ANNUAL PALAEONTOLOGICAL MONITORING REPORT (SEPTEMBER 2020) ON VAALBULT COLLIERY LOCATED ON PORTIONS 1, 9 AND 10 OF THE FARM VAALBULT 3 IT, MPUMALANGA PROVINCE

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ANNUAL PALAEONTOLOGICAL MONITORING REPORT (AUGUST 2020) ON VAALBULT COLLIERY LOCATED ON PORTIONS 1, 9 AND 10 OF THE FARM VAALBULT 3 IT, MPUMALANGA PROVINCE

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EXECUTIVE SUMMARY

Vaalbult Mining Company (Pty) Ltd owns and operates a colliery on Portions 1, 9 and 10 of the farm Vaalbult 3 IT, Gert Sibande District Municipality, located west of Carolina, Mpumalanga Province. The South African Heritage Resources Agency (SAHRA) has instructed Vaalbult Mining Company (Pty) Ltd [SAHRA document Ref: 16/5/1 Vaalbult Mining Project; dated 14 February 2014] that on-site checks for the occurrence of any fossils of the excavated pit and stockpiled material are required every six months by an experienced Karoo palaeobotanist. The Karoo palaeobotanist must submit a monitoring report to SAHRA on this work. SAHRA also indicated that the frequency of these checks should be assessed after six months, this assessment being based on the findings and the planned mining programme. In July 2016 BM Geological Services recommended that these monitoring reports should be conducted on an annual basis. Following on from those recommendations SAHRA has instructed Vaalbult Mining Company (Pty) Ltd [SAHRA document Ref: 16/5/1 Vaalbult Mining Project; dated 18 April 2017] that on-site checks for the occurrence of any fossils of the excavated pit and stockpiled material are required every twelve months.

In compliance with the SAHRA instruction discussed above, and subsequent recommendations, this report documents the results of a palaeontological monitoring program site visit conducted by Prof B Millsteed on the 28th of September 2020. Prof Millsteed was accompanied by Mr M Magagula of Geovicon Environmental (Pty) Ltd [representing Vaalbult Mining Company (Pty) Ltd] who facilitated the access to all those areas that were required. Vaalbult Mining Company made no restrictions concerning the location of areas to be investigated and access was freely available to Prof Millsteed to inspect wherever he desired. The present investigation was conducted within the mine's phase 3a and 3b cuts as well as two areas of waste rock stockpiles that emanated from the two box cuts. At the time of the site visit no areas were being actively mined. The areas visited represent all areas that have been mined since the previous site visit in 2019 and which remain unrehabilitated. The waste rock represents a cross-section of all non-coal lithologies mined from the two box cuts since the previous site visit.

The present palaeontological monitoring study revealed that the Vaalbult Colliery mining operations impact directly upon strata of the Early Permian Vryheid Formation, Karoo Supergroup. This unit is known to be richly fossiliferous elsewhere in its extent; common fossils known to occur within the unit include plant macrofossils and trace fossils. The stratigraphic succession within in the Vaalbult Colliery consists of eight distinct lithofacies, named units A-H herein. This stratigraphic sequence is dominated by two coal seams that are being economically exploited by the colliery. These seams are the upper-most D seam (unit E) and the underlying E seam (unit A). The E seam constitutes the base of the colliery pit in all areas observed and appears to be uniformly distributed throughout the pit.

The sedimentary sequence separating the two coal seams varies between 11.5 m and 12.5 m in thickness (the thickness deceases towards the west). Immediately overlying

the E seam is a highly variable sandstone unit (unit B; also known on the mine as "the parting". Unit B generally forms a fining-upward layer up to 50 cm thick with granulestone at the base, grading upward into a flaser-bedded portion and an upper-most massive to planar-bedded sandstone portion. A discontinuous, undulatory, very coarse-grained sandstone up to 30 cm thick may occur between the top of unit B and unit C. It was previously reported that unit B is also present in the colliery as a <2 m thick laminated, micaceous sandstone (the individual mica flakes exceed several millimetres in size). Overlying unit B is an approximately 6 m of black, thinly laminated, sequence of carbonaceous mudstones and sandstones (unit C). Two stratigraphically distinct, buff coloured sandstones horizons were observed within this unit C during previous site visits. Overlying unit C is approximately 5-6 m of brown coloured, sandstones of unit D. The sandstone is variable in appearance, but mostly consists of thin parallel bedded sandstones. Several thicker (40–50 cm), tabular, buff sandstones are present within unit D and are found throughout the colliery area.

The coals of Unit E (D seam) overly unit D and the maximum exposed thickness in the three cuts examined was ca. 40 cm. In the previous annual palaeontological audit site visits the unit overlying unit E was ca. 8 m of thinly laminated, black carbonaceous mudstones (termed unit F). In the current investigation, the rocks comprising unit F are sub dividable into three distinct lithological subunits (termed F1-F3 herein). Rock sequence F1 consists of ca. 2 m of massive and laminated dark grey mudstones, F2 consists of ca. 1 m of light grey, laminated mudstones and the upper part of unit F consists of ca. 3 m of black, carbonaceous mudstone (subunit F3). Overlying unit F is a light brown sandstone unit several meters in thickness termed unit G. The rocks of unit G have not been observed closely anywhere in the colliery and, as such, little detail can be discussed concerning the unit. Approximately 2 m of regolith (unit H) tops the sequence.

A revised understanding of the stratigraphic relationship between units C and D was developed and presented in the 2019 site visit report. In that it was recognised that unit D is not uniformly thick, and may occur contained in the upper half of unit C. Unit D may pinch out in some regions of the study area. The present study confirms those observations. The present study also expands the number of smaller lithofacies that occur within the broader stratigraphic classification, and which may also be fossiliferous (although no fossils were located within them during this site visit).

The strata examined within the box cuts were generally unfossiliferous and those of the waste rock piles were poorly fossiliferous. During the present site visit a small number of unidentifiable plant compressions of a woody stem segments and numerous blocks containing abundant specimens of *Skolithus* sp. ichnofossils were located within rocks in the waste rock piles (the latter was also present associate with unit B in phase 3b cut). Unfortunately, the stratigraphic context of these waste rock pile rocks could not be ascertained with precision, but they appear to be from unit B. The fossils identified were of minimal scientific importance and, thus, even if their provenance was known no

damage mitigation protocols would have been required. None of the fossils (plant macrofossil or trace fossils) identified are palaeontologically significant and require special preservation or excavation. No fossil materials were identified that would necessitate damage mitigation procedures to be enacted.

Overall, the lithological succession of the Vaalbult Colliery is fossiliferous (albeit poorly so) or low in taxonomic diversity. Thus, due care needs to be exercised to ensure that the mining activities do not diminish the palaeontological heritage of the area. That said the Vryheid Formation strata occur beneath a uniformly thick regolith horizon and do not crop out. The absence of bedrock outcrop means that no fossils are observable at surface. Thus, it is only due to the ongoing mining activities that the fossiliferous strata are exposed and made available for scientific study. None of the fossils located during either the current or the preceding study are of sufficient palaeontological significance that their excavation by a palaeontologist or their preservation is required. This situation is subject to future change but this may not always be the case. However, comparison of the stratigraphic successions studied in this and the preceding palaeontological monitoring reports indicates that several of the geological units present within the mine show significant sedimentological variation across the small area mined to date. Significant facies variations may be possible across the extent of the Mining Right area. Changes within the abundance and type of fossil assemblages may be possible and that palaeontologically significant fossil assemblages may be present. The possibility of the presence of palaeontologically significant fossils within the rocks of the colliery therefore remains a strong possibility.

It is accordingly recommended that:

- The annual palaeontological audit of the mine workings should continue (subject to later review) due to the presence of identified fossil assemblages.
- Should the rock sequence prove to become more prolifically fossiliferous in the future the frequency of the audit process should be reviewed with a view to increasing their frequency.

1 INTRODUCTION

Vaalbult Mining Company (Pty) Ltd owns and operates a colliery on Portions 1, 9 and 10 of the farm Vaalbult 3 IT, Gert Sibande District Municipality, located west of Carolina, Mpumalanga Province. The South African Heritage Resources Agency (SAHRA) has instructed Vaalbult Mining Company (Pty) Ltd [SAHRA document Ref: 16/5/1 Vaalbult Mining Project; dated 13 February 2014] that on-site checks for the occurrence of any fossils of the excavated pit and stockpiled material are required every six months by an experienced Karoo palaeobotanist. The Karoo palaeobotanist must submit a monitoring report to SAHRA on this work. SAHRA indicated that the frequency of these checks should be assessed after six months, based on the findings and the planned mining programme. In July 2016 BM Geological Services recommended that these monitoring reports should be conducted on an annual basis. Following on from those recommendations SAHRA has instructed Vaalbult Mining Company (Pty) Ltd [SAHRA document Ref: 16/5/1 Vaalbult Mining Project; dated 18 April 2017] that on-site checks for the occurrence of any fossils within the excavated pits and stockpiled materials are required every twelve months. In compliance with the SAHRA instruction and subsequent recommendations, this report documents the results of a palaeontological monitoring program site visit conducted by Prof B. Millsteed on the 28th of September 2020. Prof Millsteed was accompanied by Mr M Magagula of Geovicon Environmental (Pty) Ltd [representing Vaalbult Mining Company (Pty) Ltd] who facilitated the access to all those areas that were required. Vaalbult Mining Company (Pty) Ltd made no restrictions concerning the location of areas to be investigated and access was freely available to Dr Millsteed to inspect wherever he desired. The voids of Phase 3a and 3b cuts as well as the most recent potions of the waste rock dumps emanating from those two cuts were investigated during the site visit.

2 LOCATION

The Vaalbult Colliery mining lease lies approximately 10 km west of the town of Carolina and 28 km northeast of Hendrina, Gert Sibande District Municipality, located west of Carolina, Mpumalanga Province (Figure 1). The approximate corner points (Figure 1) of the Mining Right area are provided in Table 1. Vaalbult Colliery is located on Portions 1, 9 and 10 of the farm Vaalbult 3 IT (Figure 2). All work conducted during the present study took place on Portion 9 of the farm.

