PALAEONTOLOGICAL HERITAGE ASSESSMENT: COMBINED DESKTOP & FIELD-BASED STUDY

Proposed Meerkat Solar Power Plant on Portion 3 (Portion of Portion 2) of the Farm Vyflings Pan 598 near Vryburg, Naledi Local Municipality, North-West Province

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February 2016

EXECUTIVE SUMMARY

The company Meerkat Solar Power Plant (RF) (Pty) Ltd is proposing to develop up to 115 MW photovoltaic solar facility, known as the Meerkat Solar Power Plant, on Portion 3 (Portion of Portion 2) of the Farm Vyflings Pan 598, IN Registration Division, Province of the North-West.

The Meerkat Solar Power Plant study area is entirely underlain by late Archaean (*c*. 2.6 billion year-old) sedimentary rocks of the Schmidtsdrif Subgroup (Ghaap Group, Transvaal Supergroup). These mainly comprise shallow marine siliciclastic sediments and possible lavas of the Vryburg Formation *plus* carbonate sediments of the Boomplaas Formation.

Field assessment suggests that stromatolite-bearing carbonate rocks are not present at surface within the Vryburg and Bomplaas Formation outcrop areas in the study area. The overlying superficial sediments (*e.g.* sandy soils, calcretised pan deposits) are of low palaeontological sensitivity. It is concluded that, with or without mitigation, the overall impact of the proposed Meerkat Solar Power Plant on Farm Vyflings Pan 598 is of **NEGATIVE LOW SIGNIFICANCE** in palaeontological heritage terms.

Should significant fossil remains - such as well-preserved stromatolites - be exposed during construction, the responsible Environmental Control Officer should safeguard these, preferably *in situ*. The South African Heritage Resources Authority (SAHRA) should be alerted as soon as possible (Contact details: Mrs Colette Scheermeyer, P.O. Box 4637, Cape Town 8000, Tel: 021 462 4502, Email: cscheermeyer@sahra.org.za), so that appropriate action can be taken by a professional palaeontologist, at the developer's expense. Mitigation would normally involve the scientific recording and judicious sampling or collection of fossil material as well as associated geological data (*e.g.* stratigraphy, sedimentology, taphonomy) by a professional palaeontologist. The palaeontologist concerned with mitigation work will need a valid fossil collection permit from SAHRA and any material collected would have to be curated in an approved depository (*e.g.* museum or university collection). These recommendations should be included within the EMPr for the proposed solar power plant development.

There are no fatal flaws in the proposed solar power plant development, nor are there objections to its authorisation as far as fossil heritage conservation is concerned, *provided* that the mitigation recommendations outlined above are fully complied with. The no-go option (no solar development) will have a neutral impact on local palaeontological heritage resources.

1. INTRODUCTION & BRIEF

The company Meerkat Solar Power Plant (RF) (Pty) Ltd is proposing to develop up to 115 MW photovoltaic solar facility, known as the Meerkat Solar Power Plant, on Portion 3 (Portion of Portion 2) of the Farm Vyflings Pan 598, IN Registration Division, Province of the North-West. The land parcel measures 428,2660 hectares in area and is situated approximately 27 km WNW of the town of Vryburg, Naledi Local Municipality, North-West Province. The footprint of the proposed alternative energy project will be approximately 250 hectares (including supporting infrastructure).

The study site is situated on flat lying terrain in the south-eastern portion of the Farm Vyflings Pan 598, *c.* 27 km northwest of the R14 tar road between Vryburg and Upington. The location of the study area is shown on the map Fig. 1 and a satellite image of the area is shown in Fig. 2.

The proposed solar energy facility overlies potentially fossiliferous sediments of the Ghaap Group (Transvaal Supergroup) of Precambrian age. Fossils preserved within the bedrock or superficial deposits may be disturbed, damaged or destroyed during the construction phase of the proposed project. The extent of the proposed development (over 5000 m^2) falls within the requirements for a Heritage Impact Assessment (HIA) as required by Section 38 (Heritage Resources Management) of the South African Heritage Resources Act (Act No. 25 of 1999).

