680.1	20.0				SM	SIlty SAND: fg, yellow brown with black					Thin Walled U-Tube taken from

Notes: Vibrating Wire Piezometer installed at 12.4 m (Pressure Rating 350kPa, Serial No. 316-518). Hole grouted to 9.0 m

DRILLHOLE LOG

HATCH

Drillhole No: **CE417**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Western Buttress		

Easting:	685,120.2 m
Northing:	6,291,199.9 m
Coord.System:	GDA94
Elevation:	700.10 m
Total Depth:	39.0 m

Contractor: Groundwave	**Rig Type/ Mounting:** LS250 Sonic	**Date Logged:** 18-Jul-18	**Logged By:** BNM/IAG
Driller: HF / TB	**Hole Diameter (mm):** 115	**Date Checked:** 04-Oct-18	**Checked By:** IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Lexan			CH	specks CLAY: high plasticity, light grey with orange mottling, fissured	mc <PL	VSt-H	570		19.50-19.95m. U63 (PT2), pushed 450 mm recovered 450 mm Disturbed Sample taken from 20.00-20.10m. SA5 Lexan Tube taken from 20.10-21.10m.
	679.1	21.0	Roto Sonic				VOLCANICLASTIC: XW, behaves as clayey SILT, low plasticity, orange with some white, red and black speckling / mottling	mc <PL	H			Thin Walled U-Tube taken from 21.10-21.50m. U63 (PT3), pushed 450 mm recovered 400 mm
	678.1	22.0										
	677.1	23.0										
	676.1	24.0					brown with orange, red and grey mottling	mc <PL	H			Thin Walled U-Tube taken from 24.00-24.30m. U63 (PT4), pushed 300 mm recovered 300 mm
	675.1	25.0										
	674.1	26.0										Disturbed Sample taken from 25.90-26.00m. SA6
	673.1	27.0										
	672.1	28.0										
	671.1	29.0										
	670.1	30.0										

Notes: Vibrating Wire Piezometer installed at 12.4 m (Pressure Rating 350kPa, Serial No. 316-518). Hole grouted to 9.0 m

HATCH

DRILLHOLE LOG

Drillhole No: **CE417**

Client: Newcrest **Project No.:** H356804

Project: Cadia NTSF Failure Review

Location: Western Buttress

Easting:	685,120.2 m
Northing:	6,291,199.9 m
Coord.System:	GDA94
Elevation:	700.10 m
Total Depth:	39.0 m
Logged By:	BNM/IAG
Checked By:	IAG

Contractor: Groundwave **Rig Type/ Mounting:** LS250 Sonic **Date Logged:** 18-Jul-18

Driller: HF / TB **Hole Diameter (mm):** 115 **Date Checked:** 04-Oct-18

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
							VOLCANICLASTIC: XW, behaves as clayey SILT, low plasticity, orange with some white, red and black speckling / mottling *(Continued)*	mc <PL	H			
	669.1	31.0										
	668.1	32.0					breaks down to clayey SILT with some sand	mc <PL	H			
	667.1	33.0										
	666.1	34.0										
	665.1	35.0										
	664.1	36.0										
							HW-MW, grey brown	D				
	663.1	37.0					XW-HW, breaks down to sandy gravel, some clay, gravel MW angular to 20 mm, dark brown and black					
	662.1	38.0										Disturbed Sample taken from 38.00-38.05m. SA7
	661.1	39.0		[39.0]								
							Vibrating Wire Piezometer installed at 12.4m					
	660.1	40.0					**Drillhole CE417 terminated at 39.00m.**					

Notes: Vibrating Wire Piezometer installed at 12.4 m (Pressure Rating 350kPa, Serial No. 316-518). Hole grouted to 9.0 m

HATCH

Drill Core Photograph

Client: Newcrest | Project No.: H356804

Project : Cadia NTSF Failure Review

Location: Western Buttress | Page 1 of 2

Drillhole No.: CE417

Easting: 685,120.2m

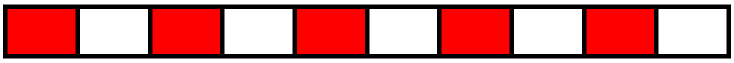
Northing: 6,291,199.9m

Horizontal Datum: GDA94

Surface Elevation: 700.08m

16.50 - 17.00 m

18.00 - 18.50 m

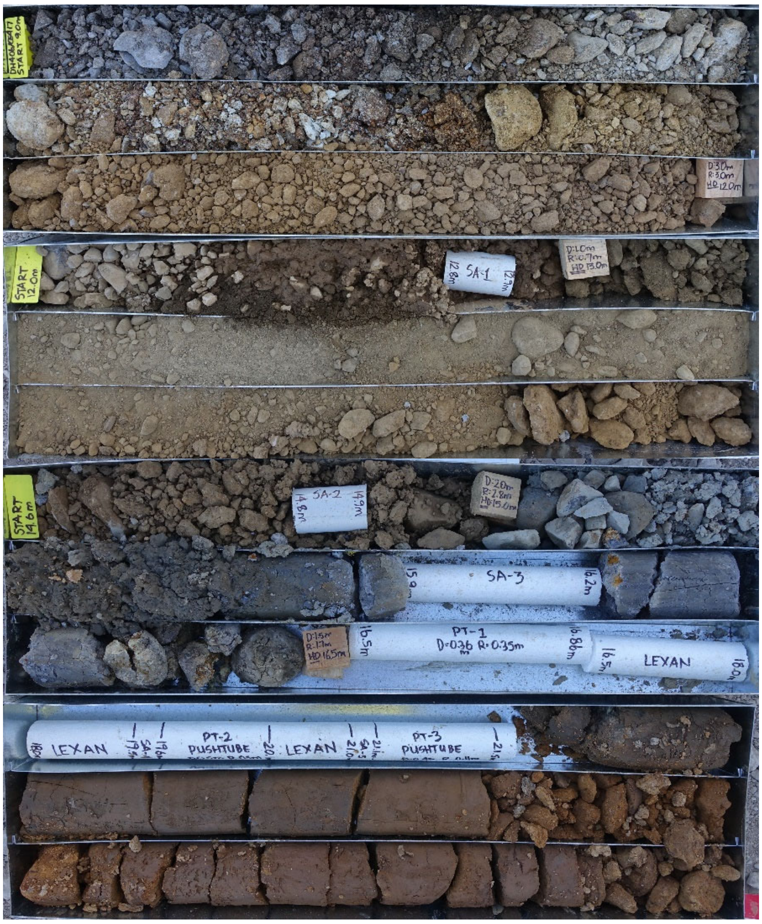


9.00 m

12.00 m

14.60 m

18.00 m



HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Western Buttress	Page 2 of 2	

Drillhole No.:	CE417
Easting:	685,120.2m
Northing:	6,291,199.9m
Horizontal Datum:	GDA94
Surface Elevation:	700.08m

0 1m

23.60 m

26.70 m

30.10 m

33.00 m

39.00 m EOH

HATCH DRILLHOLE LOG

Drillhole No: **CE430**

Sheet 1 of 5

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Western Buttress		

Easting:	685,045.1 m
Northing:	6,291,328.1 m
Coord.System:	GDA94
Elevation:	706.30 m
Total Depth:	44.5 m
Logged By:	BNM/TMY
Checked By:	IAG

Contractor: Groundwave **Rig Type/ Mounting:** LS250 Sonic **Date Logged:** 16-Jul-18

Driller: TB **Hole Diameter (mm):** 63 / 115 **Date Checked:** 04-Oct-18

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	**Soil Description** TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Roto Sonic	C		GW	[CONTAINMENT BUND ROCKFILL] (0.0 - 10.0 m) *(Continued)*	D	L			
	695.3	11.0										
	694.3	12.0										
	693.3	13.0										
	692.3	14.0										
						GC	Clayey GRAVEL: high plasticity fines, some sand, dark brown [RESIDUAL BASALT	M	D			Disturbed Sample taken from 14.80-14.90m. SA1
	691.3	15.0										
							BASALT: broken by sonic drill action into sandy gravel, red brown, extremely to moderately weathered	D	-			
	690.3	16.0					light brown					
	689.3	17.0					clayey gravel					
							sandy gravel					
							Start of Coring at 17.6m.					
							Continued on Rock Core Log sheet.					
	688.3	18.0										
	687.3	19.0										
	686.3	20.0										

Notes: Vibrating Wire Piezometer installed at 26.2 m (Pressure Rating 350kPa, Serial No. 316-283). Hole grouted to 14.45 m

HATCH

CORED DRILLHOLE LOG
ROCK CORE FORMAT

Drillhole No: **CE430**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Western Buttress		

Easting:	685,045.1 m
Northing:	6,291,328.1 m
Coord.System:	GDA94
Elevation:	706.30 m
Total Depth:	44.5 m

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Bearing:**	N/A	**Date Logged:**	16-Jul-18	**Logged By:**	BNM/TMY
Driller:	TB	**Hole Diameter (mm):**	63 / 115	**Plunge:**	Vertical	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Geological Unit	Rock Description: ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.	Weathering/ Cementation	Estimated Strength (EH VH H M L VL EL)	$Is_{(50)}$ MPa	Defect Spacing mm (2000 600 200 [100] 60 20)	RQD %	Defect Log	Defect Description: Inclination, type, infill, amount, aperture, planarity, roughness, frequency (Specific / General)
	695.3	11.0												
	694.3	12.0												
	693.3	13.0												
	692.3	14.0												
	691.3	15.0												
	690.3	16.0												
	689.3	17.0					***Resuming in Rock Core Format 17.6m.***							
		17.6	HQ-3 Coring	C			BASALT: dark grey with significant orange brown staining, highly fractured	SW						
	688.3	18.0										9		70° Cs sn
		18.7		[18.7]										
	687.3	19.0										6		70° Jt Pl Ro sn
	686.3	20.0												

Notes: Vibrating Wire Piezometer installed at 26.2 m (Pressure Rating 350kPa, Serial No. 316-283). Hole grouted to 14.45 m

CORED DRILLHOLE LOG

ROCK CORE FORMAT

HATCH

Drillhole No: CE430

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Western Buttress		

Easting:	685,045.1 m
Northing:	6,291,328.1 m
Coord.System:	GDA94
Elevation:	706.30 m
Total Depth:	44.5 m
Logged By:	BNM/TMY
Checked By:	IAG

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Bearing:**	N/A	**Date Logged:**	16-Jul-18
Driller:	TB	**Hole Diameter (mm):**	63 / 115	**Plunge:**	Vertical	**Date Checked:**	04-Oct-18

Columns: Water | Elevation (m) | Depth (m) | Method | Casing | Graphic Log | Geological Unit | Rock Description (ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.) | Weathering/ Cementation | Estimated Strength (EH VH H M L VL EL) | $Is_{(50)}$ MPa | Defect Spacing mm (2000 600 200 [100] 60 20) | RQD % | Defect Log | Defect Description (Inclination, type, infill, amount, aperture, planarity, roughness, frequency; Specific / General)

Elevation (m)	Depth (m)
685.3	21.0
684.3	22.0
683.3	23.0
682.3	24.0
681.3	25.0
680.3	26.0
679.3	27.0
678.3	28.0
677.3	29.0
676.3	30.0

Method: HQ-3 Coring

Rock Description

Geological Unit	Description
	BASALT: dark grey with significant orange brown staining, highly fractured *(Continued)*
	darker grey, less orange staining
	leaching zone
	orange brown to pale orange and white
CI	pale grey and white with orange mottling, crumbled
CH	CLAY: intermediate plasticity, dark brown, hard, trace sand and gravel [PALEO ALLUVIUM]
CL	CLAY: high plasticity, orange brown [PALEO ALLUVIUM]
.	Sandy CLAY: low plasticity [RESIDUAL

Weathering/Cementation: SW; MW (~23.8–24.3 m); SW; MW (~27.8–28.3 m); XW; HW

RQD %: 6; 23; 0; 4; 0; 0; 12

Defect Description (Specific)

- 30° Jt Pl Ro sn
- 70° Jt Pl Sm sn
- 80° Cs Weathered Rock sn
- 70° Jt Pl Ro sn
- 70° Jt Pl Ro sn
- 45° Jt Pl Sm sn
- 50° Jt Pl Ro 1 -2 mm clay sn
- 45° Jt Pl Sm 1 mm clay sn
- 60° Jt Pl Ro sn

Notes: Vibrating Wire Piezometer installed at 26.2 m (Pressure Rating 350kPa, Serial No. 316-283). Hole grouted to 14.45 m

HATCH

CORED DRILLHOLE LOG

ROCK CORE FORMAT

Drillhole No: **CE430**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Western Buttress		

Easting:	685,045.1 m
Northing:	6,291,328.1 m
Coord.System:	GDA94
Elevation:	706.30 m
Total Depth:	44.5 m

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Bearing:**	N/A	**Date Logged:**	16-Jul-18	**Logged By:**	BNM/TMY
Driller:	TB	**Hole Diameter (mm):**	63 / 115	**Plunge:**	Vertical	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Column headings: Water | Elevation (m) | Depth (m) | Method | Casing | Graphic Log | Geological Unit | **Rock Description** — ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents. | Weathering/ Cementation | Estimated Strength (EH VH H M L VL EL) | $Is_{(50)}$ MPa | Defect Spacing mm (2000 600 200 [100] 60 20) | RQD % | Defect Log | **Defect Description** — Inclination, type, infill, amount, aperture, planarity, roughness, frequency (Specific / General)

Method: HQ-3 Coring

Elevation (m)	Depth (m)	Rock Description	Weathering	RQD %
		VOLCANICLASTIC]	HW	
		VOLCANICLASTIC: light green phenocrysts up to 4mm, fine grained light yellow-grey matrix *(Continued)*		
675.3	31.0	darkish purple colouring with white mottling and quartz veins		
		31.8-32.0m interbedded HW volcanics and brown high plasticity clay, 20mm thick, stiff (PP=180kPa)	XW	
674.3	32.0	clay layer 32.0-32.1m, brown, high plasticity, very stiff (PP=260kPa)	HW / XW / HW	12
		crumbled		
673.3	33.0	crumbled into clayey sand	XW	
		CORE LOSS from 33.30m to 33.50m.		
		VOLCANICLASTIC	XW / HW	
672.3	34.0	clay layer 33.6-33.65, high plasticity, brown, very soft, mc >>PL		6
		fractured, purple/red with orange staining	XW	
		lighter, orange brown	HW	
671.3	35.0	quartz vein		
		darker purple		17
670.3	36.0	clay layer 36.35-36.4, high plasticity, brown, mc >PL, very soft	XW / HW	
669.3	37.0			7
668.3	38.0			5
667.3	39.0		MW	
		gravelly sand layer 39.4-39.7, well graded, sub angular, subrounded gravel up to 20mm at base [cuttings?]	MW	0
666.3	40.0			

Defect Description:

- 36.0 m: 30° Cs Weathered Rock
- 39.6 m: 40° Jt Pl Ro sn

Notes: Vibrating Wire Piezometer installed at 26.2 m (Pressure Rating 350kPa, Serial No. 316-283). Hole grouted to 14.45 m

CORED DRILLHOLE LOG

ROCK CORE FORMAT

Drillhole No: **CE430**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Western Buttress		

Easting:	685,045.1 m
Northing:	6,291,328.1 m
Coord.System:	GDA94
Elevation:	706.30 m
Total Depth:	44.5 m

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Bearing:**	N/A	**Date Logged:**	16-Jul-18	**Logged By:**	BNM/TMY
Driller:	TB	**Hole Diameter (mm):**	63 / 115	**Plunge:**	Vertical	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Geological Unit	**Rock Description** ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.	Weathering/ Cementation	Estimated Strength (EH VH H M L VL EL)	$Is_{(50)}$ MPa	Defect Spacing mm (2000 600 200 [100] 60 20)	RQD %	Defect Log	**Defect Description** Inclination, type, infill, amount, aperture, planarity, roughness, frequency (Specific / General)
			HQ-3 Coring				VOLCANICLASTIC *(Continued)* highly fractured	MW				0		
							darker in colour					31		
	665.3	41.0												
												24		90° Jt Un Ro
														45° Cs Weathered Rock
	664.3	42.0					dark grey, whole of rock no longer stained, stained joints, some mineral decomposition							
	663.3	43.0										33		45° Cs Weathered Rock
							dark colour, staining along joints	SW						
	662.3	44.0										31		
	661.3	45.0					Vibrating Wire Piezometer installed at 26.15m							
							Drillhole CE430 terminated at 44.5m.							
	660.3	46.0												
	659.3	47.0												
	658.3	48.0												
	657.3	49.0												
	656.3	50.0												

Notes: Vibrating Wire Piezometer installed at 26.2 m (Pressure Rating 350kPa, Serial No. 316-283). Hole grouted to 14.45 m

HATCH	**Drill Core Photograph**			Drillhole No.:	CE430
				Easting:	685,044.9m
Client:	Newcrest	Project No.:	H356804	Northing:	6,291,328.3m
Project :	Cadia NTSF Failure Review			Horizontal Datum:	GDA94
Location:	Western Buttress	Page 1 of 2		Surface Elevation:	706.32m

0 1m

14.45 m

17.60 m

21.15 m

24.75 m

28.40 m

HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Western Buttress	Page 2 of 2	

Drillhole No.:	CE430
Easting:	685,044.9m
Northing:	6,291,328.3m
Horizontal Datum:	GDA94
Surface Elevation:	706.32m

0 1m

31.98 m

35.50 m

39.30 m

44.50 m EOH

HATCH

DRILLHOLE LOG

Drillhole No: **CE432**

Sheet 1 of 4

Client:	Newcrest
Project No.:	H356804
Project:	Cadia NTSF Failure Review
Location:	Stage 2 Buttress - East
Easting:	685,499.9 m
Northing:	6,290,949.4 m
Coord.System:	GDA94
Elevation:	688.00 m
Total Depth:	39.5 m
Contractor:	Groundwave
Rig Type/ Mounting:	LS250 Sonic
Date Logged:	23-Aug-18
Logged By:	TMY
Driller:	HF / TB
Hole Diameter (mm):	63 / 115
Date Checked:	04-Oct-18
Checked By:	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
	677.0 676.0 675.0 674.0 673.0 672.0 671.0 670.0	11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0	Roto Sonic	C		GW	[DOWNSTREAM BERM ROCKFILL] (0.0 - 18.9 m) *(Continued)*					
	669.0	19.0				CH	CLAY: high plasticity, dark grey-brown, grassy roots, organic odour [RESIDUAL VOLCANICLASTIC]	mc >PL	St H	150 430		Thin Walled U-Tube taken from 19.35-19.80m. PT1
	668.0	20.0				SM	orange brown, Fe staining, subangular trace gravel to 5 mm	M	MD	>600		Lexan Tube taken from

Notes: 50 mm PVC installed to 39.4 m to preserve hole.

HATCH

DRILLHOLE LOG

Drillhole No: CE432

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Stage 2 Buttress - East		

Easting:	685,499.9 m
Northing:	6,290,949.4 m
Coord.System:	GDA94
Elevation:	688.00 m
Total Depth:	39.5 m

Contractor: Groundwave		**Rig Type/ Mounting:** LS250 Sonic		**Date Logged:** 23-Aug-18	**Logged By:** TMY
Driller: HF / TB		**Hole Diameter (mm):** 63 / 115		**Date Checked:** 04-Oct-18	**Checked By:** IAG

Method	Casing	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Additional Observations
Lexan	C	SM	Silty SAND [RESIDUAL VOLCANICLASTIC]	M	MD		19.80-20.80m. L1
		CL	Silty SAND: fine to medium grained, orange with white specs [RESIDUAL VOLCANICLASTIC]	D M	VD	>600 >600	
Roto Sonic			Sandy CLAY: off white to grey and light purple with orange staining and orange and dark purple to black banding [RESIDUAL VOLCANICLASTIC]			300 400	
Lexan		CH	Sandy CLAY: high plasticity, fine grained sand with trace of fine gravel, brown [RESIDUAL VOLCANICLASTIC]	W	S		Lexan Tube taken from 22.40-23.90m. L2 (melted below 23.15 m from sonic vibration)
			VOLCANICLASTIC: grey white with orange staining, XW	M	H		
Roto Sonic			very low strength white with orange banding and staining, broken by drill action to sandy gravel, HW	D		500 350	
			very low strength, intact, whole of rock stained orange, XW-HW	M		>600	
			off white grey to light purple with dark orange brown staining, very low strength, angular to sub angular MW gravel to 50 mm				
			becoming dark due to staining and weathering grade changing				
			black, red and orange staining, high strength, MW				

Elevation (m)	Depth (m)
667.0	21.0
666.0	22.0
665.0	23.0
664.0	24.0
663.0	25.0
662.0	26.0
661.0	27.0
660.0	28.0
659.0	29.0
658.0	30.0

Notes: 50 mm PVC installed to 39.4 m to preserve hole.

DRILLHOLE LOG

HATCH

Drillhole No: **CE432**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Stage 2 Buttress - East		

Easting:	685,499.9 m
Northing:	6,290,949.4 m
Coord.System:	GDA94
Elevation:	688.00 m
Total Depth:	39.5 m

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Date Logged:**	23-Aug-18	**Logged By:**	TMY
Driller:	HF / TB	**Hole Diameter (mm):**	63 / 115	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
	657.0	31.0	Roto Sonic	C			VOLCANICLASTIC: grey white with orange staining, XW *(Continued)*	M	H			
	656.0	32.0					***Start of Coring at 31.5m.***					
							Continued on Rock Core Log sheet.					
	655.0	33.0										
	654.0	34.0										
	653.0	35.0										
	652.0	36.0										
	651.0	37.0										
	650.0	38.0										
	649.0	39.0										
	648.0	40.0										

Notes: 50 mm PVC installed to 39.4 m to preserve hole.

CORED DRILLHOLE LOG

ROCK CORE FORMAT

Drillhole No: **CE432**

Client:	Newcrest
Project No.:	H356804
Project:	Cadia NTSF Failure Review
Location:	Stage 2 Buttress - East
Easting:	685,499.9 m
Northing:	6,290,949.4 m
Coord.System:	GDA94
Elevation:	688.00 m
Total Depth:	39.5 m
Contractor:	Groundwave
Rig Type/ Mounting:	LS250 Sonic
Bearing:	N/A
Date Logged:	23-Aug-18
Logged By:	TMY
Driller:	HF / TB
Hole Diameter (mm):	63 / 115
Plunge:	Vertical
Date Checked:	04-Oct-18
Checked By:	IAG

Columns: Water | Elevation (m) | Depth (m) | Method | Casing | Graphic Log | Geological Unit | Rock Description (ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.) | Weathering/ Cementation | Estimated Strength (EH VH H M L VL EL) | $Is_{(50)}$ MPa | Defect Spacing mm (2000 600 200 [100] 60 20) | RQD % | Defect Log | Defect Description (Inclination, type, infill, amount, aperture, planarity, roughness, frequency; Specific / General)

Elevation (m)	Depth (m)
657.0	31.0
656.0	32.0
655.0	33.0
654.0	34.0
653.0	35.0
652.0	36.0
651.0	37.0
650.0	38.0
649.0	39.0
648.0	40.0

Method: HQ-3 Coring. Casing: C [31.8]

Resuming in Rock Core Format 31.5m.

Rock Description	Weathering
VOLCANICLASTIC: grey with orange weathering, white and black specks, fine grained, highly fractured	MW
becoming dark grey, some quartz seams	
patches of fresh blue colour, orange staining on fractures, quartz veins, many small fractures	SW
quartz and other light minerals mottled throughout	
dark blue-grey, slight discolouration on joints	MW / Fr

RQD %: 11, 28, 9, 20

Defect Description:

- 45° Jt Un Ro
- 45° Jt Pl Sm
- 60° Jt Pl Ro
- 30° Cs 1 mm clay
- 45° Jt Pl Ro
- 60° Jt Un Ro sn
- 20° Jt Un Ro 1 -2 mm clay
- 60° Jt Pl Ro Weathered Rock
- 60° Jt Un Ro
- 10° Cs Sand
- 45° Jt Un Ro
- 60° Jt Pl Ro
- 60° Jt Un Ro
- 40° Cs sn
- 45° Cs sn
- 30° Jt Un Ro
- 70° Jt Un Ro
- 80° Jt Pl Ro sn
- 20° Cs sn
- 45° Jt Pl Sm
- 60° Jt Pl Ro
- 45° Jt Pl Sm
- 50° Jt Pl Ro

Drillhole CE432 terminated at 39.5m.

Notes: 50 mm PVC installed to 39.4 m to preserve hole.

HATCH

Drill Core Photograph

Client: Newcrest

Project No.: H356804

Project : Cadia NTSF Failure Review

Location: Stage 2 Buttress - East

Page 1 of 2

Drillhole No.: CE432

Easting: 685,499.9m

Northing: 6,290,949.4m

Horizontal Datum: GDA94

Surface Elevation: 688.00m

0 1m

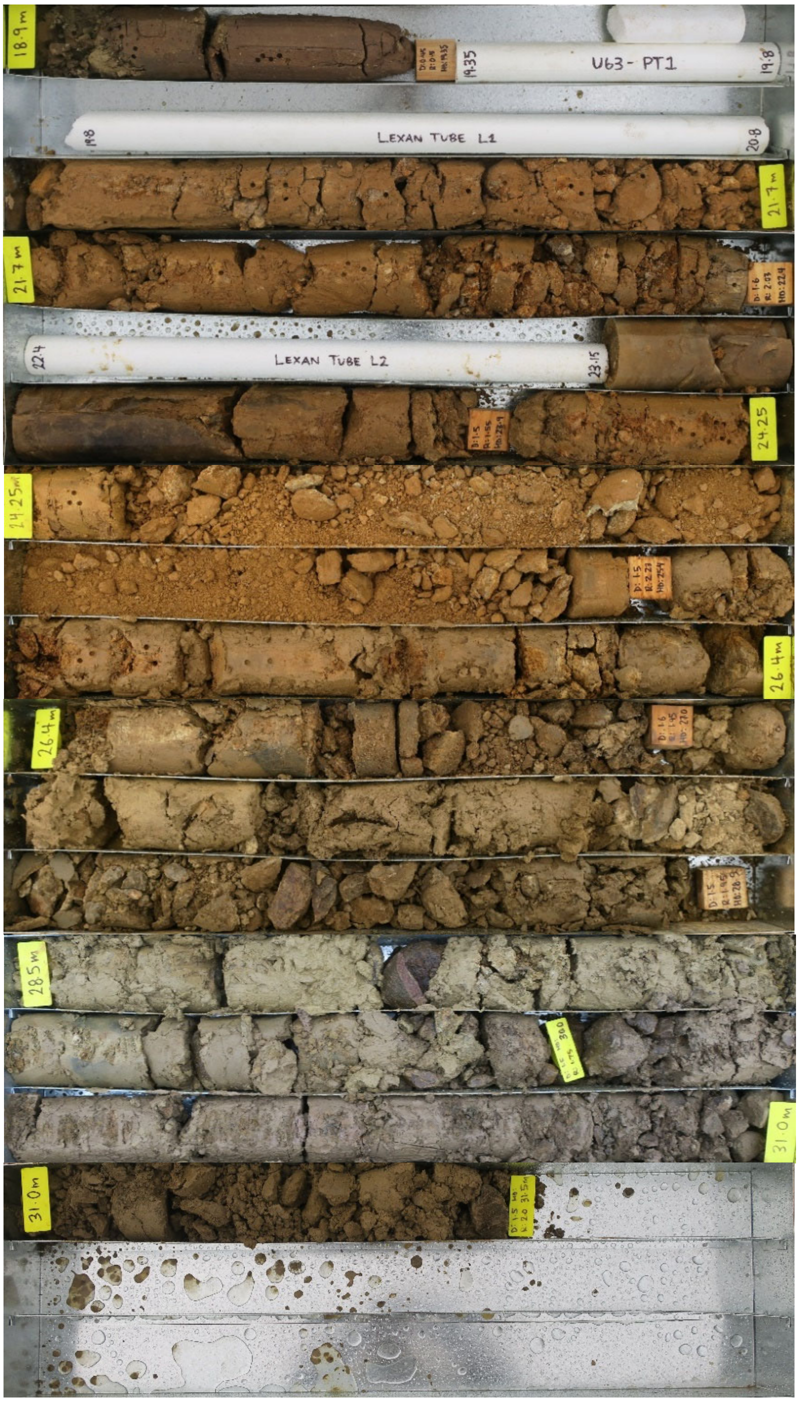
18.90 m

22.40 m

24.25 m

26.40 m

28.50 m



31.50 m

HATCH

Drill Core Photograph

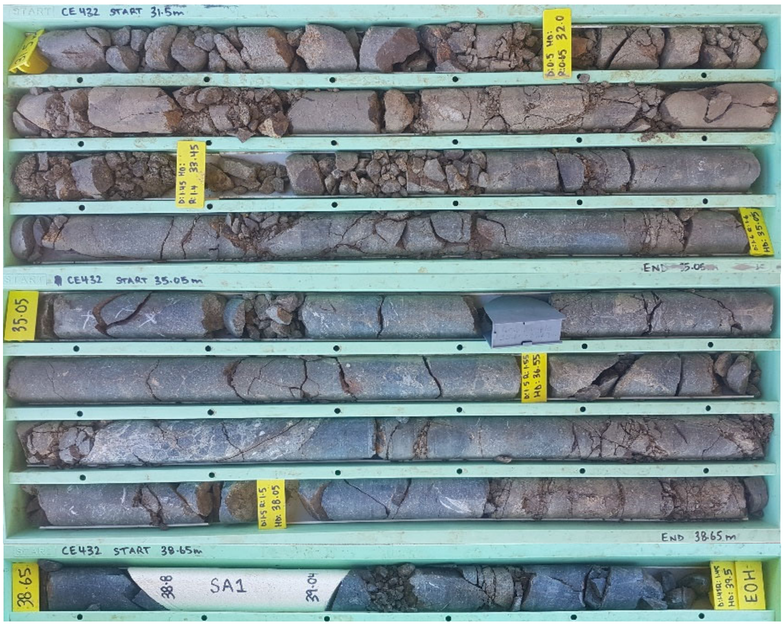
Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Stage 2 Buttress - East	Page 2 of 2	

Drillhole No.:	CE432
Easting:	685,499.9m
Northing:	6,290,949.4m
Horizontal Datum:	GDA94
Surface Elevation:	688.00m

0 1m

31.50 m

35.05 m



39.50 m EOH

HATCH

DRILLHOLE LOG

Drillhole No: **CE433**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Slump - Ch 1970		

Easting:	685,310.8 m
Northing:	6,291,091.2 m
Coord.System:	GDA94
Elevation:	709.20 m
Total Depth:	46.3 m

Contractor: Groundwave		**Rig Type/ Mounting:** LS250 Sonic		**Date Logged:** 03-Sep-18	**Logged By:** BNM/TMY
Driller: TB		**Hole Diameter (mm):** 115		**Date Checked:** 04-Oct-18	**Checked By:** IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Classification Symbol	**Soil Description** TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Roto Sonic	C	GP	[SLUMP ACCESS ROAD FILL]					
	708.2	1.0			ML	Sandy SILT, low plasticity, grey [TAILINGS]	M	S			
	707.2	2.0									
	706.2	3.0									
	705.2	4.0									
					CH	Silty CLAY, high plasticity, reddish brown with gravel and trace sand [CLAY FILL]	M	F-St			
	704.2	5.0									
	703.2	6.0			ML	Sandy SILT, low plasticity, grey to light brown [TAILINGS]	W	L			
	702.2	7.0									
	701.2	8.0									
	700.2	9.0									
▼ 6/9/18											
	699.2	10.0									

Notes:

HATCH

DRILLHOLE LOG

Drillhole No: **CE433**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Slump - Ch 1970		

Easting:	685,310.8 m
Northing:	6,291,091.2 m
Coord.System:	GDA94
Elevation:	709.20 m
Total Depth:	46.3 m

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Date Logged:**	03-Sep-18	**Logged By:**	BNM/TMY
Driller:	TB	**Hole Diameter (mm):**	115	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Roto Sonic	C		ML	Sandy SILT, low plasticity, grey to light brown [TAILINGS] *(Continued)*	W	L			
	698.2	11.0										
	697.2	12.0										
	696.2	13.0										
	695.2	14.0										
	694.2	15.0										
	693.2	16.0										
	692.2	17.0										
	691.2	18.0										
	690.2	19.0										
	689.2	20.0										

Notes:

HATCH DRILLHOLE LOG

Drillhole No: **CE433**

Sheet 3 of 5

Client: Newcrest **Project No.:** H356804

Project: Cadia NTSF Failure Review

Location: Slump - Ch 1970

Easting:	685,310.8 m
Northing:	6,291,091.2 m
Coord.System:	GDA94
Elevation:	709.20 m
Total Depth:	46.3 m
Logged By:	BNM/TMY
Checked By:	IAG

Contractor: Groundwave **Rig Type/ Mounting:** LS250 Sonic **Date Logged:** 03-Sep-18

Driller: TB **Hole Diameter (mm):** 115 **Date Checked:** 04-Oct-18

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Roto Sonic	C		ML	Sandy SILT, low plasticity, grey to light brown [TAILINGS] *(Continued)*	W	L			
	688.2	21.0										
	687.2	22.0										
	686.2	23.0										
						-	CLAY with gravel: low plasticity [MIXED FILL]					
	685.2	24.0				ML	Sandy SILT, low plasticity, grey to light brown [TAILINGS]	W	L			
	684.2	25.0										
	683.2	26.0				CH	Silty CLAY, high plasticity, reddish brown with gravel and trace sand [CLAY FILL]	M	F-St			
						-	CLAY with gravel: low plasticity [MIXED FILL]					
	682.2	27.0				ML	Sandy SILT, low plasticity, grey to light brown [TAILINGS]	W	L			
	681.2	28.0										
	680.2	29.0				CH	Silty CLAY, high plasticity, reddish brown with gravel and trace sand [CLAY FILL]	M	F-St			
						ML		W	L			
	679.2	30.0										

Notes:

HATCH — DRILLHOLE LOG

Drillhole No: **CE433**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Slump - Ch 1970		

Easting:	685,310.8 m
Northing:	6,291,091.2 m
Coord.System:	GDA94
Elevation:	709.20 m
Total Depth:	46.3 m
Logged By:	BNM/TMY
Checked By:	IAG

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Date Logged:**	03-Sep-18
Driller:	TB	**Hole Diameter (mm):**	115	**Date Checked:**	04-Oct-18

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
	678.2	31.0	Roto Sonic	C		ML	Sandy SILT, low plasticity, grey to light brown [TAILINGS] *(Continued)*	W	L			
	677.2	32.0					VOLCANICLASTIC: XW-HW, light brown with green, orange and black speckling. Breaks down into a Clayey Silt with trace of fine sand and angular gravel	mc << PL	H			
	676.2	33.0	Lexan							>600		Lexan Tube taken from 33.00-33.20m. L1A Lexan Tube taken from 33.20-33.80m. L1B Bulk Sample taken from 33.80-33.90m. SA1
	675.2	34.0	Roto Sonic									
	674.2	35.0					moderately weathered, broken by drill action to sandy gravel					
	673.2	36.0										
	672.2	37.0										
	671.2	38.0										
	670.2	39.0					highly weathered					
	669.2	40.0										

Notes:

HATCH DRILLHOLE LOG

Drillhole No: **CE433**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Slump - Ch 1970		

Easting:	685,310.8 m
Northing:	6,291,091.2 m
Coord.System:	GDA94
Elevation:	709.20 m
Total Depth:	46.3 m

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Date Logged:**	03-Sep-18	**Logged By:**	BNM/TMY
Driller:	TB	**Hole Diameter (mm):**	115	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
	668.2 667.2 666.2 665.2 664.2 663.2	41.0 42.0 43.0 44.0 45.0 46.0	Roto Sonic	C [46.3]			VOLCANICLASTIC: XW-HW, light brown with green, orange and black speckling. Breaks down into a Clayey Silt with trace of fine sand and angular gravel *(Continued)* slightly weathered to fresh, fine grained, purple to black	mc << PL	H			
	662.2 661.2 660.2 659.2	47.0 48.0 49.0 50.0					**Drillhole CE433 terminated at 46.30m.**					

Notes:

HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Slump - Centreline	Page 1 of 1	

Drillhole No.:	CE433
Easting:	685,310.8m
Northing:	6,291,091.2m
Horizontal Datum:	GDA94
Surface Elevation:	709.15m

0 1m

31.50 m

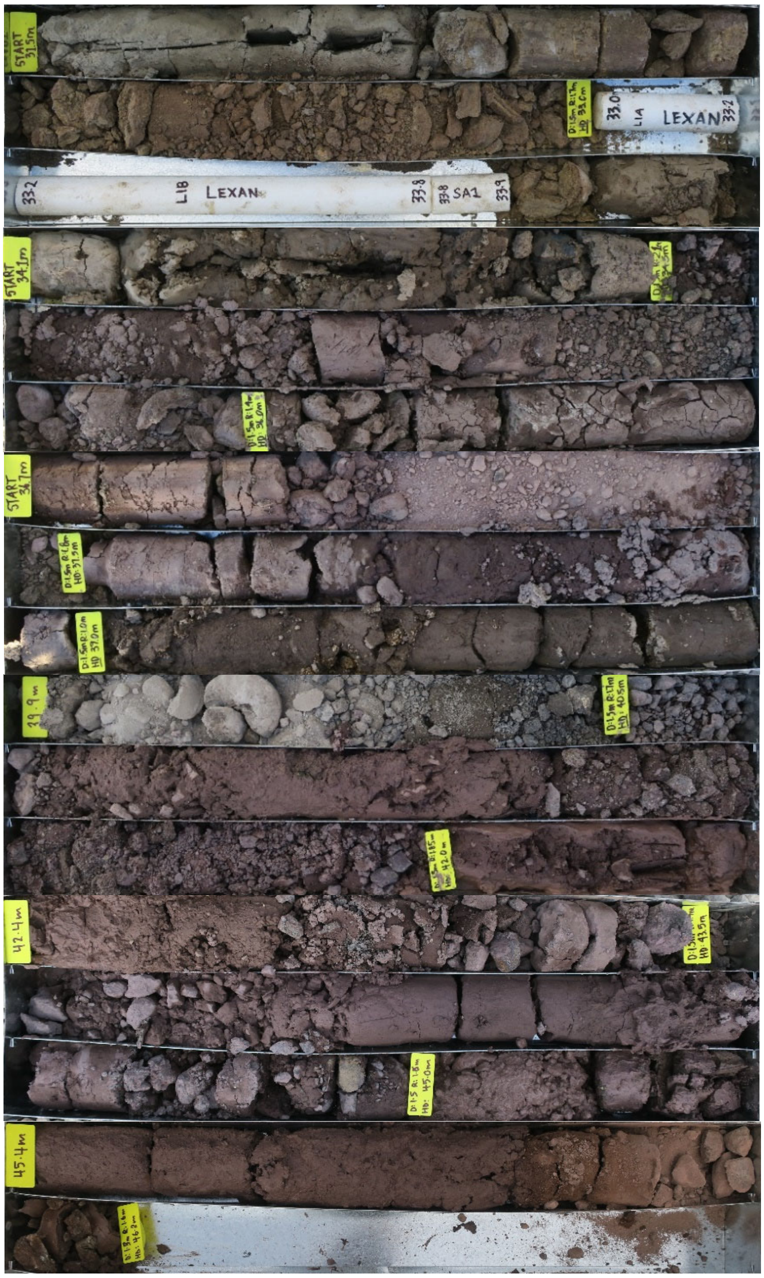
34.10 m

36.70 m

39.90 m

42.40 m

45.40 m



46.30 m EOH

HATCH

DRILLHOLE LOG

Drillhole No: **CE435**

Client:	Newcrest
Project No.:	H356804
Project:	Cadia NTSF Failure Review
Location:	Slump - Ch 1930
Easting:	685,280.0 m
Northing:	6,291,117.3 m
Coord.System:	GDA94
Elevation:	708.30 m
Total Depth:	39.2 m
Contractor:	Groundwave
Rig Type/ Mounting:	LS250 Sonic
Date Logged:	06-Sep-18
Logged By:	TMY
Driller:	TB
Hole Diameter (mm):	63 / 115
Date Checked:	04-Oct-18
Checked By:	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Roto Sonic	C		GP	[SLUMP ACCESS ROAD ROCKFILL]					
	707.3	1.0				ML	Sandy SILT: low plasticity, grey [TAILINGS]	W	VS			
	706.3	2.0										
	705.3	3.0										
	704.3	4.0										
	703.3	5.0										
	702.3	6.0										
	701.3	7.0										
	700.3	8.0										
	699.3	9.0										
	698.3	10.0										

Notes: Vibrating Wire Piezometer installed at 38.5 m (Pressure Rating 350kPa, Serial No. 316-282). Hole grouted to 28 m

DRILLHOLE LOG

Drillhole No: **CE435**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Slump - Ch 1930		

Easting:	685,280.0 m
Northing:	6,291,117.3 m
Coord.System:	GDA94
Elevation:	708.30 m
Total Depth:	39.2 m

Contractor:	Groundwave	**Rig Type/ Mounting:**	LS250 Sonic	**Date Logged:**	06-Sep-18	**Logged By:**	TMY
Driller:	TB	**Hole Diameter (mm):**	63 / 115	**Date Checked:**	04-Oct-18	**Checked By:**	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
	697.3 696.3 695.3	11.0 12.0 13.0	Roto Sonic	C		ML	Sandy SILT: low plasticity, grey [TAILINGS] *(Continued)*	W	VS			
	694.3	14.0				SM	Silty SAND: light brown and grey [TAILINGS]	W	VL			
	693.3 692.3 691.3 690.3 689.3 688.3	15.0 16.0 17.0 18.0 19.0 20.0				ML	Sandy SILT: low plasticity, grey and light brown [TAILINGS]	W M	VS			

Notes: Vibrating Wire Piezometer installed at 38.5 m (Pressure Rating 350kPa, Serial No. 316-282). Hole grouted to 28 m

HATCH_LIBRARY_REVB.GLB Log BOREHOLE/TESPIT W PP H356804_CADIA_VALLEY R2.GPJ <<DrawingFile>> 15-03-2019 12:22

DRILLHOLE LOG

Drillhole No: **CE435**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Slump - Ch 1930		

Easting:	685,280.0 m
Northing:	6,291,117.3 m
Coord.System:	GDA94
Elevation:	708.30 m
Total Depth:	39.2 m

Contractor: Groundwave	**Rig Type/ Mounting:** LS250 Sonic	**Date Logged:** 06-Sep-18	**Logged By:** TMY
Driller: TB	**Hole Diameter (mm):** 63 / 115	**Date Checked:** 04-Oct-18	**Checked By:** IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
			Roto Sonic	C		ML	Sandy SILT: low plasticity, grey and light brown [TAILINGS] *(Continued)*	W	VS			
	687.3	21.0							S			
	686.3	22.0										
							some clay fill pieces					
	685.3	23.0							F			
						SM	Silty SAND: light brown and grey [TAILINGS]	M	MD			
	684.3	24.0				ML	Sandy SILT: low plasticity, grey [TAILINGS]	M	S			
	683.3	25.0										
	682.3	26.0										
	681.3	27.0										
	680.3	28.0										
	679.3	29.0										
						-	VOLCANICLASTIC: extremely weathered, orange brown	-	-			Bulk Sample taken from 29.60-29.80m. SA1 - Sonic Core
	678.3	30.0										

Notes: Vibrating Wire Piezometer installed at 38.5 m (Pressure Rating 350kPa, Serial No. 316-282). Hole grouted to 28 m

HATCH

DRILLHOLE LOG

Drillhole No: **CE435**

Client:	Newcrest
Project No.:	H356804
Project:	Cadia NTSF Failure Review
Location:	Slump - Ch 1930
Easting:	685,280.0 m
Northing:	6,291,117.3 m
Coord.System:	GDA94
Elevation:	708.30 m
Total Depth:	39.2 m
Contractor:	Groundwave
Rig Type/ Mounting:	LS250 Sonic
Date Logged:	06-Sep-18
Logged By:	TMY
Driller:	TB
Hole Diameter (mm):	63 / 115
Date Checked:	04-Oct-18
Checked By:	IAG

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Pocket Pen (kPa)	Sample Type	Additional Observations
	677.3	31.0	Roto Sonic	C			VOLCANICLASTIC: extremely weathered, orange brown, black and green speckling, angular to subrounded moderately weathered gravel to 5 mm					
	676.3	32.0					***Start of Coring at 31.2m.*** ***Continued on Rock Core Log sheet.***					
	675.3	33.0										
	674.3	34.0										
	673.3	35.0										
	672.3	36.0										
	671.3	37.0										
	670.3	38.0										
	669.3	39.0										
	668.3	40.0										

Notes: Vibrating Wire Piezometer installed at 38.5 m (Pressure Rating 350kPa, Serial No. 316-282). Hole grouted to 28 m

HATCH

CORED DRILLHOLE LOG

ROCK CORE FORMAT

Drillhole No: **CE435**

Client:	Newcrest
Project No.:	H356804
Project:	Cadia NTSF Failure Review
Location:	Slump - Ch 1930
Easting:	685,280.0 m
Northing:	6,291,117.3 m
Coord.System:	GDA94
Elevation:	708.30 m
Total Depth:	39.2 m
Contractor:	Groundwave
Rig Type/ Mounting:	LS250 Sonic
Bearing:	N/A
Date Logged:	06-Sep-18
Logged By:	TMY
Driller:	TB
Hole Diameter (mm):	63 / 115
Plunge:	Vertical
Date Checked:	04-Oct-18
Checked By:	IAG

Elevation (m)	Depth (m)	Method	Casing	Rock Description (ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.)	Weathering/ Cementation	RQD %	Defect Description (Inclination, type, infill, amount, aperture, planarity, roughness, frequency)
677.3	31.0			***Resuming in Rock Core Format 31.2m.***			
		HQ-3 Coring	C [31.5]	CORE LOSS from 31.15m to 31.75m.			
676.3	32.0			VOLCANICLASTIC: dark grey, broken by drilling to gravelly sand and moderately weathered gravel	MW	37	
				CORE LOSS from 32.50m to 32.80m.			
675.3	33.0			VOLCANICLASTIC: blue grey, highly fractured, green and black speckling, purple staining			
674.3	34.0			CORE LOSS from 33.10m to 34.10m.			
				VOLCANICLASTIC: broken by drilling to angular gravel, cuttings and gravel mixed			
673.3	35.0				SW		45° Jt Pl Sm 45° Jt Pl Sm
672.3	36.0			broken/ crushed to gravel	HW		70° Jt Pl Ro 45° Cs sn
				pale green highly fractured, dark blue grey, green and white speckling, some reddish staining	MW		45° Jt Pl Ro sn 60° Jt Pl Ro sn
671.3	37.0				Fr	5	45° Jt Pl Ro 45° Jt Pl Weathered Rock 45° Jt Pl Ro sn
670.3	38.0					6	
669.3	39.0						
				Vibrating Wire Piezometer installed at 38.48 m			
668.3	40.0			**Drillhole CE435 terminated at 39.2m.**			

Notes: Vibrating Wire Piezometer installed at 38.5 m (Pressure Rating 350kPa, Serial No. 316-282). Hole grouted to 28 m

HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Slump - Towards Western Abutment	Page 1 of 1	

Drillhole No.:	CE435
Easting:	685,280.0m
Northing:	6,291,117.3m
Horizontal Datum:	GDA94
Surface Elevation:	708.33m

0 — 1m

29.45 m

31.15 m

34.50 m

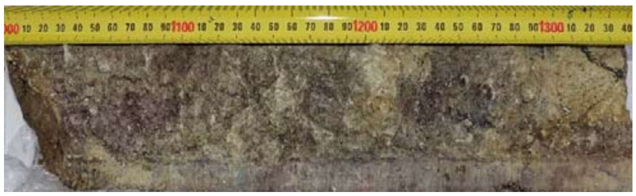
37.90 m

39.20 m EOH

Split Lexan Samples

CE411A 16.00 – 16.55m

Clayey SILT, medium plasticity, yellow orange with purple staining and red orange staining, white speckling PP = 500 to +600kPa.



CE412 62.00 – 62.35m

Clayey SILT – medium plasticity, greenish grey with some purple staining and white speckling, fine grained clasts of green grey / purple tuff. PP = 500 to +600kPa

CE416 24.50– 25.00m

Silty CLAY, medium to high plasticity, red orange with yellow white veining and some black staining of fissures, PP = 450 to 500kPa in red, 260 to 300kPa in yellow white.

CE416 25.00 – 25.50m

Clayey SILT, medium to high plasticity, red orange to red brown with white veining, possibly relict pyroclastic texture at base, an absence of mottling. PP = 230 to 330kPa.

CE416 26.00 – 26.50m

Silty CLAY, medium plasticity, red orange with yellow white and white, moist Clayey SILT veining and speckling, trace of purple staining. PP = 280 to 360kPa in red orange, 170 to 200kPa in yellow white.

CE417 16.50 – 17.00m

Silty CLAY, high plasticity, light grey with some green grey veining, blocky structure with some slickensided fissures, becoming dark grey below 16.85m.

Below 16.90m , black with some white veins and speckling. Organic matter 25mm dia with vascular structure still evident.

CE417 18.00 - 18.50

Silty CLAY, high plasticity, black with white and ferruginous staining along relict fissures, slight sulphurous odour, PP = 310 to 350kPa.

CE417 20.50 – 21.00

Silty CLAY, medium plasticity, initially grey with orange ferruginous banding, becoming light grey and fissured below 20.70m. PP = 550 to 600kPa.

CE417 21.10 – 21.52

21.10 – 21.23; Silty CLAY, high plasticity, light grey with black staining, blocky structure

21.23 – 21 34, SILT, orange brown, laminated – transitional phase

21.34 – 21.52, Clayey SILT, some fine sand, orange brown and yellow with black speckling, (EW Volcaniclastic)

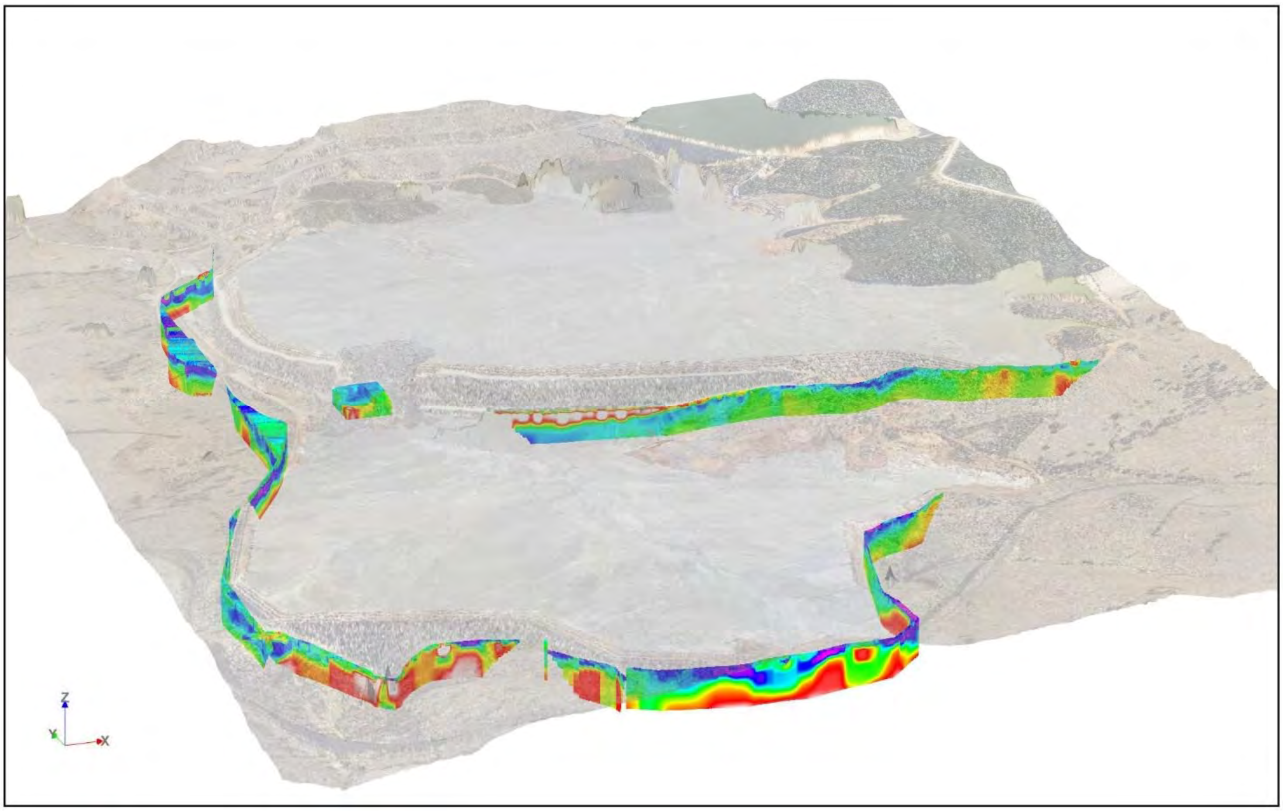
CE432 22.40 – 22.75

Sandy CLAY, high plasticity, fine grained sand with a trace of fine gravel, brown with grey white extremely weathered relict rock fragments <15mm dia.

CE433 33.20 – 33.80

Volcaniclastic, extremely to highly weathered, light brown with green, orange and black speckling, with some black staining along relict joints. Breaks down into Clayey SILT, low plasticity, with trace of fine sand. PP = +600kPa Single piece of gravel at top, 15mm dia, basaltic?

Annexure CE
ERI Traverses of Slump



Cadia Holdings Pty Ltd

Cadia NTSF Response Independent Advisor

Geophysical Investigation - Failure Zone

October 2018

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Figure index

Appendices

1. Introduction

1.1 Project Background

A breach in the Northern Tailings Storage Facility (NTSF), at Newcrest's Cadia Mine , occurred in March of 2018. A comprehensive geotechnical and geophysical investigation was then conducted by GHD over the period May 2018 to August 2018. In addition to these investigations, a 3D Electrical Resistivity Imaging (ERI) was requested on the failure zone. The failure zone ERI survey was conducted by GHD in August 2018. The main objectives of the failure zone ERI survey was to:

- Provide information on the internal geometry of the failure
- Assess the geometry of rock fill beneath the tailing
- Asses the geometry of tailings within the failure zone
- Provide information on the foundation interface

1.2 Purpose of this Report

The purpose of this report is to present to Cadia Holdings Pty Ltd the factual field data and findings from the ERI survey conducted on the failure zone of the NTSF at Cadia Mine.

1.3 Limitations

This report has been prepared by GHD for Cadia Holdings Pty Ltd and may only be used and relied on by Cadia Holdings Pty Ltd for the purpose agreed between GHD and the Cadia Holdings Pty Ltd as set out in Section 2 of this report.

GHD otherwise disclaims responsibility to any person other than Cadia Holdings Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described throughout this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Cadia Holdings Pty Ltd and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including, groundwater levels and chemistry, the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Scope of Work

2.1 Initial Scope of Work

GHD's scope of work is outlined in GHD proposal 3218788-17683 Geophysical Site Investigation - ERI Study in Failure Area Proposal, dated 3 August 2018. The initial scope of work in this document can be summarised as:

- Preparation works:
    - Mobilisation / demobilisation
    - Laying of geo-matting materials to allow failure zone access by survey crew
- Acquisition of Electrical Resistivity Imaging (ERI) data along 10 2D lines, each approximately 160 m in length as shown in Figure 2-1
- Delivery of raw data to the Hatch representative engaged by CVO

2.2 Additional Work Conducted

In addition to the initial scope of work detailed in section 2.1, processing of the data was carried out by GHD at the request of the Hatch representative. Additional work conducted can be summarised as:

- 2D inversion processing
- 3D modelling
- Factual geophysical report

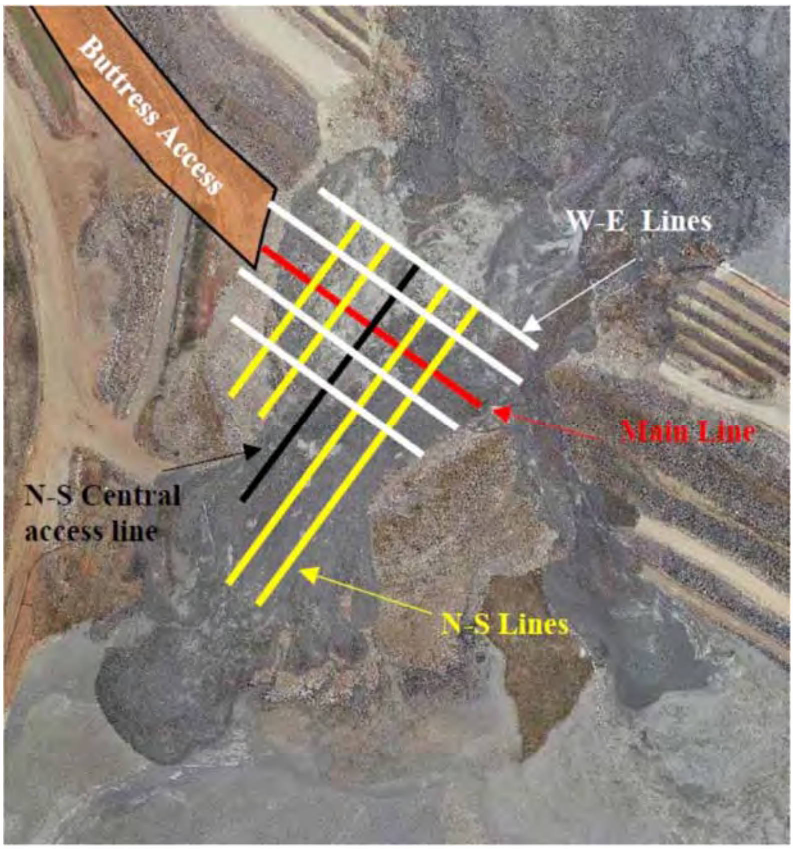


Figure 2-1 Failure zone ERI survey lines

3. Methodology

3.1 Electrical Resistivity Imaging

3.1.1 Introduction

The Electrical Resistivity Imaging method measures the electrical resistivity of the subsurface; both laterally and vertically, to infer rock/soil types, water saturation and stratigraphy. The resistivity of soil and rock depends, in part, on the constituent materials, however grain-size, porosity, soil-type, temperature, water saturation and total dissolved solids (TDS) concentration are the primary factors controlling resistivity.

3.1.2 Survey Configuration

ERI survey involves injecting an electrical current into the ground at a series of points along a line whilst simultaneously recording the change in current at numerous other points. The difference between the current introduced into the ground and the measured current received is a direct measure of the electrical resistivity of the material at which the current is passing through.

The depth at which ERI techniques can obtain information depends on the spacing of electrodes, which ultimately determines the array length, as well as the array method used to collect data. For this Tailings Storage Facility (TSF) investigation at Cadia, GHD acquired data using a Multiple Gradient array protocol (Figure 3-1, Table 3-1). This array measures all instrument channels simultaneously and provides a signal-to-noise ratio better than that of conventional array configurations to provide a balance of high resolution and depth of investigation (Dahlin and Zhou 2006). Dedicated Schlumberger, Wenner and Dipole-Dipole arrays were also tested, however each of these methods required significantly more time and sacrificed resolution in areas better captured using the Multiple Gradient array.

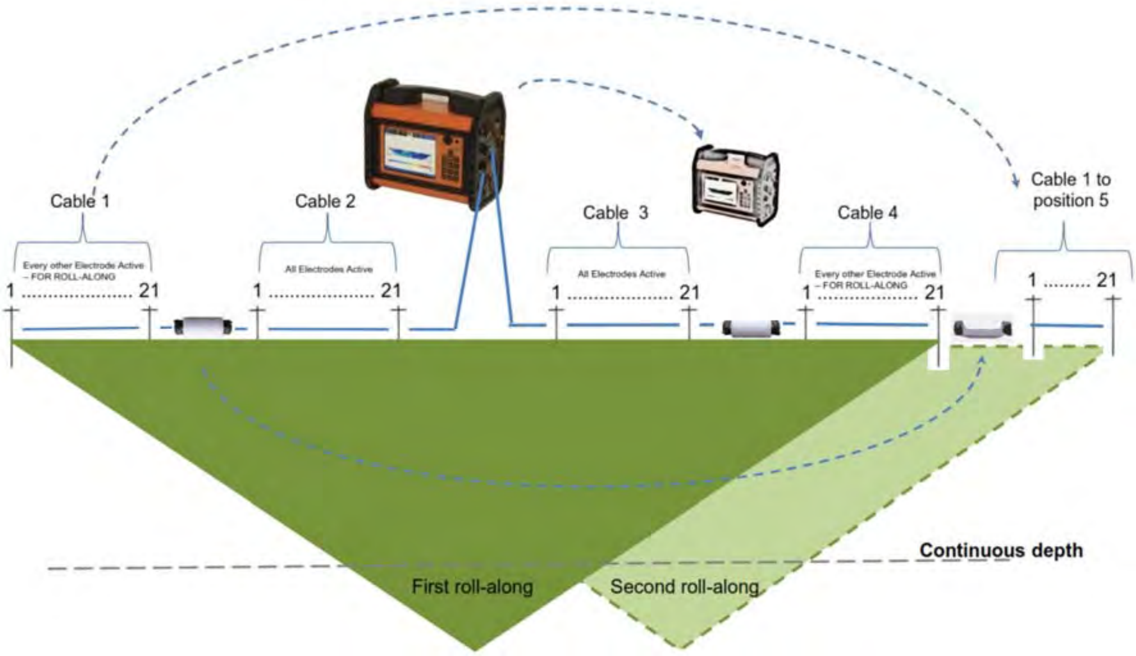


Figure 3-1 ABEM Terrameter ERI imaging system array roll-along schematic

Table 3-1 ERI survey parameters

Parameter	Value
System	ABEM Terrameter LS
Acquisition Method	Resistivity
Receiver	
Data sampling rate	30 kHz
ENOB	24
Input voltage range	+/- 600 V
Input impedance	200 MΩ, 30 MΩ, 20 GΩ
Precision	0.1 %
Accuracy	0.2 %
Resolution	3 nV at 1 second integration
Linearity	0.005 %
Frequency Response	Better than 1 % up to 300 Hz
Transmitter	
Output power	250 W

Maximum output current	2500 mA
Maximum output voltage	1200 V peak to peak
Accuracy	0.4 %
Precision	0.1 %
Survey	
Cycle time	1 s
Stacking	1
Acquisition array type	Modified Gradient Array
No. of cables and length	4 x 100 m
Electrode spacing	2 m
No. of electrodes	81 (60 active)
Full waveform record	Yes

3.1.3 Spatial Parameters

All spatial data, including figures within this report, unless otherwise stated, are presented in the Geocentric Datum of Australia 94 (GDA 1994) Map Grid of Australia (MGA) Zone 55 coordinate system using Transverse Mercator projection.

Newcrest supplied GHD with the most recent available LiDAR data as a set of xyz file tiles contained within a folder named '02_Thinned_Ground_ASCII_XYZ' in the mine grid co-ordinate system. The files were concatenated into a single file and reprojected to GDA94 MGA Zone 55 Zone 55 using control points (Table 3-2) derived from a Newcrest provided spreadsheet ('Mine Grid Transformations.xls'). An elevation shift of -5000 m was then applied.

Table 3-2 Reprojection control points

GDA94 MGA Zone 55		Mine Grid	
Easting	**Northing**	**Easting**	**Northing**
684422.828	6295810.050	13134.605	20680.888
684049.981	6295105.283	13192.082	19885.561
685014.106	6290963.821	16205.400	16884.716
687198.913	6290335.688	18391.166	17510.397
687482.358	6295162.799	16072.283	21754.120
684663.870	6296862.951	12780.782	21701.557
686226.713	6297541.418	13746.380	23105.496

4. Data Processing

4.1 2D Inversion Processing

4.1.1 Overview

In order to derive a cross-sectional model of true ground resistivity, the measured raw resistivity imaging data are subject to a finite-difference inversion process via RES2DINV software.

This data processing is based on an iterative routine involving determination of a two-dimensional simulated model of the subsurface, which is then compared to the observed data and revised. Convergence between theoretical and observed data is achieved by non-linear least squares optimisation.

4.1.2 Processing Workflow

Bad Data Point Removal

Prior to inversion pseudo-section plots and profile plots were reviewed visually for bad data. Bad data points with systematic noise show up as spots with unusually low or high values. In profile form, they stand out as elevated readings to their surrounding measurements.

Due to the quantity of resistivity data collected, manual editing of individual profiles to remove these bad data points was impractical. As a result, after initial visual QC of pseudo section plots to identify zones of noisy data, the following automated data rejection procedure was followed:

1. 1. Undertake a preliminary inversion of the profile with all the data points.
2. 2. Review RMS error statistics between the logarithms of the measured and calculated apparent resistivity values.
3. 3. Select all readings in the profile with an RMS error above a 100% threshold.
4. 4. Delete readings from observation file prior to running main inversion.

Model Discretisation

By default, RES2DINV uses a heuristic algorithm to generate the size and position of the model mesh. The depth to the deepest layer in the model is set to be approximately equal to the maximum pseudo-depth in the data set. The first layer thickness was set to the minimum pseudo-depth of the data points (~0.5 m) with the thickness of subsequent layers increased by 20 % with each deeper layer. The thickness of each deeper layer is increased to reflect the decreasing resolution of the resistivity method with increasing depth. The width of all mesh nodes was set to 1 m (1/2 of the electrode separation) with the exception of boundary nodes whose width is determined by the heuristic algorithm as a function of depth and electrode spacing.

The finite element mesh defined above is distorted into a trapezoidal mesh to take into consideration topographic variation along the profile using a damped distortion approach such that the surface nodes of the mesh match the actual topography. This gives more accurate results than using the correction factors for a homogeneous earth model calculated with the finite-element method (Fox et al., 1980) which can cause distortions in cases where large resistivity variations occur near the surface (Tong and Yang, 1990; Loke, 2000). The subsurface nodes are progressively shifted to a lesser extent compared with the surface nodes, i.e. the effect of the topography is “damped” with depth. This discretisation represents the optimal solution in the case where the curvature of the topography is less than the depth of the deepest model layer.

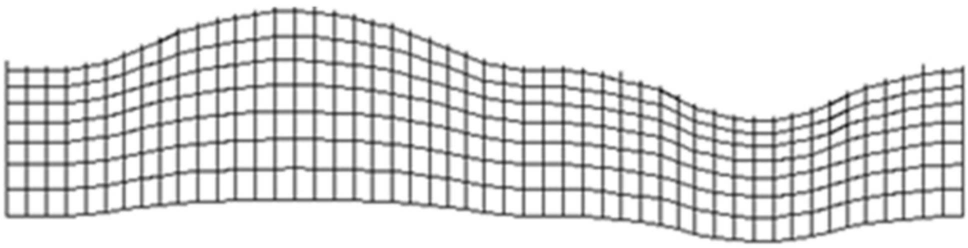


Figure 4-1 Moderately damped topographically distorted finite element mesh used in resistivity

Numerical Optimisation

RES2DINV uses a finite element modelling subroutine to calculate the apparent resistivity values, and a non-linear blocky least-squares optimisation technique is used to calculate the resistivity of the model blocks (deGroot-Hedlin and Constable 1990; Loke et al. 2003).

To reduce the effect of outlier data points, the L1 norm robust data constraint inversion method where the absolute difference (or the first power) between the measured and calculated apparent resistivity values is minimised was used (Claerbout and Muir, 1973).

In many typical environments, resistivity inversions use smoothness-constrained least squares method (deGroot-Hedlin and Constable, 1990) which attempt to minimise the square of the changes (L2 norm) in the model resistivity values. This will produce a model with a smooth variation in the resistivity values. Such a model is more suitable where subsurface resistivity also changes in a smooth manner (Loke et al., 2003). However if the subsurface bodies have sharp boundaries, the conventional least-squares smoothness-constrain method tends to smear the boundaries (Ellis and Oldenburg, 1994; Metwaly et al.2008).

As a result, a robust model constraint inversion method is used which attempts to minimise the absolute changes in the resistivity values. This constraint tends to produce models with sharp interfaces between different regions with different resistivity values, but within each region the resistivity value is almost constant.

The inversions were stopped once the difference of the root mean square (RMS) error between the current and previous iterations is <0.1%.

RES2DINV inversion parameter files for reproduction of resistivity inversion parameters are provided in Appendix A.

4.2 3D Modelling

4.2.1 Overview

The 2D ERI lines acquired were to be processed through a 3D inversion using the RES3DINV software package. Initial processing involved the collating of 2D lines into a 3D file for import into the software and subsequent inversion modelling. Site access constraints impacting data point density between 2D lines resulted in the generation of anomalous 3D resistivity models, due in part to the pronounced lateral variability in resistivity observed in the failure zone. Sensitivity analysis and non-uniqueness were poor with respect to inversion parameters and starting model.

Consequently, an alternative strategy of individual 2D inversion followed by stochastic 3D interpolation of the sparse grid was adopted.

4.2.2 Processing Workflow

Data Preparation and Importation

Sections produced from the 2D line inverse modelling processing where exported from the RES2DINV software package in XYZ ASCII format. Individual line data was then collated into a single csv file with the addition of a line number identification field, the total number of data points was 11635. Collated data was imported into the Discover PA Professional (Encom) software (Figure 4-2) for further processing as a Geosoft Database (.GDB).

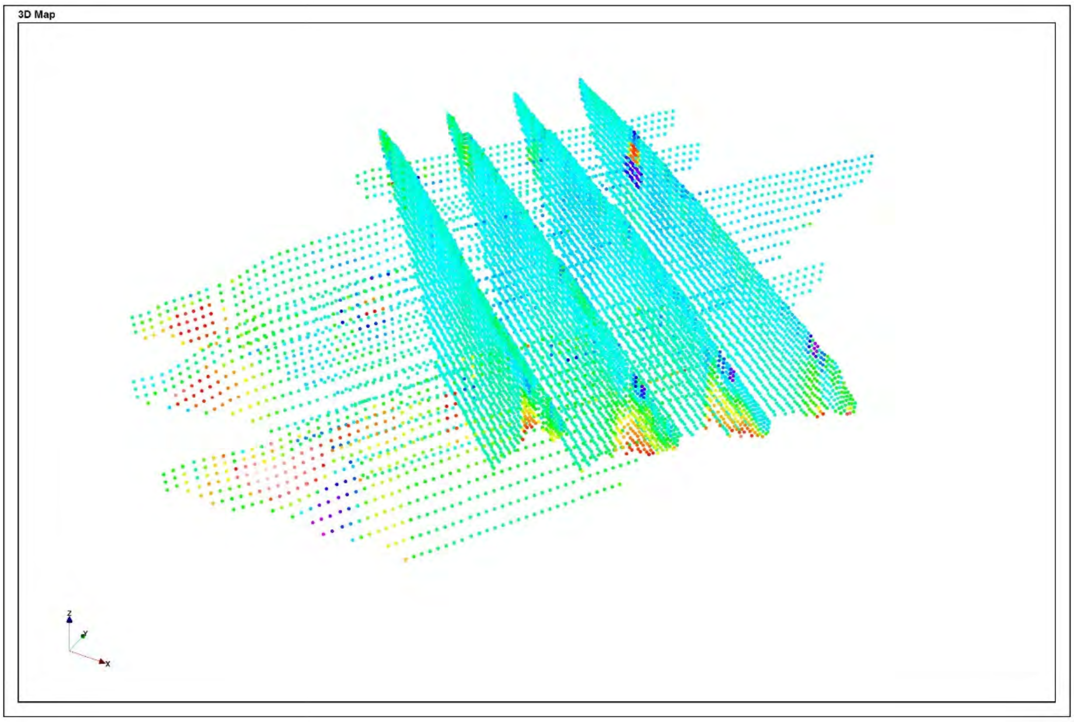


Figure 4-2 2D ERI data points imported into a 3D environment

Model Discretisation

ERI point data was gridded into a 3D model using the Voxel Gridding utility. The minimums and maximum extents of the data point was utilised to define the dimension of the 3D volume. A 1 m cell size was selected consisting of 161*176 horizontal cells with 33 depth planes (total of 935088 individual cells).

Gridding

A continuously variable meshing technique was utilised using the Inverse Distance Weighting (IDW) gridding method. IDW is a universal technique that can be applied to a wide range of spatial data. IDW uses weighted averages to estimate new grid cell values and can be used as either an exact or a smoothing interpolator. The value assigned to each grid cell in an output grid is calculated using a distance weighted average of all data point values that fall within a specified search radius if the grid cell.

The IDW gridding algorithm can be personalised to the task at hand by the alteration of gridding parameters. A number of gridding parameters where trialled prior to the selection of optimal settings. The optimal settings selected and the purpose are listed below:

1. **Searching Parameters**

   i) Search distance (3); The gridding algorithm only searches for contributing data points within the specified distance of the grid cell. Data points outside of this distance do not contribute to the solution at that cell

ii) Search expansions (4); If an insufficient number of data points are found within the search distance, that search distance is increased (by the initial distance) and the search is repeated. This occurs up to “n” times – as specified by the increment. The final search distance is the number of increments multiplied by the initial search distance

iii) Grid passes (4); The initial search distance is equal to the number of passes multiplied by the initial search distance. This feature is useful if the input data points are unevenly distributed as it fills in the gaps in coverage more efficiently

2. **Sample Selection**

i) Number of search sectors (8); used to help ensure that input data is evenly distributed spatially around the grid cell

ii) Minimum points required in each sector (1); gridding cannot succeed unless a Minimum number of input points are found within the search radius within each sector

iii) Maximum number of samples per sector (5); Restricts the number of input points that may contribute to each solution. Too many points can have unusual effects especially as you begin to move away from input data and the distance to all points becomes approximately equal

iv) Use nearest samples (Yes); Uses the closest data point when selecting samples

3. **Gridding Rules**

i) Only grid data if at least 1 sample is located in a minimum of 2 sectors

4. **Weighting Model**

i) Weight Model (Gaussian, Range 80); The weight assigned to each data value is determined according to a 1D Gaussian function centred on the grid node. The shape and standard deviation of the Gaussian function is proportional to the range with larger values producing a flatter function and a smoother grid

$$weight = \frac{1}{2\left(\frac{Distance}{\left(\frac{Range}{2}\right)^2}\right)}$$

ii) Taper (80-100); As the solution centre moves away from the data sources confidence in the solution may decrease. Statistically, at some point it will exceed the range beyond which there is no correlation between source data. The tapering option enables you to taper the solutions back to background at large distances from source data

The 3D block model created from the gridding of 2D ERI data is shown in Figure 4-3. It can be seen that the change in elevation over the survey area has resulted in the generation of blocks above the ground surface. The Clip to Surface utility was used to, as far as possible, remove model cells above the surface. The clipped 3D apparent resistivity model is shown in Figure 4-4.

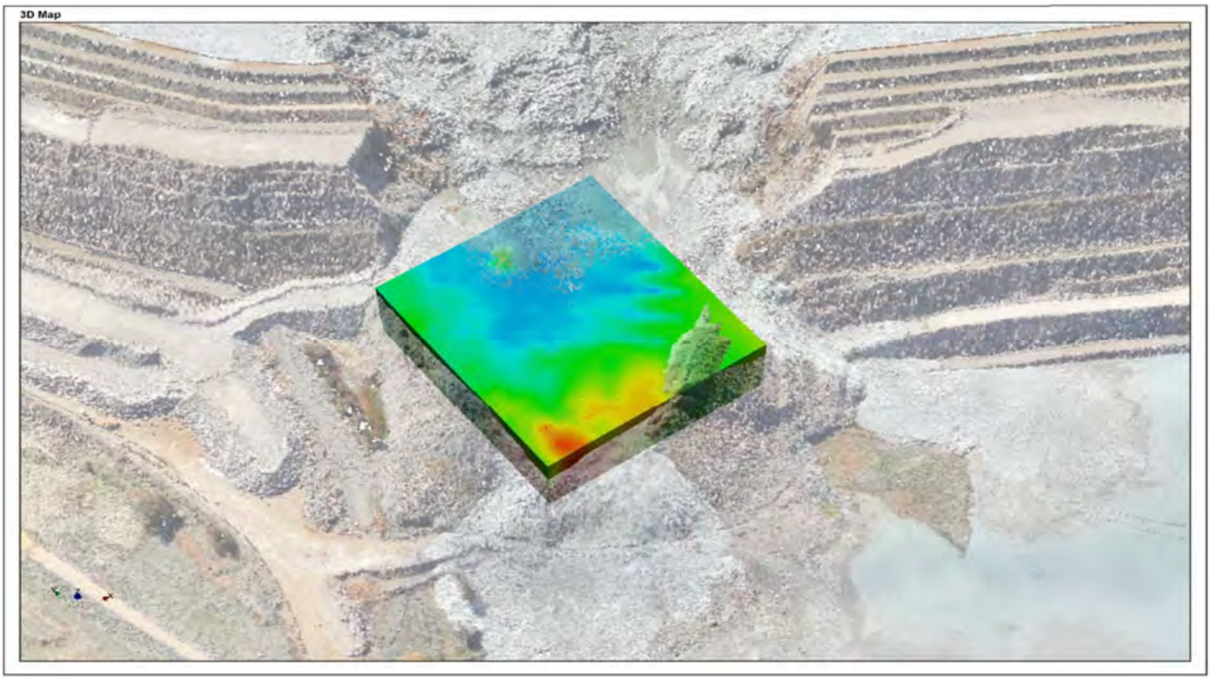


Figure 4-3 3D block model of apparent resistivity

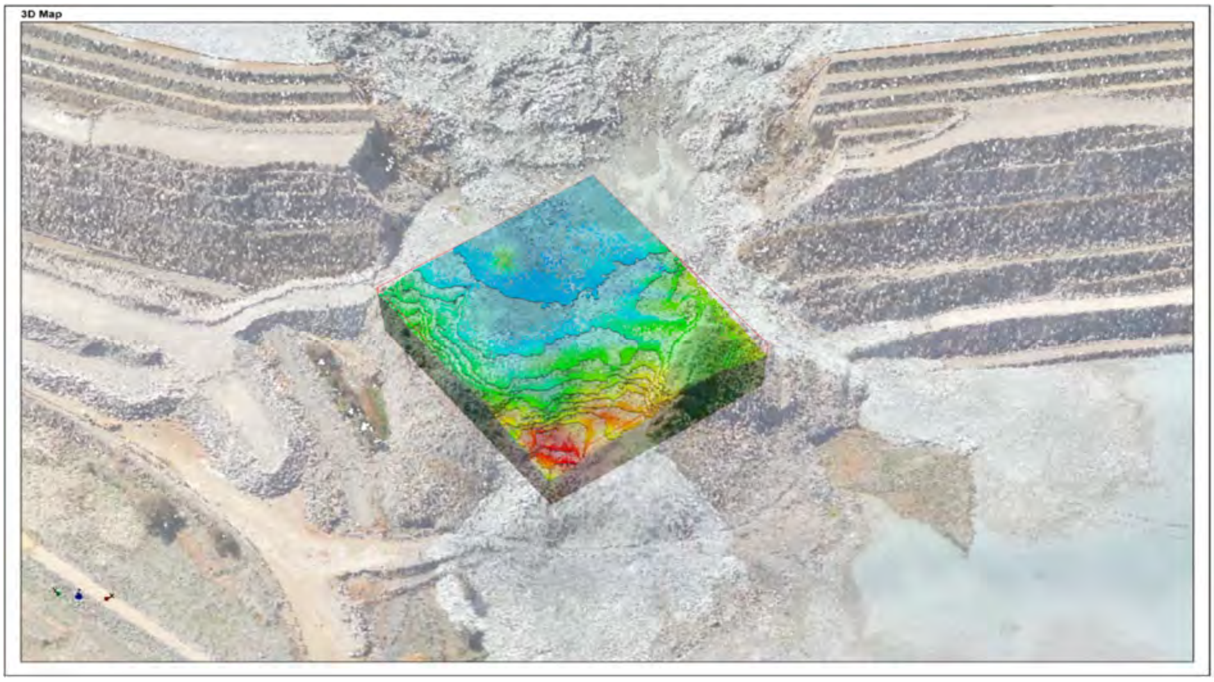


Figure 4-4 3D block model of apparent resistivity clipped to the surface elevation

5. Results and Interpretation

5.1 Results

5.1.1 2D ERI Sections

2D ERI sections are displayed in Appendix B and consist of:

- Figure B1; 2D Line Positions
- Figure B2; Line 1 and Line 2 ERI sections
- Figure B3; Line 3 and Line 4 ERI sections
- Figure B4; Line 5 and Line 7 ERI sections
- Figure B5; Line 8 and Line 9 ERI sections

5.1.2 3D ERI Modelling

3D ERI imagery is displayed in Appendix C and consist of:

- Figure C1; 3D clipped and threshold models
- Figure C2; 2D depth slices of the 3D models (elevation 676 – 688 m)
- Figure C3; 2D depth slices of the 3D models (elevation 692 – 704 m)

5.1.3 Digital Data

Digital data will be provided by a large file transfer. This package will consist of:

- Raw 2D ERI line data
- Processed 2D ERI line data
- Processed 2D ERI data point compiled for 3D software import
- 3D model data

5.2 Interpretation

Results from the 2D inversion of line data (Appendix B) shows that the majority of the sections have low apparent resistivity values (<20 ohm.m) consistent with conductive tailings materials. Higher resistivity values are observed in south and southeast of the sections likely indicating embankment materials or unsaturated tailings are present below the surface in these zones.

These occurrences are observed with the 3D model. Figure C1 displays an upper apparent resistivity threshold cut at 20 ohm.m representing the spatial extent of tailings materials. The threshold body is located to the north / northwest of the model and extends to the full depth of investigation. The lower apparent resistivity threshold cut at 200 ohm.m represents the spatial location of embankment materials. The threshold body is located to the east and south of the model with the upper extent of the body in the very near subsurface. This is consistent with the dam wall that can be visually observed protruding to the east of the modelled area.

The lower depth slice (Figure C2) indicates the lower extent of the tailings materials (blue). The interpreted lateral extent of tailings materials is predominately confined to the north, centre and central west of the model. The higher apparent resistivity zone (green) within the tailings zone likely indicates the ground surface prior to the failure, and would suggest that the surrounding tailings do not extend much deeper than an RL of 676 m.

Further work to aid in interpretation of this survey could include plotting of natural ground / pre-failure embankment surfaces on individual 2D cross sections.

The low resistivity section aligned with Ch 60m on Line 1-4 may indicate influence from a basement geological structure. This aligns with mapped location of the thrust fault separating the Weemalla formation from the Forrest Reef volcanics. Additional detailed interpretation of the 2D resistivity sections could confirm this should this be required to aid the NTSF failure mode assessment.