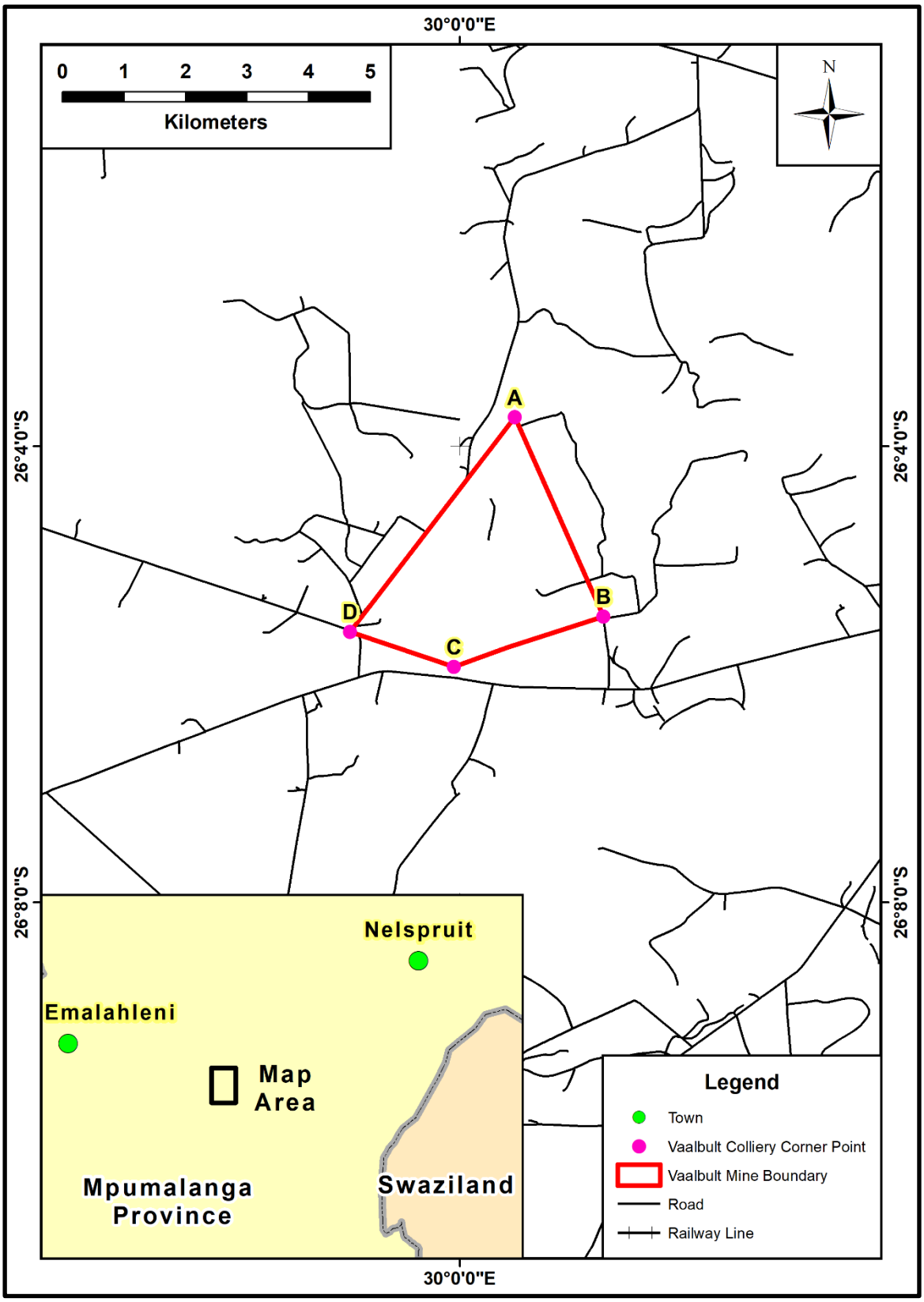

Figure 1: Location map of the Vaalbult Colliery. Shown, as the purple circles are the approximate corner points of the Mining Right area, the co-ordinates for the corner points are provided in Table1.

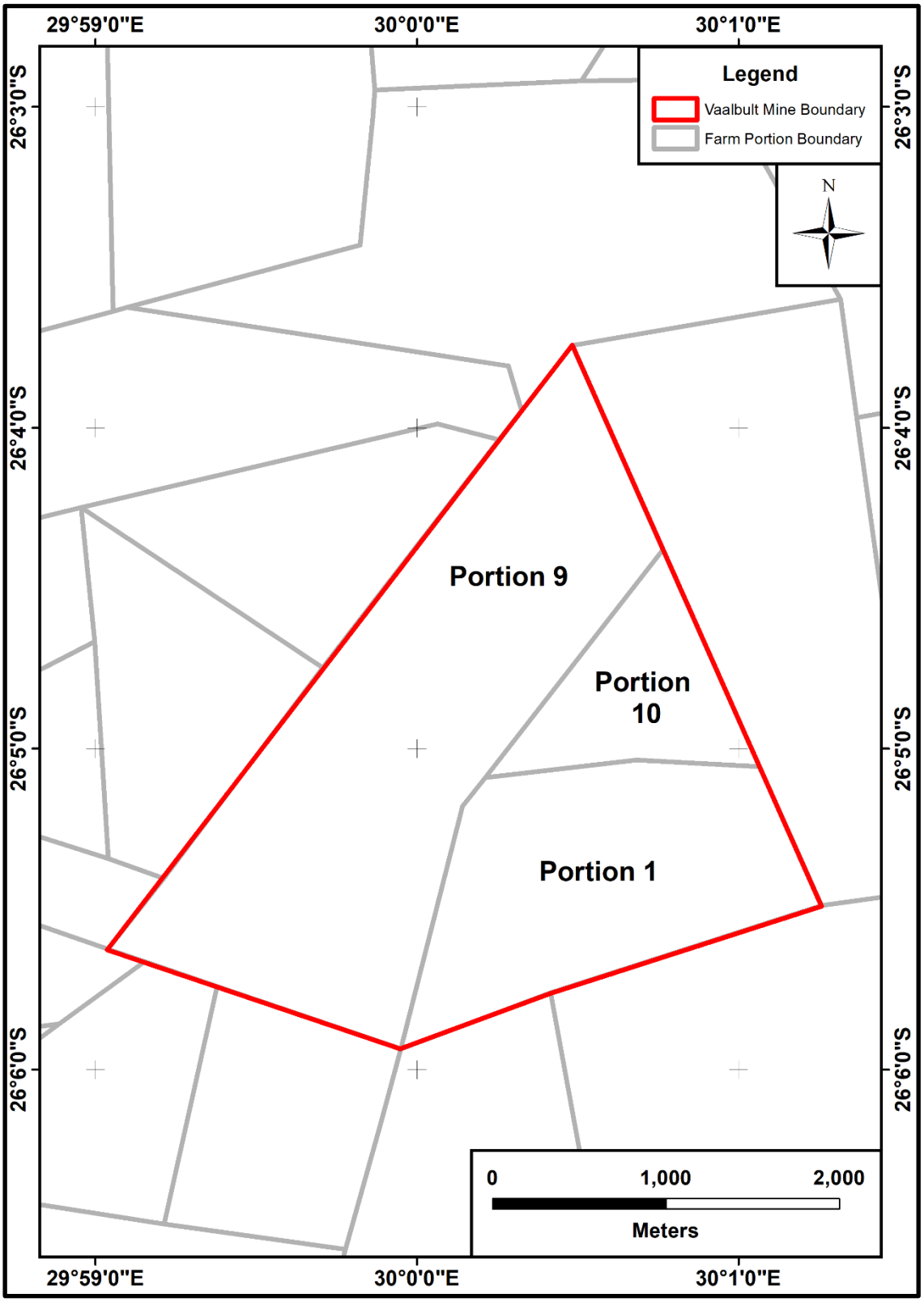

Figure 2: Map showing the location of the various portions Vaalbult 3 IT that constitute the Mining Right area. Superimposed on the farm portions is the GPS trackway indicating where the work program was conducted.

CORNER POINT	LATITUDE	LONGITUDE
A	-26.062385	30.008051
B	-26.091515	30.020978
C	-26.098911	30.999122
D	-26.093777	30.983943

Table 1: Approximate latitude and longitude of corner points of the Vaalbult Colliery Mining Right boundary. The coordinates are provided in geographic format (WGS84 datum).

3 RELEVENT EXPERIENCE

Prof B Millsteed holds a PhD in palaeontology and has previously been employed as a professional palaeontologist with the Council for Geoscience in South Africa. He is the principle of BM Geological Services and has sufficient knowledge of palaeontology and the relevant legislation required to produce this Palaeontological Monitoring Report. Prof Millsteed is registered with the South African Council for Natural Scientific Professions (SACNASP; Reg. No. 400332/07), is a member of the Palaeontological Society of South African, a member of the Association of Australasian Palaeontologists and is a fellow of the Geological Society of South Africa.

4 ACCESS AND INDEPENDENCE

Dr Millsteed was retained, as an independent consultant to conduct this palaeontological monitoring study and compile the present report, and shall receive fair remuneration for these professional services. Neither Prof Millsteed nor BM Geological Services has any financial interest in the Vaalbult Colliery, the Vaalbult Mining Company (Pty) Ltd nor any companies or individuals associated with the project.

No restrictions concerning the location of areas to be investigated were made by Vaalbult Mining Company and access was freely available to Prof Millsteed to inspect wherever he desired. Vaalbult Mining Company (Pty) Ltd made all safety and access arrangements required to inspect the areas selected by Prof Millsteed. A representative portion of the pit high walls and waste rock piles were able be visited and documented in each of the mines working cuts visited.

5 METHODOLOGY

The Vaalbult Colliery was visited and inspected by Prof Millsteed on the 28th of September 2020. Prof Millsteed was accompanied during the investigation by Mr M Magagula of Geovicon Environmental (Pty) Ltd [representing Vaalbult Mining

Company (Pty) Ltd]. Rock material comprising the waste-rock stock piles represents material that had already been mined and, thus, its exact stratigraphic context is lost. The mine's waste rock stockpiles were, however, extensively investigated as they provide a detailed, easily accessible record of the type and abundance of fossil materials that may be encountered (*in situ*) in their box cuts of origin where they are harder to observe in the high walls. All sites were inspected on foot and extensive observation was made of accessible portions of the box cut high-walls. As part of this process all sedimentary facies present in the high-walls were identified and investigated for their palaeontological content. The identified facies were described and are documented herein. The locations where detailed observations were recorded and/or photographs taken were made as waypoints using a hand-held GPS (Figure 3). The present investigation was conducted within the mine's phase 3a and 3b box cuts as well as two areas of waste rock stockpiles (Figures 4 and 5). At the time of the site visit no active mining was occurring, but these areas represent the results of the most recent mining activities. The waste rock stockpiles represent a cross-section of all non-coal lithologies mined from the two box cuts earlier in 2020.

6 GEOLOGY

Figure 6 shows that the project area is completely underlain by rocks of the Early Permian Vryheid Formation. A summary of the characteristics of the Vryheid Formation in general, the strata present within the Vaalbult Colliery open pit, and their fossiliferous content and potential follows.

6.1 Vryheid Formation

The Main Karoo Basin consists of a retro-arc foreland basin filled with a lithological succession ranging in age from the Late Carboniferous to the Middle Jurassic (Johnson *et al*., 2006). The basin-fill sequence wedges out northwards over the adjacent Kaapvaal Craton.

In the Main Karoo Basin, of South Africa the Vryheid Formation is a sandstone and coal-rich stratigraphic unit that interfingers with (i.e., is transitional with and partially time equivalent to) the overlying Volksrust and underlying Pietermaritzburg Formations; both of which are both are predominantly argillaceous (Figure 9). In terms of environment of deposition, the formation can be divided into a lower fluvial-dominated deltaic interval, a middle fluvial interval (the coal-bearing zone) and an upper fluvial-dominated deltaic interval (Johnson *et al*., 2006). The thickness and frequency of the sandstone units increases from the base of the formation, reaching their maximum in the middle fluvial interval and then decrease again towards the overlying Volksrust Formation. To the south and southeast, the Vryheid Formation grades laterally into undifferentiated, deep-water argillites of the Ecca Group (Figure 7).