The present combined desktop and field-based palaeontological study has accordingly been commissioned on behalf of the client by Meerkat Solar Power Plant (RF) (Pty) Ltd (Contact details: Mr D.P.S. Berlijn**,** Managing Director. Phone: +27 10 500 3680. Mobile: +27742 488 488. Fax: +27 862 731 614. Address: 2nd Floor West Tower, Nelson Mandela Square, Maude Street, Sandown. PO Box 785553, Sandton, 2146, RSA).

The Terms of Reference for this palaeontological study, as defined by Meerkat Solar Power Plant (RF) (Pty) Ltd, are as follows:

- A desktop investigation of the area, in which all geological maps, published scientific literature, previous paleontological impact studies in the same region and the author's field of experience (consultation with professional colleagues as well as examination of institutional fossil collections and data) should be studied and used.

- Based on the outcome of the desktop study and the comments obtained from SAHRA, the need for a field assessment must be determined. The desktop investigation must be supplemented with a field assessment if required.

- Assess the potential impacts, based on a supplied methodology.

- Describe mitigation measures to address impacts during the construction, operation and decommissioning stages.

- Develop a protocol for any paleontological finds.

- Describe cumulative impacts of the project on paleontological resources in both the local study area, regional study area and the proponent's plans to manage those effects.

- Supply the client with geo-referenced GIS shape files of any sensitive areas.

1.1. Legislative context of this palaeontological study

The various categories of heritage resources recognised as part of the National Estate in Section 3 of the National Heritage Resources Act (1999) include, among others:

- geological sites of scientific or cultural importance;
- palaeontological sites;
- palaeontological objects and material, meteorites and rare geological specimens.

According to Section 35 of the National Heritage Resources Act, dealing with archaeology, palaeontology and meteorites:
(1) The protection of archaeological and palaeontological sites and material and meteorites is the responsibility of a provincial heritage resources authority.
(2) All archaeological objects, palaeontological material and meteorites are the property of the State.
(3) Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.
(4) No person may, without a permit issued by the responsible heritage resources authority—
(a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;
(b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;
(c) trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or
(d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.
(5) When the responsible heritage resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for a permit has been submitted and no heritage resources management procedure in terms of section 38 has been followed, it may—
(a) serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order;
(b) carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary;
(c) if mitigation is deemed by the heritage resources authority to be necessary, assist the person on whom the order has been served under paragraph *(a)* to apply for a permit as required in subsection (4); and
(d) recover the costs of such investigation from the owner or occupier of the land on which it is believed an archaeological or palaeontological site is located or from the person proposing to undertake the development if no application for a permit is received within two weeks of the order being served.

Minimum standards for the palaeontological component of heritage impact assessment reports have been developed by SAHRA (2013).

2. APPROACH TO THE PALAEONTOLOGICAL HERITAGE ASSESSMENT

The information used in this desktop study was based on the following:

1. A short project outline and maps provided by Meerkat Solar Power Plant (RF) (Pty) Ltd;

2. A review of the relevant scientific literature, including published geological maps, satellite images, and previous fossil heritage assessments in the region (*e.g.* Almond 2013a, 2013b, 2013c);

3. A short site visit by the author and one assistant on 14 January 2016.

4. The author's database on the formations concerned and their palaeontological heritage.

In preparing a palaeontological desktop study the potentially fossiliferous rock units (groups, formations *etc*) represented within the study area are determined from geological maps and satellite images. The known fossil heritage within each rock unit is inventoried from the published scientific literature, previous palaeontological impact studies in the same region, and the author's field experience (Consultation with professional colleagues as well as examination of institutional fossil collections may play a role here, or later following field assessment during the compilation of the final report). This data is then used to assess the palaeontological sensitivity of each rock unit to development. The potential impact of the proposed development on local fossil heritage is then determined on the basis of (1) the palaeontological sensitivity of the rock units concerned and (2) the nature and scale of the development itself, most significantly the extent of fresh bedrock excavation envisaged. When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a Phase 1 field assessment study by a professional palaeontologist is usually warranted to identify any palaeontological hotspots and make specific recommendations for any mitigation required before or during the construction phase of the development.