Appendices

Appendix A – 2D ERI Inversion Parameters

Inversion Settings – RES2DINV

Initial damping factor (0.01 to 1.00)
0.1500
Minimum damping factor (0.001 to 0.75)
0.0200
Local optimization option (0=No, 1=Yes)
0
Convergence limit for relative change in RMS error in percent (0.1 to 20)
5.0000
Minimum change in RMS error for line search in percent (0.5 to 100)
0.5000
Number of iterations (1 to 30)
7
Vertical to horizontal flatness filter ratio (0.25 to 4.0)
1.0000
Model for increase in thickness of layers(0=default 10%, 1=default 25%, 2=user defined)
2
Number of nodes between adjacent electrodes (1, 2 or 4)
2
Flatness filter type, Include smoothing of model resistivity (0=model changes only,1=directly on model)
1
Reduce number of topographical data points? (0=No,1=Yes. Recommend leave at 0)
0
Carry out topography modeling? (0=No,1=Yes)
1
Type of topography trend removal (0=Average,1=Least-squares,2=End to end)
2
Type of Jacobian matrix calculation (0=Quasi-Newton, 1=Gauss-Newton, 2=Mixed)
1
Increase of damping factor with depth (1.0 to 2.0)
1.0500
Type of topographical modeling (0=None, 1=No longer supported so do not use, 2=uniform distorted FEM, 3=underwater, 4=damped FEM, 5=FEM with inverse Swartz-Christoffel)
4
Robust data constrain? (0=No, 1=Yes)
1
Cutoff factor for data constrain (0.0001 to 0.1))
0.0500
Robust model constrain? (0=No, 1=Yes)
1
Cutoff factor for model constrain (0.0001 to 1.0)
0.0050
Allow number of model parameters to exceed data points? (0=No, 1=Yes)
1
Use extended model? (0=No, 1=Yes)
0

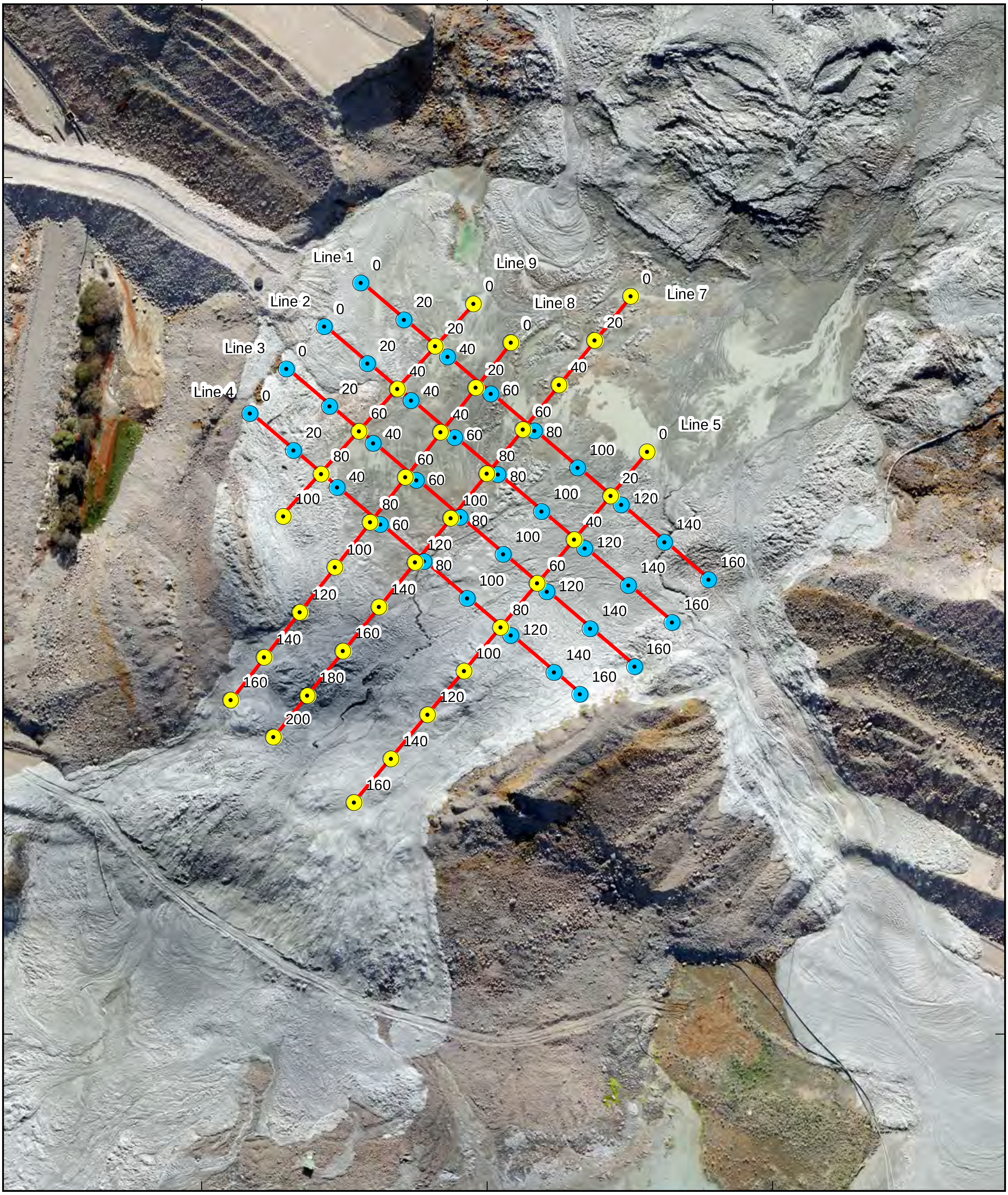
Reduce effect of side blocks? (0=No, 1=Slight, 2=Severe, 3=Very Severe)
1
Type of mesh (0=Normal,1=Fine,2=Finest)
0
Optimise damping factor? (0=No, 1=Yes)
1
Time-lapse inversion constrain (0=None,1&2=Smooth,3=Robust)
3
Type of time-lapse inversion method (0=Simultaneous,1=Sequential)
0
Thickness of first layer (0.25 to 1.0)
0.5000
Factor to increase thickness layer with depth (1.0 to 1.25)
1.1000
USE FINITE ELEMENT METHOD (YES=1,NO=0)
1
WIDTH OF BLOCKS (1=NORMAL WIDTH, 2=DOUBLE, 3=TRIPLE, 4=QUADRAPLE, 5=QUINTIPLE)
1
MAKE SURE BLOCKS HAVE THE SAME WIDTH (YES=1,NO=0)
1
RMS CONVERGENCE LIMIT (IN PERCENT)
0.100
USE LOGARITHM OF APPARENT RESISTIVITY (0=USE LOG OF APPARENT RESISTIVITY, 1=USE RESISTANCE VALUES, 2=USE APPARENT RESISTIVITY)
0
TYPE OF IP INVERSION METHOD (0=CONCURRENT,1=SEQUENTIAL)
0
PROCEED AUTOMATICALLY FOR SEQUENTIAL METHOD (1=YES,0=NO)
0
IP DAMPING FACTOR (0.01 to 1.0)
0.250
USE AUTOMATIC IP DAMPING FACTOR (YES=1,NO=0)
0
CUTOFF FACTOR FOR BOREHOLE DATA (0.0005 to 0.02)
0.00010
TYPE OF CROSS-BOREHOLE MODEL (0=normal,1=halfsize)
0
LIMIT RESISTIVITY VALUES(0=No,1=Yes)
1
Upper limit factor (10-50)
50.000
Lower limit factor (0.02 to 0.1)
0.020
Type of reference resistivity (0=average,1=first iteration)
0
Model refinement (1.0=Normal,0.5=Half-width cells)
0.50
Combined Combined Marquardt and Occam inversion (0=Not used,1=used)

0
Type of optimisation method (0=Gauss-Newton,2=Incomplete GN)
2
Convergence limit for Incomplete Gauss-Newton method (0.005 to 0.05)
0.005
Use data compression with Incomplete Gauss-Newton (0=No,1=Yes)
0
Use reference model in inversion (0=No,1=Yes)
1
Damping factor for reference model (0.0 to 0.3)
0.01000
Use fast method to calculate Jacobian matrix. (0=No,1=Yes)
0
Use higher damping for first layer? (0=No,1=Yes)
1
Extra damping factor for first layer (1.0 to 100.0)
5.00000
Type of finite-element method (0=Triangular,1=Trapezoidal elements)
1
Factor to increase model depth range (1.0 to 5.0)
1.050
Reduce model variations near borehole (0=No, 1=Yes)
0
Factor to control the degree variations near the boreholes are reduced (2 to 100)
5.0
Factor to control variation of borehole damping factor with distance (0.5 to 5.0)
1.0
Floating electrodes survey inversion method (0=use fixed water layer, 1=Incorporate water layer into the model)
1
Resistivity variation within water layer (0=allow resistivity to vary freely,1=minimise variation)
1
Use sparse inversion method for very long survey lines (0=No, 1=Yes)
0
Optimize Jacobian matrix calculation (0=No, 1=Yes)
1
Automatically switch electrodes for negative geometric factor (0=No, 1=Yes)
1
Force resistance value to be consistant with the geometric factor (0=No, 1=Yes)
1
Shift the electrodes to round up positions of electrodes (0=No, 1=Yes)
0
Use difference of measurements in time-lapse inversion (0=No,1=Yes)
0
Use active constraint balancing (0=No,1=Yes)
0
Type of active constraints (0=Normal,1=Reverse)
0

Lower damping factor limit for active constraints
0.4000
Upper damping factor limit for active constraints
2.5000
Water resistivity variation damping factor
8.0000
Use automatic calculation for change of damping factor with depth (0=No,1=Yes)
0
Type of I.P. model transformation (0=None, 1=square root, 3=range)
1
Model Chargeability Lower Limit (mV/V) for range
0.00
Model Chargeability Upper Limit (mV/V) for range
900.00
Use I.P. model refinement (0=No, 1=Yes)
1
Weight for I.P. data (1 to 10)
1.00
I.P. model damping factor (0.05 to 1.0)
0.25
Use program estimate for I.P. model damping factor (0=No, 1=Yes)
0
Type of I.P. smoothness constraint (1=Same as resistivity, 0=Different)
1
Joint or separate I.P. inversion method (1=Separate, 0=Joint)
1
Apparent I.P. cutoff value (300 to 899 mV/V)
899.00
Use diagonal filter (0=No, 1=Yes)
0
Diagonal filter weight (0.2 to 5.0)
1.00
Limit range of data weights from error estimates? (0=No, 1=Yes)
0
Lower limit of data weights (0.2 to 0.5)
0.30
Upper limit of data weights (2.0 to 5.0)
3.00
Use same data weights from error estimates for different time series? (0=No, 1=Yes)
0
Calculate model resolution? (0=No, 1=Yes)
0
Use L curve method? (0=No, 1=Yes)
0
Use same norms in L curve method? (0=No, 1=Yes)
0
Allow damping factor in increase in L curve method? (0=No, 1=Yes)
1

Type of borehole damping method (0=Horizontal distance from nearest borehole, 1=Distance from nearest active electrode)
0
Use fast Jacobian calculation for dense data sets? (0=No,1=Yes)
0
Use higher damping factors at sides of model? (0=No,1=Yes)
1
Adjust damping factors for distances between the blocks in the model? (0=No,1=Yes)
1
Number of electrodes in segment for sparse inversion method for very long survey lines.
250
Time-lapse damping factor.
0.25
Reduce time-lapse damping with each iteration? (0=No,1=Yes)
1

Appendix B – 2D ERI Figures



Paper Size A4

0 5 10 20 30 40

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Newcrest Mining Ltd
NTSF Remediation

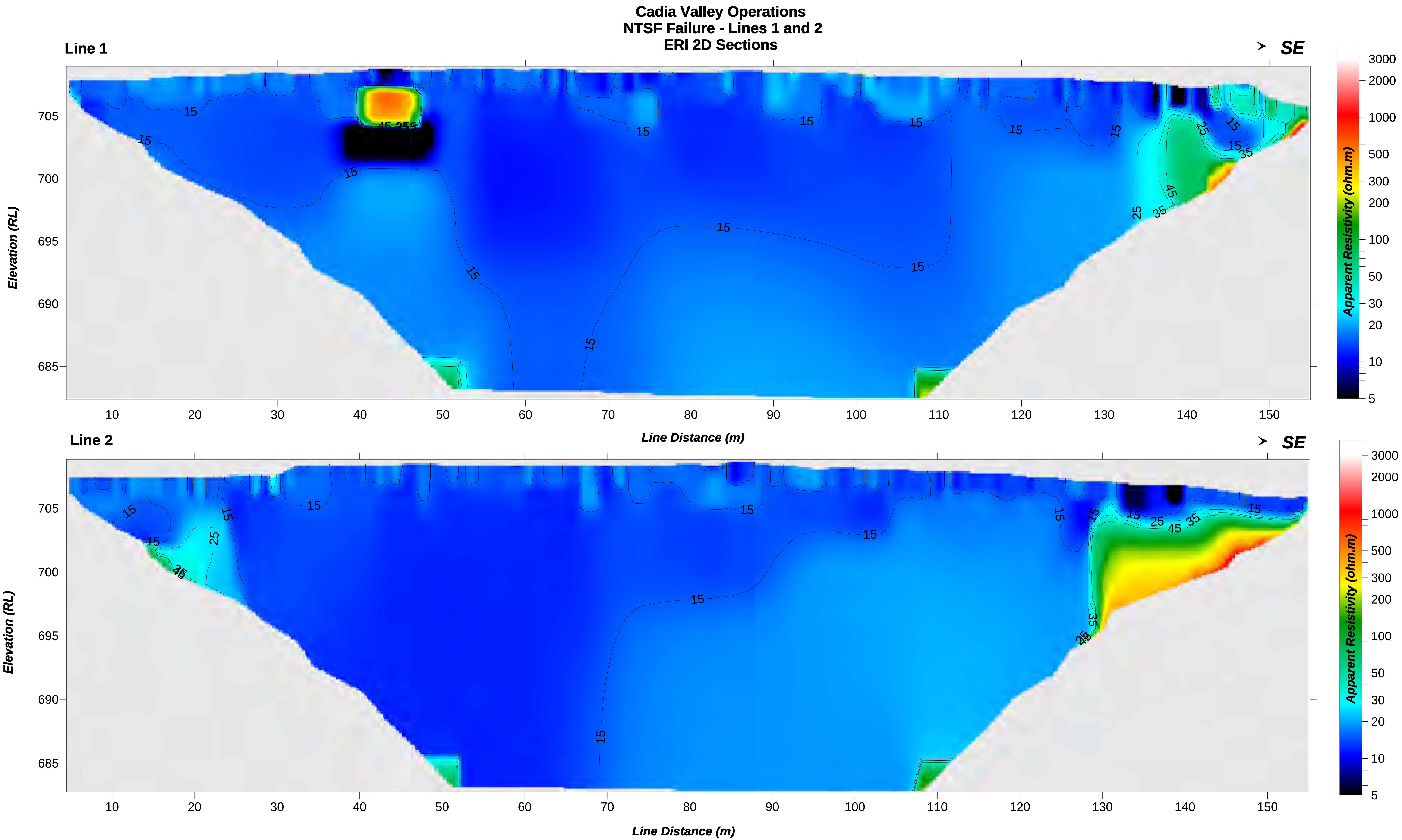
Failure ERI Investigation
2D Line Positions

Job Number	32-18788
Revision	A
Date	04 Oct 2018

Figure B1

2 Salamanca Sqaure Hobart TAS 7000 Austrailia **T** 61 3 6210 0600 **F** 61 3 6210 0601 **W** www.ghd.com

Created by:wmacadam



Client: Newcrest Mining Limited		
Geophysical Investigation NTSF		
Cadia Valley Operations		
ERI Survey		
scale	as shown	Date 03/9/2018

Projection: Tranverse Mercator
Horizontal Datum: GDA 94
Grid: MGA Zone 55S

Produced by:
M. Anderson

Job No.: 32/18788

Ref file: N:/AU/Hobart/Projects/32/18788/Technical/Geophysics/Figures/

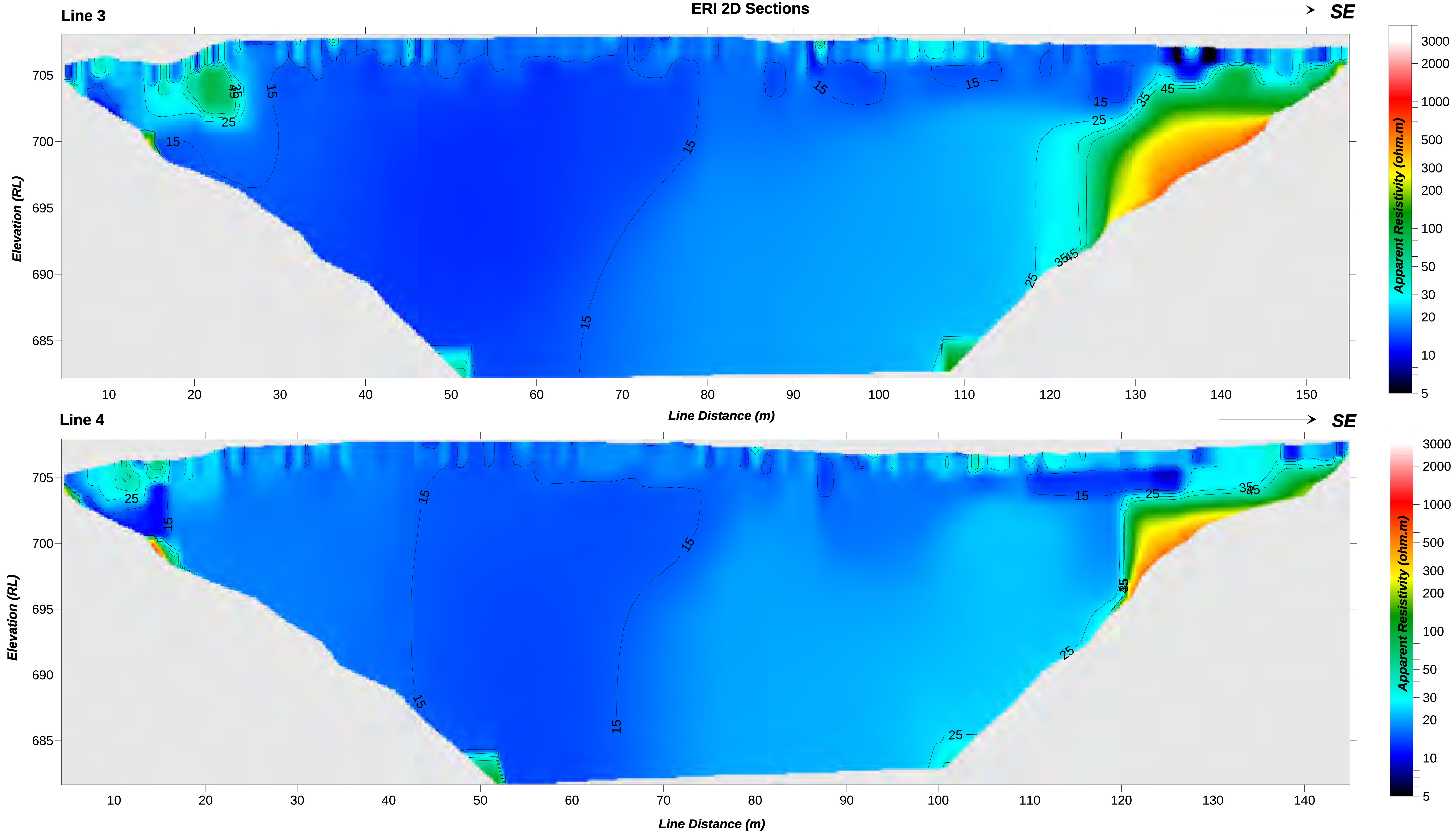
Cadia Valley Operations
ERI Model
Lines 1 and 2

N:/AU/Hobart/Projects/32/18788/Technical/Geophysics/Figures/

Figure B2

2 Salamanca Square, Hobart TAS 7000 T 61 3 6210 0600 F 61 3 6210 0601 W www.ghd.com

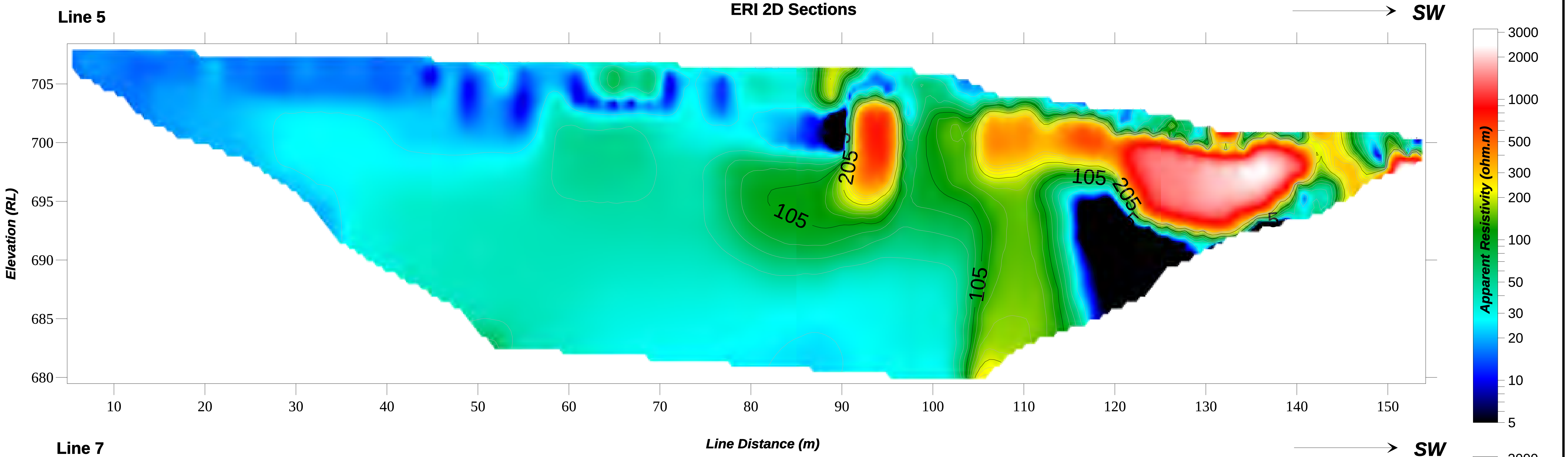
Cadia Valley Operations
NTSF Failure - Lines 3 and 4
ERI 2D Sections

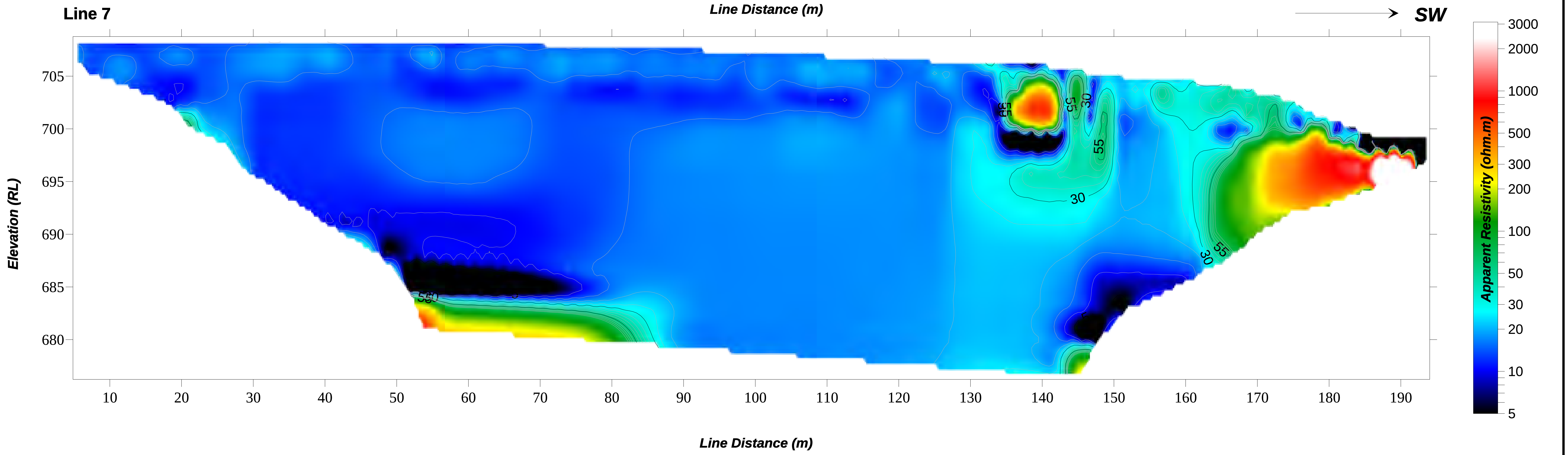


GHD / NEWCREST	Client: Newcrest Mining Limited Geophysical Investigation NTSF Cadia Valley Operations ERI Survey scale: as shown — Date 03/9/2018	*Projection: Tranverse Mercator* *Horizontal Datum: GDA 94* *Grid: MGA Zone 55S* Produced by: M. Anderson	Job No.: 32/18788 Ref file: N:/AU/Hobart/Projects/32/18788/Technical/Geophysics/Figures/ Cadia Valley Operations ERI Model Lines 3 and 4 N:/AU/Hobart/Projects/32/18788/Technical/Geophysics/Figures/ Figure B3

2 Salamanca Square, Hobart TAS 7000 T 61 3 6210 0600 F 61 3 6210 0601 W www.ghd.com

Cadia Valley Operations
NTSF Failure - Lines 5 and 7
ERI 2D Sections





Client: Newcrest Mining Limited	Projection: Tranverse Mercator Horizontal Datum: GDA 94 Grid: MGA Zone 55S
Geophysical Investigation NTSF	
Cadia Valley Operations	
ERI Survey	Produced by: M. Anderson
scale: as shown, Date 03/9/2018	

Job No.: 32/18788

Ref file: N:/AU/Hobart/Projects/32/18788/Technical/Geophysics/Figures/

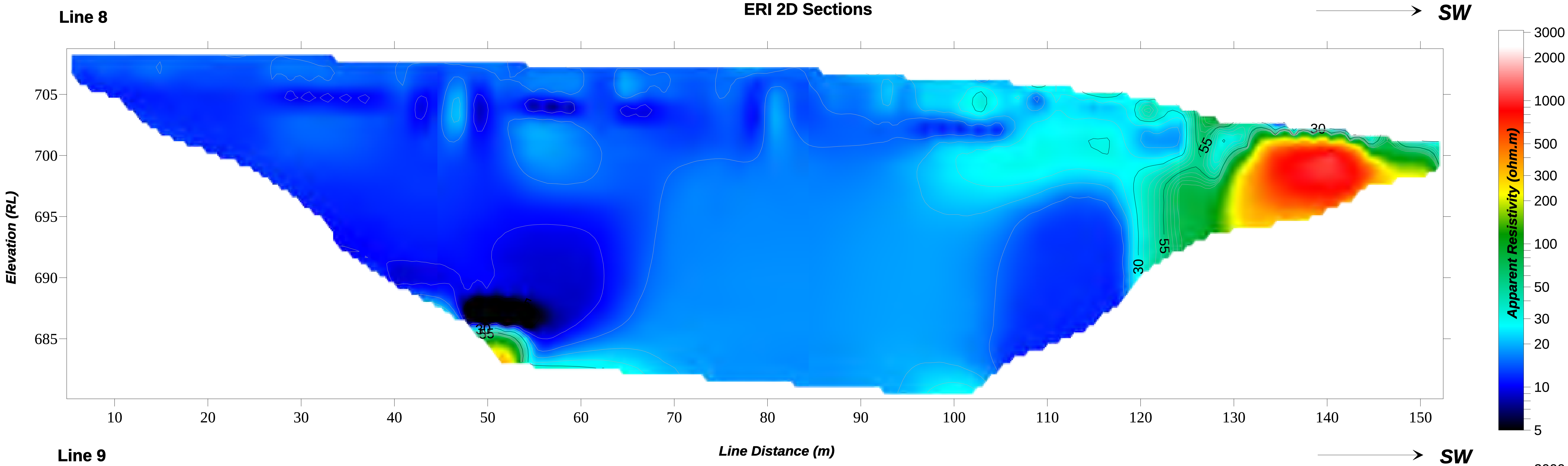
Cadia Valley Operations
ERI Model
Lines 5 and 7

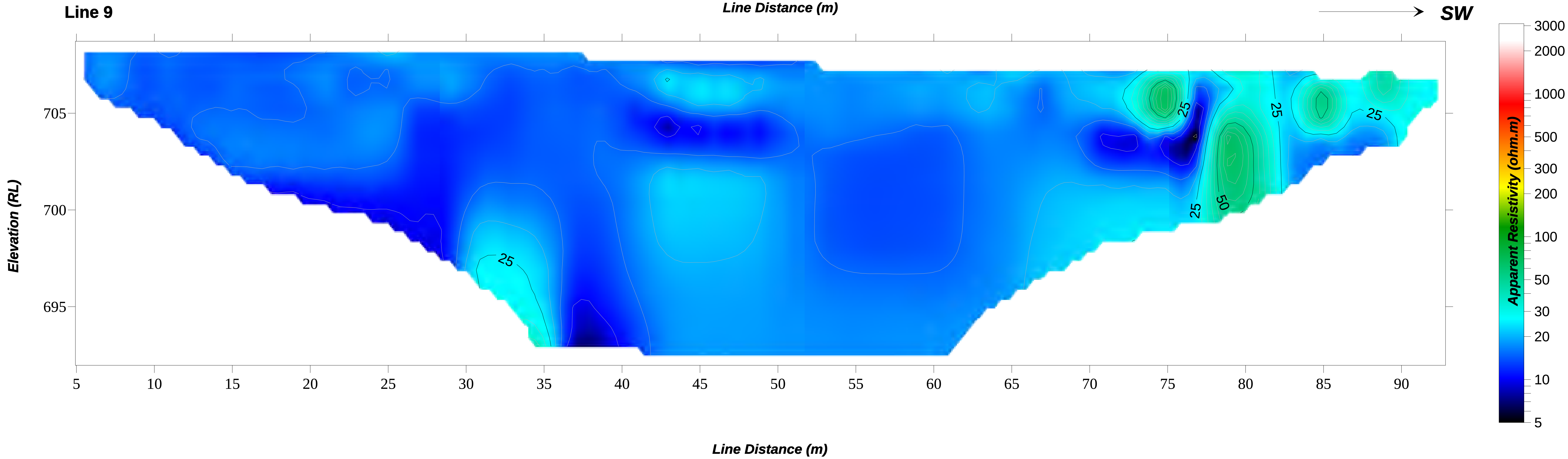
N:/AU/Hobart/Projects/32/18788/Technical/Geophysics/Figures/

Figure B4

2 Salamanca Square, Hobart TAS 7000 T 61 3 6210 0600 F 61 3 6210 0601 W www.ghd.com

Cadia Valley Operations
NTSF Failure - Lines 8 and 9
ERI 2D Sections





Client: Newcrest Mining Limited		
Geophysical Investigation NTSF		
Cadia Valley Operations		
ERI Survey		
scale	as shown	Date 03/9/2018

Projection: Tranverse Mercator
Horizontal Datum: GDA 94
Grid: MGA Zone 55S

Produced by:
M. Anderson

Job No.: 32/18788

Ref file: N:/AU/Hobart/Projects/32/18788/Technical/Geophysics/Figures/

Cadia Valley Operations
ERI Model
Lines 8 and 9

N:/AU/Hobart/Projects/32/18788/Technical/Geophysics/Figures/

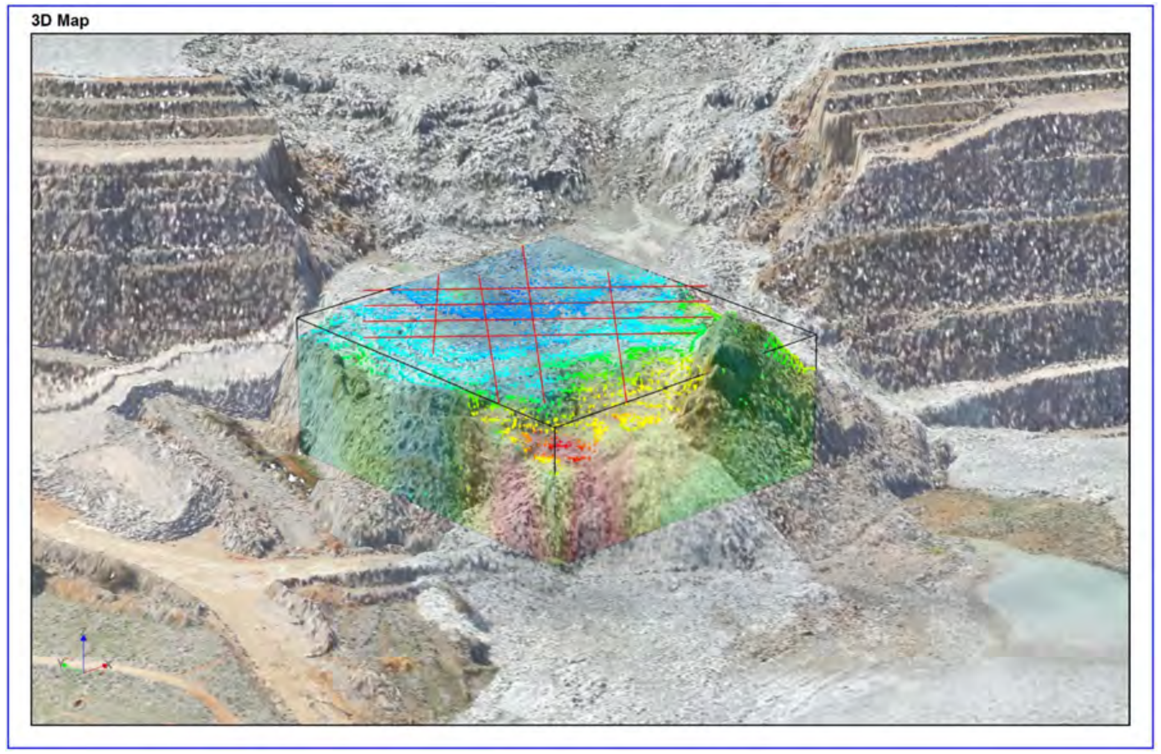
Figure B5

2 Salamanca Square, Hobart TAS 7000 T 61 3 6210 0600 F 61 3 6210 0601 W www.ghd.com

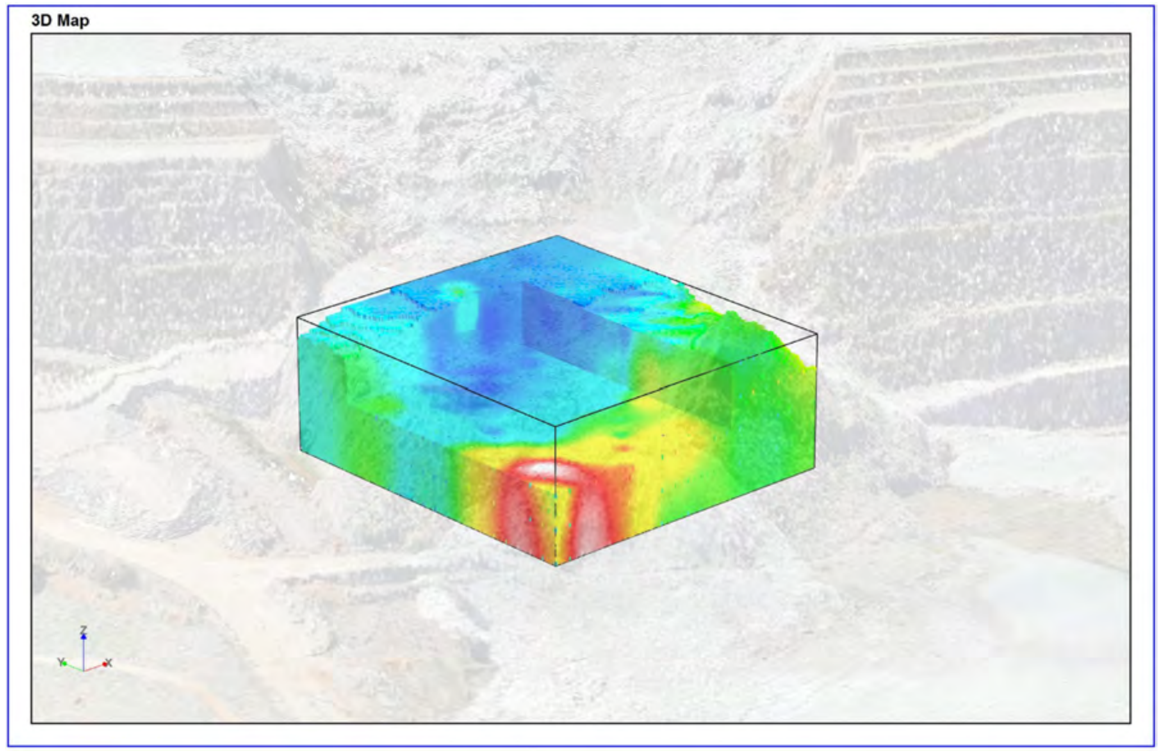
Appendix C – 3D ERI Figures

Cadia Valley Operations
NTSF Failure
ERI 3D Models

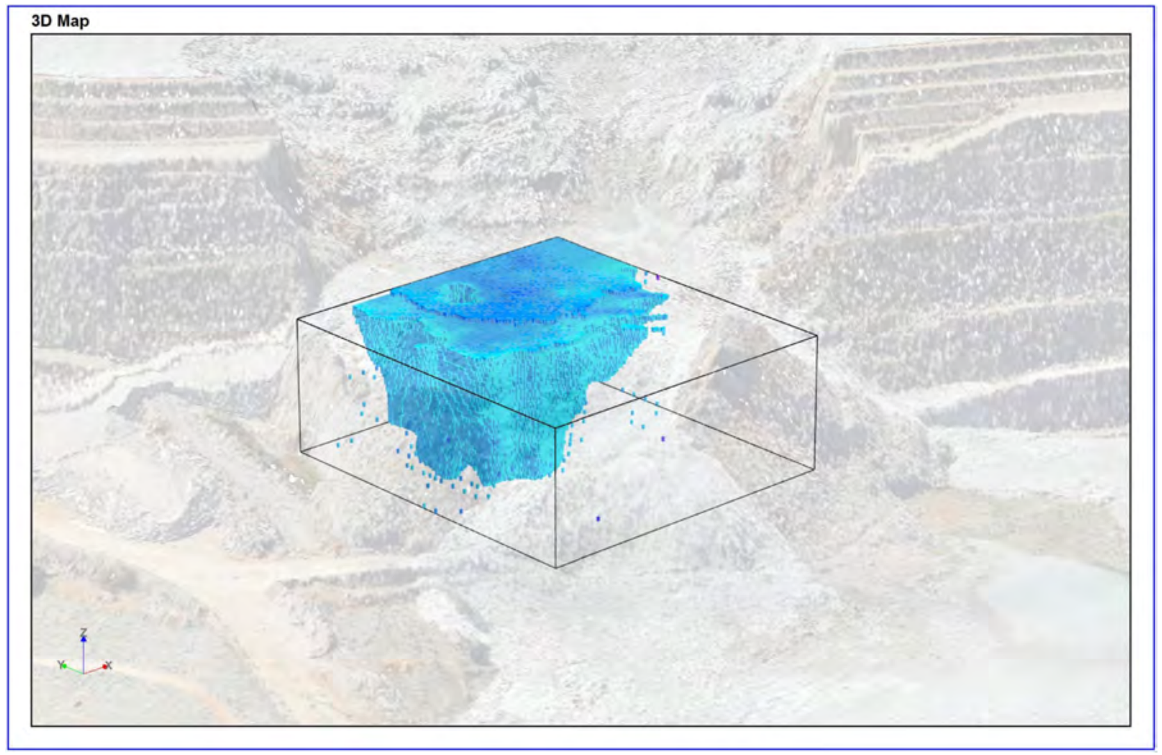
Model Extents and Line Positions



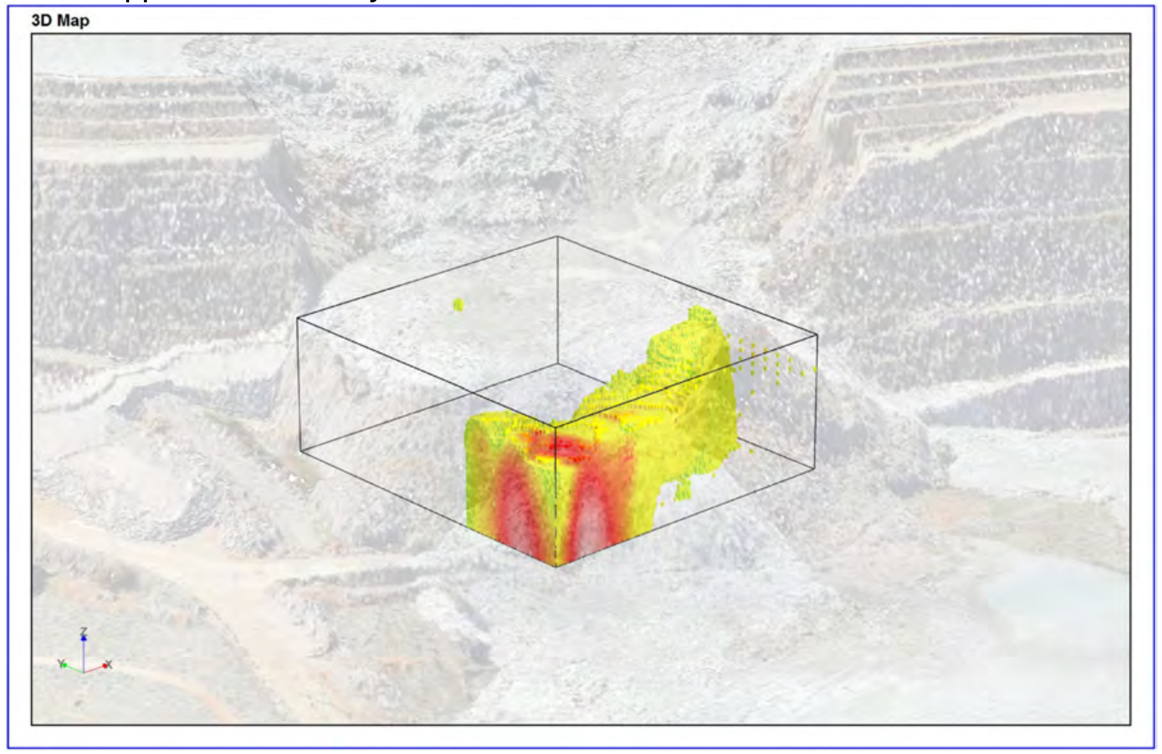
Chair Clipped Model

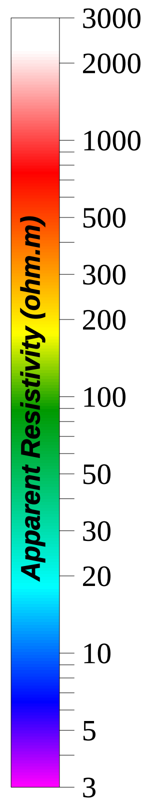


Upper Apparent Resistivity Threshold Cut - 20 ohm.m



Lower Apparent Resistivity Threshold Cut - 200 ohm.m





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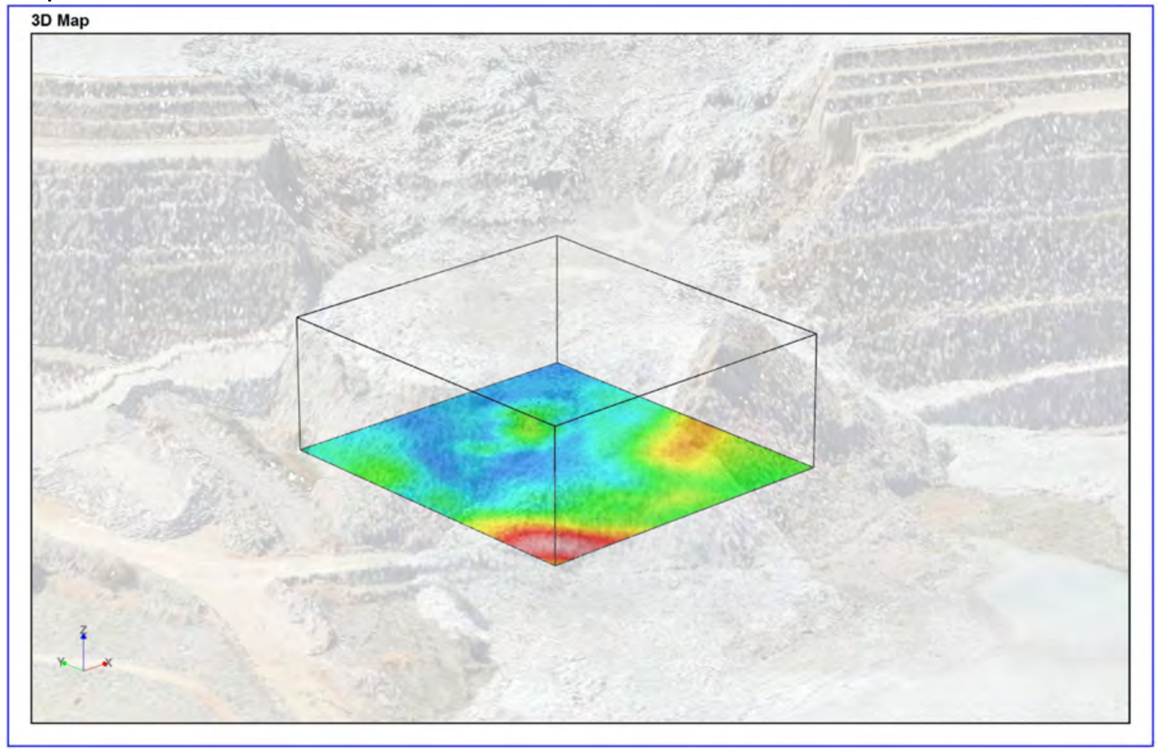
Geophysical Investigation NTSF	*Horizontal Datum: GDA 94*	Ref file: N:/AU/Hobart/Projects/32/18788/Technical/Geophysics/Figures/
Cadia Valley Operations	*Grid: MGA Zone 55S*	Cadia Valley Operations 3D ERI Models
ERI Survey	Produced by: M. Anderson	
scale / as shown / Date 03/9/2018		N:/AU/Hobart/Projects/32/18788/Technical/Geophysics/Figures/ — Figure C1

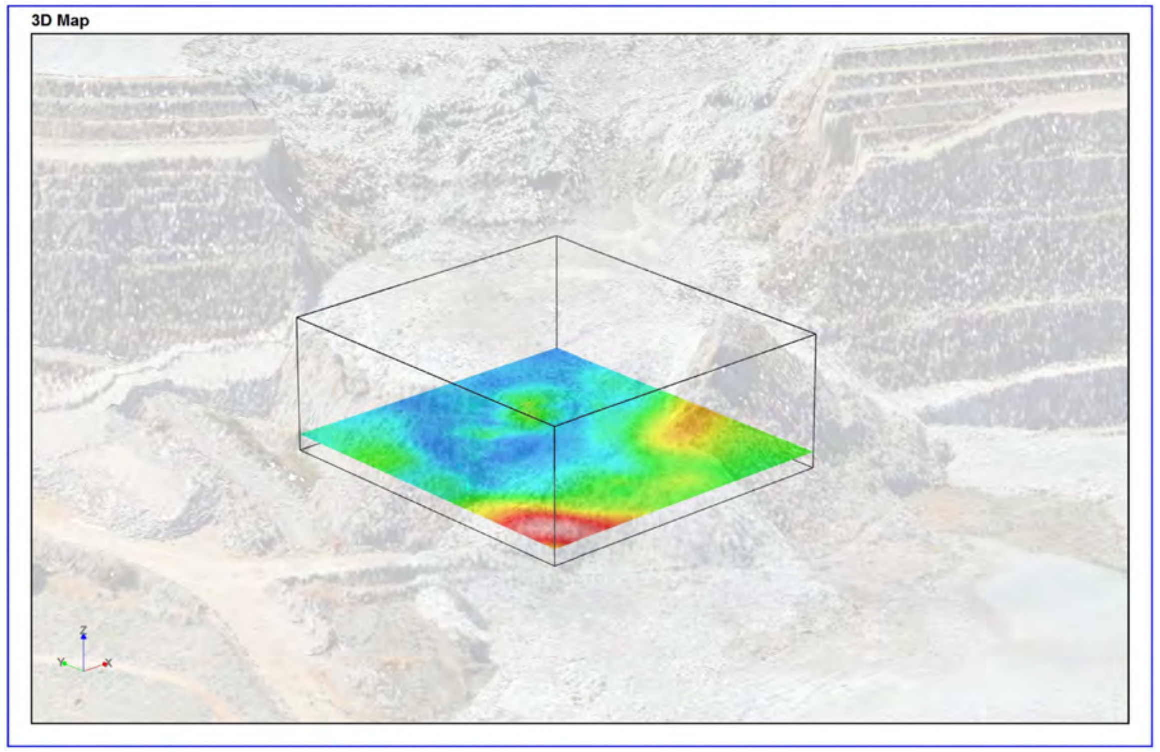
2 Salamanca Square, Hobart TAS 7000 T 61 3 6210 0600 F 61 3 6210 0601 W www.ghd.com

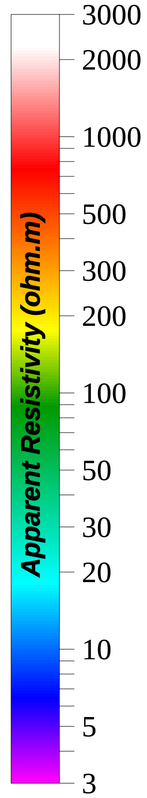
Cadia Valley Operations
NTSF Failure
ERI 3D Depth Slices

Depth Slice - Elevation 676 m

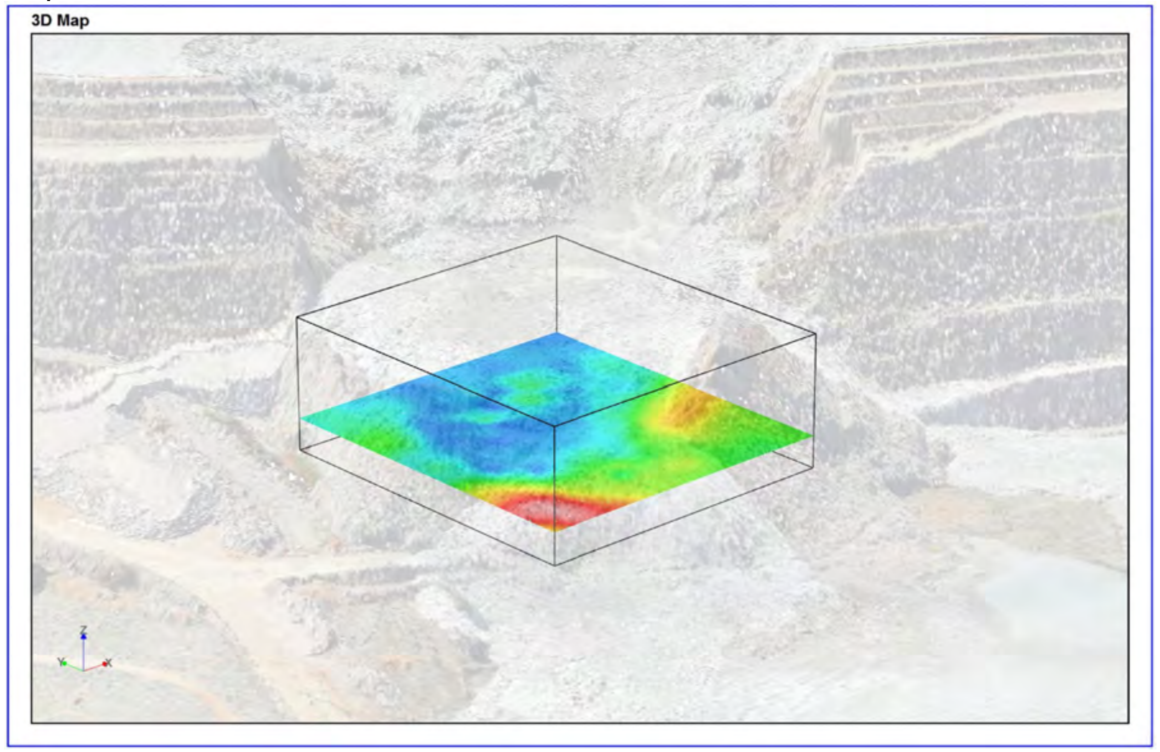


Depth Slice - Elevation 680 m

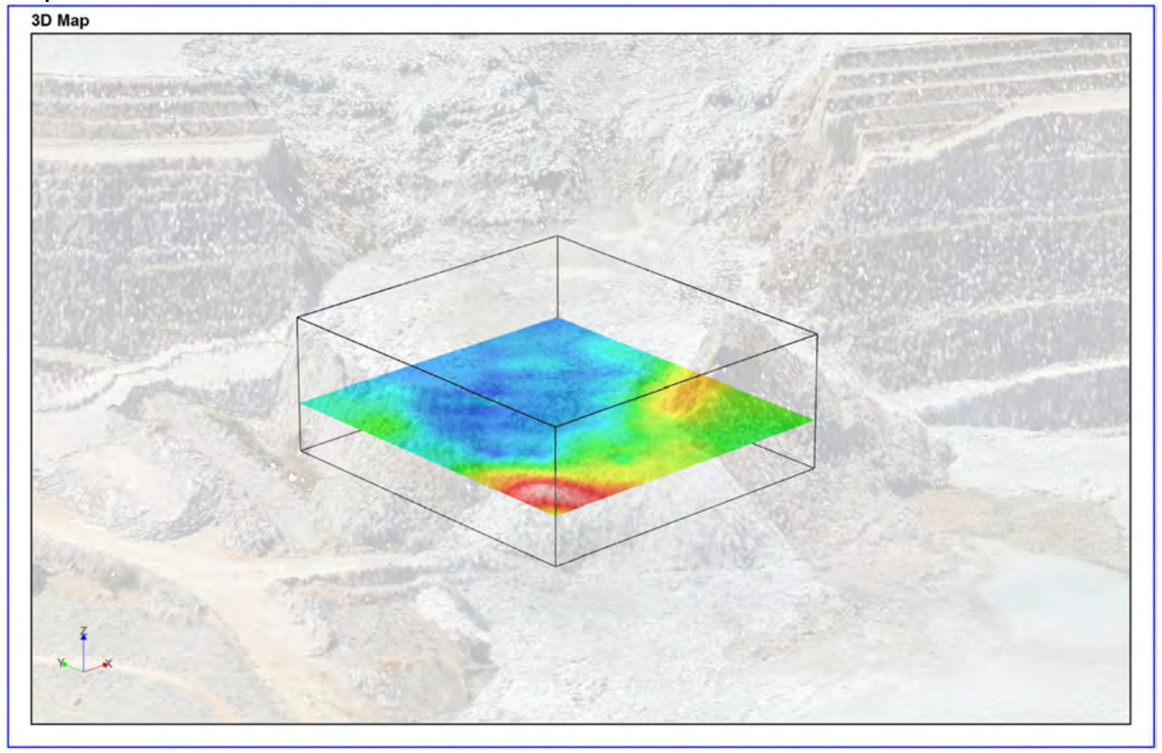




Depth Slice - Elevation 684 m



Depth Slice - Elevation 688 m

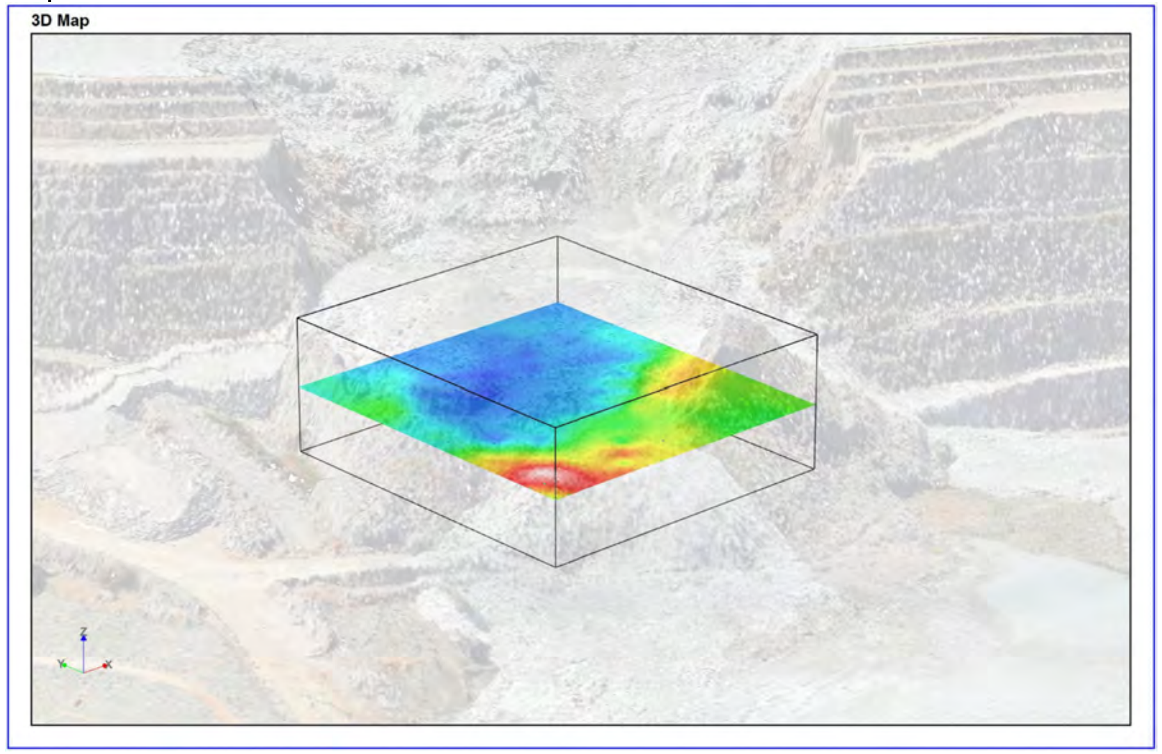


Client: Newcrest Mining Limited	*Projection: Tranverse Mercator* *Horizontal Datum: GDA 94* *Grid: MGA Zone 55S*	Job No.: 32/18788
Geophysical Investigation NTSF		Ref file: N:/AU/Hobart/Projects/32/18788/Technical/Geophysics/Figures/
Cadia Valley Operations		Cadia Valley Operations 3D ERI Depth Slices
ERI Survey	Produced by: M. Anderson	
scale: as shown; Date 03/9/2018		N:/AU/Hobart/Projects/32/18788/Technical/Geophysics/Figures/ — Figure C2

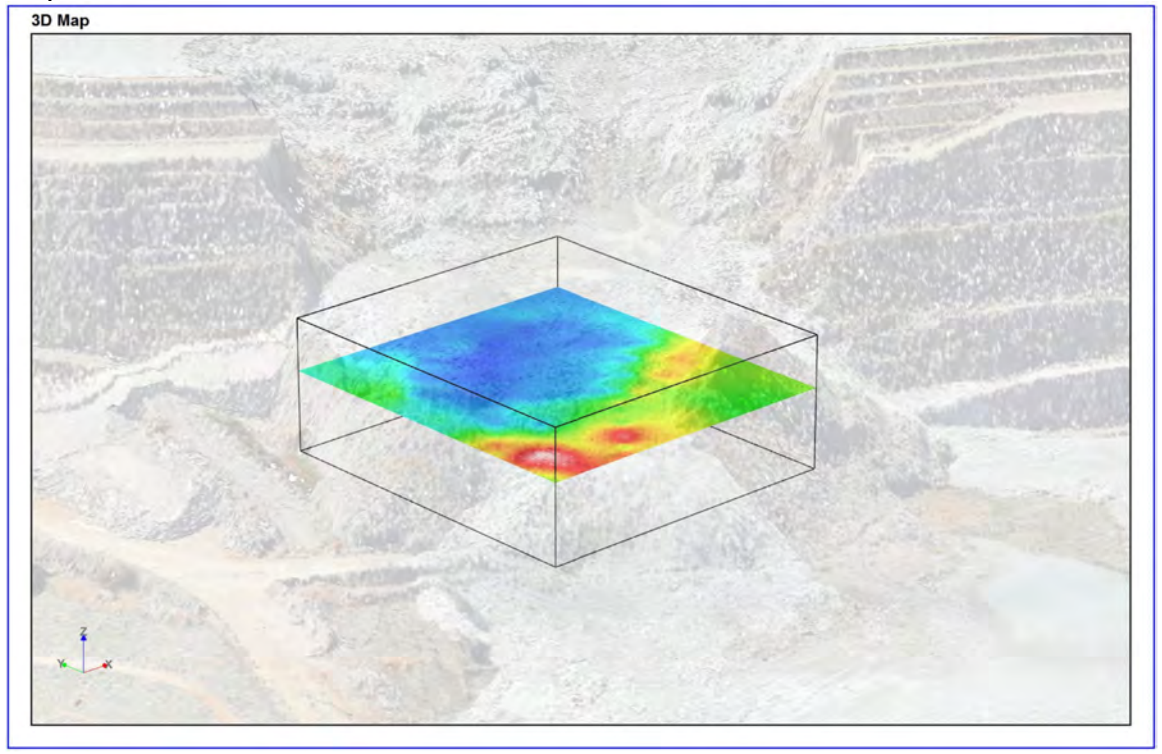
2 Salamanca Square, Hobart TAS 7000 T 61 3 6210 0600 F 61 3 6210 0601 W www.ghd.com

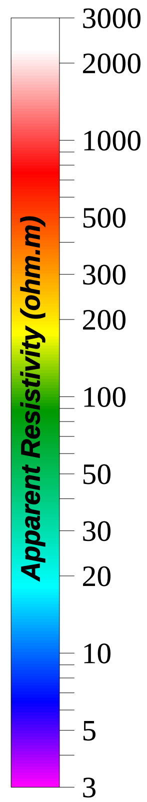
Cadia Valley Operations
NTSF Failure
ERI 3D Depth Slices

Depth Slice - Elevation 692 m

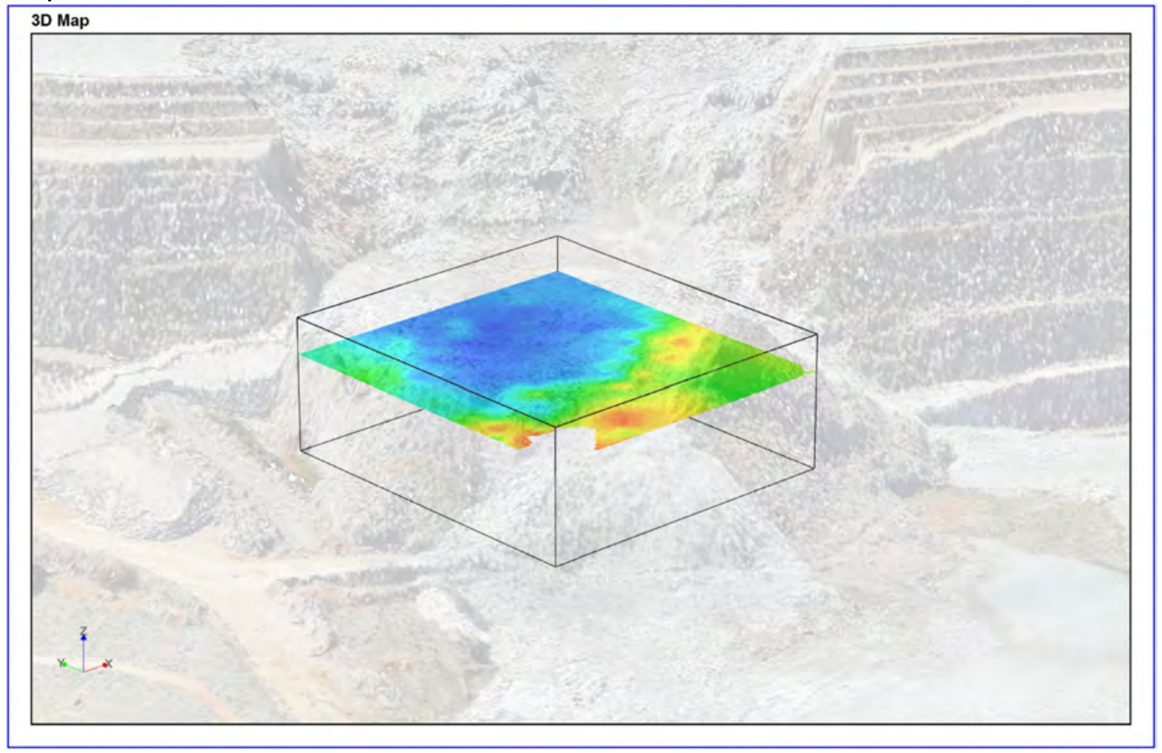


Depth Slice - Elevation 696 m

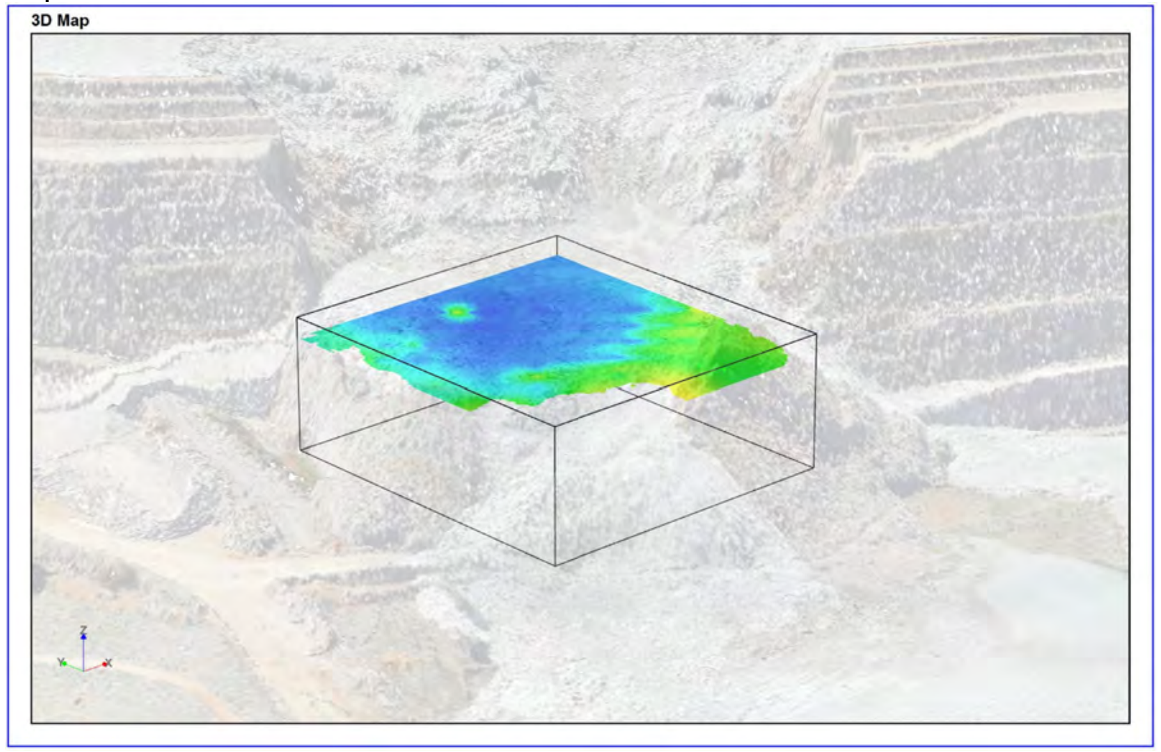




Depth Slice - Elevation 700 m



Depth Slice - Elevation 704 m



Client: Newcrest Mining Limited		
Geophysical Investigation NTSF		
Cadia Valley Operations		
ERI Survey		
scale	as shown	Date 03/9/2018

Projection: Tranverse Mercator
Horizontal Datum: GDA 94
Grid: MGA Zone 55S

Produced by:
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Job No.: 32/18788 ©
Ref file: N:/AU/Hobart/Projects/32/18788/Technical/Geophysics/Figures/

Cadia Valley Operations
3D ERI Depth Slices

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Figure C3

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3218788-41184/G:\32\18788\Tech\Geophysics\3218788_REP-A_Geophysical Investigation_Failure_Zone_RevA.docx

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
RevA	M Anderson	H Tassell		R Longey	On file	31/10/2018

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Annexure CF
Relevant GHD Drillhole Logs

CORE LOG SHEET

Client :	Newcrest
Project :	Cadia STSF Geotechnical Investigation
Location :	Cadia - CE398

LOCATION No. CE398

SHEET 1 OF 3

Position : 16234.0 E, 16857.0 N MD	Surface RL : 5671.0m	Inclination\Bearing : -90 \ 0	Processed : MR
Contractor : Deepcore	Rig Type : McCullochs		Checked :
Date Started :	Date Completed :	Logged by : MR	Date :

DRILLING: Run	MATERIAL: RL (m)	Depth (m)	Description (ROCK TYPE, colour, grain size, structure)	Weathering	Estimated Strength	RQD (%)
1		0.0	FILL: GRAVEL, brown grey, fine to coarse, angular to subangular volcanic clasts up to 160mm			0
			FILL: Gravelly CLAY, brown orange, sub angular clasts up to 70mm			0
	5670.0	1.0				0
2	5669.0	2.0	MUDSTONE, light orange grey	HW		0
						0
3	5668.0	3.0	MUDSTONE, light orange grey	HW		0
	5667.0	4.0				
4			ANDESITE, orange	XW	VL	0
5	5666.0	5.0				
6	5665.0	6.0			L	0
7	5664.0	7.0				
8	5663.0	8.0				
9	5662.0	9.0				
	5661.0	10.0				

Column headings: SCALE (m), Method, Run, Water, RL (m), Depth (m), Graphic Log, Description, Weathering, Estimated Strength, Core Recovery (%) (20, 80), RQD (%), Defect Spacing (mm) (20, 40, 100, 300, 1000), Samples & Tests. ADDITIONAL DATA: Joints, partings, seams, zones and veins; Fracture type, orientation, infilling or coating, shape, roughness, other; Insitu test results.

GHD Pty Ltd
2 Salamanca Square Hobart TAS 7001, Hobart
T: 61 3 62100 600 F: 61 3 62100601
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Job No. 3218788

Client : Newcrest			**LOCATION No. CE398**
Project : Cadia STSF Geotechnical Investigation			
Location : Cadia - CE398			SHEET 2 OF 3
Position : 16234.0 E, 16857.0 N MD	Surface RL : 5671.0m	Inclination\Bearing : -90 \ 0	Processed : MR
Contractor : Deepcore	Rig Type : McCullochs		Checked :
Date Started :	Date Completed :	Logged by : MR	Date :

SCALE (m)	Method	Run	Water	RL (m)	Depth (m)	Graphic Log	Description: ROCK TYPE, colour, grain size, structure	Weathering	Estimated Strength	Core Recovery (%)	RQD (%)	Defect Spacing (mm)	Samples & Tests	Joints, partings, seams, zones and veins; Fracture type, orientation, infilling or coating, shape, roughness, other; Insitu test results	SCALE (m)
		9													
11				5660.0	11.0										11
		10													
12				5659.0	12.0										12
13				5658.0	13.0										13
		11													
14				5657.0	14.0		fine to medium grained, orange brown, brown black phenocrysts 1-3mm, slightly fractured FE healed joints	HW	L		74				14
15				5656.0	15.0										15
16				5655.0	16.0										16
		12													
17				5654.0	17.0										17
							CORE LOSS (200mm)								
18				5653.0	18.0		ANDESITE, fine to medium grained, brown orange, brown black phenocrysts 1-3mm, moderateraly fractured FE healed joints	HW	M		7				18
		13													
19				5652.0	19.0										19
							CORE LOSS (200mm)								
		14					ANDESITE, fine to medium grained, brown orange, brown black phenocrysts 1-3mm, highly fractured	HW	M		0				
20				5651.0	20.0										20

See standard sheets for details of abbreviations & basis of descriptions

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Job No. 3218788

CORE LOG SHEET

Client : Newcrest			**LOCATION No. CE398**
Project : Cadia STSF Geotechnical Investigation			
Location : Cadia - CE398			SHEET 3 OF 3
Position : 16234.0 E, 16857.0 N MD	Surface RL : 5671.0m	Inclination\Bearing : -90 \ 0	Processed : MR
Contractor : Deepcore	Rig Type : McCullochs		Checked :
Date Started :	Date Completed :	Logged by : MR	Date :

DRILLING | MATERIAL | ADDITIONAL DATA

SCALE (m)	Method	Run	Water	RL (m)	Depth (m)	Description (ROCK TYPE, colour, grain size, structure)	Weathering	Estimated Strength	Core Recovery (%)	RQD (%)	Defect Spacing (mm)	Samples & Tests	Joints, partings, seams, zones and veins; Fracture type, orientation, infilling or coating, shape, roughness, other; Insitu test results
		14				FE healed joints							
21				5650.0	21.0	CORE LOSS (200mm)							
		15				ANDESITE, fine to medium grained, brown orange, brown black phenocrysts 1-3mm, highly fractured FE healed joints	HW	M		0			
22				5649.0	22.0								
		16					MW	H		0			
23				5648.0	23.0								
		17				qtz chlorite ca veining.	SW	VH		100			
24				5647.0	24.0								
25				5646.0	25.0								
26				5645.0	26.0								
27				5644.0	27.0								
28				5643.0	28.0								
29				5642.0	29.0								
30				5641.0	30.0								

Prepared By	Date	Job Number		Title	Client
JRN	24-May-18	32\18788	A4	Borehole Photographic Log	Newcrest
Revision	Date	Cad Reference		CE398	Project: Cadia Mine NTSF Geotechnical Investigation
A	24-May-18			0.00 - 12.10m	Figure No: Appendix B

This drawing should be read in conjunction with report number 61\xxxxx\yyy

Prepared By	Date	Job Number		Title	Client
JRN	24-May-18	32\18788	A4	Borehole Photographic Log	Newcrest
Revision	Date	Cad Reference		CE398	Project: Cadia Mine NTSF Geotechnical Investigation
A	24-May-18			12.10 - 22.10m	Figure No: Appendix B

This drawing should be read in conjunction with report number 61\xxxxx\yyy

Prepared By	Date	Job Number		Title	Client
JRN	24-May-18	32\18788	A4	Borehole Photographic Log	Newcrest
Revision	Date	Cad Reference		CE398	Project: Cadia Mine NTSF Geotechnical Investigation
A	24-May-18			22.10 - 26.40m	Figure No: Appendix B

This drawing should be read in conjunction with report number 61\xxxxx\yyy

CORE LOG SHEET

Client : Newcrest			**LOCATION No. CE399**
Project : Cadia STSF Geotechnical Investigation			
Location : Cadia - CE399			SHEET 1 OF 4
Position : , MD	Surface RL :	Inclination\Bearing : -90 \ 0	Processed : JRN
Contractor : Deepcore	Rig Type : McCullochs		Checked :
Date Started :	Date Completed :	Logged by : MR	Date :

DRILLING | MATERIAL | ADDITIONAL DATA

Method	Run	Depth (m)	Description (ROCK TYPE, colour, grain size, structure)	Weathering	Estimated Strength	RQD (%)	Samples & Tests	Joints, partings, seams, zones and veins / Fracture type, orientation, infilling or coating, shape, roughness, other / Insitu test results
PQ Coring	1	0.0	CLAY, trace gravel, orange-brown, gravel fragments are XW/HW siltstone , W<PL		VSt			
		1.0					PP	PP @ 1.0m = > 600 kPa (UCS)
							C	PP @ 1.24m = 158 kPa (UCS)
							PP	PP @ 1.6m = > 600 kPa (UCS)
		1.7	Gravelly CLAY, orange, light brown, gravel fragments are low-medium strength siltstone, W<PL		VSt		PP	PP @ 1.7m = 500 kPa (UCS)
	2	2.2	CORE LOSS (100mm)					
		2.3	BASALT, light orang-brown, fine grained, highly fractured, FE healed defects	HW	M	0		
	3	3.6	CORE LOSS (200mm)					3.55m: CS, 80°, UN, ROCK FRAGMENTS, RF, 150mm
	4	3.8	BASALT, brown-grey	HW	M	0	PP	PP @ 4.25m = 520 kPa (UCS) 4.25m: SM, CLAY, 100mm
	5, 6, 7	5.8	less FE staining	MW	H	4		
	8							7.05m: SM, CLAY, 50mm
	9	8.3	increasing FE staining	SW		37		

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GEO CORE LOG SHEET 3218788.GPJ GHD_GEO_TEMPLATE_TASMANIA.GDT 29/6/18

CORE LOG SHEET

Client : Newcrest		**LOCATION No. CE399**
Project : Cadia STSF Geotechnical Investigation		
Location : Cadia - CE399		**SHEET 2 OF 4**
Position : , MD	**Surface RL :**	**Inclination\Bearing : -90 \ 0**	**Processed : JRN**
Contractor : Deepcore	**Rig Type : McCullochs**		**Checked :**
Date Started :	**Date Completed :**	**Logged by : MR**	**Date :**

DRILLING				MATERIAL									ADDITIONAL DATA	
SCALE (m)	Method	Run	Water	RL (m)	Depth (m)	Graphic Log	**Description** ROCK TYPE, colour, grain size, structure	Weathering	Estimated Strength	Core Recovery (%) 20 80	RQD (%)	Defect Spacing (mm) 20 40 100 300 1000	Samples & Tests	Joints, partings, seams, zones and veins Fracture type, orientation, infilling or coating, shape, roughness, other Insitu test results	SCALE (m)
	PQ Coring	10													
11		11			11.0										11
12					12.0										12
13		12			13.0										13
		13						MW			26				
14		14			14.0										14
15		15			15.0										15
16		16			16.0									16.2m: SZ, ROCK FRAGMENTS, 200mm	16
17		17			17.0										17
18		18			18.0		CLAY, light cream, brown, grey		H		0		C	C63 (18.3 - 18.7m)	18
													C PP	C63 (18.7 - 18.9m) PP @ 18.8m = REFUSAL	
19		19			19.0		light cream, brown-orange		VSt				C PP	C63 (18.9 - 19.2m) PP @ 18.95 = 240 kPa (UCS)	19
													PP	PP @ 19.25 = 280 kPa (UCS)	
		20					ANDESITE	HW	L		38				
20					20.0										20

CORE LOG SHEET

Client :	Newcrest
Project :	Cadia STSF Geotechnical Investigation
Location :	Cadia - CE399

LOCATION No. CE399

SHEET 3 OF 4

Position : , MD	Surface RL :	Inclination\Bearing : -90 \ 0	Processed : JRN
Contractor : Deepcore	Rig Type : McCullochs		Checked :
Date Started :	Date Completed :	Logged by : MR	Date :

DRILLING				MATERIAL										ADDITIONAL DATA	
SCALE (m)	Method	Run	Water	RL (m)	Depth (m)	Graphic Log	Description ROCK TYPE, colour, grain size, structure	Weathering	Estimated Strength	Core Recovery (%) 20 80	RQD (%)	Defect Spacing (mm) 20 40 100 300 1000	Samples & Tests	Joints, partings, seams, zones and veins Fracture type, orientation, infilling or coating, shape, roughness, other Insitu test results	SCALE (m)
	PQ Coring	20													
21		21			21.0										21
22					22.0										22
23		22			23.0										23
							highly fractured				0				
24					24.0										24
25					25.0										25
26					26.0										26
							CORE LOSS (200mm)				0				
		23					ANDESITE, grey-brown, feldspar phenocrysts 1-3mm	HW	L		37				
									VL		0				
27					27.0										27
28					28.0				L		100				28
29		24			29.0										29
							pyroxene phenocrysts 1-5mm	MW	M		21				
30					30.0										30

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CORE LOG SHEET

Client :	Newcrest
Project :	Cadia STSF Geotechnical Investigation
Location :	Cadia - CE399

LOCATION No. CE399

Position : , MD	Surface RL :	Inclination\Bearing : -90 \ 0	Processed : JRN
Contractor : Deepcore	Rig Type : McCullochs		Checked :
Date Started :	Date Completed :	Logged by : MR	Date :

DRILLING				MATERIAL									ADDITIONAL DATA	
SCALE (m)	Method	Run	Water	RL (m)	Depth (m)	Graphic Log	Description ROCK TYPE, colour, grain size, structure	Weathering	Estimated Strength	Core Recovery (%) 20 80	RQD (%)	Defect Spacing (mm) 20 40 100 300 1000	Samples & Tests	Joints, partings, seams, zones and veins Fracture type, orientation, infilling or coating, shape, roughness, other Insitu test results	SCALE (m)
							End of Hole (30.1m)								
31					31.0										31
32					32.0										32
33					33.0										33
34					34.0										34
35					35.0										35
36					36.0										36
37					37.0										37
38					38.0										38
39					39.0										39
40					40.0										40

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Job No.
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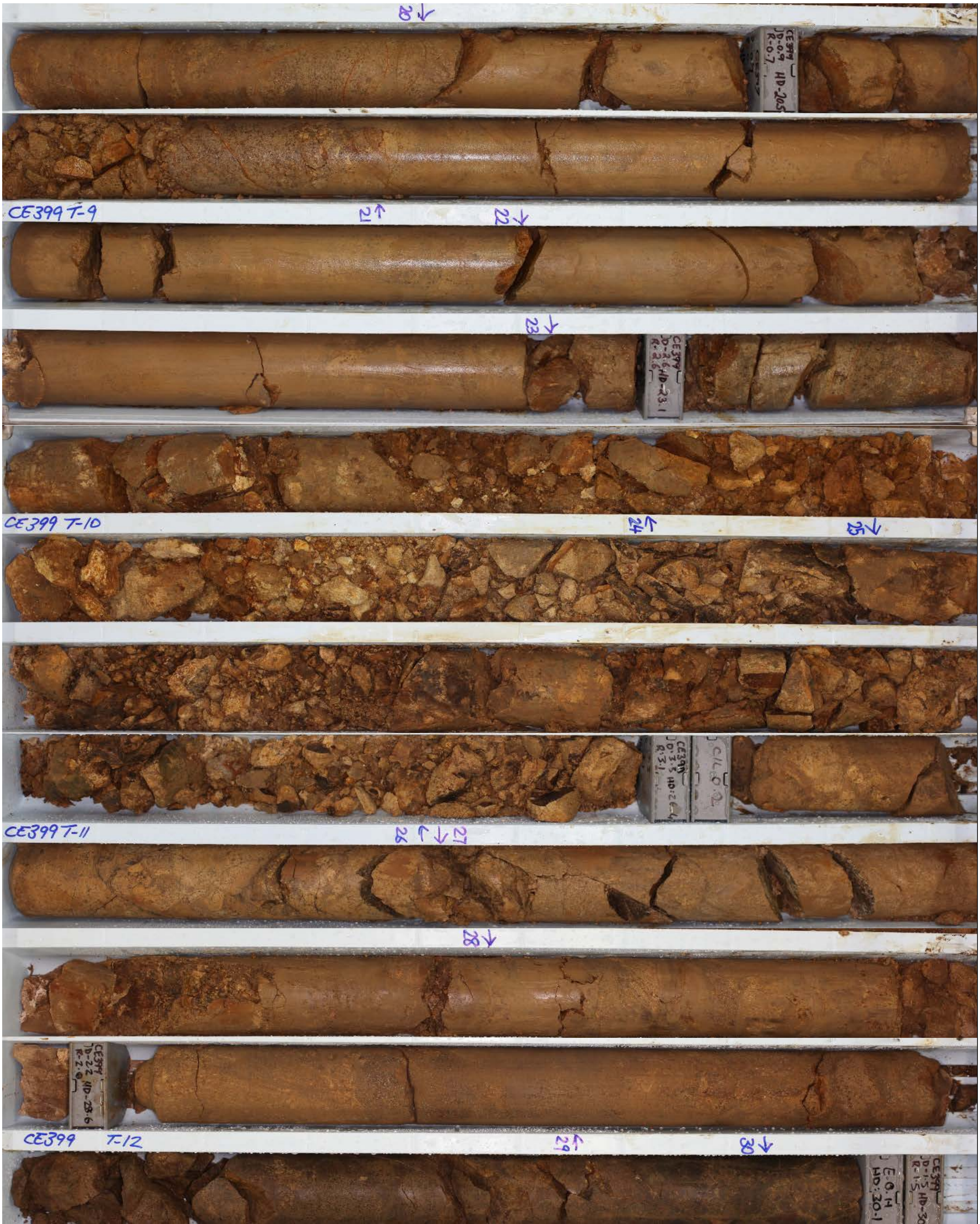
Prepared By	Date	Job Number		Title	Client
JRN	15-Jun-18	32\18788	A4	Borehole Photographic Log	Newcrest
Revision	Date	Cad Reference		CE399	Project: Cadia Mine NTSF Geotechnical Investigation
A	15-Jun-18			0.00 - 10.20m	Figure No: Appendix B

This drawing should be read in conjunction with report number 61\xxxxx\yyy

Prepared By	Date	Job Number		Title	Client
JRN	15-Jun-18	32\18788	A4	Borehole Photographic Log	Newcrest
Revision	Date	Cad Reference		CE399	Project: Cadia Mine NTSF Geotechnical Investigation
A	15-Jun-18			10.20 - 19.60m	Figure No: Appendix B

This drawing should be read in conjunction with report number 61\xxxxx\yyy



Prepared By	Date	Job Number		Title	Client
JRN	15-Jun-18	32\18788	A4	Borehole Photographic Log	Newcrest
Revision	Date	Cad Reference		CE399	Project: Cadia Mine NTSF Geotechnical Investigation
A	15-Jun-18			19.60 - 30.10m	Figure No: Appendix B

This drawing should be read in conjunction with report number 61\xxxxx\yyy

CORE LOG SHEET

Client : Newcrest		LOCATION No. CE400
Project : Cadia STSF Geotechnical Investigation		
Location : Cadia - CE400		SHEET 1 OF 4
Position : 16283.0 E, 16646.0 N MD	Surface RL : 5682.0m	Inclination\Bearing : -90 \ 0
Processed : JRN		
Contractor : Deepcore	Rig Type : McCullochs	Checked :
Date Started :	Date Completed :	Logged by : MR
Date :		

DRILLING | MATERIAL | ADDITIONAL DATA

Method	Run	RL (m)	Depth (m)	Description (ROCK TYPE, colour, grain size, structure)	Weathering	Estimated Strength	RQD (%)	Joints, partings, seams, zones and veins / Fracture type, orientation, infilling or coating, shape, roughness, other / Insitu test results
PQ CORE	1			FILL: GRAVEL, fine grained, sub angular volcanic clasts, H-VH strength				
PQ CORE	2	5681.0	1.0	CORE LOSS (500mm)				
PQ CORE	3			FILL: GRAVEL, fine grained, sub angular volcanic clasts, H-VH strength				
				CORE LOSS (100mm)				
PQ CORE	4	5680.0	2.0	BASALT, light cream, grey-brown, highly fractured	MW	H	0	
		5679.0	3.0				13	
PQ CORE	5	5678.0	4.0					
PQ CORE	6	5677.0	5.0				0	
		5676.0	6.0					5.9m: possible shear
PQ CORE	7				SW		13	
PQ CORE	8	5675.0	7.0					
PQ CORE	9			MUDSTONE, light grey, small vesicles	SW	L	0	
		5674.0	8.0	CORE LOSS (600mm)				
				Sandy CLAY (CL), grey-purple, sand is fine grained		St		
PQ CORE	10	5673.0	9.0	CLAY (CL), light purple-grey				Note: soil strengths interpreted as drilling was completed 2 weeks prior to logging
		5672.0	10.0	changing to light orange-grey				

Core Recovery (%) scale: 20 – 80. Defect Spacing (mm) scale: 20, 40, 100, 300, 1000.

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CORE LOG SHEET

Client :	Newcrest
Project :	Cadia STSF Geotechnical Investigation
Location :	Cadia - CE400

LOCATION No. CE400

Position : 16283.0 E, 16646.0 N MD	Surface RL : 5682.0m	Inclination\Bearing : -90 \ 0	Processed : JRN
Contractor : Deepcore	Rig Type : McCullochs		Checked :
Date Started :	Date Completed :	Logged by : MR	Date :

DRILLING | MATERIAL | ADDITIONAL DATA

Columns: SCALE (m) | Method | Run | Water | RL (m) | Depth (m) | Graphic Log | Description (ROCK TYPE, colour, grain size, structure) | Weathering | Estimated Strength | Core Recovery (%) (20–80) | RQD (%) | Defect Spacing (mm) (20, 40, 100, 300, 1000) | Samples & Tests | Joints, partings, seams, zones and veins; Fracture type, orientation, infilling or coating, shape, roughness, other; Insitu test results | SCALE (m)

Method	Run	RL (m)	Depth (m)	Description	Weathering	Estimated Strength	RQD (%)
PQ CORE	10	5671.0	11.0	changing to light grey-orange			
				Clayey GRAVEL (GC), white, black, cream, rounded to subrounded, volcanic clasts, matrix supported			
				CLAY (CL), red, cream-orange, relic bedding fabric (XW volcanics)			
		5670.0	12.0	CORE LOSS (200mm)			
PQ CORE	11			Silty CLAY (CL), spotted white, purple (XW andesite)			
				white colour changing to orange		F	
				changing to purple-brown		VSt	
		5669.0	13.0	changing to orange-brown		F	
						St	
		5668.0	14.0				
PQ CORE	12	5667.0	15.0				
		5666.0	16.0				
		5665.0	17.0				
PQ CORE	13	5664.0	18.0	ANDESITE, orange-brown	HW	VL	0
		5663.0	19.0				
		5662.0	20.0				

See standard sheets for details of abbreviations & basis of descriptions

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CORE LOG SHEET

Client :	Newcrest	**LOCATION No. CE400**
Project :	Cadia STSF Geotechnical Investigation	
Location :	Cadia - CE400	SHEET 3 OF 4

Position : 16283.0 E, 16646.0 N MD	Surface RL : 5682.0m	Inclination\Bearing : -90 \ 0	Processed : JRN
Contractor : Deepcore	Rig Type : McCullochs		Checked :
Date Started :	Date Completed :	Logged by : MR	Date :

SCALE (m)	Method	Run	Water	RL (m)	Depth (m)	Description (ROCK TYPE, colour, grain size, structure)	Weathering	Estimated Strength	Core Recovery (%)	RQD (%)	Additional Data (Joints, partings, seams, zones and veins; Fracture type, orientation, infilling or coating, shape, roughness, other; Insitu test results)
	PQ CORE	13									
21	PQ CORE	14		5661.0	21.0						
22				5660.0	22.0						
23				5659.0	23.0						
						CORE LOSS (200mm)					
	PQ CORE	15				ANDESITE, purple-grey, feldspar phenocrysts 1-3mm	MW	H		39	
24				5658.0	24.0						23.95m: CS, ROCK FRAGMENTS, 20mm
											24.75m: CS, ROCK FRAGMENTS, 250mm
25				5657.0	25.0						
	PQ CORE	16						VH		80	
26				5656.0	26.0						
	PQ CORE	17				changing to brown, some purple staining					
27				5655.0	27.0						
	PQ CORE	18									
28				5654.0	28.0						
	PQ CORE	19				vughy texture				96	
29				5653.0	29.0						28.9m: small cavity in rock
30				5652.0	30.0						

Graphic Log; Defect Spacing (mm): 20, 40, 100, 300, 1000; Samples & Tests

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CORE LOG SHEET

Client :	Newcrest
Project :	Cadia STSF Geotechnical Investigation
Location :	Cadia - CE400

LOCATION No. CE400

SHEET 4 OF 4

Position : 16283.0 E, 16646.0 N MD	Surface RL : 5682.0m	Inclination\Bearing : -90 \ 0	Processed : JRN
Contractor : Deepcore	Rig Type : McCullochs		Checked :
Date Started :	Date Completed :	Logged by : MR	Date :

DRILLING				MATERIAL									ADDITIONAL DATA	
SCALE (m)	Method	Run	Water	RL (m)	Depth (m)	Graphic Log	Description ROCK TYPE, colour, grain size, structure	Weathering	Estimated Strength	Core Recovery (%) 20 80	RQD (%)	Defect Spacing (mm) 20 40 100 300 1000	Samples & Tests	Joints, partings, seams, zones and veins Fracture type, orientation, infilling or coating, shape, roughness, other Insitu test results	SCALE (m)
							End of Hole (30.1m)								
31				5651.0	31.0										31
32				5650.0	32.0										32
33				5649.0	33.0										33
34				5648.0	34.0										34
35				5647.0	35.0										35
36				5646.0	36.0										36
37				5645.0	37.0										37
38				5644.0	38.0										38
39				5643.0	39.0										39
40				5642.0	40.0										40

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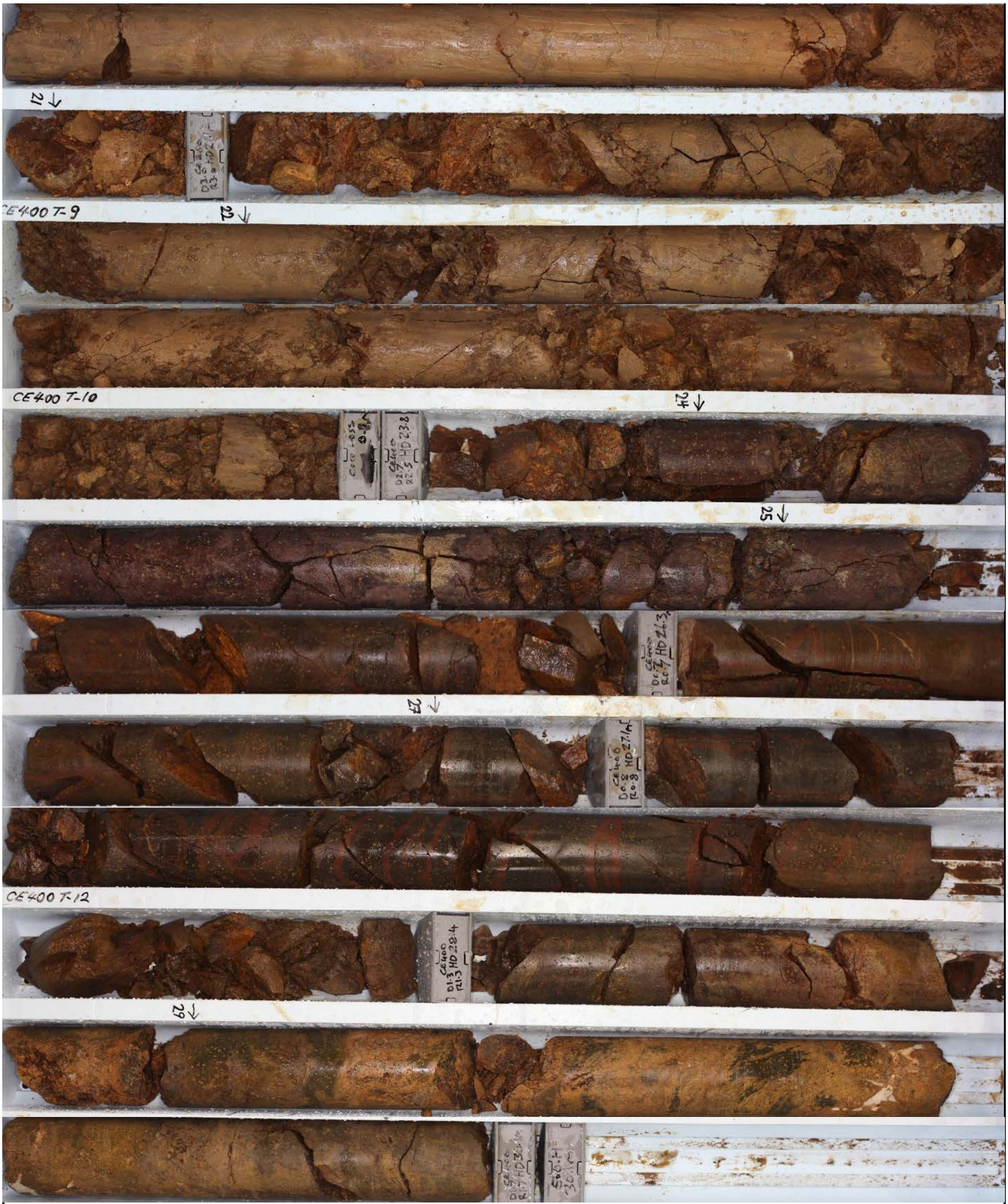
Prepared By	Date	Job Number		Title	Client
JRN	15-Jun-18	32\18788	A4	Borehole Photographic Log	Newcrest
Revision	Date	Cad Reference		CE400	Project: Cadia Mine NTSF Geotechnical Investigation
A	15-Jun-18			0.00 - 10.40m	Figure No: Appendix B

This drawing should be read in conjunction with report number 61\xxxxx\yyy

Prepared By	Date	Job Number		Title	Client
JRN	15-Jun-18	32\18788	A4	Borehole Photographic Log	Newcrest
Revision	Date	Cad Reference		CE400	Project: Cadia Mine NTSF Geotechnical Investigation
A	15-Jun-18			10.40 - 20.10m	Figure No: Appendix B

This drawing should be read in conjunction with report number 61\xxxxx\yyy



Prepared By	Date	Job Number		Title	Client
JRN	15-Jun-18	32\18788	A4	Borehole Photographic Log CE400	Newcrest
Revision	Date	Cad Reference			Project
A	15-Jun-18				Cadia Mine NTSF Geotechnical Investigation
This drawing should be read in conjunction with report number 61\xxxxx\yyy					Figure No Appendix B

CORE LOG SHEET

Client : Newcrest			**LOCATION No. CE401**
Project : Cadia STSF Geotechnical Investigation			
Location : Cadia - CE401			SHEET 1 OF 4
Position : 16301.0 E, 16529.0 N MD	Surface RL : 5682.0m	Inclination\Bearing : -90 \ 0	Processed : JRN
Contractor : Deepcore	Rig Type : McCullochs		Checked :
Date Started :	Date Completed :	Logged by : MR	Date :

DRILLING				MATERIAL									ADDITIONAL DATA	
SCALE (m)	Method	Run	Water	RL (m) / Depth (m)	Graphic Log	Description: ROCK TYPE, colour, grain size, structure	Weathering	Estimated Strength	Core Recovery (%) 20 80	RQD (%)	Defect Spacing (mm) 20 40 100 300 1000	Samples & Tests	Joints, partings, seams, zones and veins; Fracture type, orientation, infilling or coating, shape, roughness, other; Insitu test results	SCALE (m)
		1				FILL: GRAVEL, light grey, fine to coarse, subangular to angular volcanic fragments up to 100mm				0				
						CORE LOSS (300mm)				0				
1		2		5681.0 1.0		FILL: GRAVEL, grey brown, fine to coarse, sub angular to angular volcanic fragments up to 90mm				0				1
2				5680.0 2.0		CORE LOSS (1200mm)				0				2
3		3		5679.0 3.0		BASALT, grey brown, moderately fractured, healed joints	MW	H		19				3
4		4		5678.0 4.0										4
5				5677.0 5.0										5
6				5676.0 6.0		CORE LOSS (200mm)				0				6
		5				CLAY (CL) with gravel, light brown grey, volcanic clasts up to 20mm (residual)		ST		0				
7				5675.0 7.0		mottled cream orange in colour		ST		0				7
8				5674.0 8.0										8
9				5673.0 9.0		CORE LOSS (400mm)				0				9
		6				CLAY (CL), mottled cream orange (residual)		ST		0				
10				5672.0 10.0										10

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CORE LOG SHEET

Client : Newcrest	**LOCATION No. CE401**
Project : Cadia STSF Geotechnical Investigation	
Location : Cadia - CE401	SHEET 2 OF 4
Position : 16301.0 E, 16529.0 N MD	Surface RL : 5682.0m	Inclination\Bearing : -90 \ 0	Processed : JRN
Contractor : Deepcore	Rig Type : McCullochs		Checked :
Date Started :	Date Completed :	Logged by : MR	Date :

SCALE (m)	Method	Run	Water	RL (m)	Depth (m)	Graphic Log	Description (ROCK TYPE, colour, grain size, structure)	Weathering	Estimated Strength	Core Recovery (%)	RQD (%)	Defect Spacing (mm)	Samples & Tests	Joints, partings, seams, zones and veins / Fracture type, orientation, infilling or coating, shape, roughness, other / Insitu test results	SCALE (m)
11		6		5671.0	11.0										11
12				5670.0	12.0										12
							CORE LOSS (300mm)				0				
		7					CLAY (CL), mottled cream brown orange (residual)		VST		0				
13				5669.0	13.0										13
14				5668.0	14.0										14
15				5667.0	15.0										15
16		8		5666.0	16.0										16
17				5665.0	17.0										17
18				5664.0	18.0										18
19		9		5663.0	19.0										19
20				5662.0	20.0										20

CORE LOG SHEET

Client : Newcrest		**LOCATION No. CE401**
Project : Cadia STSF Geotechnical Investigation		
Location : Cadia - CE401		SHEET 3 OF 4
Position : 16301.0 E, 16529.0 N MD	Surface RL : 5682.0m	Inclination\Bearing : -90 \ 0	Processed : JRN
Contractor : Deepcore	Rig Type : McCullochs		Checked :
Date Started :	Date Completed :	Logged by : MR	Date :

SCALE (m)	Run	RL (m)	Depth (m)	Description (ROCK TYPE, colour, grain size, structure)	Weathering	Estimated Strength	RQD (%)	Joints, partings, seams, zones and veins / Fracture type, orientation, infilling or coating, shape, roughness, other / Insitu test results
	9	5661.0	21.0					
21								
	10	5660.0	22.0					
22								
23		5659.0	23.0					
24		5658.0	24.0	ANDESITE, brown orange	XW	VL	36	
25	11	5657.0	25.0					
26		5656.0	26.0	CORE LOSS (1100mm)			0	
27		5655.0	27.0	ANDESITE, brown orange	XW	VL	0	
	12			brown orange in colour	HW	M	88	
28		5654.0	28.0	mottled cream brown orange in colour, vughy texture	HW	M	18	
29		5653.0	29.0	brown orange in colour	MW	M	0	
				brown in colour	MW	M	0	
30		5652.0	30.0	CORE LOSS (700mm)			0	

See standard sheets for details of abbreviations & basis of descriptions

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Job No. 3218788

CORE LOG SHEET

Client : Newcrest			**LOCATION No. CE401**
Project : Cadia STSF Geotechnical Investigation			
Location : Cadia - CE401			SHEET 4 OF 4
Position : 16301.0 E, 16529.0 N MD	Surface RL : 5682.0m	Inclination\Bearing : -90 \ 0	Processed : JRN
Contractor : Deepcore	Rig Type : McCullochs		Checked :
Date Started :	Date Completed :	Logged by : MR	Date :

SCALE (m)	Method	Run	Water	RL (m)	Depth (m)	Description (ROCK TYPE, colour, grain size, structure)	Weathering	Estimated Strength	Core Recovery (%)	RQD (%)	Defect Spacing (mm)	Samples & Tests	Additional Data (Joints, partings, seams, zones and veins; Fracture type, orientation, infilling or coating, shape, roughness, other; Insitu test results)	SCALE (m)
		12												
		13				ANDESITE, brown	MW	H		0				
31				5651.0	31.0									31
32				5650.0	32.0									32
						End of Hole (32.1m)								
33				5649.0	33.0									33
34				5648.0	34.0									34
35				5647.0	35.0									35
36				5646.0	36.0									36
37				5645.0	37.0									37
38				5644.0	38.0									38
39				5643.0	39.0									39
40				5642.0	40.0									40

Core Recovery (%) scale: 20, 80. Defect Spacing (mm) scale: 20, 40, 100, 300, 1000.