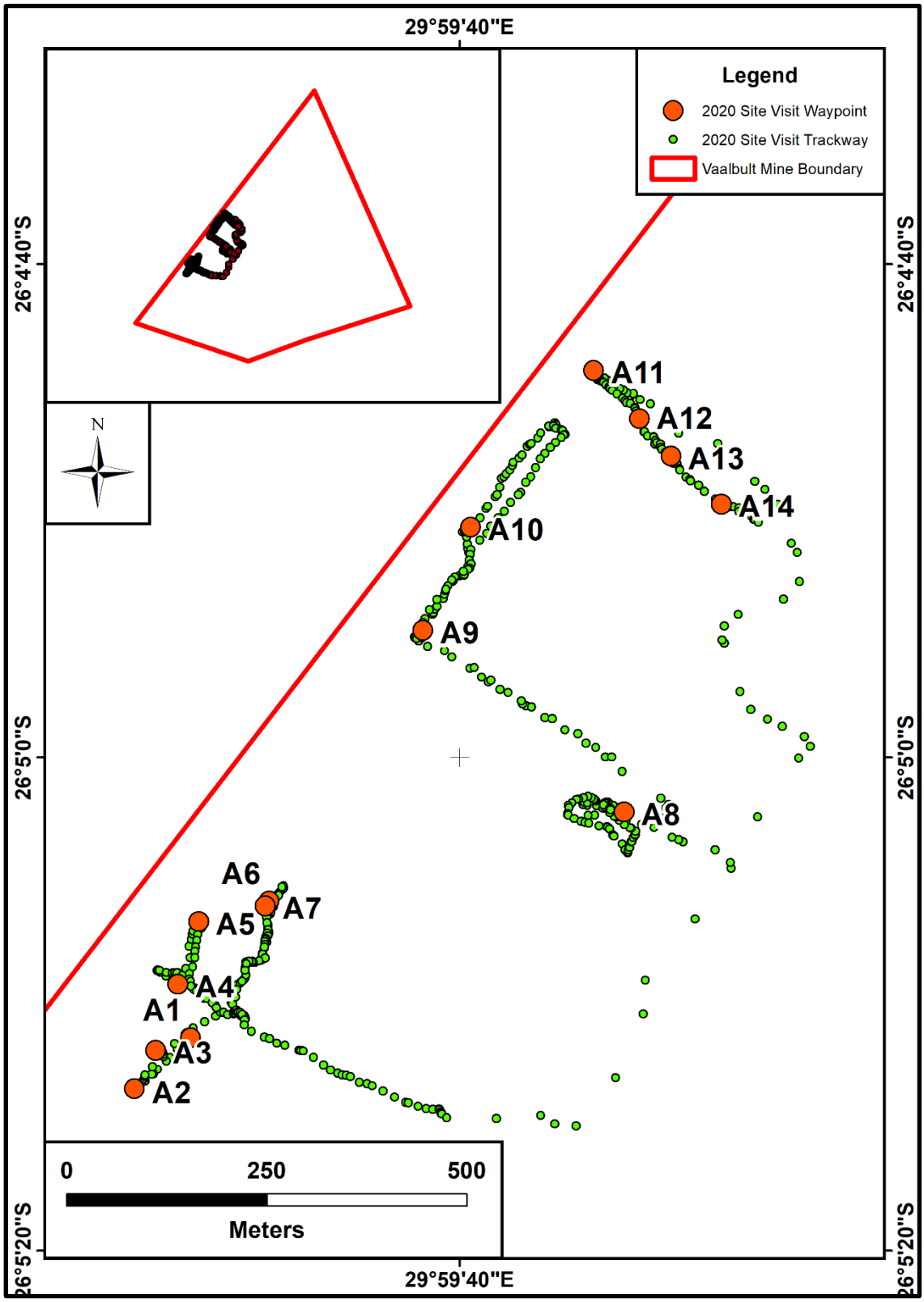

Figure 3: Map showing the location of the GPS waypoints and site visit trackway that define the areas examined during the site visit on the 28th of September 2020.

Figure 4: Waste rock piles from phase 23a cut (waypoint A12; see Figure 3).

Figure 5: Waste rock piles from phase 3b cut (waypoint A8; see Figure 3).

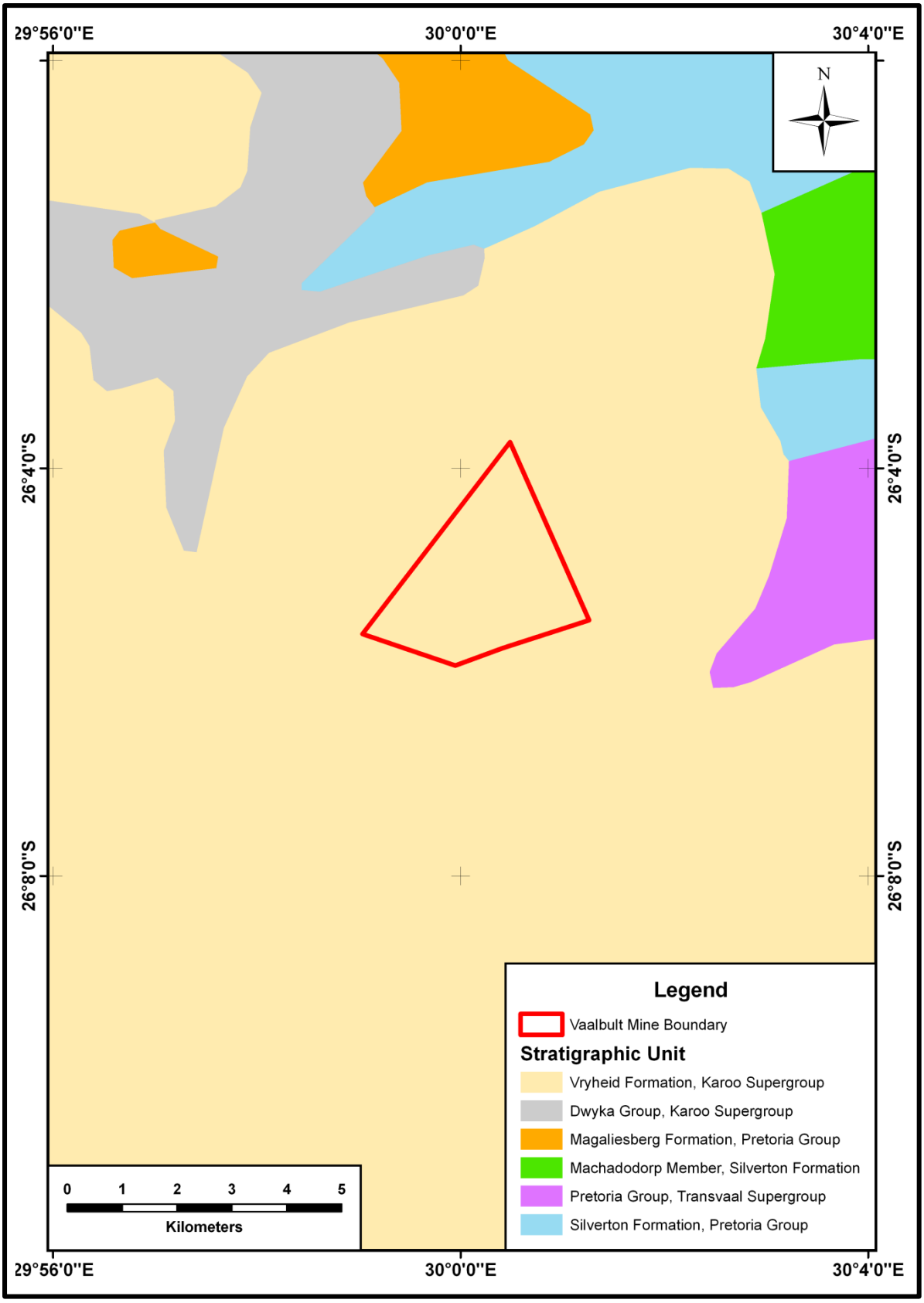

Figure 6: Geological map of the area underlying the Vaalbult Colliery Mining Right area and its immediate environs.

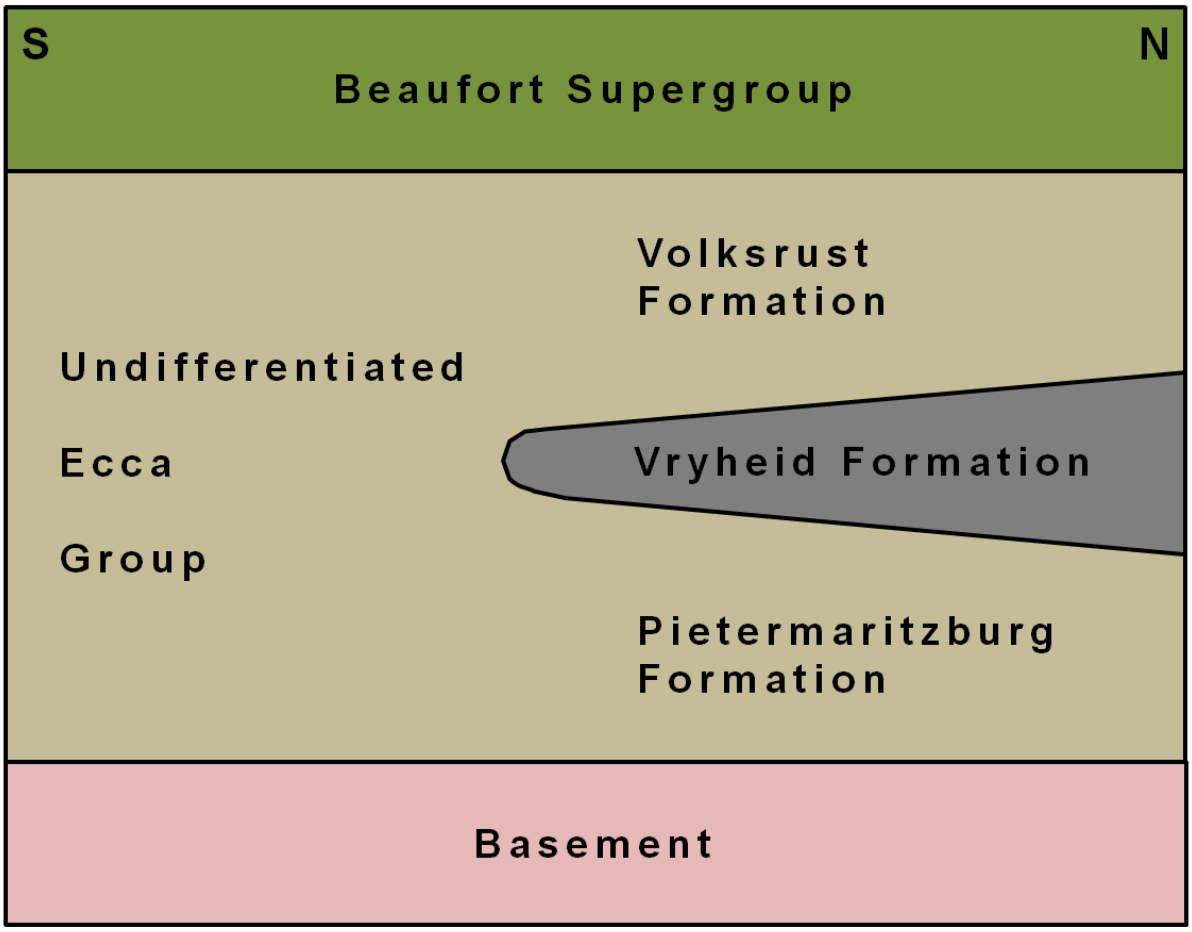

Figure 7: Schematic north-south oriented stratigraphic section of the Ecca Group in the northeast corner of the Karoo Basin. The Volksrust and Pietermaritzburg Formations can only be recognised when the Vryheid Formation forms part of the vertical sequence. In the north and north-western portions of the basin the Pietermaritzburg Formation was not deposited. In these areas the coal-bearing strata of the Vryheid Formation rest directly upon the basement.