On the basis of the desktop and Phase 1 field assessment studies, the likely impact of the proposed development on local fossil heritage and any need for specialist mitigation are then determined. Adverse palaeontological impacts normally occur during the construction rather than the operational or decommissioning phase. Phase 2 mitigation by a professional palaeontologist – normally involving the recording and sampling of fossil material and associated geological information (*e.g.* sedimentological data) may be required (a) in the pre-construction phase where important fossils are already exposed at or near the land surface and / or (b) during the construction phase when fresh fossiliferous bedrock has been exposed by excavations. To carry out mitigation, the palaeontologist involved will need to apply for a palaeontological collection permit from the relevant heritage management authority, *i.e.* The South African Heritage Resources Authority (SAHRA) (Contact details: Mrs Colette Scheermeyer, P.O. Box 4637, Cape Town 8000, Tel: 021 462 4502, Email: cscheermeyer@sahra.org.za). It should be emphasized that, *providing appropriate mitigation is carried out*, the majority of developments involving bedrock excavation can make a *positive* contribution to our understanding of local palaeontological heritage.

2.1. Assumptions & limitations

The accuracy and reliability of palaeontological specialist studies as components of heritage impact assessments are generally limited by the following constraints:

1. Inadequate database for fossil heritage for much of the RSA, given the large size of the country and the small number of professional palaeontologists carrying out fieldwork here. Most development study areas have never been surveyed by a palaeontologist.

2. Variable accuracy of geological maps which underpin these desktop studies. For large areas of terrain these maps are largely based on aerial photographs alone, without ground-truthing. The maps generally depict only significant ("mappable") bedrock units as well as major areas of superficial "drift" deposits (alluvium, colluvium) but for most regions give little or no idea of the level of bedrock outcrop, depth of superficial cover (soil *etc*), degree of bedrock weathering or levels of small-scale tectonic deformation, such as cleavage. All of these factors may have a major influence on the impact significance of a given development on fossil heritage and can only be reliably assessed in the field.

3. Inadequate sheet explanations for geological maps, with little or no attention paid to palaeontological issues in many cases, including poor locality information;

4. The extensive relevant palaeontological "grey literature" - in the form of unpublished university theses, impact studies and other reports (*e.g*. of commercial mining companies) - that is not readily available for desktop studies;

5. Absence of a comprehensive computerized database of fossil collections in major RSA institutions which can be consulted for impact studies. A Karoo fossil vertebrate database is now accessible for impact study work.

In the case of palaeontological desktop studies without supporting Phase 1 field assessments these limitations may variously lead to either:

(a) *underestimation* of the palaeontological significance of a given study area due to ignorance of significant recorded or unrecorded fossils preserved there, or

(b) *overestimation* of the palaeontological sensitivity of a study area, for example when originally rich fossil assemblages inferred from geological maps have in fact been destroyed by tectonism or weathering, or are buried beneath a thick mantle of unfossiliferous "drift" (soil, alluvium *etc*).

Since most areas of the RSA have not been studied palaeontologically, a palaeontological desktop study usually entails *inferring* the presence of buried fossil heritage within the study area from relevant fossil data collected from similar or the same rock units elsewhere, sometimes at localities far away. Where substantial exposures of bedrocks or potentially fossiliferous superficial sediments are present in the study area, the reliability of a palaeontological impact assessment may be significantly enhanced through field assessment by a professional palaeontologist.

In the case of the present project area near Vryburg the main limitation for fossil heritage assessment is the generally low level of Precambrian and Palaeozoic bedrock exposure due to extensive cover by largely unfossiliferous superficial sediments as well as the limited access to much of the study area because of the sparse road network. However, confidence levels regarding the conclusions drawn following palaeontological field assessment are moderately good.