Prepared By	Date	Job Number		Title	Client
JRN	15-Jun-18	32\18788	A4	Borehole Photographic Log	Newcrest
				CE401	Project
Revision	Date	Cad Reference		0.00 - 12.70m	Cadia Mine NTSF Geotechnical Investigation
A	15-Jun-18				Figure No
This drawing should be read in conjunction with report number 61\xxxxx\yyy					Appendix B

Prepared By	Date	Job Number		Title	Client
JRN	15-Jun-18	32\18788	A4	Borehole Photographic Log	Newcrest
Revision	Date	Cad Reference		CE401	Project: Cadia Mine NTSF Geotechnical Investigation
A	15-Jun-18			12.70 - 22.40m	Figure No: Appendix B

This drawing should be read in conjunction with report number 61\xxxxx\yyy

Prepared By	Date	Job Number		Title	Client
JRN	15-Jun-18	32\18788	A4	Borehole Photographic Log	Newcrest
Revision	Date	Cad Reference		CE401	Project
A	15-Jun-18			22.40 - 32.10m	Cadia Mine NTSF Geotechnical Investigation
This drawing should be read in conjunction with report number 61\xxxxx\yyy					Figure No: Appendix B

SOIL LOG SHEET

Client :	Newcrest
Project :	Cadia STSF Geotechnical Investigation
Location :	Cadia - CE403

LOCATION No. CE403

SHEET 1 OF 2

Position : 17222.0 E, 17250.0 N MD	Surface RL : 5688.0m	Inclination\Bearing : -90 \ 0	Processed : JRN
Contractor : Groundwave	Rig Type : Boart Longyear LS250		Checked :
Date Started : 26 May 18	Date Completed : 27 May 18	Logged by : MR	Date :

SCALE (m)	Method	Hole Support	Run	Water	RL (m)	Depth (m)	Graphic Log	Description Soil Name (USC Symbol) Other Minor Components, Plasticity or Particle Characteristics, Colour, Moisture Condition, Consistency, Structure	Group Symbol	Moisture Condition	Consistency / Relative Density	Samples & Tests	Comments/Observations Insitu test results	SCALE (m)
								FILL: GRAVEL, grey, fine to coarse, cobbles, volcanic clasts						
1					5687.0	1.0								1
2					5686.0	2.0								2
3					5685.0	3.0								3
4					5684.0	4.0								4
5	Sonic	HWT			5683.0	5.0								5
6					5682.0	6.0								6
7					5681.0	7.0								7
8					5680.0	8.0								8
9					5679.0	9.0						U63	U63 (9.0m) refusal	9
10					5678.0	10.0								10

See standard sheets for details of abbreviations & basis of descriptions

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GEO SOIL BOREHOLE LOG SHEET 3218788.GPJ GHD_GEO_TEMPLATE_TASMANIA.GDT 14/6/18

SOIL LOG SHEET

Client :	Newcrest
Project :	Cadia STSF Geotechnical Investigation
Location :	Cadia - CE403

LOCATION No. CE403

Position : 17222.0 E, 17250.0 N MD	Surface RL : 5688.0m	Inclination\Bearing : -90 \ 0	Processed : JRN
Contractor : Groundwave	Rig Type : Boart Longyear LS250		Checked :
Date Started : 26 May 18	Date Completed : 27 May 18	Logged by : MR	Date :

DRILLING					MATERIAL							ADDITIONAL DATA	
SCALE (m)	Method	Hole Support	Run	Water	RL (m)	Depth (m)	Graphic Log	Description Soil Name (USC Symbol) Other Minor Components, Plasticity or Particle Characteristics, Colour, Moisture Condition, Consistency, Structure	Group Symbol	Moisture Condition	Consistency / Relative Density	Samples & Tests	Comments/Observations Insitu test results
	Sonic	HWT						Clayey GRAVEL, brown grey, gravel fine to coarse, cobbles, volcanic clasts, clay low plasticity	GC	M		U63	(FILL?) U63 (10.5m) refusal
11					5677.0	11.0							
								CLAY with sand, brown-orange, sand fine to coarse grained, (RS andesite)	CL	M D	S H		
12					5676.0	12.0						U63 PP	U63 (12.0 - 12.09m) Recovered 90mm PP @ 12.09m = >600 kPa (UCS)
	HQ Coring							Start of coring at 12.1 metres. See Core Log Sheet for cored interval.					
13					5675.0	13.0							
14					5674.0	14.0							
15					5673.0	15.0							
16					5672.0	16.0							
17					5671.0	17.0							
18					5670.0	18.0							
19					5669.0	19.0							
20					5668.0	20.0							

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Job No. 3218788

CORE LOG SHEET

Client : Newcrest			LOCATION No. CE403
Project : Cadia STSF Geotechnical Investigation			
Location : Cadia - CE403			SHEET OF
Position : 17222.0 E, 17250.0 N MD	Surface RL : 5688.0m	Inclination\Bearing : -90 \ 0	Processed : JRN
Contractor : Groundwave	Rig Type : Boart Longyear LS250		Checked :
Date Started : 26 May 18	Date Completed : 27 May 18	Logged by : MR	Date :

DRILLING / MATERIAL / ADDITIONAL DATA

Columns: SCALE (m); Method; Run; Water; RL (m); Depth (m); Graphic Log; Description (ROCK TYPE, colour, grain size, structure); Weathering; Estimated Strength; Core Recovery (%) (20, 80); RQD (%); Defect Spacing (mm) (20, 40, 100, 300, 1000); Samples & Tests; Joints, partings, seams, zones and veins / Fracture type, orientation, infilling or coating, shape, roughness, other / Insitu test results; SCALE (m)

RL (m)	Depth (m)	Description	Weathering	Estimated Strength	RQD (%)	Samples & Tests	Additional Data
5677.0	11.0						
5676.0	12.0	Start of coring at 12.1 metres. See Soil Log Sheet for soil interval.					
	12.1	ANDESITE, mottled brown, orange, medium to coarse grained with some FE healed joints	XW-HW	VL	0	C63	C63 (12.1 - 12.4m)
5675.0	13.0	CORE LOSS (100mm)					
		ANDESITE, mottled brown, orange, medium to coarse grained with some FE healed joints				C63	C63 (13.04 - 13.44m)
5674.0	14.0						
		CORE LOSS (250mm)					
		ANDESITE, mottled brown, orange, medium to coarse grained with some FE healed joints					
5673.0	15.0		HW	L	100	C63	C63 (15.0 - 15.2m)
				VL			
		CORE LOSS (100mm)					
5672.0	16.0	ANDESITE, mottled brown, orange, medium to coarse grained with some FE healed joints		VL	0		
							16.38m: CS, 65°, UN, ROCK FRAGMENTS, RF, 80mm
				L	98		
5671.0	17.0					C63	C63 (17.3 - 17.5m)
							17.55m: JT, 85°, UN, FE, SN, VRF
5670.0	18.0						18.0m: CS, 85°, UN, ROCK FRAGMENTS, VRF, 90mm
5669.0	19.0						
5668.0	20.0						

Method: HQ Coring; Runs 1–6

GEO CORE LOG SHEET 3218788.GPJ GHD_GEO_TEMPLATE_TASMANIA.GDT 14/6/18

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CORE LOG SHEET

Client : Newcrest
Project : Cadia STSF Geotechnical Investigation
Location : Cadia - CE403

LOCATION No. CE403

SHEET OF

Position : 17222.0 E, 17250.0 N MD	Surface RL : 5688.0m	Inclination\Bearing : -90 \ 0	Processed : JRN
Contractor : Groundwave	Rig Type : Boart Longyear LS250		Checked :
Date Started : 26 May 18	Date Completed : 27 May 18	Logged by : MR	Date :

DRILLING | MATERIAL | ADDITIONAL DATA

Columns: SCALE (m), Method, Run, Water, RL (m), Depth (m), Graphic Log, Description (ROCK TYPE, colour, grain size, structure), Weathering, Estimated Strength, Core Recovery (%) (20, 80), RQD (%), Defect Spacing (mm) (20, 40, 100, 300, 1000), Samples & Tests, Joints, partings, seams, zones and veins / Fracture type, orientation, infilling or coating, shape, roughness, other / Insitu test results, SCALE (m)

Method: HQ Coring

RL (m)	Depth (m)	Run	Description	Weathering	Estimated Strength	RQD (%)
		6				
		7	CORE LOSS (600mm)			0
5667.0	21.0	7	ANDESITE, mottled brown, orange, medium to coarse grained with some FE healed joints		L	78
					M	84
5666.0	22.0	8				
5665.0	23.0					
5664.0	24.0	9				
5663.0	25.0	10	zones of medium strength (<100mm)	MW	H	77
5662.0	26.0					
5661.0	27.0	11	zones of medium to high strength		VH	75
5660.0	28.0	12				
5659.0	29.0	13				
5658.0	30.0					

Joints, partings, seams, zones and veins:

20.9m: CS, 85°, UN, ROCK FRAGMENTS, VRF, 100mm
21.66m: JT, 80°, UN, FE, SN, VRF
21.69m: JT, 55°, UN, FE, SN, RF
21.74m: JT, 80°, ST, FE, SN, VRF
22.1m: JT, 80°, CU, FE, SN, VRF
22.3m: CS, 75°, UN, FE/ROCK FRAGMENTS, VRF, 10mm
22.38m: CS, 85°, UN, FE/ROCK FRAGMENTS, VRF. 20mm
23.15m: CS, 85°, UN, ROCK FRAGMENTS, VRF, 25mm
23.43m: JT, 75°, IR, FE, SN, VRF
23.46m: CS, 75°, UN, FE/ROCK FRAGMENTS, VRF
23.77m: JT, 75°, UN, FE/ROCK FRAGMENTS, VRF
23.85m: JT, 70°, IR, FE, SN, VRF
24.3m: JT, 85°, IR, FE, SN, VRF
24.4m: CS, 80°, IR, FE/ROCK FRAGMENTS, VRF, 5mm
25.07m: CS, 80°, IR, FE/ROCK FRAGMENTS, VRF, 70mm
25.2m: JT, 75°, UN, FE, SN, VRF
25.33m: CS, 85°, IR, FE/ROCK FRAGMENTS, VRF, 40mm
25.7m: CS, 75°, UN, FE/ROCK FRAGMENTS, VRF, 50mm
26.0m: JT, 80°, UN, FE, SN, VRF
26.06m: CS, 85°, IR, FE/ROCK FRAGMENTS, VRF, 25mm
26.39m: CS, 80°, IR, ROCK FRAGMENTS, VRF, 10mm
26.46m: CS, 85°, IR, ROCK FRAGMENTS, VRF, 80mm
26.7m: CS, 75°, IR, ROCK FRAGMENTS, VRF, 30mm
26.86m: CS, 75°, IR, ROCK FRAGMENTS, VRF, 10mm
27.07m: CS, 80°, IR, ROCK FRAGMENTS, VRF, 20mm
27.27m: JT, 85°, IR, FE, SN, VRF
27.38m: CS, 85°, IR, FE/ROCK FRAGMENTS, IR, VRF, 30mm
27.49m: JT, 75°, IR, FE, SN, VRF
27.75m: JT, 80°, UN, FE, SN, VRF
28.2m: JT, 85°, IR, FE, SN, VRF
28.44m: JT, 60°, UN, FE, SN, RF
28.5m: CS, 85°, UN, FE/ROCK FRAGMENTS, VRF, 5mm
28.56m: JT, 68°, CU, FE, SN, RF
28.69m: CS, 72°, UN, ROCK FRAGMENTS, VRF, 10mm
29.13m: JT, 72°, UN, FE, SN, VRF
29.2m: JT, 75°, UN, FE, SN, VRF
29.28m: JT, 75°, UN, FE, SN, VRF
29.43m: CS, 70°, UN, ROCK FRAGMENTS, VRF, 40mm
29.55m: JT, 70°, UN, FE, SN, VRF
29.65m: JT, 60°, UN, FE, SN, VRF
29.88m: JT, 80°, UN, FE, SN, VRF

CORE LOG SHEET

Client : Newcrest			**LOCATION No. CE403**
Project : Cadia STSF Geotechnical Investigation			
Location : Cadia - CE403			**SHEET OF**
Position : 17222.0 E, 17250.0 N MD	**Surface RL :** 5688.0m	**Inclination\Bearing :** -90 \ 0	**Processed :** JRN
Contractor : Groundwave	**Rig Type :** Boart Longyear LS250		**Checked :**
Date Started : 26 May 18	**Date Completed :** 27 May 18	**Logged by :** MR	**Date :**

SCALE (m)	Method	Run	Water	RL (m)	Depth (m)	Graphic Log	Description (ROCK TYPE, colour, grain size, structure)	Weathering	Estimated Strength	Core Recovery (%)	RQD (%)	Defect Spacing (mm)	Samples & Tests	Joints, partings, seams, zones and veins; Fracture type, orientation, infilling or coating, shape, roughness, other; Insitu test results
	HQ Coring	13												29.95m: JT, 70°, UN, FE, SN, VRF 30.2m: CS, 68°, UN, FE/ROCK FRAGMENTS, VRF, 30mm 30.34m: CS, 85°, UN, FE/ROCK FRAGMENTS, VRF, 60mm 30.55m: CS, 80°, UN, FE/ROCK FRAGMENTS, VRF, 20mm
							End of Hole (30.8m)							
31				5657.0	31.0									
32				5656.0	32.0									
33				5655.0	33.0									
34				5654.0	34.0									
35				5653.0	35.0									
36				5652.0	36.0									
37				5651.0	37.0									
38				5650.0	38.0									
39				5649.0	39.0									
40				5648.0	40.0									

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Prepared By	Date	Job Number		Title	Client
JRN	15-Jun-18	32\18788	A4	Borehole Photographic Log	Newcrest
Revision	Date	Cad Reference		CE403	Project: Cadia Mine NTSF Geotechnical Investigation
A	15-Jun-18			10.25 - 23.30m	Figure No: Appendix B

This drawing should be read in conjunction with report number 61\xxxxx\yyy

Prepared By	Date	Job Number		Title	Client
JRN	15-Jun-18	32\18788	A4	Borehole Photographic Log	Newcrest
Revision	Date	Cad Reference		CE403	Project: Cadia Mine NTSF Geotechnical Investigation
A	15-Jun-18			23.30 - 30.80m	Figure No: Appendix B

This drawing should be read in conjunction with report number 61\xxxxx\yyy

SOIL LOG SHEET

Client : Newcrest		**LOCATION No. CE404**
Project : Cadia STSF Geotechnical Investigation		
Location : Cadia - CE404		SHEET 1 OF 1
Position : 17305.0 E, 17277.0 N MD	**Surface RL :** 5688.0m	**Inclination\Bearing :** -90 \ 0	**Processed :** JRN
Contractor : Groundwave	**Rig Type :** Boart Longyear LS250	**Checked :**
Date Started : 28 May 18	**Date Completed :** 30 May 18	**Logged by :** MR	**Date :**

SCALE (m)	Method	Hole Support	Run	Water	RL (m)	Depth (m)	Graphic Log	Description: Soil Name (USC Symbol), Other Minor Components, Plasticity or Particle Characteristics, Colour, Moisture Condition, Consistency, Structure	Group Symbol	Moisture Condition	Consistency / Relative Density	Samples & Tests	Comments/Observations: Insitu test results	SCALE (m)
0–5	Sonic	HWT						FILL: GRAVEL, grey, medium to coarse, cobbles, volcanic clasts						
1					5687.0	1.0								1
2					5686.0	2.0								2
3					5685.0	3.0								3
4					5684.0	4.0								4
5					5683.0	5.0								5
6	HQ Coring				5682.0	6.0								6
7					5681.0	7.0								7
8					5680.0	8.0								8
9					5679.0	9.0								9
10					5678.0	10.0		Start of coring at 9.8 metres. See Core Log Sheet for cored interval.						10

See standard sheets for details of abbreviations & basis of descriptions

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GEO SOIL BOREHOLE LOG SHEET 3218788.GPJ GHD_GEO_TEMPLATE_TASMANIA.GDT 14/6/18

CORE LOG SHEET

Client : Newcrest			LOCATION No. CE404
Project : Cadia STSF Geotechnical Investigation			
Location : Cadia - CE404			SHEET OF
Position : 17305.0 E, 17277.0 N MD	Surface RL : 5688.0m	Inclination\Bearing : -90 \ 0	Processed : JRN
Contractor : Groundwave	Rig Type : Boart Longyear LS250		Checked :
Date Started : 28 May 18	Date Completed : 30 May 18	Logged by : MR	Date :

DRILLING				MATERIAL										ADDITIONAL DATA	
SCALE (m)	Method	Run	Water	RL (m)	Depth (m)	Graphic Log	Description ROCK TYPE, colour, grain size, structure	Weathering	Estimated Strength	Core Recovery (%) 20 80	RQD (%)	Defect Spacing (mm) 20 40 100 300 1000	Samples & Tests	Joints, partings, seams, zones and veins Fracture type, orientation, infilling or coating, shape, roughness, other Insitu test results	SCALE (m)
1				5687.0	1.0										1
2				5686.0	2.0										2
3				5685.0	3.0										3
4				5684.0	4.0										4
5				5683.0	5.0										5
6				5682.0	6.0										6
7				5681.0	7.0										7
8				5680.0	8.0										8
9				5679.0	9.0										9
10				5678.0	10.0										10

See standard sheets for details of abbreviations & basis of descriptions

Sta Se .8 metres t for soil interval

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CORE LOG SHEET

Client : Newcrest		**LOCATION No. CE404**
Project : Cadia STSF Geotechnical Investigation		
Location : Cadia - CE404		SHEET OF
Position : 17305.0 E, 17277.0 N MD	Surface RL : 5688.0m	Inclination\Bearing : -90 \ 0	Processed : JRN
Contractor : Groundwave	Rig Type : Boart Longyear LS250		Checked :
Date Started : 28 May 18	Date Completed : 30 May 18	Logged by : MR	Date :

DRILLING | MATERIAL | ADDITIONAL DATA

Columns: SCALE (m), Method, Run, Water, RL (m), Depth (m), Graphic Log, Description (ROCK TYPE, colour, grain size, structure), Weathering, Estimated Strength, Core Recovery (%) (20, 80), RQD (%), Defect Spacing (mm) (20, 40, 100, 300, 1000), Samples & Tests, Joints, partings, seams, zones and veins / Fracture type, orientation, infilling or coating, shape, roughness, other / Insitu test results, SCALE (m)

Method: HQ Coring

RL / Depth (m)	Description	Weathering	Estimated Strength	RQD (%)	Samples & Tests	Additional Data
						minor wash out of material @ start of run
	CLAY (CL-CI), orange-brown		S		PP	(RS andesite?) PP @ 10.75m = 230kPa (UCS)
5677.0 11.0	Sandy CLAY (CL-CI), (RS andesite)		F		C63	C63 (10.76 - 10.9m)
					PP	PP @ 11.17m = 320kPa (UCS)
	CORE LOSS (250mm)					
	ANDESITE, orange, purple-brown, medium to coarse grained, small vesicles 1-3 mm, cream coloured phenocrysts (feldspar?)	HW	VL	0		
		MW	M	96		
5676.0 12.0						11.95m: CS, 60°, IR, ROCK FRAGMENTS, VRF, 15mm 12.01m: JT, 75°, UN, FE, SN, RF
		HW	L	83		12..22m: CS, 75°, UN, CLAY/ROCK FRAGMENTS, VRF, 40mm 12.63m: JT, 60°, UN, FE, SN, VRF
5675.0 13.0						12.81m: JT, 70°, CU, FE, SN, RF 12.86m: JT, 45°, UN, FE, SN, RF 12.92m: CS, 85°, IR, ROCK FRAGMENTS, VRF, 10mm 12.97m: JT, 67°, UN, FE, SN, VRF
	changing to purple brown with orange and cream phenocrysts, slight vughy texture				C63	13.04m: JT, 75°, UN, FE, SN, VRF 13.12m: JT, 45°, UN, FE, SN, RF 13.22m: JT, 65°, UN, FE, SN, VRF 13.34m: JT, 75°, UN, FE, SN, VRF 13.42m: CS, 65°, ROCK FRAGMENTS, VRF, 10mm C63 (13.69 - 13.83m)
5674.0 14.0						
	CORE LOSS (700mm)			0		
5673.0 15.0						
	ANDESITE, purple brown with orange and cream phenocrysts, medium to coarse grained, small vesicles 1-3 mm, slight vughy texture	XW	VL	0		15.43m: JT, 30°, UN, FE, SN, RF
	CORE LOSS (350mm)			0		
5672.0 16.0						
	ANDESITE, purple brown with orange and cream phenocrysts, medium to coarse grained, small vesicles 1-3 mm, slight vughy texture	HW	L	86		16.34m: JT, 45°, UN, FE, SN, VRF 16.4m: JT, 40°, UN, FE, SN, VRF 16.45m: JT, 70°, UN, FE, SN, VRF 16.6m: JT, 30°, UN, FE, SN, RF 16.7m: JT, 45°, UN, FE, SN, VRF
5671.0 17.0						16.95m: JT, 82°, UN, FE, SN, VRF
	CORE LOSS (450mm)			0		
	ANDESITE, purple brown with orange and cream phenocrysts, medium to coarse grained, small vesicles 1-3 mm, slight vughy texture		VL	0	C63	C63 (17.75 - 17.9m)
5670.0 18.0	orange-brown in colour, with highly healed fractures					
	CORE LOSS (50mm)			0		
	ANDESITE, purple brown with orange and cream phenocrysts, medium to coarse grained, small vesicles 1-3 mm, increasing vughy texture, less fractured, moderatley healed fractures	MW	M	67		
5669.0 19.0						19.0m: JT, 65°, UN, FE, SN, RF 19.1m: JT, 40°, UN, FE, SN, RF 19.38m: CS, 75°, UN, ROCK FRAGMENTS, VRF, 60mm 19.5m: CS, 80°, UN, ROCK FRAGMENTS, VRF, 10mm 19.75m: JT, 70°, UN, FE, SN, RF 19.79m: JT, 40°, UN, FE, SN, RF
5668.0 20.0						

CORE LOG SHEET

Client : Newcrest		**LOCATION No. CE404**
Project : Cadia STSF Geotechnical Investigation		
Location : Cadia - CE404		**SHEET OF**
Position : 17305.0 E, 17277.0 N MD	**Surface RL : 5688.0m**	**Inclination\Bearing : -90 \ 0** / **Processed : JRN**
Contractor : Groundwave	**Rig Type : Boart Longyear LS250**	**Checked :**
Date Started : 28 May 18	**Date Completed : 30 May 18**	**Logged by : MR** / **Date :**

DRILLING — SCALE (m), Method, Run, Water

MATERIAL — RL (m), Depth (m), Graphic Log, Description (ROCK TYPE, colour, grain size, structure), Weathering, Estimated Strength, Core Recovery (%) (20, 80), RQD (%), Defect Spacing (mm) (20, 40, 100, 300, 1000), Samples & Tests

ADDITIONAL DATA — Joints, partings, seams, zones and veins; Fracture type, orientation, infilling or coating, shape, roughness, other; Insitu test results

Method: HQ Coring

RL (m)	Depth (m)
5667.0	21.0
5666.0	22.0
5665.0	23.0
5664.0	24.0
5663.0	25.0
5662.0	26.0
5661.0	27.0
5660.0	28.0
5659.0	29.0
5658.0	30.0

Depth (approx.)	Description	Weathering	Estimated Strength	RQD (%)
19.92–24.8		HW	H	80
~24.6				0
24.8	less fractured, moderatley healed	MW		73
~25.55	grey-brown in colour			
~27.5		SW		94
~28.5	minor quartz veining			
29.1	End of Hole (29.1m)			

Defects:

19.92m: JT, 25°, IR, FE, SN, VRF
20.0m: JT, 80°, CU, FE, SN, RF
20.1m: CS, 80°, UN, ROCK FRAGMENTS, VRF, 100mm
20.22m: JT, 74°, UN, FE, SN, RF
20.34m: JT, 72°, UN, FE, SN, RF
20.4m: JT, 65°, CU, FE, SN, RF
20.54m: JT, 60°, IR, FE, SN, RF
20.66m: JT, 80°, IR, FE, SN, VRF
20.84m: JT, 80°, UN, FE, SN, VRF
20.89m: JT, 80°, UN, FE, SN, RF
20.94m: CS, 70°, UN, FE/CLAY, RF, 10mm
21.01m: JT, 80°, IR, FE, SN, RF
21.22m: JT, 77°, UN, FE, SN, VRF
21.39m: JT, 80°, UN, FE, SN, RF
21.46m: JT, 75°, IR, FE, SN, VRF
21.65m: JT, 80°, IR, FE, SN, VRF
21.77m: JT, 75°, IR, FE, SN, VRF
21.89m: JT, 60°, UN, FE, SN, RF
21.93m: JT, 84°, UN, FE, SN, VRF
22.11m: JT, 85°, UN, FE, SN, RF
22.24m: JT, 82°, IR, FE, SN, VRF
22.32m: JT, 85°, UN, FE, SN, VRF
22.7m: JT, 62°, CU, FE, SN, VRF
22.9m: JT, 82°, UN, FE, SN, VRF
22.95m: JT, 65°, UN, FE, SN, VRF
23.5m: JT, 80°, CU, FE, SN, VRF
23.6m: JT, 80°, IR, FE, SN, VRF
23.65m: JT, 75°, IR, FE, SN, VRF
23.75m: JT, 75°, UN, FE, SN, VRF
23.9m: JT, 80°, UN, FE, SN, VRF
24.02m: JT, 75°, UN, FE, SN, VRF
24.06m: JT, 80°, UN, FE, SN, VRF
24.17m: JT, 75°, UN, FE, SN, VRF
24.34m: JT, 70°, UN, FE, SN, VRF
24.4m: JT, 70°, UN, FE, SN, VRF
24.44m: JT, 80°, CU, FE, SN, VRF
24.49m: JT, 70°, CU, FE, SN, VRF
24.6m: SM, CLAY/GRAVEL, red-brown, low plasticity, gravel fine, subangular, 200mm
24.8m: CS, 80°, UN, CLAY/ROCK FRAGMENTS, RF, 200mm
24.9m: CS, 80°, UN, ROCK FRAGMENTS, VRF, 20mm
25.15m: CS, 85°, UN, ROCK FRAGMENTS, VRF, 50mm
25.36m: JT, 80°, UN, FE, SN, VRF
25.68m: JT, 75°, UN, FE, SN, VRF
25.78m: JT, 60°, UN, FE, SN, VRF
25.95m: JT, 80°, UN, FE, SN, VRF
26.1m: CS, 80°, UN, ROCK FRAGMENTS, VRF, 140mm
26.35m: JT, 55°, UN, FE, SN, VRF
26.47m: JT, 37°, UN, FE, SN, VRF
26.6m: JT, 75°, UN, FE, SN, VRF
26.7m: CS, 75°, UN, ROCK FRAGMENTS, VRF, 180mm
27.18m: CS, 50°, UN, ROCK FRAGMENTS, VRF, 20mm
27.3m: JT, 70°, UN, FE, SN, VRF
27.4m: CS, 75°, UN, ROCK FRAGMENTS, VRF, 10mm
27.74m: JT, 75°, UN, FE, SN, VRF
27.88m: JT. 67°, UN, FE, SN, VRF
27.9m: JT, 45°, UN, FE, SN, VRF
27.99m: JT, 88°, UN, FE, SN, SO
28.19m: JT, 72°, UN, FE, SN, VRF
28.35m: JT, 65°, CU, FE, SN, VRF
28.83m: JT, 88°, IR, FE, SN, VRF

Prepared By	Date	Job Number		Title	Client
JRN	15-Jun-18	32\18788	A4	Borehole Photographic Log	Newcrest
Revision	Date	Cad Reference		CE404	Project: Cadia Mine NTSF Geotechnical Investigation
A	15-Jun-18			9.80 - 24.30 m	Figure No: Appendix B

This drawing should be read in conjunction with report number 61\xxxxx\yyy

Prepared By	Date	Job Number		Title	Client
JRN	15-Jun-18	32\18788	A4	Borehole Photographic Log	Newcrest
Revision	Date	Cad Reference		CE403	Project: Cadia Mine NTSF Geotechnical Investigation
A	15-Jun-18			24.30 - 29.10m	Figure No: Appendix B

This drawing should be read in conjunction with report number 61\xxxxx\yyy

Annexure CG
Newcrest Core Photographs

HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	West of Slump	Page 1 of 2	

Drillhole No.:	CE380
Easting:	684,836.6 m
Northing:	6,291,480.9 m
Azimuth:	121°
Dip:	60°
Horizontal Datum:	GDA94
Surface Elevation:	697.80 m

0 1m

HATCH	Drill Core Photograph			Drillhole No.: CE380
				Easting: 684,836.6 m
				Northing: 6,291,480.9 m
				Azimuth: 121°
Client:	Newcrest	Project No.:	H356804	Dip: 60°
Project :	Cadia NTSF Failure Review			Horizontal Datum: GDA94
Location:	West of Slump	Page 2 of 2		Surface Elevation: 697.80 m

0 1m

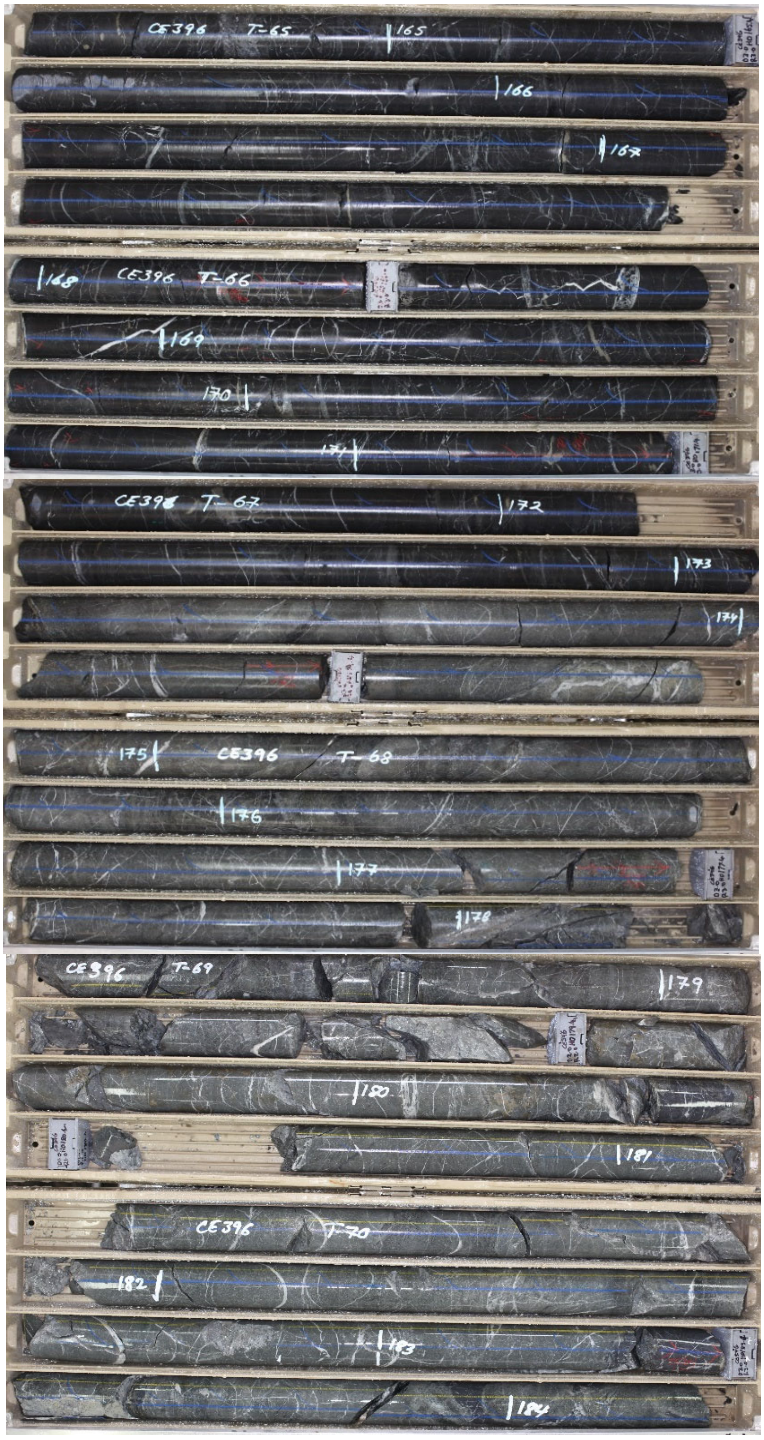
HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	West of Slump	Page 1 of 4	

Drillhole No.:	CE396
Easting:	684,815.2 m
Northing:	6,291,500.6 m
Azimuth:	121°
Dip:	60°
Horizontal Datum:	GDA94
Surface Elevation:	697.06 m

0 1m

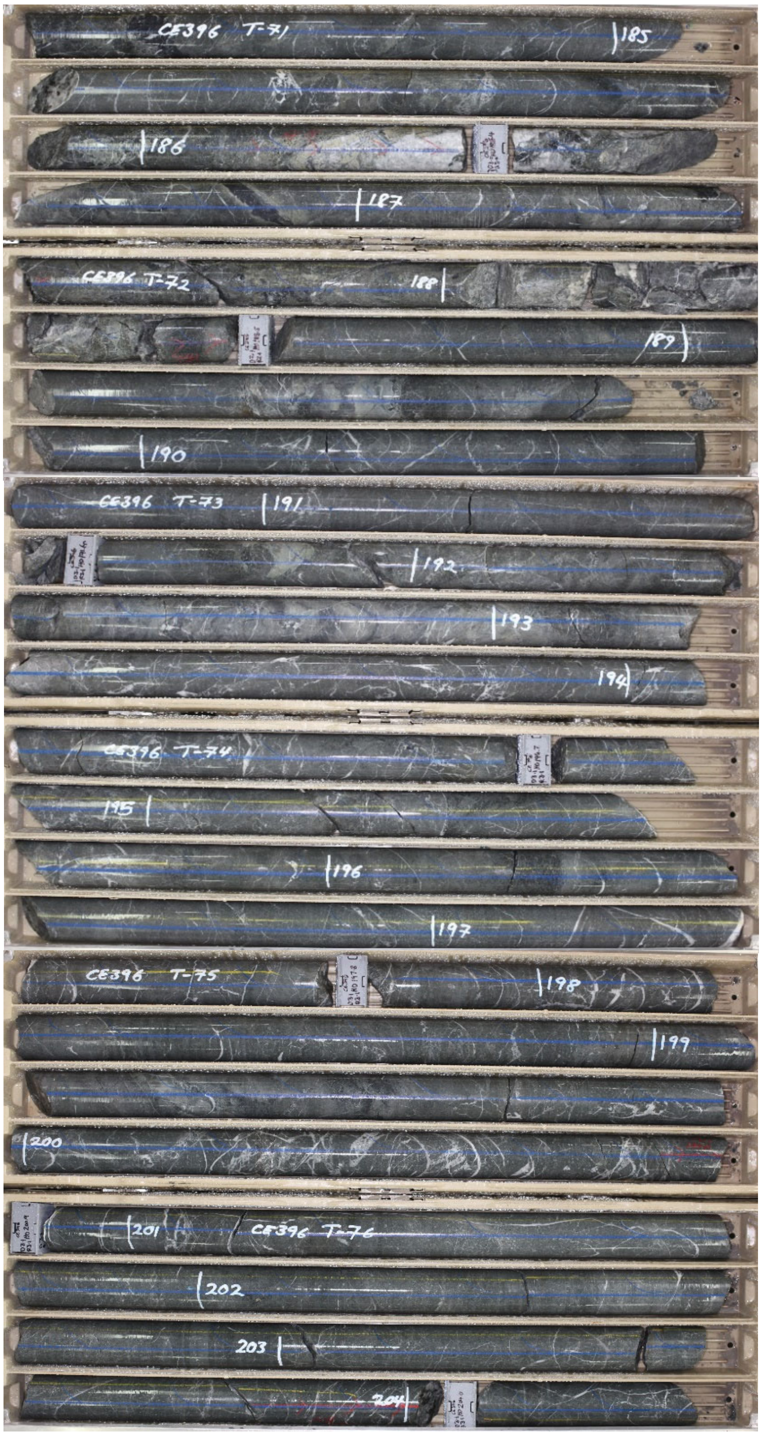


Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	West of Slump	Page 2 of 4	

Drillhole No.:	CE396
Easting:	684,815.2 m
Northing:	6,291,500.6 m
Azimuth:	121°
Dip:	60°
Horizontal Datum:	GDA94
Surface Elevation:	697.06 m

0 1m



HATCH

Drill Core Photograph

Client: Newcrest

Project No.: H356804

Project : Cadia NTSF Failure Review

Location: West of Slump

Drillhole No.: CE396

Easting: 684,815.2 m

Northing: 6,291,500.6 m

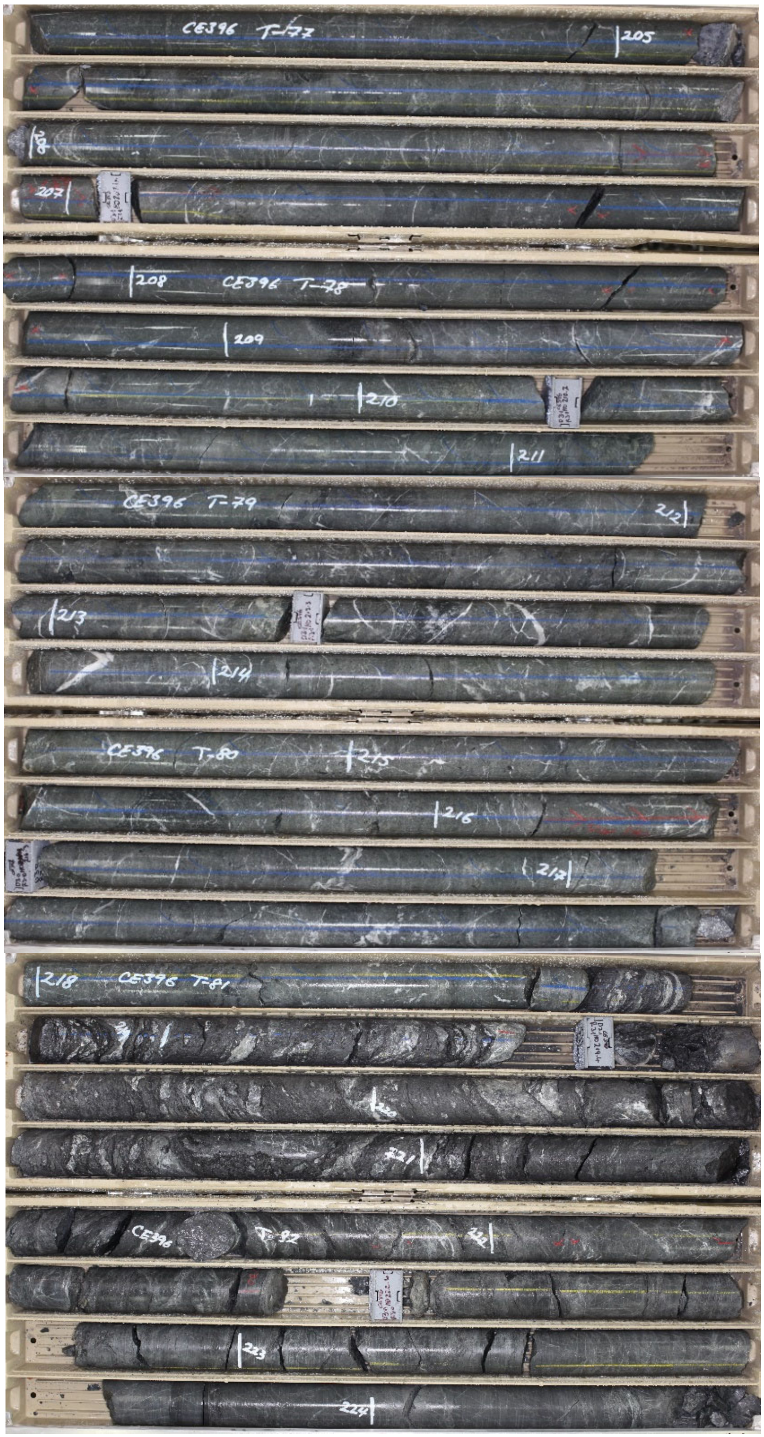
Azimuth: 121°

Dip: 60°

Horizontal Datum: GDA94

Surface Elevation: 697.06 m

0 1m



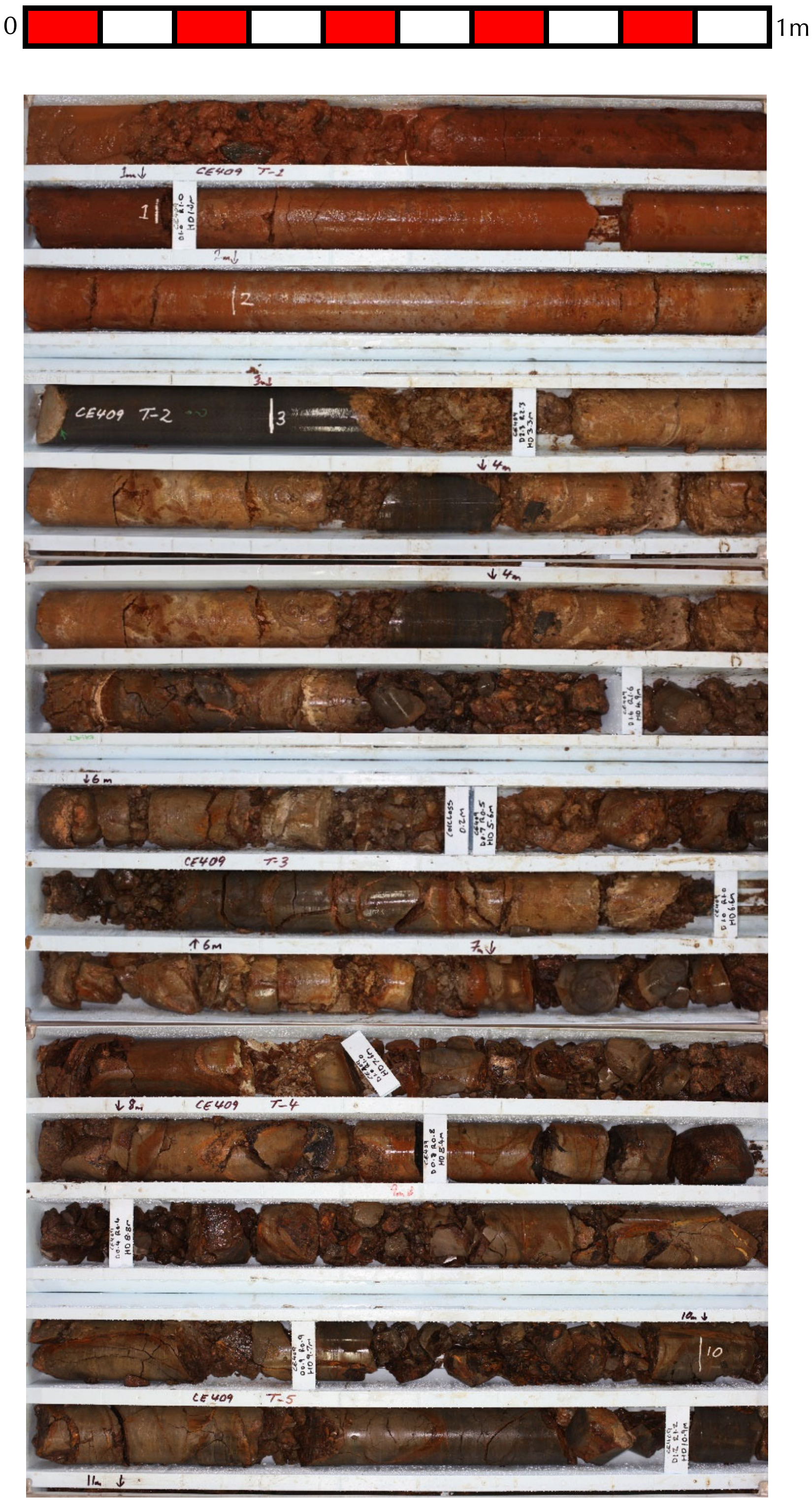
HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	West of Slump	Page 4 of 4	

Drillhole No.:	CE396
Easting:	684,815.2 m
Northing:	6,291,500.6 m
Azimuth:	121°
Dip:	60°
Horizontal Datum:	GDA94
Surface Elevation:	697.06 m

Drill Core Photograph			Drillhole No.: CE409
			Easting: 685,089.7 m
			Northing: 6,291,019.1 m
			Azimuth: 121°
Client:	Newcrest	Project No.: H356804	Dip: 60°
Project :	Cadia NTSF Failure Review		Horizontal Datum: GDA94
Location:	Haul Road - South West of Slump	Page 1 of 33	Surface Elevation: 689.11 m



HATCH

Drill Core Photograph

Drillhole No.: CE409
Easting: 685,089.7 m
Northing: 6,291,019.1 m
Azimuth: 121°
Dip: 60°
Horizontal Datum: GDA94
Surface Elevation: 689.11 m

Client: Newcrest
Project No.: H356804
Project : Cadia NTSF Failure Review
Location: Haul Road - South West of Slump

0 1m

HATCH	Drill Core Photograph		Drillhole No.: CE409
			Easting: 685,089.7 m
			Northing: 6,291,019.1 m
			Azimuth: 121°
Client: Newcrest		Project No.: H356804	Dip: 60°
Project : Cadia NTSF Failure Review			Horizontal Datum: GDA94
Location: Haul Road - South West of Slump		Page 3 of 33	Surface Elevation: 689.11 m

0 1m

HATCH	**Drill Core Photograph**	Drillhole No.: CE409
		Easting: 685,089.7 m
		Northing: 6,291,019.1 m
		Azimuth: 121°
Client: Newcrest	Project No.: H356804	Dip: 60°
Project : Cadia NTSF Failure Review		Horizontal Datum: GDA94
Location: Haul Road - South West of Slump	Page 4 of 33	Surface Elevation: 689.11 m

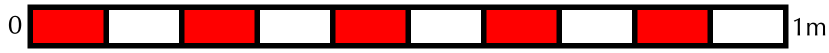
0 1m

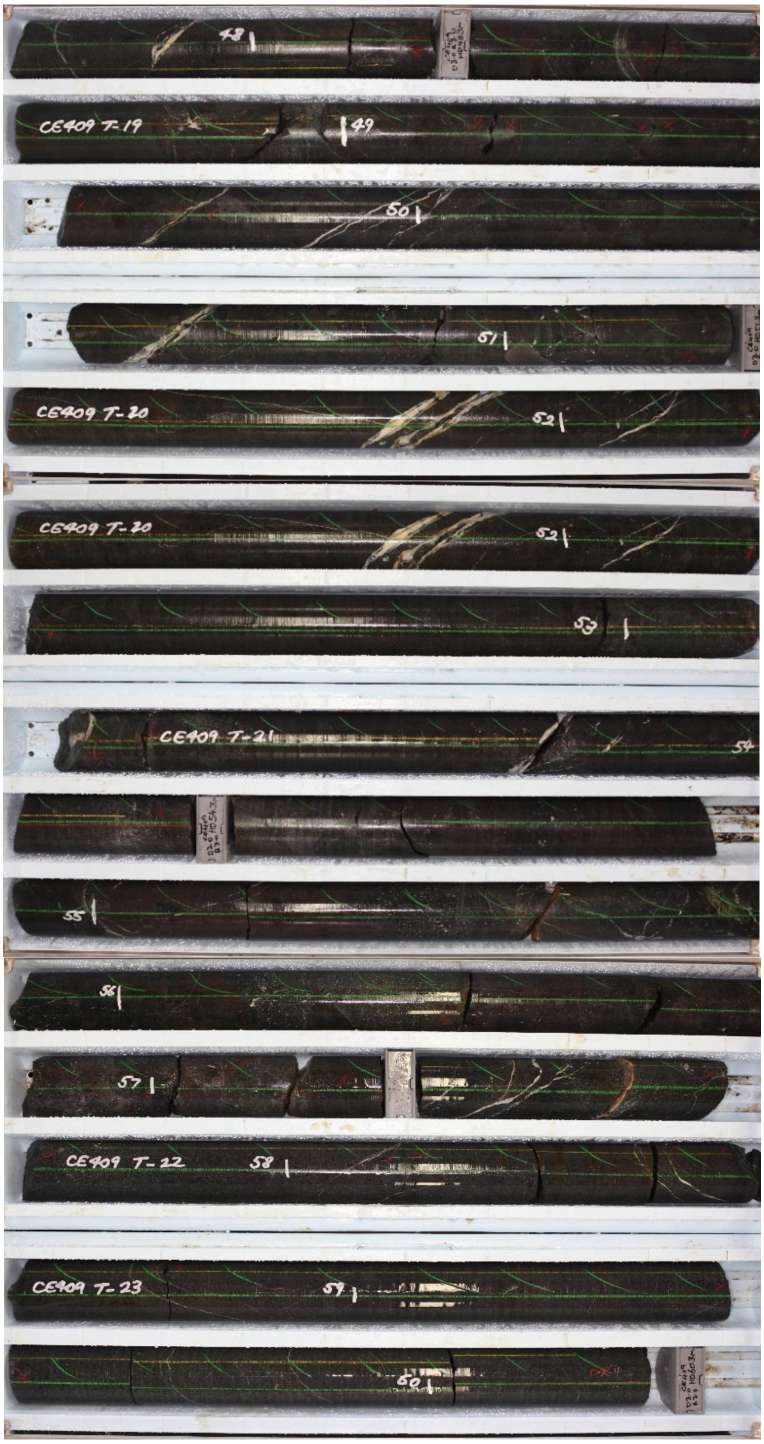
HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Haul Road - South West of Slump	Page 5 of 33	

Drillhole No.:	CE409
Easting:	685,089.7 m
Northing:	6,291,019.1 m
Azimuth:	121°
Dip:	60°
Horizontal Datum:	GDA94
Surface Elevation:	689.11 m





HATCH		Drill Core Photograph		Drillhole No.: CE409
				Easting: 685,089.7 m
				Northing: 6,291,019.1 m
				Azimuth: 121°
Client:	Newcrest	Project No.:	H356804	Dip: 60°
Project :	Cadia NTSF Failure Review			Horizontal Datum: GDA94
Location:	Haul Road - South West of Slump	Page 6 of 33		Surface Elevation: 689.11 m

HATCH

Drill Core Photograph

Client: Newcrest

Project No.: H356804

Project : Cadia NTSF Failure Review

Location: Haul Road - South West of Slump

Page 7 of 33

Drillhole No.: CE409

Easting: 685,089.7 m

Northing: 6,291,019.1 m

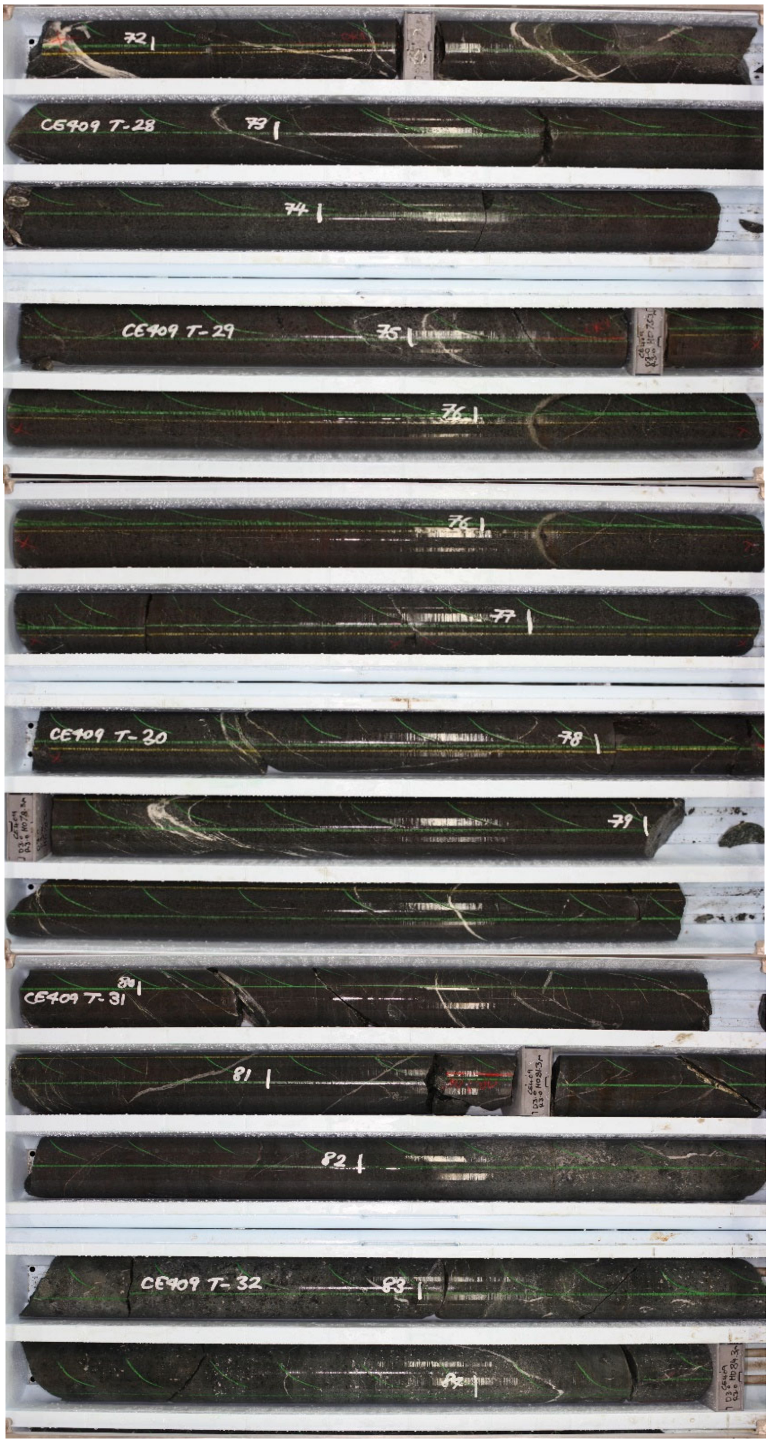
Azimuth: 121°

Dip: 60°

Horizontal Datum: GDA94

Surface Elevation: 689.11 m

0 1m



Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Haul Road - South West of Slump	Page 8 of 33	

Drillhole No.:	CE409
Easting:	685,089.7 m
Northing:	6,291,019.1 m
Azimuth:	121°
Dip:	60°
Horizontal Datum:	GDA94
Surface Elevation:	689.11 m

0 1m

HATCH	**Drill Core Photograph**	Drillhole No.: CE409
		Easting: 685,089.7 m
		Northing: 6,291,019.1 m
		Azimuth: 121°
Client: Newcrest	Project No.: H356804	Dip: 60°
Project : Cadia NTSF Failure Review		Horizontal Datum: GDA94
Location: Haul Road - South West of Slump	Page 9 of 33	Surface Elevation: 689.11 m

0 1m

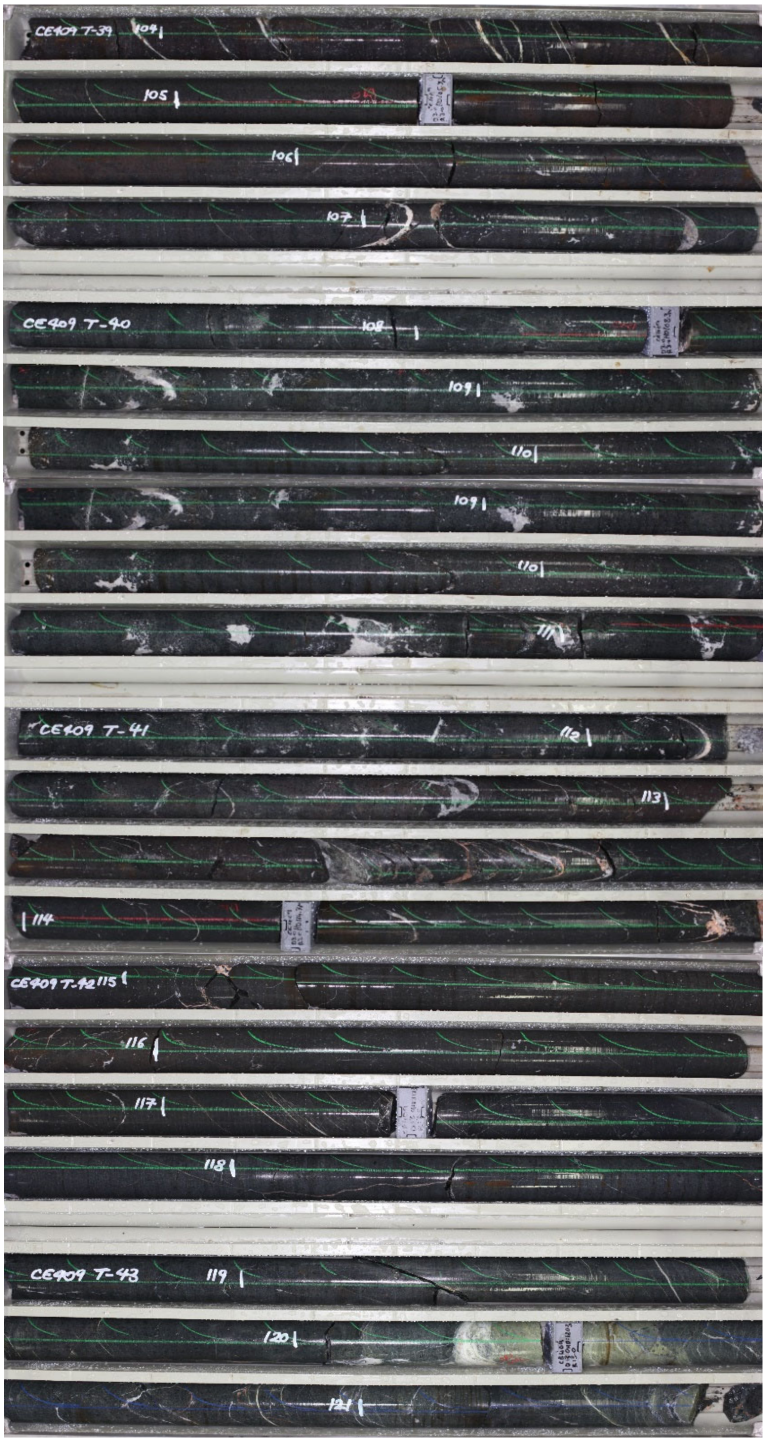
HATCH

Drill Core Photograph

Client: Newcrest
Project No.: H356804
Project : Cadia NTSF Failure Review
Location: Haul Road - South West of Slump

Drillhole No.: CE409
Easting: 685,089.7 m
Northing: 6,291,019.1 m
Azimuth: 121°
Dip: 60°
Horizontal Datum: GDA94
Surface Elevation: 689.11 m

0 1m



HATCH	**Drill Core Photograph**		Drillhole No.: CE409
			Easting: 685,089.7 m
			Northing: 6,291,019.1 m
			Azimuth: 121°
Client:	Newcrest	Project No.: H356804	Dip: 60°
Project :	Cadia NTSF Failure Review		Horizontal Datum: GDA94
Location:	Haul Road - South West of Slump	Page 11 of 33	Surface Elevation: 689.11 m

0 1m

HATCH	**Drill Core Photograph**		Drillhole No.: CE409
			Easting: 685,089.7 m
			Northing: 6,291,019.1 m
			Azimuth: 121°
Client: Newcrest		Project No.: H356804	Dip: 60°
Project : Cadia NTSF Failure Review			Horizontal Datum: GDA94
Location: Haul Road - South West of Slump		Page 12 of 33	Surface Elevation: 689.11 m

0 1m

HATCH	**Drill Core Photograph**			Drillhole No.:	CE409
				Easting:	685,089.7 m
				Northing:	6,291,019.1 m
				Azimuth:	121°
Client:	Newcrest	Project No.:	H356804	Dip:	60°
Project :	Cadia NTSF Failure Review			Horizontal Datum:	GDA94
Location:	Haul Road - South West of Slump	Page 13 of 33		Surface Elevation:	689.11 m

0 — 1m

HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Haul Road - South West of Slump	Page 14 of 33	

Drillhole No.:	CE409
Easting:	685,089.7 m
Northing:	6,291,019.1 m
Azimuth:	121°
Dip:	60°
Horizontal Datum:	GDA94
Surface Elevation:	689.11 m

0 1m

HATCH

Drill Core Photograph

Client: Newcrest
Project No.: H356804
Project : Cadia NTSF Failure Review
Location: Haul Road - South West of Slump

Drillhole No.: CE409
Easting: 685,089.7 m
Northing: 6,291,019.1 m
Azimuth: 121°
Dip: 60°
Horizontal Datum: GDA94
Surface Elevation: 689.11 m

HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Haul Road - South West of Slump	Page 16 of 33	

Drillhole No.:	CE409
Easting:	685,089.7 m
Northing:	6,291,019.1 m
Azimuth:	121°
Dip:	60°
Horizontal Datum:	GDA94
Surface Elevation:	689.11 m

0 1m

HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Haul Road - South West of Slump	Page 17 of 33	

Drillhole No.:	CE409
Easting:	685,089.7 m
Northing:	6,291,019.1 m
Azimuth:	121°
Dip:	60°
Horizontal Datum:	GDA94
Surface Elevation:	689.11 m

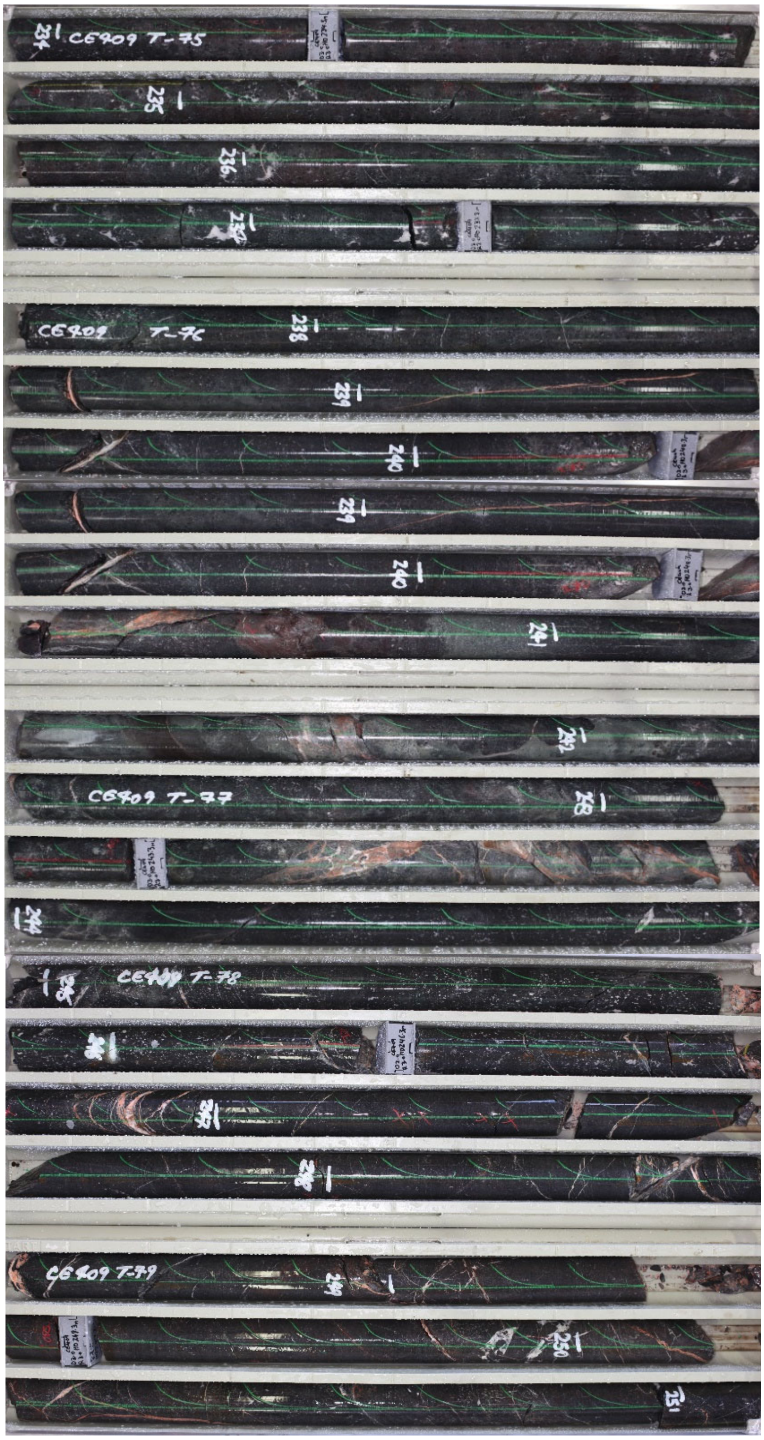
0 1m

Drill Core Photograph

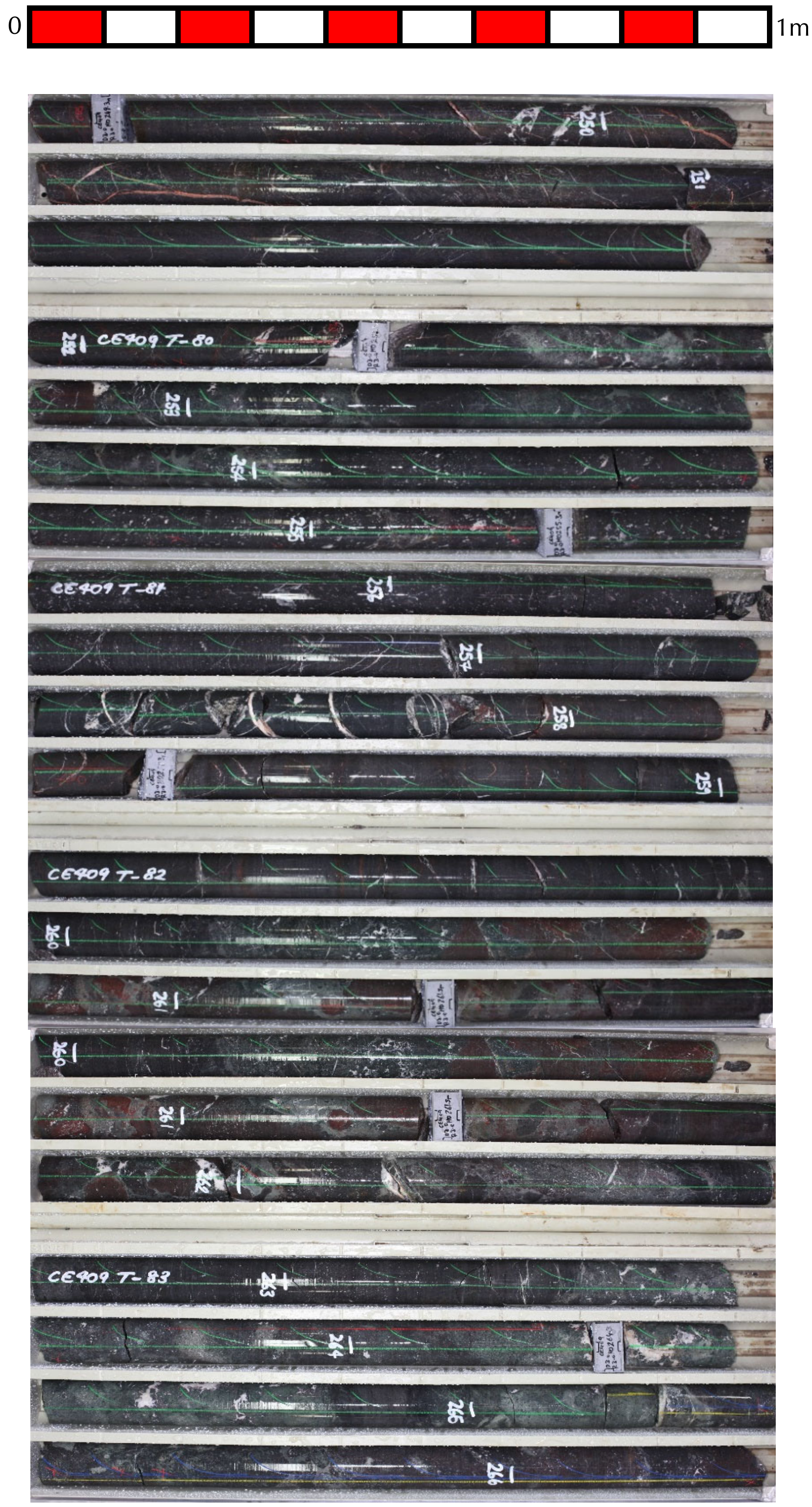
Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Haul Road - South West of Slump	Page 18 of 33	

Drillhole No.: CE409
Easting: 685,089.7 m
Northing: 6,291,019.1 m
Azimuth: 121°
Dip: 60°
Horizontal Datum: GDA94
Surface Elevation: 689.11 m

0 1m



HATCH	**Drill Core Photograph**			Drillhole No.: CE409
				Easting: 685,089.7 m
				Northing: 6,291,019.1 m
				Azimuth: 121°
Client:	Newcrest	Project No.:	H356804	Dip: 60°
Project :	Cadia NTSF Failure Review			Horizontal Datum: GDA94
Location:	Haul Road - South West of Slump	Page 19 of 33		Surface Elevation: 689.11 m



HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Haul Road - South West of Slump	Page 20 of 33	

Drillhole No.:	CE409
Easting:	685,089.7 m
Northing:	6,291,019.1 m
Azimuth:	121°
Dip:	60°
Horizontal Datum:	GDA94
Surface Elevation:	689.11 m

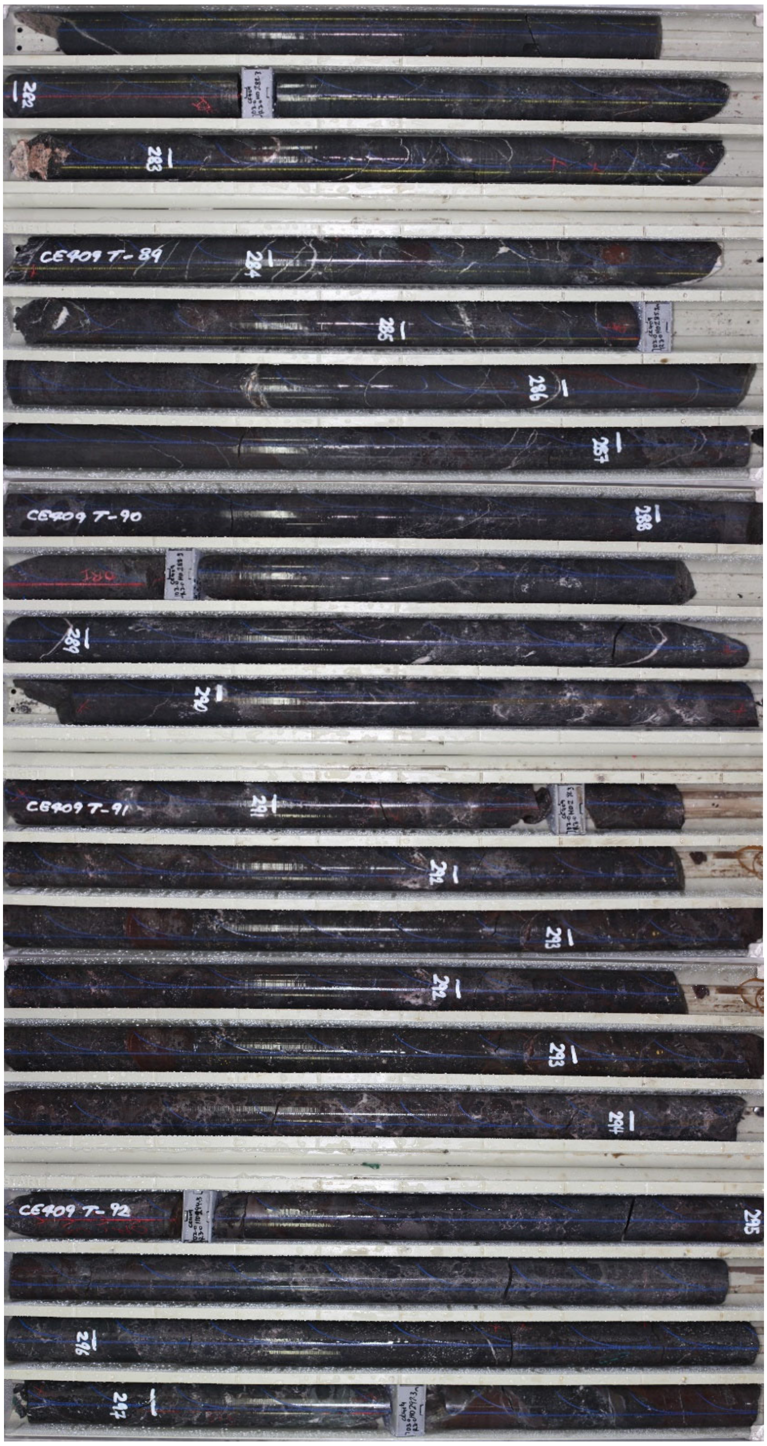
HATCH

Drill Core Photograph

Drillhole No.: CE409
Easting: 685,089.7 m
Northing: 6,291,019.1 m
Azimuth: 121°
Dip: 60°
Horizontal Datum: GDA94
Surface Elevation: 689.11 m

Client: Newcrest
Project No.: H356804
Project : Cadia NTSF Failure Review
Location: Haul Road - South West of Slump

0 1m



HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Haul Road - South West of Slump	Page 22 of 33	

Drillhole No.:	CE409
Easting:	685,089.7 m
Northing:	6,291,019.1 m
Azimuth:	121°
Dip:	60°
Horizontal Datum:	GDA94
Surface Elevation:	689.11 m

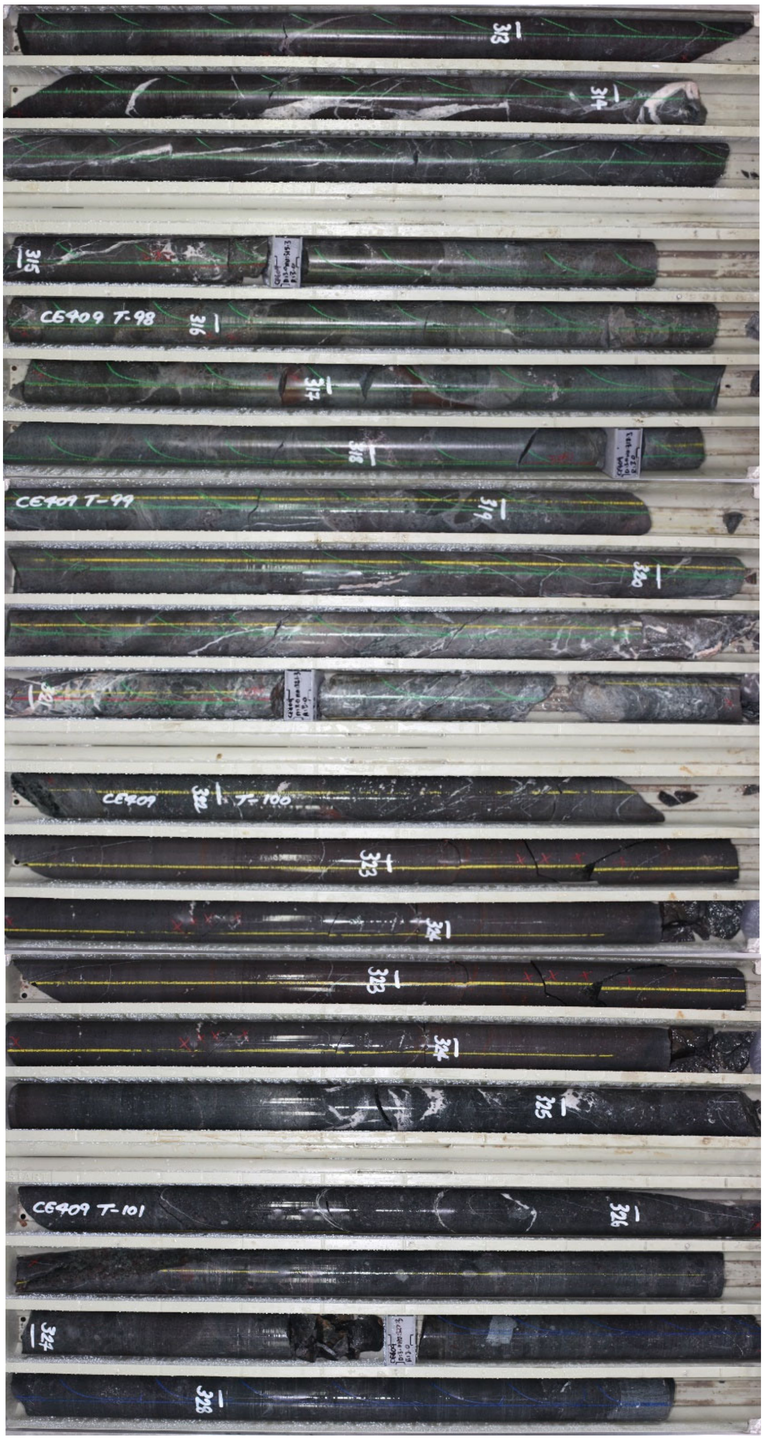
0 1m

HATCH | **Drill Core Photograph**

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Haul Road - South West of Slump	Page 23 of 33	

Drillhole No.:	CE409
Easting:	685,089.7 m
Northing:	6,291,019.1 m
Azimuth:	121°
Dip:	60°
Horizontal Datum:	GDA94
Surface Elevation:	689.11 m

0 1m



HATCH

Drill Core Photograph

Drillhole No.:	CE409
Easting:	685,089.7 m
Northing:	6,291,019.1 m
Azimuth:	121°
Dip:	60°
Horizontal Datum:	GDA94
Surface Elevation:	689.11 m

Client: Newcrest Project No.: H356804

Project : Cadia NTSF Failure Review

Location: Haul Road - South West of Slump

0 1m

HATCH

Drill Core Photograph

Client: Newcrest
Project No.: H356804
Project : Cadia NTSF Failure Review
Location: Haul Road - South West of Slump
Page 25 of 33

Drillhole No.: CE409
Easting: 685,089.7 m
Northing: 6,291,019.1 m
Azimuth: 121°
Dip: 60°
Horizontal Datum: GDA94
Surface Elevation: 689.11 m

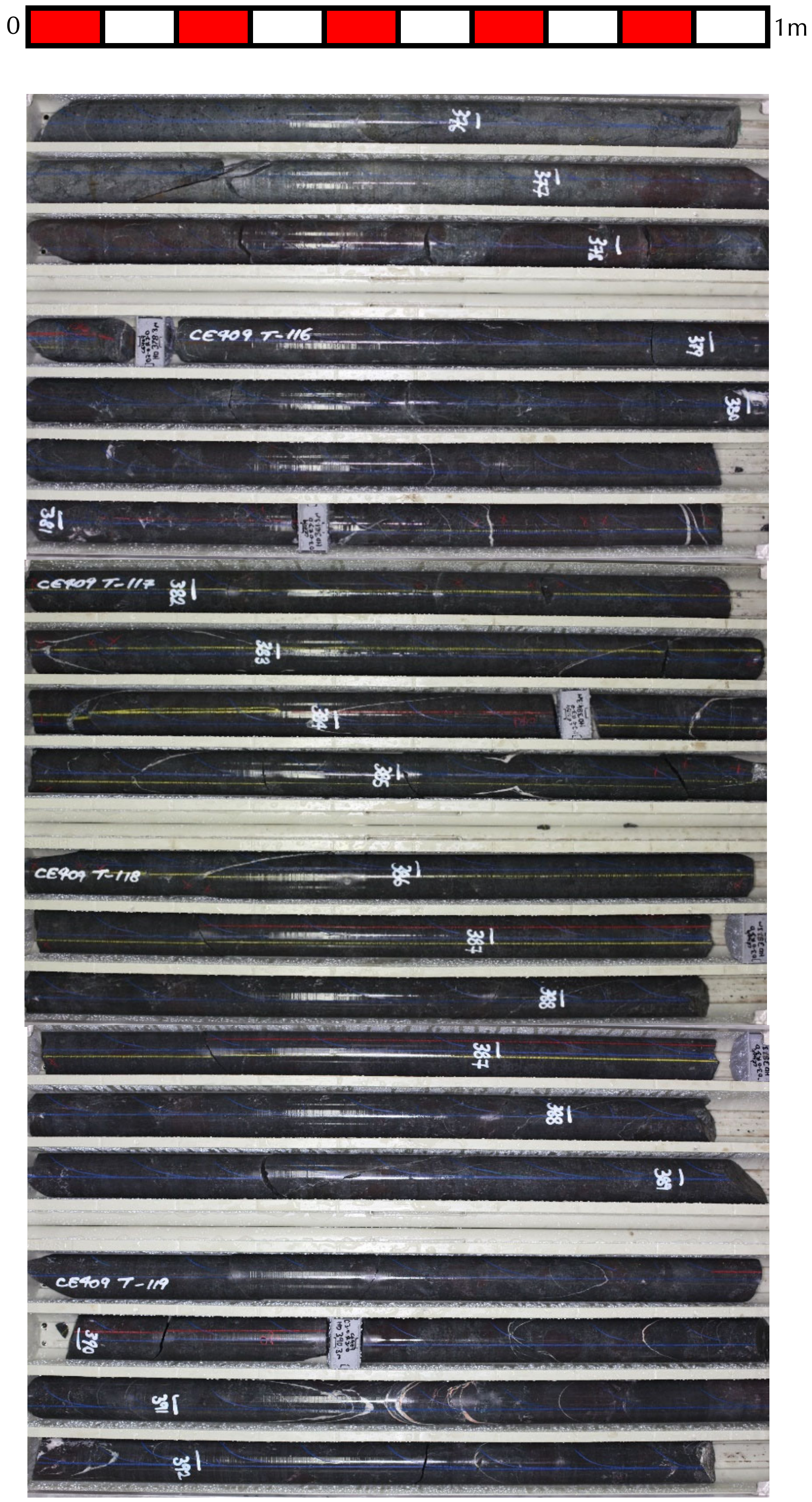
0 1m

HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Haul Road - South West of Slump	Page 26 of 33	

Drillhole No.:	CE409
Easting:	685,089.7 m
Northing:	6,291,019.1 m
Azimuth:	121°
Dip:	60°
Horizontal Datum:	GDA94
Surface Elevation:	689.11 m



Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Haul Road - South West of Slump	Page 27 of 33	

Drillhole No.:	CE409
Easting:	685,089.7 m
Northing:	6,291,019.1 m
Azimuth:	121°
Dip:	60°
Horizontal Datum:	GDA94
Surface Elevation:	689.11 m

0 1m

HATCH	**Drill Core Photograph**			Drillhole No.: CE409
				Easting: 685,089.7 m
				Northing: 6,291,019.1 m
				Azimuth: 121°
Client:	Newcrest	Project No.:	H356804	Dip: 60°
Project :	Cadia NTSF Failure Review			Horizontal Datum: GDA94
Location:	Haul Road - South West of Slump	Page 28 of 33		Surface Elevation: 689.11 m

0 1m

HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Haul Road - South West of Slump	Page 29 of 33	

Drillhole No.:	CE409
Easting:	685,089.7 m
Northing:	6,291,019.1 m
Azimuth:	121°
Dip:	60°
Horizontal Datum:	GDA94
Surface Elevation:	689.11 m

0 1m

HATCH

Drill Core Photograph

Client: Newcrest

Project No.: H356804

Project : Cadia NTSF Failure Review

Location: Haul Road - South West of Slump

Drillhole No.: CE409

Easting: 685,089.7 m

Northing: 6,291,019.1 m

Azimuth: 121°

Dip: 60°

Horizontal Datum: GDA94

Surface Elevation: 689.11 m

0 1m

HATCH	**Drill Core Photograph**			Drillhole No.: CE409
				Easting: 685,089.7 m
				Northing: 6,291,019.1 m
				Azimuth: 121°
Client:	Newcrest	Project No.:	H356804	Dip: 60°
Project :	Cadia NTSF Failure Review			Horizontal Datum: GDA94
Location:	Haul Road - South West of Slump	Page 31 of 33		Surface Elevation: 689.11 m

0 1m

HATCH	Drill Core Photograph	Drillhole No.: CE409
		Easting: 685,089.7 m
		Northing: 6,291,019.1 m
		Azimuth: 121°
Client: Newcrest	Project No.: H356804	Dip: 60°
Project : Cadia NTSF Failure Review		Horizontal Datum: GDA94
Location: Haul Road - South West of Slump	Page 32 of 33	Surface Elevation: 689.11 m

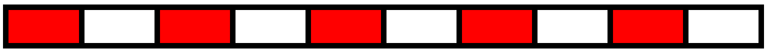
0 1m

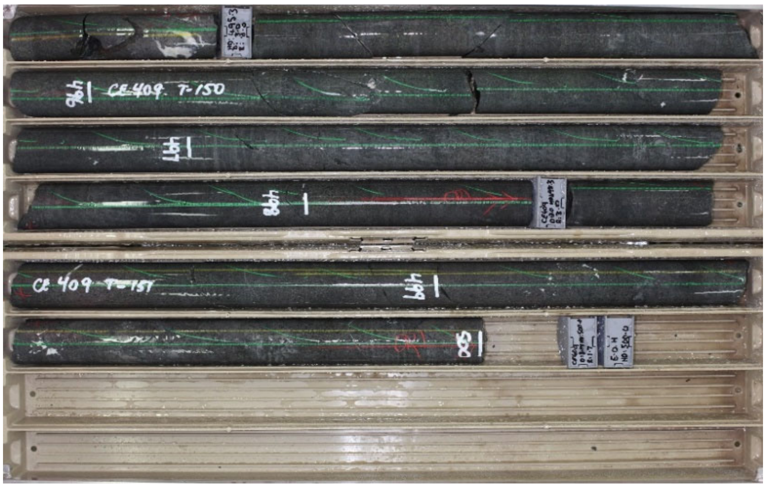
HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Haul Road - South West of Slump	Page 33 of 33	

Drillhole No.:	CE409
Easting:	685,089.7 m
Northing:	6,291,019.1 m
Azimuth:	121°
Dip:	60°
Horizontal Datum:	GDA94
Surface Elevation:	689.11 m

0  1m



HATCH

Drill Core Photograph

Client: Newcrest

Project : Cadia NTSF Failure Review

Location: Stage 2 Buttress - East

Project No.: H356804

Drillhole No.: CE431

Easting: 685,504.1 m

Northing: 6,290,946.7 m

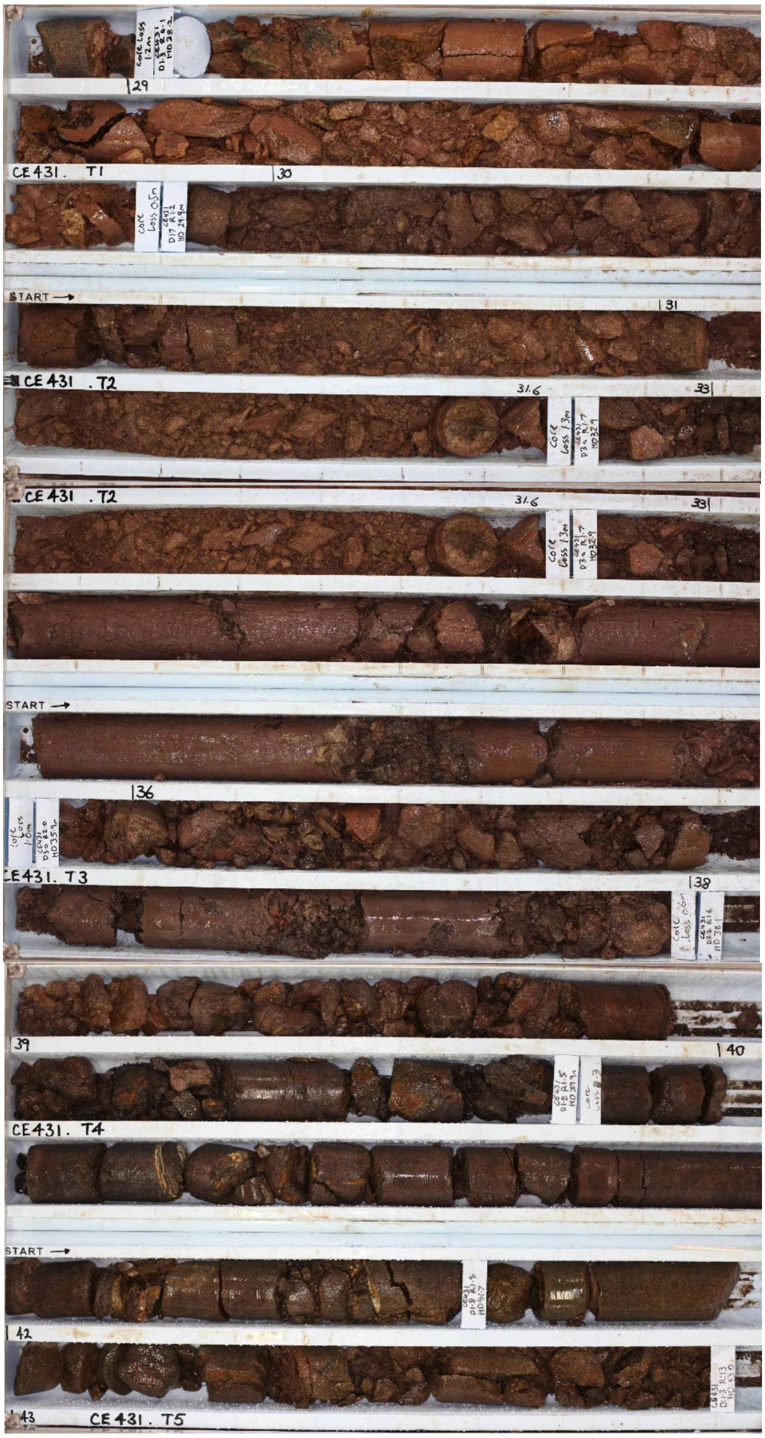
Azimuth: 291°

Dip: 53°

Horizontal Datum: GDA94

Surface Elevation: 688.00 m

0 1m



HATCH

Drill Core Photograph

Client: Newcrest
Project No.: H356804
Project : Cadia NTSF Failure Review
Location: Stage 2 Buttress - East
Page 2 of 28