The Vryheid Formation is one of sixteen (16) recognised stratigraphic units that constitute the Permian Ecca Group. During the deposition of the Ecca Group the basin was dominated by a large sea; the salinity levels of this water body remain unresolved. The exception to this model was the deposition of the coal-bearing strata of the Vryheid Formation along the northern margin during an episode of deltaic progradation into the basin.

Deposition of the Vryheid Formation was terminated by a basin-wide transgression. This event drowned the Vryheid Formation deltas and their coal swamps resulting in the deposition of the deep-water sediments of the Volksrust Formation. The investigation of

the project area did not identify any outcrops of bedrock, the entire area being covered by Cainozoic Regolith.

6.2 Geology of the Vaalbult Colliery

6.2.1 Historical overview

The major lithological succession described by BM Geological Services in previous reports from the colliery is outlined in Table 2. This stratigraphic sequence is dominated by the two coal seams that are being economically exploited by Vaalbult Colliery (Figures 8 and 9). These coal seams are the stratigraphically younger D seam (unit E) and the underlying E seam (unit A). The E seam constitutes the base of the colliery pit in all area observed and appears to be uniformly distributed throughout the colliery. The E seam has been observed to be up to ca. 1.5 m thick. Unit E has been observed to be present as a predominantly mudstone-rich horizon containing numerous thin, discontinuous coaly stringers; it has also observed as a well-developed coal seam > 40 cm and < 1.5 m in thickness. In this thicker part of the unit E a ±15-20 cm thick, grey coloured granulestone has previously been identified approximately half-way up the coal seam.

Lithological Unit	**Unit Code**
Regolith	H
Brown sandstone	G
Carbonaceous mudstone	F
D seam	E
Buff sandstone	D
Carbonaceous mudstone	C
Buff sandstone	B
E seam	A

Table 2: Lithological succession previously described from within the Vaalbult Colliery pit. The code indicated is the letter code used to identify the individual major lithological units in this report.

The sedimentary sequence separating the two seams varies between 11.5 m and 12.5 m in thickness (the thickness deceases towards the west; Figure 8). The inter-seam lithostratigraphic succession within the colliery is as follows. Immediately overlying the E seam is a highly variable sandstone unit (unit B) which is termed "the parting" in the mine's terminology. Unit B has been observed to be a 30 cm thick, buff coloured

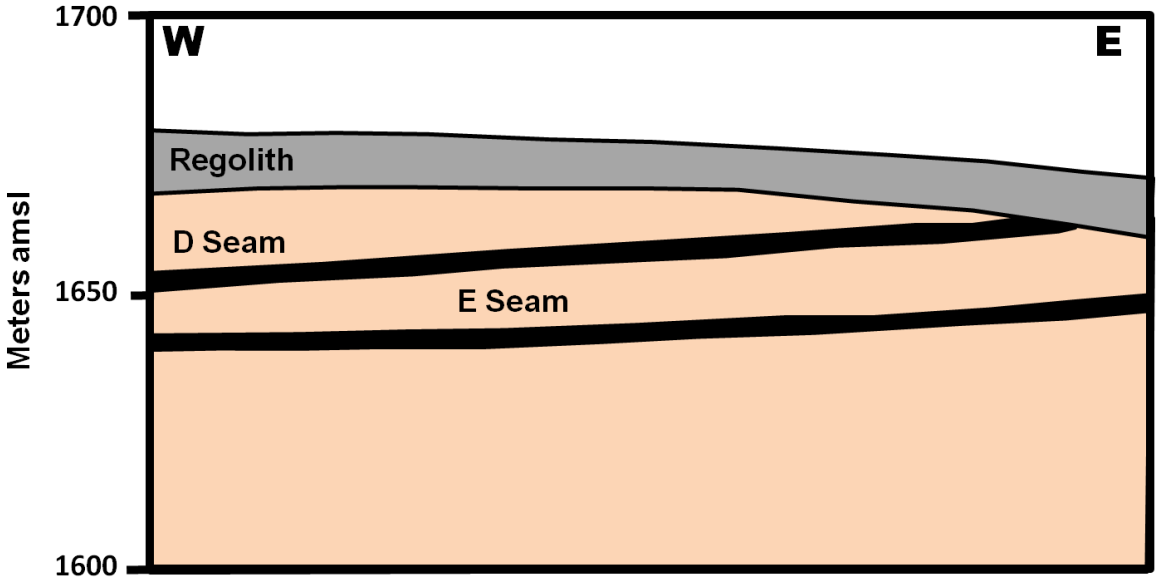

Figure 8: Schematic E-W oriented geological cross section across the central western section of the Mining Right area, and approximately in the same location as the mine pit (data obtained from the client). The location of this cross-section is provided in Figure 9.

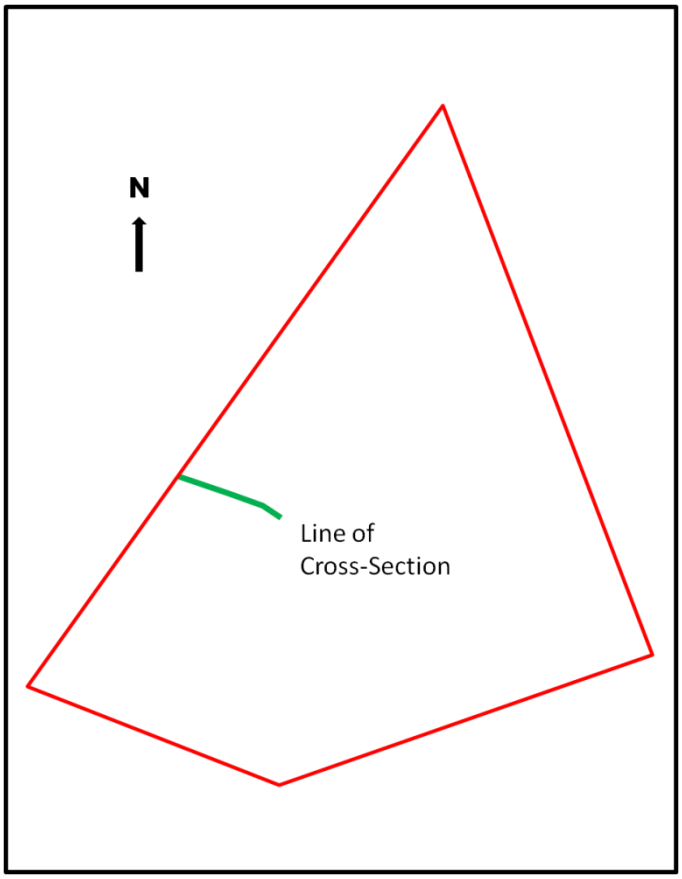

Figure 9: Map showing the location of the geological cross-section shown in Figure 8.

uniform, massively bedded unit. However, in some areas the sandstone forms a 50 cm thick fining-upward sequence with granulestone at the base, grading upward into a flaser-bedded portion and an upper-most massive to planar-bedded sandstone portion. A carbonaceous, very-coarse grained, highly irregularly thick, undulatory and lenticular, sandstone horizon up to ca. 30 cm thick occurs in some areas occurring between the top of the E seam and the base of Unit B. Elsewhere, unit B is present as a <2 m thick laminated, micaceous sandstone (the individual mica flakes exceed several millimetres in size. Overlying unit B is approximately 6 m of black, thinly laminated, carbonaceous mudstone and fine-sandstones. Unit C overlies unit B and consists of ca. 9-10 m of buff coloured sandstone. Overlying unit C is approximately 5-6 m of brown coloured, sandstones of unit D. The sandstone is variable in appearance, being parallel bedded in and exhibiting well developed point bar cross-beds. Unit C has been observed as being extremely variable in appearance. It sporadically occurs as a discontinuous 30-40 cm thick, buff coloured sandstone (maximum thickness) that occurs approx. 40–50 cm above the top of unit B. In some areas the sandstone is a distinct tabular member. Elsewhere along strike the sandstone lenses out to become a discontinuous non-connected series of lenses distributed over a 30-40 cm vertical stratigraphic thickness. Occurring above this sandstone, but still within unit C in the present site investigation is a ca. 30-40 cm thick buff coloured, tabular sandstone is present throughout all the sections identified and occurs ca. 2 m above the top of unit B.

Unit D has been observed to consist of approximately 5 m of tabular sandstones which are lighter in colour (buff) than in the underlying unit C. The unit is mostly composed of thin, well delineated tabular sandstones, but that distributed throughout the succession are a number (four were observed) of much thicker, laterally continuous buff sandstones.

The coals of Unit E (D seam) overly unit D and the maximum exposed thickness in the colliery is ca. 40 cm. In the previous biannual site visit the unit overlying unit E was ca. 8 m of thinly laminated, black carbonaceous mudstones (termed unit F). The rocks comprising unit F was subdivided in a previous palaeontological audit report into three distinct lithological subunits (termed F1-F3). Rock sequence F1 consists of ca. 2 m of massive and laminated dark grey mudstones, F2 consists of ca. 1 m of light grey, laminated mudstones and the upper part of unit F consists of ca. 3 m of black, carbonaceous mudstone (subunit F3). Overlying unit F is a light brown sandstone unit several meters in thickness termed unit G. The light brown sandstones of unit G have not been observed closely anywhere in the colliery and, as such, little detail can be provided of it. Approximately 2 m of regolith (unit H) tops the sequence.