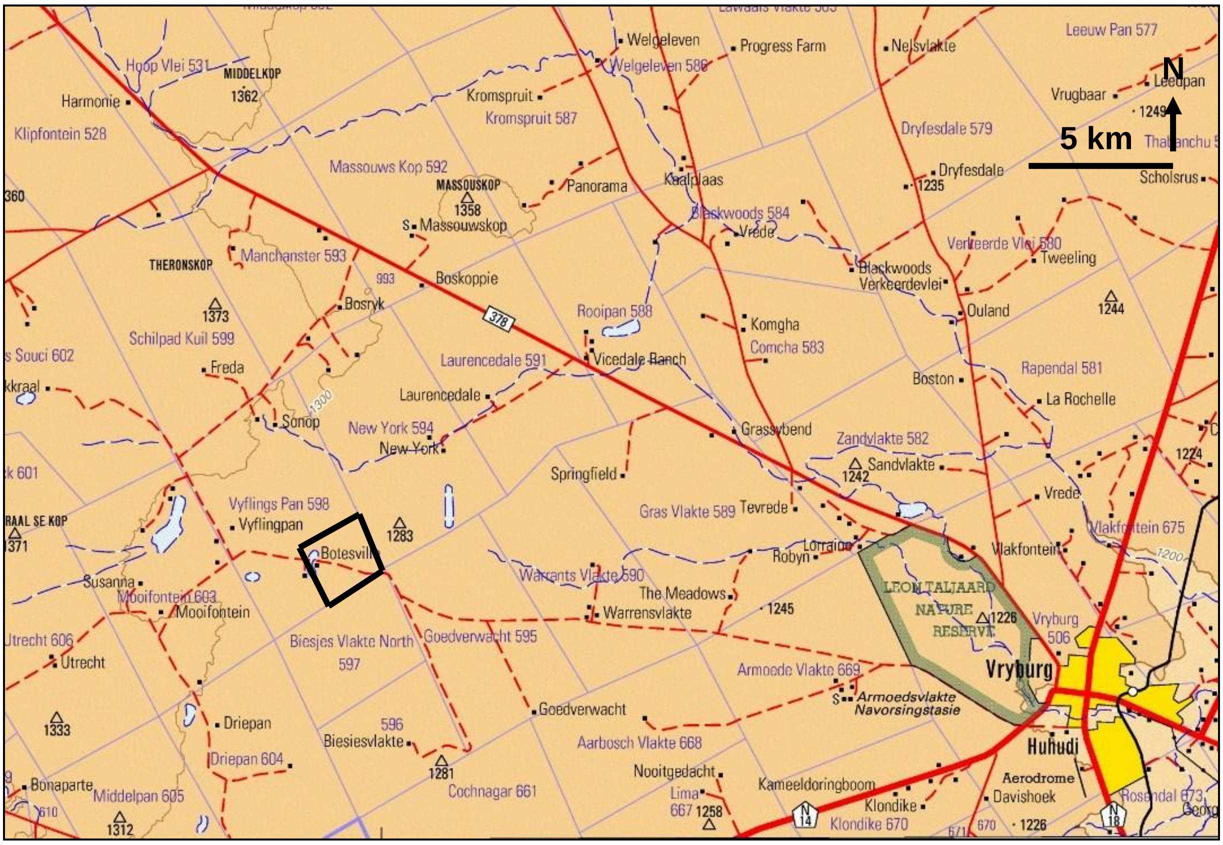

Fig. 1. Extracts from the 1: 250 000 topographical map 2624 Vryburg (Courtesy of the Chief Directorate National Geo-spatial Information, Mowbray) showing the location of the proposed Meerkat Solar Power Plant study area on Portion 3 (Portion of Portion 2) of the Farm Vyflings Pan 598, some 25 km WNW of Vryburg, North-West Province (black polygon).

Fig. 2. Google earth© satellite image of the Meerkat Solar Power Plant study area on Portion 3 (Portion of Portion 2) of the Farm Vyflings Pan 598 to the west of Vryburg, North-West Province (red polygon).

3. GEOLOGICAL & PALAEONTOLOGICAL BACKGROUND

The Meerkat Solar Power Plant study area on the south-eastern sector of Farm Vyflings Pan 598 near Vryburg consists of typical flat-lying terrain of the Ghaap Plateau region at an elevation of *c*. 1290 m amsl that is currently used for agricultural purposes (principally cattle farming) (Figs. 3 & 4). The climate is semi-arid and the dense vegetation cover of grassy thornveld is mapped as Ghaap Plateau Vaalbosveld. There are numerous small to large pans, often associated with substantial calcrete deposits (grey on satellite images, Fig. 2), within or just outside the study area. Bedrock exposure within the study area is generally very poor due to extensive cover by superficial deposits such as sandy soils and calcrete.