Drillhole No.: CE431
Easting: 685,504.1 m
Northing: 6,290,946.7 m
Azimuth: 291°
Dip: 53°
Horizontal Datum: GDA94
Surface Elevation: 688.00 m

0 1m

HATCH	Drill Core Photograph			Drillhole No.:	CE431
				Easting:	685,504.1 m
				Northing:	6,290,946.7 m
				Azimuth:	291°
Client:	Newcrest	Project No.:	H356804	Dip:	53°
Project :	Cadia NTSF Failure Review			Horizontal Datum:	GDA94
Location:	Stage 2 Buttress - East	Page 3 of 28		Surface Elevation:	688.00 m

0 1m

HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Stage 2 Buttress - East	Page 4 of 28	

Drillhole No.:	CE431
Easting:	685,504.1 m
Northing:	6,290,946.7 m
Azimuth:	291°
Dip:	53°
Horizontal Datum:	GDA94
Surface Elevation:	688.00 m

0 1m

HATCH	**Drill Core Photograph**	Drillhole No.: CE431 Easting: 685,504.1 m Northing: 6,290,946.7 m Azimuth: 291° Dip: 53°
Client: Newcrest	Project No.: H356804	
Project : Cadia NTSF Failure Review		Horizontal Datum: GDA94
Location: Stage 2 Buttress - East	Page 5 of 28	Surface Elevation: 688.00 m

0 1m

HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Stage 2 Buttress - East	Page 6 of 28	

Drillhole No.:	CE431
Easting:	685,504.1 m
Northing:	6,290,946.7 m
Azimuth:	291°
Dip:	53°
Horizontal Datum:	GDA94
Surface Elevation:	688.00 m

0 1m

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Stage 2 Buttress - East	Page 7 of 28	

Drillhole No.: CE431
Easting: 685,504.1 m
Northing: 6,290,946.7 m
Azimuth: 291°
Dip: 53°
Horizontal Datum: GDA94
Surface Elevation: 688.00 m

HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Stage 2 Buttress - East	Page 8 of 28	

Drillhole No.:	CE431
Easting:	685,504.1 m
Northing:	6,290,946.7 m
Azimuth:	291°
Dip:	53°
Horizontal Datum:	GDA94
Surface Elevation:	688.00 m

0 1m

HATCH	Drill Core Photograph			Drillhole No.: CE431	
				Easting:	685,504.1 m
				Northing:	6,290,946.7 m
				Azimuth:	291°
Client:	Newcrest	Project No.:	H356804	Dip:	53°
Project :	Cadia NTSF Failure Review			Horizontal Datum:	GDA94
Location:	Stage 2 Buttress - East	Page 9 of 28		Surface Elevation:	688.00 m

0 1m

HATCH

Drill Core Photograph

Client: Newcrest

Project : Cadia NTSF Failure Review

Location: Stage 2 Buttress - East

Project No.: H356804

Drillhole No.: CE431

Easting: 685,504.1 m

Northing: 6,290,946.7 m

Azimuth: 291°

Dip: 53°

Horizontal Datum: GDA94

Surface Elevation: 688.00 m

0 1m

HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Stage 2 Buttress - East	Page 11 of 28	

Drillhole No.:	CE431
Easting:	685,504.1 m
Northing:	6,290,946.7 m
Azimuth:	291°
Dip:	53°
Horizontal Datum:	GDA94
Surface Elevation:	688.00 m

0 1m

HATCH	Drill Core Photograph			Drillhole No.: CE431
				Easting: 685,504.1 m
				Northing: 6,290,946.7 m
				Azimuth: 291°
Client:	Newcrest	Project No.:	H356804	Dip: 53°
Project :	Cadia NTSF Failure Review			Horizontal Datum: GDA94
Location:	Stage 2 Buttress - East	Page 12 of 28		Surface Elevation: 688.00 m

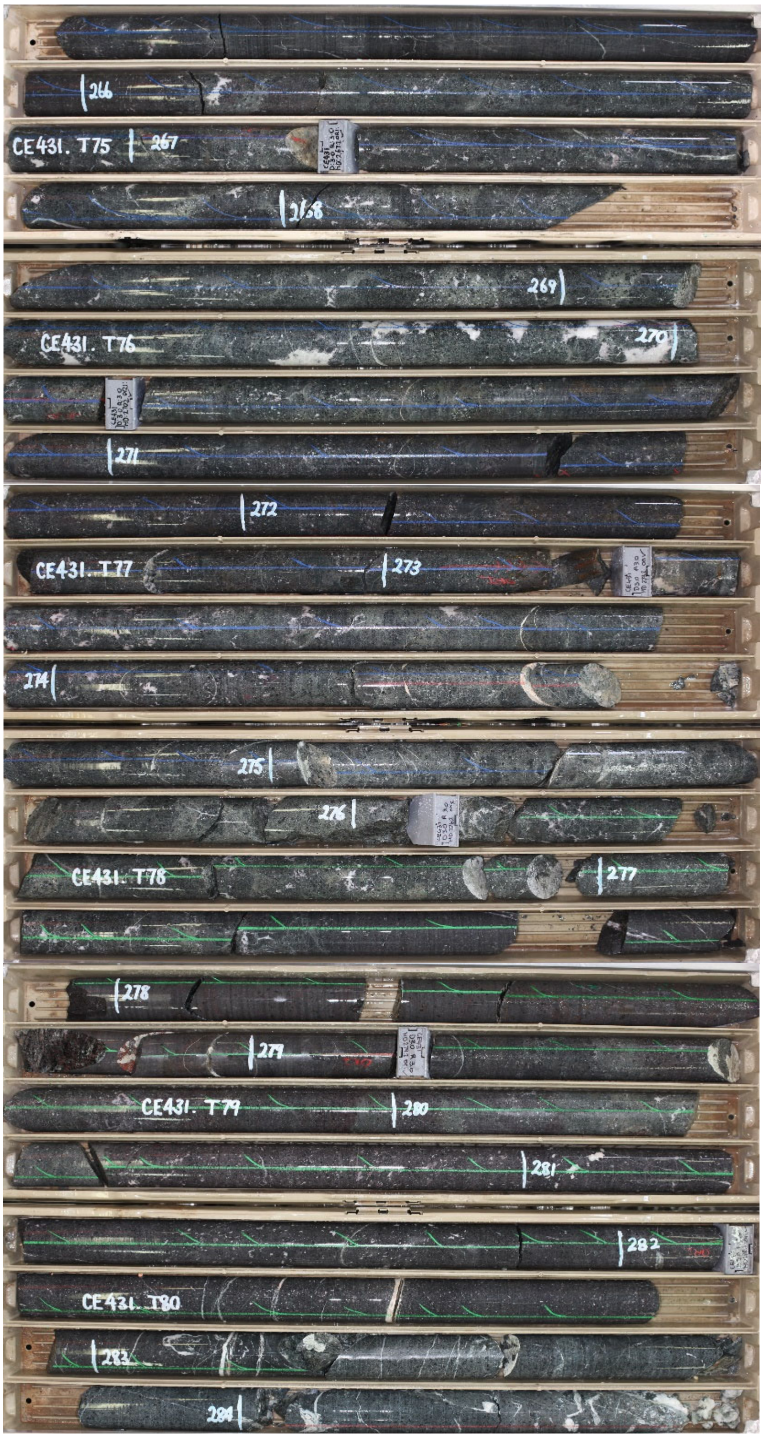
0 — 1m

HATCH	Drill Core Photograph			Drillhole No.: CE431 Easting: 685,504.1 m Northing: 6,290,946.7 m Azimuth: 291° Dip: 53°
Client:	Newcrest	Project No.:	H356804	
Project :	Cadia NTSF Failure Review			Horizontal Datum: GDA94
Location:	Stage 2 Buttress - East	Page 13 of 28		Surface Elevation: 688.00 m

0 1m

HATCH	**Drill Core Photograph**			Drillhole No.: CE431
				Easting: 685,504.1 m
				Northing: 6,290,946.7 m
				Azimuth: 291°
Client:	Newcrest	Project No.:	H356804	Dip: 53°
Project :	Cadia NTSF Failure Review			Horizontal Datum: GDA94
Location:	Stage 2 Buttress - East	Page 14 of 28		Surface Elevation: 688.00 m

0 1m



Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Stage 2 Buttress - East	Page 15 of 28	

Drillhole No.:	CE431
Easting:	685,504.1 m
Northing:	6,290,946.7 m
Azimuth:	291°
Dip:	53°
Horizontal Datum:	GDA94
Surface Elevation:	688.00 m

0 1m

HATCH

Drill Core Photograph

Client: Newcrest

Project No.: H356804

Project : Cadia NTSF Failure Review

Location: Stage 2 Buttress - East

Page 16 of 28

Drillhole No.: CE431

Easting: 685,504.1 m

Northing: 6,290,946.7 m

Azimuth: 291°

Dip: 53°

Horizontal Datum: GDA94

Surface Elevation: 688.00 m

0 1m

HATCH

Drill Core Photograph

Client: Newcrest
Project No.: H356804
Project : Cadia NTSF Failure Review
Location: Stage 2 Buttress - East

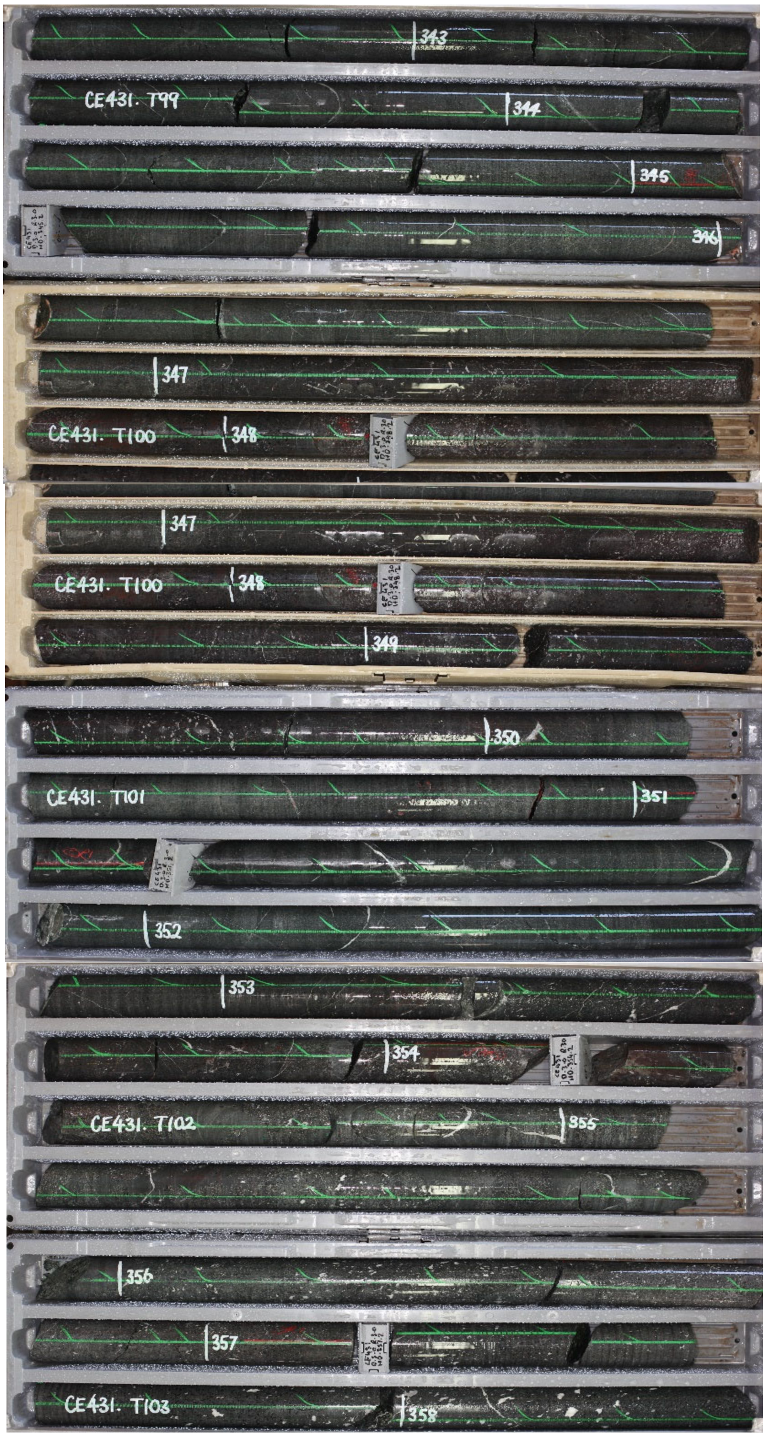
Drillhole No.: CE431
Easting: 685,504.1 m
Northing: 6,290,946.7 m
Azimuth: 291°
Dip: 53°
Horizontal Datum: GDA94
Surface Elevation: 688.00 m

0 1m

Drill Core Photograph	
Client: Newcrest	Project No.: H356804
Project : Cadia NTSF Failure Review	
Location: Stage 2 Buttress - East	Page 18 of 28

Drillhole No.:	CE431
Easting:	685,504.1 m
Northing:	6,290,946.7 m
Azimuth:	291°
Dip:	53°
Horizontal Datum:	GDA94
Surface Elevation:	688.00 m

0 1m



HATCH	**Drill Core Photograph**			Drillhole No.: CE431 Easting: 685,504.1 m Northing: 6,290,946.7 m Azimuth: 291° Dip: 53°
Client:	Newcrest	Project No.:	H356804	Horizontal Datum: GDA94
Project :	Cadia NTSF Failure Review			
Location:	Stage 2 Buttress - East	Page 19 of 28		Surface Elevation: 688.00 m

0 1m

HATCH

Drill Core Photograph

Client: Newcrest

Project No.: H356804

Project : Cadia NTSF Failure Review

Location: Stage 2 Buttress - East

Drillhole No.: CE431

Easting: 685,504.1 m

Northing: 6,290,946.7 m

Azimuth: 291°

Dip: 53°

Horizontal Datum: GDA94

Surface Elevation: 688.00 m

0 1m

HATCH	**Drill Core Photograph**		
Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Stage 2 Buttress - East	Page 21 of 28	

Drillhole No.: CE431
Easting: 685,504.1 m
Northing: 6,290,946.7 m
Azimuth: 291°
Dip: 53°
Horizontal Datum: GDA94
Surface Elevation: 688.00 m

0 ... 1m

HATCH

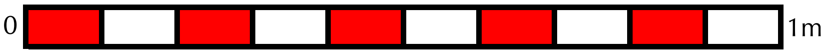
Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Stage 2 Buttress - East	Page 22 of 28	

Drillhole No.:	CE431
Easting:	685,504.1 m
Northing:	6,290,946.7 m
Azimuth:	291°
Dip:	53°
Horizontal Datum:	GDA94
Surface Elevation:	688.00 m

0 1m

HATCH	Drill Core Photograph			Drillhole No.: CE431
				Easting: 685,504.1 m
				Northing: 6,290,946.7 m
				Azimuth: 291°
Client:	Newcrest	Project No.:	H356804	Dip: 53°
Project :	Cadia NTSF Failure Review			Horizontal Datum: GDA94
Location:	Stage 2 Buttress - East	Page 23 of 28		Surface Elevation: 688.00 m



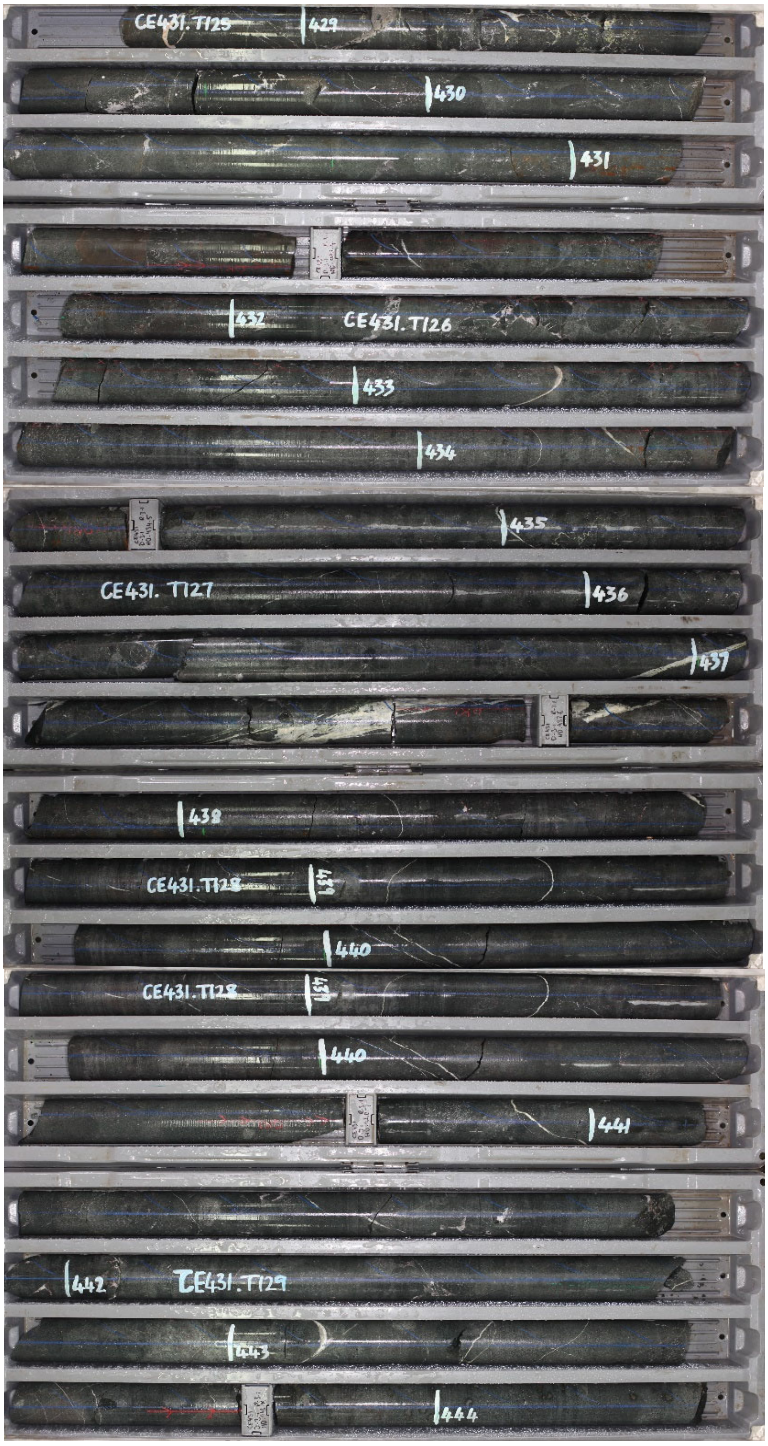
HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Stage 2 Buttress - East	Page 24 of 28	

Drillhole No.:	CE431
Easting:	685,504.1 m
Northing:	6,290,946.7 m
Azimuth:	291°
Dip:	53°
Horizontal Datum:	GDA94
Surface Elevation:	688.00 m

0 1m



HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Stage 2 Buttress - East	Page 25 of 28	

Drillhole No.:	CE431
Easting:	685,504.1 m
Northing:	6,290,946.7 m
Azimuth:	291°
Dip:	53°
Horizontal Datum:	GDA94
Surface Elevation:	688.00 m

0 1m

HATCH

Drill Core Photograph

Client:	Newcrest	Project No.:	H356804
Project :	Cadia NTSF Failure Review		
Location:	Stage 2 Buttress - East	Page 26 of 28	

Drillhole No.:	CE431
Easting:	685,504.1 m
Northing:	6,290,946.7 m
Azimuth:	291°
Dip:	53°
Horizontal Datum:	GDA94
Surface Elevation:	688.00 m

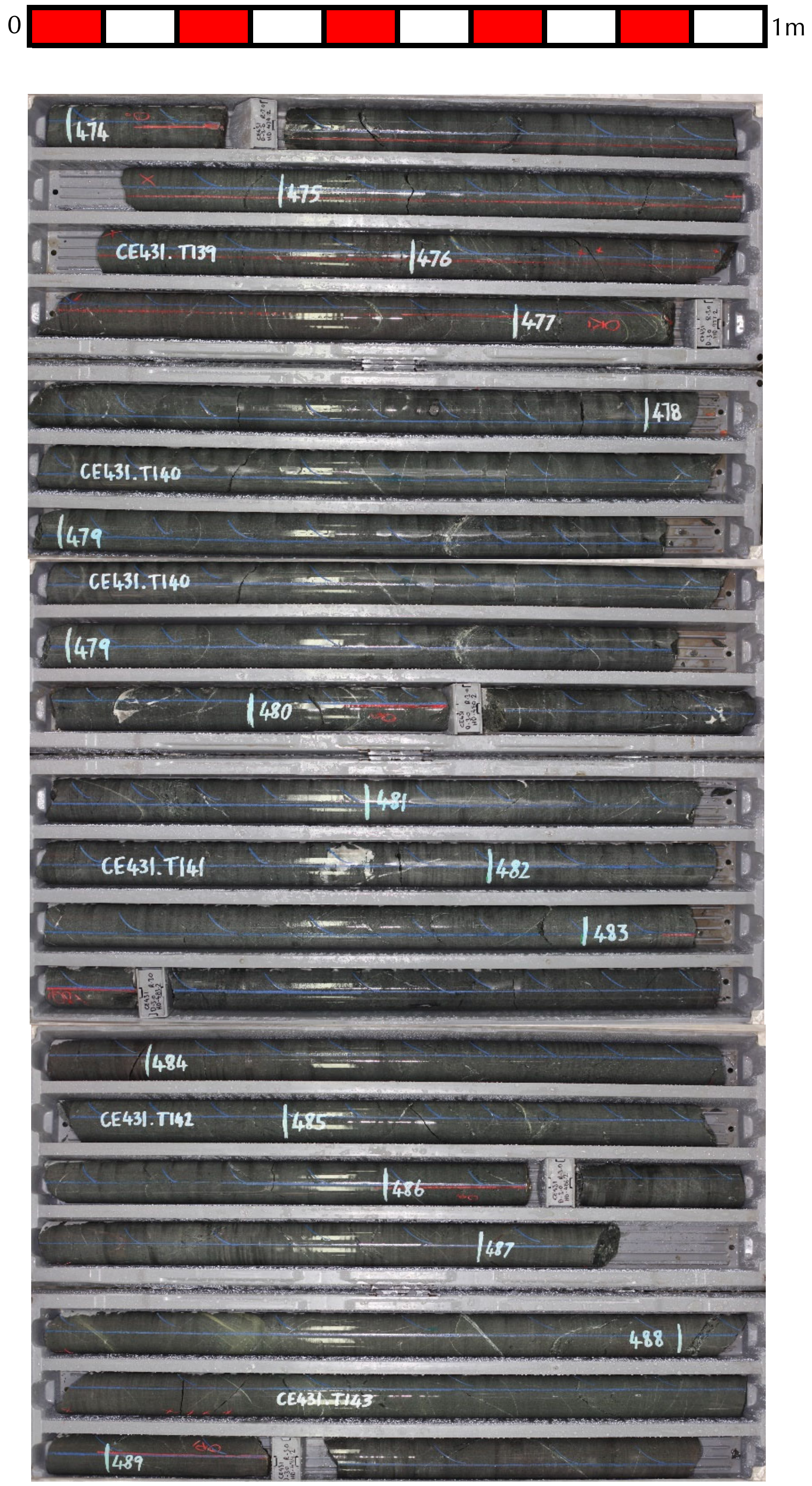
0 1m

HATCH

Drill Core Photograph

Drillhole No.: CE431
Easting: 685,504.1 m
Northing: 6,290,946.7 m
Azimuth: 291°
Dip: 53°
Horizontal Datum: GDA94
Surface Elevation: 688.00 m

Client: Newcrest
Project No.: H356804
Project : Cadia NTSF Failure Review
Location: Stage 2 Buttress - East
Page 27 of 28



HATCH	**Drill Core Photograph**		Drillhole No.: CE431
			Easting: 685,504.1 m
			Northing: 6,290,946.7 m
			Azimuth: 291°
Client: Newcrest		Project No.: H356804	Dip: 53°
Project : Cadia NTSF Failure Review			Horizontal Datum: GDA94
Location: Stage 2 Buttress - East		Page 28 of 28	Surface Elevation: 688.00 m

0 1m

Annexure CH
Palynology Report

POLLEN ANALYSIS OF SEDIMENTS ASSOCIATED WITH BASALTS NEAR CADIA, ORANGE DISTICT, CENTRAL-WEST NEW SOUTH WALES

Mike Macphail

Sub-fossil corpse of an unidentified insect identical to those recovered from 16.5 m depth in CE417

Revised report prepared 30 November 2018 for *Hatch*
61 Petrie Terrace, Brisbane, QLD 4000, Australia

Consultant Palynological Services, 13 Walu Place Aranda, ACT 2614
Ph. 0432-233-230. E-mail mike.macphail@anu.edu.au

SYNOPSIS

- Two samples associated with basalts from the Cadia gold mine *c*. 25 km southwest of Orange in central-west NSW were submitted for dating via fossil pollen and spores.

- CE417 16.5 m depth, from a sub-basaltic clay identified by *Hatch* geologists as possibly lacustrine', yielded trace numbers of modern pollen and the corpses of an unidentified micro-insect. Microfossils representing aquatic or semi-aquatic plants were not recorded.

- CE417 16.95 m depth, from sub-basaltic clay surrounding a fossilized root, did not preserve any spores or pollen (modern or fossil) and cannot be dated.

- Neither sample can be dated using fossil pollen and spores but isotopic dates for basalts near Cadia indicate the basalts will be mid Miocene, i.e. between *c* 11 and 13 million years old.

INTRODUCTION

Plant microfossil, in particular pollen and spores, are widely used to date fine textured Phanerozoic sediments and reconstruct past depositional environments across Australia. In some cases the same deposits can be independently dated using isotopic technique, e.g. unweathered basalts (see Gibson 2007).

This report

This report analyses and discusses pollen and spores (miospores) and other microfossils preserved in two samples of sub-basaltic clays submitted by Ian Gordon (Hatch) from the Cadia gold mine in the Orange district on the central western plains of NSW, Australia (Figs.1, 2). Aims were to:

- To determine whether fossil pollen and spores were preserved in the samples and, if so,
- Use these plant microfossils to date the samples and reconstruct the environment prevailing at the time(s) of deposition.

Fig. 1: Map showing the location of Orange in central-west NSW

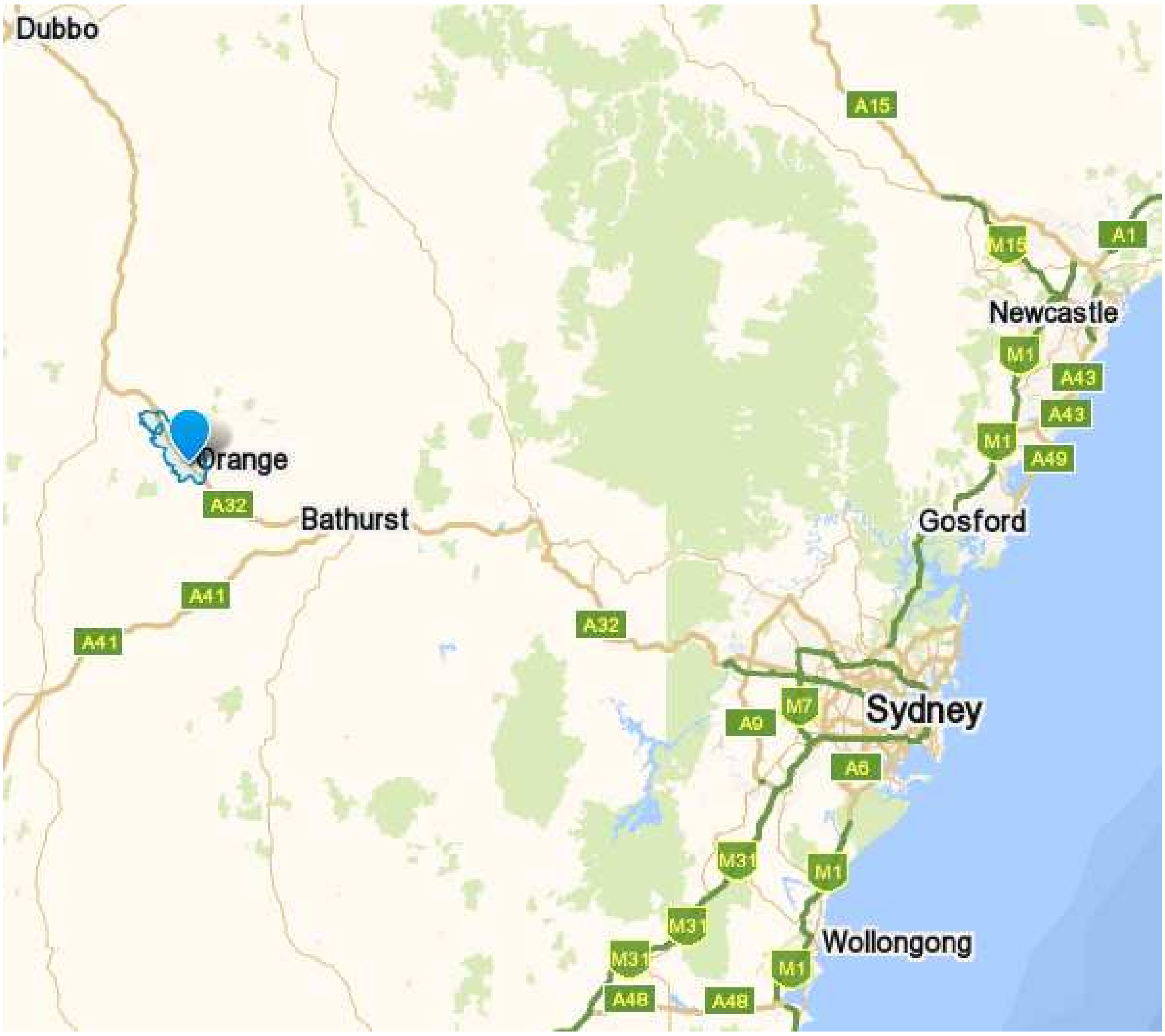


Fig. 2: Location of Cadia gold mine. Dark green areas between the mine and Orange are uncleared areas of sclerophyll vegetation growing on the extinct volcano of Mt. Canobolas and on lava flows around the volcano (from Google Earth TM)

3. SETTING

The Cadia mine, one of Australia's largest gold mines, is located 25 kilometres from the city of Orange in central west New South Wales and 250 kilometres west of Sydney.

Owing to a mean elevation of 862 metres (2,828 feet), the district has a temperate climate, characterized by warm summers, cool winters with frequent frosts and occasional snow falls. Rainfall is enhanced by the proximity of Mt. Canobolas and, for this reason and fertile soils, much of the surrounding district has been long-cleared for agriculture, including grazing and stone-fruits, and pine (*Pinus radiata*) plantations.

In contrast ,the slopes of Mt. Canobolas remains uncleared and support a complex of *Eucalyptus*-dominated native forest, woodland, grassy woodland and sclerophyll heath communities. These communities have been severely impacted by bushfires, e.g. in 1967, 1982 and as recently as February of this year [en.wikipedia.org/wiki/Mount_Canobolas]. A detailed species lists of the plant species is given in Hunter (ibid).

3.1 Geology

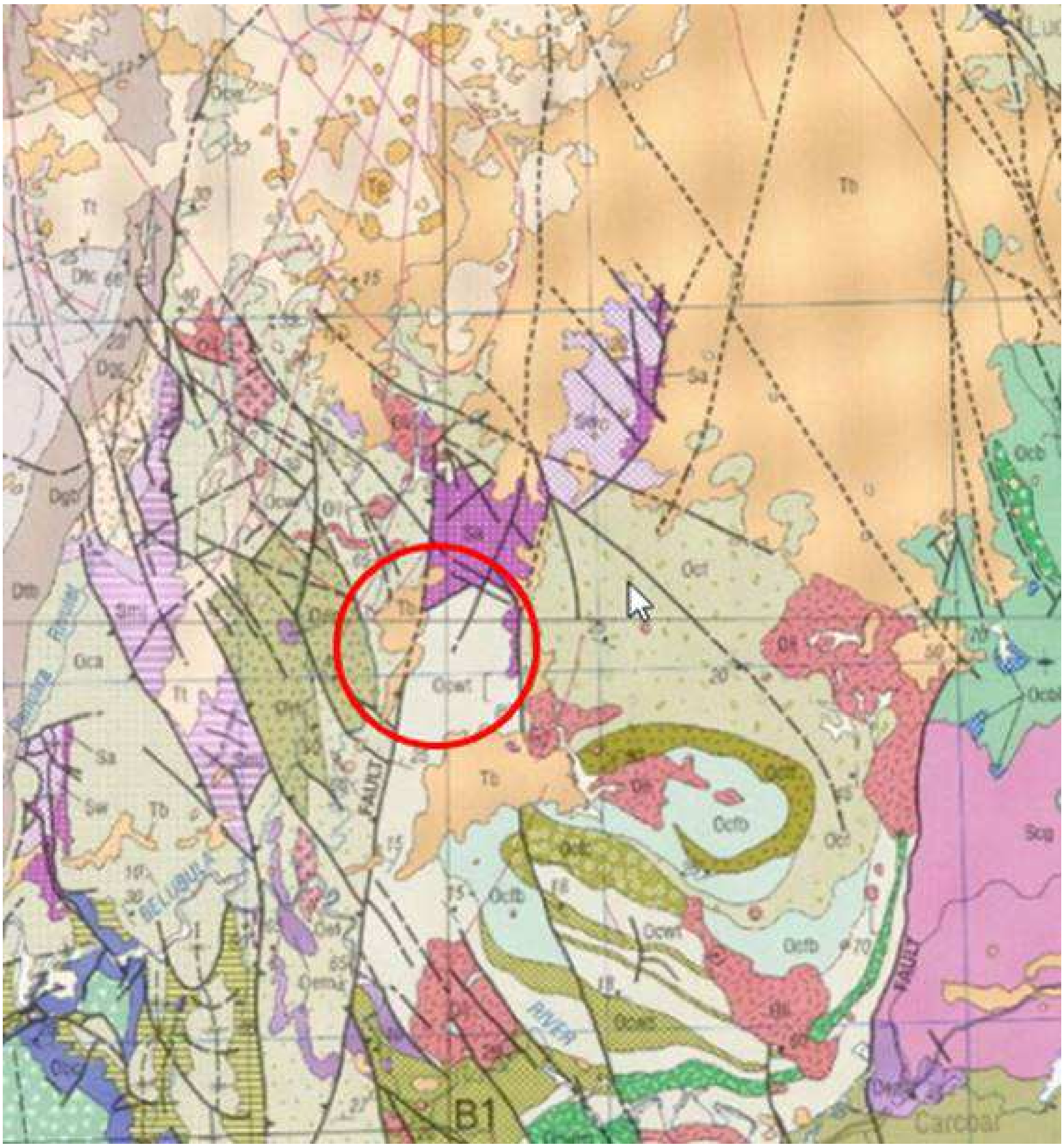
Details on the geology/geomorphology of Mt. Canobolas and Cadia gold mine are available from [www.resourcesandenergy.nsw.gov.au/miners-and-explorers/geoscience-information/…] and Wilson (2003), respectively.

The Orange district are underlain by Ordovician mafic volcanic sandstones, basalts, siltstones and black shales (marked **Oco** on Fig. 3), with smaller outcrops of volcanics replaced by magnetite-haematite to the east and south. These rocks predate the evolution of terrestrial plant life.

Mt. Canobolas, which is a spur of the Great Dividing Range, is an extinct volcano that erupted in several phases in the mid Miocene between c 11-13 million years (Ma) ago (Gibson 2007). Earlier eruptions are claimed to have been less violent than later ones, with free flowing lavas extending over large areas. Basalts (marked **Tb** on Fig. 3) outcrop within or adjacent to the mined area (red circle) and have been reported in sub-crop in the same general area (Hunter 2002).

The complex of volcanic domes, vents, dykes and plugs consist of extrusive igneous rocks (predominately tracyte) but it is probable that potentially fossiliferous deposits have accumulated during quiescent periods.

Fig. 3: Geological map of Mt Canobolas and Cadia areas showing the location of the mine (red circle). The Tertiary basalt outcrop marked **Tb**, on the southern margin of the circle is assumed to be that sampled for this study (map provided by Ian Gordon)



4. PALYNOLOGY

4.1 Sample data

The sub-basaltic clay sample at 16.5 m depth in **CE417** is considered to be of possible lacustrine origin (I. Gordon pers. com.). The sub-basaltic clay sample at 16.95 m depth **CE417** taken below the possible 'lacustrine' clay is penetrated by a medium sized root (Fig. 4).

Both samples were processed for acid-resistant microfossils by *MGPalaeo* Pty. Ltd. (Perth) using only physical (microfiltration) techniques to remove organic fines small than 5 microns in diameter.

Fig. 4: Image of **CE417 16.95 m** depth showing a poorly-preserved fossil root penetrating probable weathered volcanoclastic deposits. Samples of the heavy grey clay matrix processed for plant microfossils were taken adjacent to this root (photo by Ian Gordon)

4.2 Age control

The time distributions of fossil pollen and spores used to date Tertiary (now Palaeogene-Neogene) sediments in South-East Australia are given in Macphail (1999) and Partridge (1999).

Volcanic rocks at a site 21 km SSE of Orange have been potassium/argon-dated as 11.8 Ma (Jones 1987 cited in Gibson (2007: 40).

4.2 Organic yield

Both samples yielded finely dispersed well-preserved to strongly humified lignitic plant detritus although yields varied markedly – from negligible in the sub-basaltic clay (**CE417 16.95 m**) to abundant in the sub-basaltic 'lacustrine clay' (**CE417 16.5 m**). In both cases the plant detritus was predominantly lignitic and is suggested to have been derived from root tissues.

4.3 Results

CE417 16.95 m depth lacked fossil pollen and spores (i.e. is palynologically barren) whilst the negligible number of pollen and spores in **CE417 16.5 m** depth almost certainly are modern contaminants (Table 1). Otherwise the microfossil component in this ample consisted of abundant fungal spores (chiefly *Diporicellaesporites* and *Multicellaesporites* spp.) and included the remains of an unidentified micro-insect (see Frontispiece)

Table 1: Microfossils recovered from **CE417 16.5 m** depth

Microfossil type	Common name	Comment	
Plants			
Allocasuarina/Casuarina	she- & river-oaks	1 specimen	Definite modern contaminant (bright yellow colour)
Asteraceae (Tubuliflorae)	daisy/daisy-bush family	1 specimen	Probable modern contaminant
Chenopodiaceae	salt-bush/samphires	1 specimen	Definite modern contaminant (pollen includes cytoplasm)
Myrtaceae (Chamelaucieae)	(numerous genera)	1 specimen	Probable modern contaminant (type not known as a fossil *)
Myrtaceae (*Eucalyptus*-type)	gum-trees, eucalypts	1 specimen	Definite modern contaminant (pollen includes cytoplasm)
Insects			
Unidentified micro-insect	-	9 specimens	identical specimens found as subfossil in 19th century deposits

* Thornhill & Macphail (2012)

4.4 Comment

CE417 16.5 m depth:

- The sub-basaltic 'lacustrine' clay preserved trace numbers of pollen grains and low numbers of the corpses of an unidentified micro-insect. All specimens are considered to be modern contaminants, carried down into the deposit on the cutting head during undisturbed sampling of the deposit.

- In the highly unlikely event that the Asteraceae pollen grain is contemporary with the plant detritus, the maximum age of the sample will be Miocene, based on the first appearance of the fossil pollen type (*Tubulifloridites simplis*) in Southeast Australia.

- Pollen of aquatic or semi-aquatic plants were not recorded and the data are inadequate to determine if the depositional environment of the clay at 16.5 m was or was not lacustrine.

CE417 16.95 m depth:

- The sub-basaltic clay sample did not preserve plant microfossils and cannot be dated. On the evidence available the clay matrix has not been exposed to the atmosphere during or since deposition.

- A Miocene age is considered probable based on Potassium/Argon dating of 'Tertiary' volcanics elsewhere in the Cadia area (cf. Gibson 2007).

Pollen analysis confirms that clays and claystones interbedded with volcanic and volcanoclastic deposits elsewhere in eastern Australia can preserve abundant fossil pollen and spores, which in turn can be used to date the sediments. Examples from claystones between two independently-dated (*c*. 23 Ma) basalts exposed during construction of the Toowoomba Main Range By-pass in Southeast Queensland are reproduced in Fig. 5.

Fig. 5: Fossil pollen and spores preserved in a *c.* 23 Ma claystone from Toowoomba (from Macphail & Gibson 2104).

5. REFERENCES

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Partridge, A.D. (1999). Late Cretaceous to Tertiary Geological Evolution of the Gippsland Basin, Victoria, 2 Volumes. PhD Thesis, Latrobe University, Melbourne; 439 pp.

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Annexure CI
Petrographic Reports

CE405-29.7m

Macroscopic and binocular description of rock

This is a mostly dark-grey, porphyritic, dense, volcanic rock type featuring considerable colour and textural heterogeneity. Reddish patches, light greenish patches and whitish alteration patches are throughout the core sample. Variations in the distribution and size of the feldspar are commonplace.

Under the binocular microscope the rock displays a porphyritic texture with quite large phenocrysts of green pyroxene and numerous smaller crystals of feldspar. Pitting of the pyroxene indicates advanced weathering.

A scratch test shows that the rock type is generally quite hard and could not be easily scratched (except for numerous small soft parts). It was fairly easy to cut.

An acid test reveals that there is abundant reactive carbonate. Porosity is moderately low.

Petrographic description of thin-section

This is porphyritic, chemically intermediate volcanic rock that has an involved alteration history. It has been modified by hydrothermal fluids that periodically changed its composition, if only slightly. Without a detailed knowledge of the extremely fine groundmass this rock appears to be a pyroxene andesite with large, quite common phenocrysts of calcic pyroxene (to 4mm) and smaller phenocrysts of plagioclase feldspar (to 3mm). As illustrated in the photograph the groundmass consists of extremely numerous tiny laths of feldspar and abundant submicroscopic chlorite. One feature of the groundmass is its variability and the presence of numerous irregular patches of chlorite. Without any certainty, some of the shapeless patches have the appearance of voids caused by volatiles in a fairly fluid lava. The small to large (>12mm) patches of carbonate are also highly irregular.

There is no alignment of the feldspar and apart from the deformation in the carbonate there are no obvious signs in the mineralogy. Yet there is a shear zone with a small section of mylonitized rock (see photograph).

The outstanding textural feature is the close intermingling of patches of groundmass with chlorite. The groundmass patches are typically between 1mm and 4mm with similar sized infillings of chlorite. In places it is somewhat reddish and other places it appears “burnt”. It is difficult to envisage a process that caused this texture except if the lava spewed out in shallow water, such as a lake or lagoon.

Post-crystallization hydrothermal fluid activity affected the rock and minerals such as sericite formed as partial replacement throughout the rock. Epidote also formed in high calcium environments such as plagioclase feldspar cores and in some of the calcic pyroxene small amounts of actinolite formed. In a few places secondary quartz formed, especially within the calcic pyroxene crystals.

Mode of rock

quartz	<1%
feldspar phenocrysts	20%
calcic pyroxene	16%
chlorite	25%
epidote	<1%
actinolite	1%
sericite	2%
carbonate	4%
opaque minerals	4%
others	<1%
groundmass	28%

Name of rock Altered andesite

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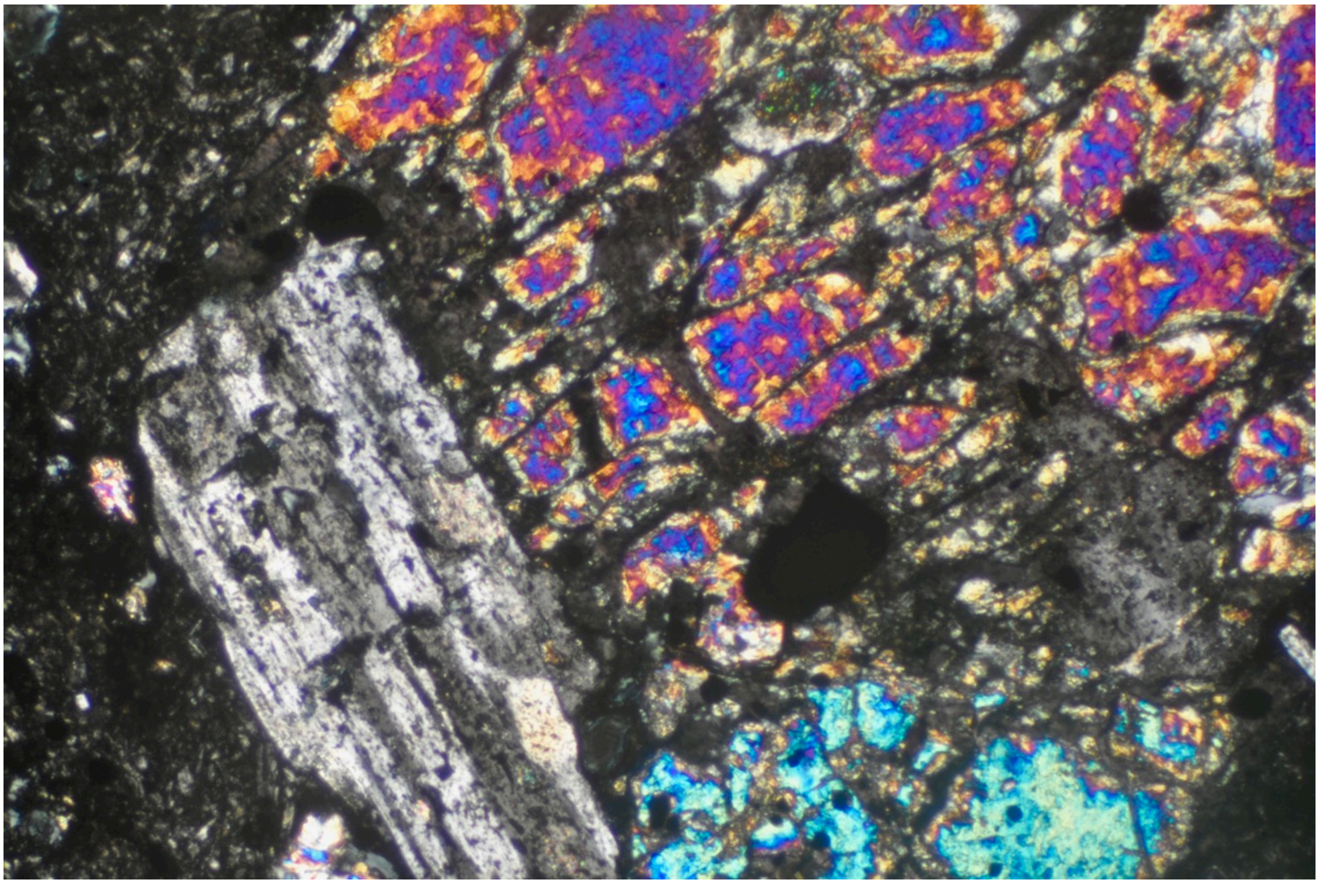
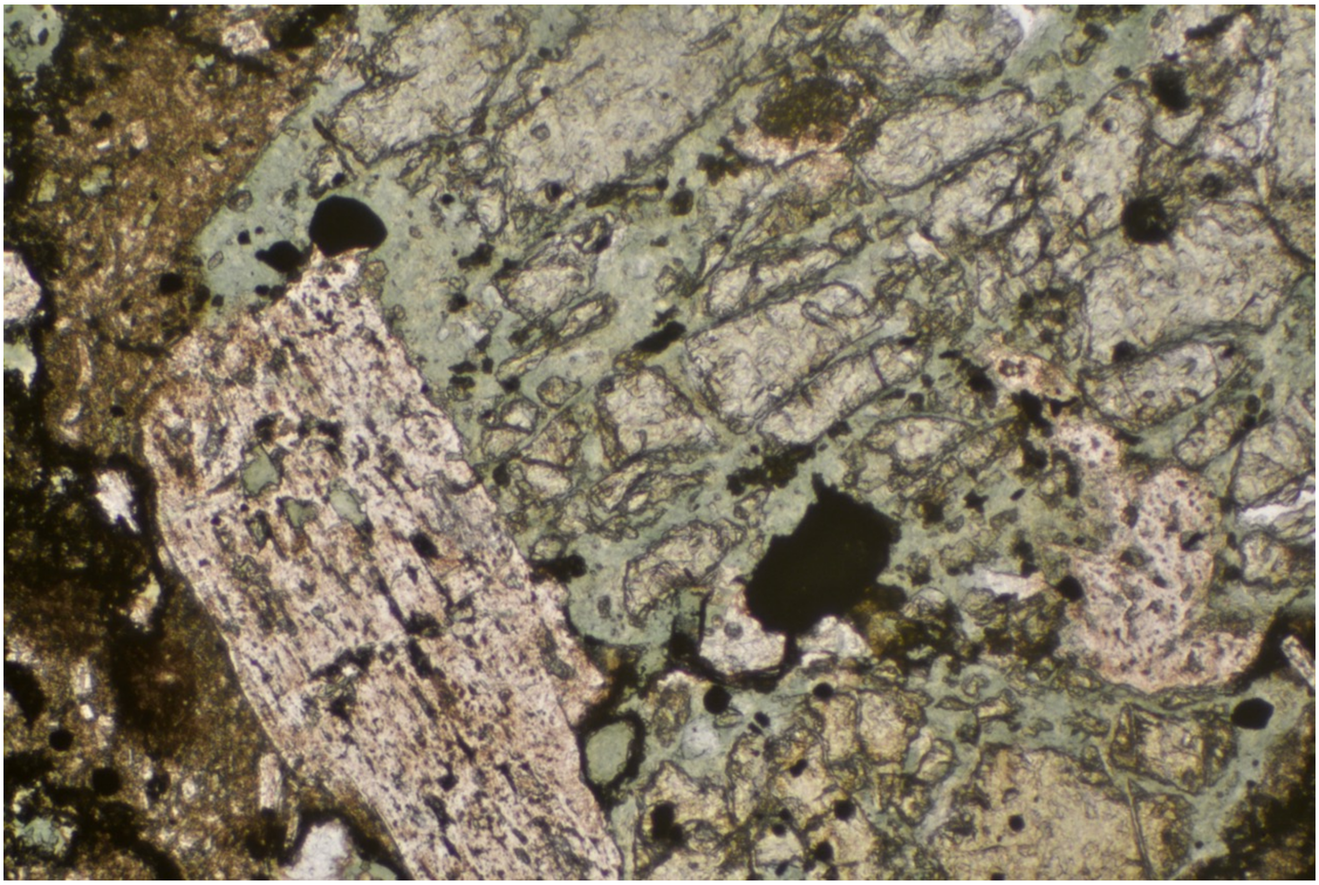
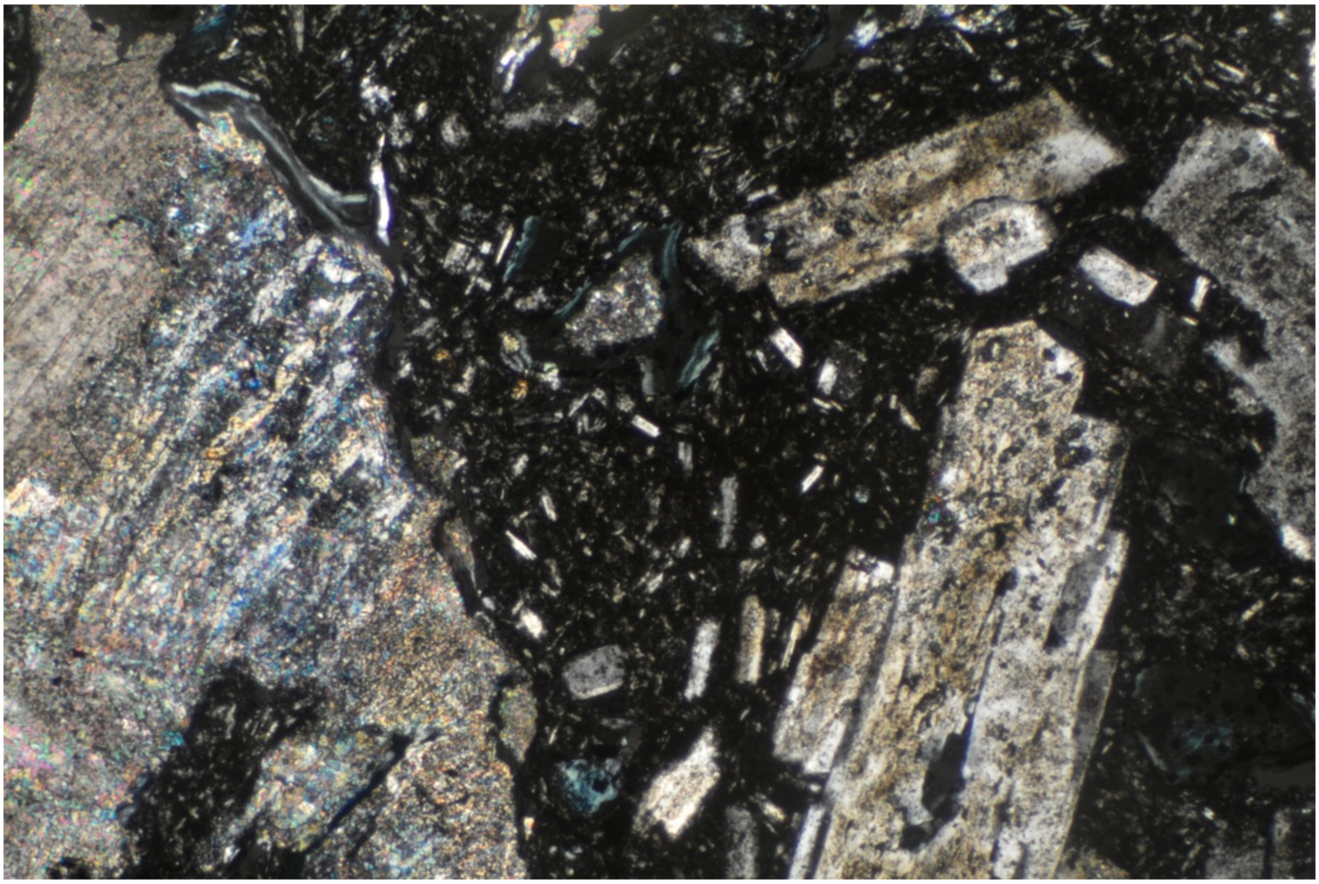
(27th August, 2018)



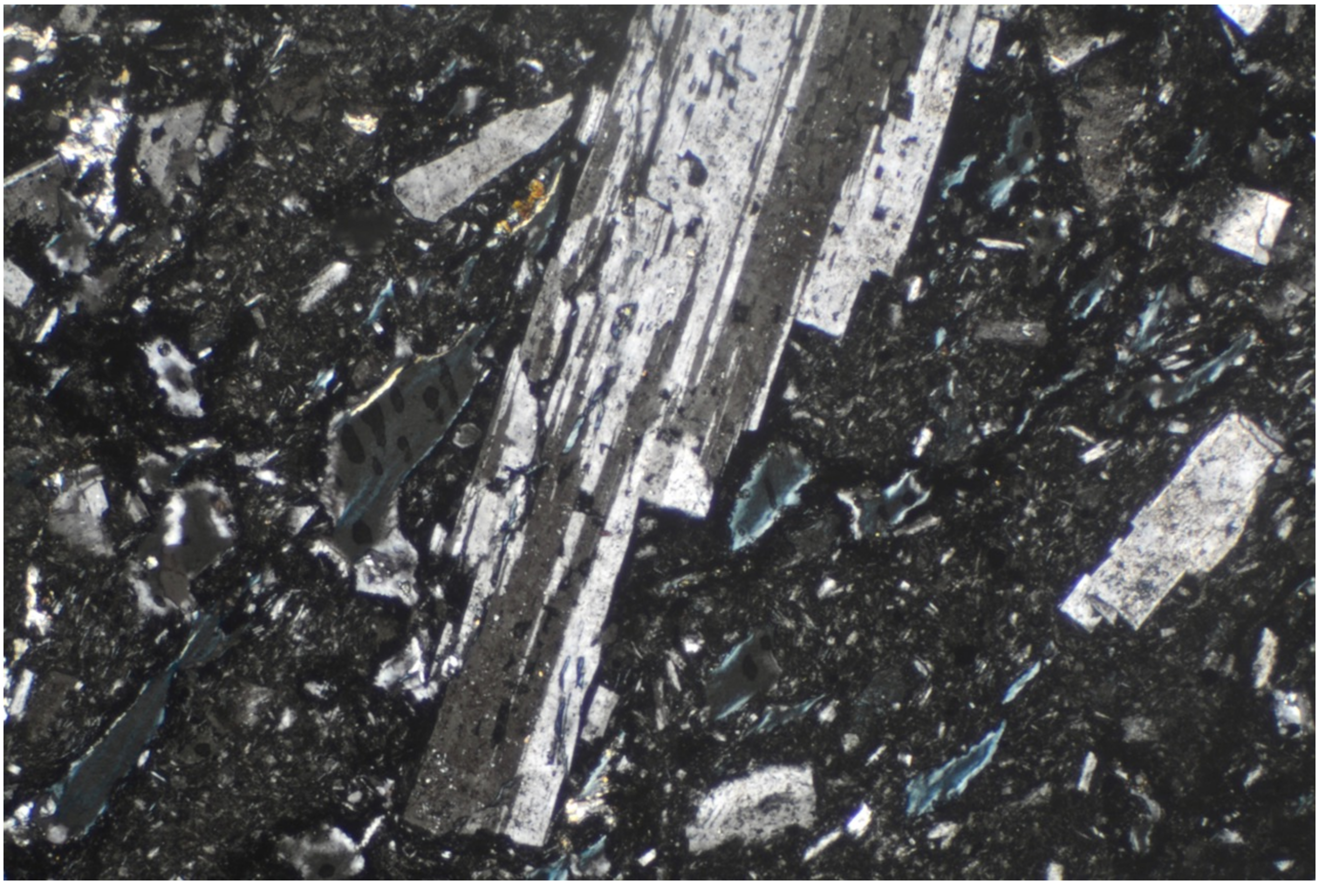
CE405-29.7m a - a common textural view in polarized light of this volcanic rock showing the main pyroxene and feldspar phenocrysts. Scale: side of photograph is 1.6mm



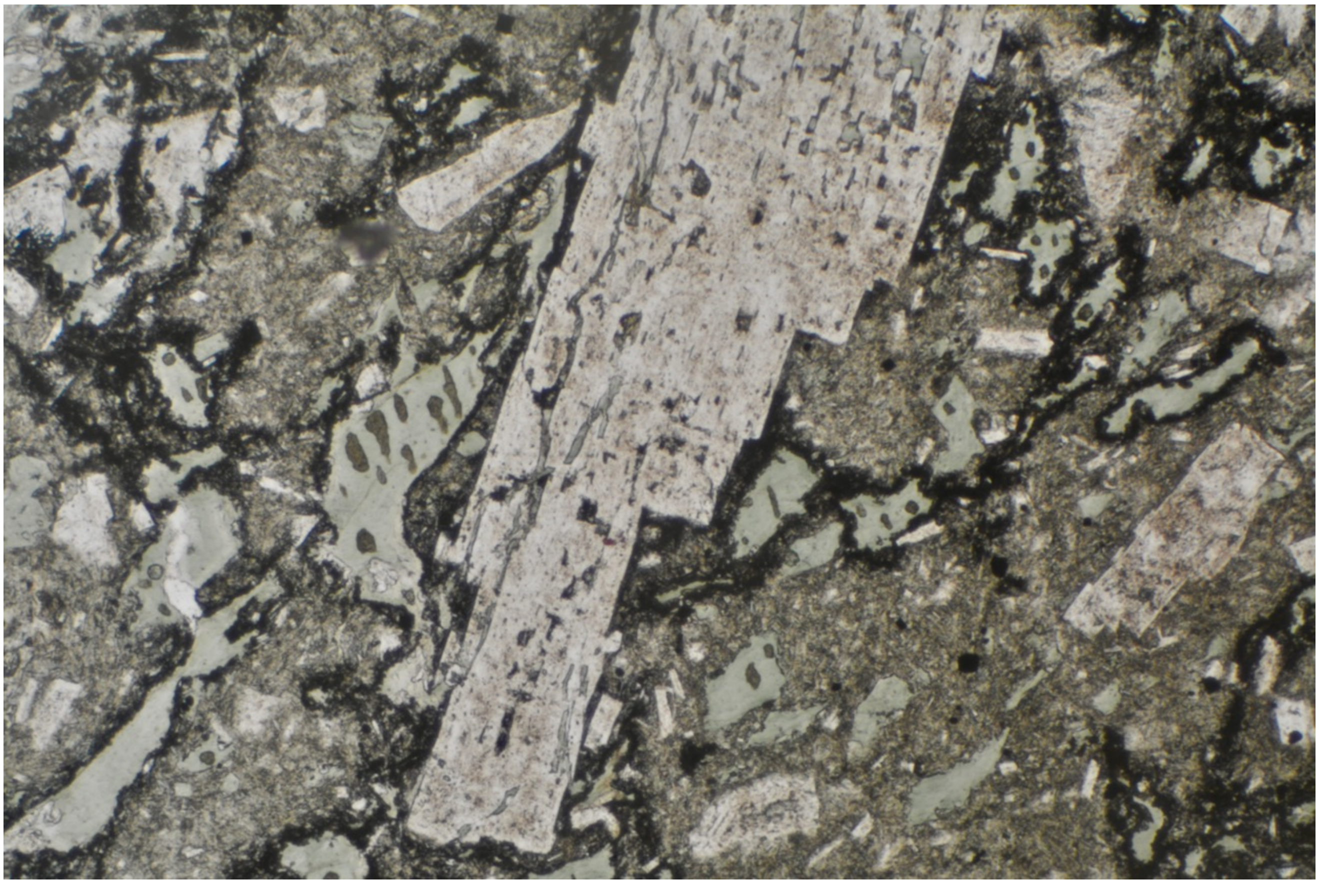
CE405-29.7m – b – same view as previous photo in ordinary light to better distinguish the dominant chlorite mineralogy. Scale: side of photograph is 1.6mm



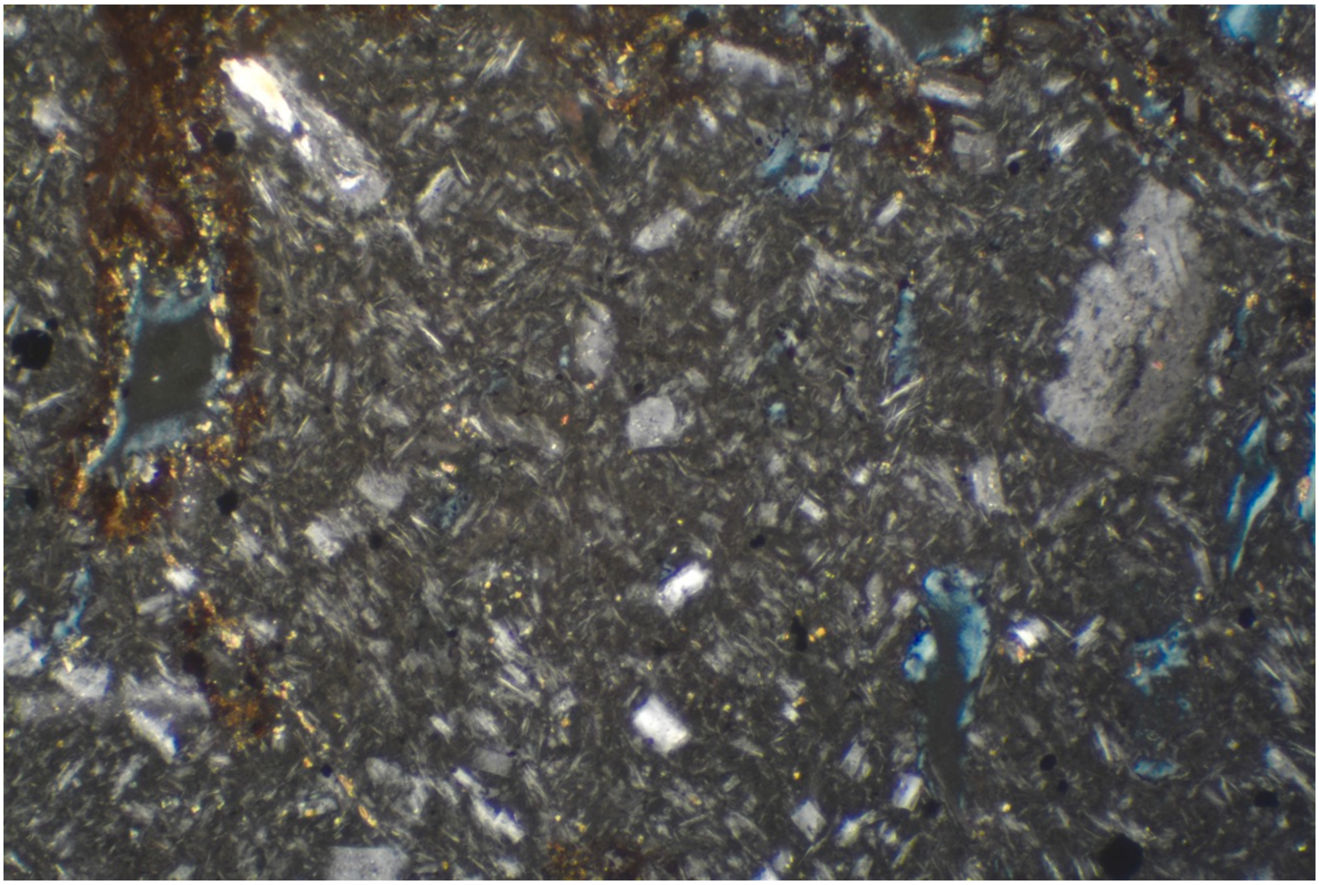
CE405-29.7m – c – feldspar phenocrysts set in a very fine-grained groundmass. The pastel-coloured mass to the left is carbonate. Scale: side of photograph is 1.6mm



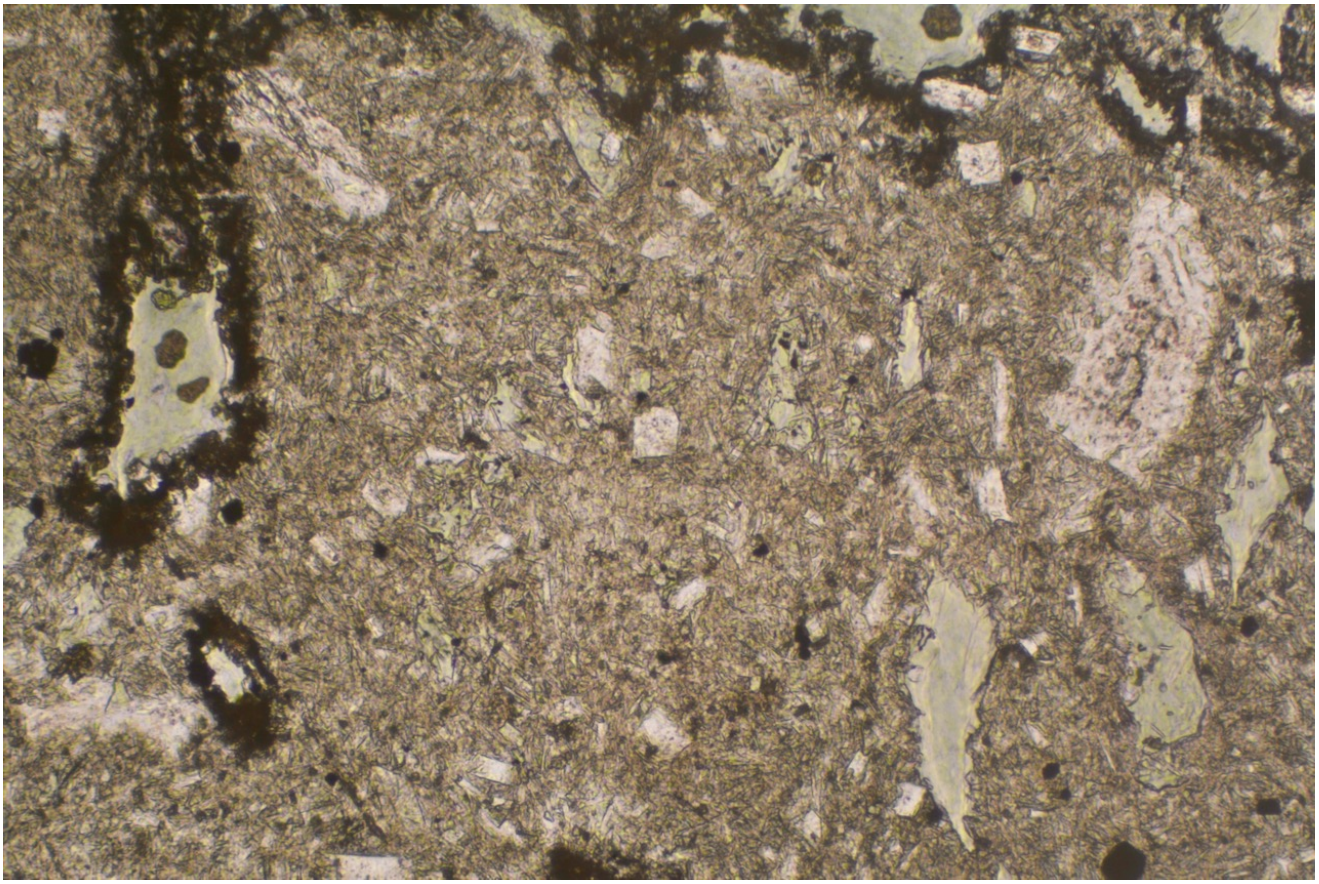
CE405-29.7m – d – more detailed view of the plagioclase feldspar in a groundmass that contains numerous irregular chlorite patches. Scale: side of photograph is 1.6mm



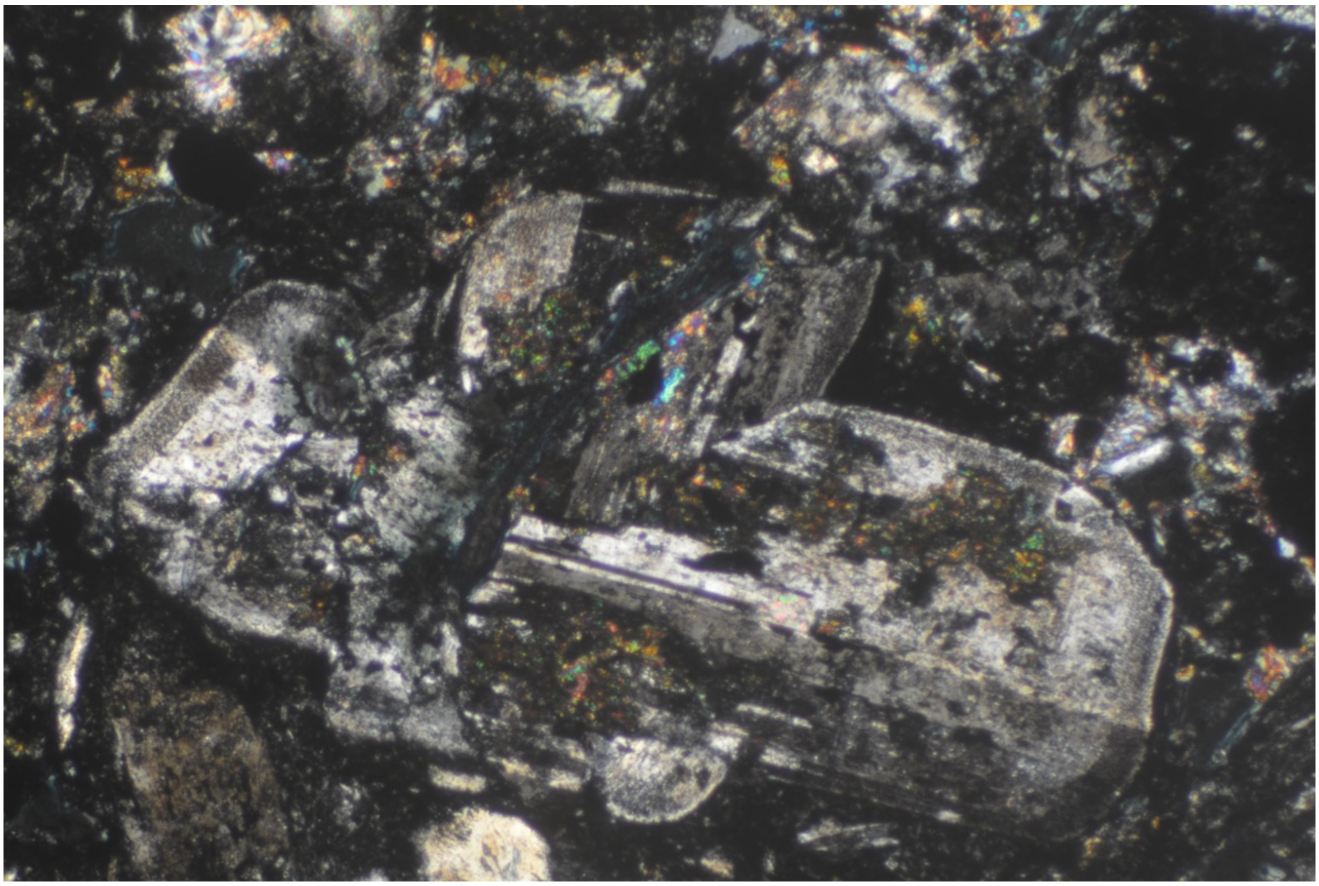
CE405-29.7m – e – same view as previous photo in ordinary light to highlight the amount of chlorite in the groundmass. Scale: side of photograph is 1.6mm



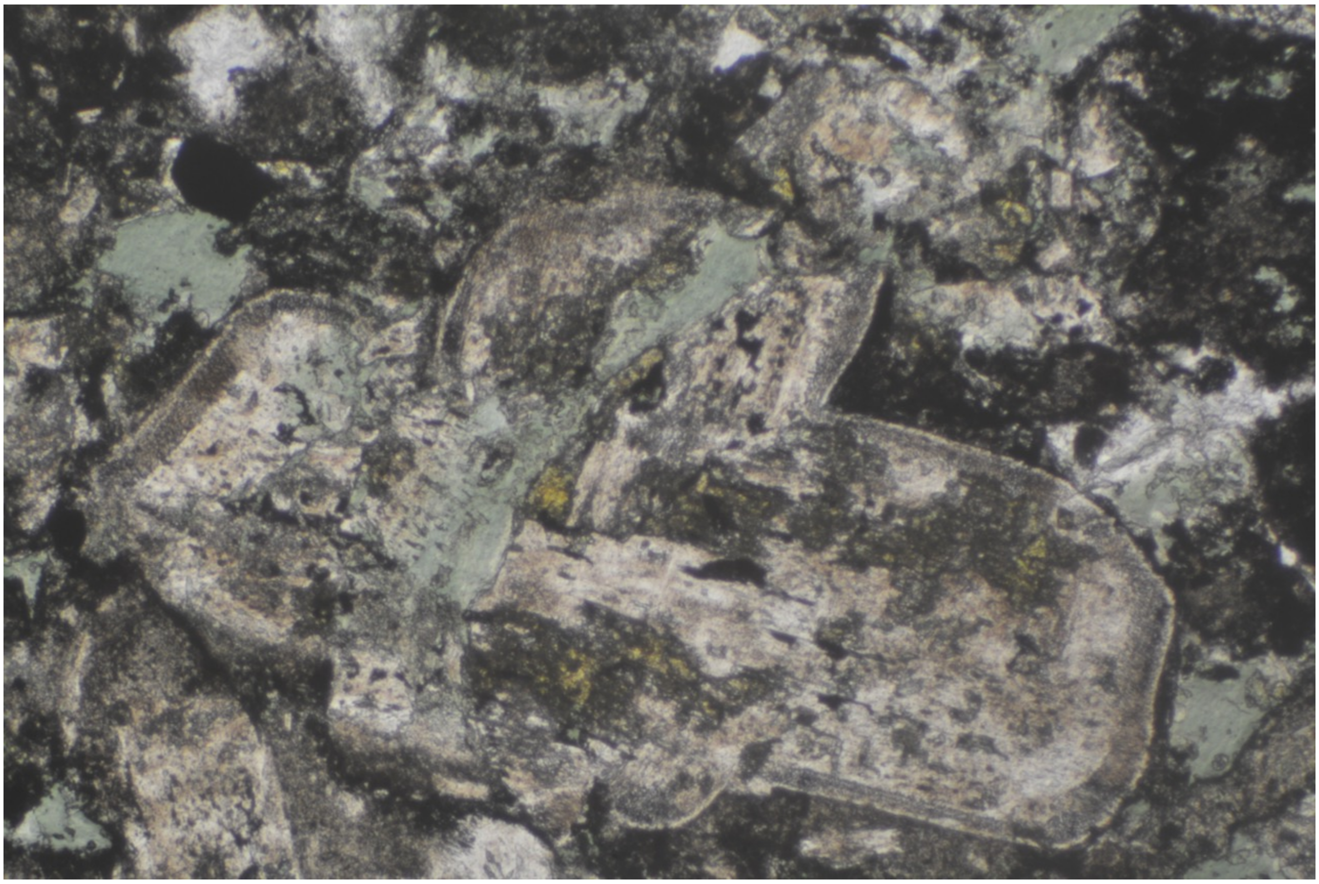
CE405-29.7m – f – a slightly magnified, condenser-enhanced view of the groundmass to reveal the detail in the groundmass. Scale: side of photograph is 0.8mm



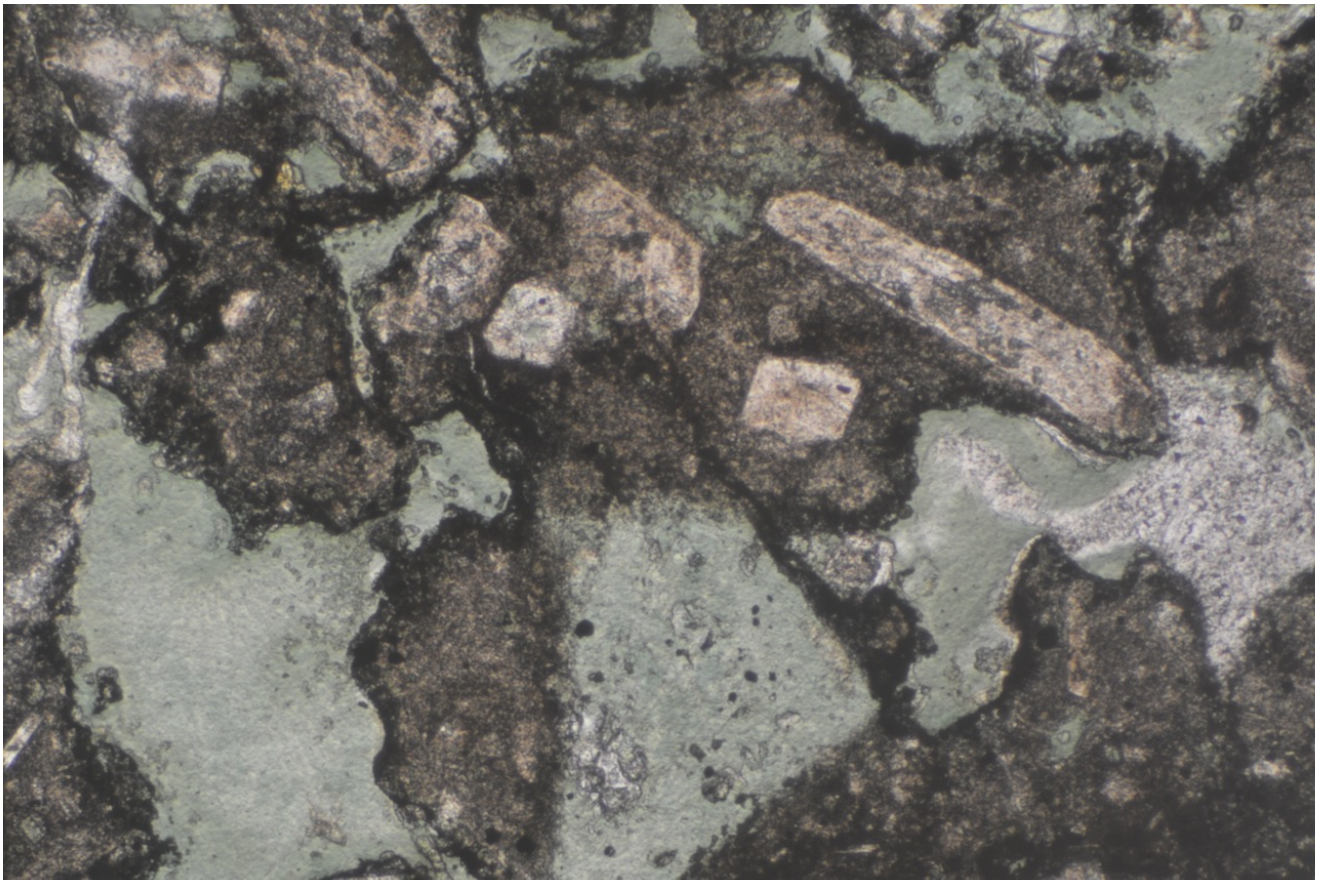
CE405-29.7m – g – same view as previous photo in ordinary light to show the abundance of submicroscopic chlorite throughout the groundmass. Scale: side of photograph is 0.8mm



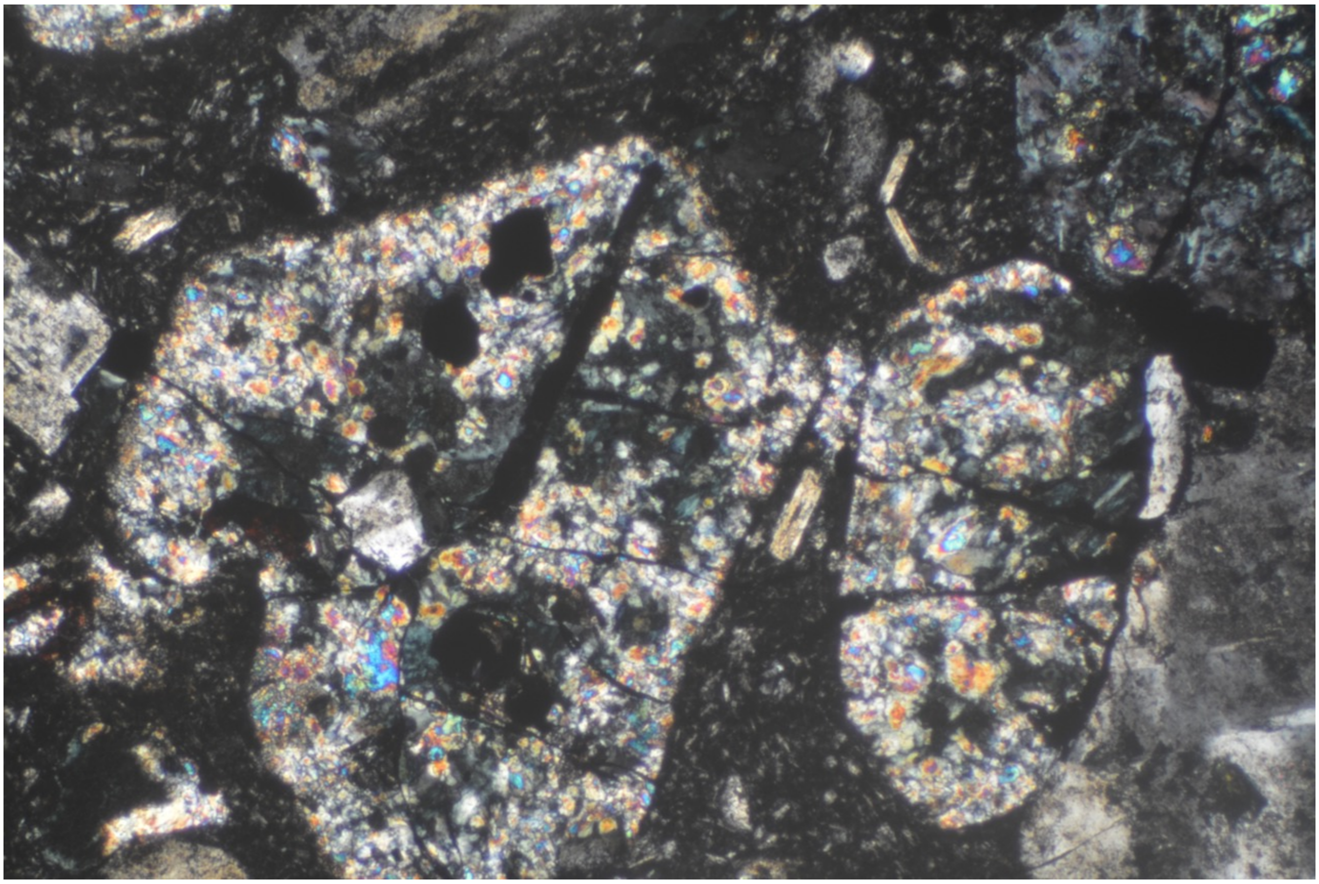
CE405-29.7m – h – a plagioclase feldspar with interpenetrant twin. The greenish alteration minerals are epidote whereas the bluish coloured minerals are sericite. The dark bluish streak through the middle is chlorite. Scale: side of photograph is 1.6mm



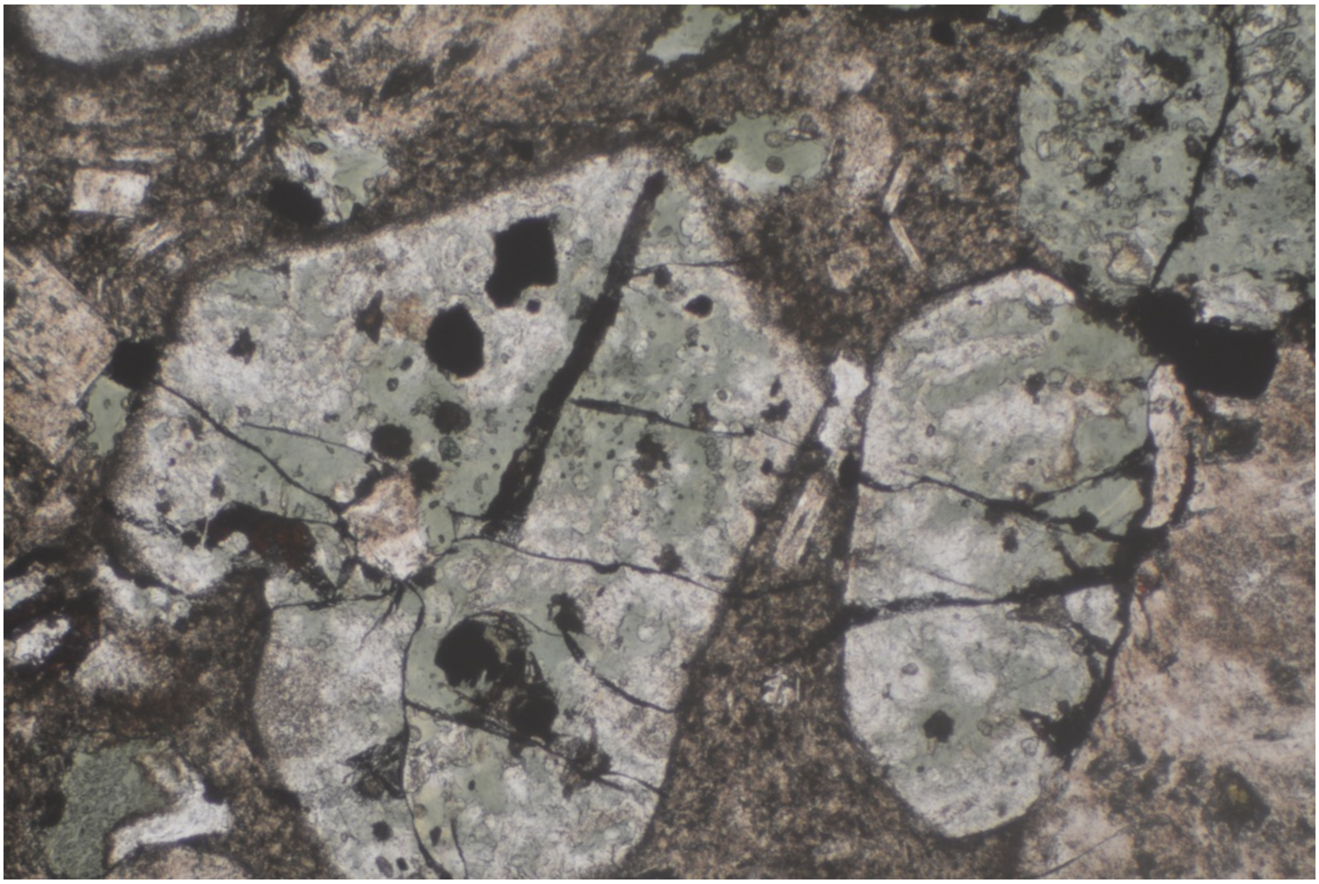
CE405-29.7m – i – same view as previous photo in ordinary light to highlight the compositional rim around the crystal. Scale: side of photograph is 1.6mm



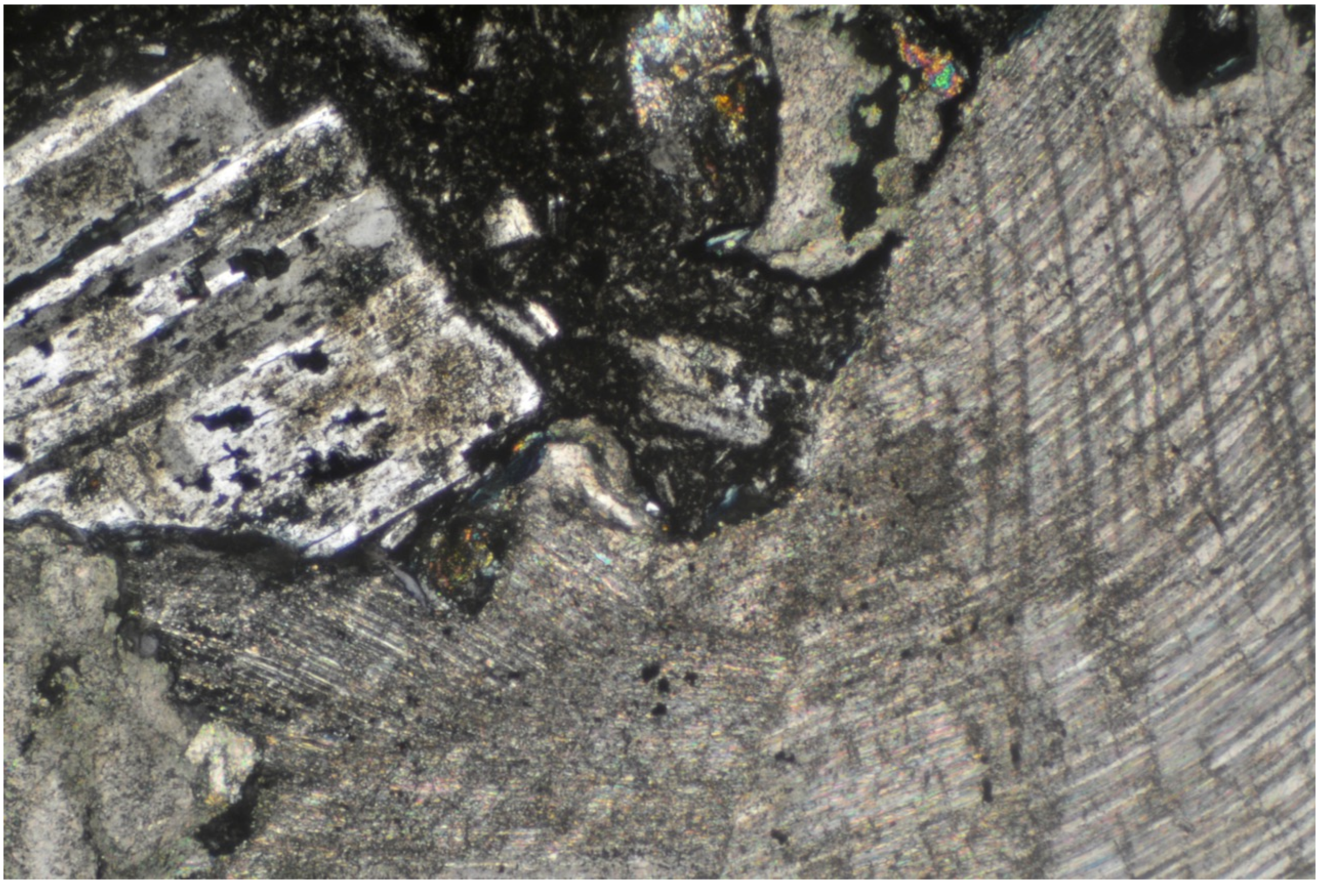
CE405-29.7m – j – another section of rock containing much larger patches of chlorite in a dense groundmass. The whitish patch at centre right is calcite. Scale: side of photograph is 1.6mm