6.2.2 Observations from the current study

Figures 10-18 depict the lithological successions identified during the conduct of the present study. Figures 10-18 are presented below and grouped according to their

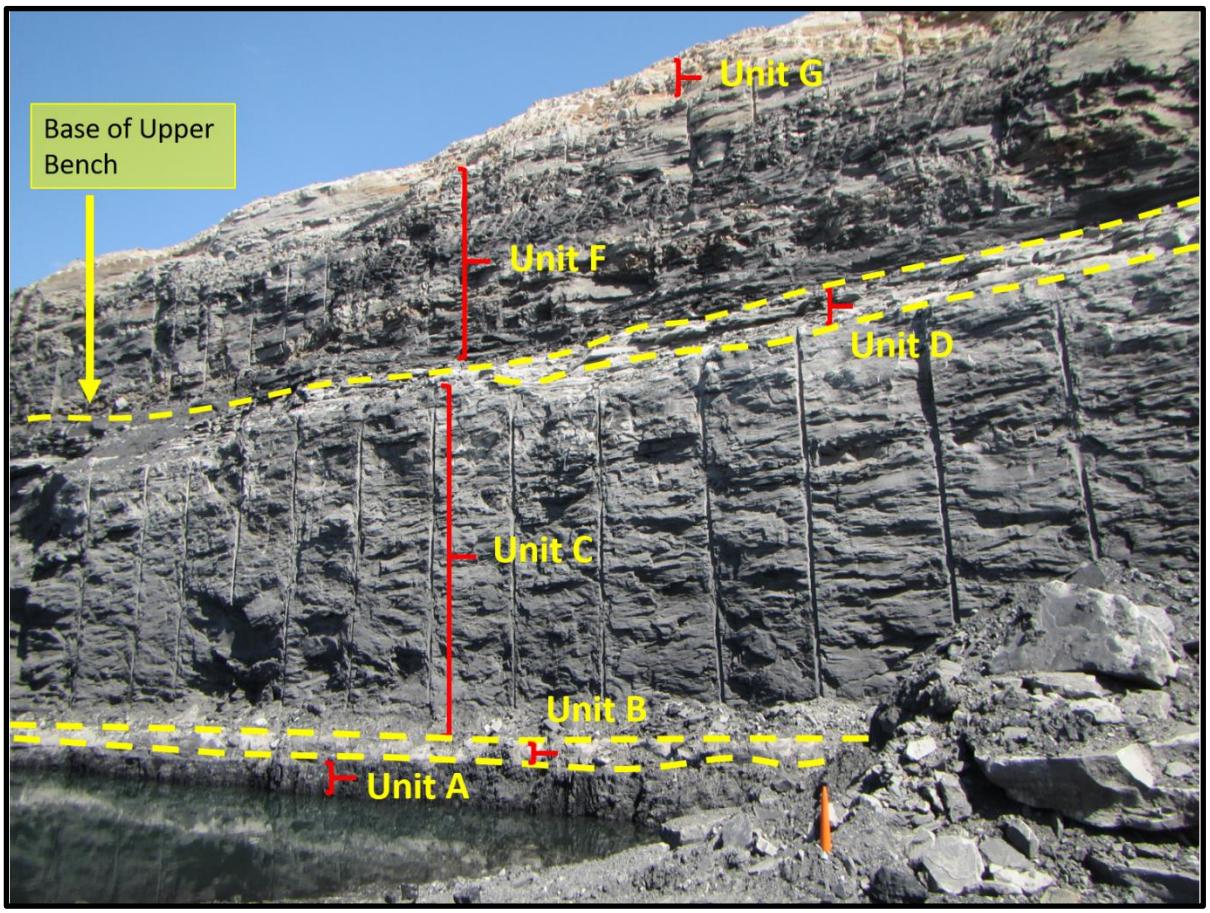

Figure 10: View of the western end of phase 23b cut (waypoint A2; see Figure 3). Both the lower and upper bench highwalls are evident. It is apparent that in this section of the colliery unit D occurs at the top of unit C (it occurs sporadically throughout unit C elsewhere in the colliery) and pinches out within the field of view.

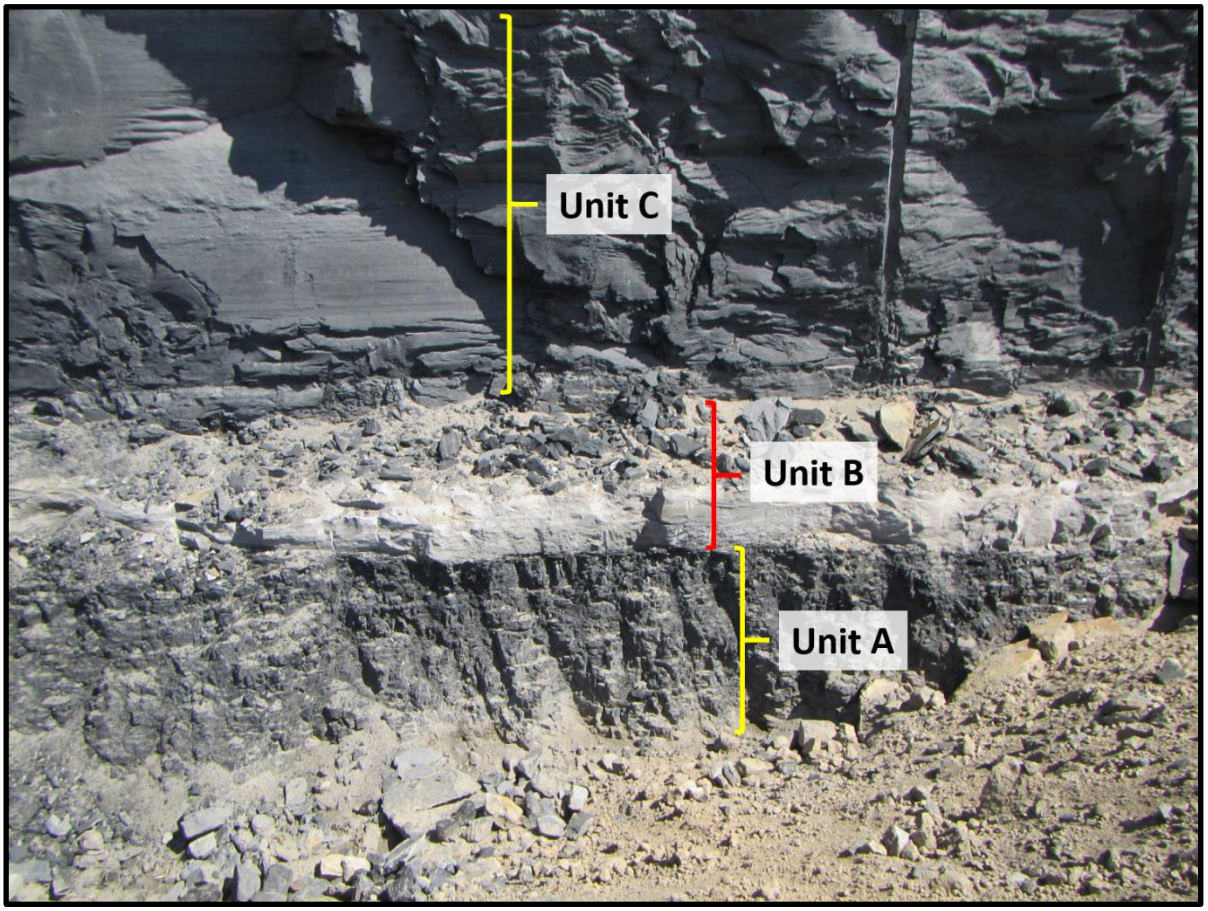

Figure 11: View of the roof of unit A (E seam) in the floor of the western end of phase 3b cut (waypoint A3; see Figure 3). The development of the overlying unit B is typical of that seen elsewhere in the colliery. Scattered examples of *Skolithus* burrows were observed associated with unit B in this area.

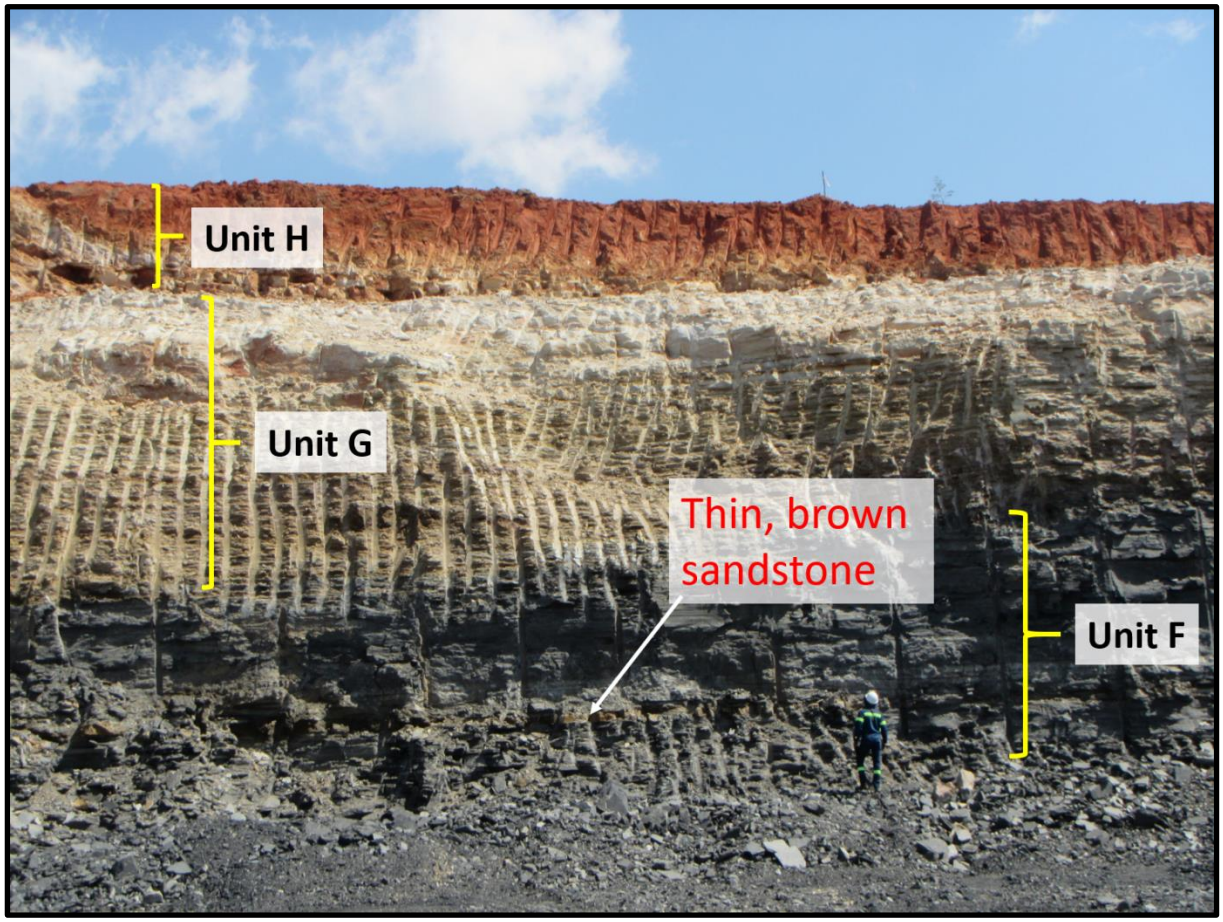

Figure 12: View of the upper bench highwall in the eastern end of the phase 3b cut (waypoint A4; see Figure 3). Visible are the carbonaceous mudstones of unit F at the base of the highwall, the overlying brown sandstones of unit F and a layer of brown regolith (unit H) forming the top of the highwall. Mr M Magagula forms the scale for the image. The stratigraphic position of the thin, brown sandstone within unit F and illustrated in Figure 12 is indicated.

Figure 13: Close-up view of the ca. 15 cm thick brown sandstone bed that occurs approximately 2,5 m above the base of unit F (see Figure 11 for context. The image was taken at waypoint A4 (see Figure 3 for location). The extend of the unit is denoted by the red bracket.

