PACE Copper Coompana Drilling Project

Drillhole CDP002
preliminary field-data report

Rian Dutch, Liz Jagodzinski, Tom Wise,
Mark Pawley, Luke Tylkowski,
Amy Lockheed, Sarlae McAlpine
and Philip Heath

Report Book 2017/00038

PACE Copper

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SOUTH AUSTRALIA

Government of South Australia
Department of the Premier and Cabinet

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Geological Survey of South Australia
Resources and Energy Group
Department of the Premier and Cabinet

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Rian Dutch, Liz Jagodzinski, Tom Wise, Mark Pawley, Luke Tylkowski, Amy Lockheed, Sarlae McAlpine and Philip Heath

ABSTRACT

The Geological Survey of South Australia, in partnership with Geoscience Australia, is undertaking a regional pre-competitive geoscience research drilling program in the far west of South Australia called the Coompana Drilling Project. The Coompana Province, located between the western Gawler Craton to the east, the Musgrave Province to the north and the Madura Province to the west, is one of the least understood and explored geological provinces remaining on the Australian Continent. The region is completely covered by Neoproterozoic to Cenozoic sediments and there are no known basement exposures. Up to 18 new drillholes were planned as part of this project to intersect as many of the different geophysical domains as possible, as delineated from the recently acquired Coompana Magnetic survey and Coompana Gravity survey.

The primary objective of the Coompana Drilling Project is to obtain high quality drill core samples from the untested basement units beneath the Nullarbor Plain. The outcome of the Coompana Drilling Project will be to provide our stakeholders with new pre-competitive data and a geological framework that more clearly defines the geology and prospectivity in this region. This report provides the first release of the preliminary data collected on-site during the drilling of drillhole CDP002. This compilation includes well completion information, location and site access data, results of pre-drilling cover geophysics and depth estimates as well as the field geological logs and acquired down-hole geophysical data.

INTRODUCTION

PROJECT BACKGROUND

The Geological Survey of South Australia (GSSA), part of the Department of the Premier and Cabinet, in partnership with Geoscience Australia (GA) is undertaking a regional pre-competitive geoscience research drilling program in the far west of South Australia: The Coompana Drilling Project.

The GSSA and GA are committed to driving scientific understanding and discovery beneath post-mineralisation cover in South Australia through pre-competitive data capture and knowledge value-add. These goals are aligned with the objectives set out in the National Mineral Exploration Strategy and the UNCOVER Initiative.

The Coompana Drilling project forms a major part of, and is funded through, the Far West Discovery Program component of the South Australian Governments $20M *PACE* Copper initiative. Additional funding for the project comes from Geoscience Australia and the Australian Federal Governments Exploring for the Future initiative.

The Coompana Drilling Project is the next phase in a staged pre-competitive geoscience data acquisition program for the far west of South Australia which includes:

- The deep crustal seismic profile 13GA-EG1 (Eucla-Gawler seismic line). A collaborative project between the GSSA, GA, The Geological Survey of Western Australia and AuSCOPE.
- The Coompana airborne magnetic and radiometric survey. Currently the largest single survey in South Australia acquired by GA on behalf of the GSSA and funded through the *PACE* Frontiers initiative.
- The Coompana Gravity Survey. A regional 2, 1 and 0.5 km gravity survey to be acquired as part of the Far West Discovery Program component of the South Australian Governments *PACE* Copper initiative.

All data and reports associated with the Coompana Drilling Project and associated geophysical acquisitions is available from the GSSA Coompana Project website (http://minerals.dpc.sa.gov.au/geoscience/geological_survey/gssa_projects/far_west) and the South Australian Resources Information Gateway (https://map.sarig.sa.gov.au/).

PROJECT OVERVIEW

The Coompana Province is one of the least understood geological provinces remaining on the Australian Continent. The region is completely covered by Neoproterozoic to Cenozoic sediments and there are no known basement exposures. Limited previous exploration in the province resulted in 16 existing drillholes that intersect basement, only 8 of which are diamond holes (Fig. 1; Table 1). Because of these factors the geology and mineral prospectivity of the region is largely unknown.

Geographically, the Coompana Province is located under the Nullarbor Plain, across the SA/WA border. Geologically, the Coompana Province is situated at the nexus between the West, South and Northern Australian Cratons (Fig. 2), and may record the final amalgamation of the proto-Australian Continent during the Mesoproterozoic.

Due to the absence of basement outcrop, the newly acquired Coompana airborne magnetic survey (Fig. 3a) and Coompana gravity survey (Fig. 3b) have been used to sub-divide the Coompana Province into a series of domains with distinct geophysical characteristics (Fig. 4; See Wise, et al. (2015) for preliminary domain definitions based on the Coompana magnetic survey). These are interpreted to represent regions with distinct lithologies and geological histories. The aeromagnetic domains are consistent with the crustal blocks recognised in the 13GA-EG1 deep crustal seismic profile (Dutch, et al., 2016b). The SA Coompana Province also hosts a number of intriguing geophysical anomalies including the enigmatic Coompana Magnetic Anomaly (Fig. 3a; Wise, et al., 2015). This ~50 km wide deep seated remanently magnetised anomaly is associated with a low density signature (Fig. 3b). The cause and significance of this anomaly is currently unknown.

Drillhole locations (Fig. 4) have been planned to intercept as many of the different geophysical domains as possible. These domains include the moderate magnetic intensity, low density domains with a defined NNE trending fabric (Domain 1; Fig. 4) which likely represent the oldest protoliths in the region. Domain 2 is characterised by a variable, mottled magnetic signature with both high and low densities which may represent reworked basement by subsequent granitic intrusions (Fig. 4). Domain 3 includes the prominent NE trending line of magnetic intrusions that bisects the province (Fig. 4). Finally, there is the main remanently magnetised Coompana Magnetic Anomaly itself and a number of possibly associated smaller satellite intrusions located coincident and adjacent to the main magnetic anomaly, but which are associated with density highs.

Approximately 18 new drillholes were planned as part of this project to intersect the above domains and other structures seen in the geophysical data (Fig. 4). The drillholes are located in the far south-west of South Australia: south of the Trans-Australia Railway, east of the SA/WA border, west of a line ~130.00°E and north of the Eyre Highway (Fig. 5).

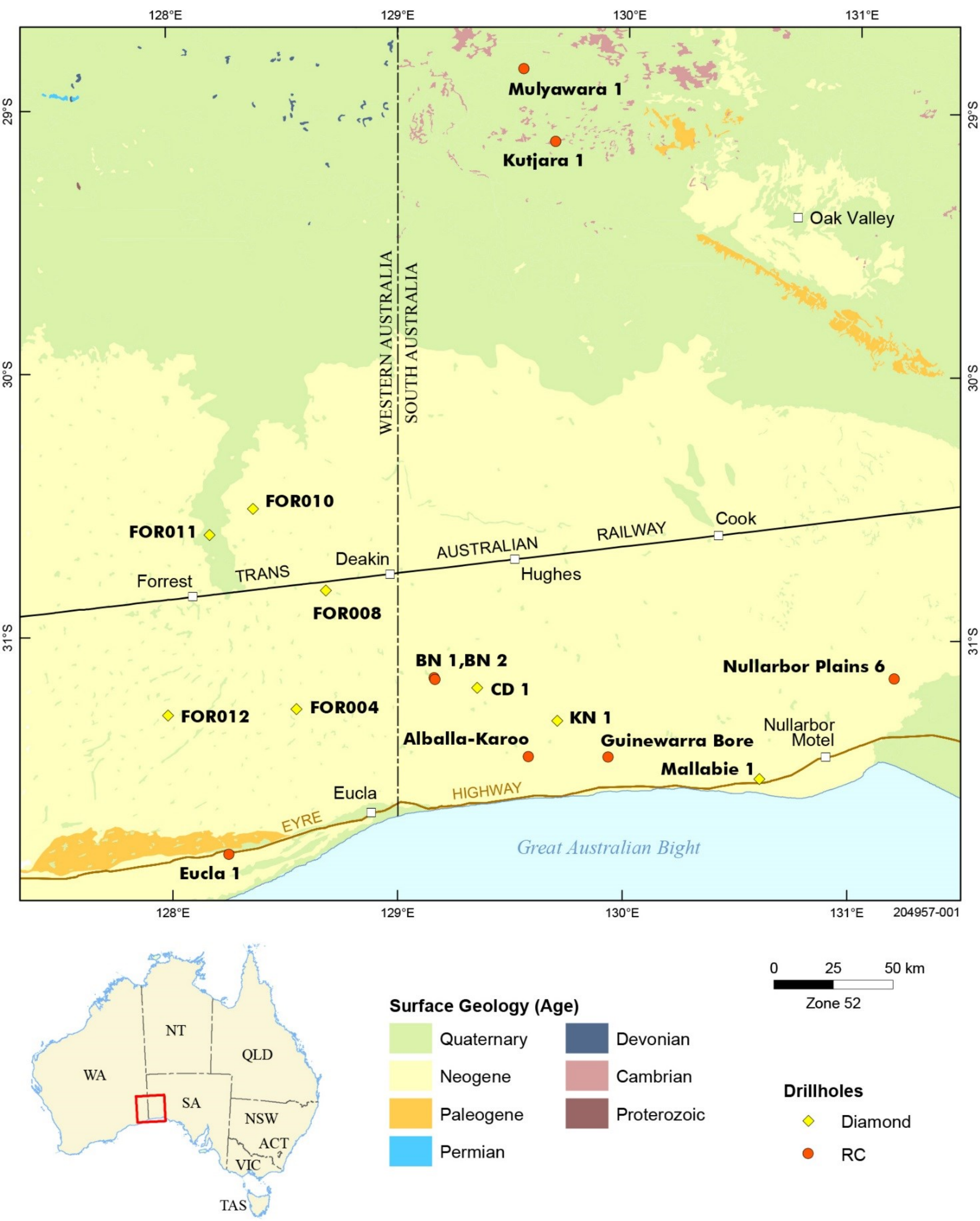

Figure 1. Location of the Coompana Province with existing drillhole locations on 2 million scale surface geology.