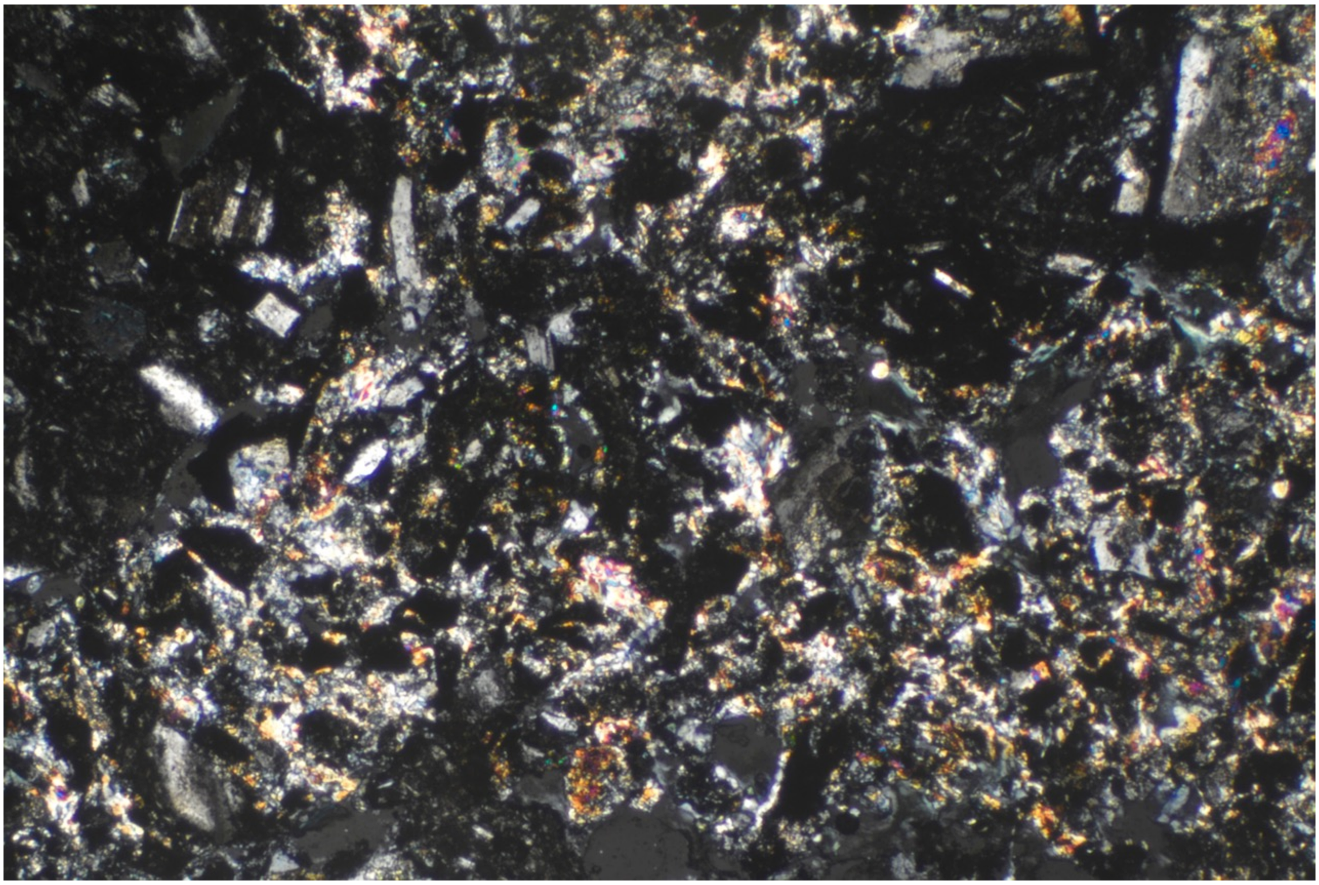
CE405-29.7m – k – sericite-chlorite pseudomorphs after ?pyroxene. Scale: side of photograph is 1.6mm



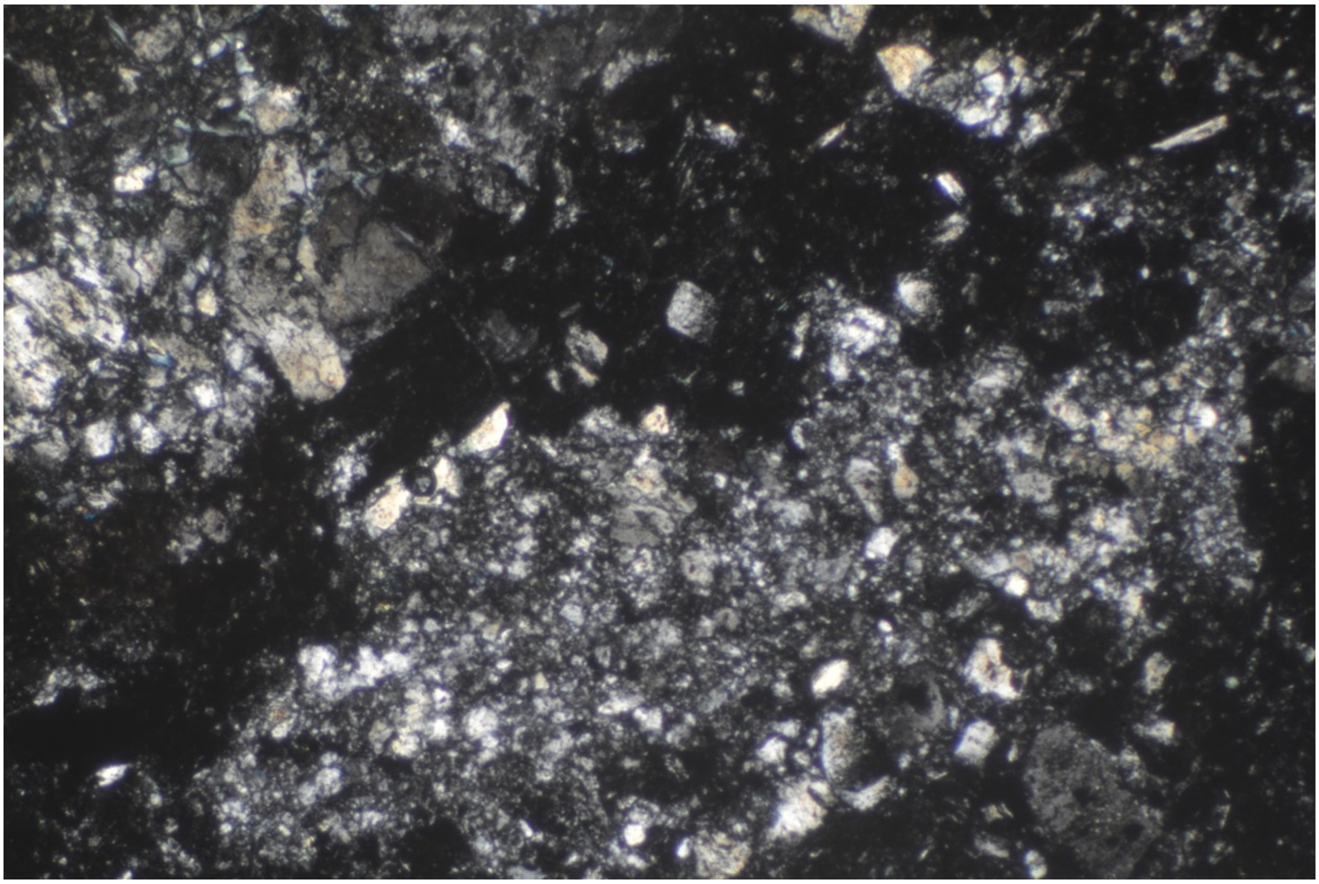
CE405-29.7m – L – same view as previous photo in ordinary light showing the composite nature of the alteration. Scale: side of photograph is 1.6mm



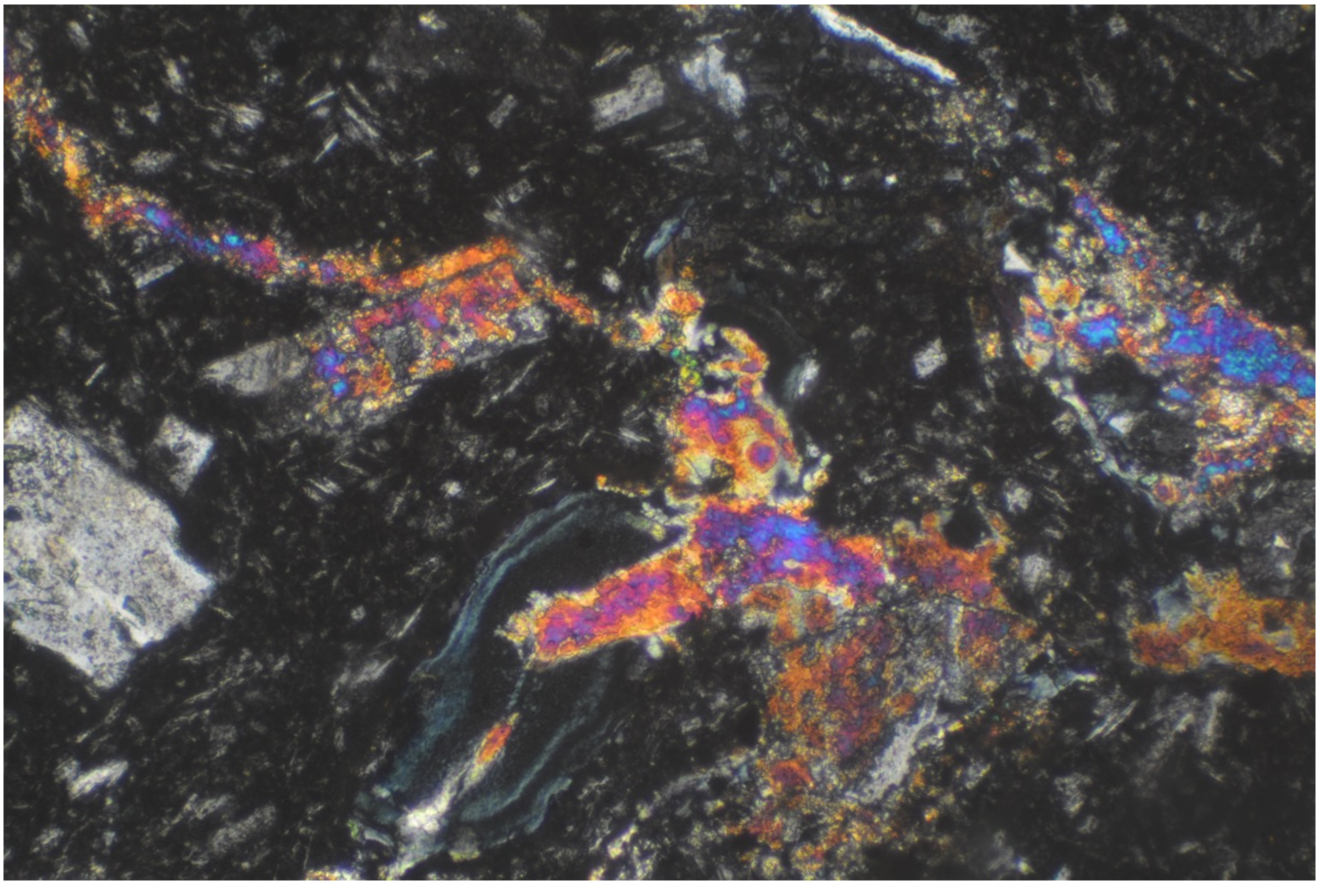
CE405-29.7m – m – section of rock containing random, quite large patches of deformed carbonate. Scale: side of photograph is 1.6mm



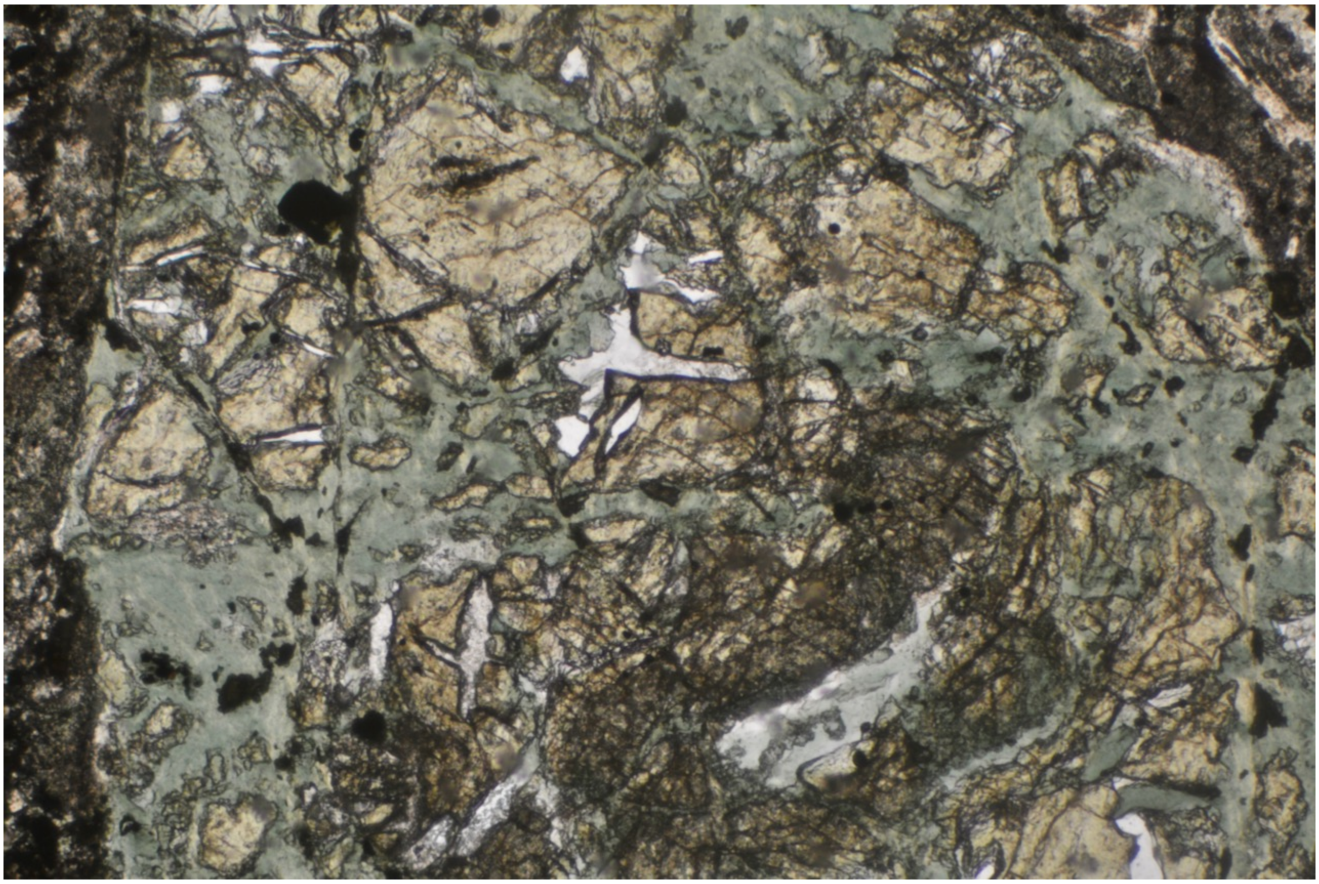
CE405-29.7m – n – patch of sericitic alteration (coloured) intermingled with chlorite (black). Scale: side of photograph is 1.6mm



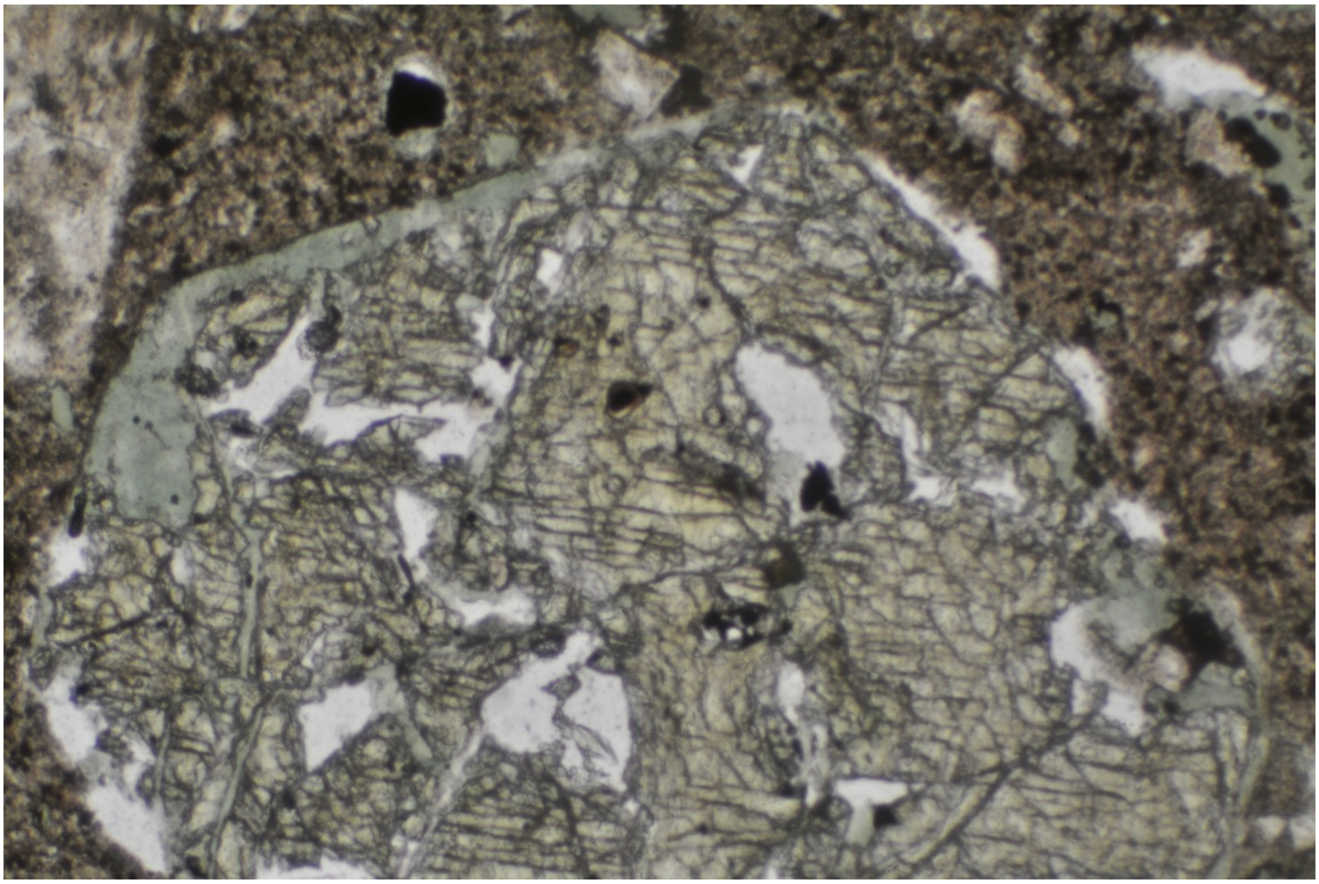
CE405-29.7m – o – unusual occurrence of mylonitized rock along a minor shear zone. Scale: side of photograph is 1.6mm



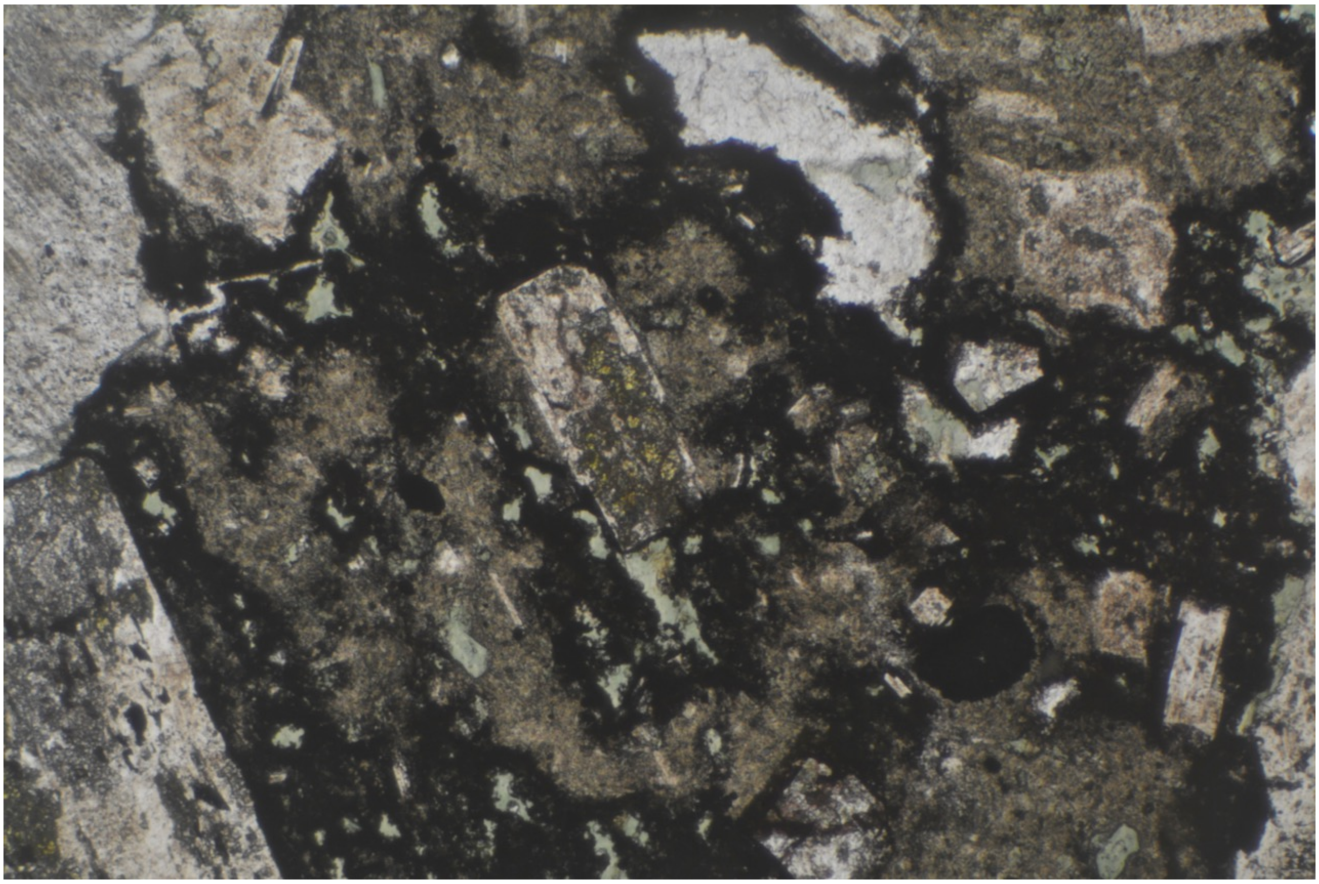
CE405-2.79m – p – actinolitic amphibole replacing some of the groundmass and small portions of both the feldspar and pyroxene phenocrysts. Greenish-coloured mineral above centre is epidote. Scale: side of photograph is 1.6mm



CE405-29.7m – q – typical view of a calcic pyroxene phenocryst showing the extent of replacement by chlorite. White patches are mostly secondary quartz. Scale: side of photograph is 1.6mm



CE405-29.7m – r – a calcic pyroxene phenocrysts with only minor replacement by chlorite. White patches are mostly secondary quartz. Scale: side of photograph is 1.6mm



CE405-29.7m – s – typical view of groundmass that has almost black boundaries giving the appearance of being burnt. Scale: side of photograph is 1.6mm

CE409-42.3m

Macroscopic and binocular description of rock

This is a composite dark-grey, mildly porphyritic, dense, volcanic rock type featuring some textural heterogeneity. Several texturally variable inclusions are a feature.

Under the binocular microscope the rock displays a somewhat subtle porphyritic texture with phenocrysts of green pyroxene and dark feldspar. Some pitting of the pyroxene indicates weathering/alteration. There is also one prominent, light-greenish inclusion and several smaller ones. A few whitish patches are almost certainly carbonate. There are also some spidery veinlets.

A scratch test shows that the rock type is generally quite hard and could not be easily scratched (except for small soft parts). This small sample was fairly easy to cut.

An acid test reveals that there is some reactive carbonate, mostly in small patches and fine hairline structures. Porosity is moderately low.

Petrographic description of thin-section

This is another porphyritic, composite, chemically intermediate volcanic rock that is superficially similar to the samples from CE405 and CE416 but contains elements of CE415. It also has an involved history and appears to be a mixture. This rock is unlikely to have been a straight lava flow. The commonality with the previous rocks is that there has been an early form of alteration followed by some mild subsequent hydrothermal alteration.

The overall appearance of this rock is a messy, somewhat composite, andesitic rock containing texturally and mineralogically different inclusions similar to, but not as diverse and common as in CE415. Also different is that this rock has a distinct lineation of the stumpy feldspar laths.

The basic rock appears to be a pyroxene andesite with quite common phenocrysts of partly to substantially altered calcic pyroxene (approaching 2mm), plagioclase feldspar (also to 2mm) and one solitary amphibole (1.2mm). The alteration to the pyroxene is chloritic but the pattern of alteration seems random, i.e. not following compositional zones. Some of the pyroxene is in clots which may be rounded. The pyroxene often contains numerous inclusions of opaque minerals, similar to previously described rocks. The feldspar crystals are invariably altered/modified. Where the feldspar (calcic variety) shows strong compositional zoning the cores are often charged with an abundance of tiny opaque minerals and hydrated iron oxide. But more often than not it is the intermediate zones (which are often even more calcic than the cores) that are heavily altered. There are also oscillatory zoned crystals where individual zones are substantially replaced by chlorite (see photographs).

It has a surprisingly sparse groundmass that is difficult to resolve because of the fine grainsize and the extent of alteration. Along with very fine-grained feldspar both chlorite and hydrated iron oxide are common components. Illite/sericite, carbonate and opaque minerals are present randomly. But there is one additional component that is unusual. It consists of usually rounded forms that display an extremely fine mosaic of undulose crystal forms. The best explanation is for them to be poorly devitrified glass.

The inclusions are quite different to the host rock. One large inclusion (see photograph) has an abundance of lineated plagioclase feldspar laths with a messy groundmass of feldspar, chlorite and opaque minerals. Many of the laths are of similar size – between 0.8mm and 1.2mm. Cross-sections show strong oscillatory zoning but alteration is typically limited to a dusting. There is one large pyroxene phenocryst (3mm) and several smaller ones. Other inclusions are sparsely porphyritic with extremely fine-grained feldspar, chlorite and opaque minerals. The phenocrysts are both pyroxene and feldspar and there are small crystals of amphibole.

In proximity to the large inclusion are several highly irregular patches of carbonate. Chlorite forms the outside of the patch typically in a layer only 0.03mm thick but it may be composite. Not all the carbonate is encased by chlorite. Similar, scalloped forms of sericite also occur albeit smaller. In one or two locations quartz accompanies the chlorite and/or the sericite. Several quartz veinlets partly traverse the rock. Other veinlets are carbonate and even some sericite.

The interpretation of this rock is that it is a nuee ardente-type flow with abundant volatiles that entered a lake or seawater. The inclusions The numerous voids of irregular shape or spaces between the phenocrysts were filled with chlorite. At the time it hit the water the lava was still quite hot and this led to a large amount of vesiculation and oxidation.

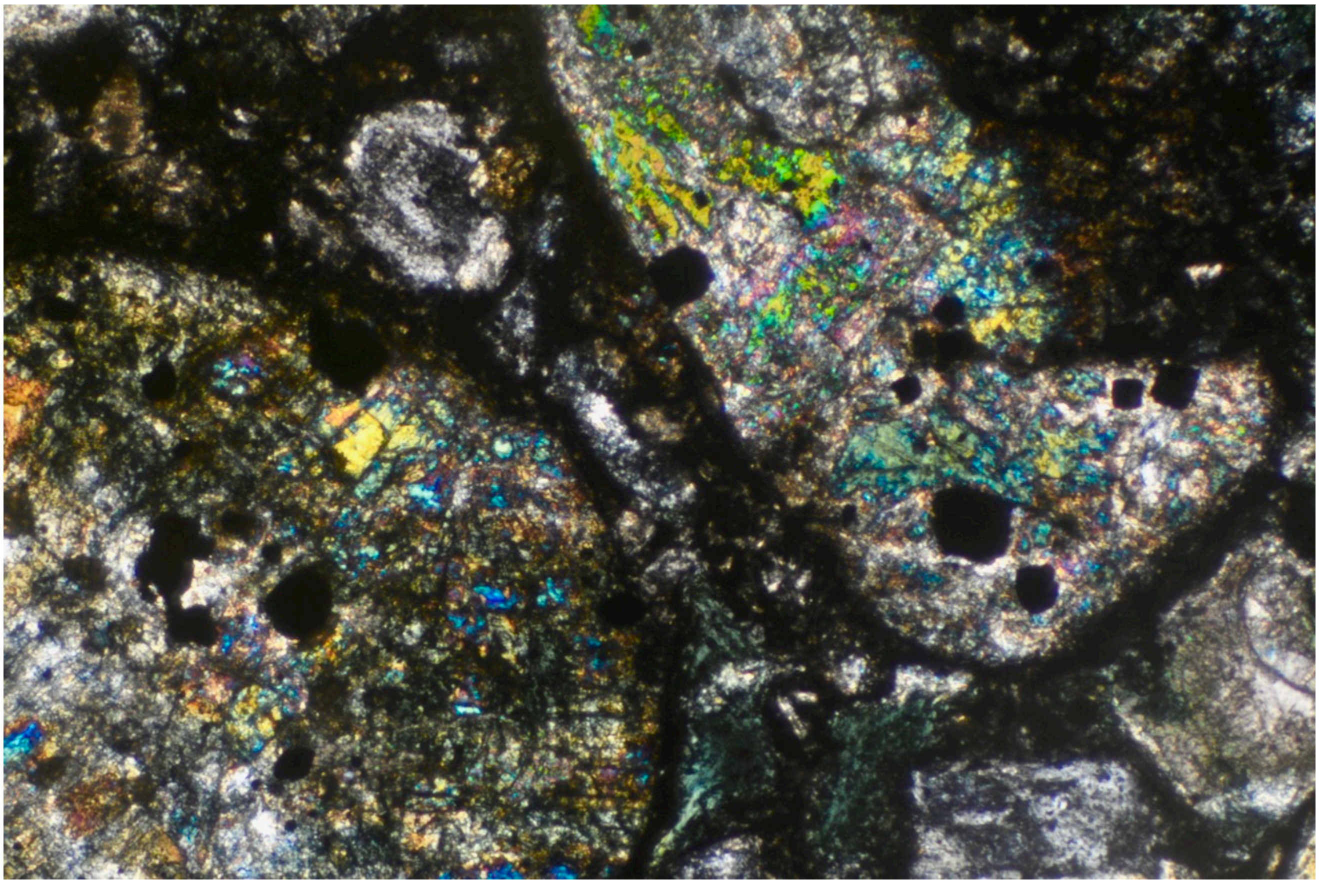
Mode of rock

quartz	<1%
feldspar phenocrysts	35%
calcic pyroxene	15%
chlorite	26%
sericite	<1%
carbonate	1%
amphibole	<1%
opaque minerals	8%
groundmass	15%

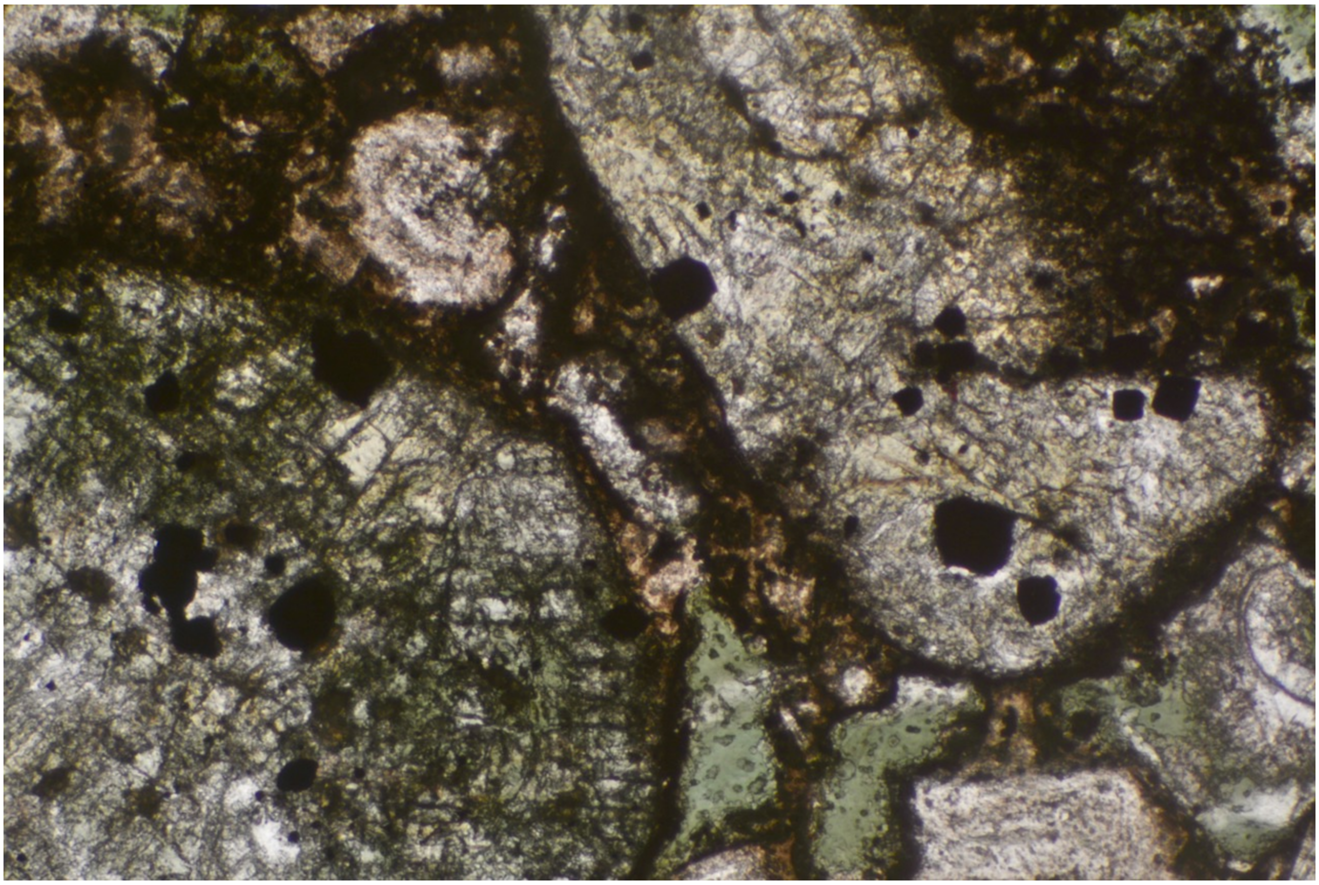
Name of rock Altered pyroxene andesite

Dr. H. D. Hensel
(HENSEL GEOSCIENCES)
(27th August, 2018)

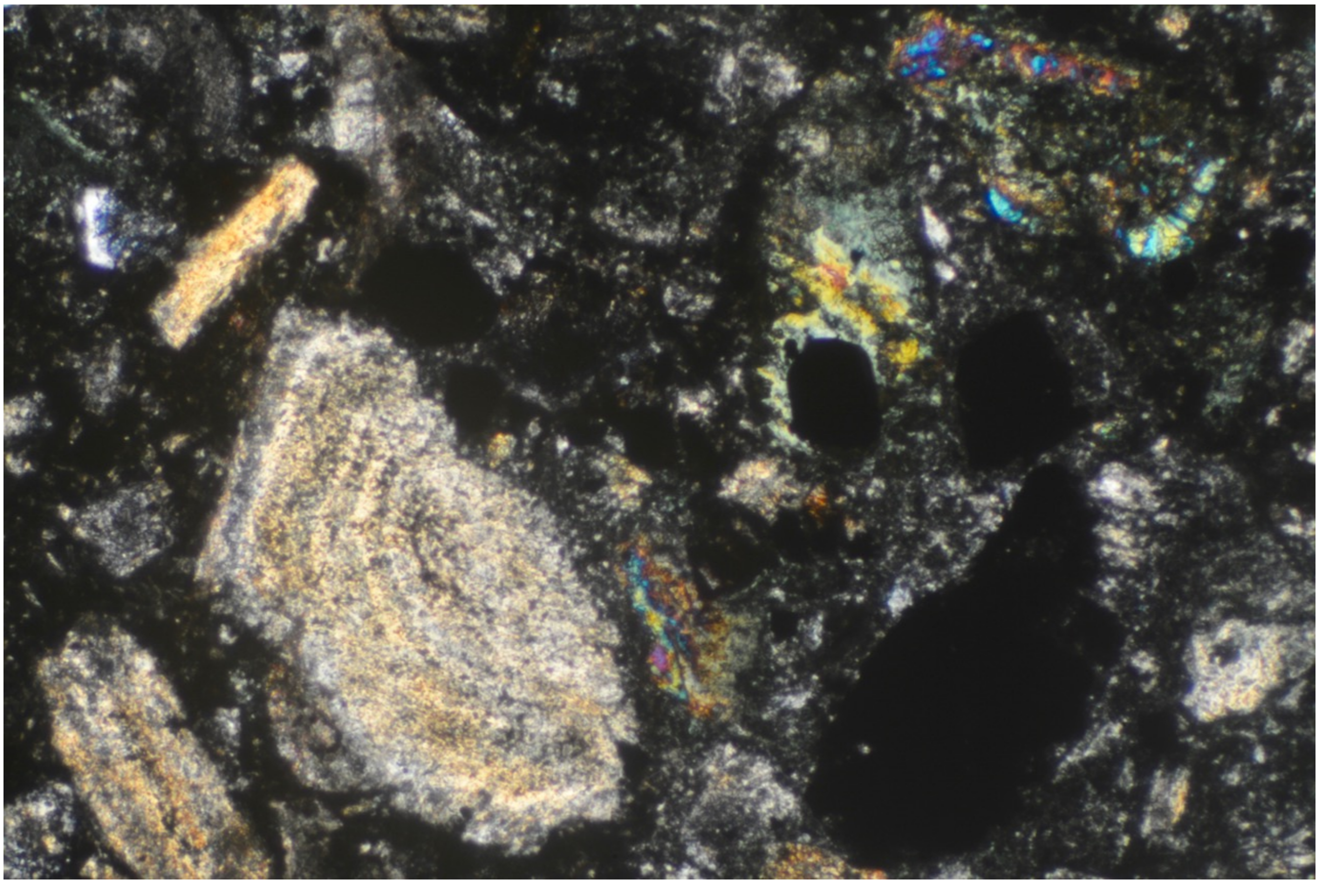
CE409–42.3m a - a common textural view in ordinary transmitted light of this volcanic rock showing some characteristic textures of the feldspar phenocrysts. Note also the numerous patches of green chlorite. Scale: side of photograph is 1.6mm



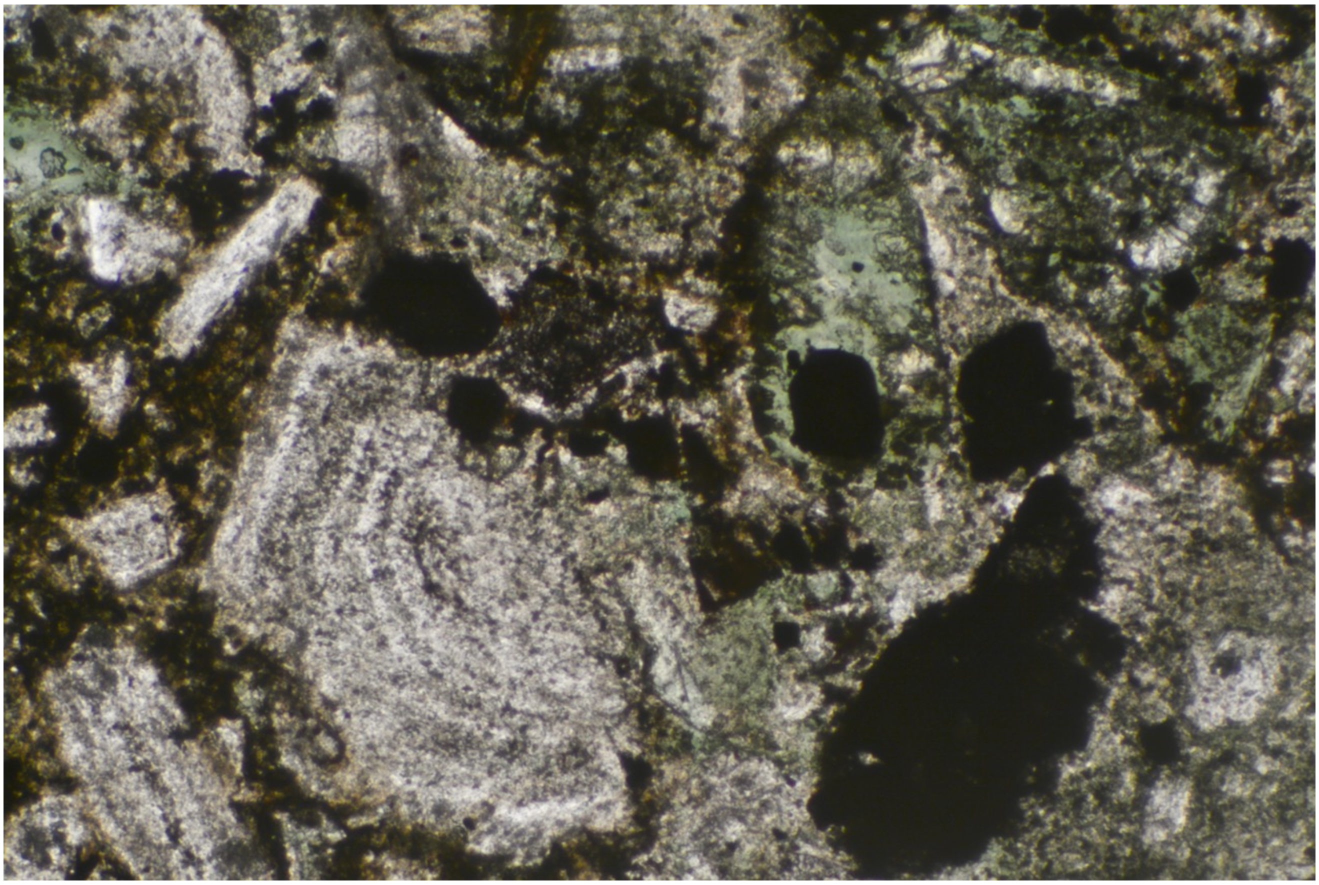
CE409-42.3m – b – view of two calcic pyroxene “phenocrysts” which are composite clots. Scale: side of photograph is 1.6mm



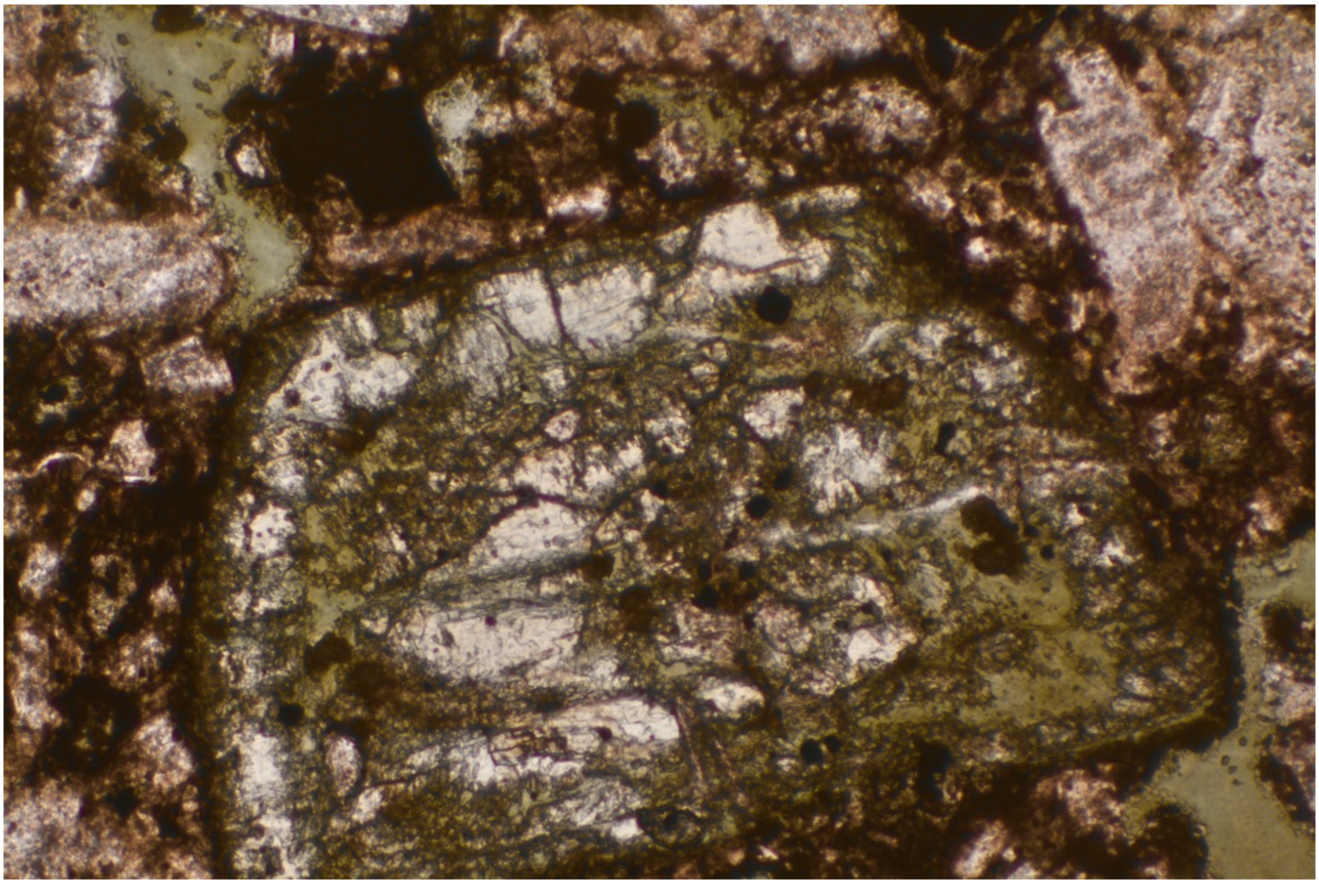
CE409-42.3m – c – same view as previous photo in ordinary light showing the subtle alteration. Scale: side of photograph is 1.6mm



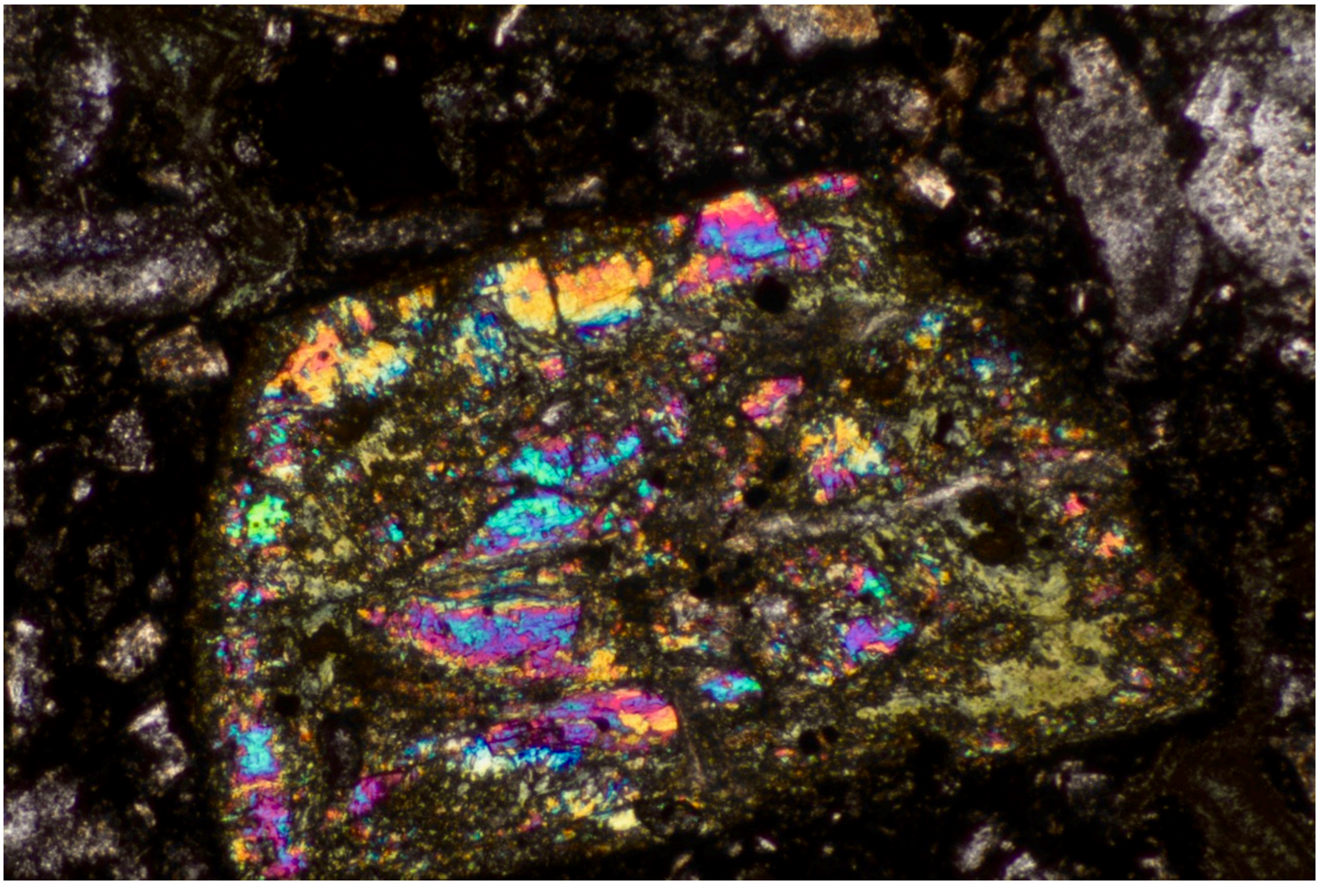
CE409-42.3m – d – a fractured/truncated plagioclase phenocryst showing multiple compositional zones. Note also the large opaque mineral. Scale: side of photograph is 1.6mm



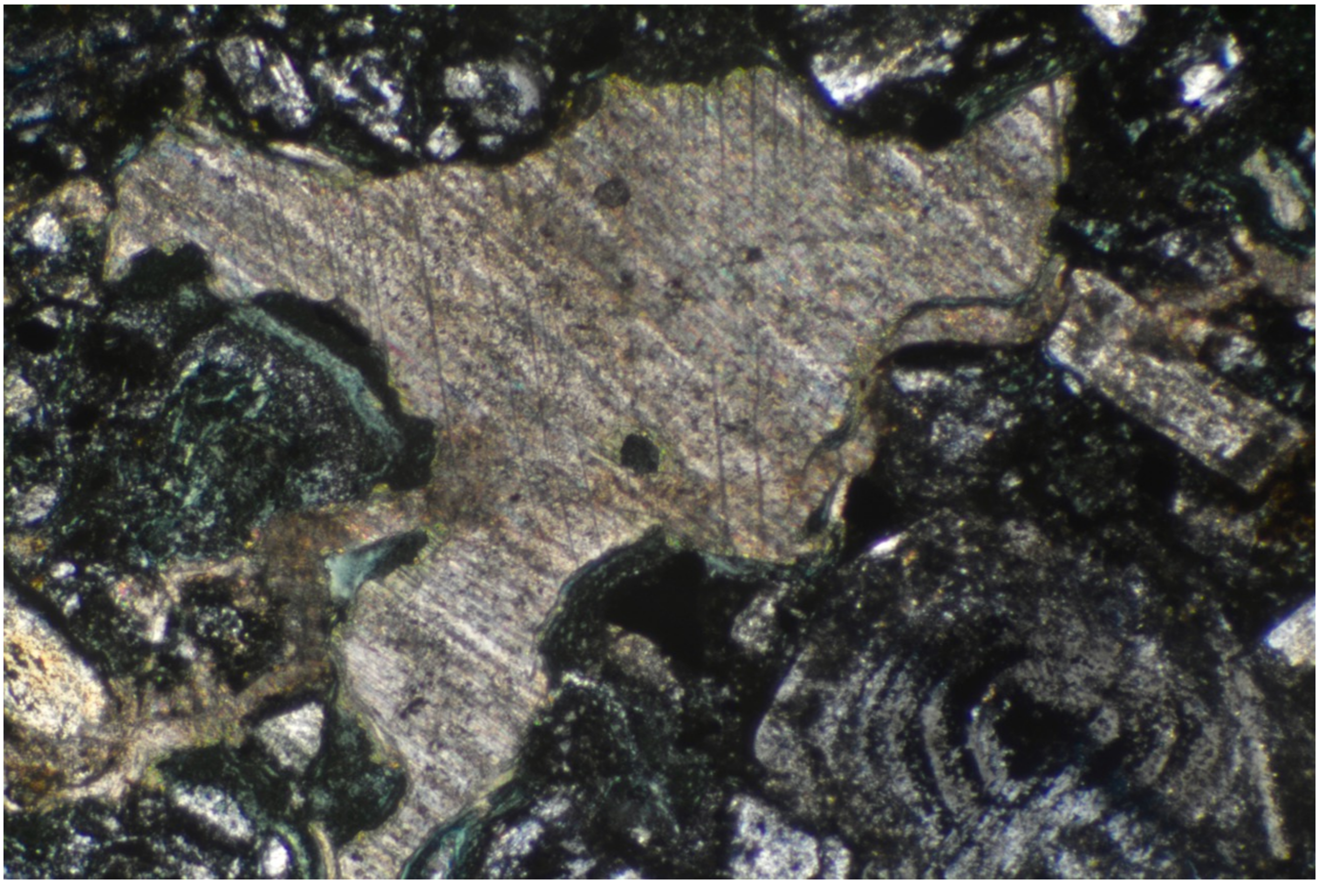
CE409-42.3m – e – same view as previous photo viewed in ordinary light showing the abundant chlorite and also the “spongy” nature of the opaque minerals. Scale: side of photograph is 1.6mm



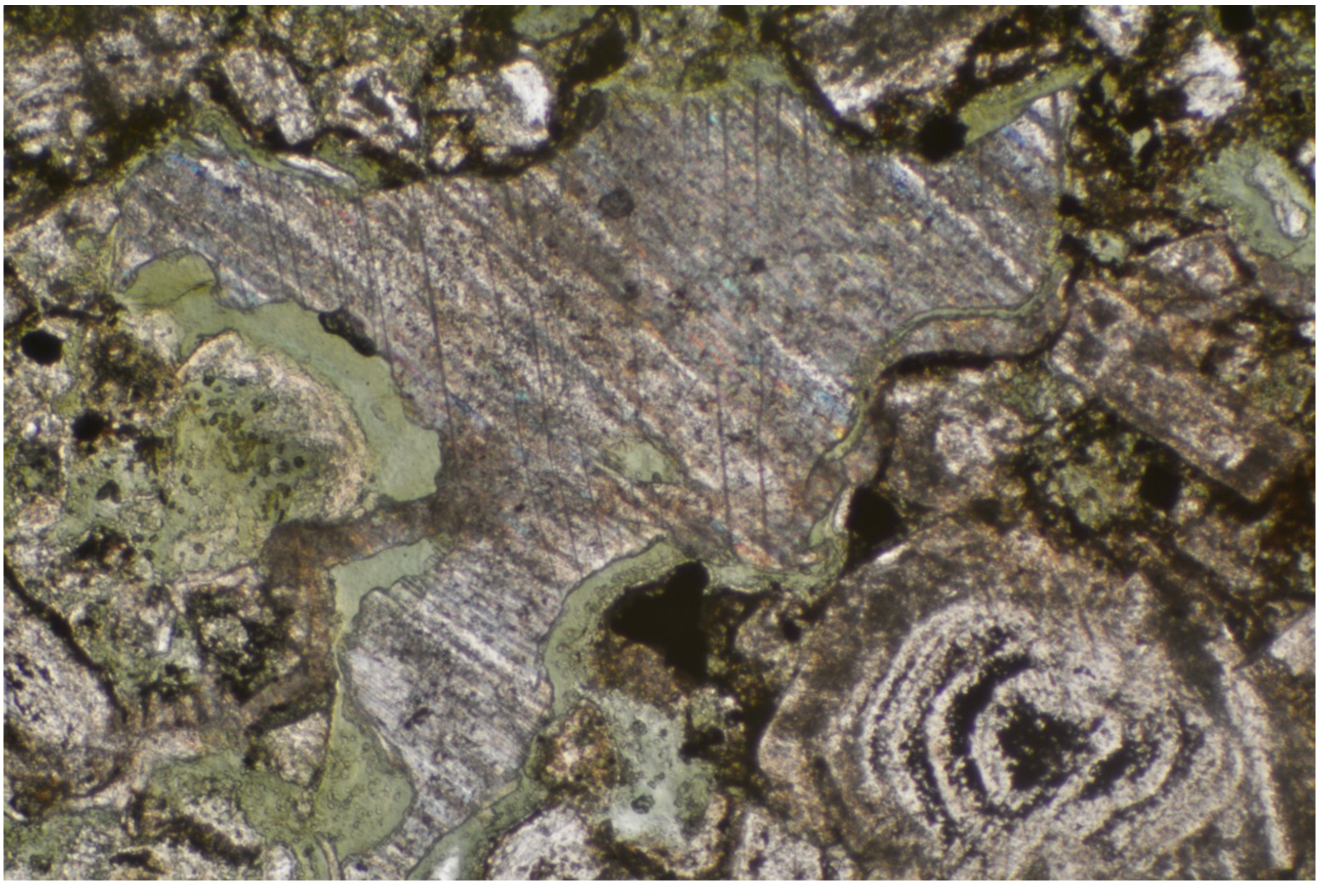
CE409-42.3m – f – a pyroxene phenocrysts that has been substantially altered to chlorite with little regard to compositional zones. Scale: side of photograph is 1.6mm



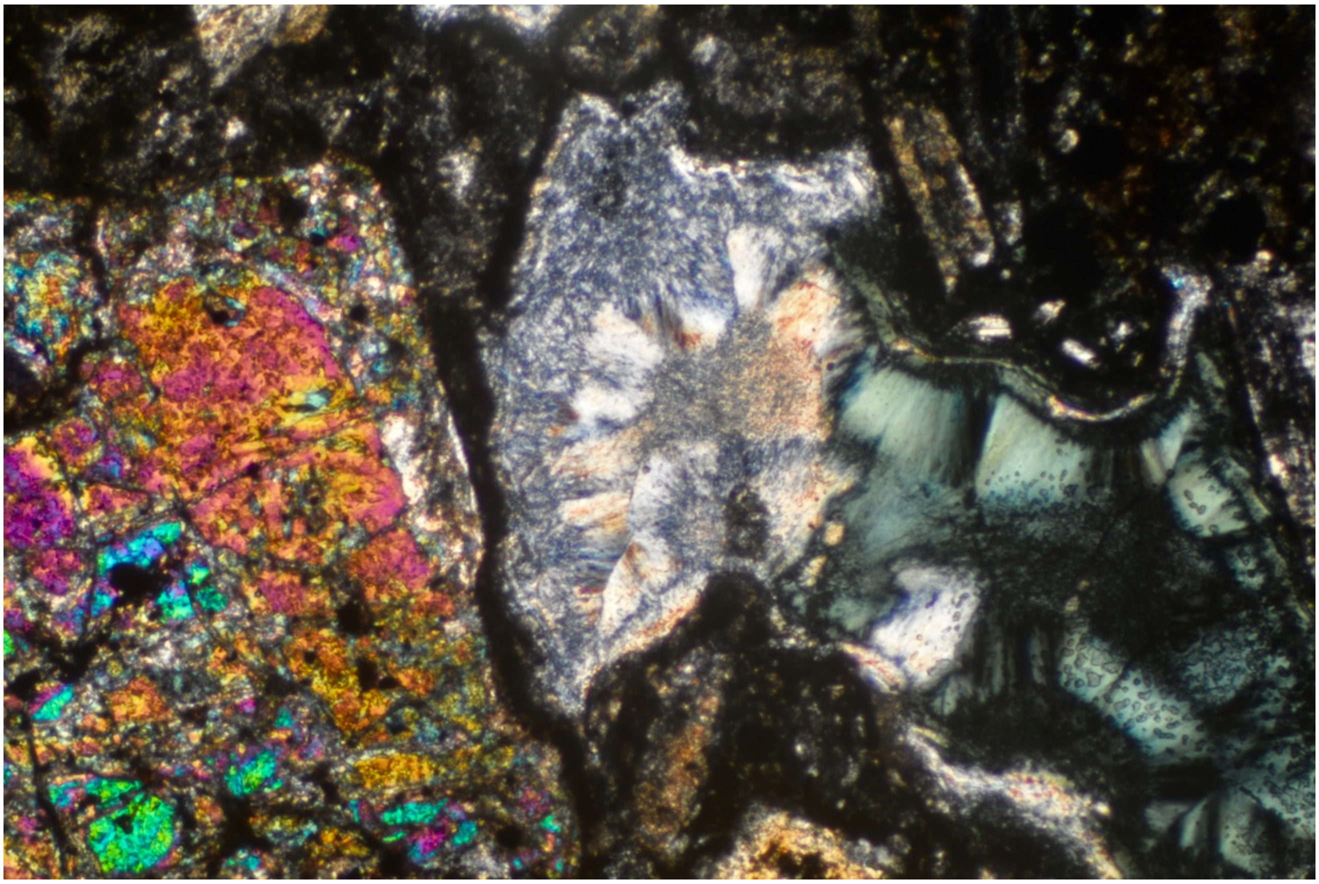
CE409-42.3m – g – same view as previous photo in polarized light to show more accurately the unaltered portions. Scale: side of photograph is 1.6mm



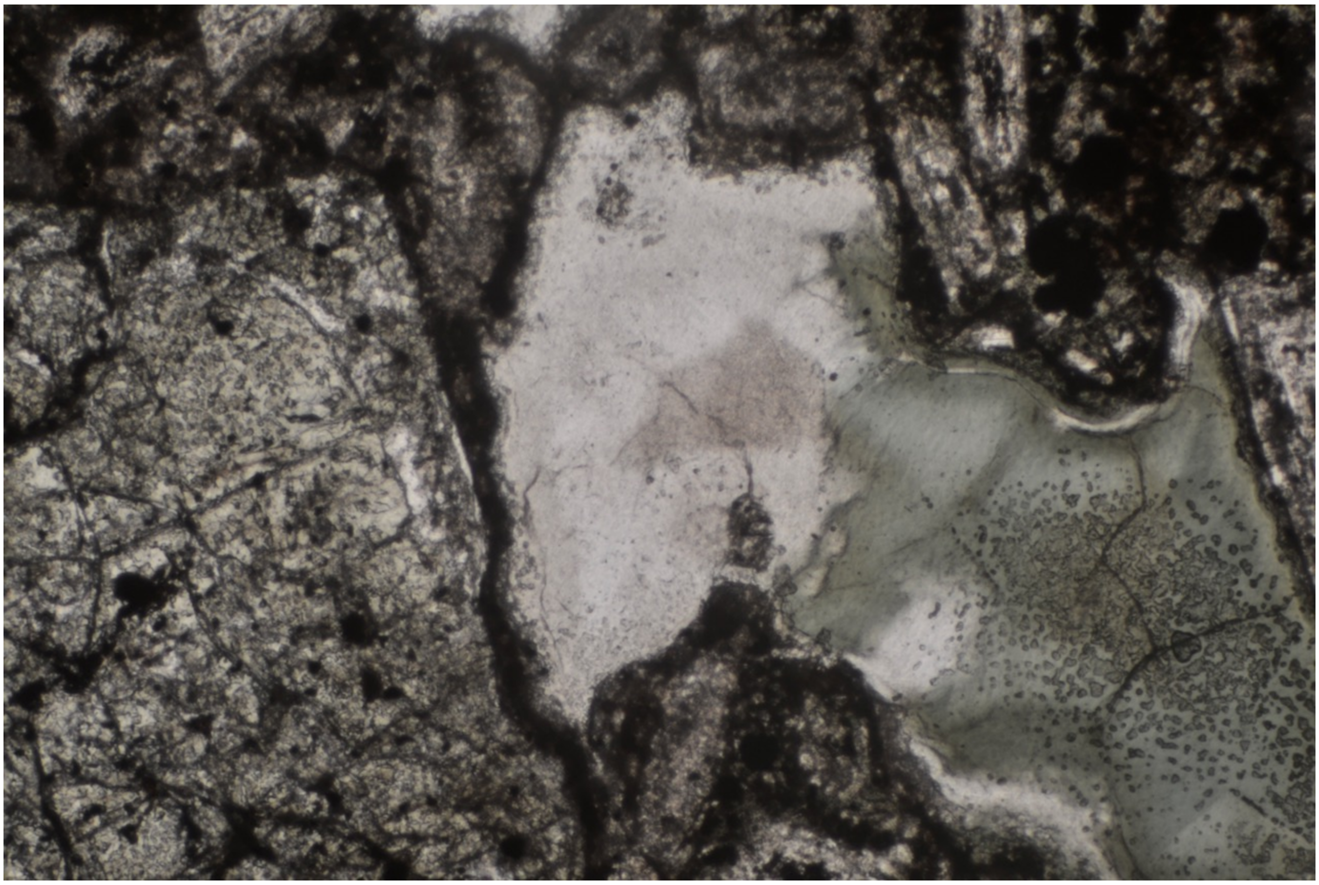
CE409-42.3m – h – patch of numerous irregular carbonate infillings. At bottom right is a zoned plagioclase feldspar that is strongly deformed. The black line defines the deformation zone. Scale: side of photograph is 1.6mm



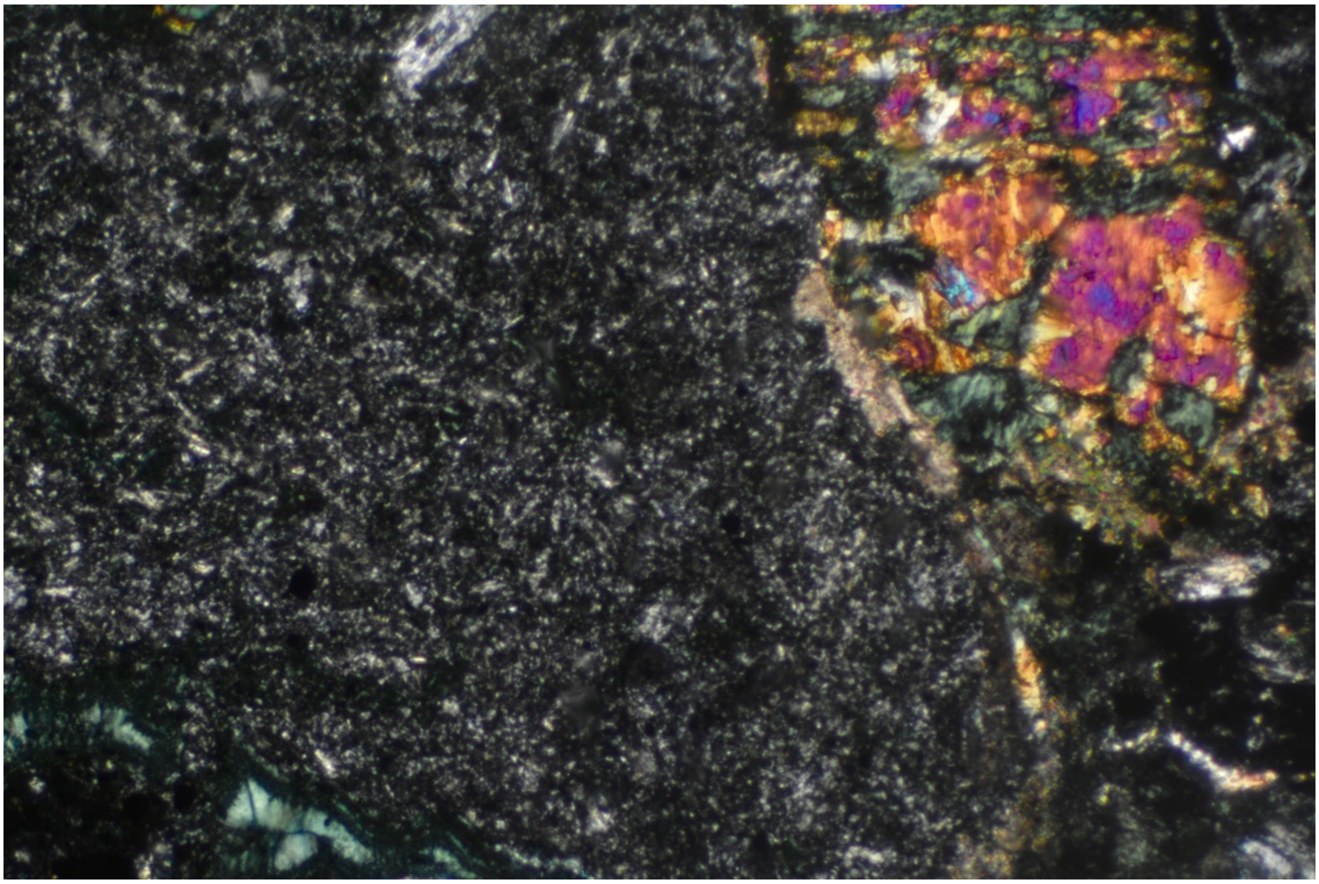
CE409-42.3m – i – same view as previous photo in ordinary light showing the twinned carbonate occupying areas within a boundary of chlorite. Scale: side of photograph is 1.6mm



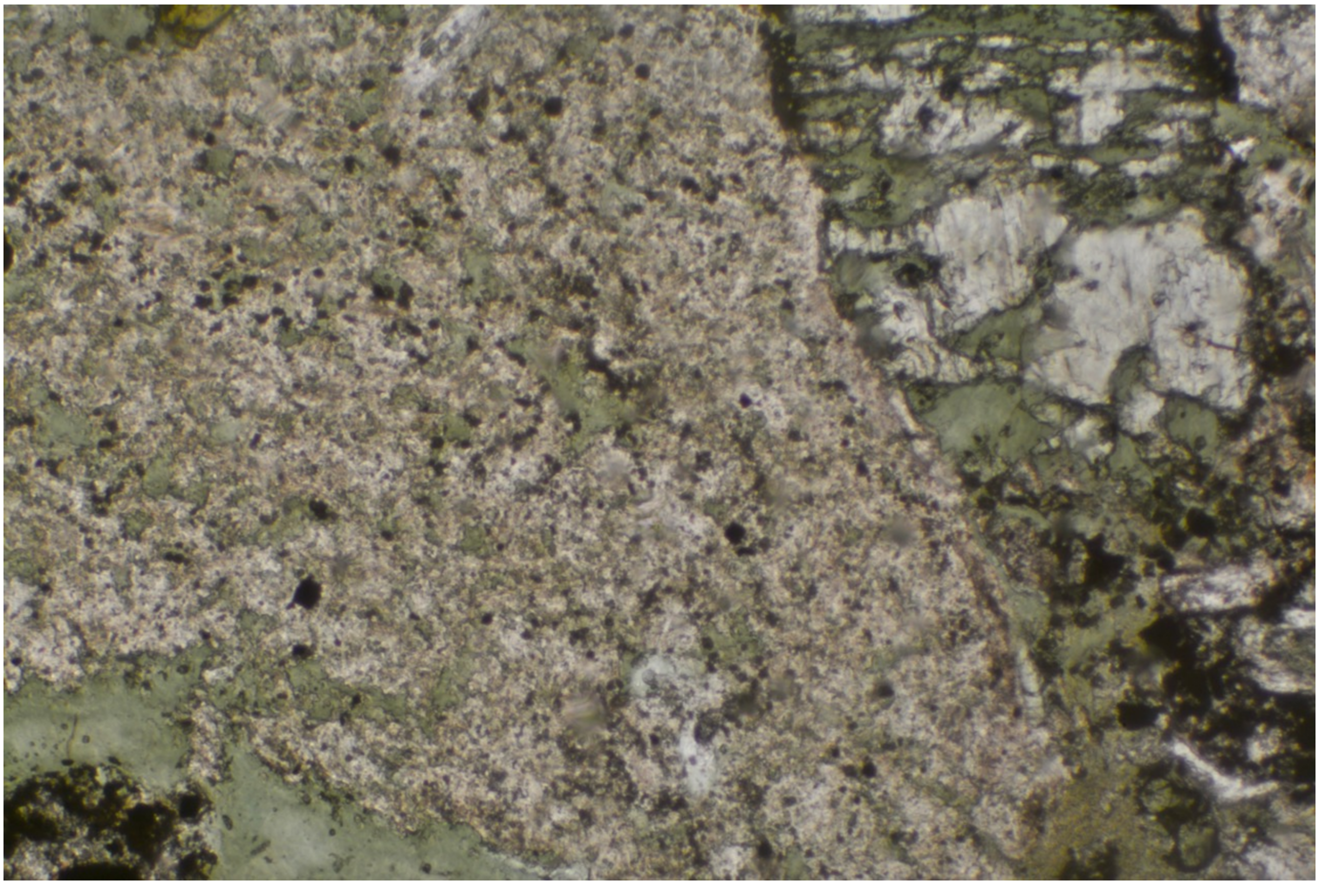
CE409-42.3m – j – another section of rock containing a large calcic pyroxene crystal adjacent to a large infill patch of sericite and chlorite. Scale: side of photograph is 1.6mm



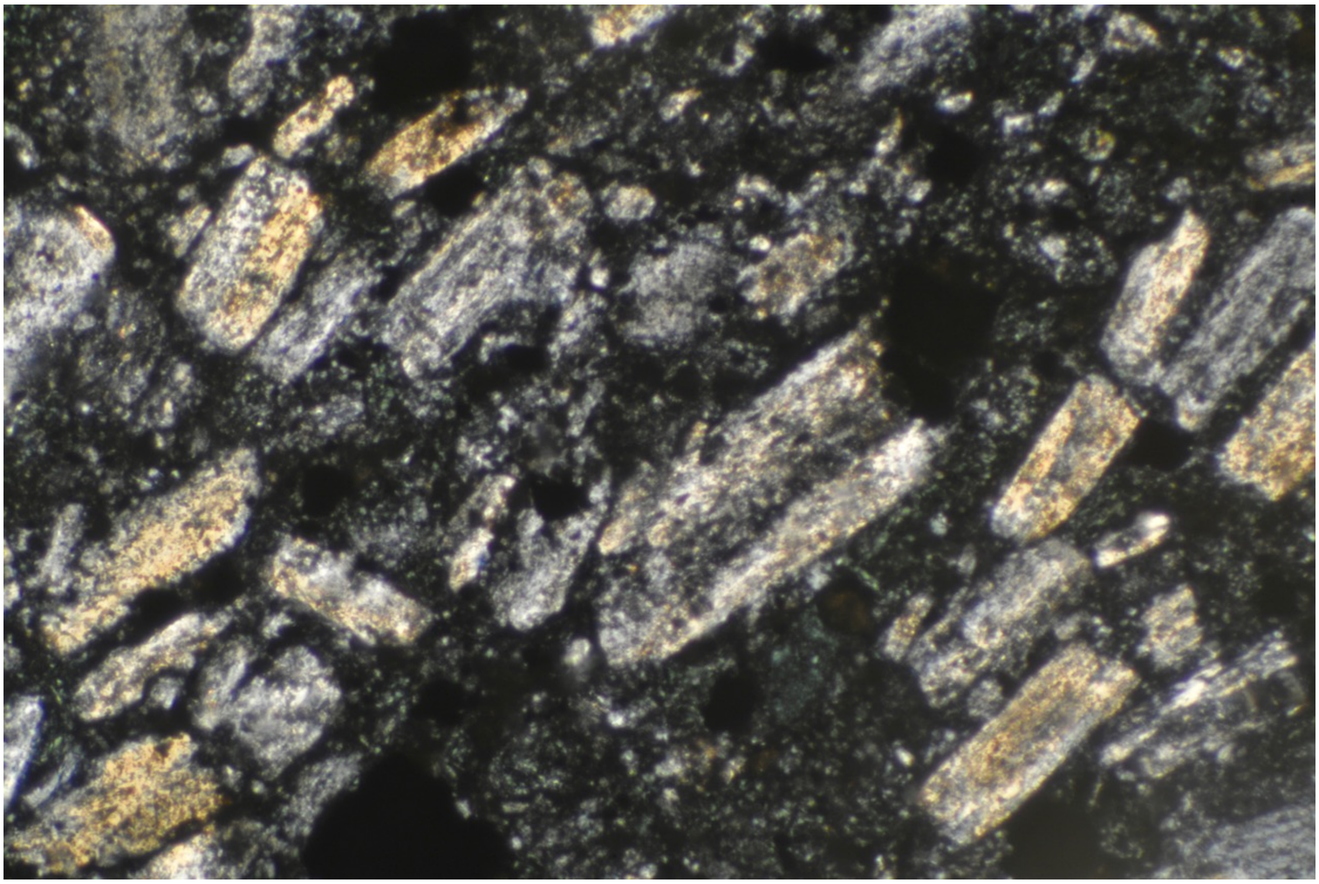
CE409-42.3m – k – same view as previous photo to show the delicate relationship between the chlorite and the sericite. Scale: side of photograph is 1.6mm



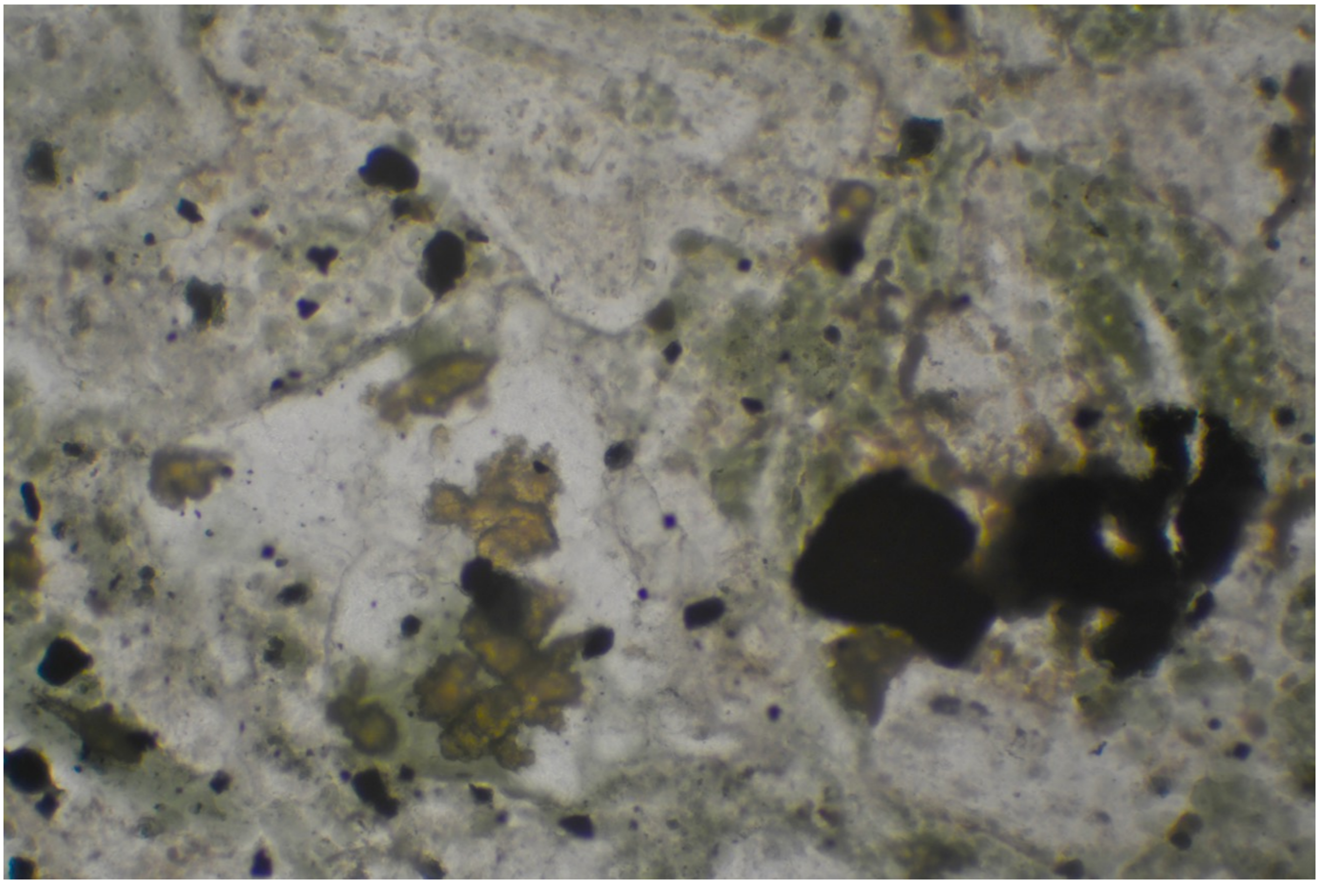
CE09-42.3m – L – view of an inclusion that is partly bound by calcite and chlorite. Note the very fine grainsize. Scale: side of photograph is 1.6mm



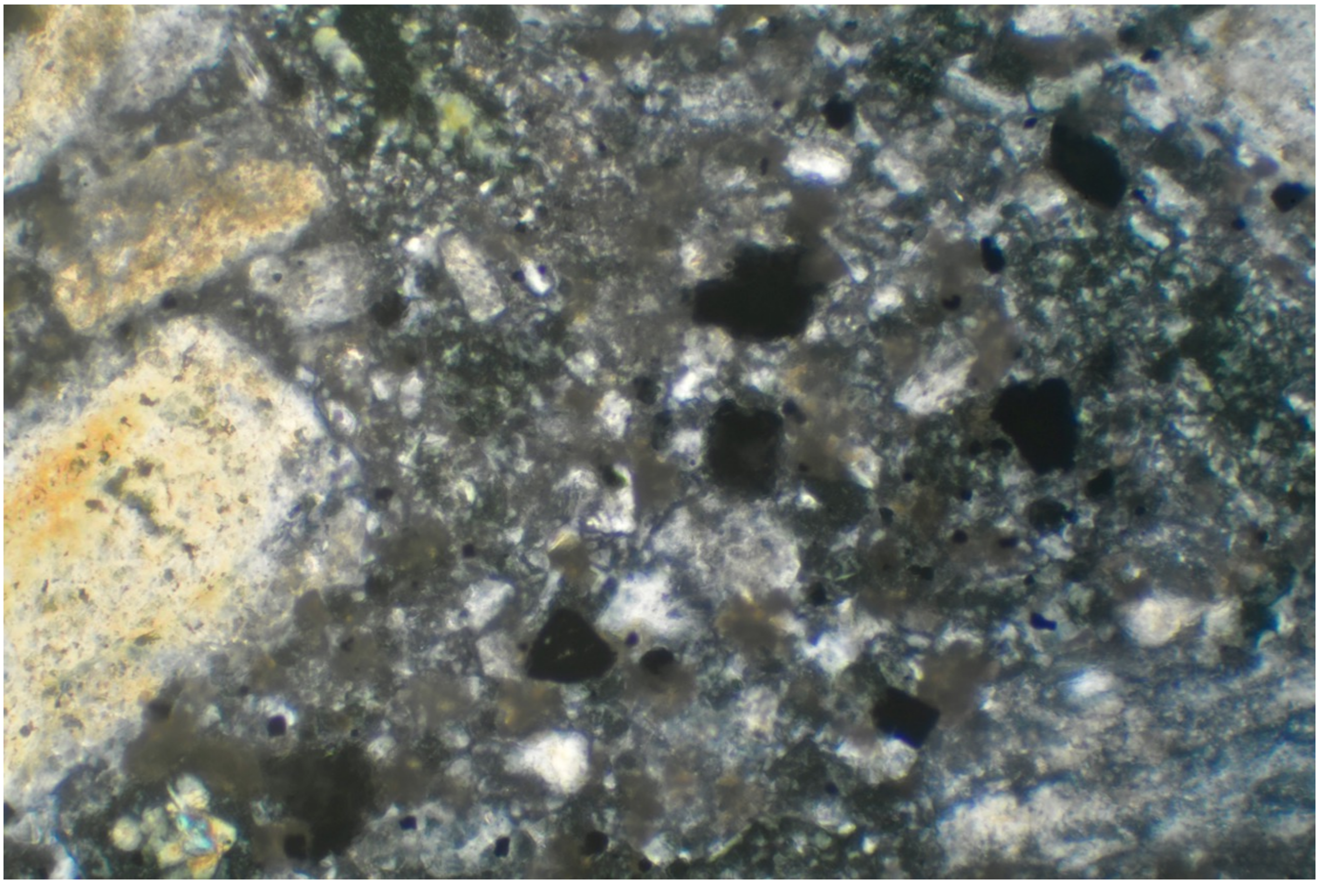
CE409-42.3m – n – same view as previous photo in ordinary light to show the extent of chloritization inside and outside of the inclusion. Scale: side of photograph is 1.6mm



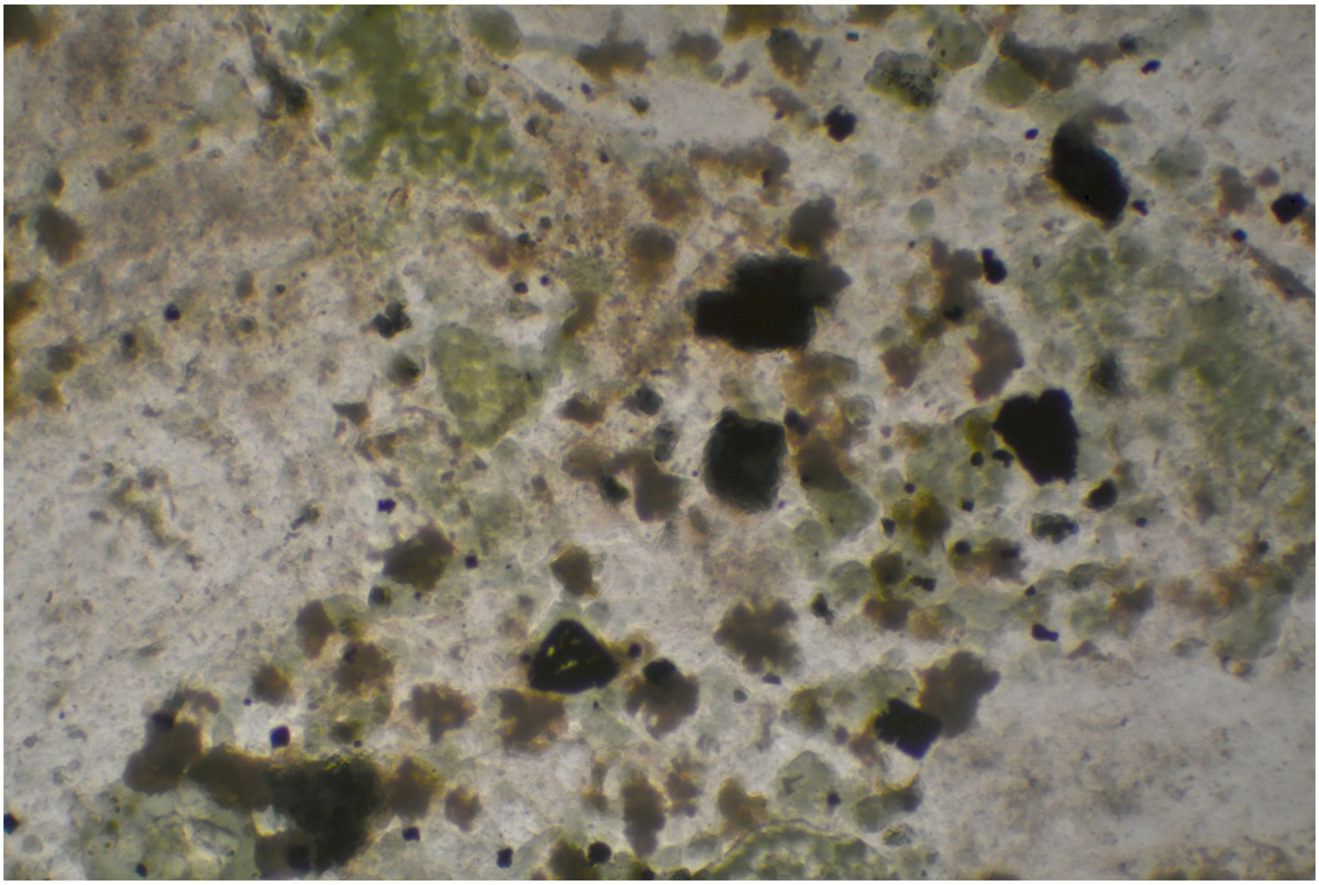
CE409-42.3m – o – another inclusion containing lineated feldspar laths. Scale: side of photograph is 1.6mm



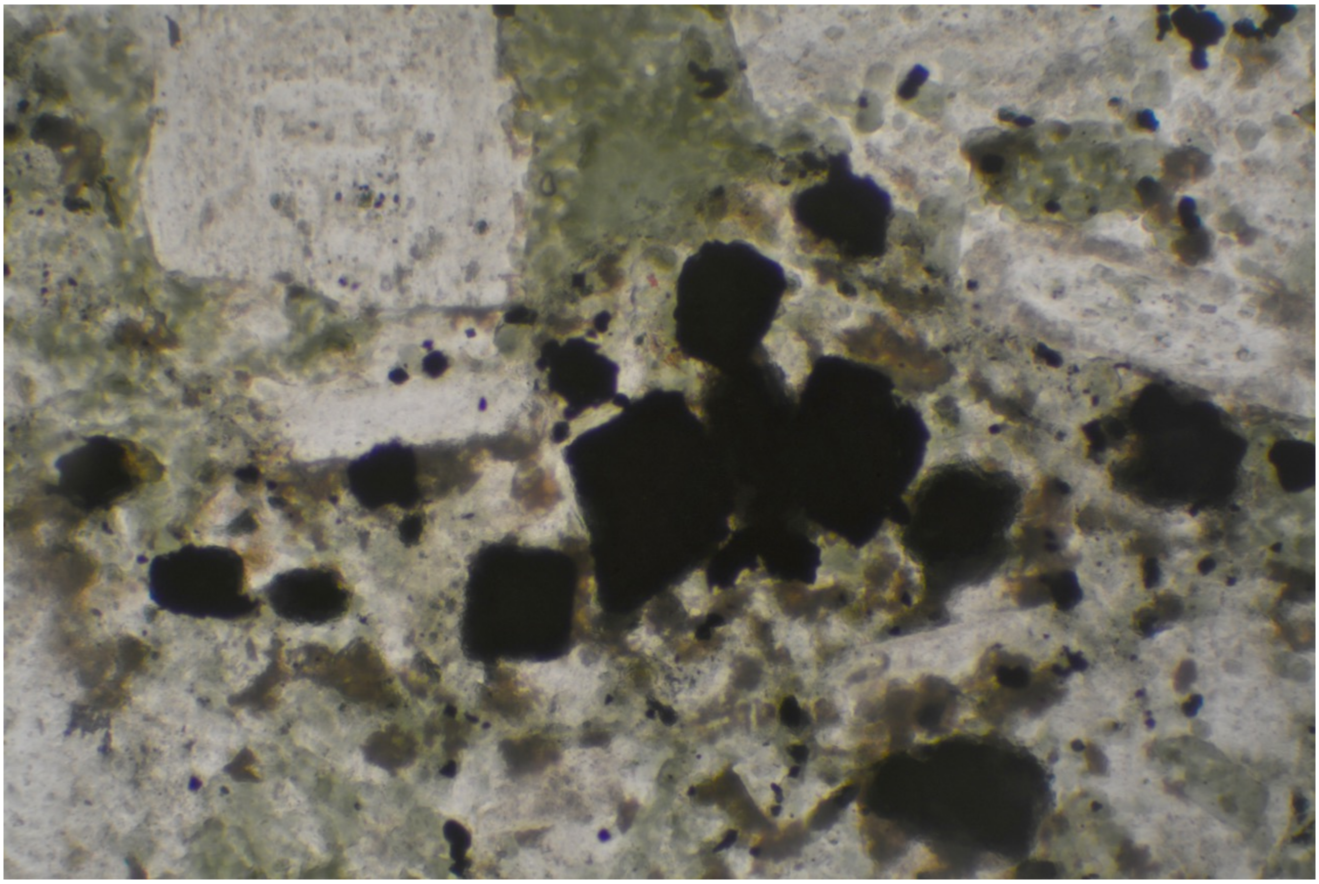
CE409-42.3m – p – slightly magnified view in ordinary condenser-enhanced light to show the abundant small anhedral, brownish grains that have formed throughout the groundmass. Scale: side of photograph is 0.8mm