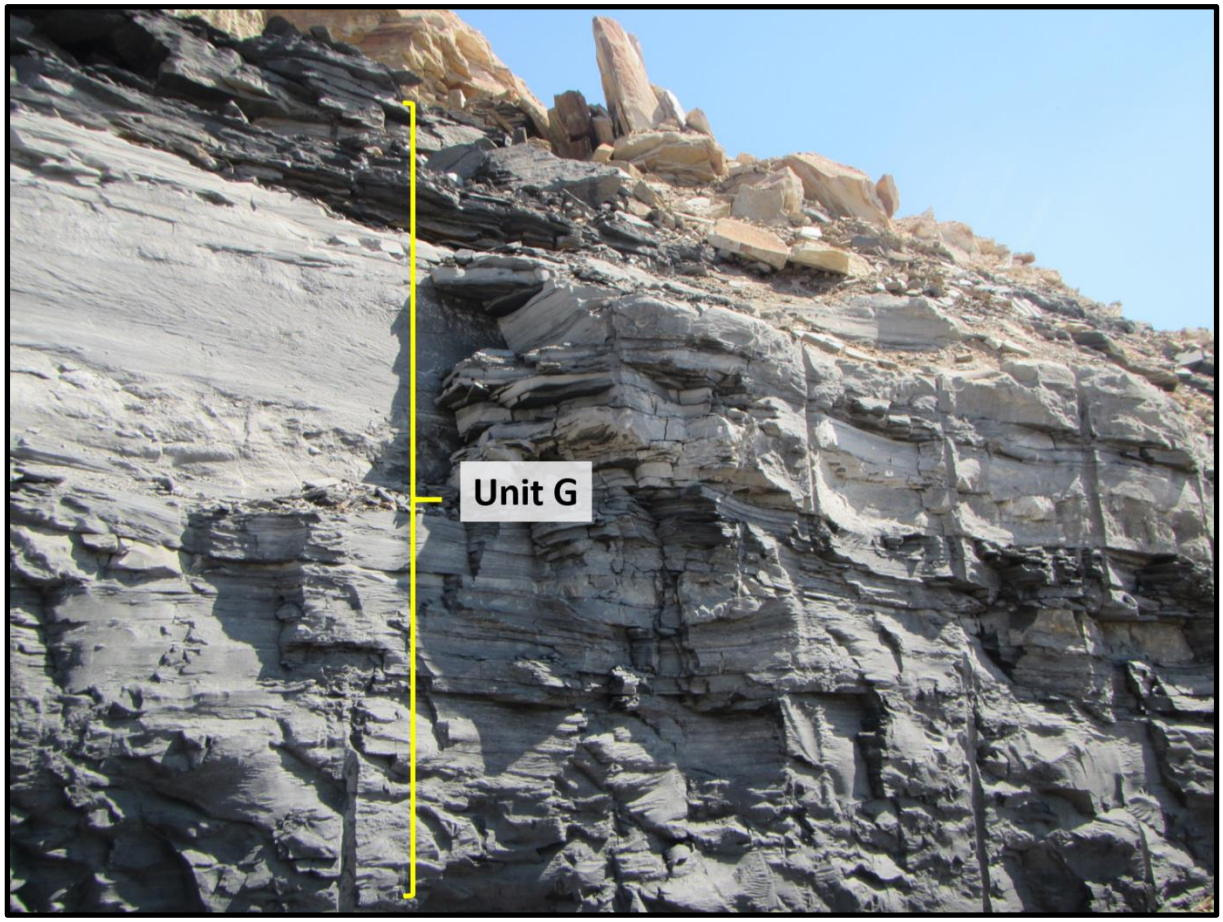

Figure 14: View of the light grey, finely, planar-bedded sandstones of unit G (waypoint A4; see Figure 3). This exposure provided a previously unavailable close-up view of this lithology.

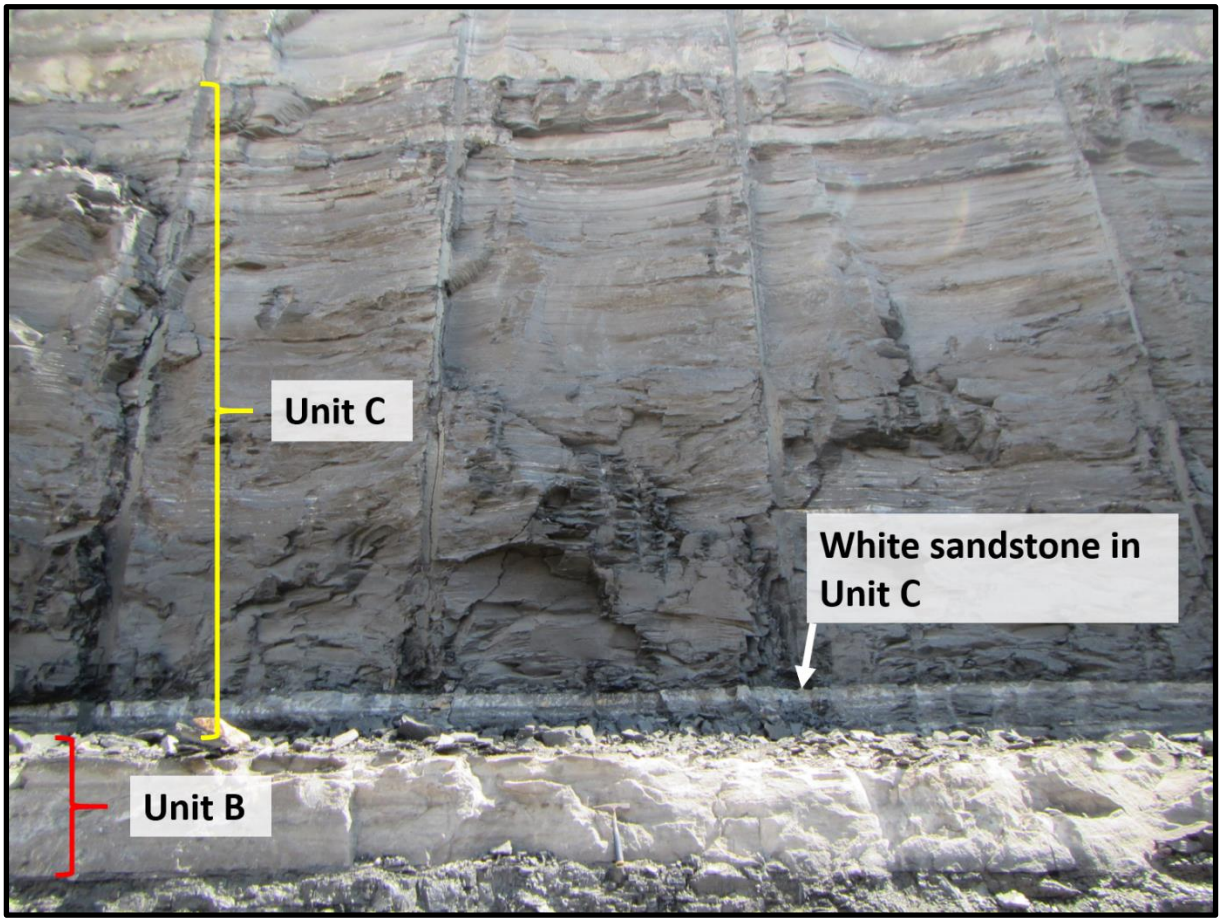

Figure 15: View of a typical exposure of unit B. However, a local variation in the stratigraphy in the eastern end of the phase 3b cut is the ca. 7-15 cm thick thin, tabular, white sandstone that occurs just above the base of unit C. It is possible that this represents a distal crevasse splay deposit (waypoint A7, see Figure 3).

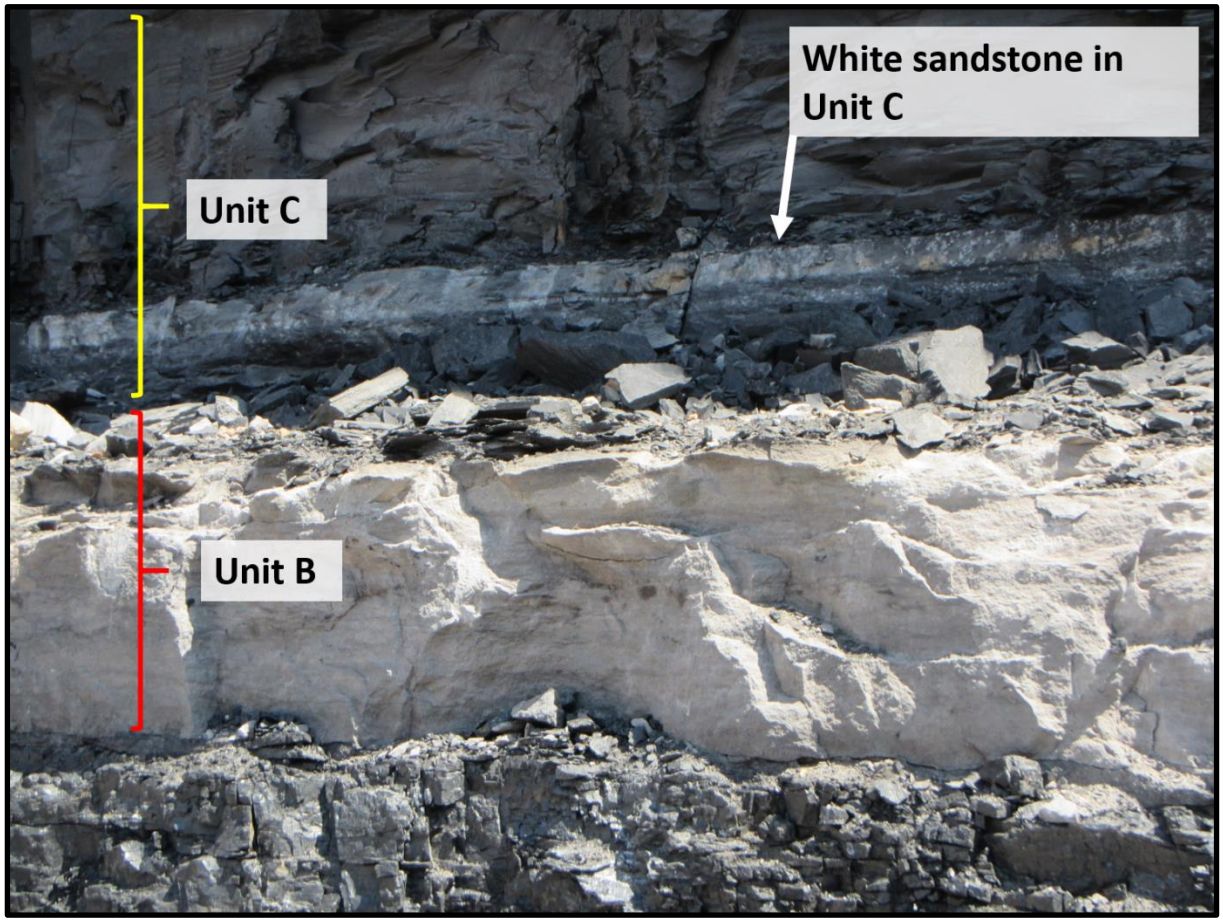

Figure 16: Close-up view of a typical exposure of unit B and the overlying white, tabular sandstone horizon shown in Figure 13 (waypoint A7, see Figure 3). It is evident that the white sandstone is composed of multiple, closely separated beds.