Table 1. Summary of basement-intersecting drillholes in the Coompana Province

Drillhole	Geology	Unit	Magmatic age (Ma)	Metamorphic age (Ma)	Geochron reference	Drillhole reference
Guinewarra Bore	Granitic basement					
Alballa-Karoo	Granitic basement					
Nullarbor Plains 6	Granitic basement					
FOR004	Granitic basement	Toolgana Supersuite	1613 ± 4; 1611 ± 7	1179 ± 10	1	2
FOR008	Granitic basement	Toolgana Supersuite	1613 ± 13; 1604 ± 6	1150 ± 10	1	2
Kutjara 1	Granitic basement	Toolgana Supersuite	1591 ± 11	1167 ± 7	3	4
Mallabie 1	Granitic basement	Undawidgi Supersuite	1505 ± 7		5	6
FOR012	Granitic basement	Undawidgi Supersuite	1499 ± 9		1	2
FOR011	Granitic basement	Undawidgi Supersuite	1488 ± 4	1174 ± 12	1	2
FOR010	Granitic basement	Undawidgi Supersuite	1487 ± 9		1	2
Mulyawara 1	Granitic basement	Moodini Supersuite	1168 ± 6		3	7
Eucla 1	Granitic basement	Moodini Supersuite	1140 ± 8		1	2
CD 1	Mafic volcanics and intrusives	Neoproterozoic volcanics	859 ± 66		8	9
BN 2	Mafic volcanics and intrusives	Neoproterozoic volcanics				10
BN 1	Mafic volcanics and intrusives	Neoproterozoic volcanics				10
KN 1	Mafic volcanics and intrusives	Neoproterozoic volcanics				11

References: 1. Wingate, et al. (2015); 2. Spaggiari and Smithies (2015); 3. Neumann and Korsch (2014); 4. Baily, et al. (2012a); 5. Wade et al. (2007); 6. Outback Oil Company NL (1969); 7. Baily, et al. (2012b); 8. Travers (2015); 9. The Shell Co. of Australia Ltd (1983); 10. Carpentaria Exploration Co. Pty Ltd (1982a); 11. Carpentaria Exploration Co. Pty Ltd (1982b).

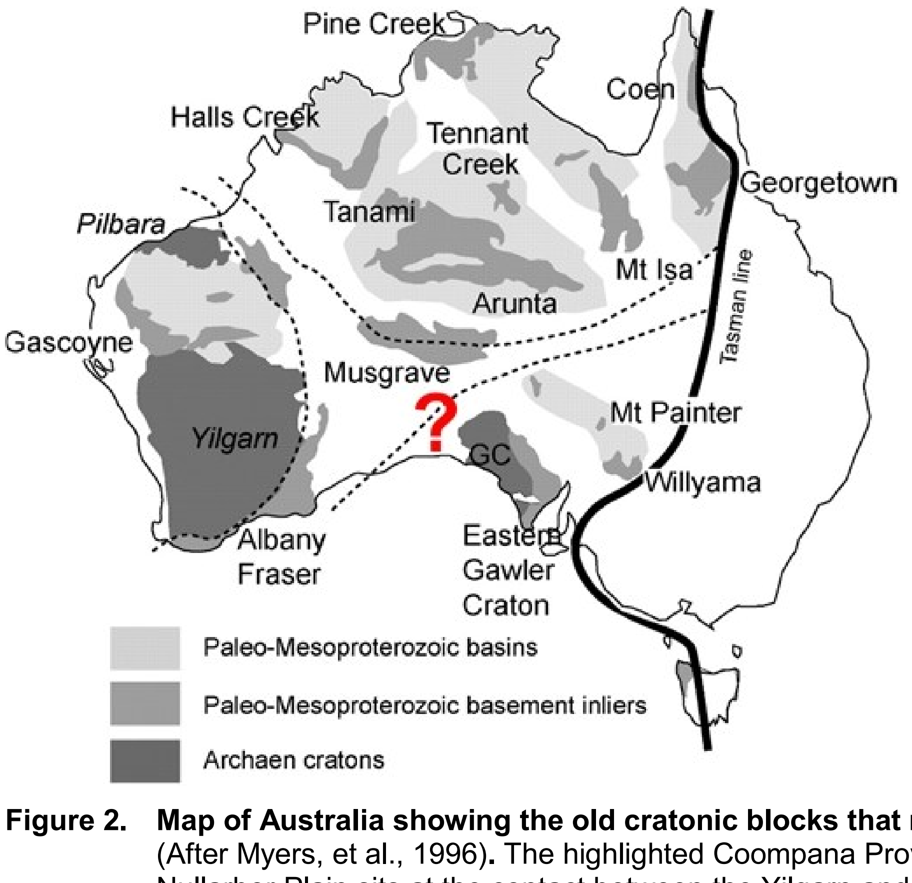

Figure 2. Map of Australia showing the old cratonic blocks that make up the continent (After Myers, et al., 1996)**.** The highlighted Coompana Province area beneath the Nullarbor Plain sits at the contact between the Yilgarn and Gawler (GC) cratons.

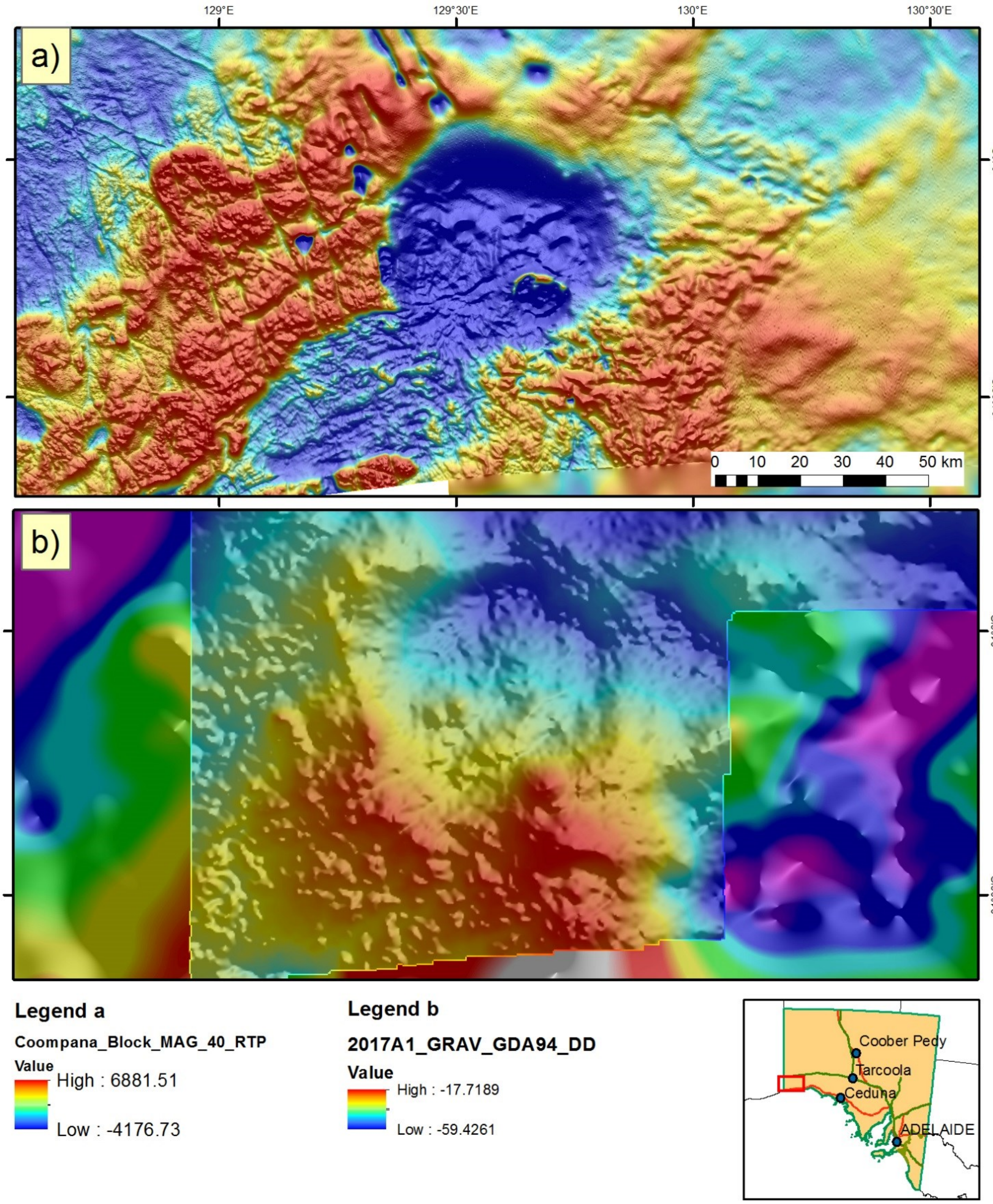

Figure 3. Newly acquired Coompana magnetic and gravity data. a) 200 m and 400 m line spaced Coompana RTP magnetic grid. **b)** 1 km and 0.5 km spaced Coompana gravity grid over regional onshore gravity data.