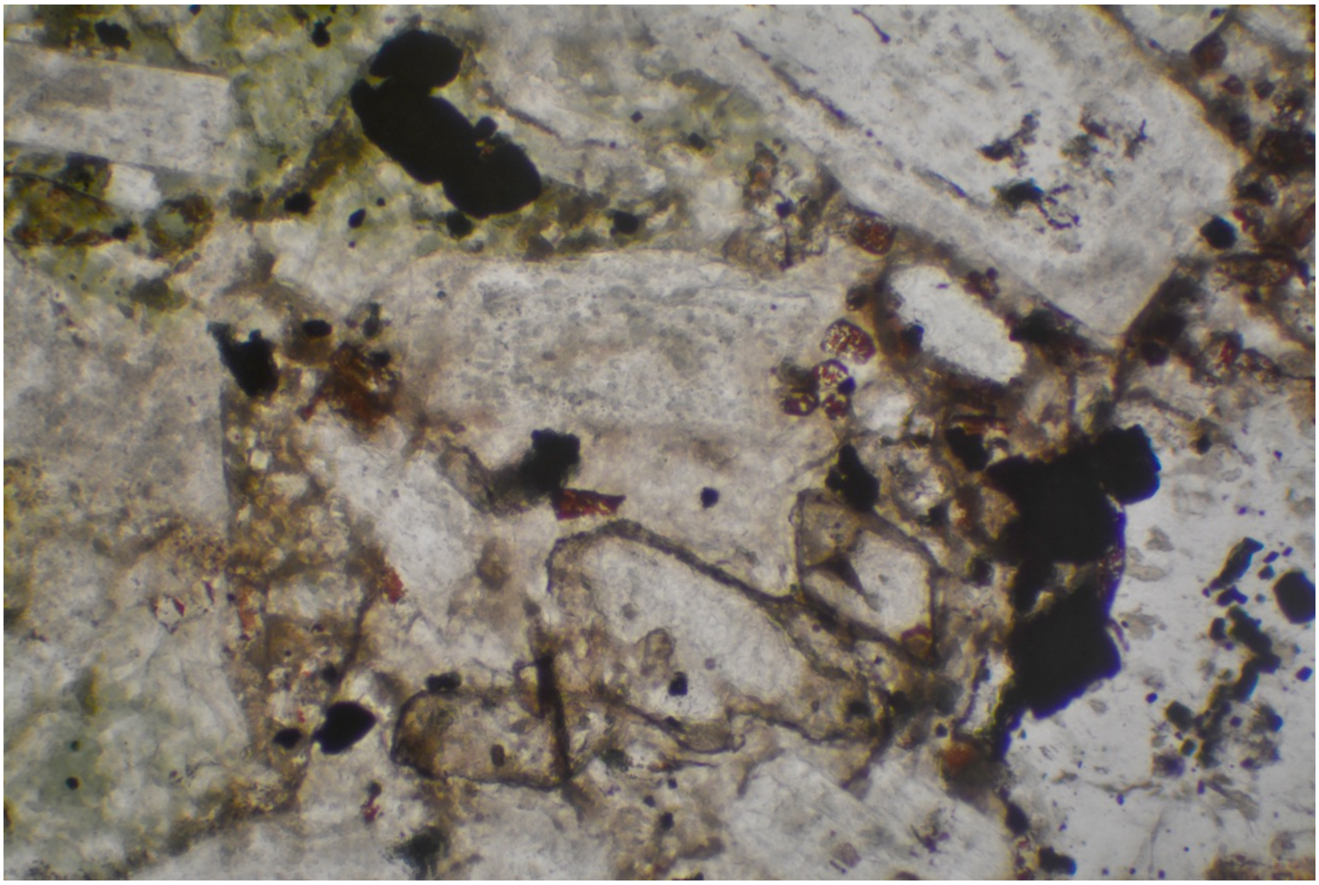
CE409-42.3m – q – Slightly magnified condenser-enhanced view in polarized light showing a messy poorly defined groundmass. Scale: side of photograph is 0.8mm



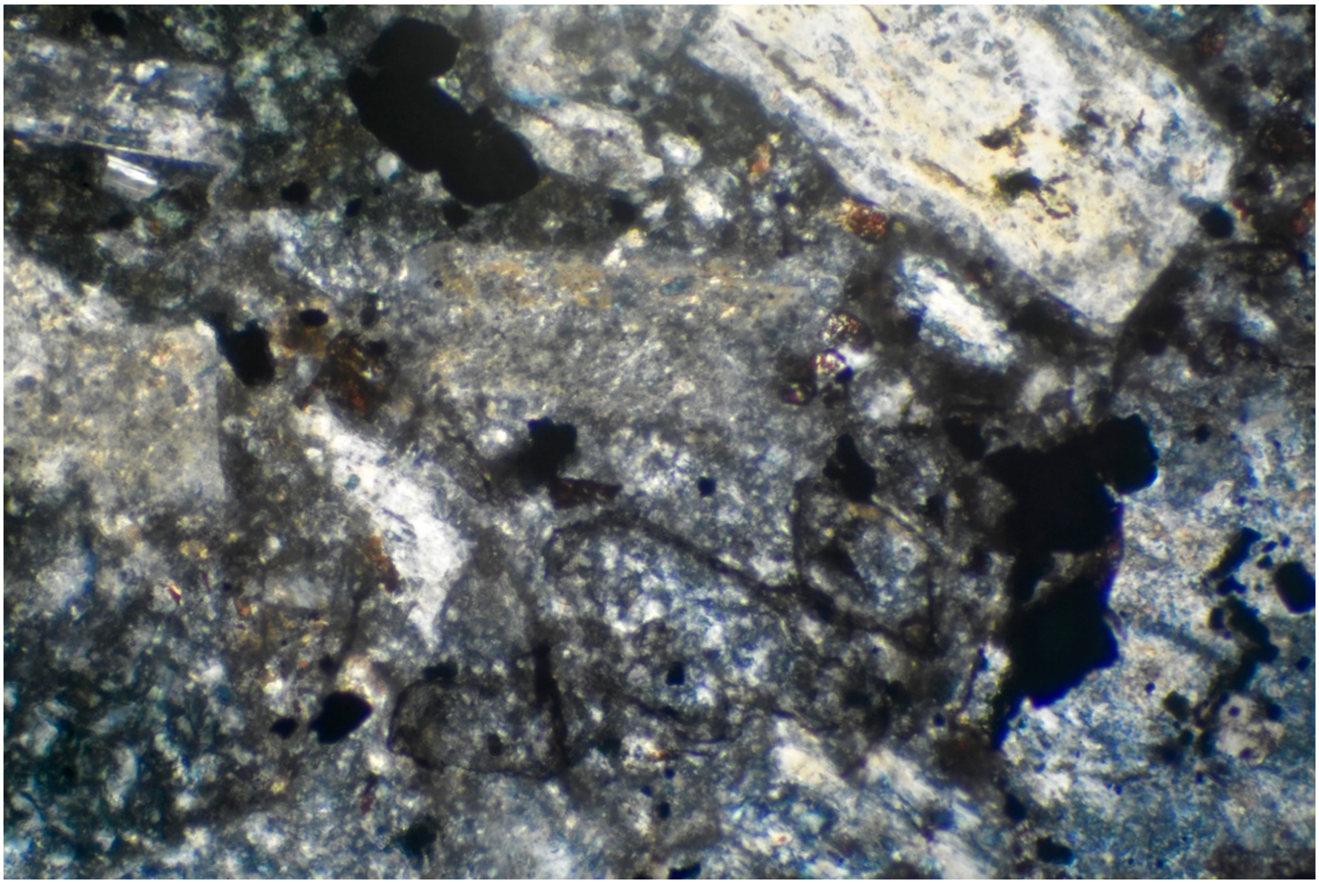
CE409-42.3m – r – same view as previous photo in ordinary light showing the high abundance of secondary minerals other than chlorite. Scale: side of photograph is 0.8mm



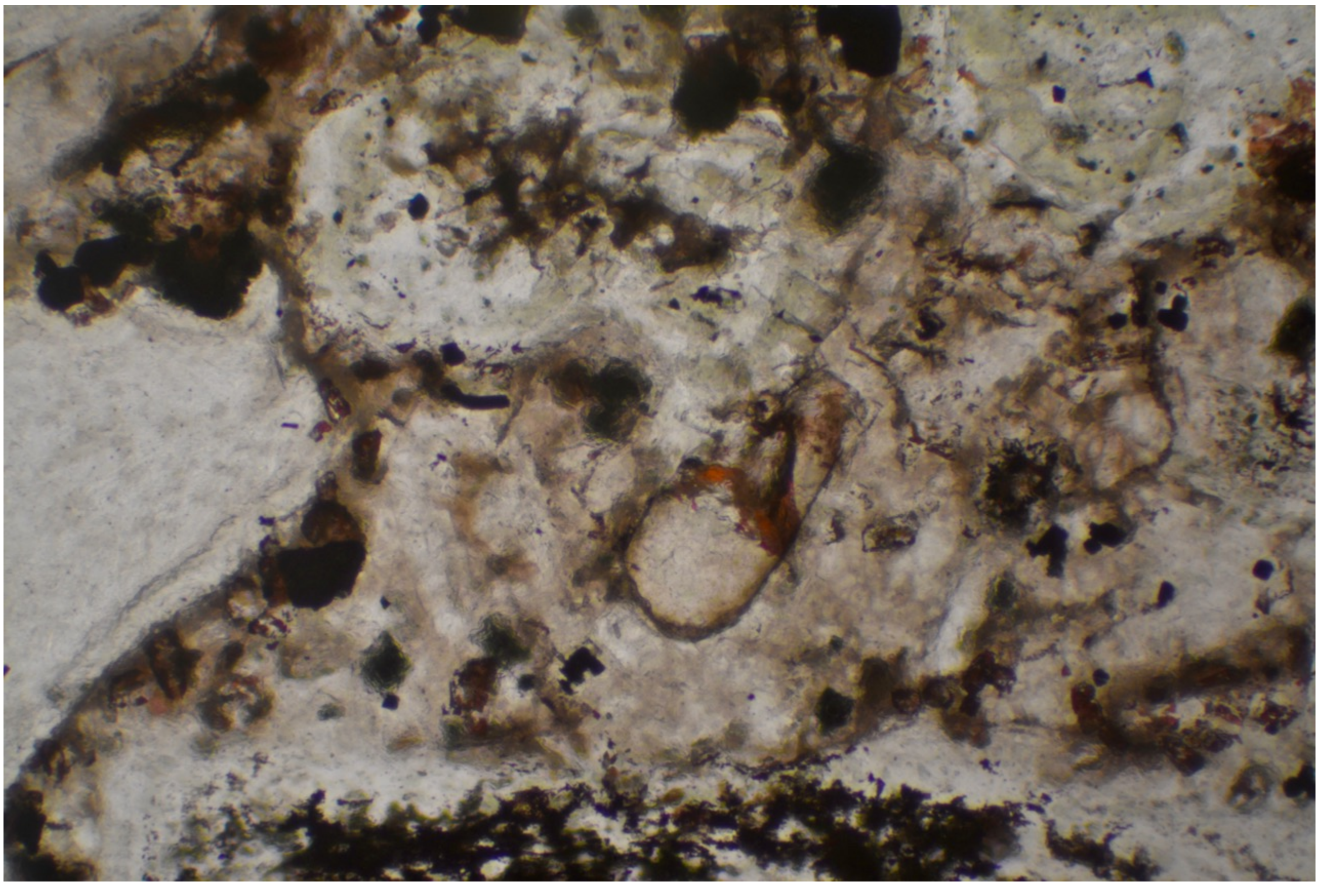
CE409-42.3m – s – a view similar to the previous photo focusing on the prismatic opaque minerals and the associated alteration. Scale: side of photograph is 0.8mm



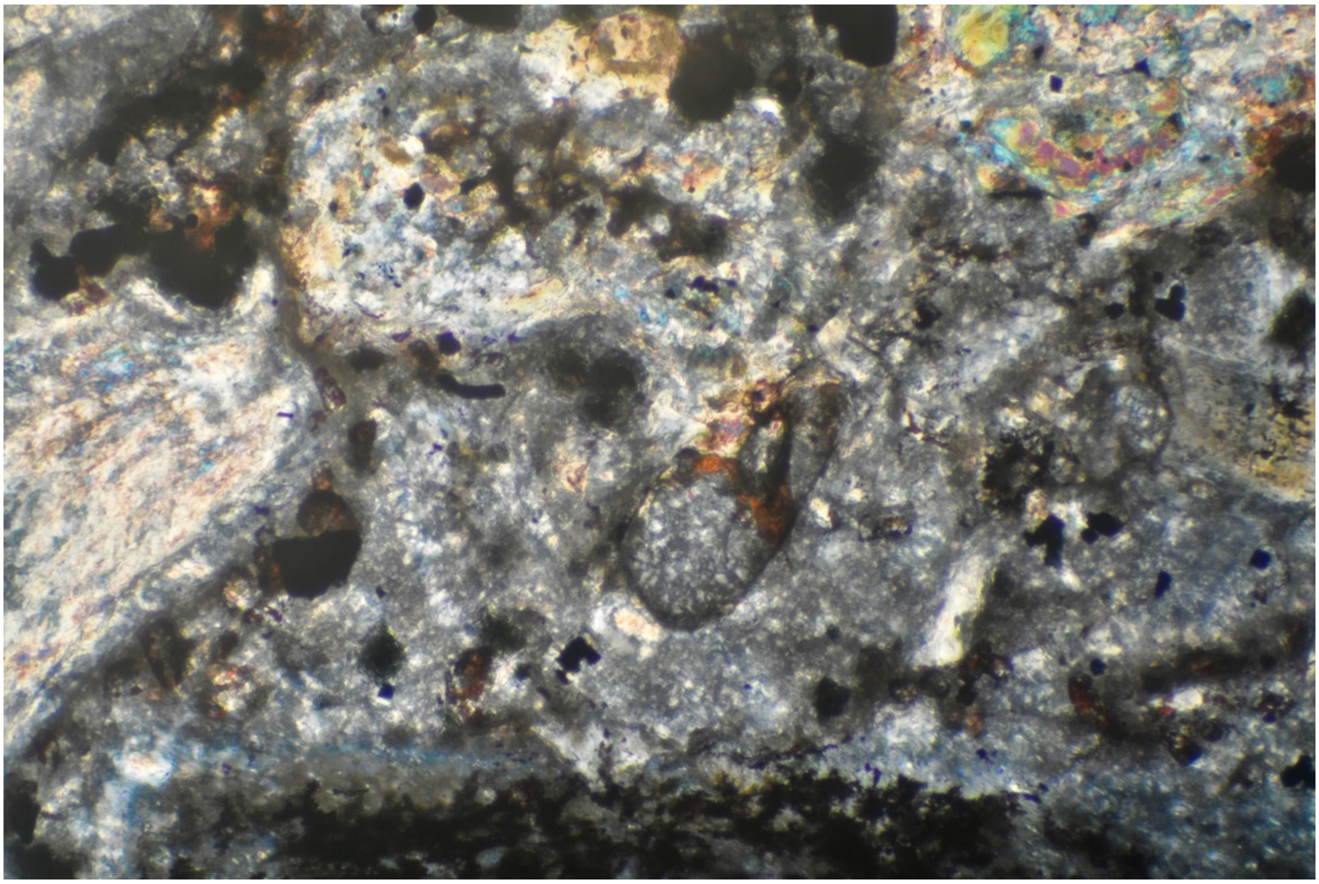
CE409-42.3m – t – a condenser-enhanced view of several forms (below centre) within the groundmass. Scale: side of photograph is 0.8mm



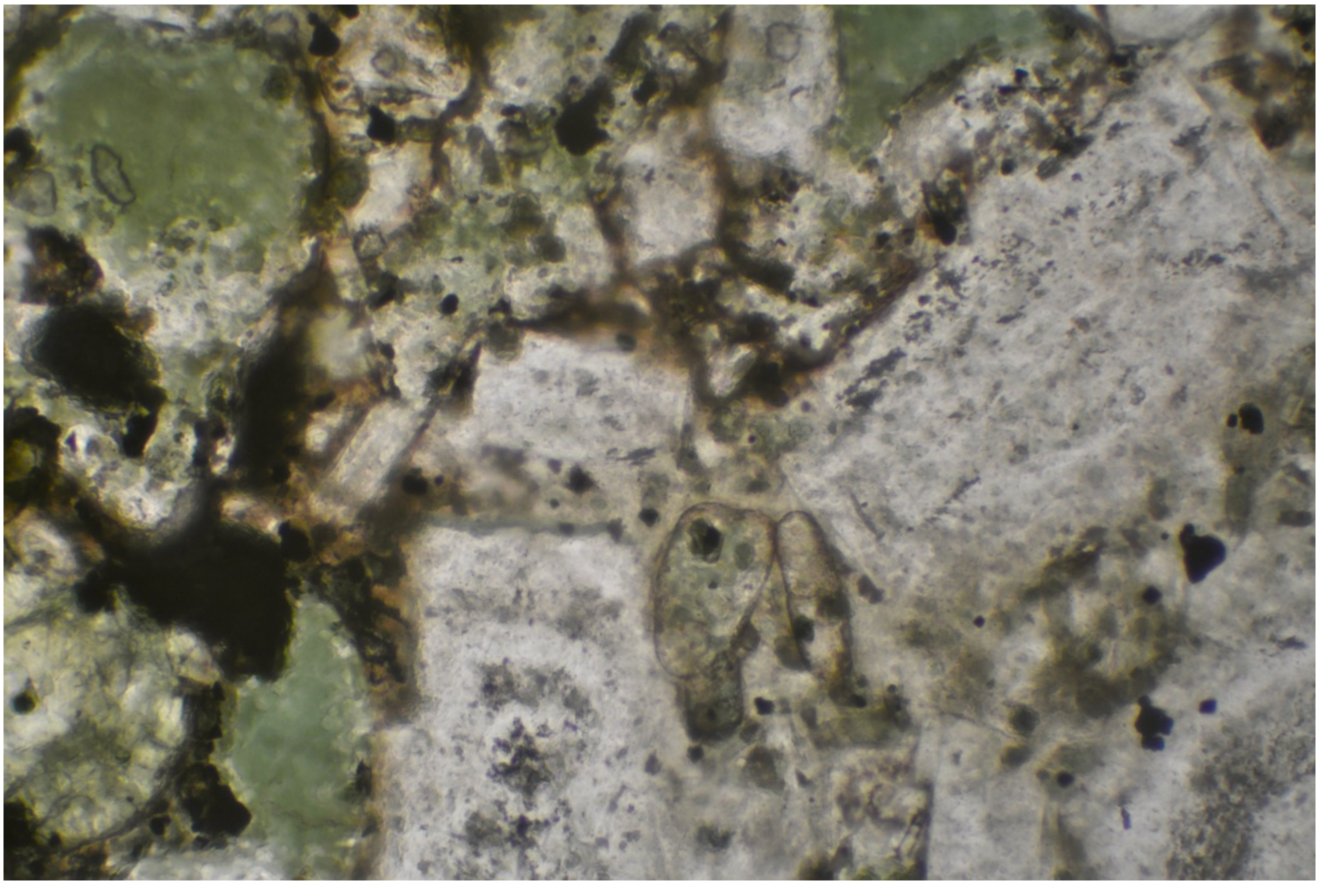
CE409-42.3m – u – same view as previous photo in polarized light to show the finely speckled nature in these forms. Scale: side of photograph is 0.8mm



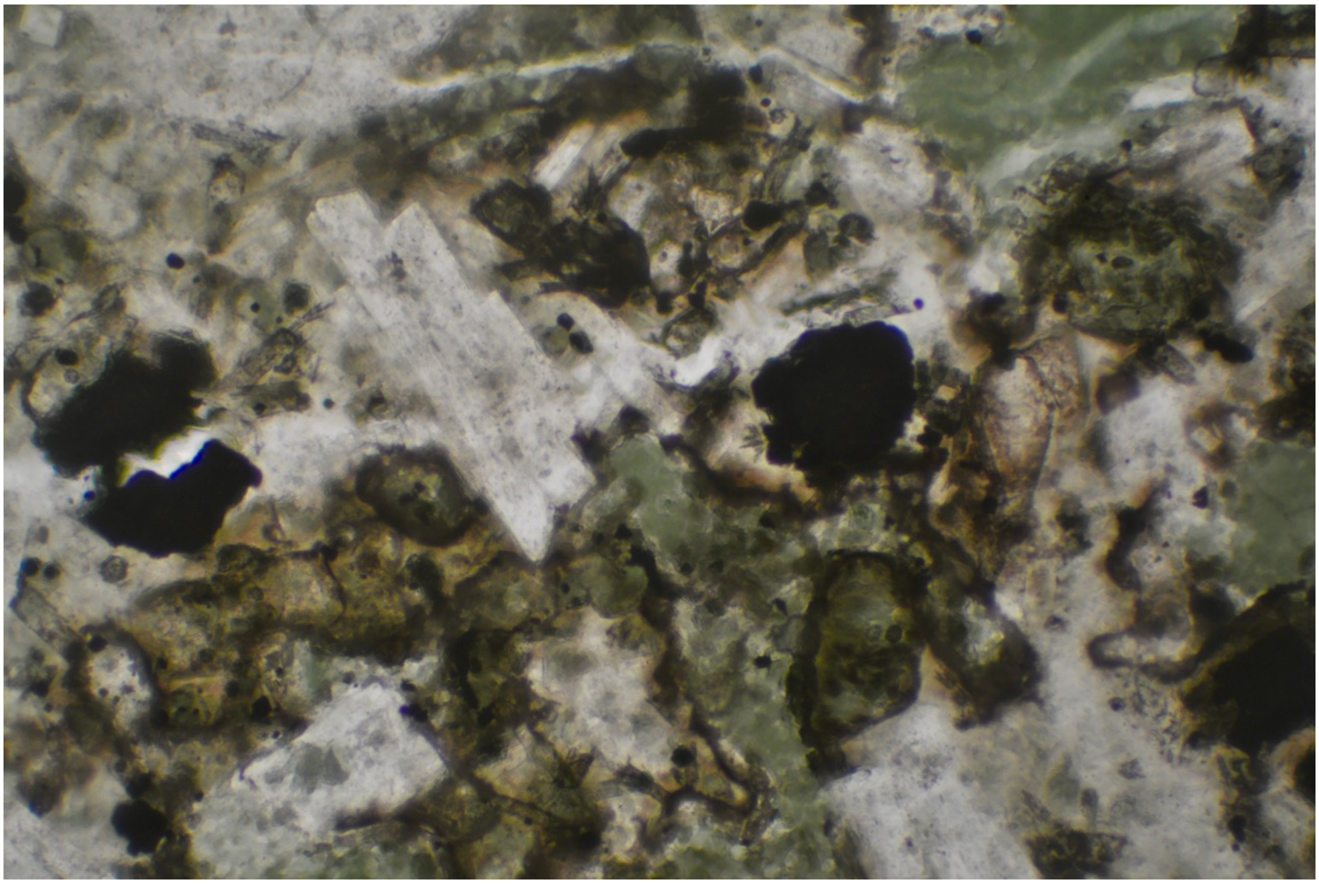
CE409-42.3m – v – another view of these forms in the groundmass. Scale: side of photograph is 0.8mm



CE409-42.3m – w – same view as the previous photo in polarized light showing the speckled texture. Scale: side of photograph is 0.8mm



CE409-42.3m – x – another view of two rounded forms, the left with some chloritic alteration. Scale: side of photograph is 0.8mm



CE409-42.3m – y – another condenser-enhanced view of the typical groundmass, including several of the unidentified forms. Scale: side of photograph is 0.8mm

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CE415-26.1m

Macroscopic and binocular description of rock

This is a composite dark-grey to reddish-burgundy coloured, porphyritic, dense, volcanic rock type featuring considerable colour and textural heterogeneity. On wetting the rock displays mostly a reddish colour. Numerous texturally variable inclusions are a feature.

Under the binocular microscope the rock displays a porphyritic texture with phenocrysts of green pyroxene and feldspar. Some pitting of the pyroxene indicates weathering/alteration. There is also one prominent, light-greenish inclusion, one dark-coloured inclusion and several smaller lithic fragments. A few whitish patches are at one end of the core.

A scratch test shows that the rock type is generally quite hard and could not be easily scratched (except for small soft parts). It was fairly difficult to cut.

An acid test reveals that there is some reactive carbonate, mostly in fine hairline structures. Porosity is moderately low.

Petrographic description of thin-section

This is another porphyritic, chemically intermediate volcanic rock that is superficially similar to the samples from CE405 and CE416. It also has an involved history but the history and the rock itself are different to the previous rocks. This rock is unlikely to have been a lava flow nor is it likely to have been extruded hot into a lagoon or seawater. The commonality with the previous rocks is that there has been some mild subsequent hydrothermal alteration.

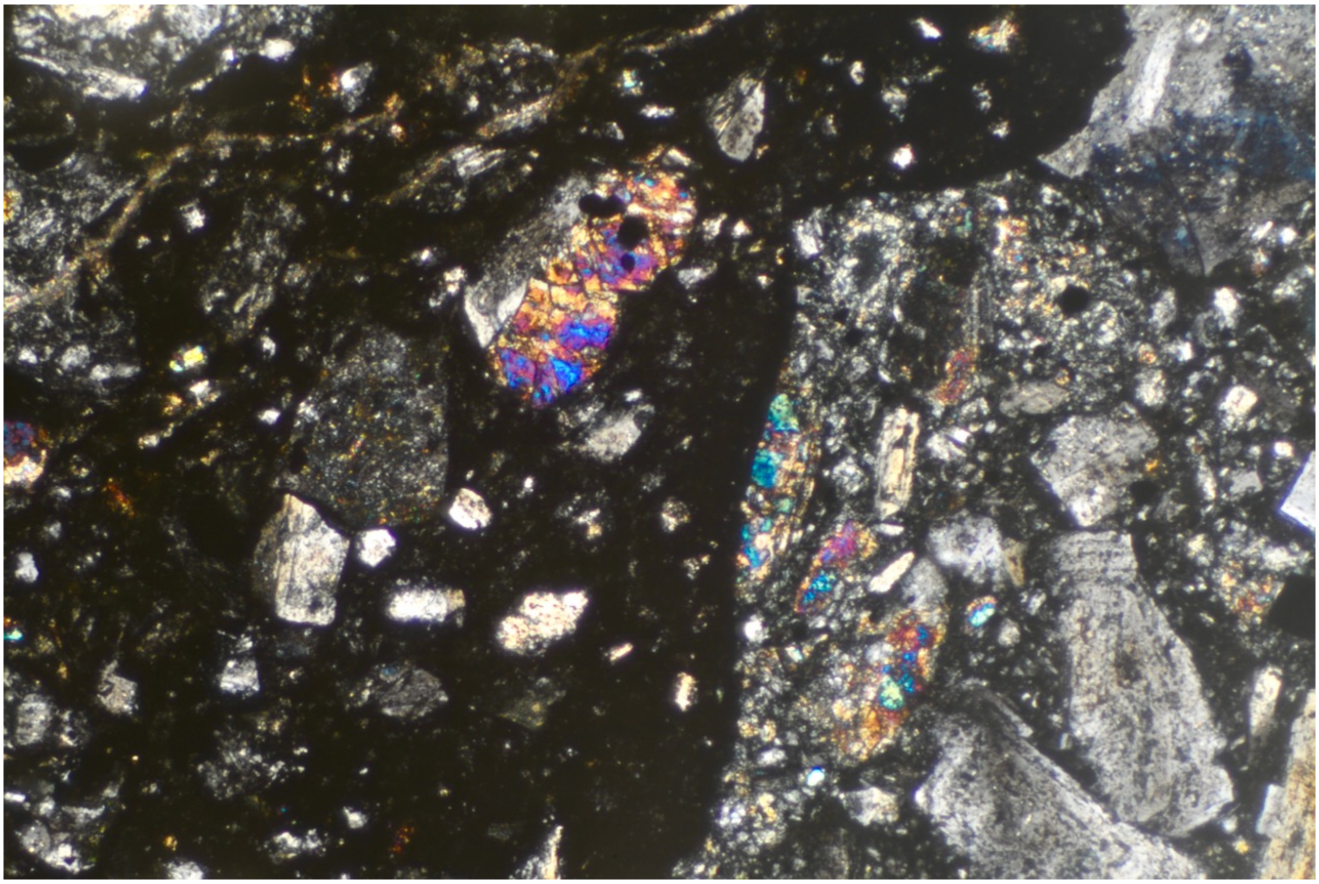
The overall appearance of this rock is an andesitic rock containing innumerable texturally and mineralogically different inclusions. Yet it is not a conglomerate. Nor is it an ash-flow/ignimbritic rock. It has a groundmass that is surprisingly difficult to resolve because of the high number of small inclusions, many with textures that would be expected in a groundmass. The scenario for the formation of this rock is difficult to imagine but most likely the result of multiple volcanoes erupting or that have erupted over a radius of 10-20km. This is not unprecedented and is typical of an erosive, nuee ardente. The key factor is that many of the inclusions have undergone some alteration prior to being incorporated. Others remain surprisingly fresh even though a separate, low intensity alteration event was superimposed after solidification. Minor sericitization appears to be a late-formed mineral whereas the minor formation of epidote and prehnite within the inclusions has preceded the incorporation.

The basic rock appears to be a pyroxene andesite with large, quite common phenocrysts of partly altered calcic pyroxene (to 2mm) and plagioclase feldspar (to 2mm). The outstanding difference to the sample at CE405 and CE416 is the presence of innumerable rock fragments. Many of the feldspar crystals are fractured and with a small amount of groundmass attached or wedged in between another feldspar. Some of the pyroxene is in clots. The pyroxene often contains numerous inclusions of opaque minerals, similar to previously described rocks. The feldspar shows only minor alteration. One feature of many feldspars, including those in inclusions, is a reddening. It is uncertain if this reddening is the result of elevated temperatures or simply recent weathering (more favoured explanation).

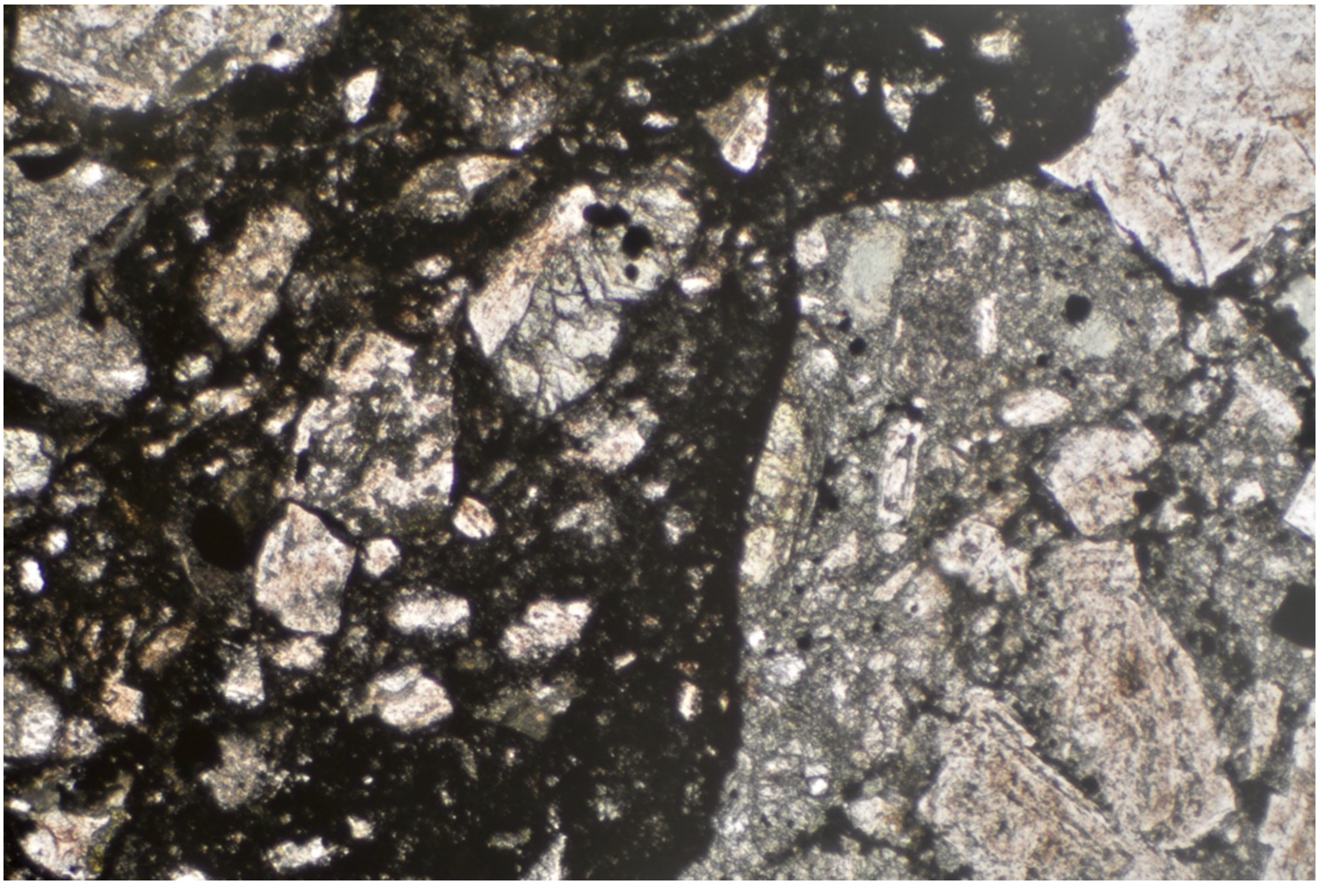
Mode of rock	feldspar phenocrysts	35%
	calcic pyroxene	15%
	chlorite	18%
	epidote	1%
	prehnite	1%
	sericite	1%
	carbonate	<1%
	opaque minerals	4%
	groundmass	25%

Name of rock Altered pyroxene andesite

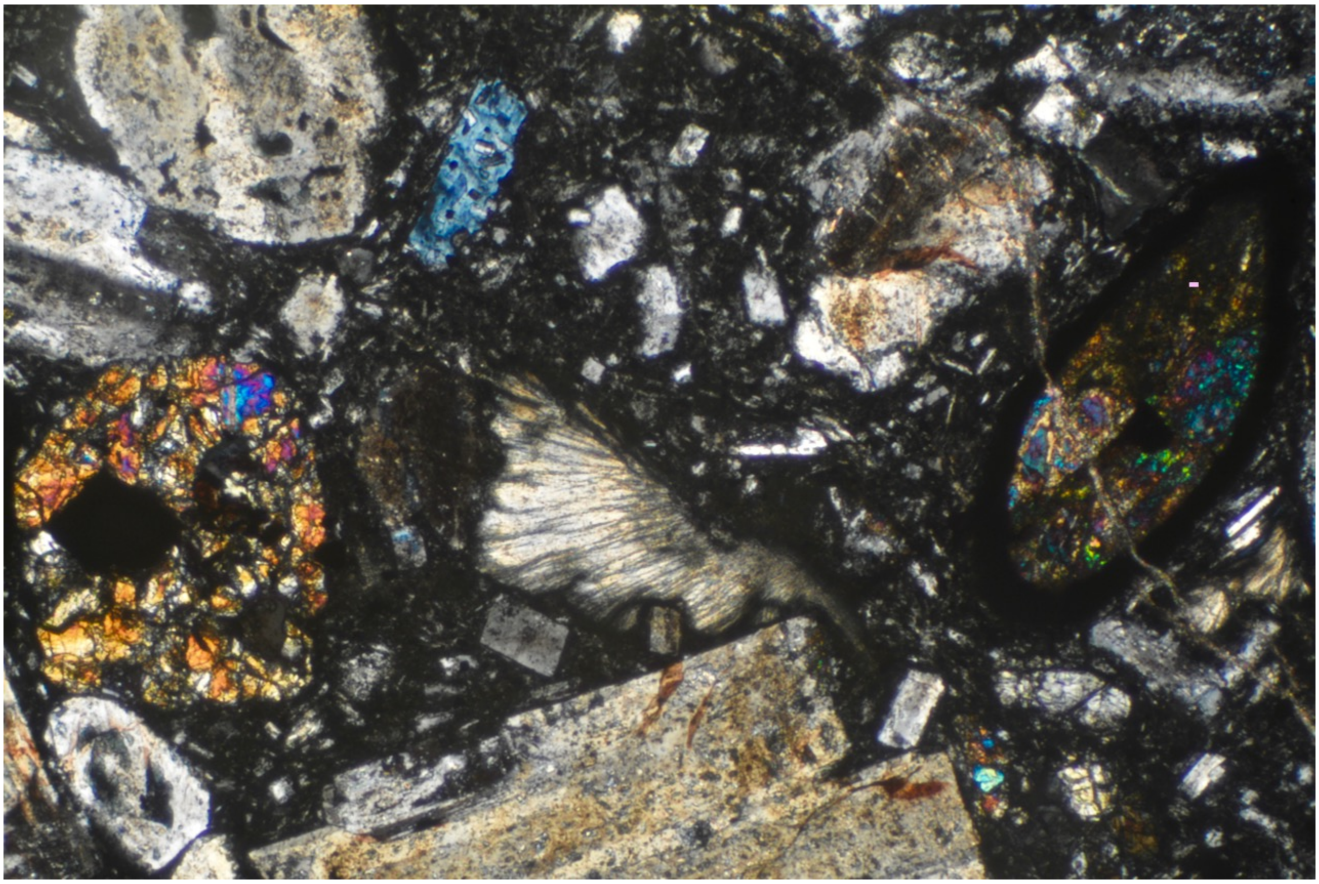
Dr. H. D. Hensel
(HENSEL GEOSCIENCES)
(27th August, 2018)



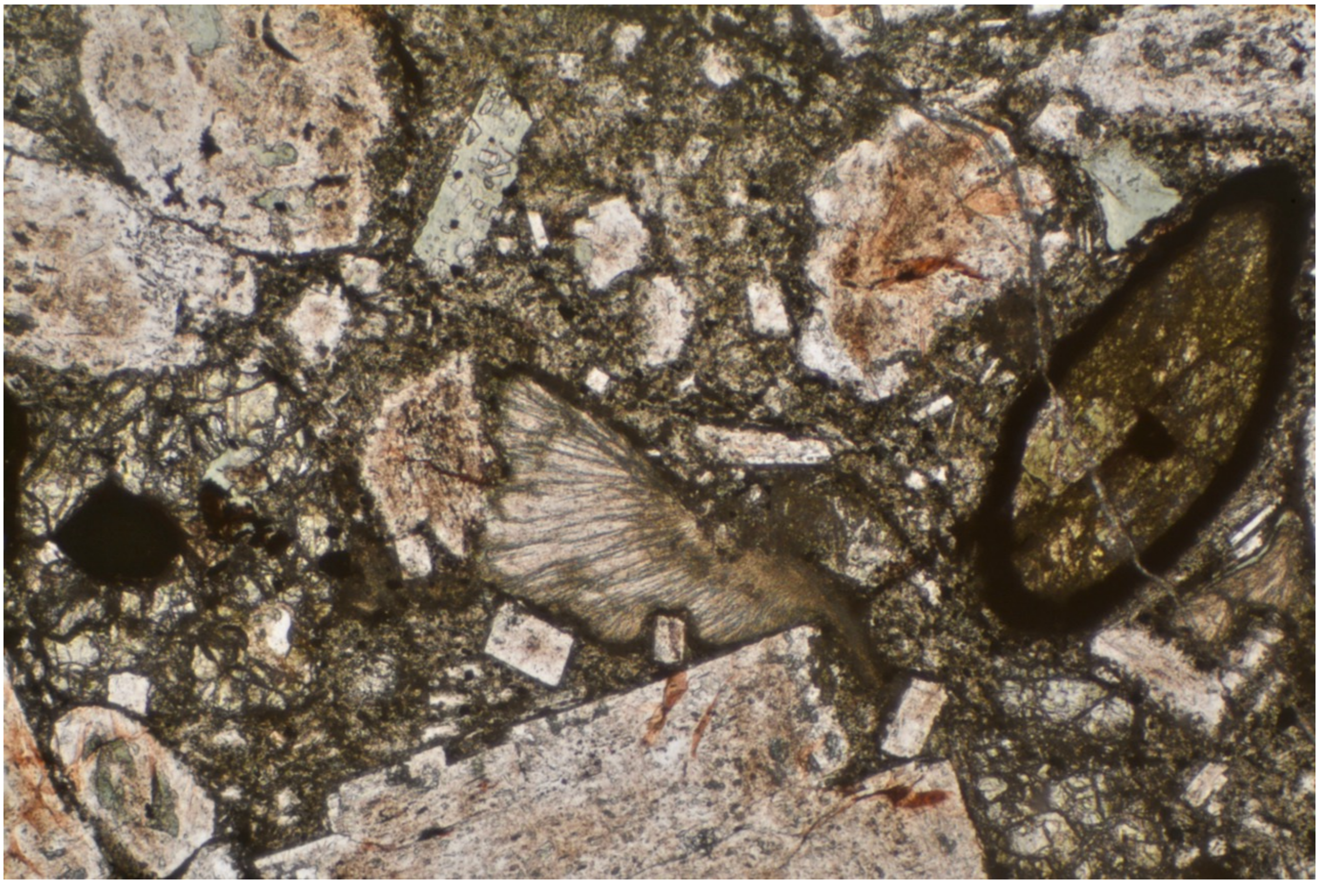
CE415-26.1m a - a common textural view in polarized light of this volcanic rock showing the contrast between the general groundmass and a large inclusion. Scale: side of photograph is 1.6mm



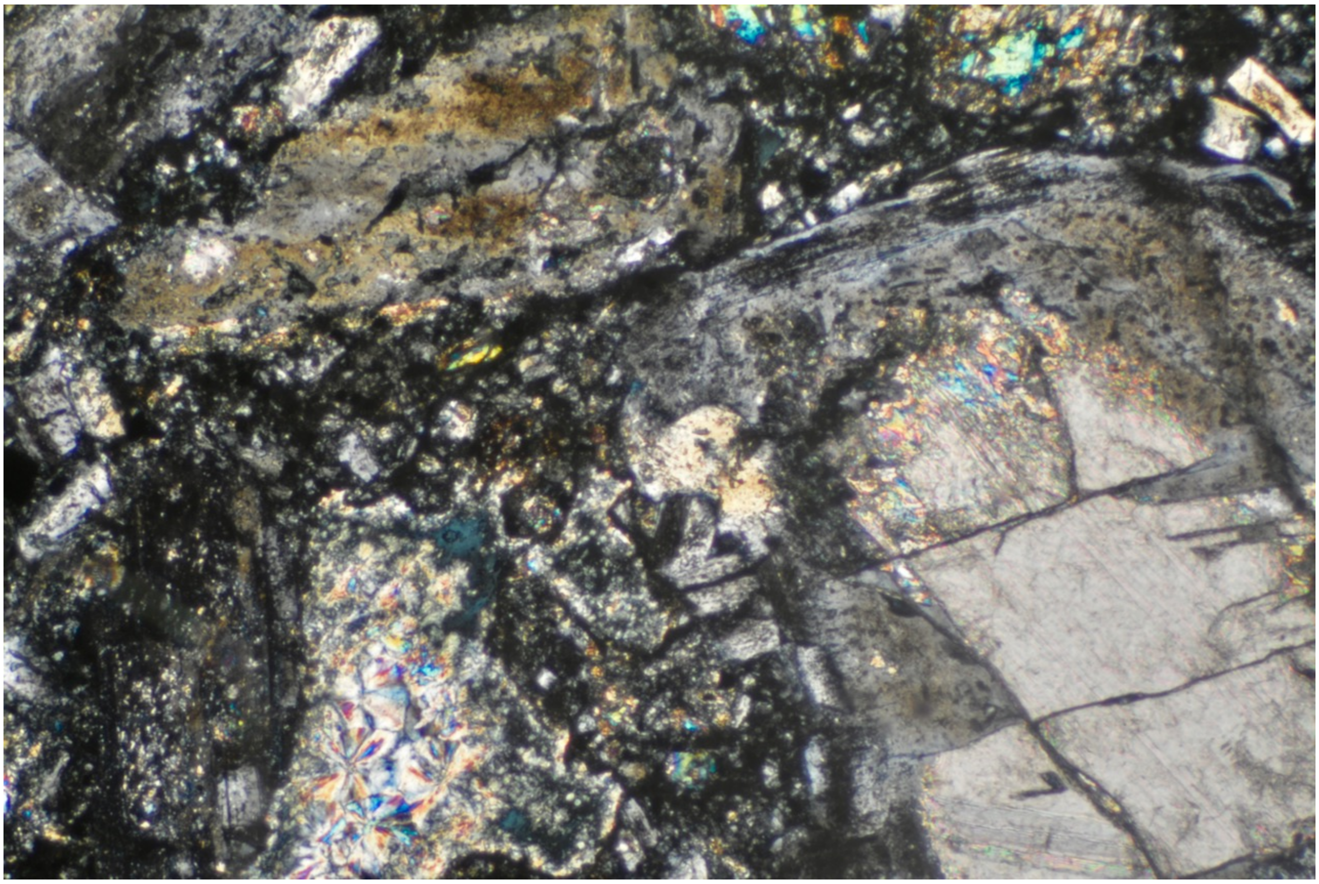
CE415-26.1m – b – same view as previous photo in ordinary light to better distinguish the dense dominant chlorite mineralogy of the groundmass. Scale: side of photograph is 1.6mm



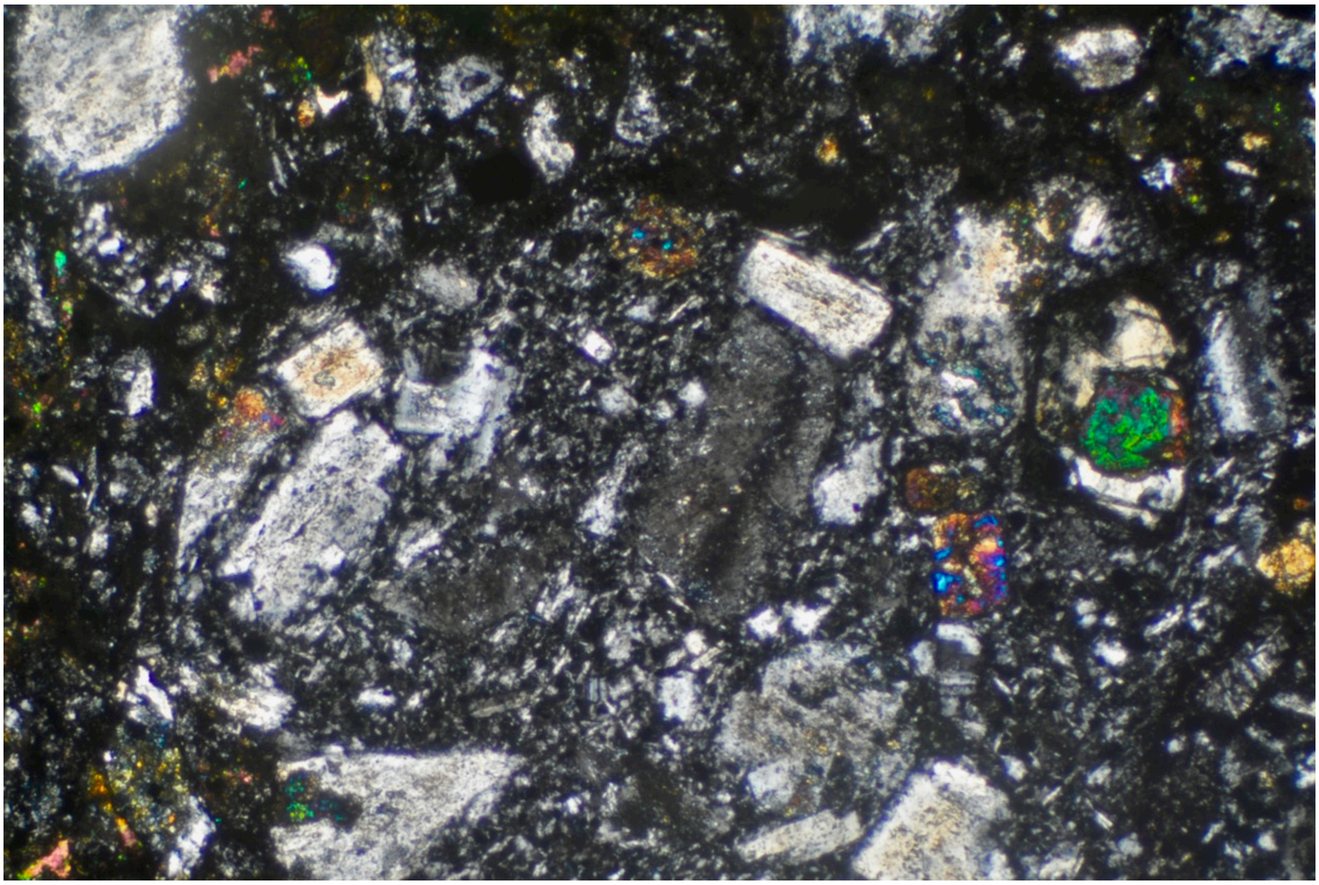
CE415-26.1m – c – a strange collection of items including a prismatic calcic pyroxene crystal with a large opaque mineral inclusion, a lens-shaped feature with a thick oxidation rim (right) but containing epidote, a radiating prehnite structure in the centre, a bluish chlorite patch and a thin calcitic veinlet.   Scale: side of photograph is 1.6mm



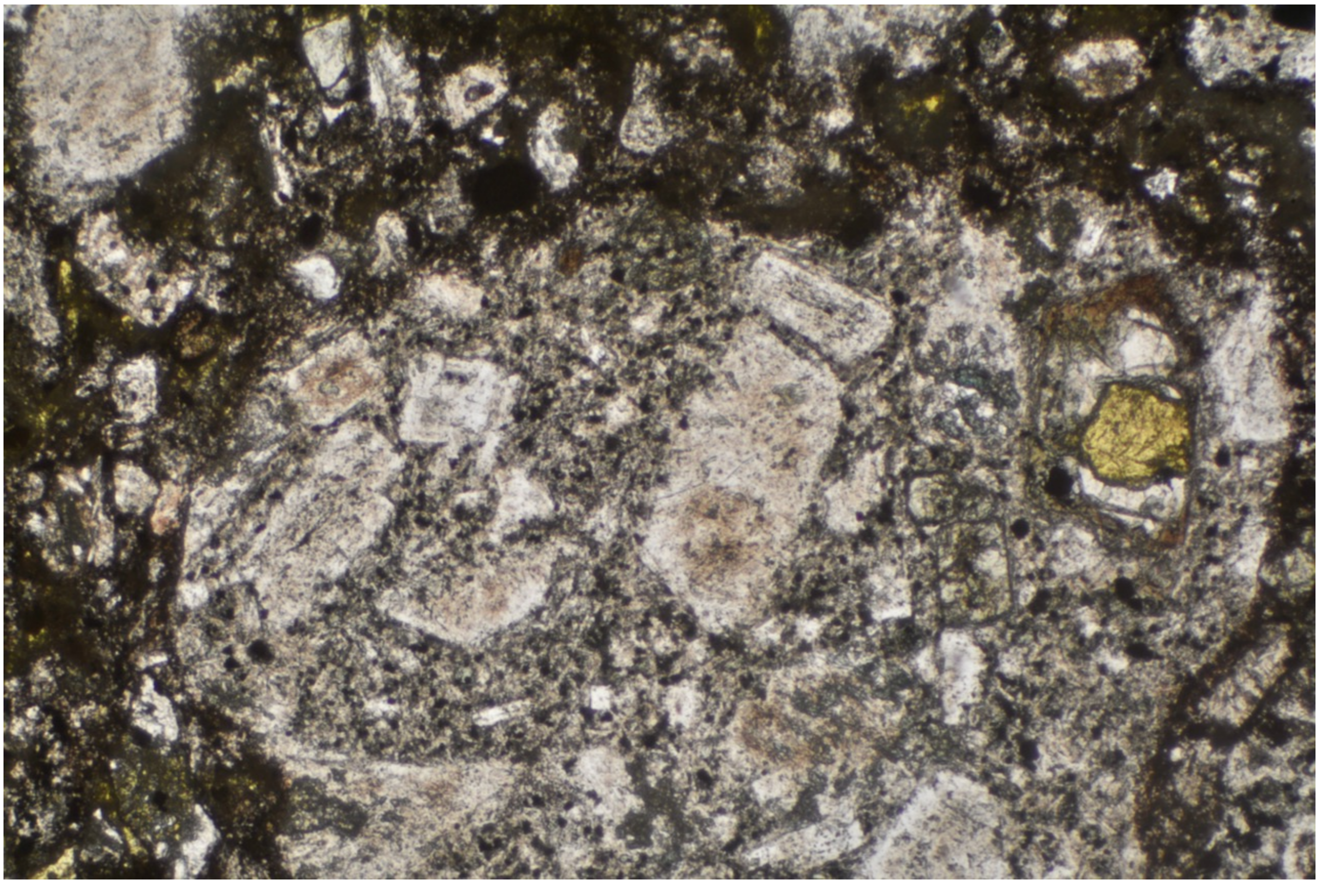
CE415-26.1m – d – same view as previous photo in ordinary light highlighting the discolouration of the plagioclase feldspar.   Scale: side of photograph is 1.6mm



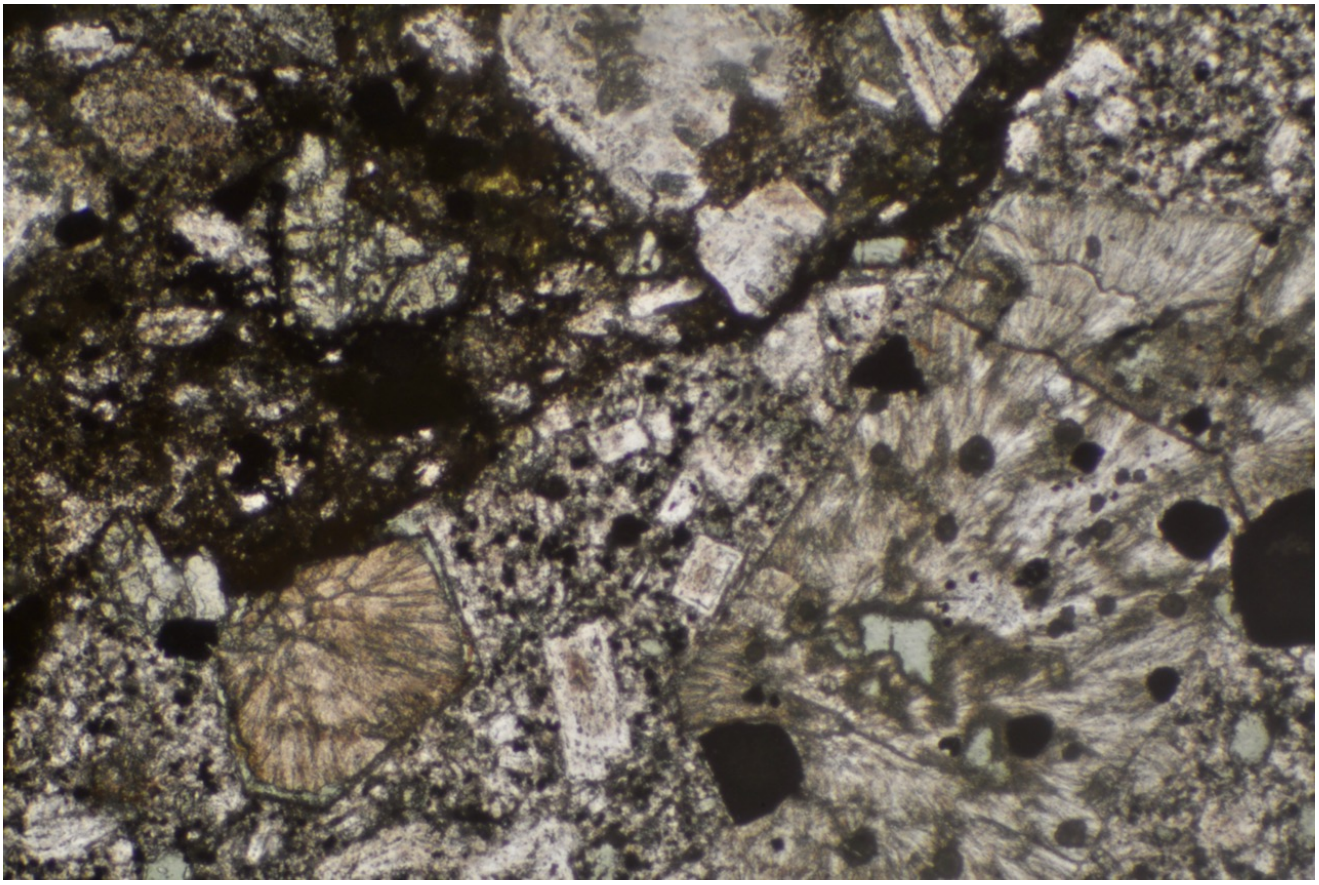
CE415-26.1m – e – a view of a large feldspar crystal that has been substantially replaced by calcite. Note also the patch of coloured sericite. Scale: side of photograph is 1.6mm



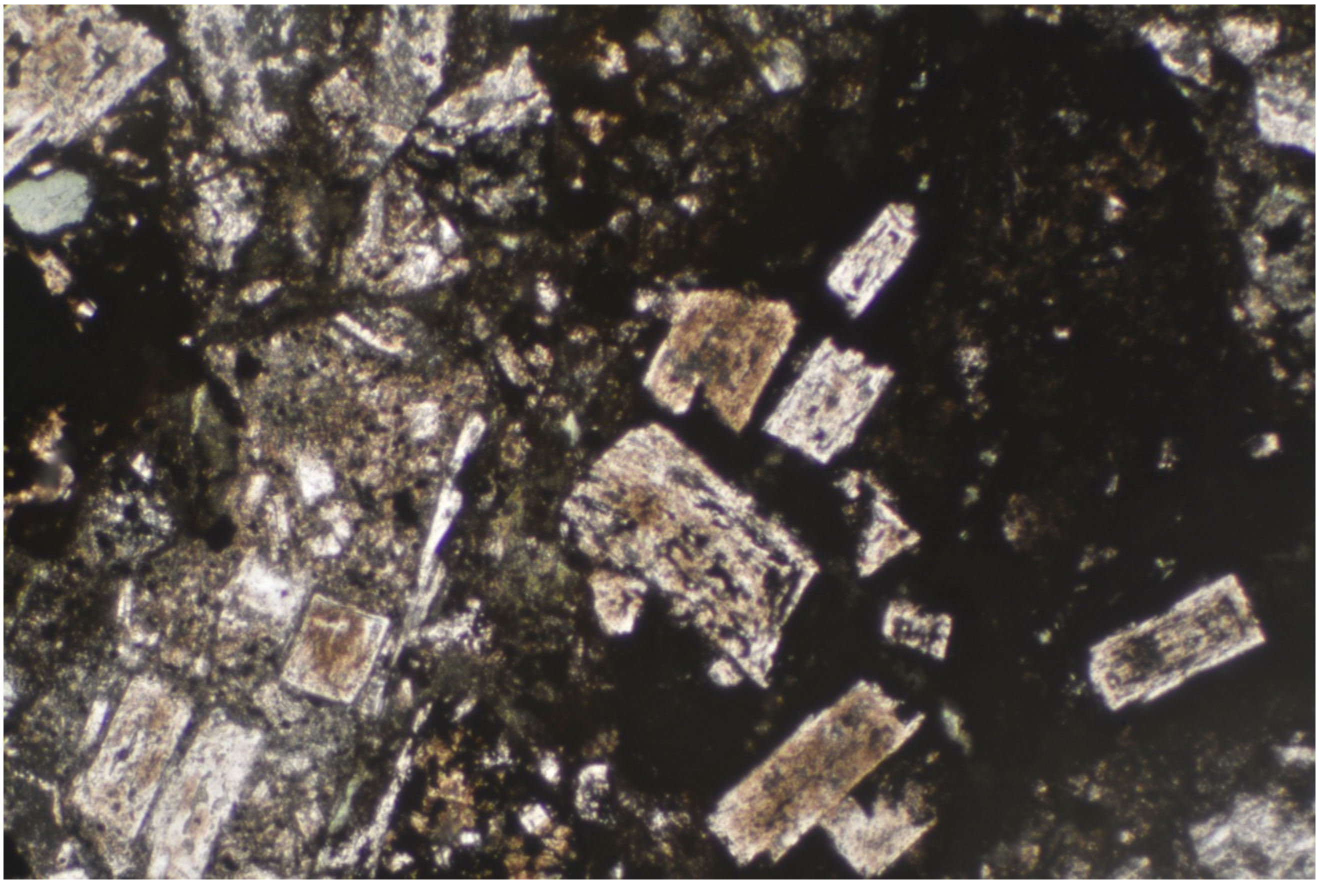
CE415-26.1m – f – a common type of inclusion. Note the more discernible groundmass crystals. Coloured crystals are epidote. Scale: side of photograph is 1.6mm



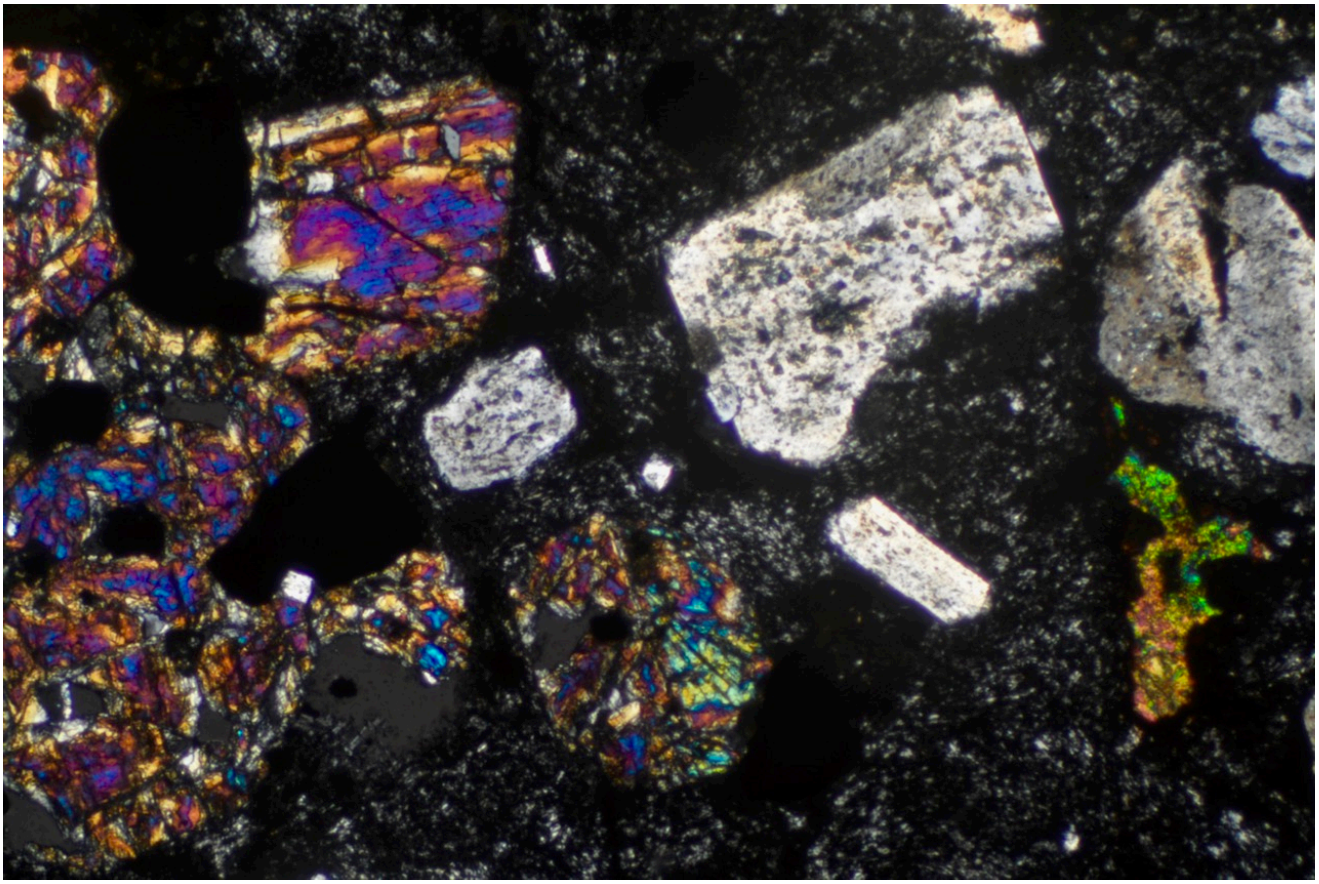
CE415-26.1m – g – same view as previous photo in ordinary light showing some feldspar colouration. Scale: side of photograph is 1.6mm



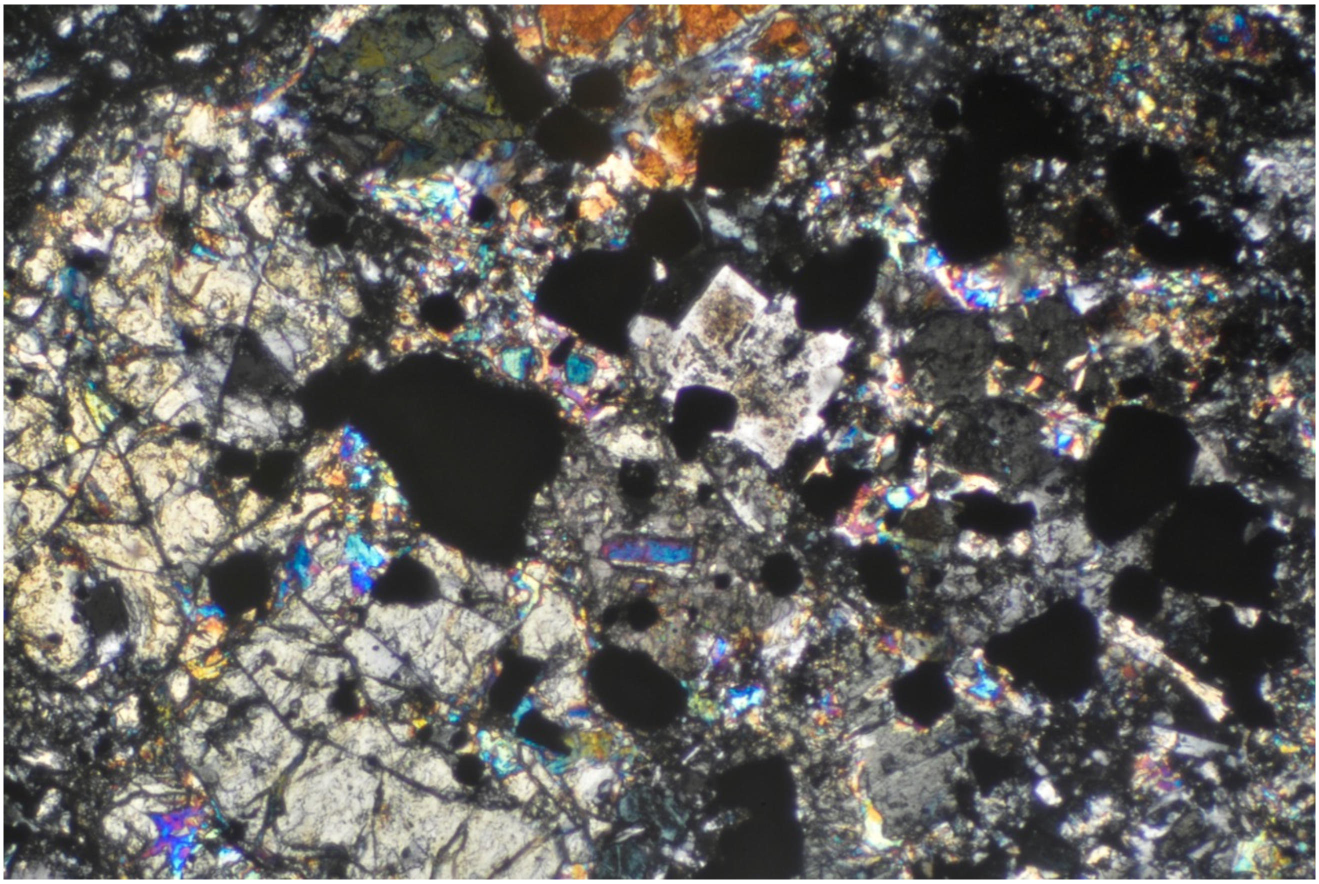
CE415-26.1m – h – portion of a large inclusion with prismatic feldspar and 3 patches of radiating prehnite. Scale: side of photograph is 1.6mm



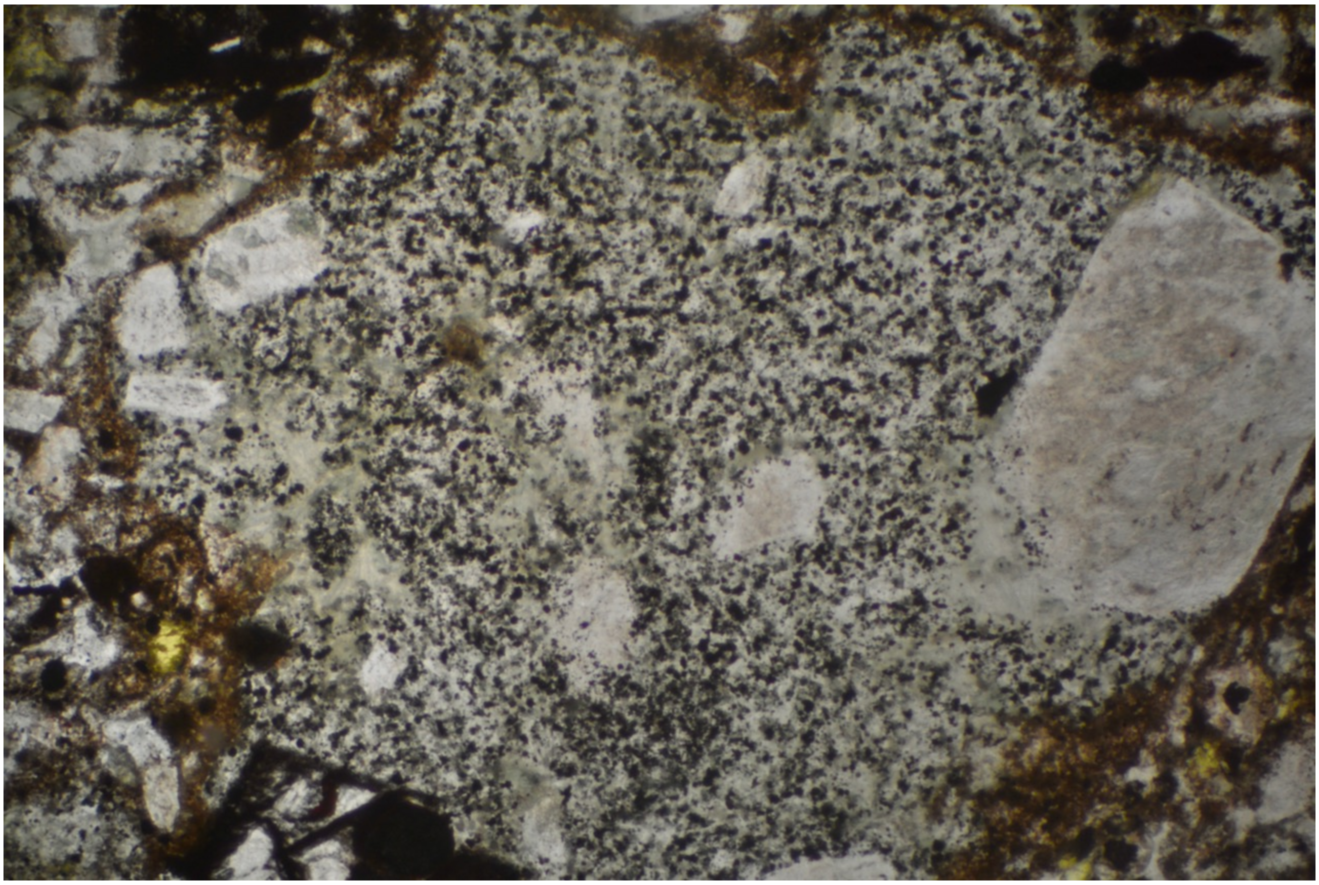
CE415-26.1m – i – two contrasting types of inclusion. Scale: side of photograph is 1.6mm



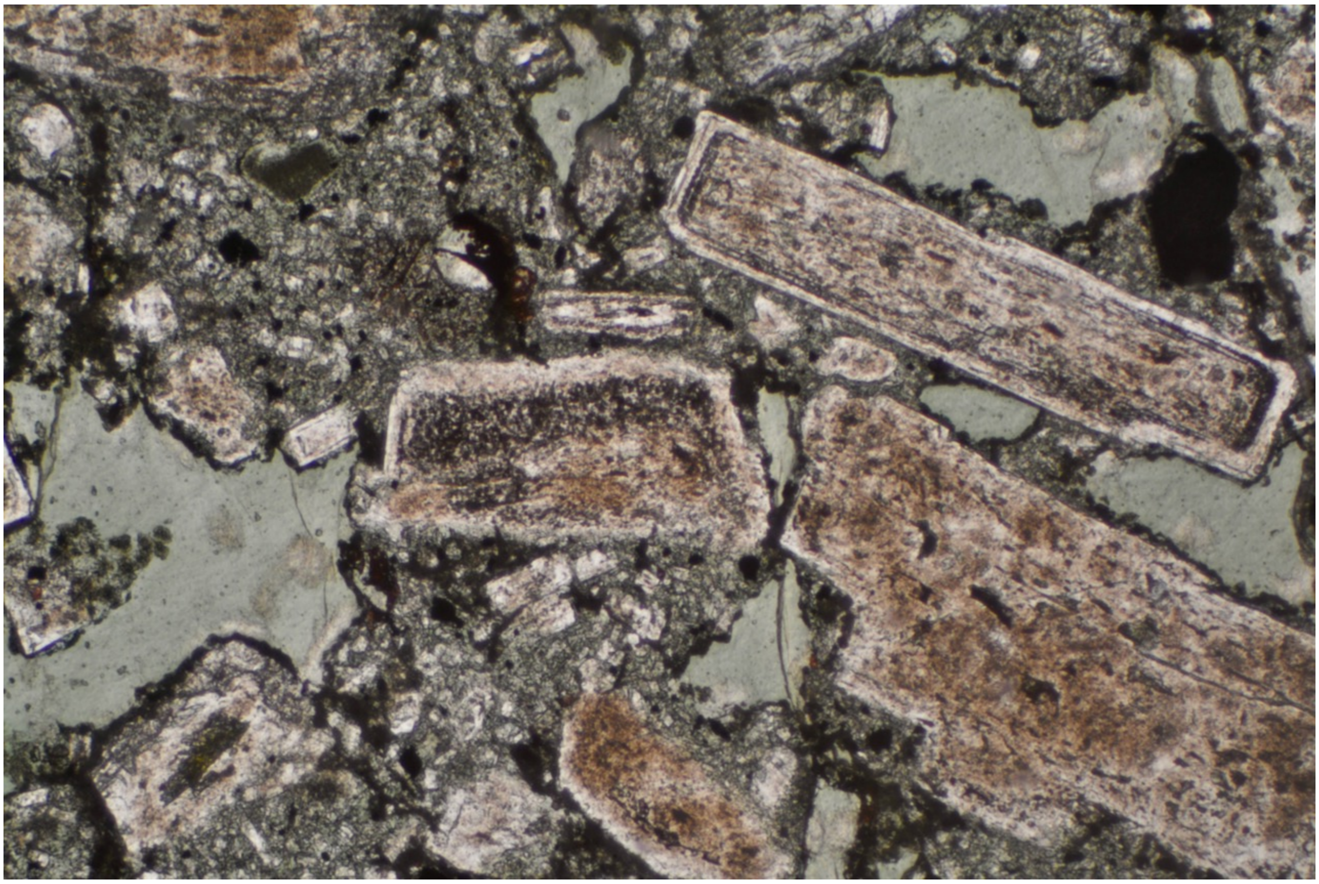
CE415-26.1m – j – another type of inclusion in which there are fresh-looking pyroxene crystals. The groundmass is extremely fine-grained. The greenish crystal to the right is epidote. Scale: side of photograph is 1.6mm



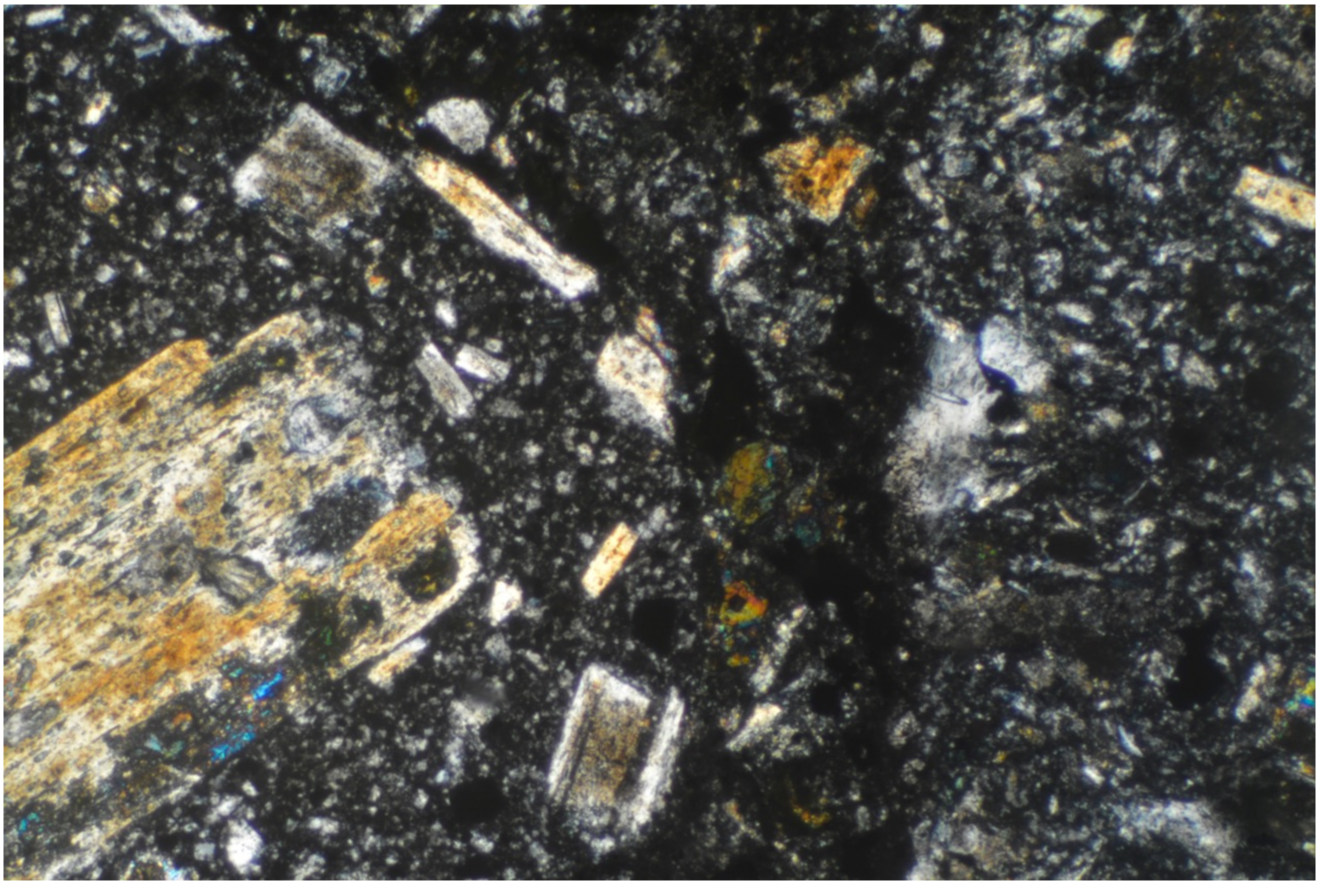
CE415-26.1m – k – a large calcic pyroxene crystal hosting numerous opaque oxide crystals. Scale: side of photograph is 1.6mm



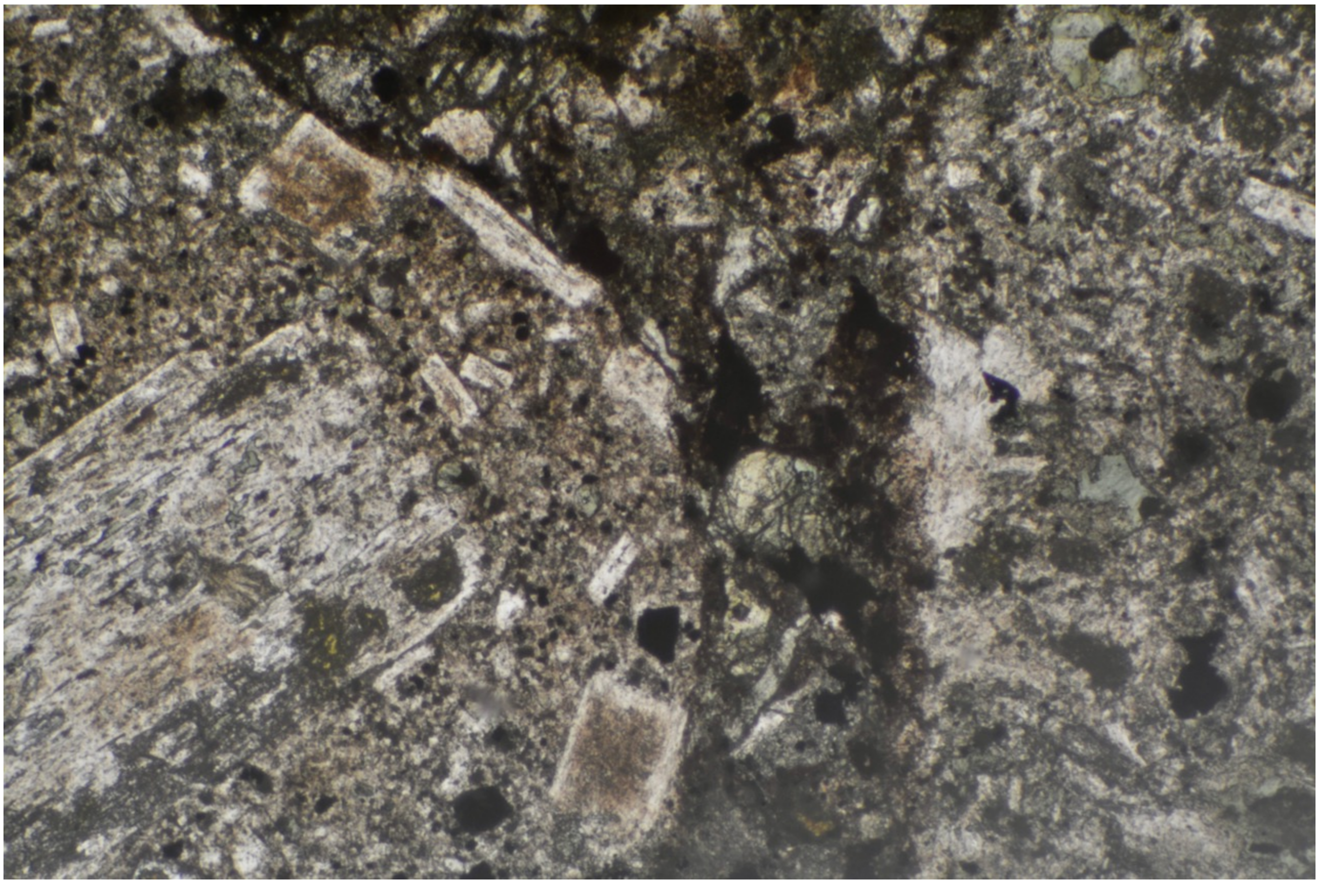
CE415-26.1m – L – another type of inclusion where the feldspar of the groundmass has been almost entirely replaced by chlorite. Scale: side of photograph is 1.6mm



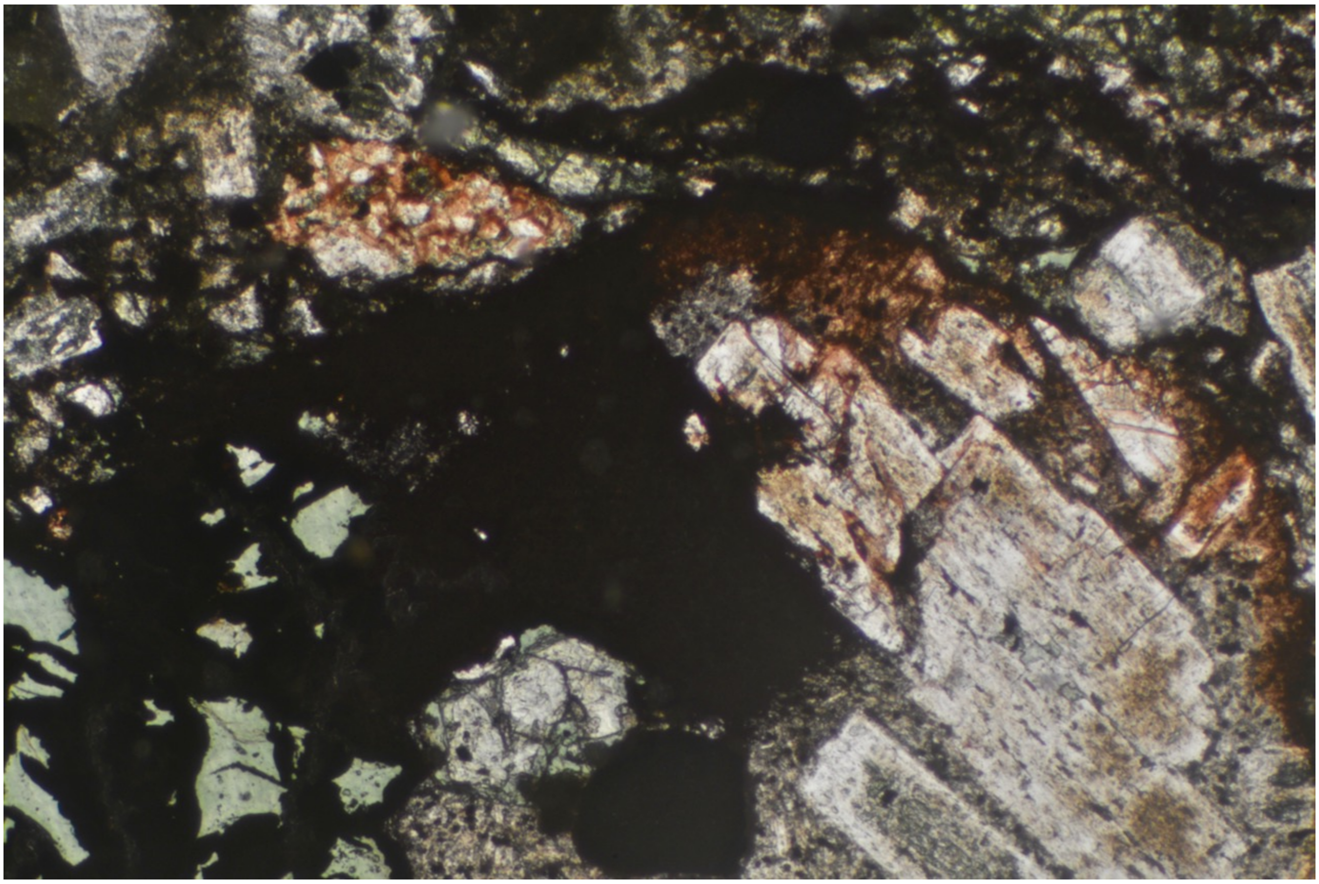
CE415-26.1m – n – another type of inclusion containing prismatic, compositionally zoned and reddened feldspar accompanied by numerous irregular patches of chlorite. Scale: side of photograph is 1.6mm



CE415-26.1m – o – two slightly different inclusions of chemically intermediate volcanic rocks. Scale: side of photograph is 1.6mm



CE415-26.1m – o – same view as previous photo in ordinary light to better distinguish the mineralogy. The inclusion on the left has large feldspar phenocrysts and little chlorite whereas the inclusion on the right has no large phenocrysts but has abundant chlorite. Scale: side of photograph is 1.6mm



CE415-26.1m – o – a composite inclusion featuring a large patch of opaque material with associated chlorite as well as discoloured feldspar. Scale: side of photograph is 1.6mm

CE416-38.8m

Macroscopic and binocular description of rock

This is a mostly dark-grey, porphyritic, dense, volcanic rock type featuring considerable colour and textural heterogeneity. Dark reddish-burgundy patches, light greenish minerals and patches and whitish alteration patches are throughout the core sample. On wetting the rock displays mostly a reddish colour. Several light-coloured veinlets or joint fillings traverse the sample.

Under the binocular microscope the rock displays a porphyritic texture with quite large phenocrysts of green pyroxene and numerous smaller crystals of feldspar. Pitting of the pyroxene indicates advanced weathering. There is also one prominent lithic fragment/inclusion.

A scratch test shows that the rock type is generally quite hard and could not be easily scratched (except for numerous small soft parts). It was fairly difficult to cut.

An acid test reveals that there is abundant reactive carbonate, mostly in fine hairline structures. Porosity is moderately low.

Petrographic description of thin-section

This is another porphyritic, chemically intermediate volcanic rock that is similar to the sample from CE405. It also has an involved alteration history. It has been modified by fluids during or soon after the formation. Without a detailed knowledge of the extremely fine groundmass this rock appears to be a pyroxene andesite with large, quite common phenocrysts of partly altered calcic pyroxene (to 3mm) and plagioclase feldspar (to 3mm). The outstanding difference to the sample at CE405 is the presence of quite large areas of prehnite.

The groundmass consists of extremely numerous tiny laths of feldspar, abundant submicroscopic chlorite and hydrated iron oxide. One feature of the groundmass is its variability and the presence of numerous irregular patches of chlorite. The intimate intermingling of quite dark groundmass with chlorite is another outstanding feature. The shapeless patches of groundmass, chlorite and perhaps prehnite have the appearance of original voids caused by volatiles in a fairly fluid lava, or more likely, the result of hot lava extruding into water, preferably seawater. The groundmass patches are typically between 1mm and 4mm with similar sized infillings of chlorite (see photographs). In places it is somewhat reddish and other places it appears “burnt”. Although quite dark and apparently oxidized small phenocrysts of feldspar are unaffected.