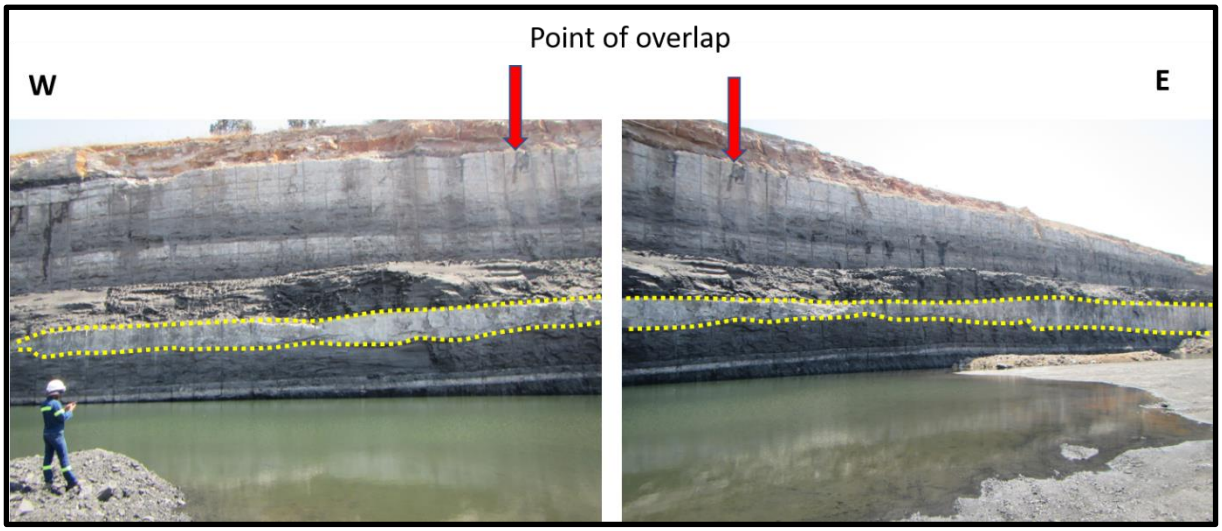

Figure 17: A series of photographs from east to west along the highwall of the phase 3a cut (a common point in the overlapping images is indicted). It is apparent the unit D (indicted by the yellow stippled line) thins from east to west and, indeed, lenses out within the highwall exposure.

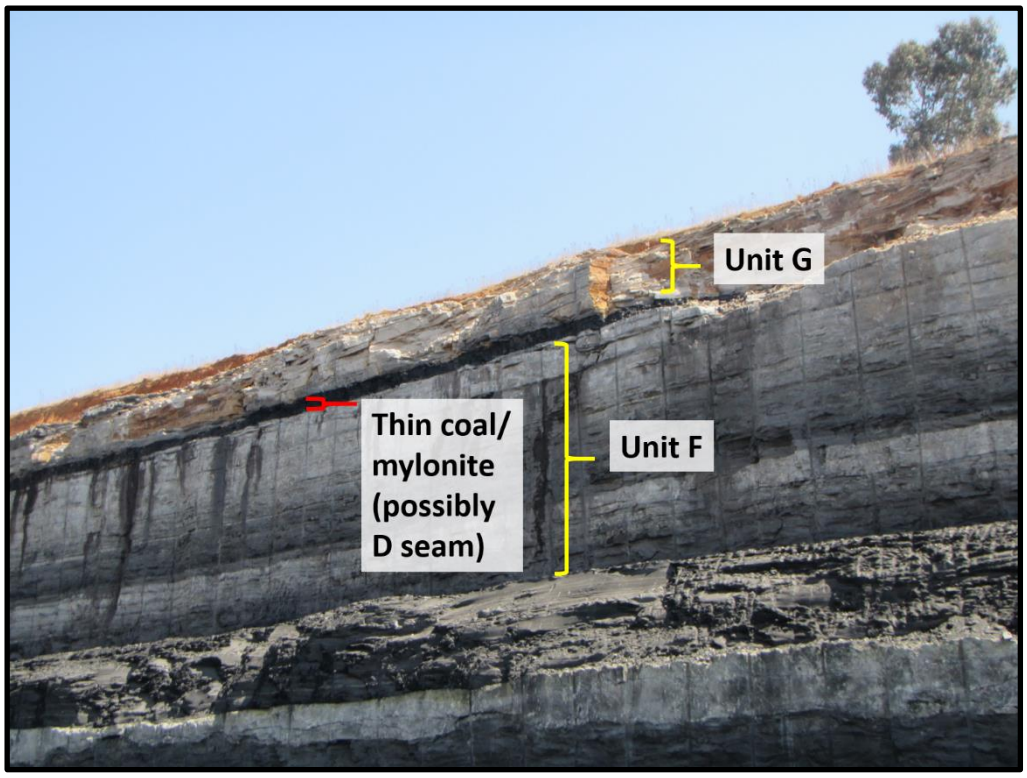

Figure 18: A local variation in the stratigraphy of the colliery (waypoint A9, see Figure 3). Here a thing coal seam is exposed between unit F and unit G and it appears to pinch out to the east. Thin, discontinuous coals were reported in a similar stratigraphic position during the 2019 site visit report from near the southern boundary

presence in phase 3b cut and then phase 3a cut, as well as if they represent the lower or upper bench of the cut.

The stratigraphic sequence depicted in Figure 10 is reasonably representative of observations made throughout the extent of the mining operations to date. The lensing-out of the sandstones of unit D exhibited here is not uncommon, nor is the fact that the unit occurs at different levels within unit C. This fact is exemplified by comparison to its stratigraphic position in Figure 17. Recognition of this stratigraphic relationship in the 2019 study prompted a revision of the stratigraphy outlined in Table 2 to produce Table 3.

Lithological Unit	**Unit Code**
Regolith	H
Brown sandstone	G
Carbonaceous mudstone	F
D seam	E
	D
	C
Buff sandstone	B
E seam	A

Table 3: Revised Lithological succession for the Vaalbult Colliery. The code indicated is the letter code used to identify the individual lithological units in this report.

A new stratigraphic observation is the development of a thin (<15 cm thick), white, tabular sandstone inconsistently located just above the top of unit B (Figures 15 and 16). This unit may be the distal facies of another crevasse splay deposit.

Figure 12 presents a reasonably representative stratigraphic section encountered in the upper bench of most cuts in the colliery (i.e., the sequence overlying D seam). However, a new lithofacies facies was identified in this sequence and is represented by the brown tabular sandstone in Figures 12-13. It was also possible in the upper bench of the phase 3b cut to gain access to unit G that had previously been impossible (Figure 14). The tabular, well-bedded nature of the unit G sandstones was evident.

In the 2019 site visit to the southern-most sections of the Mining Right area the highwall in the southern portion of cut 8 exposed the carbonaceous sandstones normally overlying unit D to be absent from the lithological section. In this part of cut 8 unit E lay directly upon unit D (as it does in the central and northern portions of the mine area) and unit C appears to be attenuated at ca. 4 m thick. The absence of the upper portion of unit C may, however, be explained by the presence of a fault in southern extent of cut 8. In the faulted portion of the sequence a normal fault is present, and sandstones attributed to unit G lies directly upon a thin succession of unit C. The fault plane is delineated by an inconsistently thin, black mylonite that probably represents the mylonitized remnants of the D seam. Figure 18 from the highwall of the upper bench of the phase 3a cut shows the presence of an unusually thin, stratigraphically anomalous "coal" that occurs between units F and G. The "coal" is seen to lens-out to the centre of the field of view. It is interpreted herein that this anomalous coal may well also be a mylonitized coal delineating a low-angle fault trace. Although the possibility that it is a third coal seam present within the colliery cannot also be discounted.

6.3 Palaeontological potential

6.3.1 Palaeontology of the Vryheid Formation

The most conspicuous and common components of the palaeontological record of the Ecca Group in general are the plant macrofossils of the *Glossopteris* flora. Two large and conspicuous leaf form taxa dominate the *Glossopteris* flora, these being *Glossopteris* and *Gangamopteris*. Within the upper Ecca (containing the Vryheid Formation) *Gangamopteris* has ceased to occur with only *Glossopteris* present (Anderson and McLauchlan, 1976). The palaeobotanical record of the Ecca Group is diverse and the literature describing it is voluminous (numerous papers having been published by E. Plumstead, H. Anderson, J. Anderson, E. Kovaks-Endrődy, R. Prevec, and M. Bamford amongst others). A comprehensive review of the flora in the Karoo Basin literature is, accordingly, beyond the scope of this study, but a thorough review of the palaeobotanical content of the Ecca Group in general and the Vryheid Formation is presented in Bamford (2004). In that summary, it is indicated that the Vryheid Formation can be expected to contain the plant macrofossils *Buthelezia*, *Sphenophyllum*, *Rangia*, *Phyllotheca*, *Schizoneura*, *Sphenopteris*, *Noeggerathiopsis*, *Taeniopteris*, *Pagiophyllum* and *Benlightfootia* and the wood taxa *Australoxylon* and *Prototaxoxylon*. In addition to the above records can be added the observations of Tavener-Smith *et al*., (1988) where it was noted that both *Glossopteris* and *Vertebraria* occur within the palaeontological record of the formation.

In portions of the formation typified by low thermal alteration, abundant assemblages of palynomorph plant microfossils (including acritarchs) can be expected (Anderson, 1977).

Jubb and Gardiner (1975) report the presence of fragmentary fish fossils within the Ecca sequence of southern Africa, these being *Coelacanthus dendrites* from the Somkele coal-

field of northern Natal and *Namaicthys digitata* from correlative strata in the Senge Coal-fields of Zimbabwe. While fish faunas are obviously rare and none have been reported from the Vryheid Formation the possibility remains that they may be present.

Animal body fossils are rare within the Ecca Group in general (excepting the time equivalent faunas of the Whitehill Formation). However, no reptile fossils have been identified within the Vryheid Formation.

Hobday and Tavener-Smith (1975) reviewed trace fossil assemblages identified within the Vryheid Formation. Within that fossil assemblage, they identified two forms (*Helminthiopsis* and *Taphrelminthopsis* within horizontally laminated siltstones and mudstones that represent part of the deep-water *Nerites* community.

6.3.2 Palaeontology of the Vaalbult Colliery

Two district groups of fossils were identified within the sedimentary strata that comprise the Vaalbult Colliery highwalls and the waste rock stockpiles. The fossil assemblages consist of plant macrofossils and a trace fossil assemblage.

6.3.2.1 Plant macrofossils

During the conduct of this site visit the small number of plant macrofossils identified consisted of unidentifiable woody, carbonaceous, stem compressions (waypoints A11, A13-14; Figures 19-21). Unfortunately, the stratigraphic provenance of many of these fossils could not be accurately determined, as they were located within the waste rock pile material that had been both mined and transported, but the rock material containing the plant fossils appears to originate from unit B. Similarly, the precise geographic provenance the fossils could not be determined. Prof Millsteed was informed that the rock material in the waste rock piles originated from mining activities that had been conducted and completed earlier in phase 3a cut. In any event, the fossils identified in the waste rock piles were of little scientific value and were similar to fossils identified during earlier site visits.

The fossil materials located in the visit are not palaeontologically significant, due to their unidentifiable nature and the lack of precise stratigraphic provenance. What is evident from these fossils is that their distribution is highly patchy within the mine sequence. The large size of the original woody stem segments and the absence of smaller plant fragments (common leaves, fructifications or fragmentary accumulations) suggests a high energy depositional system dominated the environment of deposition of the enclosing sediments.