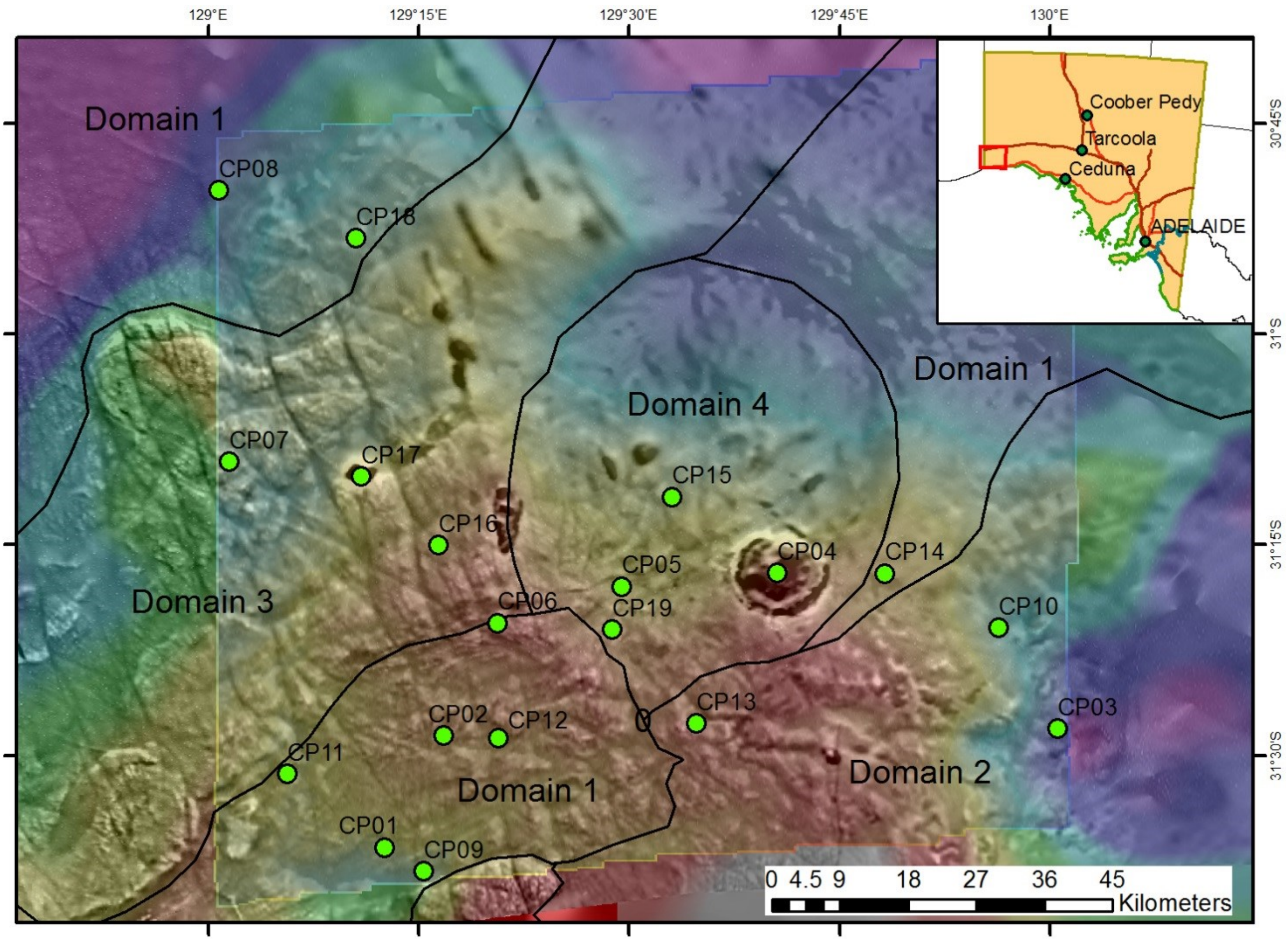

Figure 4. Coompana Province interpreted basement domains with planned drillhole locations. The image is a composite with Bouger gravity (colour) beneath grayscale 1VD total magnetic intensity (TMI). The interpreted domains are preliminary and based on both the TMI and gravity response and extend the preliminary domains proposed by Wise et al. (2015).

PROJECT OBJECTIVES

The primary objective of the Coompana Drilling Project is to address this lack of knowledge and test geophysically derived geological models by collecting high quality drill core samples from the untested basement units beneath the Nullarbor Plain. The outcome of the Coompana Drilling Project will be to provide our stakeholders with new pre-competitive data and a geological framework that more clearly defines the geology and prospectivity in this region.

The Project aims to:

- Undertake rigorous scientific analysis of the retrieved samples to improve our understanding of the stratigraphy and tectono-thermal history of the region, to generate a knowledge-framework to understand the geological significance and potential for different mineral systems in the buried basement rocks beneath the Nullarbor Plain.
- Provide new pre-competitive geological, geophysical and geochemical data in an under-explored greenfields area. This new data will be used to map cover thickness and character, identity possible distal footprints of buried mineralisation or mineralised terranes and estimate the depth to target source rocks which may have economic potential for various commodities.
- Be an exemplar for reducing exploration risk in challenging greenfields regions and provide generic work flows and understanding that will be applicable for exploration and discovery in the far west of South Australia, utilising a best practice approach to environmental protection and safety in this sensitive and logistically challenging area.

- Enhance each Project Parties organisational capabilities in drilling as a pre-competitive data product for research and industry through exposure to standard drilling technologies as well as innovative technologies where deemed appropriate.
- Allow use of the data by a broad range of State and Federal government agencies, researchers and private companies engaged in natural resources and water management.

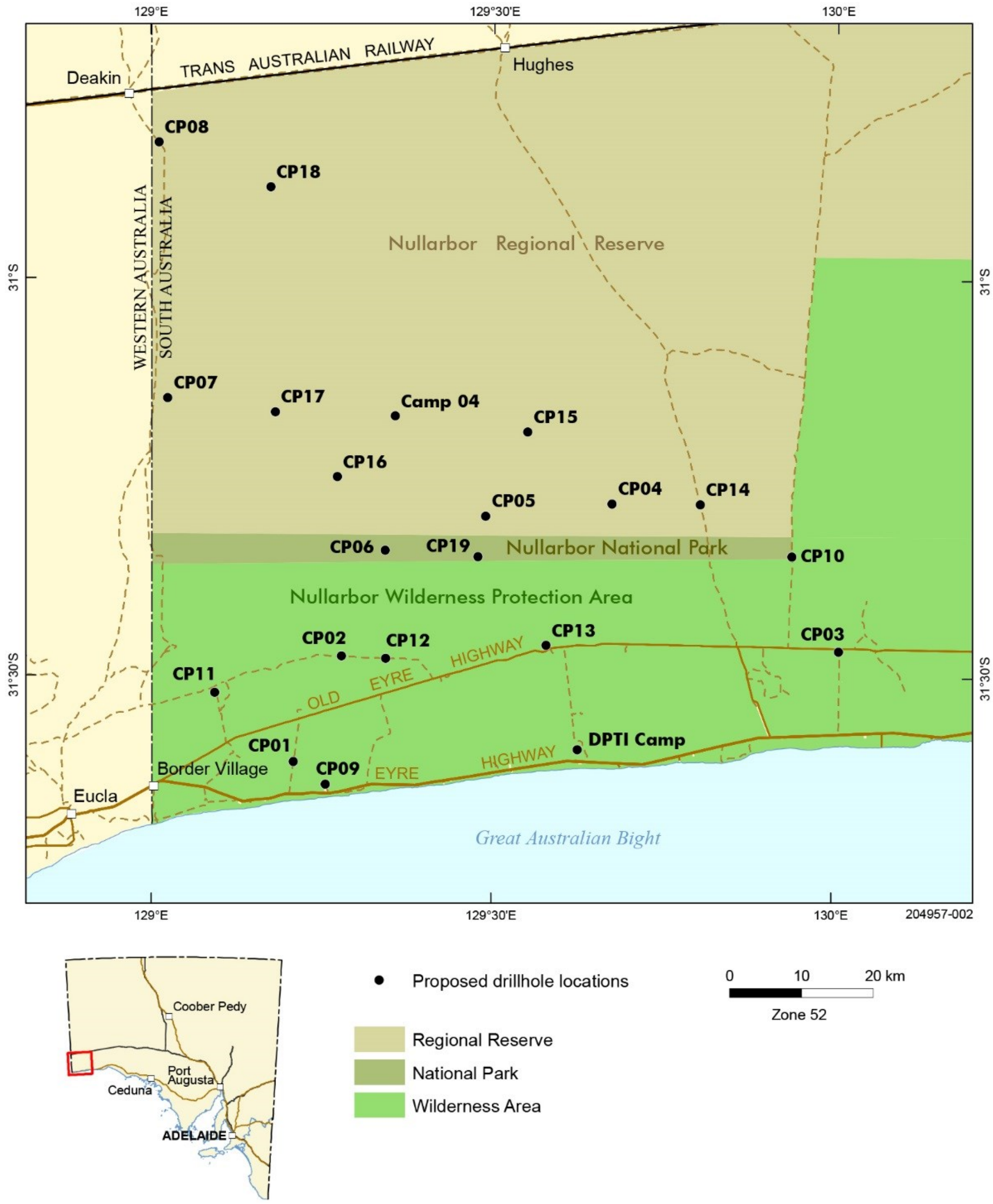

Figure 5. Topographic map of the Coompana area of interest showing proposed drillhole locations and different National Parks land tenure.

LAND TENURE, GEOGRAPHY AND ACCESS

The area of the planned Coompana Drilling project occupies three different land tenures (Fig. 5). Drill sites located south of a line -31.3°S fall within the recently proclaimed Nullarbor Wilderness Area, a single proclamation wilderness protection area. Drill sites located north of this line fall within the Nullarbor National Park and the Nullarbor Regional Reserve, both dual proclamation conservation reserves. The entire area is within the determined Native Title claim of the Far West Coast Aboriginal Corporation.

Access to the Coompana Drilling Project area is either via the Eyre Highway or the Trans-Australia railway access road. Access to the proposed drill sites is via established park roads (including the old Eyre Highway and Koonalda Station tracks), previous exploration tracks and some new tracks within the Regional Reserve. No new tracks will be created within the Nullarbor Wilderness Area.