The geology of the study area west of Vryburg is shown on the 1: 250 000 geology map 2624 Vryburg (Council for Geoscience, Pretoria; Fig. 5 herein). An explanation for the Vryburg geological map has been published by Keyser & Du Plessis (1993) and that for the adjoining Christiana sheet 2724 to the south is also very relevant (Schutte 1994). The entire study area is underlain by ancient sedimentary rocks of the **Schmidtsdrif Subgroup** that are almost flat-lying in this area. This is the basal subdivision of the Late Archaean to Early Proterozoic **Ghaap Group** (**Transvaal Supergroup**) in the Griqualand West Basin, Ghaap Plateau Subbasin (Fig. 5). Useful reviews of the stratigraphy and sedimentology of these Transvaal Supergroup rocks have been given by Moore *et al.* (2001), Eriksson and Altermann (1998) as well as Eriksson *et al.* (1993, 1995, 2006). The Ghaap Group represents some 200 Ma of chemical sedimentation - notably iron and manganese ores, cherts and carbonates with subordinate siliclastic rocks - within the Griqualand West Basin that was situated towards the western edge of the Kaapvaal Craton (See fig. 4.19 in McCarthy & Rubidge 2005).

The north-eastern half or so of the study area on Farm Vyflings Pan 598 is underlain by the **Vryburg Formation** (**Vv**) that comprises siliclastic fluvial and shallow marine / lagoonal sediments as well as volcanic rocks in the Vryburg area itself (The latter are indicated on the geological map by stippling). The Vryburg Formation is approximately 140 m thick in this region and unconformably overlies lavas of the Venterdorp Supergroup (Allanridge Formation). An important reference section (Stratotype G), including good examples of the two major volcanic packages known as the Rosendal and Waterloo Members, is located on Waterloo Farm 992 just to the southeast of Vryburg (Smit *et al.* 1991). These last authors give a useful summary of the geology and sedimentology of the Vryburg succession, together with a detailed stratigraphic column for Waterloo Farm largely based on exposures along or close to the Droë Harts River (See also Almond 2013a). The lower portion of the Vryburg succession there comprises a basal conglomerate followed by a 20 m-thick, prominent-weathering package of cross-bedded feldspathic quartzites known as the Kobaga beds. This is overlain by *c*. 20 m of andesitic or basaltic lavas (the Rosendal Member) and pyroclastic sediments and then another 20 m package of varied siliciclastic rocks including conglomerates, quartzites, grits, flaggy sandstones (often ripple marked) and shales. These last are often pitch black and calcitic. The overlying Waterloo Member consists of c. 20-50 m of amydaloidal and non-amydaloidal basaltic / andesitic lavas and is overlain by 14 m of interbedded pyroclastic sediments and thin lenticular limestones. These last form the top of the Vryburg Formation and are followed by the carbonate-dominated beds of the Boomplaas Formation. According to Schutte (1994), however, the uppermost Vryburg beds, especially well exposed on Waterloo 992, comprise thin-bedded flaggy sandstones, pale quartzites and interbedded dolomite.

Minor carbonate interbeds within the upper Vryburg Formation in its southern, more distal outcrop area (*e.g.* near Douglas) contain microbial stromatolites, and these are also recorded from the holostratotype section some 40 km south of Vryburg (Smit *et al.* 1991). The stromatolitic carbonates within the Vryburg succession interfinger with and pass up into siliclastic sediments and are interpreted as intertidal in setting (Altermann & Wotherspoon 1995). To the author’s knowledge, a detailed description of the Vryburg stromatolite occurrences has not yet been published. Useful reviews of Archaean stromatolites and associated organic-walled microfossils from southern Africa and elsewhere are provided by Altermann (2001), Buick (2001), Brasier *et al.* (2006) and Schopf (2006). Bertrand-Sarfarti and Eriksson (1977) describe columnar stromatolites from the Schmidtsdrift Subgroup of the Northern Cape.

The Vryburg Formation is treated as the basal unit of the Schmidtsdrif Subgroup by several recent authors (*e.g.* Altermann & Wotherspoon 1995, Sumner & Beukes 2006) but was previously placed below the base of the Ghaap Group succession (See stratigraphic column in Fig. 6). The Vryburg siliciclastics and overlying carbonate-rich Boomplaas Formation of the Griqualand West Basin have classically been correlated with the Black Reef Formation and overlying basal Malmani dolomites of the Transvaal Basin (*e.g.* Eriksson *et al.* 1995, 2006). However, recent sequence stratigraphic studies of the Transvaal Supergroup have demonstrated that the Vryburg / Boomplaas / Clearwater sequence is in fact older than the Black Reef Formation (Sumner & Beukes 2006). Lavas from the Vryburg Formation have been radiometrically dated to 2.64 Ga (billion years old), *i.e.* Late Archaean in age (Eriksson *et al.* 2006), and the overlying Boomplaas stromatolitic carbonates are likewise assigned a Neoarchaean age (Fig. 6).