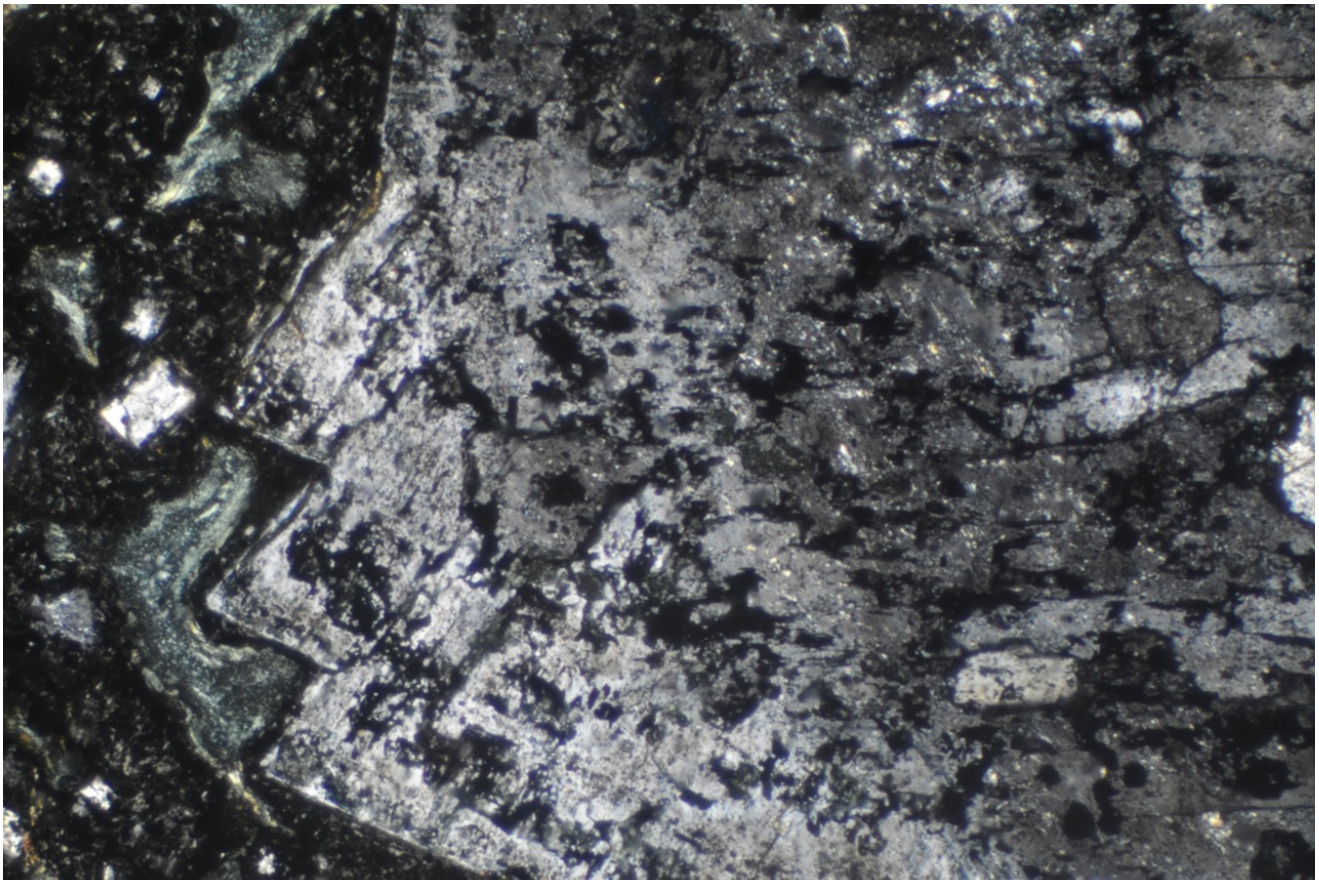
The small to large (>6mm) patches of prehnite are also highly irregular. Its presence is also likely to be the result of volatile activity on the basis of size and shape. Most of the patches consist of several crystals (see photographs).

There is no alignment of the feldspar but there is evidence for deformation after extrusion with some of the large feldspars displaying obvious bending. The prehnite also shows signs of deformation but this could be a mineralogical feature which can occur during crystal growth. Some of the feldspar phenocrysts exhibit unusual crystallization textures and alteration, indicating changes on the condition of the magma or lava. Yet, apart from some chlorite replacement the pyroxene and enclosed opaque minerals remained resilient to the changes.

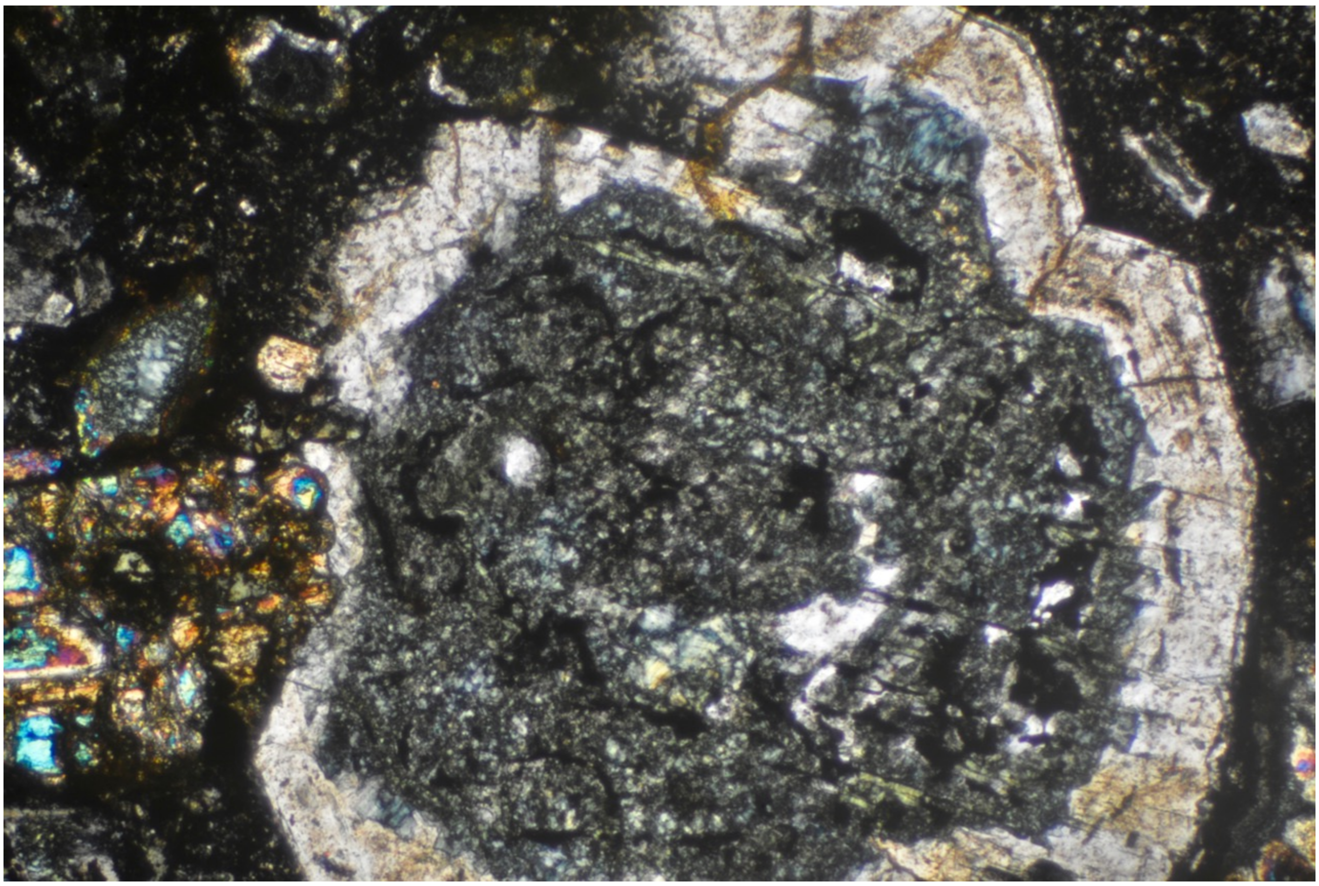
Mode of rock	quartz	<1%
	feldspar phenocrysts	25%
	calcic pyroxene	15%
	chlorite	26%
	epidote	1%
	prehnite	4%
	sericite	<1%
	carbonate	<1%
	opaque minerals	4%
	groundmass	25%

Name of rock Altered pyroxene andesite

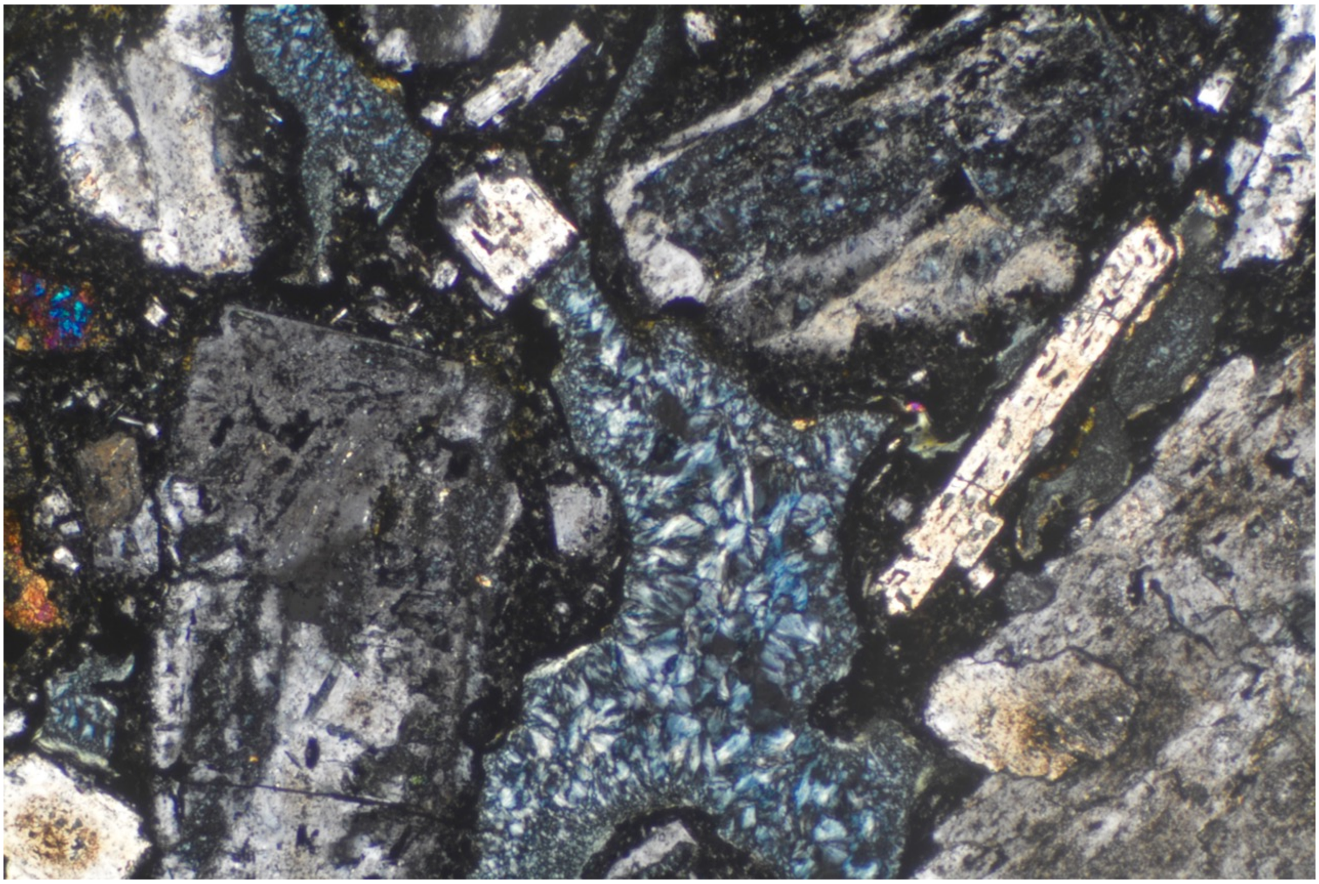
Dr. H. D. Hensel
(HENSEL GEOSCIENCES)
(27th August, 2018)



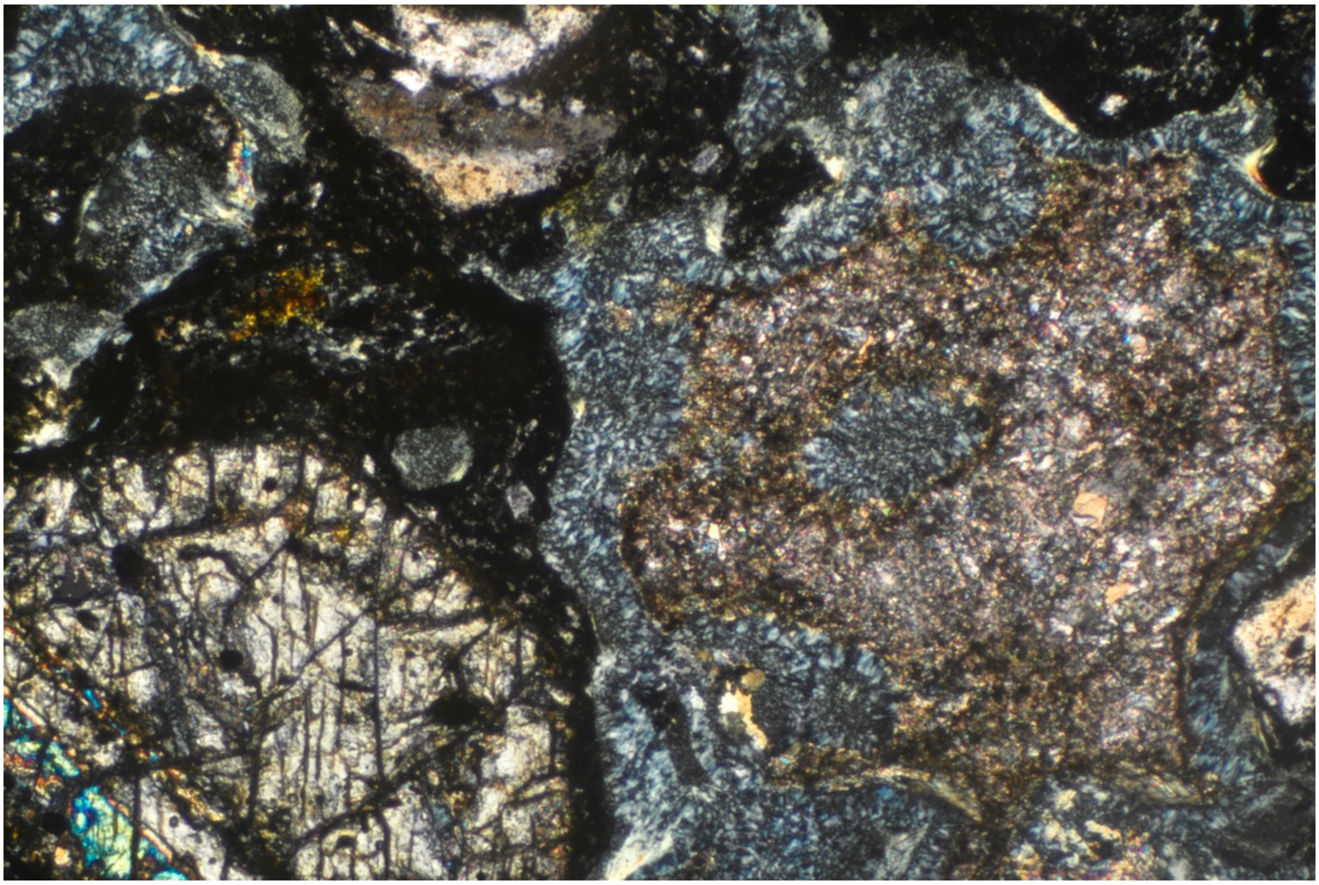
CE416-38.8m a - a common textural view in polarized light of this felsic volcanic rock showing some deformation textures of feldspar phenocrysts. The line of contrast through the centre is due to undulose extinction. Note the abundance of small opaque minerals. Scale: side of photograph is 1.6mm



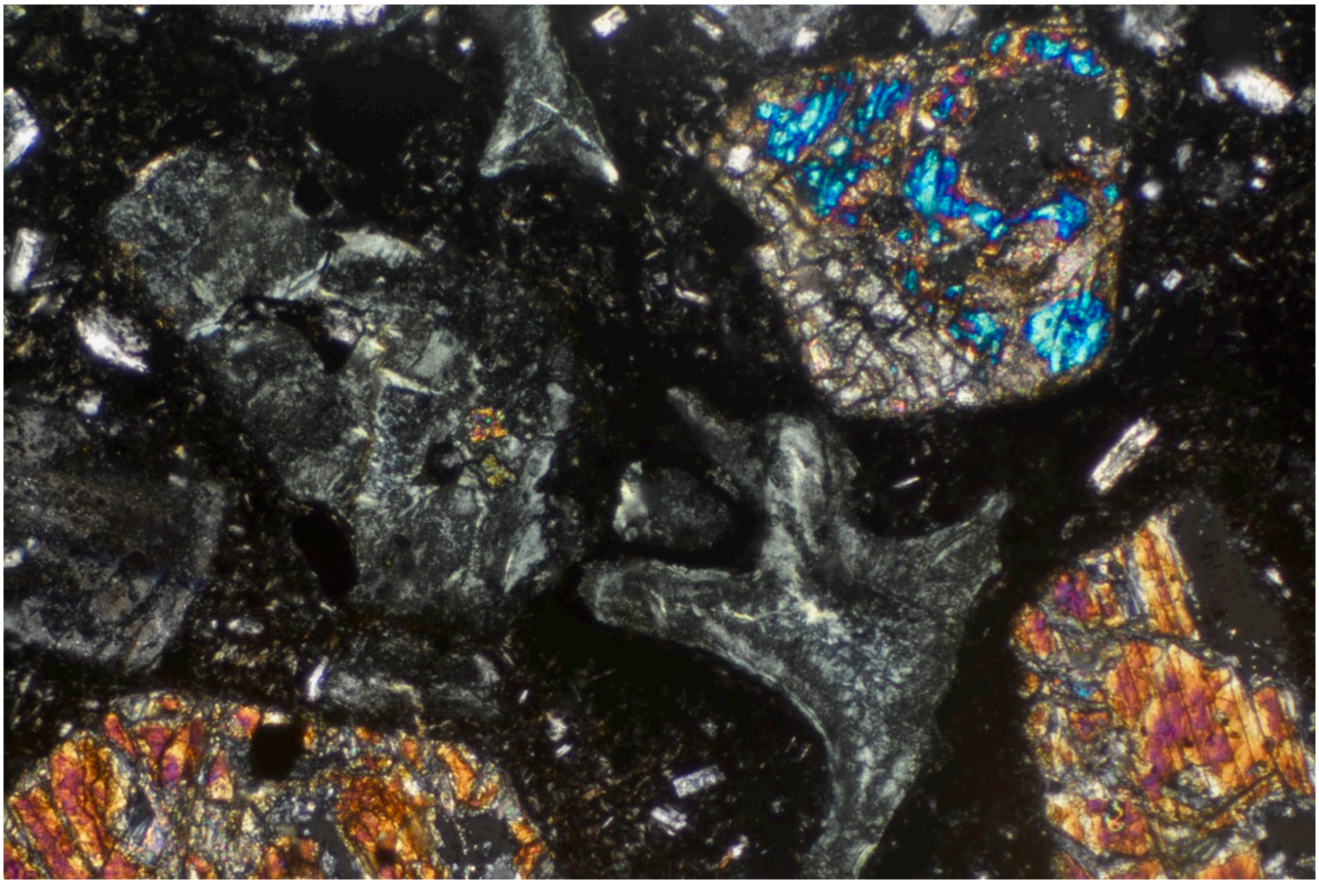
CE416-38.8m – b – another feldspar showing a thick rim and a chloritized core. Scale: side of photograph is 1.6mm



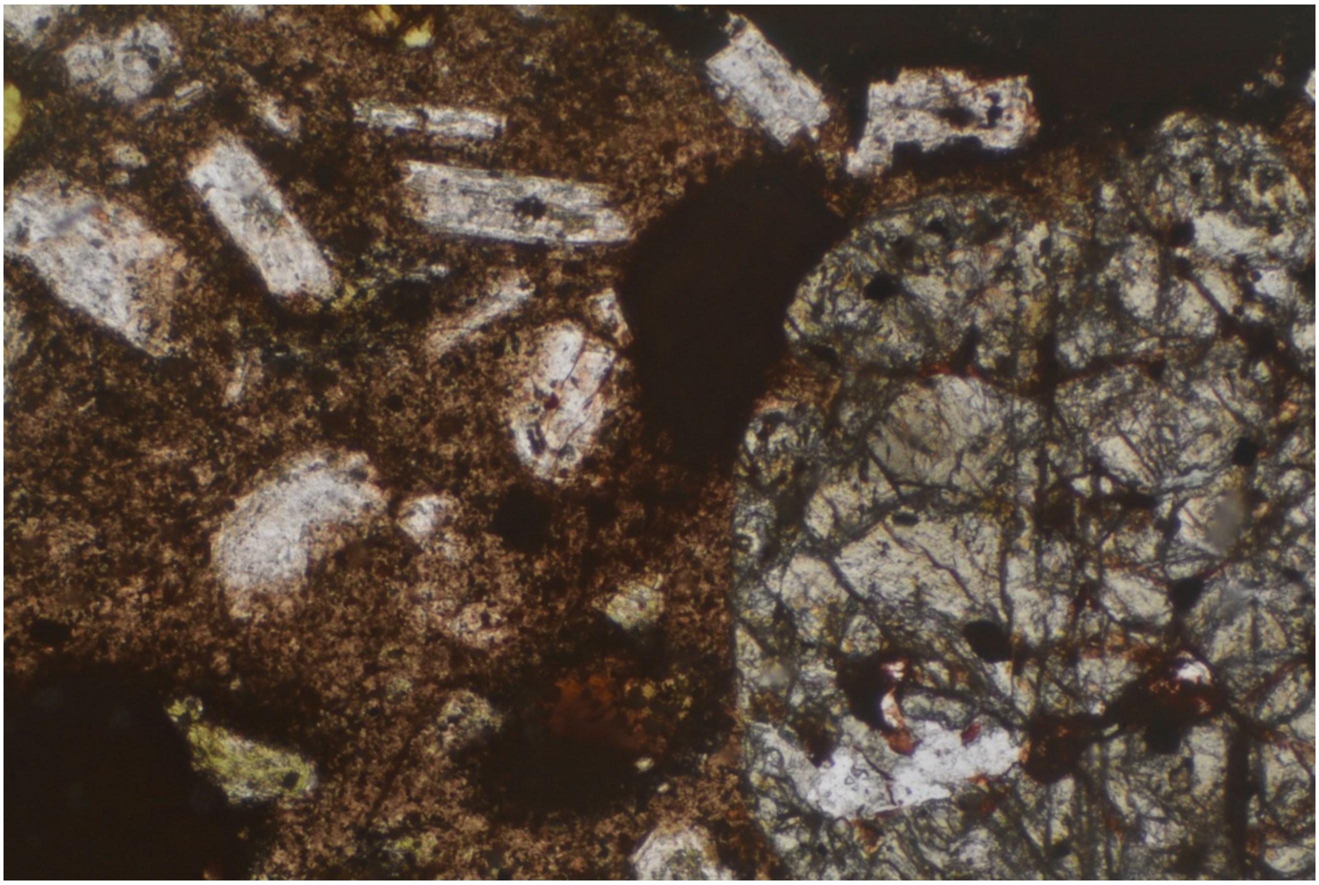
CE416-38.8m – c – a common textural feature showing chlorite patch between several feldspar phenocrysts. Scale: side of photograph is 1.6mm



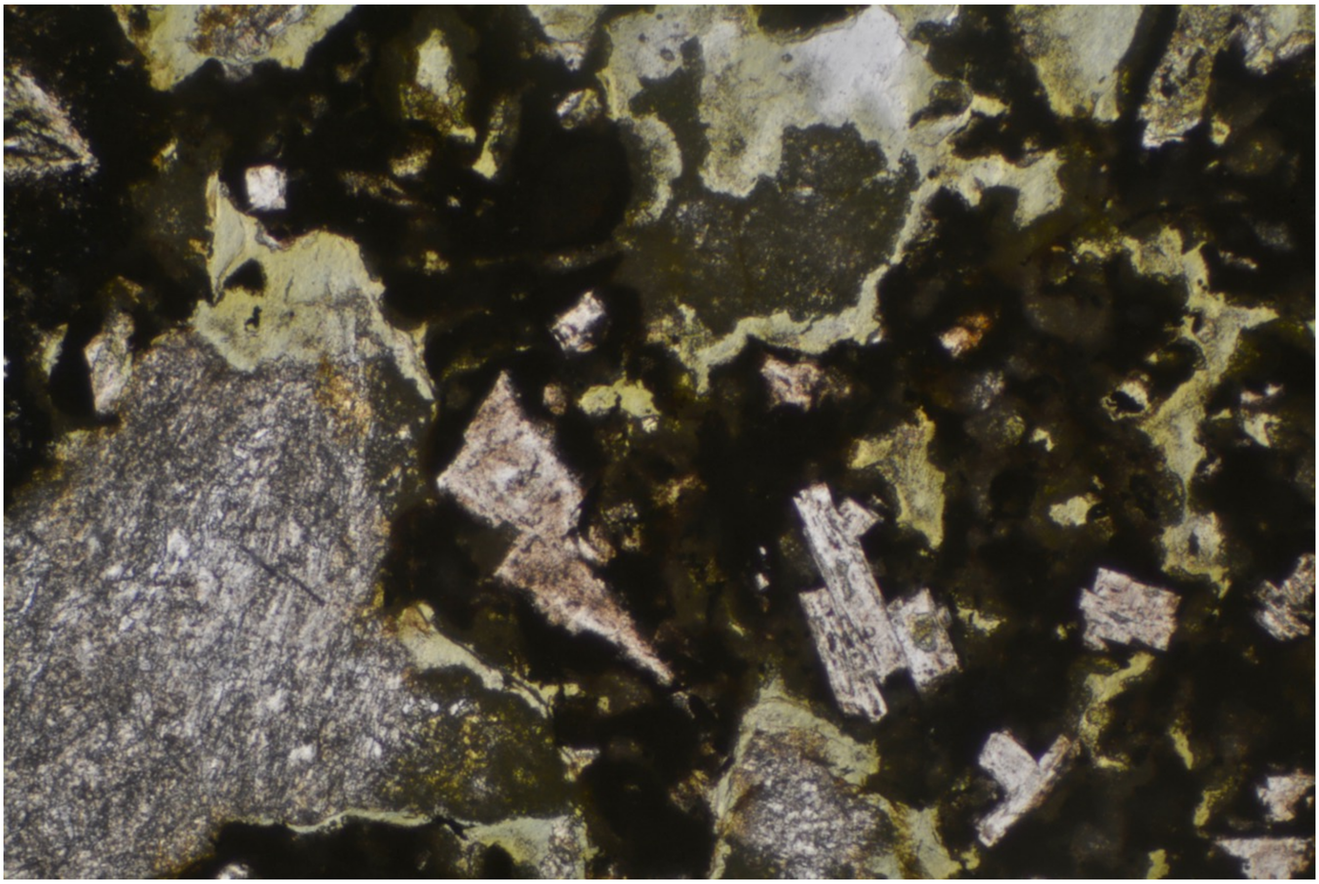
CE416-38.8m – d – a prismatic calcic pyroxene crystals adjacent to a blob of chlorite that is encasing carbonate. Scale: side of photograph is 1.6mm



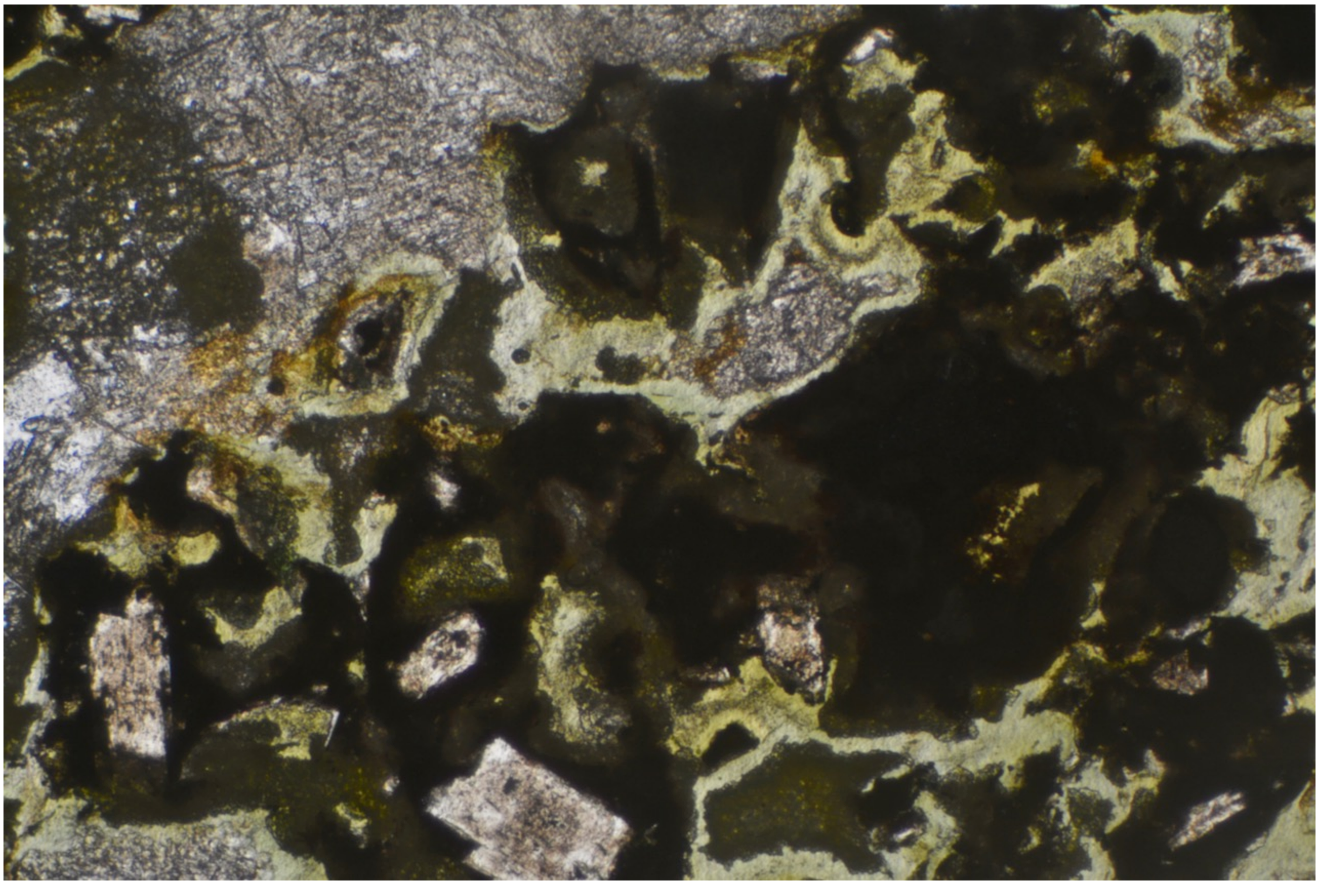
CE416-38.8m – e – a view of chlorite occupying the space between several pyroxene phenocrysts. Scale: side of photograph is 1.6mm

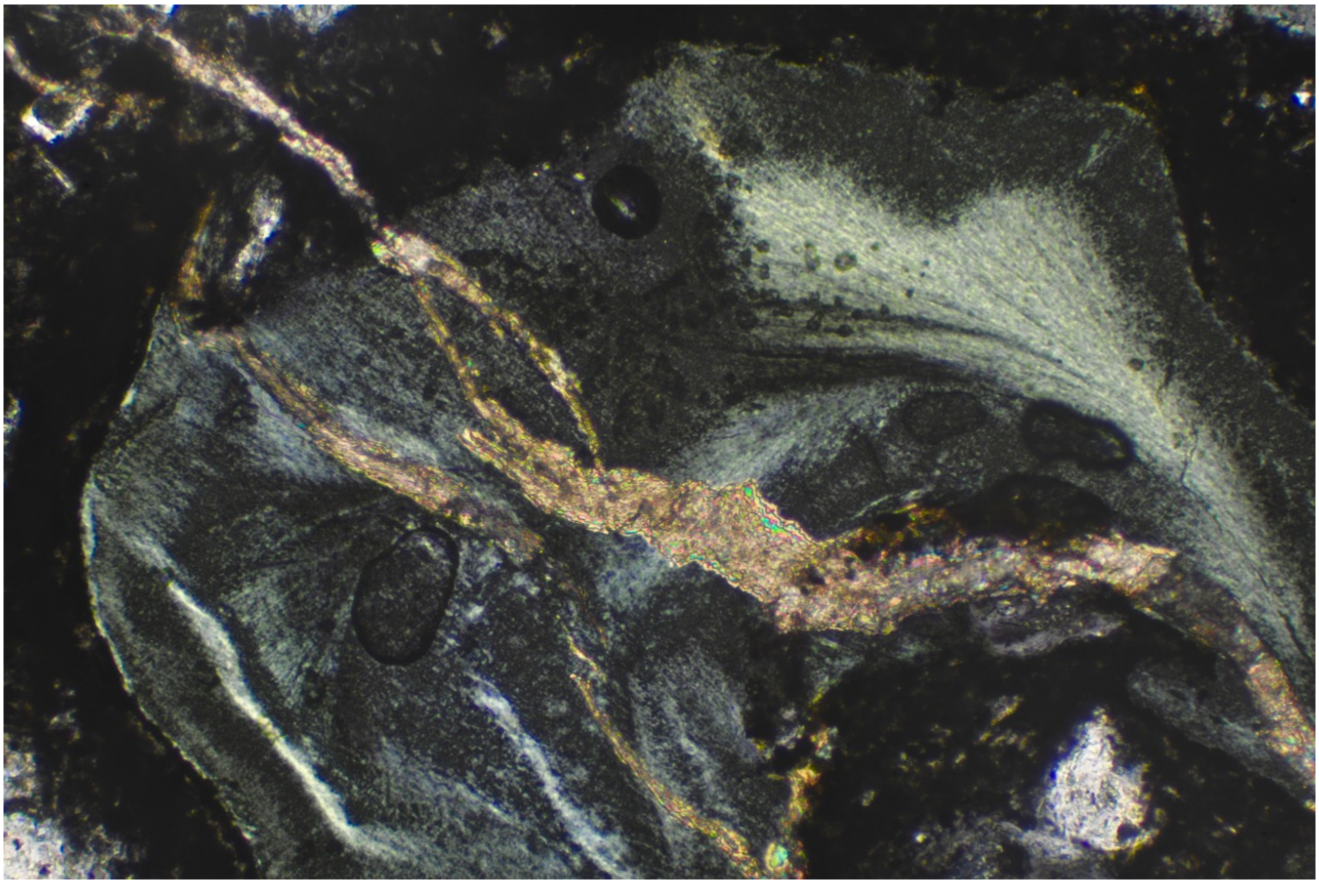


CE416-38.8m – f – view of a pyroxene crystal set in a reddish groundmass. Scale: side of photograph is 1.6mm

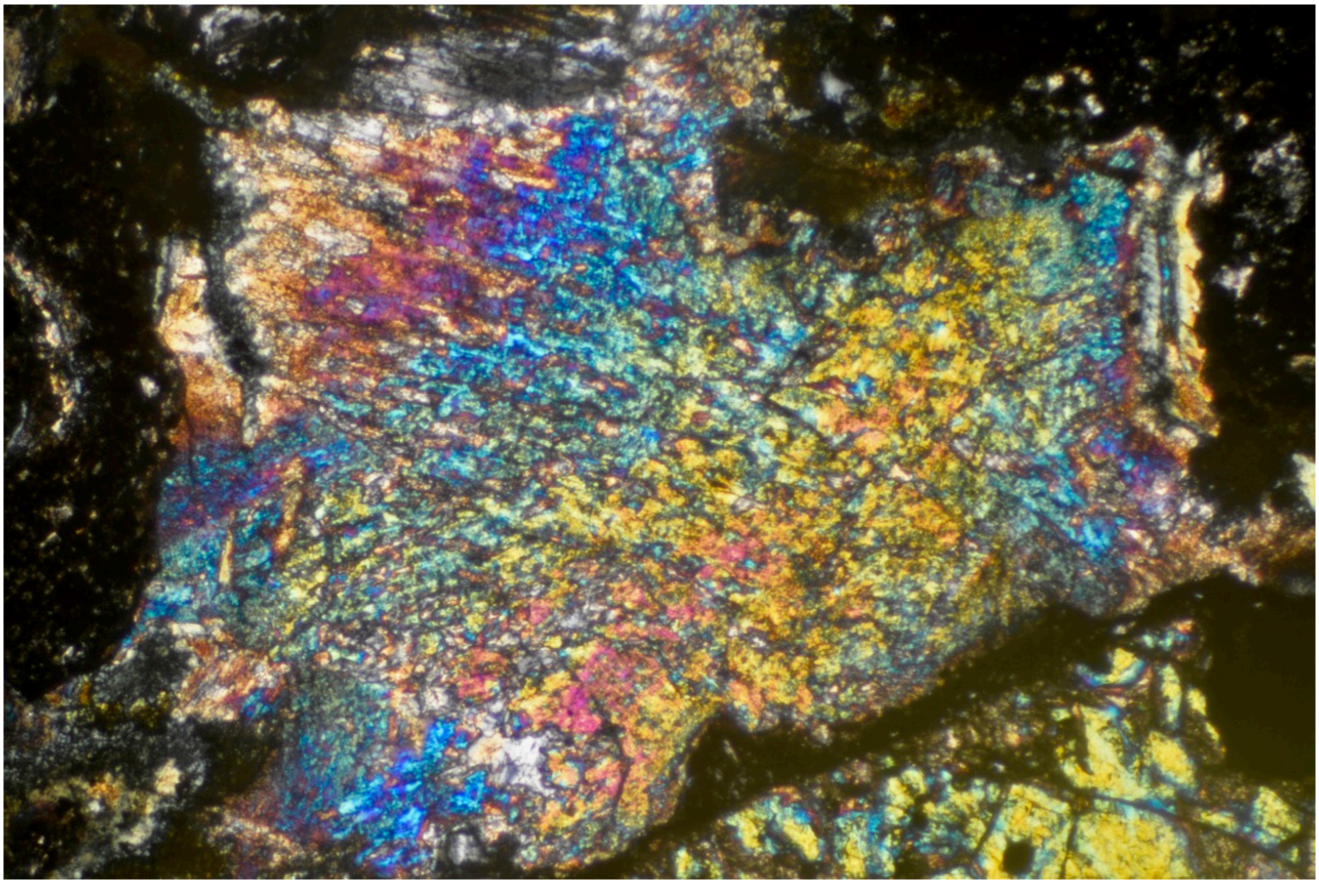


CE416-38.8m – g – view of highly irregular groundmass fragments in a sea of chlorite. The clear crystal aggregate on the left is prehnite. Scale: side of photograph is 1.6mm

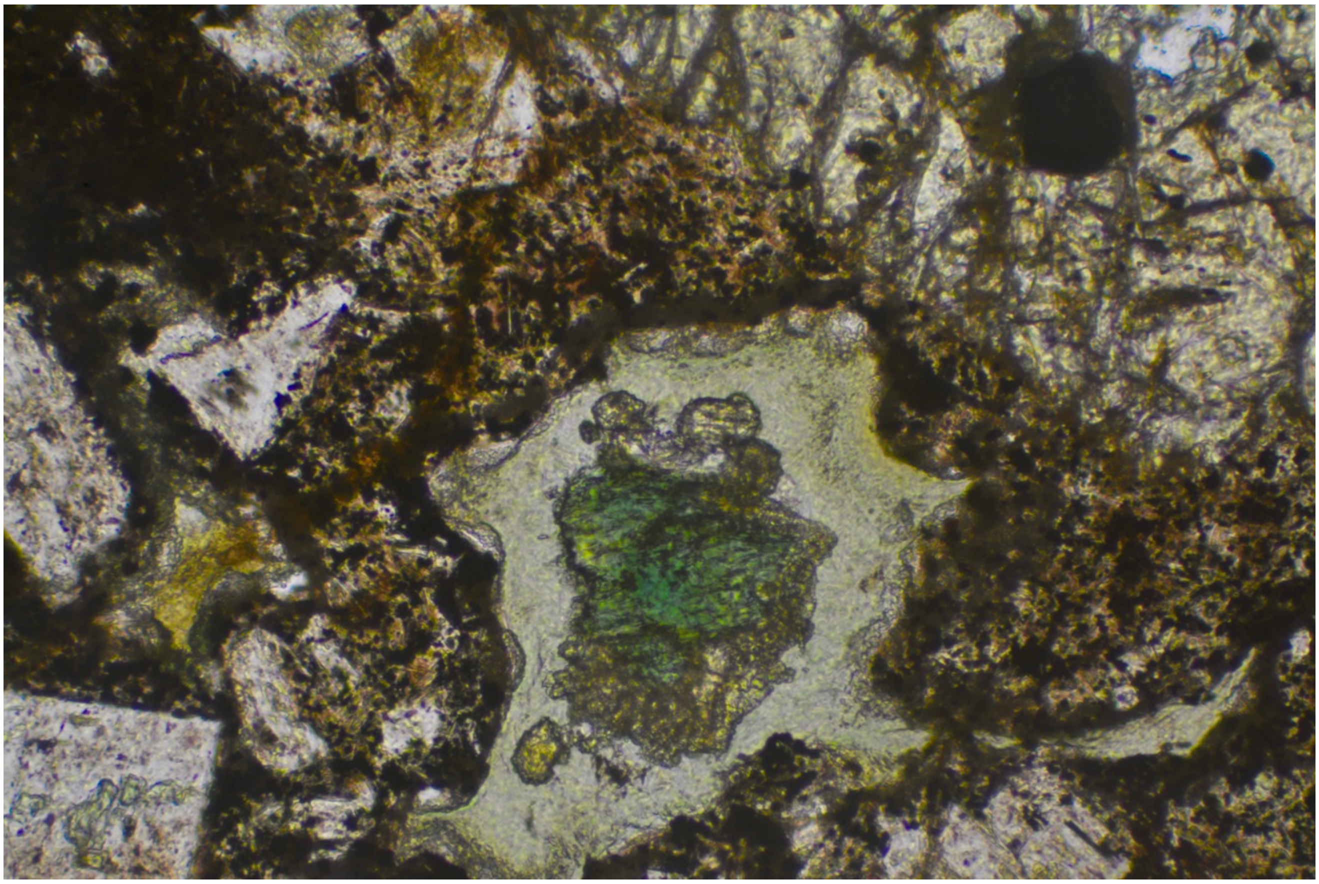

CE416-38.8m – h – similar view to previous photo showing very dark dense groundmass containing small feldspar phenocrysts. Scale: side of photograph is 1.6mm



CE416-38.8m – i – slightly magnified view of a chloritic infilling with a calcite vein. Scale: side of photograph is 0.8mm



CE416-38.8m – j – patch of prehnite adjacent to a calcic pyroxene phenocryst. Scale: side of photograph is 1.6mm



CE416-38.8m – k – an oddity – a brightly coloured crystal of prehnite surrounded by epidote and chlorite. Scale: side of photograph is 0.8mm

Dr. H. D. Hensel
(HENSEL GEOSCIENCES)
(27th August, 2018)

CE430- 44.0m

Macroscopic and binocular description of rock

This is a highly weathered, porphyritic, volcanoclastic rock with fairly abundant creamish-coloured phenocrysts of feldspar set in a dark brownish groundmass.

Under the binocular microscope the rock displays a porphyritic texture with phenocrysts of white, pale greenish and pinkish coloured feldspar. There are no obvious quartz phenocrysts. The groundmass is extremely finely speckled with quite abundant small black specks of probable chlorite. A feature is that the phenocrysts are soft and were easily abraded during cutting. There are also a couple of reddish brown veinlets that traverse the rock. Probably hydrated iron oxide but could even have some siderite.

A scratch test shows that the rock type is soft could be easily scratched. It was fairly easy to cut.

An acid test reveals that there is no reactive carbonate. Porosity is moderate.

Petrographic description of thin-section

This is a very weathered porphyritic, volcanic rock with plagioclase feldspar the only original mineral not entirely replaced. Quite abundant, large prismatic forms containing only secondary weathering minerals were almost certainly calcic pyroxene. There is no quartz. There are no surviving original opaque oxides and no resolvable secondary minerals after those opaque oxides.

Much of the fine groundmass has been replaced by yellowish clays (see photographs). Alteration has been progressive as evidenced by subtle successive bands. Much of the clay appears to be smectite but there could be a substantial proportion of kaolinite that has been discoloured by the abundant hydrated iron oxide. The replacement minerals of the pyroxene are different but cannot be resolved. Some appears to be an iron carbonate.

Texturally there is vague lineation of the feldspar. Much of the feldspar is between 0.2mm and 0.3mm long but there is also a large population smaller than that as part of the groundmass. The largest feldspar crystal approaches 0.5mm. Some compositional zoning is visible with darker, altered cores and there is some vague twinning.

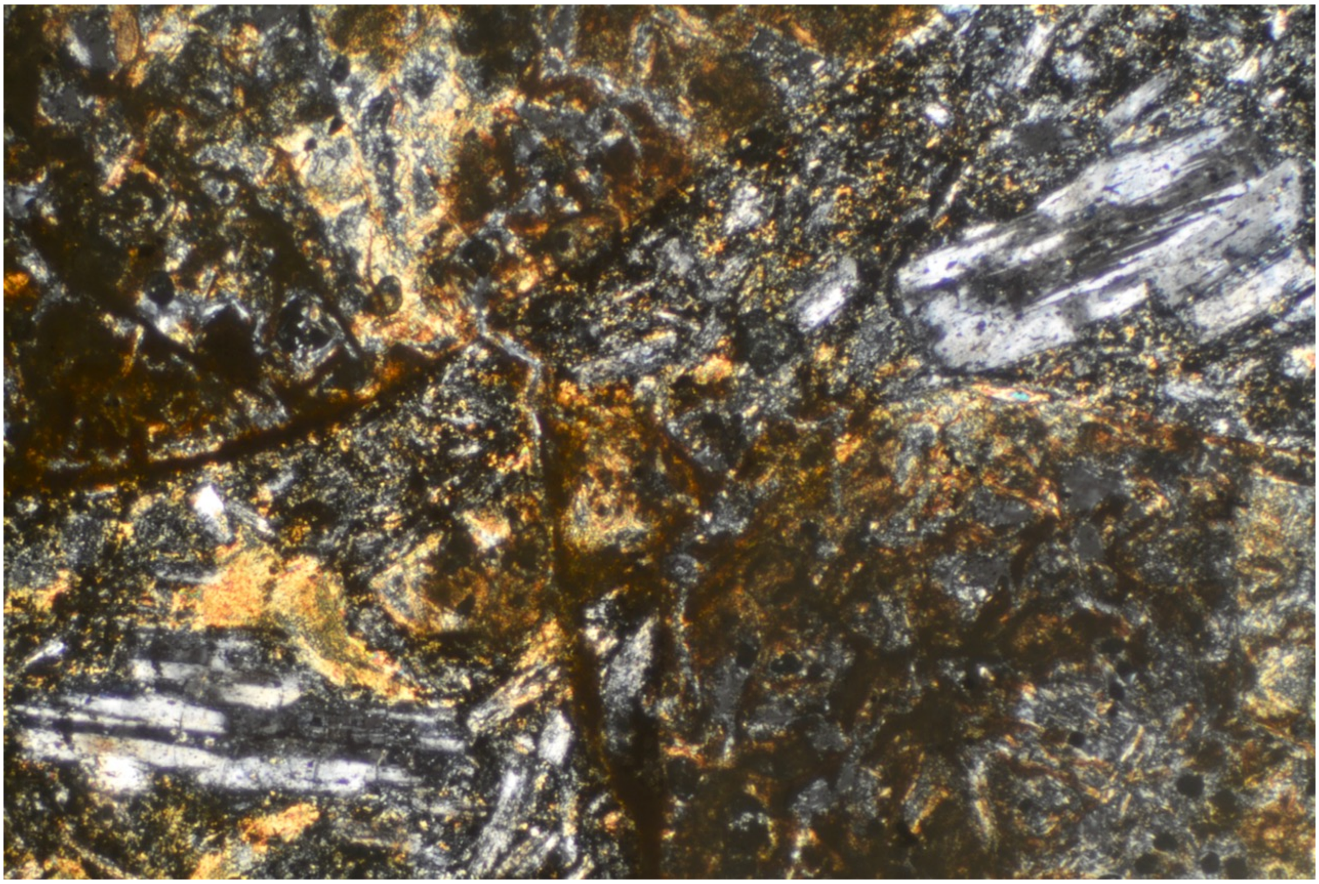
In contrast there are fairly abundant large forms after pyroxene that are between 2mm and 4mm in size. Evidence for it exists with several highly prismatic forms that have resisted weathering. Nothing remains of the original mineralogy. This is unusual because calcic pyroxene is often a fairly resistant mineral in alteration and weathering. However, there may be particular conditions where the fluids are of a composition (probably acidic) that can basically remove the pyroxene (and opaque minerals) yet essentially not affect the feldspar.

Mode of “original” rock

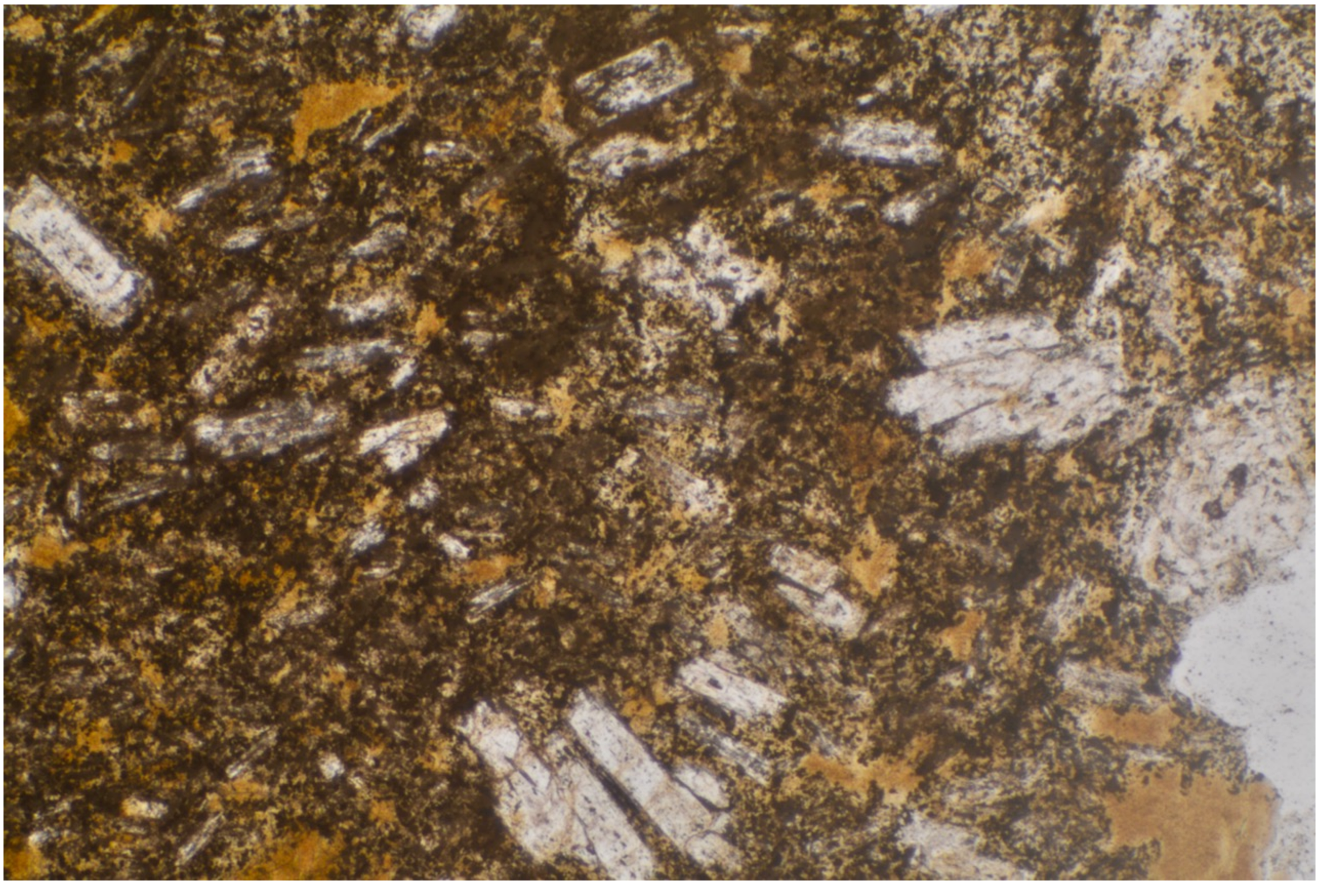
feldspar	30%
calcic pyroxene	25%
opaque minerals	5%
groundmass	40%

Name of rock Altered pyroxene andesite

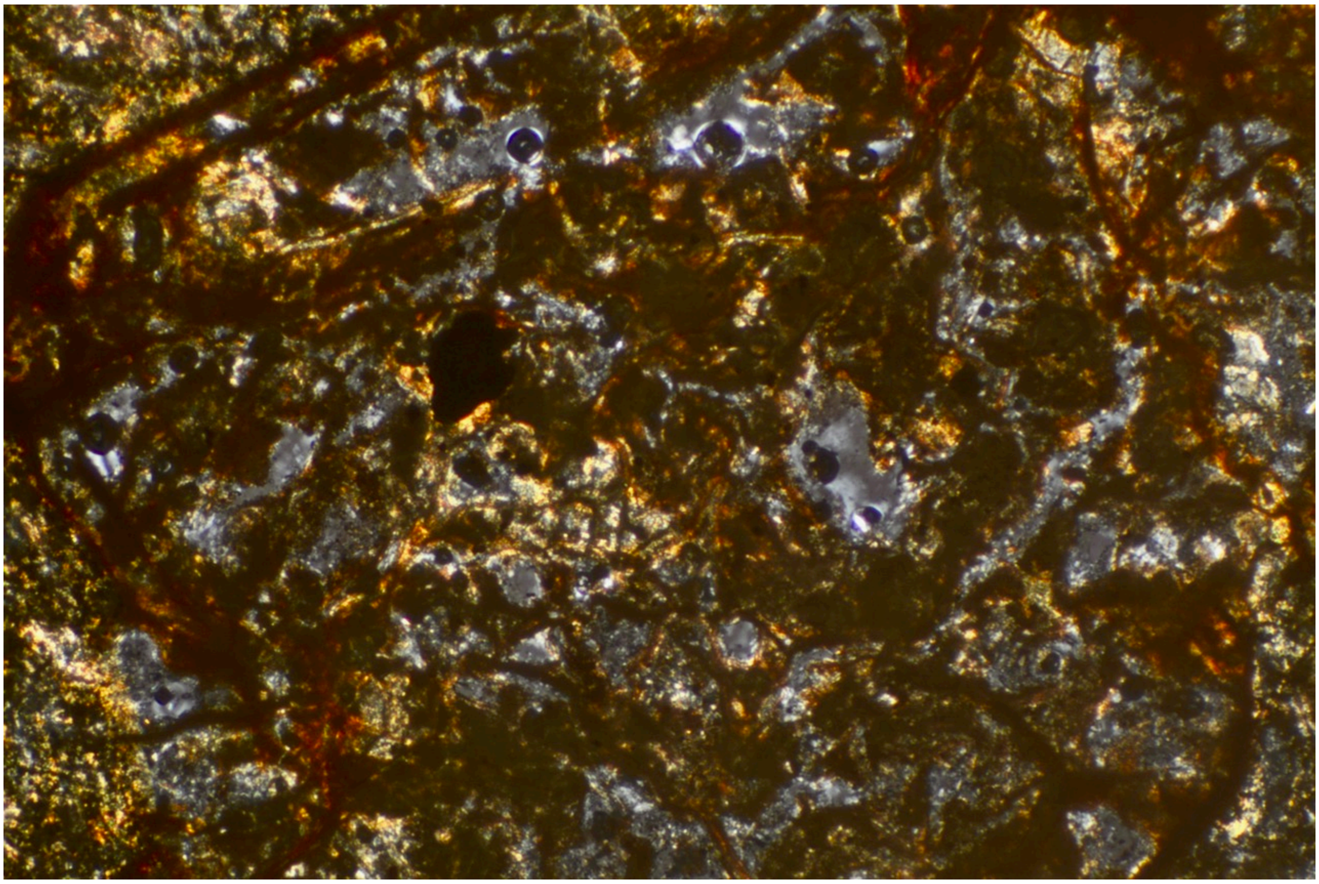
Dr. H. D. Hensel
(HENSEL GEOSCIENCES)
(24th August, 2018)



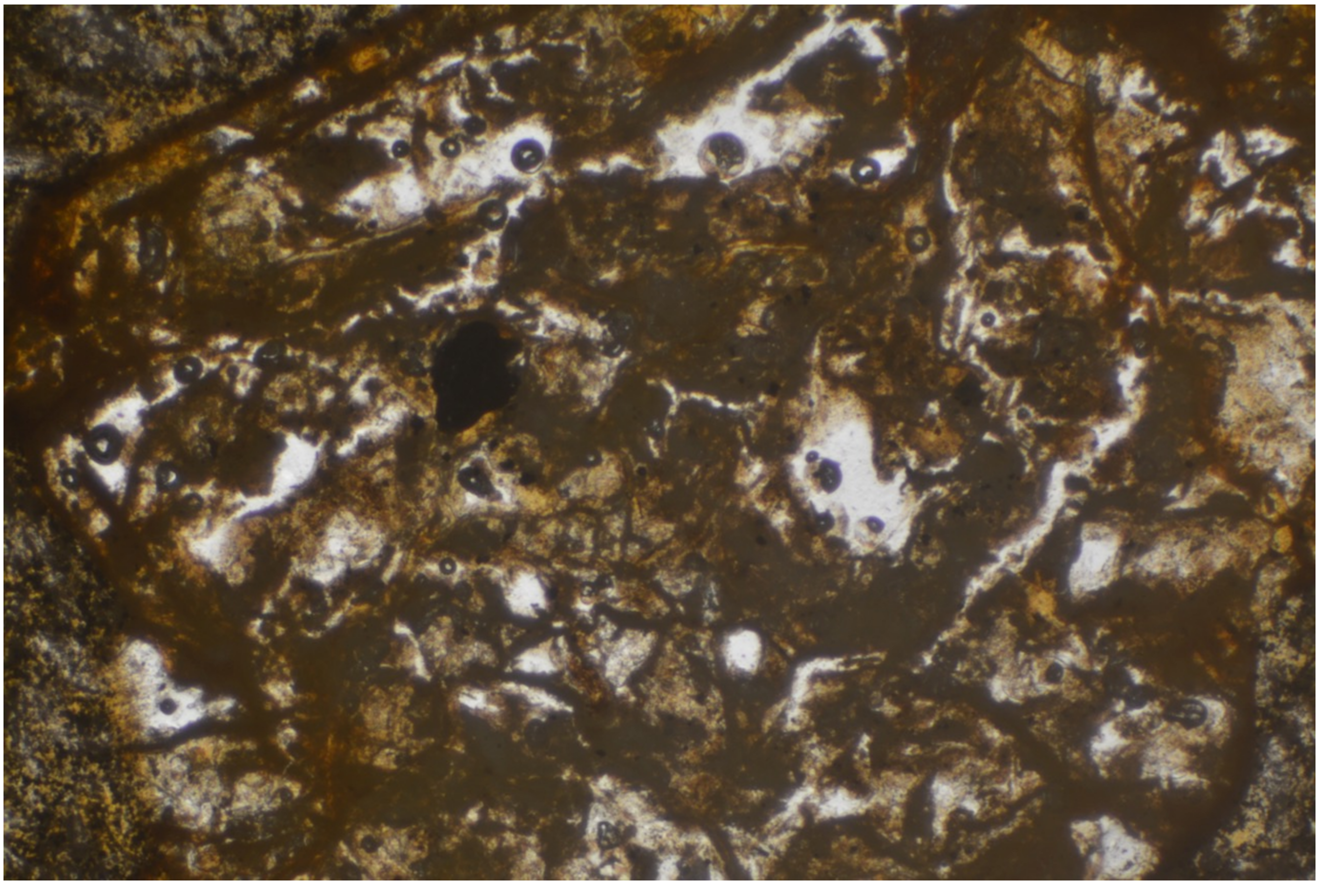
CE430-44.0m a - a common textural view in polarized light of this volcanic rock showing several plagioclase feldspar crystals in a rough alignment. Scale: side of photograph is 1.6mm



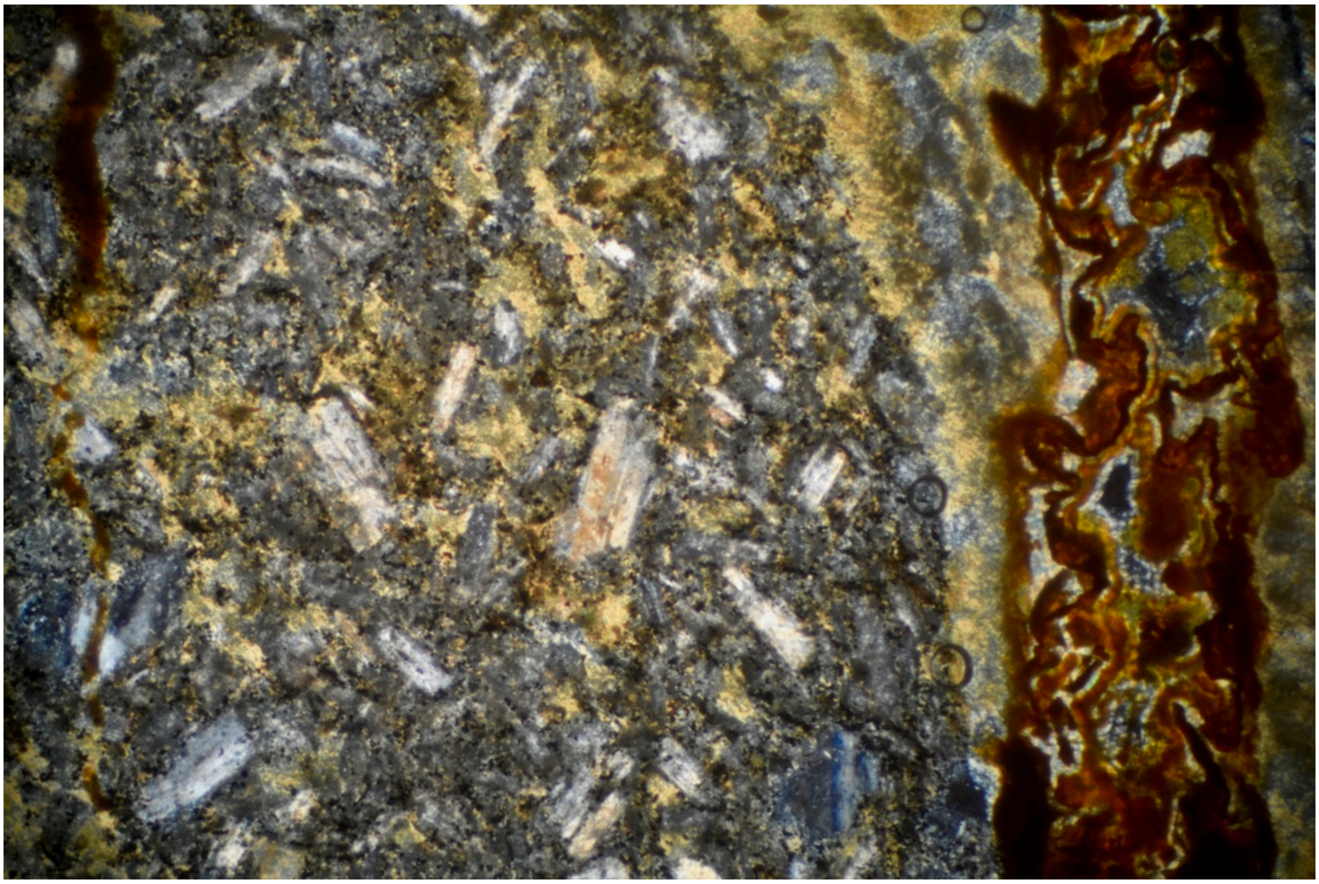
CE430-44.0m – b – another textural view in ordinary transmitted light to show the size and distribution of the feldspar. Scale: side of photograph is 1.6mm



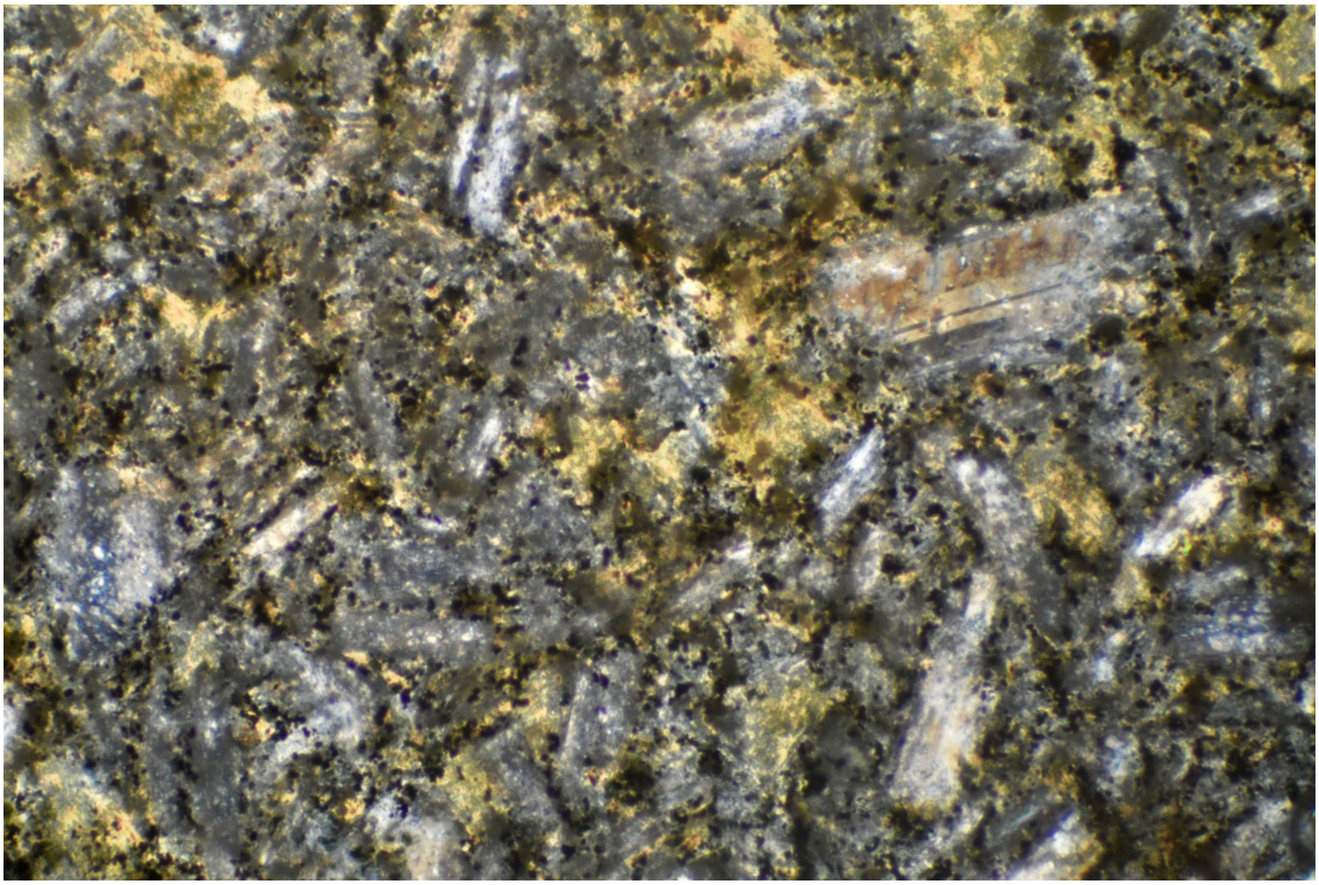
CE430-44.0m – c – portion of a large pyroxene phenocryst that has been totally altered. Note the prismatic shape (top left corner). Scale: side of photograph is 1.6mm



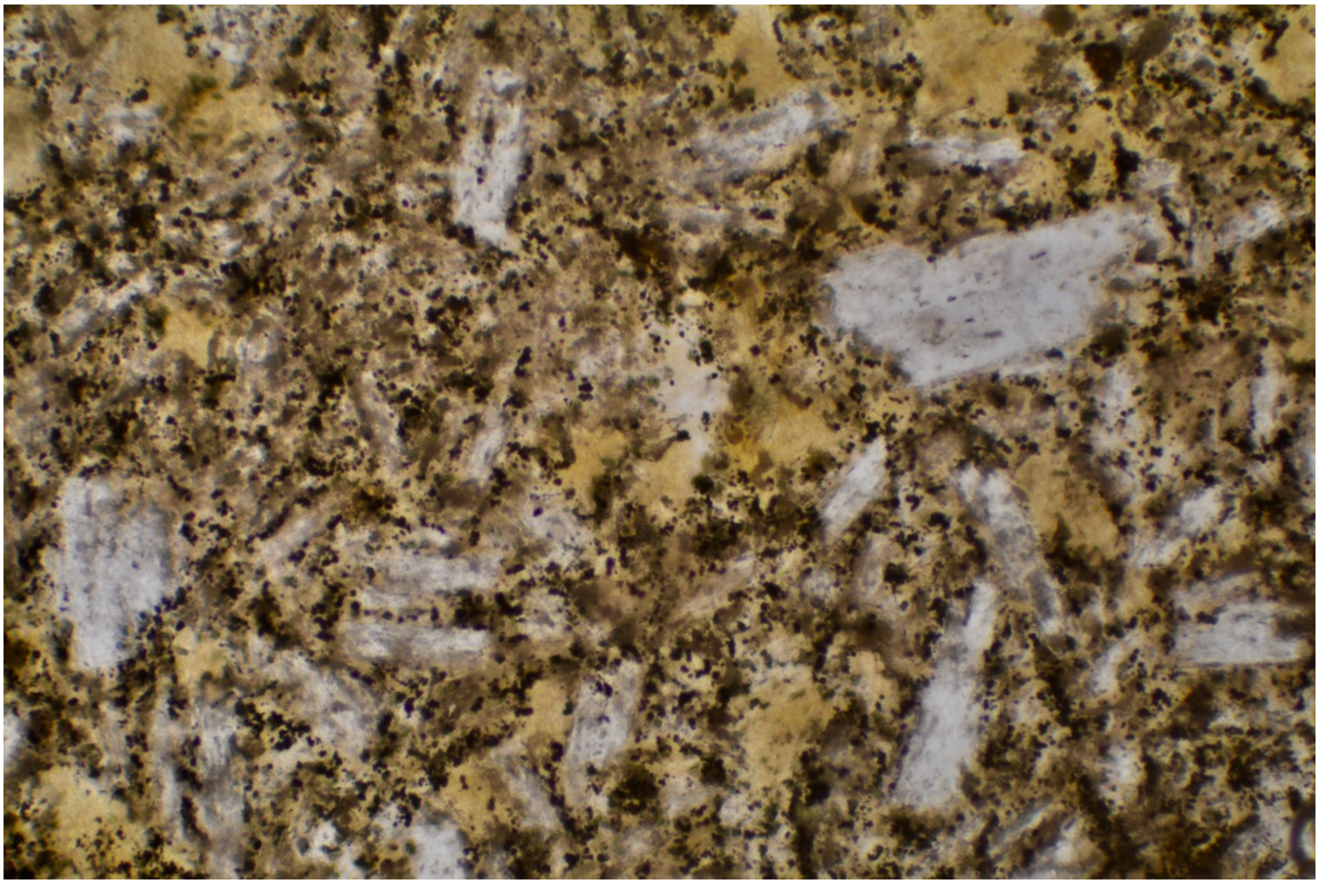
CE430-44.0m – d – same view as previous photo in ordinary light to better show the structure of this original pyroxene. Scale: side of photograph is 1.6mm



CE430-44.0m – e – a condenser-enhanced view of the texture in the most unaltered area. Scale: side of photograph is 1.6mm



CE430-44.0m – f – a slightly magnified, condenser-enhanced view of the groundmass showing some twinning in the feldspar. Scale: side of photograph is 0.8mm



CE430-44.0m – g – same view as previous photo in condenser-enhanced light showing the patchy alteration to clays and the abundance of tiny encrustations of hydrated iron oxide.   Scale: side of photograph is 0.8mm

Annexure CJ
X-Ray Diffraction Analyses

37 Kensington Street
East Perth
WA 6004

Client: Golder Associates Pty Ltd
Job number: 18_1340
Sample: 18_1340_02
Client ID: TC1
Date: 21-08-18
Analysis : Semi-quantitative XRD analysis

Sample preparation

The sample was supplied by the client to Microanalysis Australia on 13th August 2018 for the above mentioned analyses. A representative sub –sample was removed and lightly ground such that 90% was passing 20 µm. Grinding to this size helps eliminate preferred orientation.

Analysis

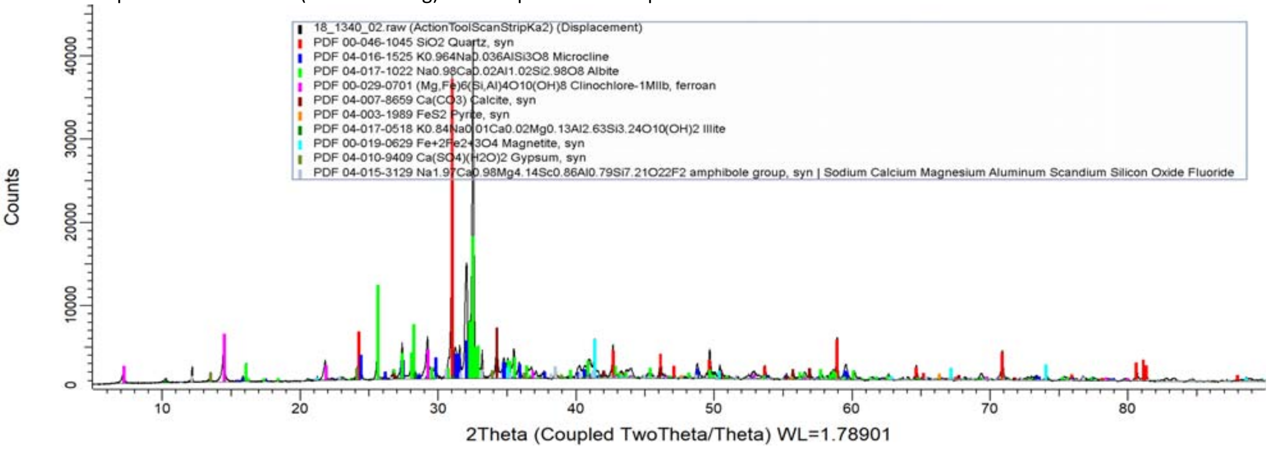
Only crystalline material present in the sample will give peaks in the XRD scan. Amorphous (non crystalline) material will add to the background. The search match software used was Eva 4.3. An up-to-date ICDD card set was used. The X-ray source was cobalt radiation.

No standards were used in the quantification process. The concentrations were calculated using the peak area integration method where the area of the 100% peak for each mineral phase is summed and the relative percentages of each phase calculated based on the relative contribution to the sum. This method allows for some attention to be paid to preferred orientation but is limited in considering substitution and lattice strain.

Summary
The phases are listed in order of interpreted concentration:

Mineral phase	Concentration (%)	ICDD match probability
Albite (Na0.98Ca0.02Al1.02Si2.98O8)	46	medium
Quartz, syn (SiO2)	19	good
Microcline (K0.964Na0.036AlSi3O8)	14	medium
Clinochlore-1MIIb, ferroan ((Mg,Fe)6(Si,Al)4O10(OH)8)	9	good
amphibole group, syn | Sodium Calcium Magnesium Aluminum Scandium Silicon Oxide Fluoride (Na1.97Ca0.98Mg4.14Sc0.86Al0.79Si7.21O22F2)	4	medium
Calcite, syn (Ca(CO3))	3	good
Magnetite, syn (Fe+2Fe2+3O4)	2	good
Illite (K0.84Na0.01Ca0.02Mg0.13Al2.63Si3.24O10(OH)2)	2	medium
Gypsum, syn (Ca(SO4)(H2O)2)	1	low
Pyrite, syn (FeS2)	trace	low

The ICDD match probability is reported as an indication as to how well the peak positions and relative intensities for the sample matched those in the published literature (www.icdd.org) for that particular compound.



Analyst: Owen Carpenter, B.Sc.(Physics)
Reported: Owen Carpenter, B.Sc.(Physics)
Approved: Ian Davies, B.Sc.(Chemistry)

37 Kensington Street
East Perth
WA 6004

Client: Golder Associates Pty Ltd
Job number: 18_1340
Sample: 18_1340_03
Client ID: HA401 0-2m
Date: 21-08-18
Analysis : Semi-quantitative XRD analysis

Sample preparation

The sample was supplied by the client to Microanalysis Australia on 13th August 2018 for the above mentioned analyses. A representative sub –sample was removed and lightly ground such that 90% was passing 20 µm. Grinding to this size helps eliminate preferred orientation.

Analysis

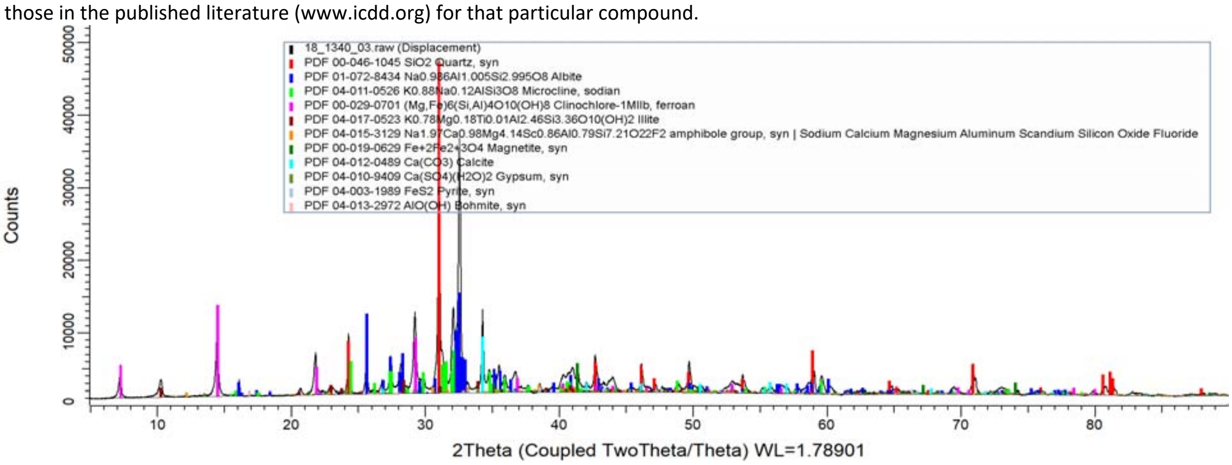
Only crystalline material present in the sample will give peaks in the XRD scan. Amorphous (non crystalline) material will add to the background. The search match software used was Eva 4.3. An up-to-date ICDD card set was used. The X-ray source was cobalt radiation.

No standards were used in the quantification process. The concentrations were calculated using the peak area integration method where the area of the 100% peak for each mineral phase is summed and the relative percentages of each phase calculated based on the relative contribution to the sum. This method allows for some attention to be paid to preferred orientation but is limited in considering substitution and lattice strain.

Summary
The phases are listed in order of interpreted concentration:

Mineral phase	Concentration (%)	ICDD match probability
Albite (Na0.986Al1.005Si2.995O8)	34	medium
Quartz, syn (SiO2)	21	good
Clinochlore-1MIIb, ferroan ((Mg,Fe)6(Si,Al)4O10(OH)8)	18	good
Microcline, sodian (K0.88Na0.12AlSi3O8)	15	medium
Illite (K0.78Mg0.18Ti0.01Al2.46Si3.36O10(OH)2)	4	medium
Calcite (Ca(CO3))	3	good
amphibole group, syn | Sodium Calcium Magnesium Aluminum Scandium Silicon Oxide Fluoride (Na1.97Ca0.98Mg4.14Sc0.86Al0.79Si7.21O22F2)	2	medium
Magnetite, syn (Fe+2Fe2+3O4)	1	medium
Gypsum, syn (Ca(SO4)(H2O)2)	trace	low
Pyrite, syn (FeS2)	trace	low
Bohmite, syn (AlO(OH))	trace	low

The ICDD match probability is reported as an indication as to how well the peak positions and relative intensities for the sample matched those in the published literature (www.icdd.org) for that particular compound.



Analyst: Owen Carpenter, B.Sc.(Physics)
Reported: Owen Carpenter, B.Sc.(Physics)
Approved: Ian Davies, B.Sc.(Chemistry)

37 Kensington Street
East Perth
WA 6004

Client: Golder Associates Pty Ltd
Job number: 18_1341
Sample: 18_1341_01
Client ID: PL01-BS1 0.0-0.5m
Date: 21-08-18
Analysis : Semi-quantitative XRD analysis

Sample preparation

The sample was supplied by the client to Microanalysis Australia on 13th of August 2018 for the above mentioned analyses. A representative sub –sample was removed and lightly ground such that 90% was passing 20 µm. Grinding to this size helps eliminate preferred orientation.

Analysis

Only crystalline material present in the sample will give peaks in the XRD scan. Amorphous (non crystalline) material will add to the background. The search match software used was Eva 4.2. An up-to-date ICDD card set was used. The X-ray source was cobalt radiation.

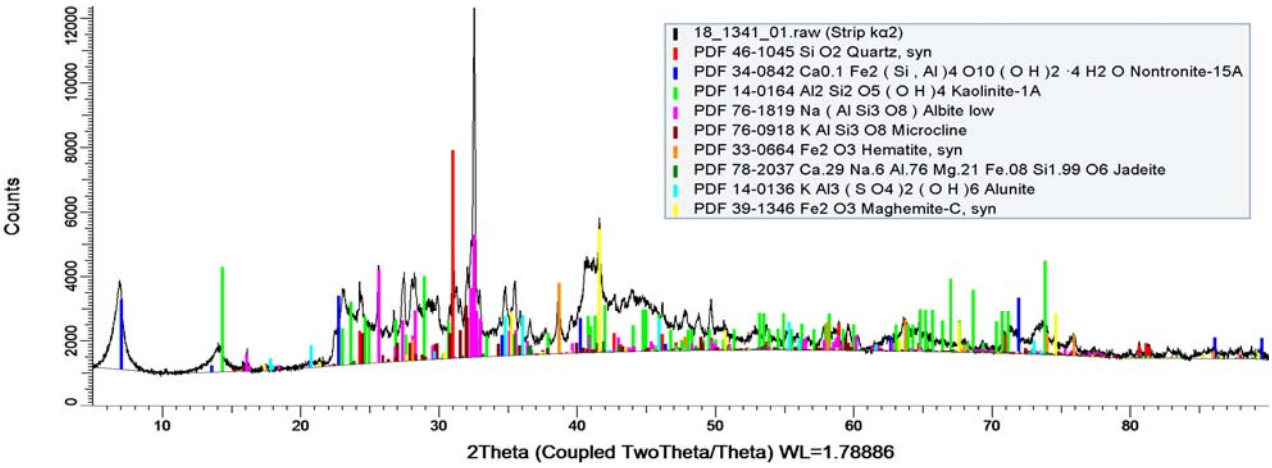
No standards were used in the quantification process. The concentrations were calculated using the peak area integration method where the area of the 100% peak for each mineral phase is summed and the relative percentages of each phase calculated based on the relative contribution to the sum. This method allows for some attention to be paid to preferred orientation but is limited in considering substitution and lattice strain.

Summary

The phases are listed in order of interpreted concentration:

Mineral phase	Concentration (%)	ICDD match probability
Albite low (Na (Al Si3 O8))	31	good
Kaolinite-1A (Al2 Si2 O5 (O H)4)	17	medium
Microcline (K Al Si3 O8)	14	good
Nontronite-15A (Ca0.1 Fe2 (Si , Al)4 O10 (O H)2 ·4 H2 O)	11	medium
Quartz, syn (Si O2)	10	good
Maghemite-C, syn (Fe2 O3)	5	medium
Hematite, syn (Fe2 O3)	5	good
Alunite (K Al3 (S O4)2 (O H)6)	3	low
Jadeite (Ca.29 Na.6 Al.76 Mg.21 Fe.08 Si1.99 O6)	3	low

The ICDD match probability is reported as an indication as to how well the peak positions and relative intensities for the sample matched those in the published literature (www.icdd.org) for that particular compound.



Analyst: Ian Davies, B.Sc.(Chemistry)
Reported: Ian Davies, B.Sc.(Chemistry)
Approved: Owen Carpenter, B.Sc.(Physics)

37 Kensington Street
East Perth
WA 6004

Client: Golder Associates Pty Ltd
Job number: 18_1341
Sample: 18_1341_02
Client ID: TP401-BL1 0.7-1.0m
Date: 21-08-18
Analysis : Semi-quantitative XRD analysis

Sample preparation

The sample was supplied by the client to Microanalysis Australia on 13th of August 2018 for the above mentioned analyses. A representative sub –sample was removed and lightly ground such that 90% was passing 20 µm. Grinding to this size helps eliminate preferred orientation.

Analysis

Only crystalline material present in the sample will give peaks in the XRD scan. Amorphous (non crystalline) material will add to the background. The search match software used was Eva 4.2. An up-to-date ICDD card set was used. The X-ray source was cobalt radiation.

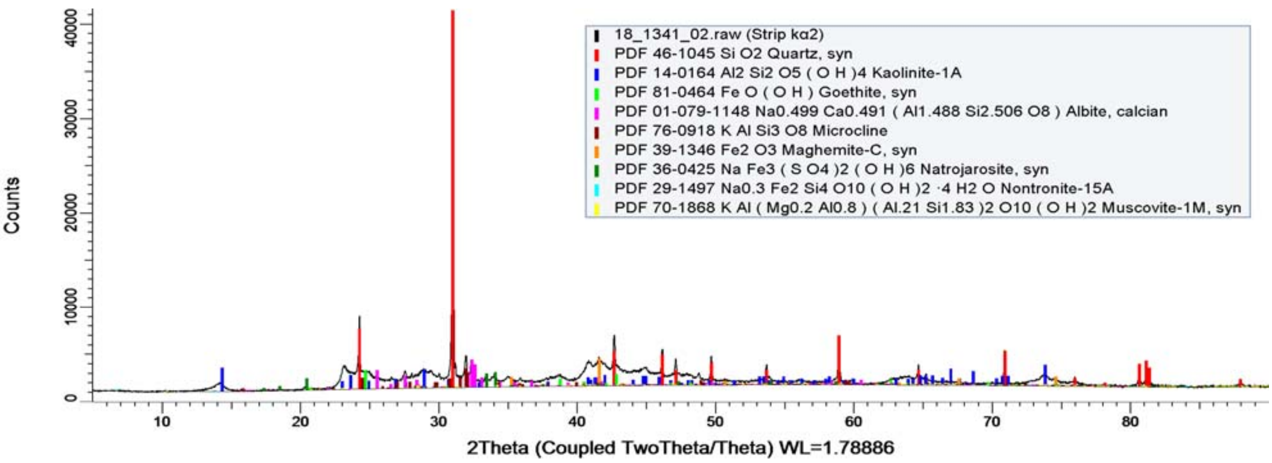
No standards were used in the quantification process. The concentrations were calculated using the peak area integration method where the area of the 100% peak for each mineral phase is summed and the relative percentages of each phase calculated based on the relative contribution to the sum. This method allows for some attention to be paid to preferred orientation but is limited in considering substitution and lattice strain.

Summary

The phases are listed in order of interpreted concentration:

Mineral phase	Concentration (%)	ICDD match probability
Quartz, syn (Si O2)	42	good
Albite, calcian (Na0.499 Ca0.491 (Al1.488 Si2.506 O8))	19	good
Microcline (K Al Si3 O8)	12	good
Kaolinite-1A (Al2 Si2 O5 (O H)4)	9	medium
Maghemite-C, syn (Fe2 O3)	7	medium
Natrojarosite, syn (Na Fe3 (S O4)2 (O H)6)	6	good
Goethite, syn (Fe O (O H))	3	medium
Muscovite-1M, syn (K Al (Mg0.2 Al0.8) (Al.21 Si1.83)2 O10 (O H)2)	1	low
Nontronite-15A (Na0.3 Fe2 Si4 O10 (O H)2 ·4 H2 O)	1	low

The ICDD match probability is reported as an indication as to how well the peak positions and relative intensities for the sample matched those in the published literature (www.icdd.org) for that particular compound.



Analyst: Ian Davies, B.Sc.(Chemistry)
Reported: Ian Davies, B.Sc.(Chemistry)
Approved: Owen Carpenter, B.Sc.(Physics)

37 Kensington Street
East Perth
WA 6004

Client: Golder Associates Pty Ltd
Job number: 18_1341
Sample: 18_1341_03
Client ID: TP405-BL1 1.9-2.2m
Date: 21-08-18
Analysis : Semi-quantitative XRD analysis

Sample preparation

The sample was supplied by the client to Microanalysis Australia on 13th of August 2018 for the above mentioned analyses. A representative sub –sample was removed and lightly ground such that 90% was passing 20 µm. Grinding to this size helps eliminate preferred orientation.

Analysis

Only crystalline material present in the sample will give peaks in the XRD scan. Amorphous (non crystalline) material will add to the background. The search match software used was Eva 4.2. An up-to-date ICDD card set was used. The X-ray source was cobalt radiation.

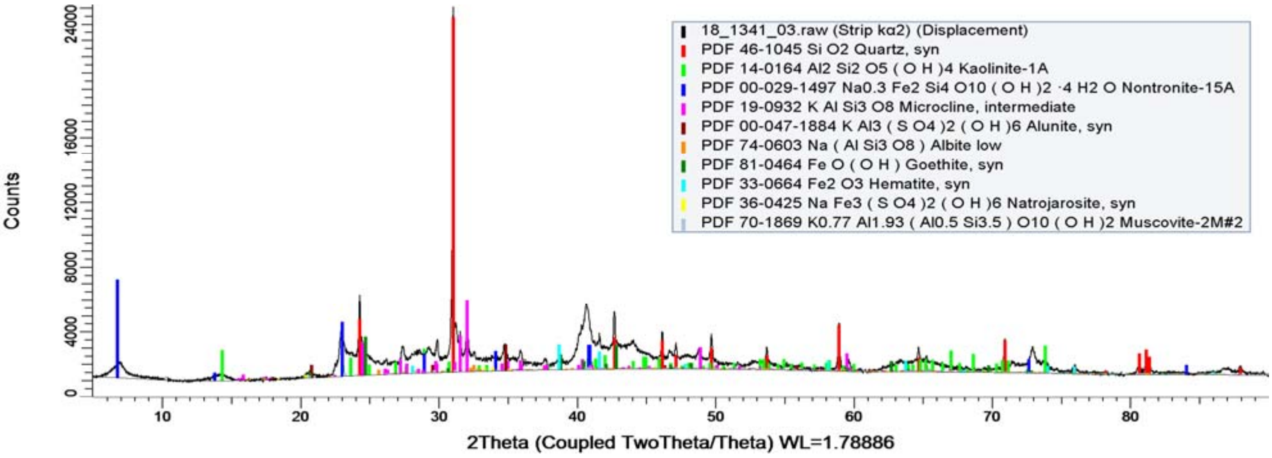
No standards were used in the quantification process. The concentrations were calculated using the peak area integration method where the area of the 100% peak for each mineral phase is summed and the relative percentages of each phase calculated based on the relative contribution to the sum. This method allows for some attention to be paid to preferred orientation but is limited in considering substitution and lattice strain.