The nearest populated centers are Eucla and Border Village located at the SA/WA border, the Nullarbor Roadhouse and Cook railway siding. The nearest major center is Ceduna, ~500 km east along the Eyre Highway.

PURPOSE OF THIS REPORT

This report represents a progressive update and data release during the operational phase of the Coompana Drilling Project. The results presented here are preliminary in nature and are intended for reference purposes only. All care has been taken to ensure accuracy but this represents field data acquired at site and is subject to revision, updating and subsequent QA/QC processes.

GEOLOGICAL OVERVIEW

COVER SEQUENCES

The cover overlying the Coompana Province in the study area is interpreted to comprise three main packages; the Carboniferous-Permian Denman Basin, Jurassic-Cretaceous rocks of the Bight Basin and the Tertiary Eucla Basin.

Carboniferous-Permian Denman Basin

The Denman Basin is an intracratonic, north-northwest-trending, fault-bounded trough ~200 km long and between 20–70 km wide (Hibburt, 1995). The sedimentary package in the trough varies from 300 m thick in the north, to 1000 m thick in the south.

The basin is filled with Permian sediments that unconformably overly the basement, and are unconformably overlain by Cretaceous and Tertiary rocks. The rocks are glacial at the base, and up sequence are interpreted to represent progressive de-glaciation and glacio-eustatic marine transgression.

Jurassic-Cretaceous Bight Basin

The Jurassic-Cretaceous Bight Basin is a large, mainly offshore basin that extends along the southern Australian margin (Hill, 1995). The basin contains a Middle Jurassic to Late Cretaceous sedimentary succession that is unconformably overlain by the Eucla Basin.

LOONGANA FORMATION

The Early Cretaceous Loongana Formation is a sandy to shaly succession with a maximum thickness of 324 m (Hill, 1991; 1995). The unit has been formally described as “Cross-bedded feldspathic sandstone, locally conglomeratic, carbonaceous sandstone; glauconitic sandstone, siltstone, claystone and shale; commonly pyritic” (Geoscience Australia and Australian Stratigraphy Commission, 2017). The rocks are interpreted to represent an initial rift phase in a terrestrial low-sinuosity fluvial environment within isolated grabens of the developing rift valley (Hill, 1995).

MADURA FORMATION

The Early Cretaceous Madura Formation conformably overlies the Loongana Formation. The Madura Formation has a maximum thickness of 474 m, and has been formally described as “Carbonaceous or glauconitic sandstone, siltstone, and claystone and shale; commonly pyritic” (Geoscience Australia and Australian Stratigraphy Commission, 2017). The sediments were interpreted to have been deposited in a marine environment with limited circulation suggested by low-energy lacustrine conditions (Hill, 1995).

Tertiary Eucla Basin

The Tertiary Eucla Basin comprises a widespread, thin package of marine and terrestrial sediments that were deposited on the passive margin along southern Australia.

PIDINGA FORMATION

The lower unit is the Pidinga Formation. This is a 30–60 m thick package of carbonaceous, terrigenous clastic sedimentary rocks that were deposited in topographically low settings, such as palaeochannels and broader depressions (Benbow, et al., 1995). The Pidinga Formation has been formally described as “Interbedded, well-sorted, fine to coarse-grained carbonaceous sand and silt with minor lignite. Flood zone clays and lignite, fluvial/estuarine channel sands, gravelly (carboneous) coarse sands” (Geoscience Australia and Australian Stratigraphy Commission, 2017).

HAMPTON SANDSTONE

The Pidinga Formation is overlain by the Hampton Sandstone. This unit comprises quartz-rich sands that were deposited as lenses and sheets in marine, estuarine and fluvial environments (Benbow, et al., 1995). The Hampton Sandstone has been formally described as “Poorly sorted limonite-stained sandstone, typically quartz rich; includes subordinate gravel, conglomerate and siltstone” (Geoscience Australia and Australian Stratigraphy Commission, 2017).

WILSON BLUFF LIMESTONE

The Wilson Bluff Limestone overlies the Hampton Sandstone. The Wilson Bluff Limestone is <150 m thick east of the Coompana Block, increasing westwards to ~300 m thick in Western Australia (Benbow, et al., 1995). The unit has been formally described as “Wackestone, white to grey; skeletal mudstone; rudstone and minor packstone. Locally laminations and scour channels, infilled with coarser material” (Geoscience Australia and Australian Stratigraphy Commission, 2017). The limestone is interpreted to have been deposited during marine transgression on a drowned carbonate platform (Benbow, et al., 1995). This is the rock that forms the whitish cross-bedded and parallel-bedded unit in the lower parts of the Bunda Cliffs.

ABRAKURRIE LIMESTONE

The Abrakurrie Limestone is thin (generally <10 m thick) unit that overlies the Wilson Bluff Limestone, and forms a distinct yellow-brown band in the Bunda Cliffs (Benbow, et al., 1995). The Abrakurrie Limestone has been formally described as “Yellowish coarse-grained bryozoan calcarenite and calcirudite, distinctly cyclic, and contains numerous hardgrounds; locally dolomitized” (Geoscience Australia and Australian Stratigraphy Commission, 2017). The limestone is interpreted to have been deposited on partly to completely drowned platform (James and Bone, 1991).

NULLARBOR LIMESTONE

The Nullarbor Limestone is a 20–35 m thick unit that overlies the Abrakurrie Limestone, and forms the ‘lumpy’ brown, parallel-bedded unit at the top of the Bunda Cliffs (Benbow, et al., 1995). The unit has been formally described as “Limestone, bioclastic, micritic. Subtidal, platformal, above fair weather wave-base. Includes large benthic foraminifera and aragonitic material; well-cemented” (Geoscience Australia and Australian Stratigraphy Commission, 2017). The limestone is interpreted to have been deposited in a shallow platform setting, with the paucity of terrigenous material suggesting river systems carried little debris to the coast (James and Bone, 1991).

BASEMENT

Recent drilling by the Geological Survey of Western Australia (Spaggiari and Smithies, 2015) has begun to shed light on the evolution of the region, indicating a complex multi-phase history beginning with interpreted Paleoproterozoic oceanic crust formation. This was followed by magmatic events, associated with subduction and crustal reworking, throughout the Mesoproterozoic (Spaggiari and Smithies, 2015; Dutch, et al., 2016a; Kirkland, et al., 2017).

Isotopic constraints indicate the development of oceanic crust at c. 2000–1900 Ma. There is no direct geological evidence for this event (Kirkland, et al., 2017).

This was followed by widespread arc magmatism and recycling of the oceanic crust at c. 1610 Ma, which resulted in the Toolgana Supersuite (Spaggiari and Smithies, 2015). The Toolgana Supersuite comprises granitic to monzodioritic rocks with compositions that suggests a subduction-modified mantle source. In particular, the rocks appear to be derived from a mantle wedge or subduction-modified lithosphere (Wingate, et al., 2015; Kirkland, et al., 2017). In drill core, GSWA found the Toolgana Supersuite to include locally migmatitic monzodioritic to granodioritic to monzogranitic gneisses and metadolerites that have been metamorphosed to amphibolite facies (Spaggiari and Smithies, 2015). The Toolgana Supersuite is the same age as, and is geochemically and isotopically similar to, the St Peter Suite in the western Gawler Craton (Wingate, et al., 2015; Dutch, et al., 2016a).

The Toolgana Supersuite was followed by c. 1500 Ma extension and rift-related c. 1490 Ma Undawidgi Supersuite magmatism in the west. This supersuite includes metagranitic and possible bimodal metavolcanic rocks that are derived by melting of lower mafic crust and the introduction of a mantle component. They are also interpreted to include recycled Toolgana Supersuite material (Wingate, et al., 2015). In drill core, GSWA found the Undawidgi Supersuite to include: variably foliated metatonalites and metamonzogranites, which are locally gneissic and migmatitic; metamonzodiorites; and variably sheared/mylonitic felsic and mafic schists. The felsic schists are interpreted to have a monzogranitic or volcanic protolith (Spaggiari and Smithies, 2015). The Undawidgi Supersuite is similar in age to the granodiorite gneiss from Mallabie 1 to the east of the current project (Fig. 1; Wade, et al., 2007).

Major extension at c. 1200–1120 Ma resulted in crustal thinning and widespread reworking of the crust. Reworking included generation and intrusion of the widespread intraplate c. 1190–1140 Ma Moodini Supersuite (Spaggiari and Smithies, 2015). In the western Coompana Province, this supersuite comprises high-KMg shoshonitic magmas that are bimodal with mafic and felsic compositions. The compositions are interpreted to reflect deep melting of wet, oxidised modified mantle lithosphere, indicating that the western Coompana Province retained a thick lithosphere into the c. 1200–1120 Ma event. This contrasts with the Madura Province to the west, where compositions suggest highly extended, dry and reduced crust with little or no remaining lithosphere (Wingate, et al., 2015). In drill core, GSWA found the Moodini Supersuite to include: equigranular to porphyritic, massive syenogranites, shoshonites and monzogranites that form thin sheets that cut the earlier foliations at variable angles (Spaggiari and Smithies, 2015). The magnetotelluric data suggests that some of the crustal-scale structures and crustal blocks are conductive, representing significant fluid flow and magmatic processes, such as MASH zones (Thiel, et al., 2016). This extensional event in the Coompana Province (and Madura Province to the west) coincides with Stage II of the Albany–Fraser Orogeny to the west, and the Musgravian Orogeny to the north. This widespread event, which affected the crust between the Yilgarn, Gawler and North Australian cratons has been called the Maralinga Event.