The south-western half or more of the Vyflings Pan 598 study area is underlain by shallow marine carbonates (predominantly dolomites) and subordinate siliclastic sediments of the **Boomplaas Formation** (**Vb**). This mixed carbonate and siliciclastic succession is 100 – 185 m in thickness and is transitional between the predominantly continental Vryburg beds and the fully marine Campbell Rand platform carbonates of the Kaapvaal Craton. The Boomplaas beds are dominated by grey dolomites (weathering reddish-brown) with subordinate interbeds of limestone (weathering blue-grey), quartzite, flaggy sandstone and shale. Packages of oolitic and stromatolitic dolomite alternate with intervals of carbonaceous mudrocks (possibly lagoonal) containing interbeds of calcareous sandstone and mudclast breccias. Nearshore oolitic and stromatolitic facies with cherty layers and inclusions (probably secondary replacement of carbonate) predominate in the northern outcrop area of the Boomplaas Formation, as at Vryburg, while offshore mudrock facies are found towards the south. The Boomplaas beds are overlain by the grey- to khaki-hued mudrocks and interbedded dolomites, flagstones, tuffites and BIF-like cherts of the **Clearwater Formation** (**Vc**) (= Lokamonna Formation), the uppermost subunit of the Schmidtsdrif Subgroup. The finer mudrocks are pitch black and locally pyritic and calcitic while the carbonates may show crinkly stromatolitic textures.

A detailed, comprehensive account of the Neoarchaean stromatolites from the Boomplaas Formation of the Schmidtsdrif Subgroup has not been published, to the author's knowledge. Brief mention of large stromatolites from 50 cm up to 2 m across within the Boomplaas Formation in the Vryburg area is made by Keyser and Du Plessis (1993). Preferential north-south elongation seen in some examples may reflect dominant onshore-offshore, wave-generated currents scouring sediment from between the domes. Wright and Altermann (2000) discuss slumping and contortion of partially decomposed, pyrite-rich stromatolitic laminae as well as preservation of organic-walled filamentous cyanobacterial microfossils within stromatolites of the Boomplaas Formation. A shallow subtidal setting for large stromatolitic domes in the Transvaal Supergroup is inferred by Truswell and Eriksson (1973), with oolites generated in higher energy inshore settings, although they may subsequently have been reworked into deeper waters offshore (See also Eriksson & Altermann 1998, Altermann 2008).

Fig. 3. Typical flat terrain in the southern portion of the study area on Vyflings Pan 598 with sandy soils and grassy Kalahari Thornveld vegetation.

Fig. 4. Flat sandy terrain in the northern portion of the study area with small, low rocky exposures of Vryburg Formation quartzites (Hammer = 30 cm).