Summary

The phases are listed in order of interpreted concentration:

Mineral phase	Concentration (%)	ICDD match probability
Quartz, syn (Si O2)	28	good
Nontronite-15A (Na0.3 Fe2 Si4 O10 (O H)2 ·4 H2 O)	26	medium
Microcline, intermediate (K Al Si3 O8)	19	good
Kaolinite-1A (Al2 Si2 O5 (O H)4)	8	medium
Alunite, syn (K Al3 (S O4)2 (O H)6)	7	medium
Goethite, syn (Fe O (O H))	4	medium
Hematite, syn (Fe2 O3)	3	medium
Albite low (Na (Al Si3 O8))	3	medium
Muscovite-2M#2 (K0.77 Al1.93 (Al0.5 Si3.5) O10 (O H)2)	2	low
Natrojarosite, syn (Na Fe3 (S O4)2 (O H)6)	1	low

The ICDD match probability is reported as an indication as to how well the peak positions and relative intensities for the sample matched those in the published literature (www.icdd.org) for that particular compound.



Analyst: Ian Davies, B.Sc.(Chemistry)
Reported: Ian Davies, B.Sc.(Chemistry)
Approved: Owen Carpenter, B.Sc.(Physics)

37 Kensington
Street
East Perth

Client: Golder Associates Pty Ltd
Job number: 18_1484
Sample: 18_1484_01
Client ID: CE406 SA3 22.2-22.3m
Date: 14-09-18
Analysis : Semi-quantitative XRD analysis

Sample preparation

The sample was supplied by the client to Microanalysis Australia on 5th of September 2018 for the above mentioned analyses. A representative sub –sample was removed and lightly ground such that 90% was passing 20 µm. Grinding to this size helps eliminate preferred orientation.

Analysis

Only crystalline material present in the sample will give peaks in the XRD scan. Amorphous (non crystalline) material will add to the background. The search match software used was Eva 4.2. An up-to-date ICDD card set was used. The X-ray source was cobalt radiation.

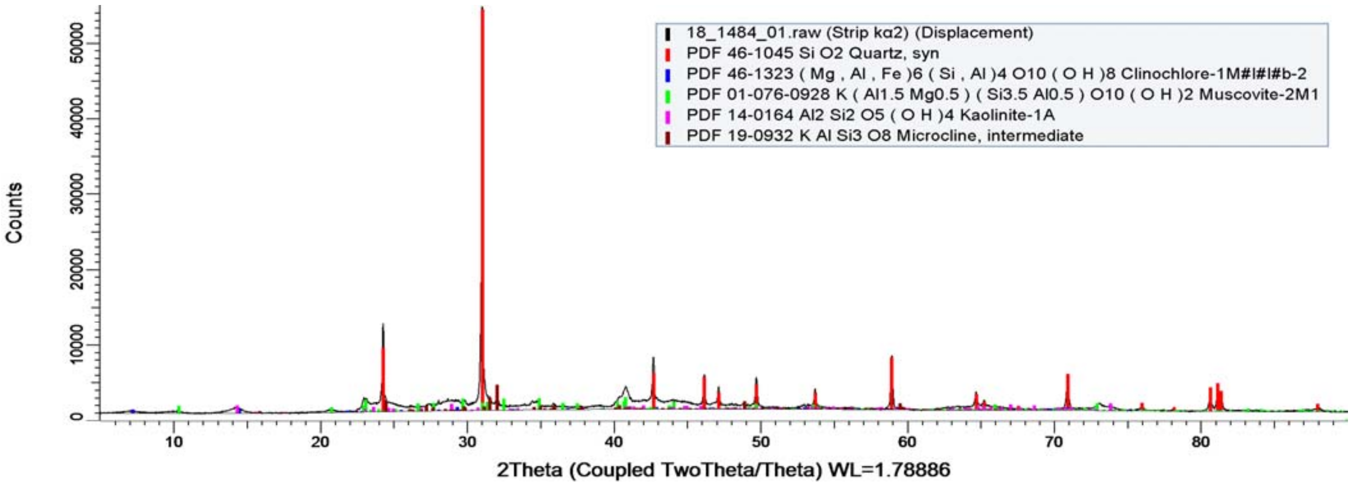
No standards were used in the quantification process. The concentrations were calculated using the normalized reference intensity ratio method where the intensity of the 100% peak divided by the published I/Ic value for each mineral phase is summed and the relative percentages of each phase calculated based on the relative contribution to the sum. This method allows for slight attention to be paid to preferred orientation but is limited in considering other factors including but not limited to; variable crystallinity, alteration, fluorescence, substitution and lattice strain.

Summary

The phases are listed in order of interpreted concentration:

Mineral phase	Concentration (%)	ICDD match probability
Quartz, syn (Si O2)	57	good
Microcline, intermediate (K Al Si3 O8)	20	good
Muscovite-2M1 (K (Al1.5 Mg0.5) (Si3.5 Al0.5) O10 (O H)2)	16	medium
Kaolinite-1A (Al2 Si2 O5 (O H)4)	4	medium
Clinochlore-1M#I#I#b-2 ((Mg , Al , Fe)6 (Si , Al)4 O10 (O H)8)	2	low

The ICDD match probability is reported as an indication as to how well the peak positions and relative intensities for the sample matched those in the published literature (www.icdd.org) for that particular compound.



Analyst: Ian Davies, B.Sc.(Chemistry)
Reported: Ian Davies, B.Sc.(Chemistry)
Approved: Michael Simeoni, B.Sc.(Chemistry), M.Sc. (Science Administration), Ph.D.

37 Kensington
Street
East Perth

Client: Golder Associates Pty Ltd
Job number: 18_1484
Sample: 18_1484_02
Client ID: CE416 PT4 27.0-27.45m
Date: 14-09-18
Analysis : Semi-quantitative XRD analysis

Sample preparation

The sample was supplied by the client to Microanalysis Australia on 5th of September 2018 for the above mentioned analyses. A representative sub –sample was removed and lightly ground such that 90% was passing 20 µm. Grinding to this size helps eliminate preferred orientation.

Analysis

Only crystalline material present in the sample will give peaks in the XRD scan. Amorphous (non crystalline) material will add to the background. The search match software used was Eva 4.2. An up-to-date ICDD card set was used. The X-ray source was cobalt radiation.

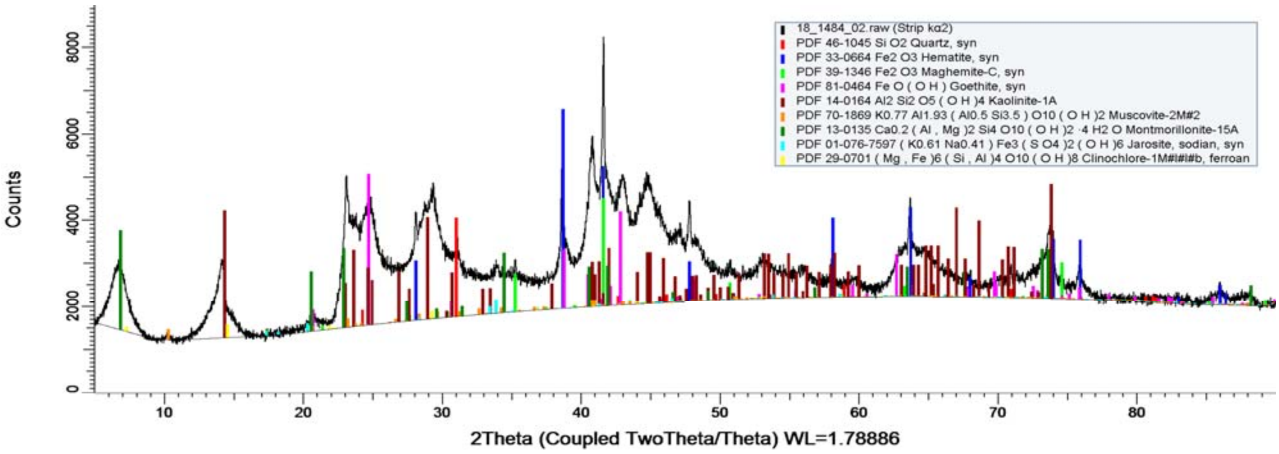
No standards were used in the quantification process. The concentrations were calculated using the normalized reference intensity ratio method where the intensity of the 100% peak divided by the published I/Ic value for each mineral phase is summed and the relative percentages of each phase calculated based on the relative contribution to the sum. This method allows for slight attention to be paid to preferred orientation but is limited in considering other factors including but not limited to; variable crystallinity, alteration, fluorescence, substitution and lattice strain.

Summary

The phases are listed in order of interpreted concentration:

Mineral phase	Concentration (%)	ICDD match probability
Kaolinite-1A (Al2 Si2 O5 (O H)4)	25	medium
Montmorillonite-15A (Ca0.2 (Al , Mg)2 Si4 O10 (O H)2 ·4 H2 O)	19	medium
Hematite, syn (Fe2 O3)	16	good
Maghemite-C, syn (Fe2 O3)	15	good
Goethite, syn (Fe O (O H))	11	good
Quartz, syn (Si O2)	6	good
Muscovite-2M#2 (K0.77 Al1.93 (Al0.5 Si3.5) O10 (O H)2)	5	medium
Clinochlore-1M#I#I#b, ferroan ((Mg , Fe)6 (Si , Al)4 O10 (O H)8)	3	low
Jarosite, sodian, syn ((K0.61 Na0.41) Fe3 (S O4)2 (O H)6)	1	low

The ICDD match probability is reported as an indication as to how well the peak positions and relative intensities for the sample matched those in the published literature (www.icdd.org) for that particular compound.



Analyst: Ian Davies, B.Sc.(Chemistry)
Reported: Ian Davies, B.Sc.(Chemistry)
Approved: Michael Simeoni, B.Sc.(Chemistry), M.Sc. (Science Administration), Ph.D.

37 Kensington
Street
East Perth

Client: Golder Associates Pty Ltd
Job number: 18_1484
Sample: 18_1484_03
Client ID: CE415 PT1 6.0-6.5m
Date: 14-09-18
Analysis : Semi-quantitative XRD analysis

Sample preparation

The sample was supplied by the client to Microanalysis Australia on 5th of September 2018 for the above mentioned analyses. A representative sub –sample was removed and lightly ground such that 90% was passing 20 µm. Grinding to this size helps eliminate preferred orientation.

Analysis

Only crystalline material present in the sample will give peaks in the XRD scan. Amorphous (non crystalline) material will add to the background. The search match software used was Eva 4.2. An up-to-date ICDD card set was used. The X-ray source was cobalt radiation.

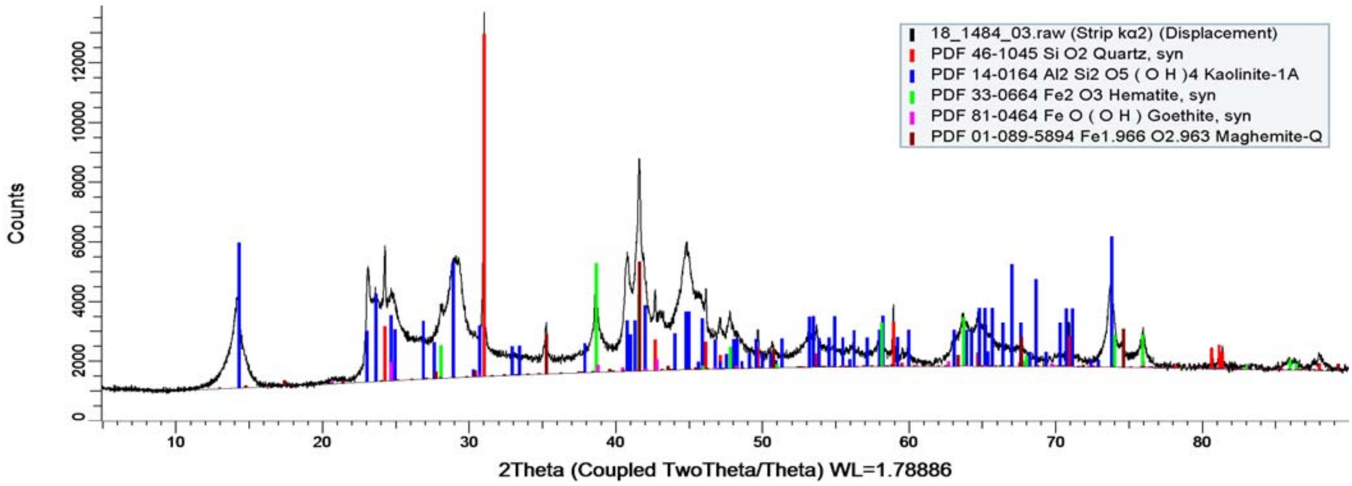
No standards were used in the quantification process. The concentrations were calculated using the normalized reference intensity ratio method where the intensity of the 100% peak divided by the published I/Ic value for each mineral phase is summed and the relative percentages of each phase calculated based on the relative contribution to the sum. This method allows for slight attention to be paid to preferred orientation but is limited in considering other factors including but not limited to; variable crystallinity, alteration, fluorescence, substitution and lattice strain.

Summary

The phases are listed in order of interpreted concentration:

Mineral phase	Concentration (%)	ICDD match probability
Kaolinite-1A (Al2 Si2 O5 (O H)4)	43	medium
Quartz, syn (Si O2)	30	good
Hematite, syn (Fe2 O3)	13	good
Maghemite-Q (Fe1.966 O2.963)	12	medium
Goethite, syn (Fe O (O H))	2	medium

The ICDD match probability is reported as an indication as to how well the peak positions and relative intensities for the sample matched those in the published literature (www.icdd.org) for that particular compound.



Analyst: Ian Davies, B.Sc.(Chemistry)
Reported: Ian Davies, B.Sc.(Chemistry)
Approved: Michael Simeoni, B.Sc.(Chemistry), M.Sc. (Science Administration), Ph.D.

Annexure CK
Drillhole Logs – Previous Investigations

DRILLHOLE LOG

HATCH

Drillhole No: **BH017**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		DRAFT
Location:	Rodds Creek Tailings Dam		

Easting:	685,818.6 m
Northing:	6,290,983.7 m
Coord.System:	GDA94
Elevation:	656.00 m
Total Depth:	32.2 m

Contractor:		**Rig Type/ Mounting:**	Warman 500	**Date Logged:**	08-Feb-95	**Logged By:**	Woodward Clyde
Driller:	Anderson Drilling	**Hole Diameter (mm):**		**Date Checked:**		**Checked By:**	

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Sample Type	Additional Observations
	656.0–653.0	0.0–3.0				CL/CH	Silty Gravelly CLAY: medium plasticity, light brown.	D-M			
	653.0–651.0	3.0–5.0				CH	Silty CLAY: high plasticity, dark brown.	M			
	651.0–646.0	5.0–10.0					ANDESITE: brown grey, facture, red brown to brown iron staining along fractures, fractures rough. Extremely weathered to highly weathered from 5.0 m to 10.0 m.		S		

Elevation scale: 655.0, 654.0, 653.0, 652.0, 651.0, 650.0, 649.0, 648.0, 647.0, 646.0

Depth scale: 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0

Notes:

DRILLHOLE LOG

HATCH

Drillhole No:	**BH017**
Sheet 2 of 4	
Easting:	685,818.6 m
Northing:	6,290,983.7 m
Coord.System:	GDA94
Elevation:	656.00 m
Total Depth:	32.2 m
Logged By:	Woodward Clyde
Checked By:	

Client: Newcrest
Project No.: H356804
Project: Cadia NTSF Failure Review
Location: Rodds Creek Tailings Dam

DRAFT

Contractor: **Rig Type/ Mounting:** Warman 500 **Date Logged:** 08-Feb-95
Driller: Anderson Drilling **Hole Diameter (mm):** **Date Checked:**

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Sample Type	Additional Observations
							ANDESITE: brown grey, facture, red brown to brown iron staining along fractures, fractures rough. Extremely weathered to highly weathered from 5.0 m to 10.0 m. *(Continued)*		S		
	645.0	11.0					... Moderately weathered from 10.0 m to 13.0 m.				
	644.0	12.0									
	643.0	13.0									
	642.0	14.0					... Water inflow.	W			
	641.0	15.0					... Slightly weathered from 15.0 m to 27.0 m. Becoming predominantly red brown, altered, quartz veina >3mm thick.				
	640.0	16.0									
	639.0	17.0									
	638.0	18.0									
	637.0	19.0									
	636.0	20.0									

Notes:

HATCH

DRILLHOLE LOG

Drillhole No: **BH017**

Client: Newcrest
Project No.: H356804
Project: Cadia NTSF Failure Review
Location: Rodds Creek Tailings Dam

DRAFT

Easting:	685,818.6 m
Northing:	6,290,983.7 m
Coord.System:	GDA94
Elevation:	656.00 m
Total Depth:	32.2 m

Contractor:
Rig Type/ Mounting: Warman 500
Date Logged: 08-Feb-95
Logged By: Woodward Clyde
Driller: Anderson Drilling
Hole Diameter (mm):
Date Checked:
Checked By:

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Sample Type	Additional Observations
							ANDESITE: brown grey, facture, red brown to brown iron staining along fractures, fractures rough. Extremely weathered to highly weathered from 5.0 m to 10.0 m. *(Continued)*		S		
	635.0	21.0									
	634.0	22.0									
	633.0	23.0									
	632.0	24.0									
	631.0	25.0									
	630.0	26.0									
	629.0	27.0					... Vuggy from 26.9 m to 27.36m ... Slightly weathered from 27.0 m to 32.2 m. Grey green, fractured with calcite and quartz infill along fractures.		Fr		
	628.0	28.0									
	627.0	29.0									
	626.0	30.0									

Notes:

DRILLHOLE LOG

Drillhole No: **BH017**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Rodds Creek Tailings Dam		

DRAFT

Easting:	685,818.6 m
Northing:	6,290,983.7 m
Coord.System:	GDA94
Elevation:	656.00 m
Total Depth:	32.2 m

Contractor:		**Rig Type/ Mounting:**	Warman 500	**Date Logged:**	08-Feb-95	**Logged By:**	Woodward Clyde
Driller:	Anderson Drilling	**Hole Diameter (mm):**		**Date Checked:**		**Checked By:**	

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Sample Type	Additional Observations
	625.0 624.0	31.0 32.0					ANDESITE: brown grey, facture, red brown to brown iron staining along fractures, fractures rough. Extremely weathered to highly weathered from 5.0 m to 10.0 m. *(Continued)*		S		
	623.0 622.0 621.0 620.0 619.0 618.0 617.0 616.0	33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0					To Target Depth. **Drillhole BH017 terminated at 32.15m.**				

Notes:

HATCH

DRILLHOLE LOG

Drillhole No: **BH020**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Rodds Creek Tailings Dam		DRAFT

Easting:	685,334.8 m
Northing:	6,291,180.0 m
Coord.System:	GDA94
Elevation:	684.58 m
Total Depth:	15.0 m

Contractor:		**Rig Type/ Mounting:**	Warman 500	**Date Logged:**	11-Feb-95	**Logged By:**	Woodward-Clyde
Driller:	Anderson Drilling	**Hole Diameter (mm):**		**Date Checked:**		**Checked By:**	DWI

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Sample Type	Additional Observations
						CH	Silty CLAY: medium to high plasticity, dark brown.	M	VSt		
	683.6	1.0					BASALT: moderately weathered, dark grey, fractured, limonite staining along fractures.	D	H		
	682.6	2.0									
	681.6	3.0									
	680.6	4.0					... red brown Fe alteration from 4.0 m to 11.0 m.				
	679.6	5.0									
	678.6	6.0									
	677.6	7.0									
	676.6	8.0									
	675.6	9.0									
	674.6	10.0									

Notes:

HATCH

DRILLHOLE LOG

Drillhole No: **BH020**

Sheet 2 of 2

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		DRAFT
Location:	Rodds Creek Tailings Dam		

Easting:	685,334.8 m
Northing:	6,291,180.0 m
Coord.System:	GDA94
Elevation:	684.58 m
Total Depth:	15.0 m

Contractor:		**Rig Type/ Mounting:**	Warman 500	**Date Logged:**	11-Feb-95	**Logged By:**	Woodward-Clyde
Driller:	Anderson Drilling	**Hole Diameter (mm):**		**Date Checked:**		**Checked By:**	DWI

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Sample Type	Additional Observations
	673.6	11.0					BASALT: moderately weathered, dark grey, fractured, limonite staining along fractures. *(Continued)*	D	H		
	672.6	12.0					BASALT: slightly weathered, dark grey, fractured, some limonite staining along fractures.		Fr		
	671.6	13.0									
	670.6	14.0					... fresh.				
	669.6	15.0					To Target Depth. **Drillhole BH020 terminated at 15.00m.**				
	668.6	16.0									
	667.6	17.0									
	666.6	18.0									
	665.6	19.0									
	664.6	20.0									

Notes:

DRILLHOLE LOG

Drillhole No: **BH101**

Sheet 1 of 4

Client: Newcrest	**Project No.:** H356804	**Easting:**	685,441.0 m
Project: Cadia NTSF Failure Review	DRAFT	**Northing:**	6,291,112.7 m
Location: Stage I Dam Right Abutment		**Coord.System:**	GDA94
		Elevation:	680.54 m
		Total Depth:	20.6 m

Contractor:	**Rig Type/ Mounting:** HQ3- 63mm	**Date Logged:** 28-Nov-96	**Logged By:** PSM
Driller: McDermott Drilling	**Hole Diameter (mm):** 63	**Date Checked:**	**Checked By:**

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Sample Type	Additional Observations
							WASHBORE: brown/orange, sandy return (EW/HW ANDESITE?).				
	679.5	1.0									
	678.5	2.0					***Start of Coring at 2.0m.*** ***Continued on Rock Core Log sheet.***				
	677.5	3.0									
	676.5	4.0									
	675.5	5.0									
	674.5	6.0									
	673.5	7.0									
	672.5	8.0									
	671.5	9.0									
	670.5	10.0									

Notes:

CORED DRILLHOLE LOG
ROCK CORE FORMAT

Drillhole No: **BH101**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Stage I Dam Right Abutment		DRAFT

Easting:	685,441.0 m
Northing:	6,291,112.7 m
Coord.System:	GDA94
Elevation:	680.54 m
Total Depth:	20.6 m

Contractor:		**Rig Type/ Mounting:**	HQ3- 63mm	**Bearing:**	°	**Date Logged:**	28-Nov-96	**Logged By:**	PSM
Driller:	McDermott Drilling	**Hole Diameter (mm):**	63	**Plunge:**	°	**Date Checked:**		**Checked By:**	

Elevation (m)	Depth (m)	Rock Description (ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.)	Weathering/ Cementation	Estimated Strength	$Is_{(50)}$ [UCS] MPa	RQD %
679.5	1.0					
678.5	2.0	***Resuming in Rock Core Format 2.0m.*** ANDESITE: green to grey, massive, small feldspar phenocrysts.	MW			65
677.5	3.0				Dia 0.56	
676.5	4.0					0
675.5	5.0	... becomes dark grey to red brown.				
674.5	6.0				Dia 1.01	10
673.5	7.0					0
672.5	8.0	... becomes grey to green.	SW			80
671.5	9.0				Dia 1.55	40
670.5	10.0					

Column headings: Water, Elevation (m), Depth (m), Method, Casing, Graphic Log, Geological Unit, Rock Description, Weathering/ Cementation, Estimated Strength (EH VH H M L VL EL), $Is_{(50)}$ [UCS] MPa, Defect Spacing mm (2000 600 200 [100] 60 20), RQD %, Defect Log, Defect Description (Inclination, type, infill, amount, aperture, planarity, roughness, frequency; Specific, General)

Notes:

HATCH

CORED DRILLHOLE LOG

ROCK CORE FORMAT

Drillhole No: **BH101**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Stage I Dam Right Abutment		DRAFT

Easting:	685,441.0 m
Northing:	6,291,112.7 m
Coord.System:	GDA94
Elevation:	680.54 m
Total Depth:	20.6 m

Contractor:		**Rig Type/ Mounting:**	HQ3- 63mm	**Bearing:**	°	**Date Logged:**	28-Nov-96	**Logged By:**	PSM
Driller:	McDermott Drilling	**Hole Diameter (mm):**	63	**Plunge:**	°	**Date Checked:**		**Checked By:**	

Columns: Water | Elevation (m) | Depth (m) | Method | Casing | Graphic Log | Geological Unit | Rock Description (ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.) | Weathering/ Cementation | Estimated Strength (EH VH H M L VL EL) | Is(50) [UCS] MPa | Defect Spacing mm (2000 600 200 [100] 60 20) | RQD % | Defect Log | Defect Description (Inclination, type, infill, amount, aperture, planarity, roughness, frequency; Specific / General)

Elevation (m)	Depth (m)	Rock Description	Weathering/ Cementation	Is(50) MPa	RQD %
		ANDESITE: green to grey, massive, small feldspar phenocrysts. *(Continued)*	SW		
		... becomes dark purple to grey.			0
669.5	11.0			Dia 2.57	
				Dia 1.68	
				Axial 1.56	
		... becomes green to grey.			80
				Dia 3.83	
668.5	12.0				0
				Dia 5.44	
667.5	13.0				75
					100
666.5	14.0		Fr	Dia 3.01	0
		... becomes grey to purple.			
				Dia 1.88	
665.5	15.0			Dia 4.9	
					100
				Dia 2.75	
664.5	16.0				
		... becomes purple.			
663.5	17.0			Dia 2.93	
662.5	18.0				98
661.5	19.0			Dia 4.9	
					100
660.5	20.0			Dia	

Notes:

HATCH

CORED DRILLHOLE LOG

ROCK CORE FORMAT

Drillhole No: **BH101**

Client: Newcrest	**Project No.:** H356804
Project: Cadia NTSF Failure Review	
Location: Stage I Dam Right Abutment	DRAFT
Easting: 685,441.0 m	**Northing:** 6,291,112.7 m
Coord.System: GDA94	**Elevation:** 680.54 m
Total Depth: 20.6 m	
Contractor:	**Rig Type/ Mounting:** HQ3- 63mm
Bearing: °	**Date Logged:** 28-Nov-96
Logged By: PSM	**Driller:** McDermott Drilling
Hole Diameter (mm): 63	**Plunge:** °
Date Checked:	**Checked By:**

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Geological Unit	Rock Description ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.	Weathering/ Cementation	Estimated Strength EH VH H M L VL EL	$Is_{(50)}$ [UCS] MPa	Defect Spacing mm 2000 600 200 [100] 60 20	RQD %	Defect Log	Defect Description Inclination, type, infill, amount, aperture, planarity, roughness, frequency Specific / General
							ANDESITE: green to grey, massive, small feldspar phenocrysts. *(Continued)*	Fr		5.26		40		
	659.5	21.0					**Drillhole BH101 terminated at 20.6m.**							
	658.5	22.0												
	657.5	23.0												
	656.5	24.0												
	655.5	25.0												
	654.5	26.0												
	653.5	27.0												
	652.5	28.0												
	651.5	29.0												
	650.5	30.0												

Notes:

DRILLHOLE LOG

Drillhole No: **BH102**

Sheet 1 of 3

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		DRAFT
Location:	Right Rodds Creek		

Easting:	685,666.0 m
Northing:	6,290,997.1 m
Coord.System:	GDA94
Elevation:	667.34 m
Total Depth:	14.8 m

Contractor:		**Rig Type/ Mounting:**	HQ3- 63mm	**Date Logged:**	02-Dec-96	**Logged By:**	PSM
Driller:	McDermott Drilling	**Hole Diameter (mm):**	63	**Date Checked:**		**Checked By:**	

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	**Soil Description** TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Sample Type	Additional Observations
	666.3	1.0					WASHBORE: brown/orange, sandy return (EW/HW ANDESITE?)				
	665.3	2.0									
	664.3	3.0					***Start of Coring at 2.6m.*** ***Continued on Rock Core Log sheet.***				
	663.3	4.0									
	662.3	5.0									
	661.3	6.0									
	660.3	7.0									
	659.3	8.0									
	658.3	9.0									
	657.3	10.0									

Notes:

HATCH

CORED DRILLHOLE LOG

ROCK CORE FORMAT

Drillhole No: **BH102**

Client: Newcrest **Project No.:** H356804

Project: Cadia NTSF Failure Review

Location: Right Rodds Creek

DRAFT

Easting:	685,666.0 m
Northing:	6,290,997.1 m
Coord.System:	GDA94
Elevation:	667.34 m
Total Depth:	14.8 m

Contractor: **Rig Type/ Mounting:** HQ3- 63mm **Bearing:** ° **Date Logged:** 02-Dec-96 **Logged By:** PSM

Driller: McDermott Drilling **Hole Diameter (mm):** 63 **Plunge:** ° **Date Checked:** **Checked By:**

Elevation (m)	Depth (m)	Rock Description (ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.)	Weathering/ Cementation	Is(50) [UCS] MPa	RQD %
666.3	1.0				
665.3	2.0				
		Resuming in Rock Core Format 2.6m.			
		ANDESITE: dark green/brown, feldspar phenocrysts, fine to medium grained, massive.	HW		0
664.3	3.0	... grey, some vesicles.	MW		
663.3	4.0			Dia 5.97 Axial 7.89	85
		... becomes non vesicular, some thin white quartz veins.	SW		
662.3	5.0			Dia 9.4 Axial 11.08	100
661.3	6.0		Fr		
660.3	7.0			Dia 8.11	95
659.3	8.0			Dia 6.39	
658.3	9.0				100
657.3	10.0				

Other columns: Water, Method, Casing, Graphic Log, Geological Unit, Estimated Strength (EH VH H M L VL EL), Defect Spacing mm (2000 600 200 [100] 60 20), Defect Log, Defect Description (Inclination, type, infill, amount, aperture, planarity, roughness, frequency; Specific / General).

Notes:

CORED DRILLHOLE LOG
ROCK CORE FORMAT

HATCH

Drillhole No: **BH102**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Right Rodds Creek		DRAFT

Easting:	685,666.0 m
Northing:	6,290,997.1 m
Coord.System:	GDA94
Elevation:	667.34 m
Total Depth:	14.8 m

Contractor:		**Rig Type/ Mounting:**	HQ3- 63mm	**Bearing:**	°	**Date Logged:**	02-Dec-96	**Logged By:**	PSM
Driller:	McDermott Drilling	**Hole Diameter (mm):**	63	**Plunge:**	°	**Date Checked:**		**Checked By:**	

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Geological Unit	Rock Description: ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.	Weathering/ Cementation	Estimated Strength (EH VH H M L VL EL)	$Is_{(50)}$ [UCS] MPa	Defect Spacing mm (2000 600 200 [100] 60 20)	RQD %	Defect Log	Defect Description: Inclination, type, infill, amount, aperture, planarity, roughness, frequency (Specific / General)
							ANDESITE: dark green/brown, feldspar phenocrysts, fine to medium grained, massive. *(Continued)*	Fr		Dia 5.64				
	656.3	11.0										100		
										Dia 3.76				
	655.3	12.0												
	654.3	13.0								Dia 3.38				
												97		
	653.3	14.0												
										Dia 6.02				
	652.3	15.0					**Drillhole BH102 terminated at 14.8m.**							
	651.3	16.0												
	650.3	17.0												
	649.3	18.0												
	648.3	19.0												
	647.3	20.0												

Notes:

HATCH

DRILLHOLE LOG

Drillhole No: **BH103**

Sheet 1 of 3

Client:	Newcrest
Project:	Cadia NTSF Failure Review
Location:	Left of Rodd's Creek
Project No.:	H356804

DRAFT

Easting:	685,980.6 m
Northing:	6,290,862.3 m
Coord.System:	GDA94
Elevation:	675.79 m
Total Depth:	21.3 m

Contractor:		**Rig Type/ Mounting:**	HQ3- 63mm	**Date Logged:**	03-Dec-96
Driller:	McDermott Drilling	**Hole Diameter (mm):**	63	**Date Checked:**	

Logged By:	PSM
Checked By:	

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	**Soil Description** TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Sample Type	Additional Observations
							WAHBORE: brown to orange, sandy return (EW/HW ANDESITE?).				
	674.8	1.0									
	673.8	2.0									
	672.8	3.0					ANDESITE TUFF: light brown to orange, massive, some sericite altered feldspar, occasional vesicles.				
	671.8	4.0									
	670.8	5.0									
	669.8	6.0					... becomes brown to orange.				
	668.8	7.0									
	667.8	8.0									
	666.8	9.0									
	665.8	10.0									

Notes:

HATCH

DRILLHOLE LOG

Drillhole No: **BH103**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Left of Rodd's Creek		DRAFT

Easting:	685,980.6 m
Northing:	6,290,862.3 m
Coord.System:	GDA94
Elevation:	675.79 m
Total Depth:	21.3 m

Contractor:		**Rig Type/ Mounting:**	HQ3- 63mm	**Date Logged:**	03-Dec-96	**Logged By:**	PSM
Driller:	McDermott Drilling	**Hole Diameter (mm):**	63	**Date Checked:**		**Checked By:**	

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Sample Type	Additional Observations
							ANDESITE TUFF: light brown to orange, massive, some sericite altered feldspar, occasional vesicles. *(Continued)* ... becomes grey/ brown/ orange.				
	664.8	11.0									
	663.8	12.0									
	662.8	13.0									
	661.8	14.0									
	660.8	15.0									
	659.8	16.0									
	658.8	17.0									
	657.8	18.0									
	656.8	19.0									
	655.8	20.0									

Notes:

HATCH

DRILLHOLE LOG

Drillhole No: **BH103**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		DRAFT
Location:	Left of Rodd's Creek		

Easting:	685,980.6 m
Northing:	6,290,862.3 m
Coord.System:	GDA94
Elevation:	675.79 m
Total Depth:	21.3 m

Contractor:		**Rig Type/ Mounting:**	HQ3- 63mm	**Date Logged:**	03-Dec-96	**Logged By:**	PSM
Driller:	McDermott Drilling	**Hole Diameter (mm):**	63	**Date Checked:**		**Checked By:**	

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Sample Type	Additional Observations
	654.8	21.0					ANDESITE TUFF: light brown to orange, massive, some sericite altered feldspar, occasional vesicles. *(Continued)*				
	653.8	22.0					To Target Depth. **Drillhole BH103 terminated at 21.30m.**				
	652.8	23.0									
	651.8	24.0									
	650.8	25.0									
	649.8	26.0									
	648.8	27.0									
	647.8	28.0									
	646.8	29.0									
	645.8	30.0									

Notes:

DRILLHOLE LOG

Drillhole No: **BH106**

Sheet 1 of 3

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Right Abutment, Stage 1 Dam		

DRAFT

Easting:	685,177.7 m
Northing:	6,291,292.6 m
Coord.System:	GDA94
Elevation:	694.00 m
Total Depth:	15.8 m

Contractor:		**Rig Type/ Mounting:**	HQ3- 63mm	**Date Logged:**	08-Dec-96	**Logged By:**	PSM
Driller:	McDermott Drilling	**Hole Diameter (mm):**		**Date Checked:**		**Checked By:**	

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Sample Type	Additional Observations
	693.0	1.0				GP	Silty Sandy GRAVEL: brown, fine grained sand particles, fine to medium grained gravel particles, gravels sub-angular, R4 strength Basalt (COLLUVIUM/ EW BASALT).	D-M			
	692.0	2.0									
	691.0	3.0									
	690.0	4.0									
	689.0	5.0					***Start of Coring at 4.3m.*** ***Continued on Rock Core Log sheet.***				
	688.0	6.0									
	687.0	7.0									
	686.0	8.0									
	685.0	9.0									
	684.0	10.0									

Notes:

CORED DRILLHOLE LOG

ROCK CORE FORMAT

Drillhole No: **BH106**

DRAFT

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Right Abutment, Stage 1 Dam		

Easting:	685,177.7 m
Northing:	6,291,292.6 m
Coord.System:	GDA94
Elevation:	694.00 m
Total Depth:	15.8 m

Contractor:		**Rig Type/ Mounting:**	HQ3- 63mm	**Bearing:**	Vertical°	**Date Logged:**	08-Dec-96	**Logged By:**	PSM
Driller:	McDermott Drilling	**Hole Diameter (mm):**		**Plunge:**	°	**Date Checked:**		**Checked By:**	

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Geological Unit	Rock Description: ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.	Weathering/ Cementation	Estimated Strength (EH VH H M L VL EL)	$Is_{(50)}$ [UCS] MPa	Defect Spacing mm (2000 600 200 [100] 60 20)	RQD %	Defect Log	Defect Description (Inclination, type, infill, amount, aperture, planarity, roughness, frequency) Specific / General
	693.0	1.0												
	692.0	2.0												
	691.0	3.0												
	690.0	4.0					***Resuming in Rock Core Format 4.3m.***							
							BASALT: grey, fine grained, massive, occasional phenocrysts olivene and hornblende.	MW		Dia 3.38		85		
	689.0	5.0												
	688.0	6.0					... becomes grey to brown.					40		
	687.0	7.0					... becomes green to grey.	SW		Dia 6.77 Axial 9.23		100		
								Fr						
	686.0	8.0												
										Dia 9.4		80		
	685.0	9.0												
	684.0	10.0												

Notes:

HATCH

CORED DRILLHOLE LOG
ROCK CORE FORMAT

Drillhole No: **BH106**

DRAFT

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Right Abutment, Stage 1 Dam		

Easting:	685,177.7 m
Northing:	6,291,292.6 m
Coord.System:	GDA94
Elevation:	694.00 m
Total Depth:	15.8 m
Logged By:	PSM
Checked By:	

Contractor:		**Rig Type/ Mounting:**	HQ3- 63mm	**Bearing:**	Vertical°	**Date Logged:**	08-Dec-96
Driller:	McDermott Drilling	**Hole Diameter (mm):**		**Plunge:**	°	**Date Checked:**	

Elevation (m)	Depth (m)	Geological Unit	Rock Description (ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.)	Weathering/ Cementation	RQD %
			BASALT: grey, fine grained, massive, occasional phenocrysts olivene and hornblende. *(Continued)*	Fr / MW	80 / 83
			MUDSTONE: grey, massive (ALLUVIUM).		
		SC	Clayey SAND: slight plasticity, grey, massive, medium grained sand particles (ALLUVIUM).		
		CL	Sandy CLAY: light grey, gravels sub-angular sandstone and mudstone, fine to coarse grained gravel. Unit matrix supported (ALLUVIUM).		
		CL	CLAY: red to brown, with some fine grained sand, massive (RESIDUAL SOIL ANDESITE).		
			To Target Depth. **Drillhole BH106 terminated at 15.8m.**		

Depth scale: 683.0 / 11.0; 682.0 / 12.0; 681.0 / 13.0; 680.0 / 14.0; 679.0 / 15.0; 678.0 / 16.0; 677.0 / 17.0; 676.0 / 18.0; 675.0 / 19.0; 674.0 / 20.0

Columns: Water; Elevation (m); Depth (m); Method; Casing; Graphic Log; Geological Unit; Rock Description; Weathering/ Cementation; Estimated Strength (EH VH H M L VL EL); $Is_{(50)}$ [UCS] MPa; Defect Spacing mm (2000 600 200 [100] 60 20); RQD %; Defect Log; Defect Description (Inclination, type, infill, amount, aperture, planarity, roughness, frequency; Specific / General)

Notes:

DRILLHOLE LOG

HATCH

Drillhole No: **BH107**

Client:	Newcrest
Project:	Cadia NTSF Failure Review
Location:	Right Embankment, Stage 3 Dam
Project No.:	H356804

DRAFT

Easting:	684,979.6 m
Northing:	6,291,543.0 m
Coord.System:	GDA94
Elevation:	701.69 m
Total Depth:	20.0 m

Contractor:		**Rig Type/ Mounting:**	HQ3- 63mm	**Date Logged:**	10-Dec-96
Driller:	McDermott Drilling	**Hole Diameter (mm):**	63	**Date Checked:**	
Logged By:	PSM	**Checked By:**			

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Classification Symbol	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Moisture Condition	Consistency/ Density	Sample Type	Additional Observations
						SM	Silty SAND: grey, fine to medium grained sand particles, with some clay (COLLUVIUM?).	D-M			
	700.7	1.0					... becomes light brown, remnant HW Basalt gravels.	D			
	699.7	2.0									
	698.7	3.0									
	697.7	4.0				CL	CLAY: brown to orange, with some fine to medium grained sand (RESIDUAL SOIL BASALT?).	M			
	696.7	5.0									
							Start of Coring at 5.2m. Continued on Rock Core Log sheet.				
	695.7	6.0									
	694.7	7.0									
	693.7	8.0									
	692.7	9.0									
	691.7	10.0									

Notes:

CORED DRILLHOLE LOG
ROCK CORE FORMAT

Drillhole No: **BH107**

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Right Embankment, Stage 3 Dam		DRAFT

Easting:	684,979.6 m
Northing:	6,291,543.0 m
Coord.System:	GDA94
Elevation:	701.69 m
Total Depth:	20.0 m

Contractor:		**Rig Type/ Mounting:**	HQ3- 63mm	**Bearing:**	Vertical°	**Date Logged:**	10-Dec-96	**Logged By:**	PSM
Driller:	McDermott Drilling	**Hole Diameter (mm):**	63	**Plunge:**	°	**Date Checked:**		**Checked By:**	

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Geological Unit	Rock Description: ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.	Weathering/ Cementation	Estimated Strength (EH VH H M L VL EL)	Is(50) [UCS] MPa	Defect Spacing mm (2000 600 200 [100] 60 20)	RQD %	Defect Log	Defect Description: Inclination, type, infill, amount, aperture, planarity, roughness, frequency (Specific / General)
	700.7	1.0												
	699.7	2.0												
	698.7	3.0												
	697.7	4.0												
	696.7	5.0					***Resuming in Rock Core Format 5.2m.***							
							BASALT: fine grained, massive, some vesicles and occasional phenocryts olivene/ hornblende.	SW				30		
	695.7	6.0					MUDSTONE: dark grey/ purple, massive (ALLUVIUM; baked zone).					70		
						ML	Clayey SILT: light grey, massive (ALLUVIUM).							
	694.7	7.0					.. becomes Silty CLAY.							
	693.7	8.0				SC	Clayey SAND: slight plasticity, brown, fine grained sand particles, massive. Material highly disturbed by drilling.							
	692.7	9.0												
	691.7	10.0												

Notes:

HATCH

CORED DRILLHOLE LOG
ROCK CORE FORMAT

Drillhole No: **BH107**

Client: Newcrest **Project No.:** H356804

Project: Cadia NTSF Failure Review

Location: Right Embankment, Stage 3 Dam

DRAFT

Easting:	684,979.6 m
Northing:	6,291,543.0 m
Coord.System:	GDA94
Elevation:	701.69 m
Total Depth:	20.0 m

Contractor:		**Rig Type/ Mounting:** HQ3- 63mm	**Bearing:** Vertical°	**Date Logged:** 10-Dec-96	**Logged By:** PSM
Driller: McDermott Drilling		**Hole Diameter (mm):** 63	**Plunge:** °	**Date Checked:**	**Checked By:**

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Geological Unit	Rock Description ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.	Weathering/ Cementation	Estimated Strength EH VH H M L VL EL	Is(50) [UCS] MPa	Defect Spacing mm 2000 600 200 [100] 60 20	RQD %	Defect Log	Defect Description Inclination, type, infill, amount, aperture, planarity, roughness, frequency Specific / General
							Clayey SAND: slight plasticity, brown, fine grained sand particles, massive. Material highly disturbed by drilling. *(Continued)*							
	690.7	11.0												
	689.7	12.0												
	688.7	13.0												
	687.7	14.0												
	686.7	15.0												
	685.7	16.0												
	684.7	17.0												
	683.7	18.0												
	682.7	19.0				CI	Sandy CLAY: medium plasticity, orange to brown, massive (RESIDUAL SOIL ANDESITE?).							
	681.7	20.0												

Notes:

Drillhole BH107 terminated at 20.0m.

CORED DRILLHOLE LOG
ROCK CORE FORMAT

Drillhole No: **BH107**

DRAFT

Client:	Newcrest	**Project No.:**	H356804
Project:	Cadia NTSF Failure Review		
Location:	Right Embankment, Stage 3 Dam		

Easting:	684,979.6 m
Northing:	6,291,543.0 m
Coord.System:	GDA94
Elevation:	701.69 m
Total Depth:	20.0 m

Contractor:		**Rig Type/ Mounting:**	HQ3- 63mm	**Bearing:**	Vertical°	**Date Logged:**	10-Dec-96	**Logged By:**	PSM
Driller:	McDermott Drilling	**Hole Diameter (mm):**	63	**Plunge:**	°	**Date Checked:**		**Checked By:**	

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Geological Unit	Rock Description: ROCK TYPE; Grain size, texture and fabric, colour, general defect conditions, minor constituents.	Weathering/ Cementation	Estimated Strength (EH VH H M L VL EL)	$Is_{(50)}$ [UCS] MPa	Defect Spacing mm (2000 600 200 [100] 60 20)	RQD %	Defect Log	Defect Description: Inclination, type, infill, amount, aperture, planarity, roughness, frequency (Specific / General)
	680.7	21.0												
	679.7	22.0												
	678.7	23.0												
	677.7	24.0												
	676.7	25.0												
	675.7	26.0												
	674.7	27.0												
	673.7	28.0												
	672.7	29.0												
	671.7	30.0												

Notes:

Annexure CL
VWP Details

INSTALL DATA

Newcrest Drill Hole ID	VWP Serial Number	Hatch Drill Hole ID	Ground Level (RL)	Install level (depth, m)	Install level (RL)	Pressure Rating (kPa)	Cable Length (m)	F_0 (Hz^2 10-3)	T_0 (deg celcius)	C_p	C_t	Ambient Temp (deg celcius)	Ambient Pressure (kPa)
CE405	316-284	DH403	687.83	30.25	657.58	350	60	9227.0	17.0	0.1211	-0.12940	18.0	93.59
CE406	316-285	DH410	688.04	30.15	657.89	350	60	8949.8	2.7	0.1114	-0.05206	1.6	93.11
CE407	25009	DH402	731.80	51.00	680.80	700	80	8880.3	8.6	0.1724	-0.06540	15.0	93.68
CE408	25012	DH401	743.80	56.95	686.85	700	80	8818.4	9.6	0.1771	-0.06719	11.8	94.13
CE412	25010	DH405	732.14	56.50	675.64	700	80	9002.8	7.3	0.1707	-0.07620	6.6	94.20
CE413	25011	DH404	743.85	57.35	686.50	700	80	8799.6	5.4	0.1730	0.00203	8.0	93.96
CE415	316-280	DH408	686.16	25.00	661.16	350	40	9155.6	5.7	0.1223	-0.08155	11.1	93.28
CE417	316-518	DH406	701.00	12.40	688.60	350	50	8860.5	9.3	0.1224	-0.04933	3.0	92.74
CE430	316-283	DH411	706.32	26.15	680.17	350	60	9016.5	11.4	0.1220	-0.11630	21.3	92.53
CE435	316-282	NA	708.33	38.48	669.85	350	60	9310.8	23.7	0.1308	-0.08425	25.48	93.9

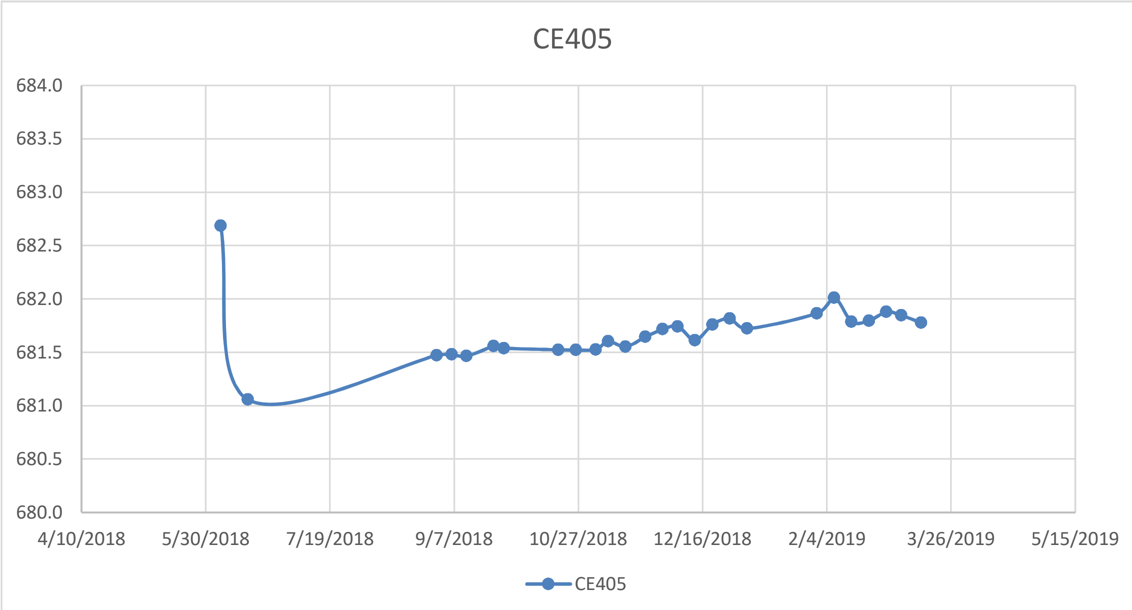
HATCH

Drill Hole ID CE405

Serial Number 316-284

MEASUREMENTS (Fill Reading Date, VWP Serial Number, F1 and T1)

Reading Date	F_1 (Hz^2 10-3)	T_1 (deg celcius)	Pressure (kPa)	Head (m)	Water Level (RL)
6/5/2018	7196.1	14.4	246.28	25.10	682.68
6/16/2018	7329.3	13.2	230.30	23.48	681.06
8/31/2018	7296.0	13.0	234.36	23.89	681.47
9/6/2018	7295.2	13.0	234.46	23.90	681.48
9/12/2018	7296.5	13.0	234.30	23.88	681.46
9/23/2018	7288.3	13.6	235.22	23.98	681.56
9/27/2018	7290.6	12.9	235.03	23.96	681.54
10/19/2018	7291.9	12.8	234.88	23.94	681.52
10/26/2018	7292.1	12.8	234.86	23.94	681.52
11/3/2018	7291.7	12.8	234.91	23.95	681.53
11/8/2018	7285.6	12.7	235.66	24.02	681.60
11/15/2018	7289.6	12.7	235.18	23.97	681.55
11/23/2018	7282.1	12.8	236.07	24.06	681.64
11/30/2018	7276.4	12.7	236.77	24.14	681.72
12/6/2018	7274.2	12.8	237.03	24.16	681.74
12/13/2018	7284.7	12.7	235.77	24.03	681.61
12/20/2018	7272.9	12.7	237.20	24.18	681.76
12/27/2018	7268.2	12.7	237.77	24.24	681.82
1/3/2019	7275.9	12.7	236.83	24.14	681.72
1/31/2019	7264.2	12.8	238.24	24.29	681.87
2/7/2019	7266.1		239.66	24.43	682.01
2/14/2019	7270.5	12.8	237.48	24.21	681.79
2/21/2019	7269.9	12.8	237.55	24.21	681.79
2/28/2019	7263.1	12.8	238.37	24.30	681.88
3/6/2019	7265.6	12.9	238.06	24.27	681.85
3/14/2019	7271.2	12.9	237.38	24.20	681.78


CE405
684.0
683.5
683.0
682.5
682.0
681.5
681.0
680.5
680.0
4/10/2018
5/30/2018
7/19/2018
9/7/2018
10/27/2018
12/16/2018
2/4/2019
3/26/2019
5/15/2019
CE405

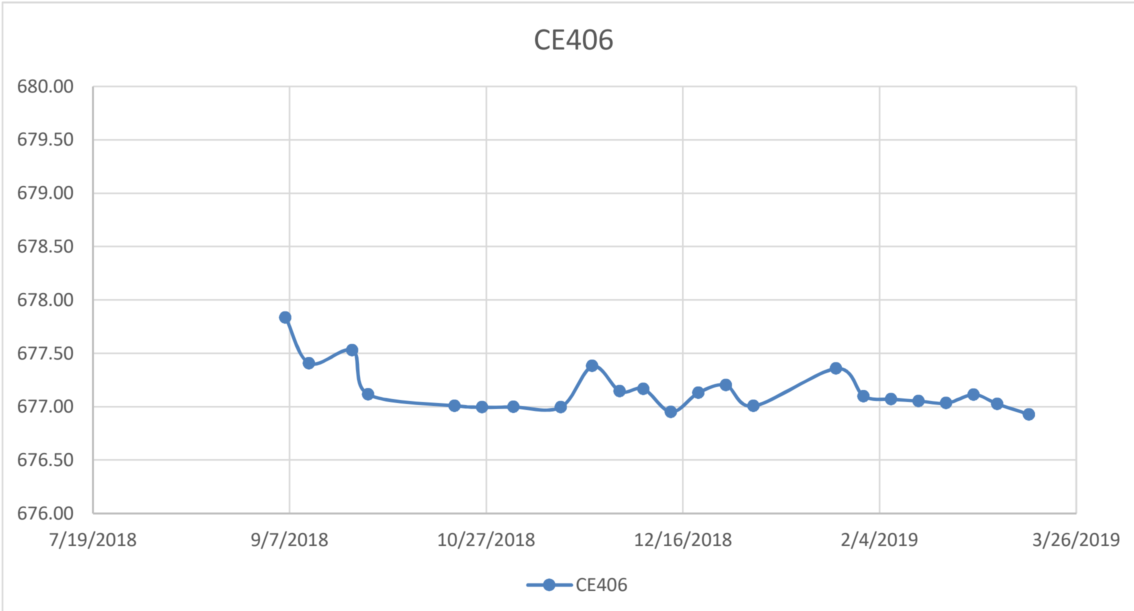
HATCH

Drill Hole ID CE406

Serial Number 316-285

MEASUREMENTS (Fill Reading Date, VWP Serial Number, F1 and T1)

Reading Date	F_1 (Hz^2 10-3)	T_1 (deg celcius)	Pressure (kPa)	Head (m)	Water Level (RL)
9/6/2018	7187.3	15.9	195.66	19.94	677.83
9/12/2018	7225.1	16.0	191.44	19.51	677.40
9/23/2018	7214.3	16.0	192.64	19.64	677.53
9/27/2018	7250.6	16.0	188.60	19.23	677.12
10/19/2018	7260.1	15.9	187.55	19.12	677.01
10/26/2018	7261.3	15.9	187.41	19.10	676.99
11/3/2018	7261.1	15.9	187.43	19.11	677.00
11/15/2018	7260.7	16.9	187.43	19.11	677.00
11/23/2018	7227.3	15.9	191.20	19.49	677.38
11/30/2018	7248.1	16.0	188.88	19.25	677.14
12/6/2018	7246.2	15.9	189.09	19.28	677.17
12/13/2018	7265.2	15.9	186.98	19.06	676.95
12/20/2018	7249.3	15.9	188.75	19.24	677.13
12/27/2018	7243.1	16.0	189.43	19.31	677.20
1/3/2019	7260.3	15.9	187.52	19.12	677.01
1/24/2019	7229.4	16	190.96	19.47	677.36
1/31/2019	7252.2	15.9	188.43	19.21	677.10
2/7/2019	7254.7	15.9	188.15	19.18	677.07
2/14/2019	7256.2	15.9	187.98	19.16	677.05
2/21/2019	7257.9	15.9	187.79	19.14	677.03
2/28/2019	7250.9	16	188.57	19.22	677.11
3/6/2019	7258.6	15.9	187.71	19.13	677.02
3/14/2019	7266.8	16.9	186.75	19.04	676.93


CE406
680.00
679.50
679.00
678.50
678.00
677.50
677.00
676.50
676.00
7/19/2018
9/7/2018
10/27/2018
12/16/2018
2/4/2019
3/26/2019
CE406

Drill Hole ID CE406

Serial Number 316-285

MEASUREMENTS (Fill Reading Date, VWP Serial Number, F1 and T1)

Reading Date	F_1 (Hz^2 10-3)	T_1 (deg celcius)	Pressure (kPa)	Head (m)	Water Level (RL)
8/31/2018	7915.1	16.8	165.86	16.91	697.71
9/6/2018	7916.8	16.8	165.57	16.88	697.68
9/12/2018	7921.2	16.8	164.81	16.80	697.60
9/23/2018	7214.3	16.0	286.73	29.23	
9/27/2018	7924.4	16.8	164.26	16.74	697.54
10/5/2018	7923.7	16.7	164.39	16.76	697.56
10/19/2018	7920.2	16.8	164.98	16.82	697.62
10/26/2018	7917.3	16.8	165.48	16.87	697.67
11/3/2018	7922.6	16.8	164.57	16.78	697.58
11/8/2018	7922.2	16.8	164.64	16.78	697.58
11/15/2018	7925.3	16.8	164.11	16.73	697.53
11/23/2018	7936.1	16.7	162.25	16.54	697.34
11/30/2018	7934.2	16.7	162.58	16.57	697.37
12/6/2018	7930.7	16.7	163.18	16.63	697.43
12/13/2018	7944.1	16.6	160.88	16.40	697.20
12/20/2018	7946.2	16.7	160.51	16.36	697.16
12/27/2018	7943.3	16.8	161.00	16.41	697.21
1/3/2019	7947.5	16.7	160.28	16.34	697.14
1/17/2019	7952.2	16.7	159.47	16.26	697.06
1/24/2019	7952.8	16.7	159.37	16.25	697.05
1/31/2019	7956.6	16.7	158.72	16.18	696.98
2/7/2019	7959.1	16.8	158.28	16.13	696.93
2/14/2019	7959.3	16.7	158.25	16.13	696.93
2/21/2019	7963.9	16.6	157.46	16.05	696.85
2/28/2019	7961.2	16.8	157.92	16.10	696.90
3/6/2019	7967.7	16.7	156.80	15.98	696.78
3/14/2019	7970.8	16.7	156.27	15.93	696.73
			-	-	-
			-	-	-
			-	-	-
			-	-	-
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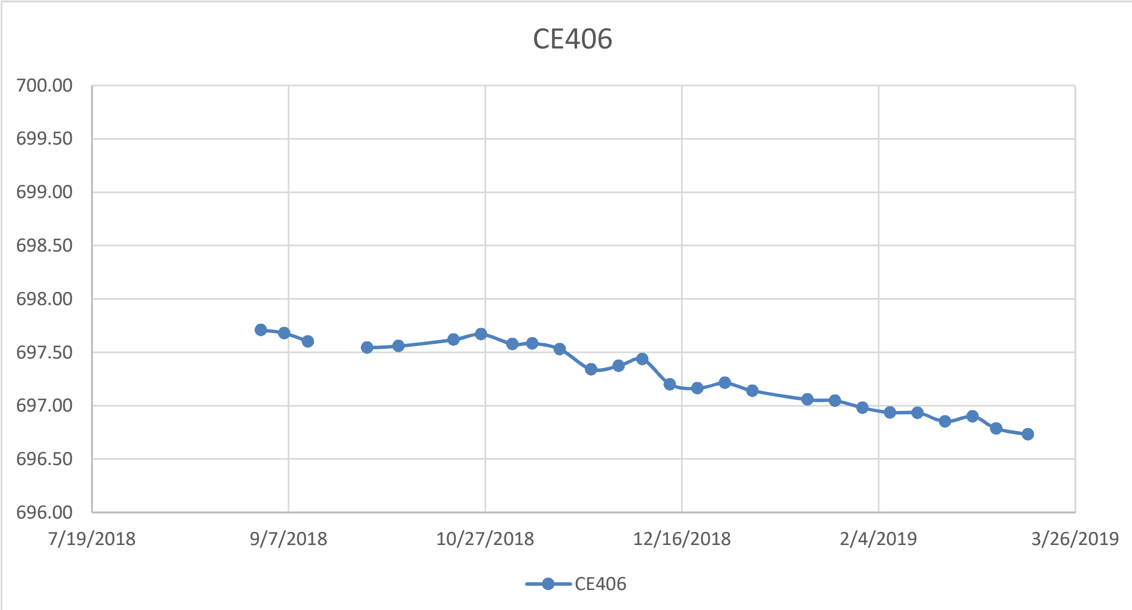
			-	-	-
			-	-	-
			-	-	-
			-	-	-

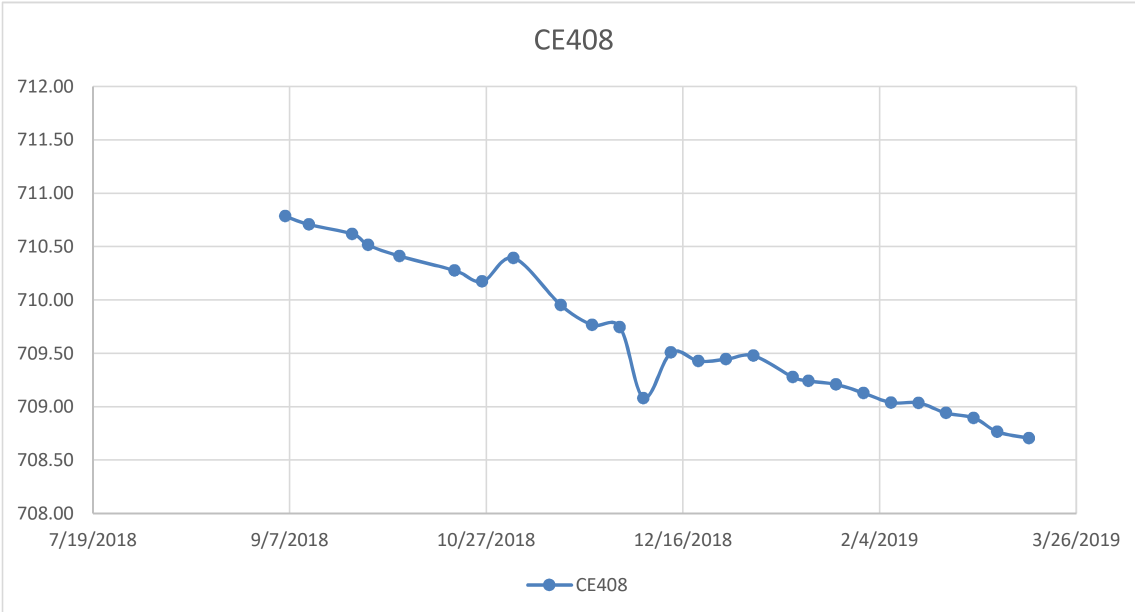

CE406
700.00
699.50
699.00
698.50
698.00
697.50
697.00
696.50
696.00
7/19/2018
9/7/2018
10/27/2018
12/16/2018
2/4/2019
3/26/2019
CE406

Drill Hole ID CE408

Serial Number 25012

MEASUREMENTS (Fill Reading Date, VWP Serial Number, F1 and T1)

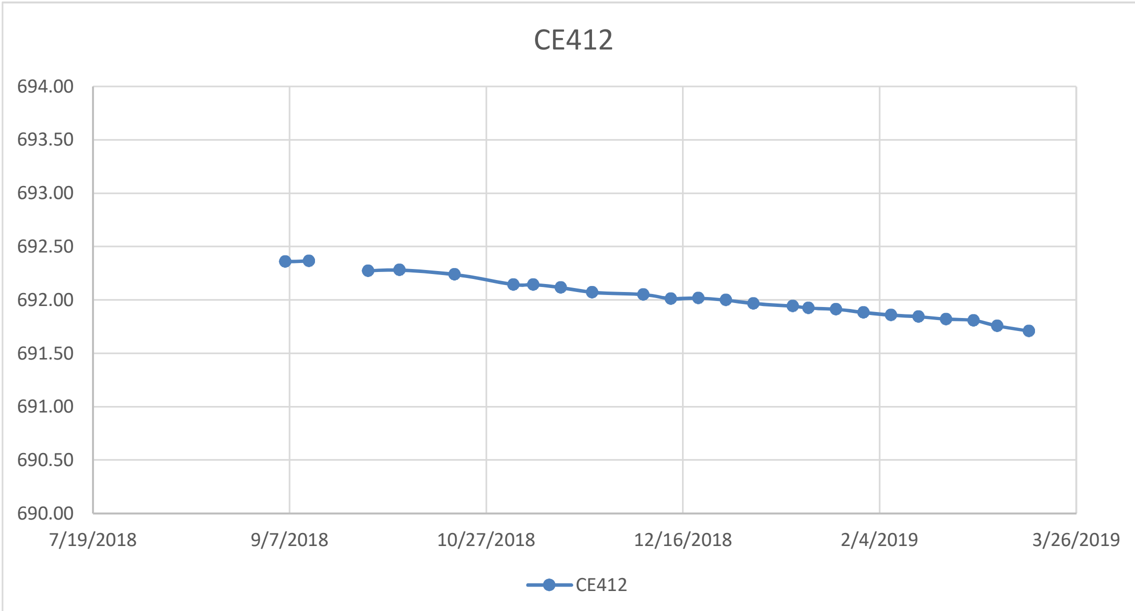
Reading Date	F_1 (Hz^2 10-3)	T_1 (deg celcius)	Pressure (kPa)	Head (m)	Water Level (RL)
9/6/2018	7489.9	16.8	234.79	23.93	710.78
9/12/2018	7494.2	16.9	234.03	23.86	710.71
9/23/2018	7499.1	16.9	233.16	23.77	710.62
9/27/2018	7504.8	16.9	232.15	23.66	710.51
10/5/2018	7510.6	16.8	231.13	23.56	710.41
10/19/2018	7518.1	16.8	229.80	23.43	710.28
10/26/2018	7523.8	16.8	228.79	23.32	710.17
11/3/2018	7511.6	16.8	230.95	23.54	710.39
11/15/2018	7536.1	16.8	226.61	23.10	709.95
11/23/2018	7546.3	16.9	224.80	22.92	709.77
11/30/2018	7547.5	16.8	224.59	22.89	709.74
12/6/2018	7584.3	16.9	218.07	22.23	709.08
12/13/2018	7560.6	16.9	222.27	22.66	709.51
12/20/2018	7565.1	16.8	221.48	22.58	709.43
12/27/2018	7564.1	16.9	221.65	22.59	709.44
1/3/2019	7562.3	16.9	221.96	22.63	709.48
1/13/2019	7573.5	16.8	219.99	22.42	709.27
1/17/2019	7575.4	16.9	219.64	22.39	709.24
1/24/2019	7577.2	16.9	219.33	22.36	709.21
1/31/2019	7581.7	16.9	218.53	22.28	709.13
2/7/2019	7586.6	16.9	217.66	22.19	709.04
2/14/2019	7586.8	16.8	217.63	22.18	709.03
2/21/2019	7592.1	16.8	216.69	22.09	708.94
2/28/2019	7594.6	16.8	216.25	22.04	708.89
3/6/2019	7601.8	16.8	214.98	21.91	708.76
3/14/2019	7605.1	16.8	214.39	21.85	708.70


CE408
712.00
711.50
711.00
710.50
710.00
709.50
709.00
708.50
708.00
7/19/2018
9/7/2018
10/27/2018
12/16/2018
2/4/2019
3/26/2019
CE408

Drill Hole ID CE412
Serial Number 25010

MEASUREMENTS (Fill Reading Date, VWP Serial Number, F1 and T1)

Reading Date	F_1 (Hz^2 10-3)	T_1 (deg celcius)	Pressure (kPa)	Head (m)	Water Level (RL)
9/6/2018	8037.7	16.9	164.01	16.72	692.36
9/12/2018	8037.4	16.9	164.06	16.72	692.36
9/23/2018	8309.3	16.9	117.65	11.99	
9/27/2018	8042.7	16.9	163.16	16.63	692.27
10/5/2018	8042.3	16.8	163.23	16.64	692.28
10/19/2018	8044.7	16.8	162.82	16.60	692.24
11/3/2018	8050.1	16.8	161.90	16.50	692.14
11/8/2018	8050.2	16.8	161.88	16.50	692.14
11/15/2018	8051.7	16.8	161.63	16.48	692.12
11/23/2018	8054.3	16.8	161.19	16.43	692.07
12/6/2018	8055.5	16.8	160.98	16.41	692.05
12/13/2018	8057.7	16.8	160.60	16.37	692.01
12/20/2018	8057.4	16.8	160.66	16.38	692.02
12/27/2018	8058.5	16.8	160.47	16.36	692.00
1/3/2019	8060.3	16.8	160.16	16.33	691.97
1/13/2019	8061.7	16.9	159.91	16.30	691.94
1/17/2019	8062.7	16.9	159.74	16.28	691.92
1/24/2019	8063.4	16.9	159.62	16.27	691.91
1/31/2019	8065.1	16.8	159.34	16.24	691.88
2/7/2019	8066.6	16.7	159.09	16.22	691.86
2/14/2019	8067.4	16.8	158.95	16.20	691.84
2/21/2019	8068.7	16.8	158.73	16.18	691.82
2/28/2019	8069.4	16.8	158.61	16.17	691.81
3/6/2019	8072.4	16.8	158.10	16.12	691.76
3/14/2019	8075.1	16.8	157.63	16.07	691.71


CE412
694.00
693.50
693.00
692.50
692.00
691.50
691.00
690.50
690.00
7/19/2018
9/7/2018
10/27/2018
12/16/2018
2/4/2019
3/26/2019
CE412

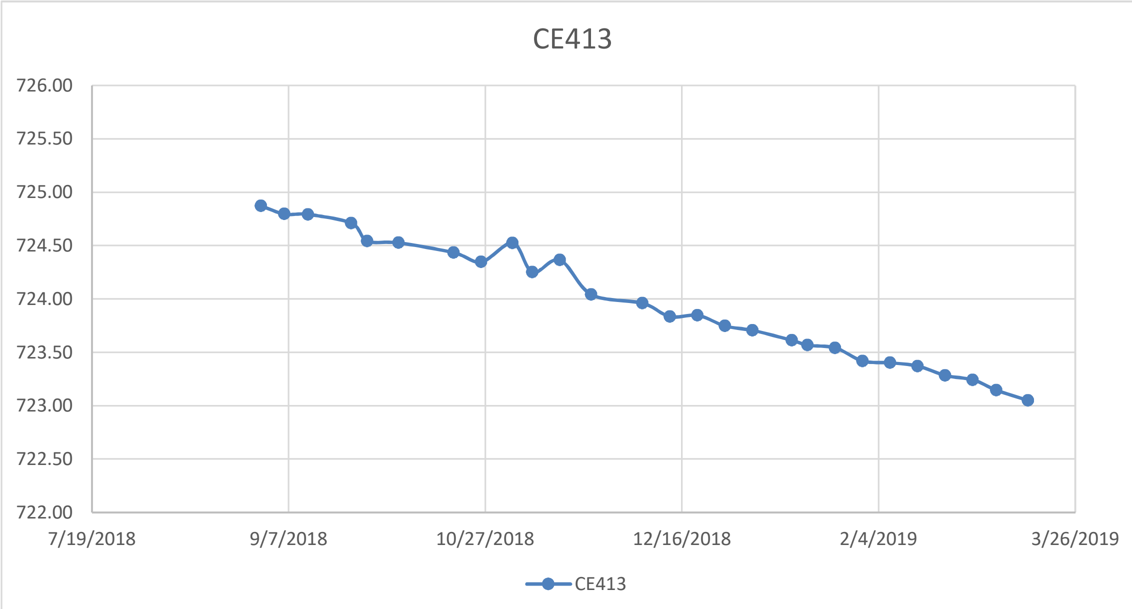
HATCH

Drill Hole ID CE413

Serial Number 25011

MEASUREMENTS (Fill Reading Date, VWP Serial Number, F1 and T1)

Reading Date	F_1 (Hz^2 10-3)	T_1 (deg celcius)	Pressure (kPa)	Head (m)	Water Level (RL)
8/31/2018	6623.8	16.9	376.44	38.37	724.87
9/6/2018	6628.2	17.1	375.68	38.30	724.80
9/12/2018	6628.4	17.0	375.64	38.29	724.79
9/23/2018	6633.1	17.1	374.83	38.21	724.71
9/27/2018	6642.5	17.1	373.20	38.04	724.54
10/5/2018	6643.5	17.0	373.03	38.03	724.53
10/19/2018	6648.7	17.0	372.13	37.93	724.43
10/26/2018	6653.6	17.0	371.28	37.85	724.35
11/3/2018	6643.6	17.0	373.01	38.02	724.52
11/8/2018	6659.1	17.0	370.33	37.75	724.25
11/15/2018	6652.6	17.0	371.45	37.86	724.36
11/23/2018	6671.0	17.1	368.27	37.54	724.04
12/6/2018	6675.6	17.0	367.48	37.46	723.96
12/13/2018	6682.7	17.0	366.25	37.33	723.83
12/20/2018	6682.0	17.0	366.37	37.35	723.85
12/27/2018	6687.7	17.0	365.38	37.25	723.75
1/3/2019	6690.0	17.0	364.98	37.21	723.71
1/13/2019	6695.3	17.0	364.07	37.11	723.61
1/17/2019	6697.9	17.0	363.62	37.07	723.57
1/24/2019	6699.3	17.0	363.38	37.04	723.54
1/31/2019	6706.3	17.0	362.16	36.92	723.42
2/7/2019	6707.2	17.0	362.01	36.90	723.40
2/14/2019	6709.0	17.0	361.70	36.87	723.37
2/21/2019	6714.0	17.0	360.83	36.78	723.28
2/28/2019	6716.3	17.1	360.43	36.74	723.24
3/6/2019	6721.8	17.0	359.48	36.64	723.14
3/14/2019	6727.3	17.0	358.53	36.55	723.05

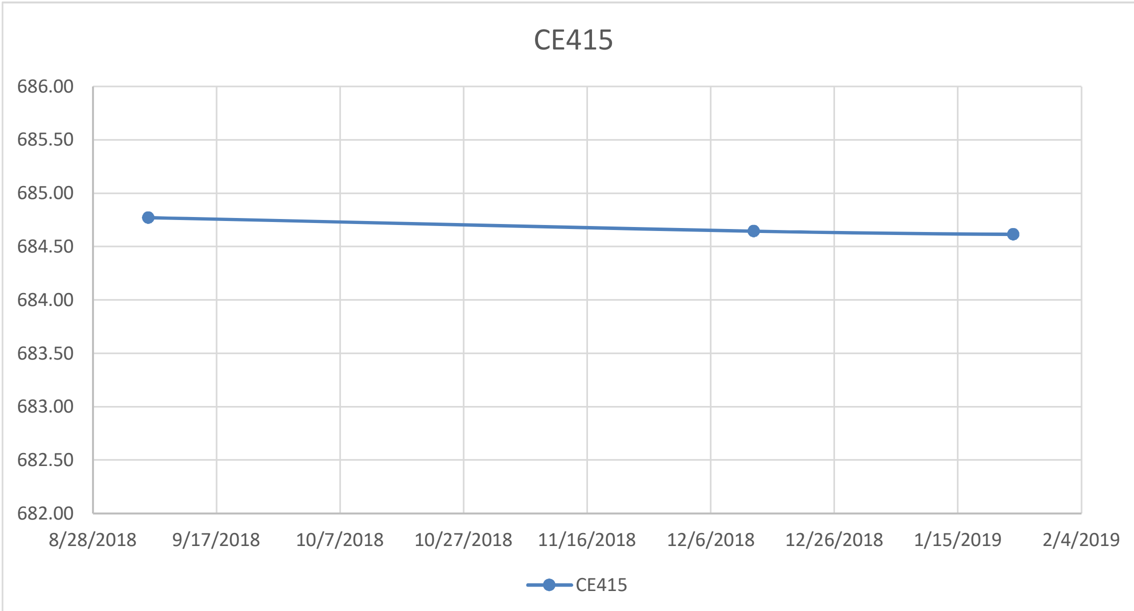

CE413
726.00
725.50
725.00
724.50
724.00
723.50
723.00
722.50
722.00
7/19/2018
9/7/2018
10/27/2018
12/16/2018
2/4/2019
3/26/2019
CE413

Drill Hole ID CE415

Serial Number 316-280

MEASUREMENTS (Fill Reading Date, VWP Serial Number, F1 and T1)

Reading Date	F_1 (Hz^2 10-3)	T_1 (deg celcius)	Pressure (kPa)	Head (m)	Water Level (RL)
9/6/2018	7254.7	16.2	231.62	23.61	684.77
12/13/2018	7264.9	16.2	230.38	23.48	684.64
1/24/2019	7267.4	16.1	230.08	23.45	684.61


CE415
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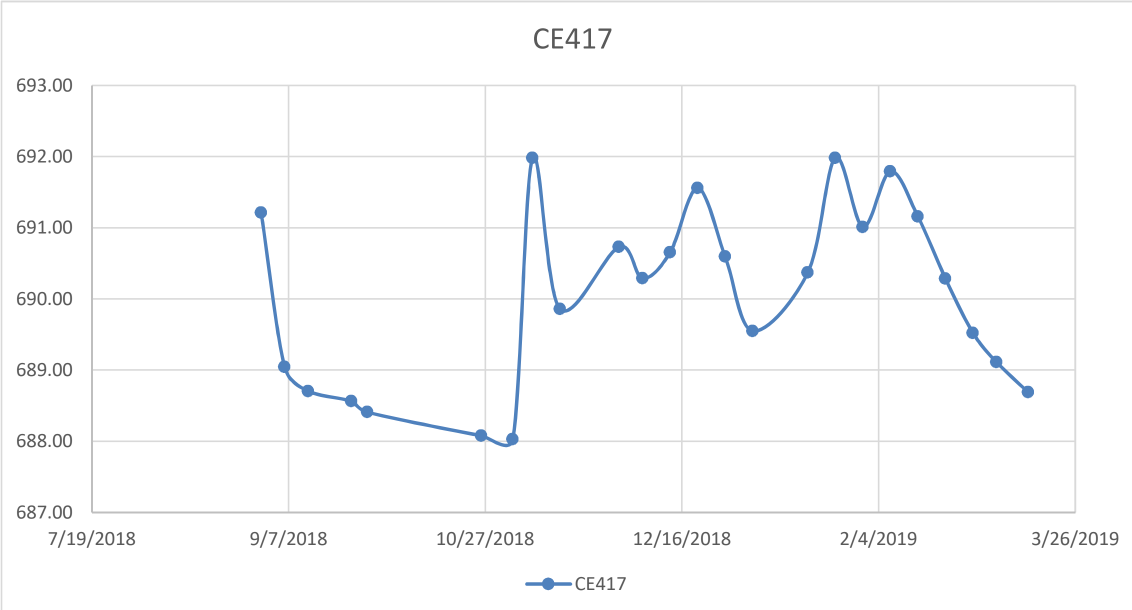
8/28/2018
9/17/2018
10/7/2018
10/27/2018
11/16/2018
12/6/2018
12/26/2018
1/15/2019
2/4/2019
CE415

Drill Hole ID CE417
Serial Number 316-518

MEASUREMENTS (Fill Reading Date, VWP Serial Number, F1 and T1)

Reading Date	F_1 (Hz^2 10-3)	T_1 (deg celcius)	Pressure (kPa)	Head (m)	Water Level (RL)
8/31/2018	8648.7	14.9	25.65	2.61	691.21
9/6/2018	8822.2	16.0	4.36	0.44	689.04
9/12/2018	8849.6	15.5	1.03	0.10	688.70
9/23/2018	8867.2	0.0	-0.36	-0.04	688.56
9/27/2018	8873.5	15.1	-1.88	-0.19	688.41
10/26/2018	8900.2	14.6	-5.12	-0.52	688.08
11/3/2018	8904.1	14.5	-5.59	-0.57	688.03
11/8/2018	8587.7	14.0	33.16	3.38	691.98
11/15/2018	8757.6	14.6	12.33	1.26	689.86
11/30/2018	8687.6	14.2	20.92	2.13	690.73
12/6/2018	8723.1	14.3	16.57	1.69	690.29
12/13/2018	8694.1	13.8	20.15	2.05	690.65
12/20/2018	8621.4	13.9	29.04	2.96	691.56
12/27/2018	8698.7	14.1	19.57	1.99	690.59
1/3/2019	8782.4	14.4	9.31	0.95	689.55
1/17/2019	8716.5	14.1	17.39	1.77	690.37
1/24/2019	8587.4	14.0	33.20	3.38	691.98
1/31/2019	8665.3	14.1	23.66	2.41	691.01
2/7/2019	8602.6	14.1	31.33	3.19	691.79
2/14/2019	8653.5	14.2	25.10	2.56	691.16
2/21/2019	8723.3	14.3	16.55	1.69	690.29
2/28/2019	8784.6	14.4	9.04	0.92	689.52
3/6/2019	8817.4	14.5	5.02	0.51	689.11
3/14/2019	8851.4	14.3	0.87	0.09	688.69


CE417
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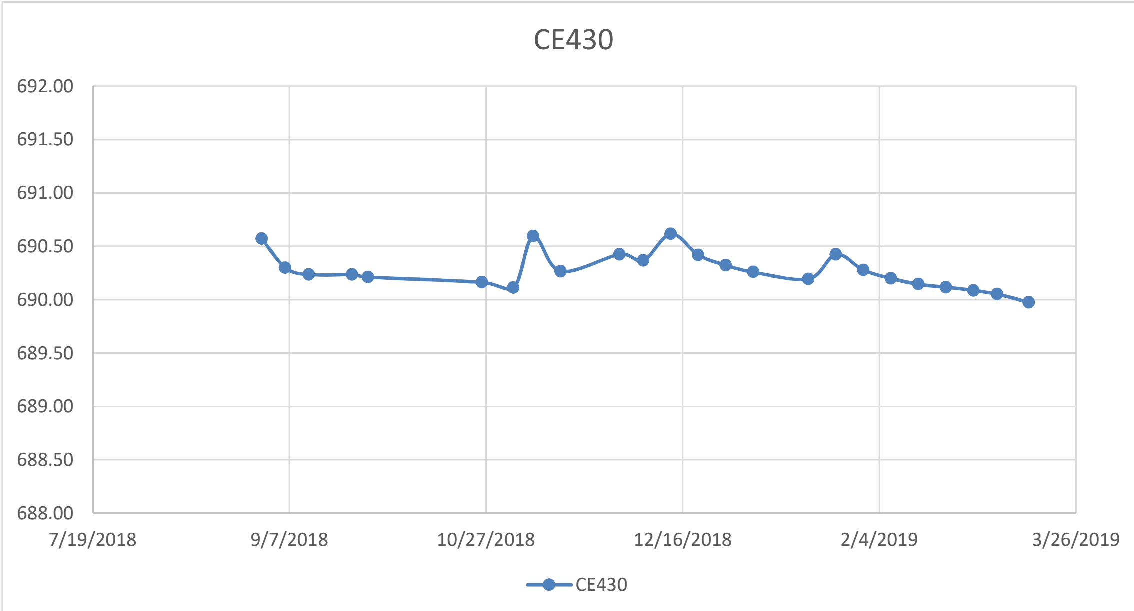
7/19/2018
9/7/2018
10/27/2018
12/16/2018
2/4/2019
3/26/2019
CE417

Drill Hole ID CE430

Serial Number 316-283

MEASUREMENTS (Fill Reading Date, VWP Serial Number, F1 and T1)

Reading Date	F_1 (Hz^2 10-3)	T_1 (deg celcius)	Pressure (kPa)	Head (m)	Water Level (RL)
8/31/2018	8177.7	13.6	102.08	10.41	690.57
9/6/2018	8199.3	13.9	99.41	10.13	690.30
9/12/2018	8204.6	13.6	98.80	10.07	690.24
9/23/2018	8204.8	13.5	98.78	10.07	690.23
9/27/2018	8206.5	13.6	98.56	10.05	690.21
10/26/2018	8210.5	13.6	98.08	10.00	690.16
11/3/2018	8214.6	13.6	97.58	9.95	690.11
11/8/2018	8175.6	13.8	102.31	10.43	690.59
11/15/2018	8202.0	13.8	99.09	10.10	690.27
11/30/2018	8189.4	13.6	100.65	10.26	690.42
12/6/2018	8194.1	13.6	100.08	10.20	690.37
12/13/2018	8173.1	14.5	102.53	10.45	690.62
12/20/2018	8190.0	13.5	100.59	10.25	690.42
12/27/2018	8197.6	13.6	99.65	10.16	690.32
1/3/2019	8202.7	13.7	99.02	10.09	690.26
1/17/2019	8207.7	13.8	98.39	10.03	690.20
1/24/2019	8189.5	13.6	100.64	10.26	690.42
1/31/2019	8201.7	13.2	99.20	10.11	690.28
2/7/2019	8207.4	13.8	98.43	10.03	690.20
2/14/2019	8212.4	13.1	97.90	9.98	690.14
2/21/2019	8214.0	13.8	97.63	9.95	690.12
2/28/2019	8216.4	13.8	97.33	9.92	690.09
3/6/2019	8219.2	13.8	96.99	9.89	690.05
3/14/2019	8221.1	18.4	96.22	9.81	689.97


CE430
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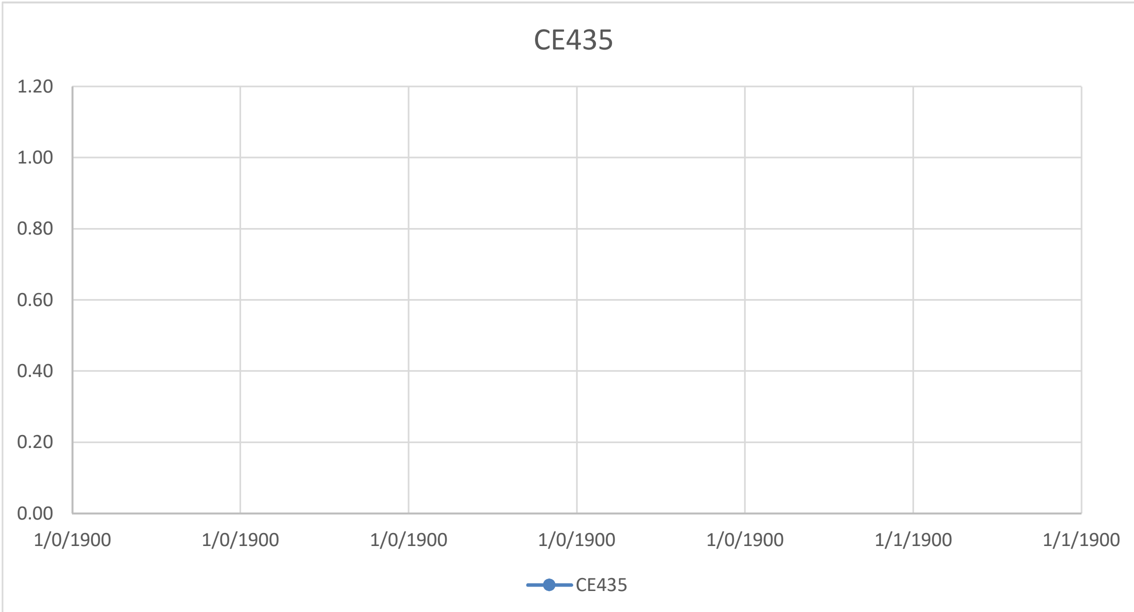
688.00
7/19/2018
9/7/2018
10/27/2018
12/16/2018
2/4/2019
3/26/2019
CE430

Drill Hole ID	CE435
Serial Number	316-282

MEASUREMENTS (Fill Reading Date, VWP Serial Number, F1 and T1)

Reading Date	F_1 (Hz^2 10-3)	T_1 (deg celcius)	Pressure (kPa)	Head (m)	Water Level (RL)


CE435
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0.80
0.60
0.40
0.20
0.00
1/0/1900
1/0/1900
1/0/1900
1/0/1900
1/0/1900
1/1/1900
1/1/1900
CE435

Annexure CM
ITRB PSD & Index Testing Summary

HOLE No.	DEPTH RANGE (m)		GRADATION (% passing)											ATTERBERG LIMITS			Linear Shrinkage %	Field MC (%)	Dry Density (t/m^3)	Specific Gravity
			GRAVEL			SAND						Fines								
			19.0	9.50	4.75	2.36	1.18	600	425	300	150	75	2	LL	PL	PI				
	From	To	mm	mm	mm	mm	mm	µm	µm	µm	µm	µm	µm							
CE406	18.40	18.50				100	98	95	94	92	89	86		71	24	47	19.0	27.5		
CE406	19.65	19.95			100	94	88	80	75	70	60	52		33	23	10	6.0	22.3	1.54	
CE406	22.20	22.30		100	98	95	91	86	83	80	74	68	32	40	20	20	8.0	13.6	1.80	2.82
CE406	23.80	23.90																19.8	1.75	
CE407	50.00	50.50												54	19	35	15.5	23.1	1.73	
CE407	51.00	51.50			100	99	99	97	96	96	95	93	43	51	19	32	15.0	22.2	1.77	2.57
CE411A	12.50	12.95	93	85	78	72	64	52	47	42	34	30	14	53	27	26	12.0	25.8	1.52	2.87
CE411A	14.50	15.00			99	99	99	97	95	94	90	83	32	53	25	28	12.0	25.7	1.64	2.70
CE411A	15.00	15.35												54	27	27	11.5	28.4	1.58	
CE411A	3.00	3.45	90	87	82	80	77	75	74	74	72	71	38	59	21	38	15.0	30.3	1.52	2.79
CE411A	16.00	16.50				100	99	98	97	94	89	82	37	61	31	30	12.5	37.7	1.28	2.58
CE411A	16.50	16.95		100	96	90	85	78	75	70	60	51	11	53	31	22	12.5	37.4	1.46	2.83
CE412	60.70	60.80			100	99	95	87	82	77	69	62		34	16	18	7.0	11.7		
CE412	39.50	39.72				100	97	86	79	73	62	54	12	81	37	44	17.5	48.5		2.55
CE412	62.15	62.20												47	22	25	12.5	23.3		
CE412	65.50	66.00					100	96	90	85	71	59	14	50	23	27	11.5	25.5	1.5	2.64
CE413	53.50	53.80				100	99	96	95	93	90	87		39	15	24	12.5	20.1		
CE415	4.12	4.30			100	99	97	92	90	87	80	76		52	33	19	8.5	38.4		
CE415	6.00	6.50					100	98	98	97	95	93	47	56	31	25	9.0	43.8	1.28	2.89
CE415	20.20	20.40			100	97	89	76	69	62	47	37		39	25	14	6.5	17.3		
CE416	21.85	21.90				100	99	99	99	98	97	96		87	27	60	22.0	34.1		
CE416	23.00	23.50					100	98	96	94	86	81	39	59	28	31	12.0	27.7	1.59	2.77
CE416	24.00	24.33				100	99	98	98	98	97	96	70	63	26	37	11.5	25.6		2.85
CE416	24.50	25.00						100	99	98	96	94	61	73	33	40	13.0	34	1.4	2.66
CE416	25.00	25.50				100	99	98	97	94	89	82	37	67	32	35	14.0	39.3	1.41	2.72
CE416	25.50	25.95					100	96	94	90	83	76	23	60	29	31	11.0	38.7	1.33	2.66
CE416	26.50	27.00					100	99	99	99	97	96	36	64	30	34	14.5	38.4	1.41	2.62
CE416	27.00	27.45								100	99	98	49	67	25	41	13.0	37.9	1.36	2.9
CE417	16.50	16.86			100	98	94	94	93	93	92	90	40	61	24	36	12.5	27.4	1.59	2.74
CE417	18.50	19.00					100	98	96	95	93	90	35	80	32	48	19.0	42.3	1.31	2.49
CE417	19.50	20.00												58	22	36	13.0	34.9	1.46	
CE417	20.80	20.85					100	99	99	98	94	90		48	19	29	13.0	26.3		
CE417	24.00	24.30				99	97	92	89	86	78	67	23	55	28	27	10.5	42.8	1.29	2.85
CE417	25.90	26.00					100	95	90	83	70	60		54	30	24	9.0	36		
CE431	23.50	24.00	100	96	93	90	89	86	84	80	74	68	15	45	30	15		31.8		
CE431	24.00	24.50	100	93	92	89	87	85	82	79	74	69	16	44	27	17		26.3		
CE432	19.50	20.30		100	99	98	91	82	78	74	65	57		40	27	13	8.0	24.2	1.61	
CE432	20.30	20.80			100	97	92	85	81	77	68	59		40	24	16	6.5	28.2		
CE432	23.50	24.00																26.4	1.58	2.7
CE433	33.20	33.80												26	17	9	6.0	28.2		
PL01	0.00	0.50				100	95	87	82	76	65	55	22	51	25	26	13.5	33.5	1.38	2.78
TP401	0.70	1.00		100	98	96	94	92	91	91	89	87	48	53	20	33	14.5	21.7	1.76	2.8
TP405	1.90	2.20					100	99	99	98	95	93	39	48	26	22	12.0	28.6	1.58	2.75