BOREHOLE DATA

Site ID: CP04	
Hole ID: CDP002	
Easting (MGA z52J)	564319
Northing (MGA z52J)	6538743
Latitude (WGS84)	-31°17'02"
Longitude (WGS84)	129°40'32"
Elevation (m)	~120
Bore Spud Date	2/05/2017
Bore Completion Date	8/06/2017
Total Depth (m)	698.7
Drilling Contractor	Boart Longyear Australia Pty Ltd
Drilling Supervisor Name	B Vandekamp/N Hodgettsl
GSSA Drilling Coordinator Name	L Tylkowski/A Lockheed
On-site Geologist Name (Pre-collar)	L Tylkowski/A Lockheed
On-site Geologist Name (Diamond Coring)	M Pawley/T Wise/L Jagodzinski

SITE ACCESS

CDP002 (CP04) is located approximately 27km north-west of Koonalda Homestead. The site is located adjacent to the exploration access track through the Regional Reserve. The site can be accessed from either the east via Koonalda or the west via the Eucla-Deakin road. The Eyre Highway and Diamond Bore Yard is approximately 54km south-west. Border Village is ~113km away via the Diamond Bore Yard and Eyre Highway or ~147km via Eucla and the Eucla-Deakin road. CP04 is within the Nullarbor Regional Reserve.			
Land Tenure	Wilderness Area ☐	National Park ☐	Regional Reserve ☒
	DPTI ☐		
Associated PEPR	Coompana Stage 1 ☐	Coompana Stage 2 ☒	
Heritage Survey Undertaken	Yes ☒	No ☐	
DEWNR Permit Number	Q26618-1		

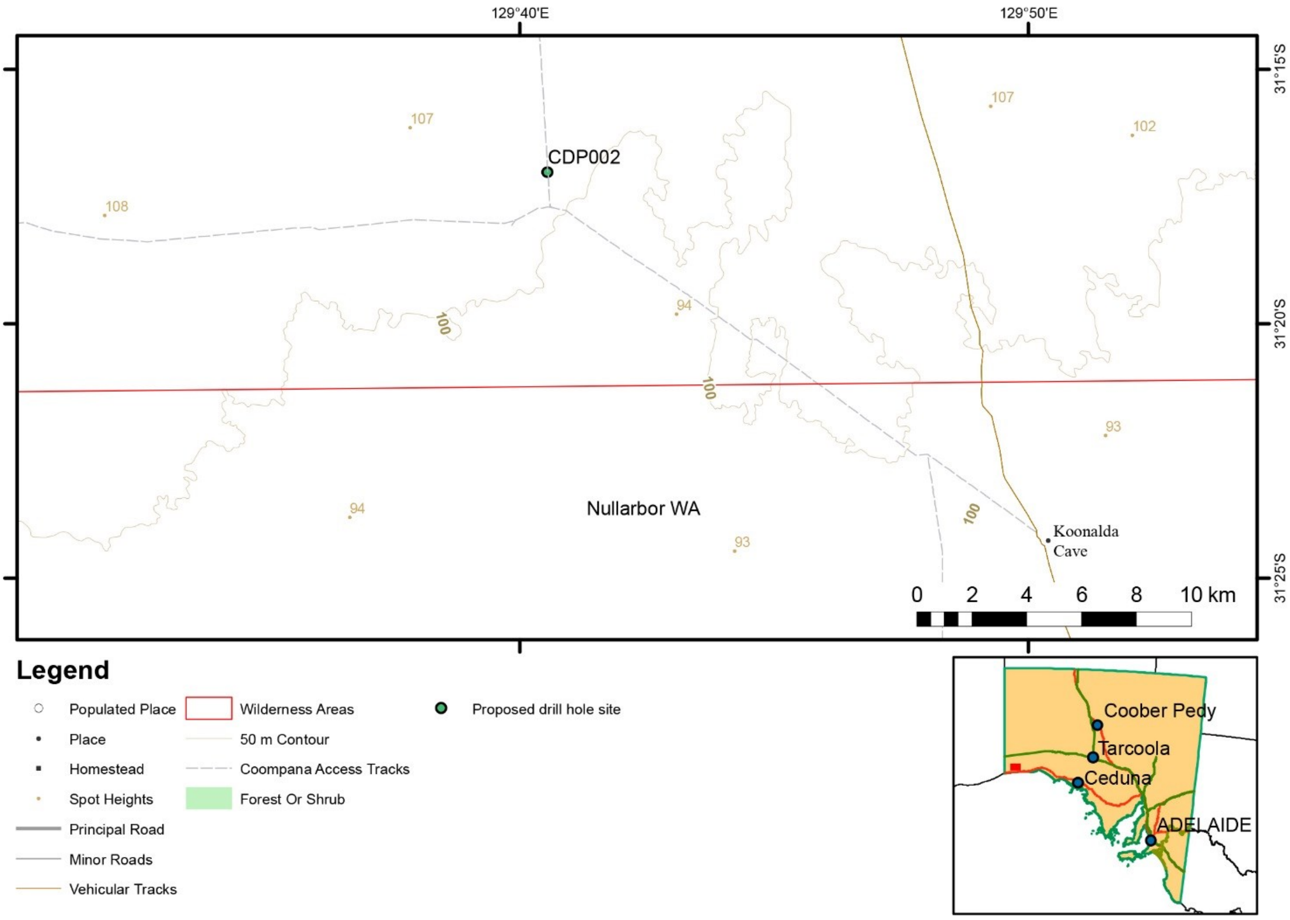

Figure 6. Site access map for CDP002 (site CP04) on 1:250 000 scale topographic map.

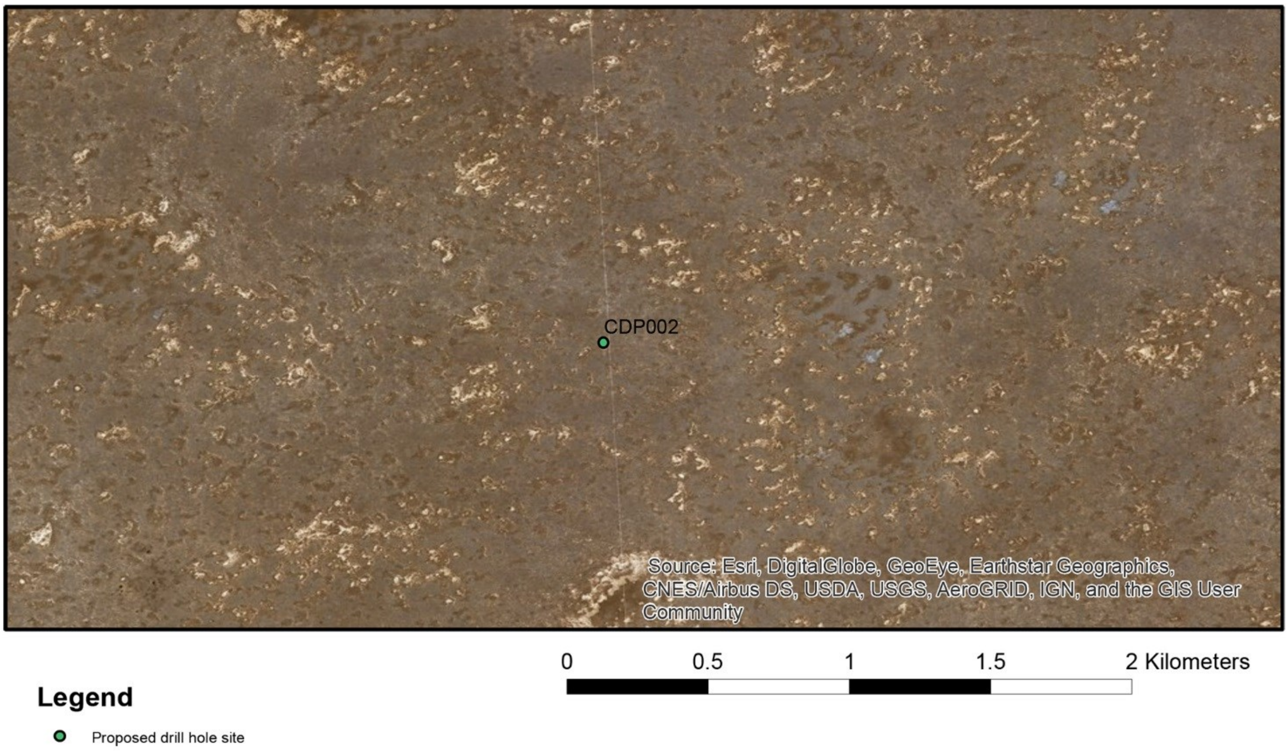

Figure 7. Orthoimage of site CDP002.

DRILLHOLE TARGET

Drillhole CP04 targets a circular magnetic feature, about 11 km in diameter, which appears to intrude into the south-eastern quadrant of the large Coompana Magnetic Anomaly. The circular feature has a concentrically zoned rim about 2 km wide, and the core displays variable magnetisation. The hole is right in the centre of the feature, corresponding to a strongly remnantly magnetised zone. The circular feature is magnetically similar to several other remnant magnetic bodies in the region.

A borehole near the southeastern margin of the anomaly (KN1) intersected gabbro at a depth of 340 m. Consequently, it is possible that the basement in this hole will comprise mafic intrusive rocks.