6.3.2.2 Trace fossils

During the conduct of earlier site visits conducted in the period 2016-2019 trace fossils representing burrows of two types were identified within the sedimentary rocks of the mine sequence. These fossils are a) closely spaced, unbranching, vertical, tubular burrows identified as the ichnogenus *Skolithus* and b) branching or bifurcating horizontal burrows tentatively identified as the ichnogenus cf. *Scolicia*. The fossils identified as the ichnogenus *Skolithus* were overwhelmingly the dominant ichnogenus recognised at the colliery. During the conduct of the present site visit only *Skolithus* sp. burrows were identified. *Skolithus* sp. specimens (Figures 22-23) were located in the present site visit within rocks of unit B in phase 3b cut (waypoint waste rock stockpiles at waypoints A2 and A3 (see Figure 3 for locations) and in the waste rock piles emanating from phase 3b cut at waypoints A8 (see Figure 3 for locations). The fossils occurring in the waste rock piles occur in coarse-grained, sandstones with carbonaceous/micaceous laminations typical of unit B.

Hobday and Tavener-Smith (1975) report the presence of this fossil type elsewhere in the Ecca Subgroup where they occur in sandstones associated with upward-coarsening regressive facies cycles attributed to delta progradation.

As with the plant macrofossils discussed in Section 6.3.2.1 above the ichnofossil assemblages are not uniformly distributed within the rocks of the coalmine sequence, but are instead markedly patchy in their occurrence. These specimens were present in extensive accumulations of evenly spaced burrows. The lithology containing these fossils is micaceous, carbonaceous sandstones similar to those observed in “the parting” and otherwise known as unit B.

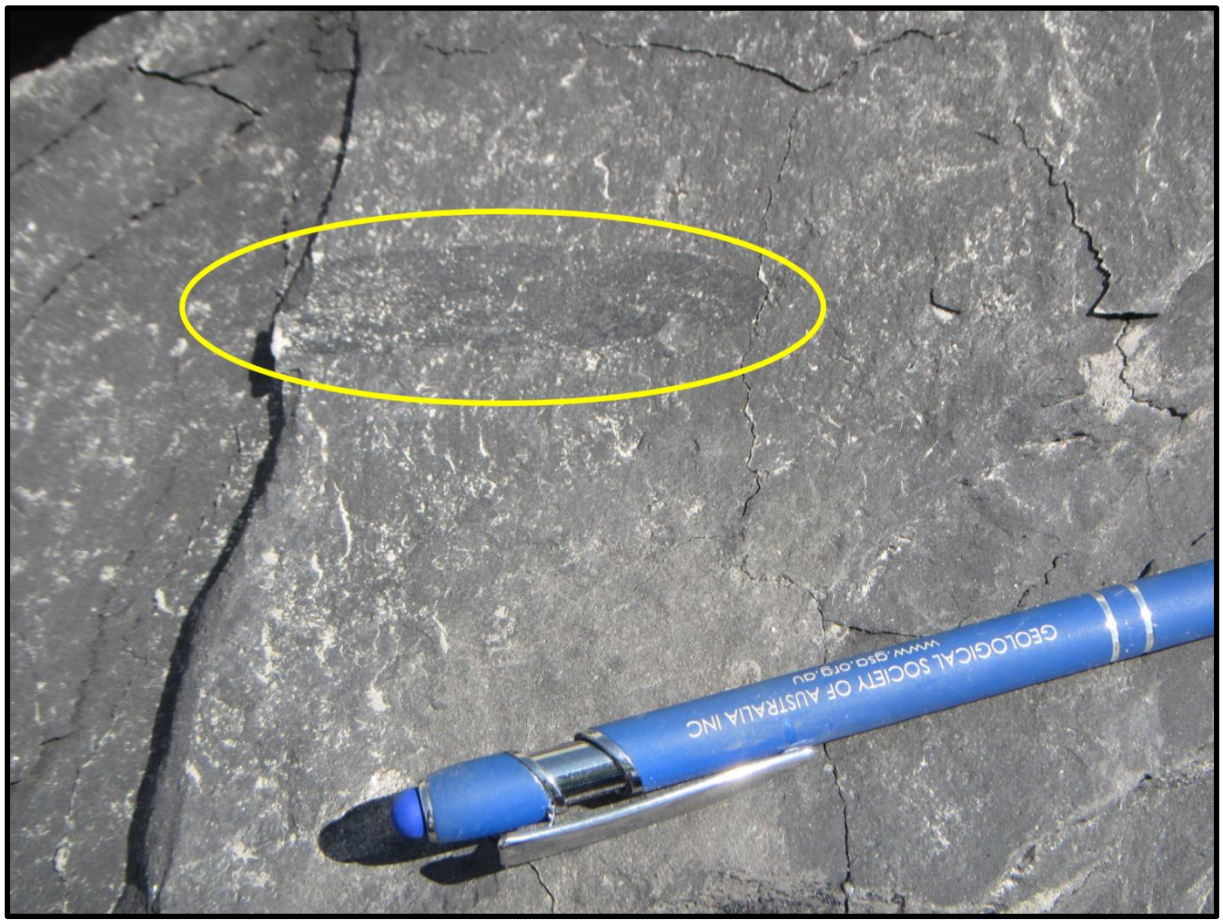

Figure 19: Carbonaceous leaf compression (marked by yellow oval). The fossil is probably a Glossopterid leaf based on the age of the strata and the tongue-shape of the compression. Location is waypoint A11 (see Figure 3).

Figure 20: Stem segment compression approximately 30 cm long x 10 cm wide. Location is waypoint A13 (see Figure 3). The surrounding matric appears to be that of unit B.

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Figure 21: Large carbonaceous compression of woody stem segment (trunk or branch). The specimen (within the yellow polygon) is ca. 1m long x 5-7 cm wide. The surrounding matrix appears similar to that of unit B. Location of the image is waypoint A4 (see Figure 3).

Figure 22: Densely packed specimens of *Skolithus* sp. on a single bedding plane (waypoint A8, see Figure 3).

Figure 23: Densely packed specimens of *Skolithus* sp. on a single bedding plane (waypoint A8, see Figure 3).

7 SUMMARY

Prof B. Millsteed in the presence of Mr M Magagula of Geovicon Environmental (Pty) Ltd [representing Vaalbult Mining Company (Pty) Ltd] conducted a site investigation of various box cuts in the open pit and associated waste rock stockpiles at the Vaalbult Colliery on the 28th of September 2020. The present investigation was conducted within the mine's phase 3a and 3b cuts as well as the waste rock piles that were derived from those two cuts. No areas were being actively mined at the time of the site visit, but these areas represent all unrehabilitated area that had been mined since the previous site visit in 2019. The waste rock represents a cross-section of all non-coal lithologies mined from those two unrehabilitated cuts.

The site investigation confirmed the presence of the eight-separate major lithofacies (including an upper-most unconsolidated regolith horizon) which include two coal seams (the D Seam and the E Seam) that were identified during the preceding annual palaeontological monitoring investigations. However, the author's understanding of the stratigraphic relationships in the mine sequence has been expanded and advanced as a result of observations made during this visit.

The strata examined to date within the mine pit and associated waste rock stockpiles are generally poorly fossiliferous. During the present site visit several unidentifiable carbonaceous stem compressions of a woody stem segments and a small number of blocks containing numerous *Skolithus* sp. ichnofossils were located within rocks attributed in the waste rock dumps examined. Unfortunately, the stratigraphic and box cut provenance of these fossils was not known. However, it was known that the rock material originated from cuts mined since the previous site visit in late 2019. The fossils themselves were of minimal scientific importance and, thus, even if the provenance was known no damage mitigation protocols would have been required. No fossil materials were identified in the box cuts visited.

As stated above, none of the fossils (plant macrofossil or trace fossils) identified are palaeontologically significant and require special preservation or excavation. Burrows attributable to *Skolithus* provided permanent shelter to animals that procured their food above the level of the sediment-water interface (Hobday and Tavener-Smith, 1975). The ichnogenus has been observed to be associated with the sandstones of unit B, with the sandier basal portion of unit C, and with the base of unit F elsewhere in the colliery in the preceding palaeontological monitoring reports (dated 2016 to 2019).

None of the fossils identified are palaeontologically significant and require special preservation or excavation. It is evident that the colliery is currently exploiting rocks that are typified by being either palaeontologically depauperate or low in taxonomic diversity. This may however change as different portions of the Mining Right area and/or new lithological successions are exploited.

8 RECOMMENDATIONS AND CONSIDERED OPINION

The lithological succession of the Vaalbult Colliery is fossiliferous (although not abundantly so) and so due care needs to be exercised to ensure that the palaeontological heritage of the area is not diminished by the mining activities. That said, the strata being mined by the colliery occur beneath a uniformly thick regolith horizon and do not crop out. The absence of bedrock outcrop means that no fossils are observable at surface. As a result, it is only due to the ongoing mining activities that the fossiliferous strata are exposed and made available for scientific study. None of the fossils located during this study or the preceding study are of sufficient palaeontological significance that their excavation by a palaeontologist or their preservation is required, but this may not always be the case. However, the area planned to be mined is large and only a small proportion of it has been exploited to date. In addition, several of the geological units present within the mine show significant sedimentological variation across the small area mined to date. It is interpreted, herein, that significant facies variations may be possible across the full extent of the Mining Right area. Changes within the abundance and type of fossil assemblages may be possible and that palaeontologically significant fossil assemblages may be present. The possibility of the presence of palaeontologically significant fossils within the rocks of the colliery therefore remains a strong possibility.

It is accordingly recommended that:

- The annual palaeontological audit of the mine workings should continue (subject to later review) due to the presence of identified fossil assemblages.
- Should the rock sequence prove to become more prolifically fossiliferous in the future the frequency of the audit process should be reviewed with a view to increasing their frequency.

9 REFERENCES

Anderson, J.M. (1977). The biostratigraphy of the Permian and Triassic. Part 3. A review of Gondwana Permian palynology with particular reference to the northern Karroo Basin of South Africa. *Memoirs of the Botanical Survey of South Africa*, 41: 1–133.

Anderson, A.M. and McLauchlan, I.R. (1976). The plant record in the Dwyka and Ecca Series (Permian) of the south-western half of the Great Karoo Basin, South Africa. *Palaeontologia Africana*, 19: 31-42.

Bamford, M.K. (2004). Diversity of woody vegetation of Gondwanan southern Africa. Gondwana Research, 7: 153-164.

Johnson, M.R., van Vuuren, C.J., Visser, J.N.J., Cole, D.I., de V. Wickens, H., Christie, A.D.M., Roberts, D.I., and Brandl, G. (2006). *Sedimentary Rocks of the Karoo Supergroup*, in Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J. (eds) The Geology of

South Africa, Johannesburg: Council for Geoscience, Pretoria: Geological Society of South Africa: 461–499.

Jubb, R.A. and *Gardiner,* B.G., (1975). A preliminary catalogue of identifiable fossil fish material from southern Africa. *Annals of the South African Museum*, 67 (11): 381–440.

Hobday, D.K. and Taverner-Smith, R. (1975). Trace fossils in the Ecca of northern Natal and their palaeoenvironmental significance. *Palaeontologia Africana*, 18: 47-52.

Tavener-Smith, R., Cooper, J.A.G. and Rayner, R.J. (1988). Depositional environments in the Volksrust Formation (Permian) in the Mhlatuze River, Zululand. *South African Journal of Geology,* 91: 198-206.

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26 October 2020