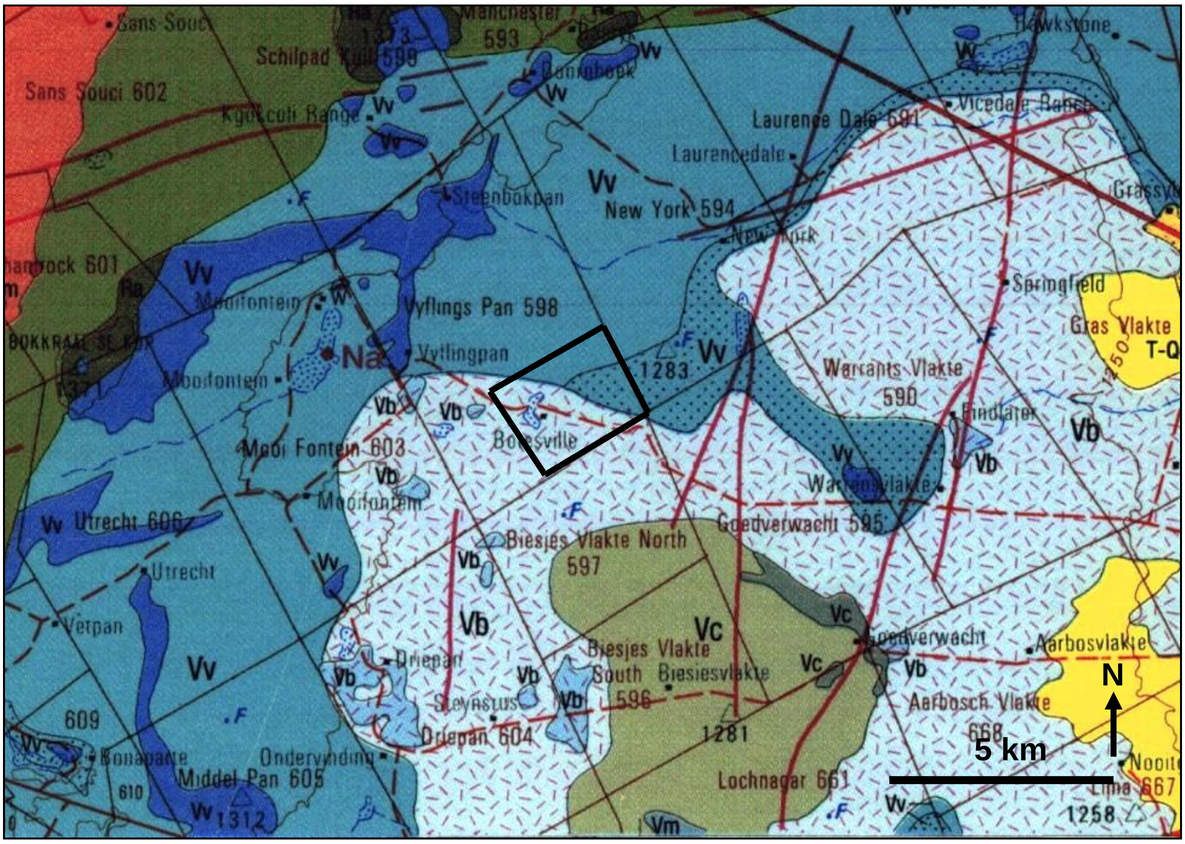

Fig. 5. Extract from the 1: 250 000 geological map 2624 Vryburg (Council for Geoscience, Pretoria) showing the outline of the study area for the proposed Meerkat Solar Power Plant study area on Portion 3 (Portion of Portion 2) of the Farm Vyflings Pan 598, some 25 km WNW of Vryburg (black polygon). The main geological units represented mapped the broader study region include:

Vryburg Formation (Vv, middle and dark blue) – late Archaean fluvial and shallow marine quartzites, mudrocks, conglomerates with two intervals of andesitic volcanics (stippled)

Boomplaas Formation (Vb, pale & middle blue with dashes) – late Archaean dolomites (locally stromatolitic or oolitic) interbedded with siliciclastics (quartzite, shale, flagstone)

Clearwater Formation (Vc, dark grey) – late Archaean mudrocks with interbedded dolomites, flagstones, tuffites, cherts.