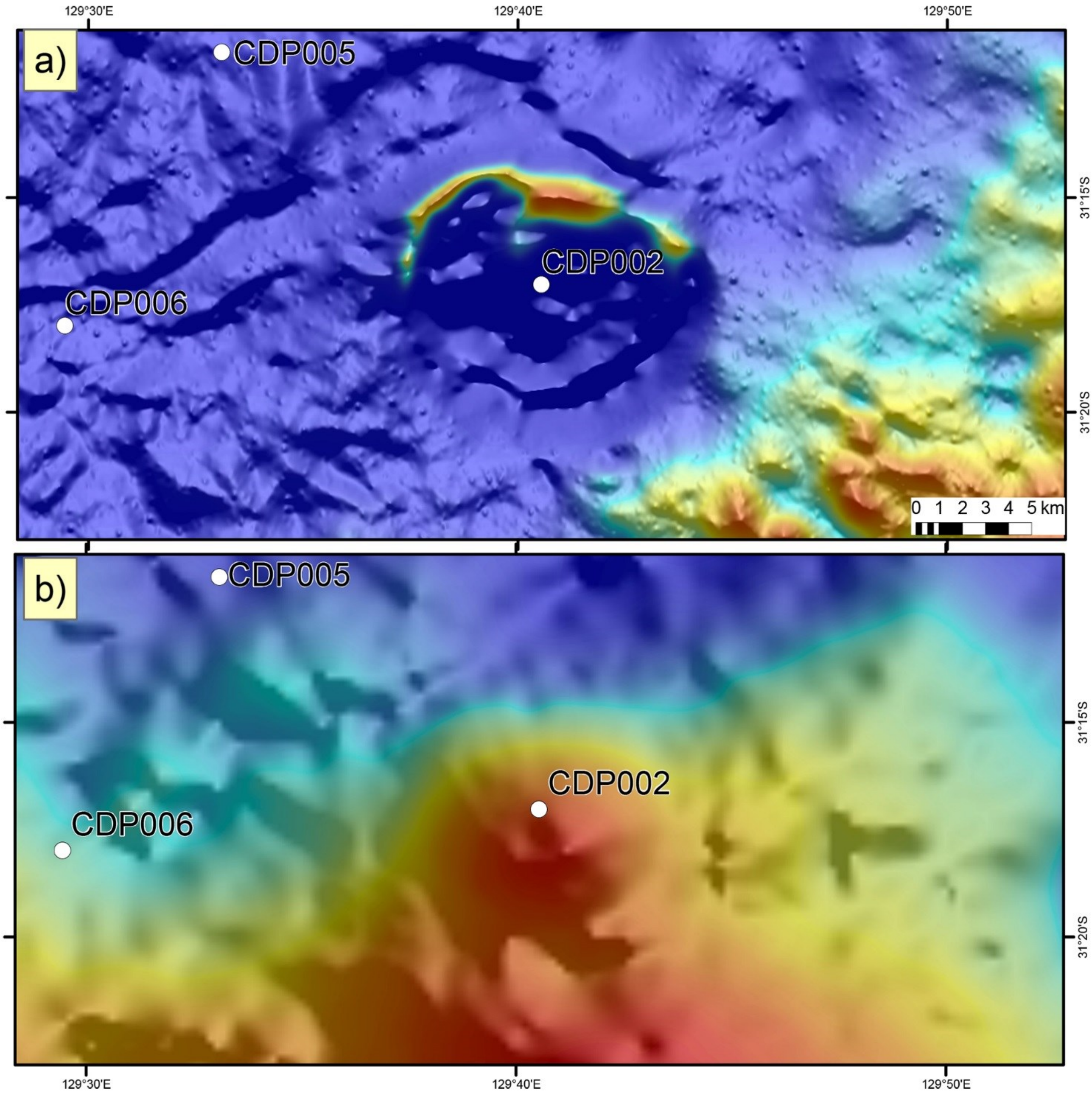

Figure 8. Site of drillhole CDP002 on a) RTP TMI and b) Bouger gravity.

DRILLING SPECIFICATIONS

Bore inclination (deg):	-80°			
Bore Azimuth (deg):	000°			
Pre-collar 1 Limestone	From (m): 0		To (m): 180	
	RC ☒	Mud rotary ☐	Diamond ☐	DTFR ☐
	Rig Type	8” Open hole hammer (to 157.7m), PCD Bit, UDR1200		
Pre-collar 2 Soft seds	From (m): 180		To (m): 374.47	
	RC ☐	Mud rotary ☒	Diamond ☐	DTFR ☐
	Rig Type	PCD Bit, UDR1200		
Diamond Tail	Length (m): 324.23			
	Rig Type	UDR1200		
Diamond Core size	PQ (85 mm) ☐	HQ3 (61.1 mm) ☒	NQ2 (45 mm) ☐	
Casing Specifications	1st casing to isolate limestone at 157.7 m. Cased to basement			
Casing Notes	1st casing is PWT to 157.70 m, 2nd Casing HWT to 374.70 m			
Casing Retrieved	Pre-collar 1 Yes ☐ No ☒	Pre-collar 2 Yes ☒ No ☒	Stratigraphic Hole ☐	
Casing Retrieval Notes	PWT casing stuck between 97 – 157.7m. Cut and partially retrieved HWT casing stuck between 242.7 – 374.4m. Cut and partially retrieved			
Water Source	Eucla ☐	Border Village ☒	KN1 ☐ KN2 ☐	Other ☐
Borehole Abandonment	Abandoned according to regulatory requirements: Yes ☒ No ☐			
Borehole Abandonment Notes	Borehole abandoned by placing a Van Ruth plug and grouting with cement from 197m to isolate the unconfined aquifer in the Wilson’s Bluff Limestone.			
Additional Notes				

PRE-DRILLING GEOPHYSICS AND DEPTH ESTIMATES

Prior to the commencement of drilling, a number of geophysical techniques were trialled to ascertain their effectiveness at determining the thickness and nature of the cover units overlying the Nullarbor basement rocks. This work was done in conjunction with GA and the CSIRO. A combination of Audio Magnetotellurics (AMT) passive seismic and active seismic (reflection and refraction) were undertaken at selected proposed drill sites prior to drilling. For details of the methodologies and full results the reader is referred to Gorbatov, et al. (in prep.), Holzschuh, et al. (in prep.), and Jiang, et al. (in prep.). In addition to acquiring new data, depth to magnetic basement estimates were calculated using the newly acquired Coompana airborne magnetic data. The reader is referred to Foss, et al. (2017) for the full methodology and results.

Depth estimate results

Thickness of Nullarbor/Wilsons Bluff limestone	
Method	**Depth (m)**
Nearby bores	182 (KN1 5.4km SE) 166 (KN2 6.6km N-NW)
AMT	
Passive Seismic	
Active Seismic	210 ± 10%
Depth to Basement interface	
Method	**Depth (m)**
Nearby bores	340 (KN1 5.4km SE) >436 (KN2 6.6km N-NW)
Magnetic basement	163-846 (8 models within 6km) best est 300-400
AMT	437 ± 10%
Passive Seismic	
Active Seismic	325 ±10%
Depth Recorded from Drilling	
Base limestone cover	180
Basement interface	374.47
Pre-drilling micro-gravity undertaken	Yes ☒ No ☐
Recommendations	Hole location OK

Micro-gravity

The Nullarbor Plain is known for its large and numerous cave systems. Because of this aspect, prior to drilling a series of micro-gravity surveys were undertaken at each site in an attempt to locate the presence of large, blind, cavities that may be in the vicinity of the drill collar. The survey was undertaken using two Scintrex CG5 gravity meters on a regular grid pattern with stations spaced at 10 m intervals. The total gravity field was measured and then the regional trend has been removed in post-processing to highlight the near surface density variation. The results indicate areas of lower density in the near surface that may indicate the location of sub-surface cavities and allow the drill collar to be moved to avoid intersecting these. For a full account of the methodologies and results the reader is referred to Heath, et al. (2017).

The results for the survey around the CDP002 collar (Fig. 9) indicate a total variation in the gravity field of 0.24 mGal. The location of the collar (central point on Fig. 9) was determined to be clear of large cavities and clear to drill.

DOWN HOLE SURVEYS AND ANALYSIS

Directional survey required every 30m and EOH ☒	Multi-shot survey ☐ Single-shot survey ☒	Gyro ☐

Core orientation required	Yes ☒Every Run No ☐
Core Orientation Tool Used	Boart Longyear TruCore
Downhole geophysical surveys planned	Yes ☒ No ☐
Downhole geophysical surveys run	Yes ☒ No ☐
Tru-scan XRF scanning run on core	Yes ☐ No ☒

Survey Tool	**Method**	**Date**	**Run By**
Globaltech TruProbe	Wireline and In-rod	19/05/201717	T Hamon/G Stewart
Temperature Probe	Wireline in rods	9/06/2017	A Pollett/T Wise
Temperature Probe	Wireline in open hole	11/06/2017	A Pollett/T Wise

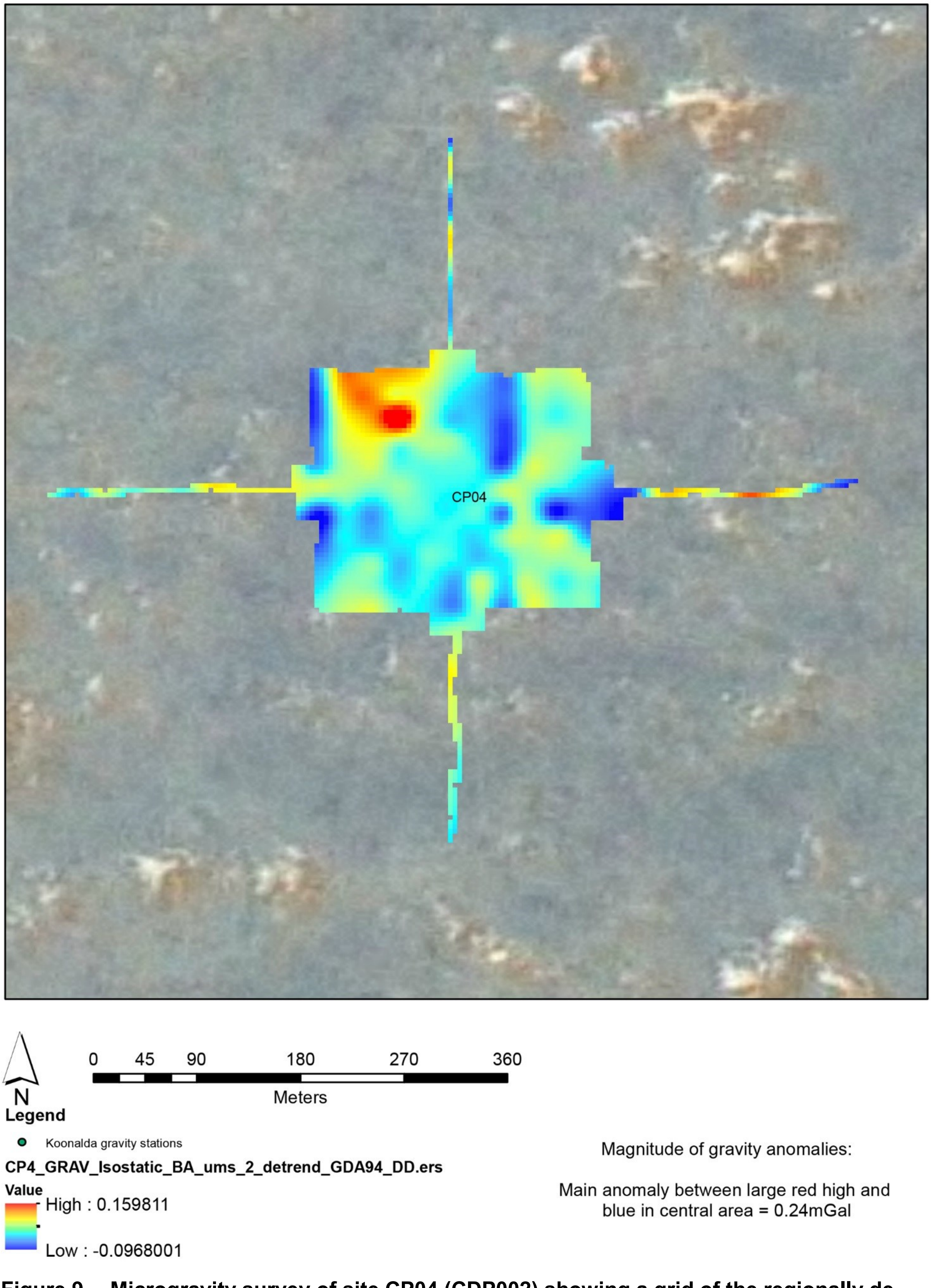

Figure 9. Microgravity survey of site CP04 (CDP002) showing a grid of the regionally de-trended isostatic gravity. Green dots indicate survey points.

FIELD SUMMARY LOGS

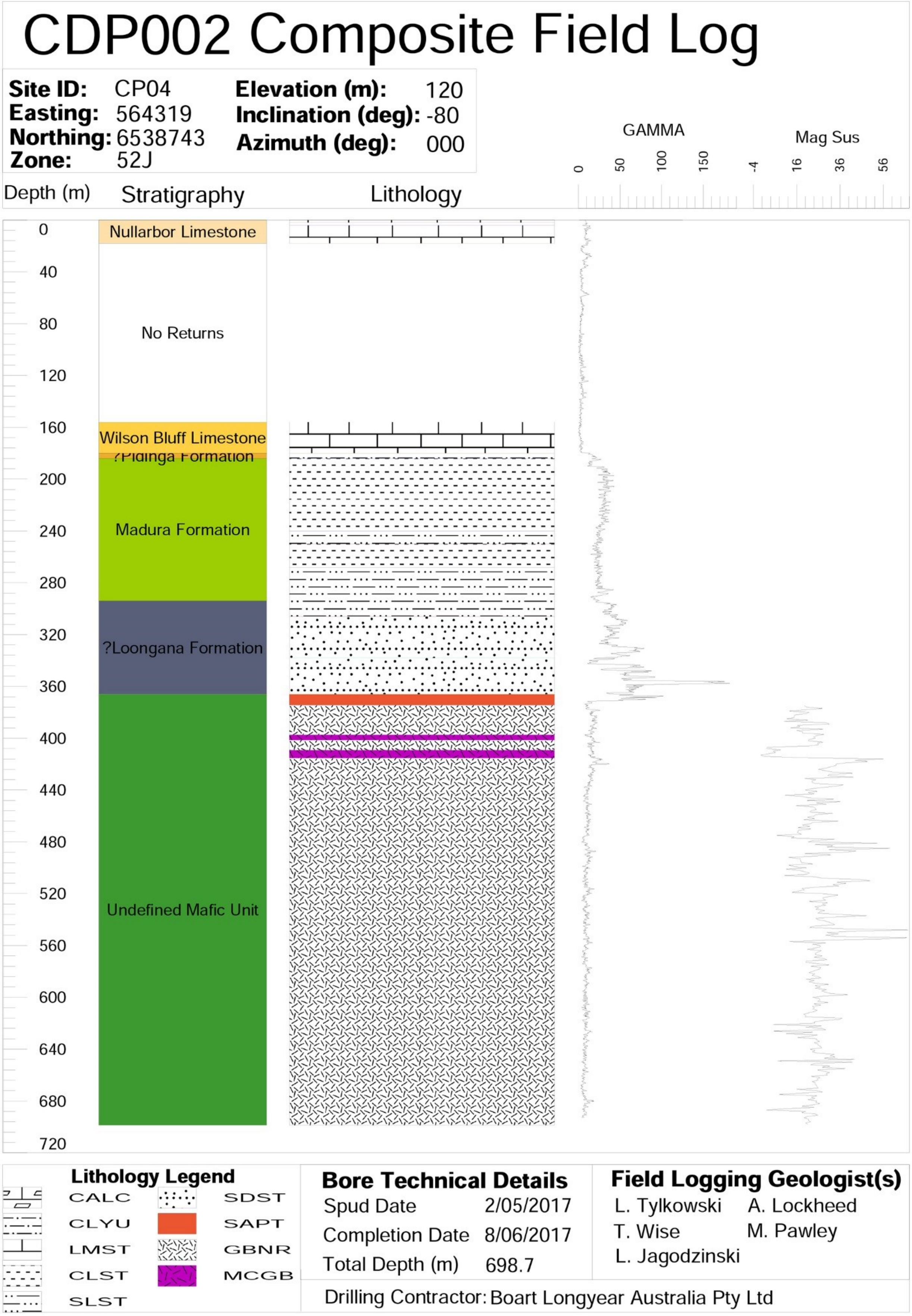

Figure 10. Summary graphic log of drillhole CDP002. Abbreviations; CALC calcrete, CLYU clay unit, LMST limestone, CLST clay stone, SLST silt stone, SDST sand stone, SAPT saprolite, GBNR gabbro/gabbro norite, MCGB microgabbro.

BASEMENT LITHOLOGY DESCRIPTIONS

Gabbro (GBNR)

The gabbro is predominantly equigranular in texture with an average grainsize of ~5 mm. Interlocking white plagioclase prisms and dull grey, blocky ferromagnesian crystals, in places having a brown, sub-metallic lustre suggestive of the orthopyroxene bronzite, comprise about 80–90% of the rock. Minor blocky, black ferromagnesian crystals, some doubly terminated and hexagonal in shape (possibly chlorite-altered clinopyroxene), comprise the remaining 10–20%. There is compositional variation throughout the intrusion, with light coloured plagioclase-rich intervals (40–50% plagioclase) and darker grey plagioclase-poor intervals (20–30% plagioclase), in places interlayered or co-mingled (Fig. 11 a,b). Plagioclase-rich gabbro dominates the top 225 m of the section, and plagioclase-poor gabbro the bottom 100 m (Fig. 11). The black euhedral clinopyroxene crystals can concentrate in thin layers (Fig. 11c), but this is uncommon.

Locally, the gabbro displays inequigranular textures, with patches of pink or red-brown fine-grained groundmass rich in feldspar and possibly quartz, and containing acicular black ferromagnesian crystals which could be clinopyroxene, or possibly hornblende or even biotite (Fig. 11d-h). The pink colour is most likely attributable to minor hematite in incipiently altered K-feldspar grains. These patches of groundmass represent local concentration and crystallisation of the residual silicate liquid after crystallisation of the plagioclase and associated ferromagnesian minerals. In the top 100 m of the drillhole, the residual melt forms segregation patches free of the earlier-formed liquidus minerals. These melt segregations decrease in size and abundance down hole, consistent with magmatic segregation of the residual liquid toward the physical top of the intrusion, and confirming the intrusion is not overturned. From 100 m below the top of the intrusion, the residual melt occurs only as smaller, interstitial patches ~5 mm in size (Fig. 11h). The melt segregations, particularly in the top 25 m of the hole, are commonly associated with a coarser grainsize, with the formation of larger skeletal plagioclase prisms up to 1 cm in length indicating super cooling (quenching) and disequilibrium in the melt (Fig. 11d), an indication of shallow level (hypabyssal) intrusion.

Overall, this rock is relatively unaltered. The white to pale greenish white colour of the plagioclase suggests it is probably altered to zoisite ± sericite ± trace chlorite, the ferromagnesian minerals are probably chlorite altered, and there is a weak, patchy hematitic alteration throughout the gabbro. Intermittent veins of calcite, epidote, hematite, chlorite and possibly serpentinite with small chalcopyrite and pyrite grains are surrounded by wider hematite (red), possibly potassic (pink) and epidote-chlorite (green) alteration zones (Fig. 12).

Microgabbro (MCGB)

The greatest grainsize variations occur in the top 100 m of the section, which includes two intervals of microgabbro, or dolerite. The microgabbro is of similar composition to the gabbro comprising plagioclase prisms and ferromagnesian grains, probably pyroxene, but is finer grained, with an average grainsize of ~2 mm. Between 399.3 and 401.4 m the microgabbro is grey in colour, with a few thin, red mm-scale hematite veins cross cutting the core at a low angle (Fig. 13a). The texture is porphyritic, with blocky, euhedral black ferromagnesian (?clinopyroxene) crystals slightly larger in size than the intergrown plagioclase prisms and dull grey ferromagnesian (?orthopyroxene) grains.

Between 409.2 and 415.3 m, the microgabbro is patchy grey and pink in colour (Fig. 13b). The pink patches are felsic melt segregations, as found in the surrounding, coarser-grained gabbros. Red hematite alteration associated with epidote-chlorite and calcite veins locally overprints the primary textures. In places the microgabbro is green in colour, possibly indicating epidote-chlorite alteration.

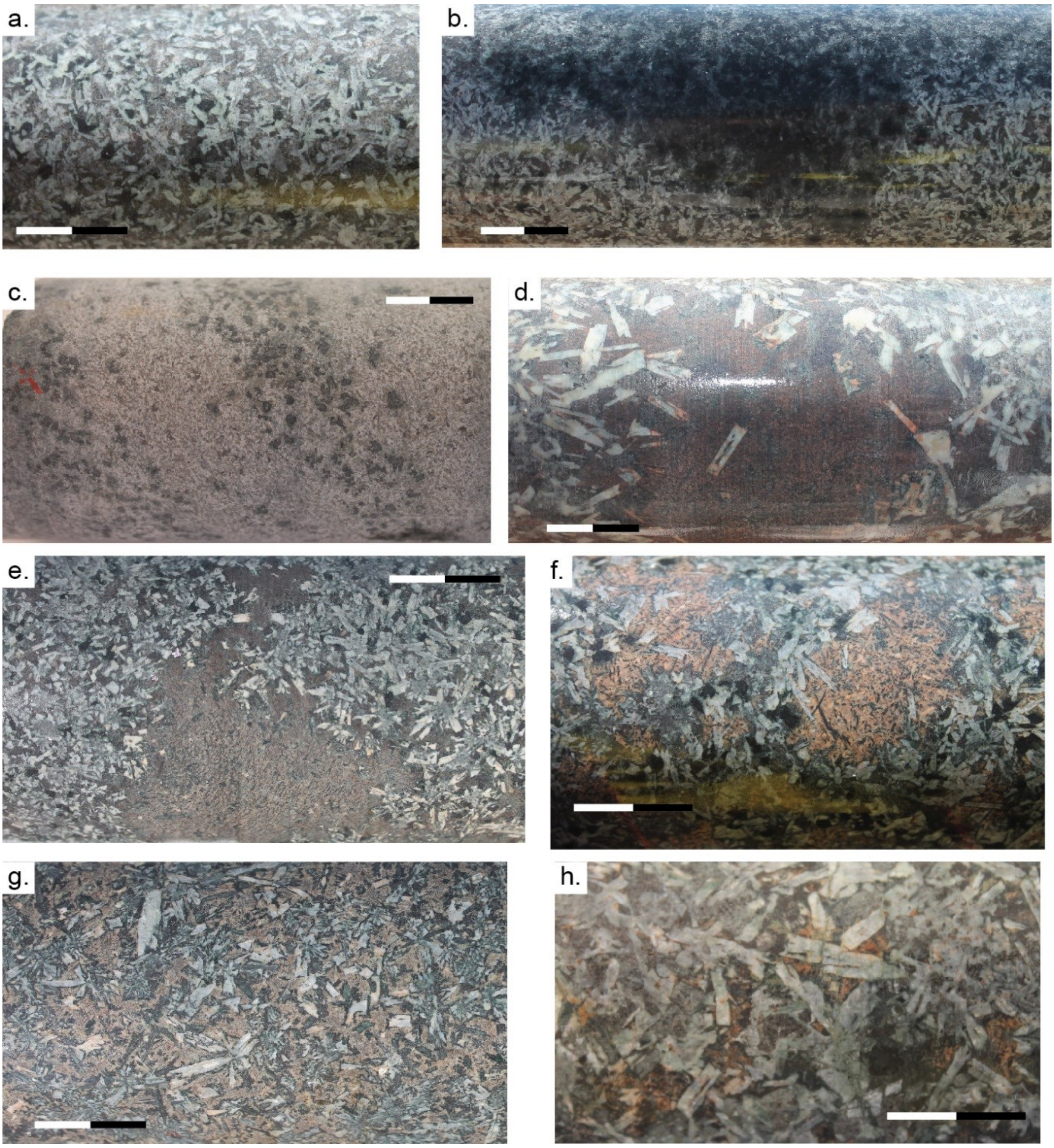

Figure 11. Representative core photos of the gabbro. Scale bars are 2 cm. **a)** Equigranular plagioclase-rich gabbro, 551.4 m. **b)** Co-mingled plagioclase-rich and plagioclase-poor gabbro, 525.5 m. **c)** Clinopyroxene crystals concentrated in layers ~2 cm thick, 434 m. **d)** Large melt segregation surrounded by skeletal (hopper) plagioclase prisms, formed under conditions of super cooling (quenching) in coarse-grained gabbro, 377 m. **e)** Fine-grained feldspar-rich groundmass with acicular ferromagnesian minerals representing a segregation patch of residual melt, 468.9 m. **f)** and **g)** Smaller pink melt segregations at greater depths of 483.7 m and 553.95 m, respectively. **h)** Small, ~5 mm patches of pink, fine-grained groundmass representing interstitial melt.

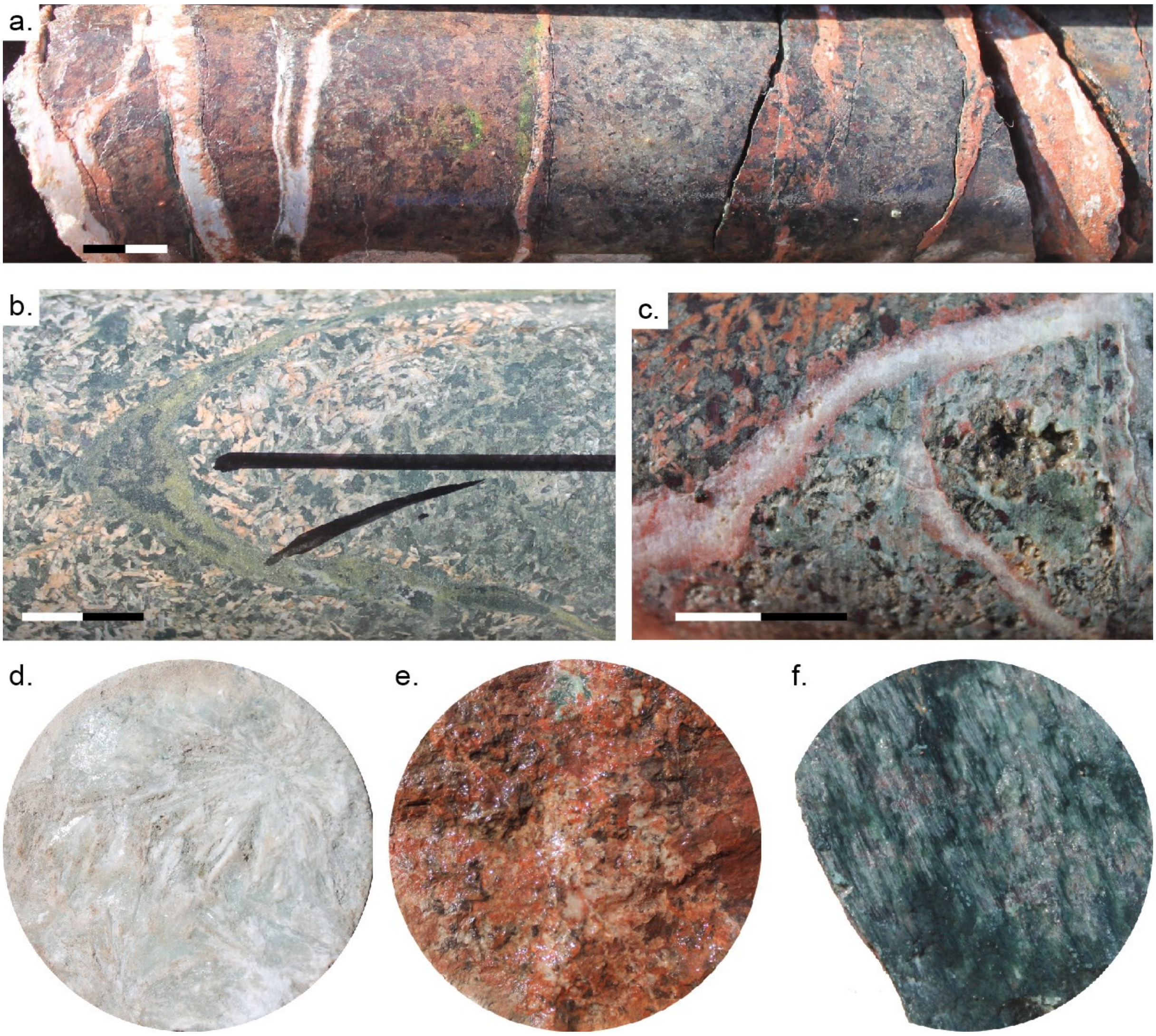

Figure 12. Representative core photos of veining and alteration in gabbro. Scale bars are 2 cm, Core cross sections (d-f) are 6 cm in diameter. **a)** Calcite veins surrounded by red hematite alteration, 648.9–649.1 m. **b)** Epidote-chlorite vein surrounded by pink ?potassic alteration, and epidote-chlorite alteration 568.3 m. **c)** Calcite vein surrounded by hematite and ?serpentinite alteration, with small vughs infilled with specular hematite, 643.2 m. Cross sections of **d)** Carbonate vein, 587.7 m, **e)** Hematite vein, 621.39 m, and **f)** ?Serpentinite vein, 649.7 m.

Figure 13. Representative core photos of microgabbro. a) 399.3–401.4 m: porphyritic, with thin hematite veins, and **b)** 409.2–415.3 m, with abundant pink patches representing felsic melt segregations.

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