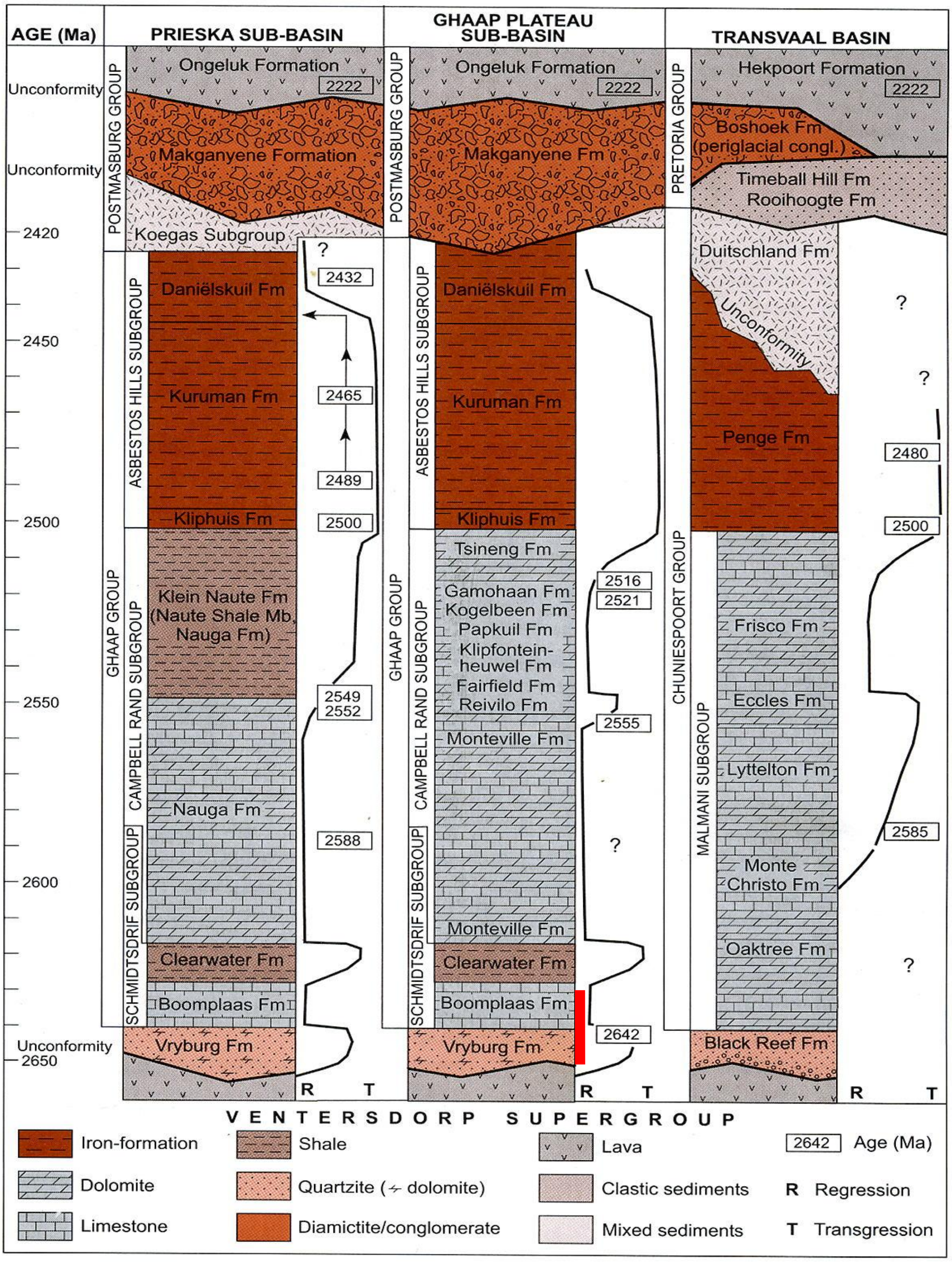

Fig. 6. Stratigraphy of the Transvaal Supergroup of the Ghaap Plateau Basin (central column) showing the position of the Vryburg and Boomplaas Formations that are represented in the study area (red line) (From Eriksson *et al.* 2006). Note that the is incorporated within the base of the Schmidtsdrif Subgroup by some recent authors and is no longer correlated with the Black Reef Formation of the Transvaal Basin as shown here (*e.g.* Altermann & Wotherspoon 1995, Sumner & Beukes 2006).

4. FIELD OBSERVATIONS ON FARM VYFLINGS PAN 598

Since Neoarchaean stromatolites have been reported from the Vryburg and Boomplaas Formations to the south of Vryburg, the field assessment of Farm Vyflings Pan 598 concentrated on this stratigraphic unit. As mentioned earlier, superficial deposits such as river alluvium, colluvial rubble, downwasted surface gravels and sandy soils are generally unfossiliferous, or at most sparsely fossiliferous, in this region. GPS locations of sites mentioned by number in the text are listed in the Appendix.

4.1. Vryburg Formation

Surface exposure of the Vryburg Formation within the northern part of the study area on Vyflings Pan 598 is limited to small areas of pale brown to greyish quartzite emerging through the cover sands as well as local accumulations of well-jointed float blocks of brown-weathering quartzite in pan areas other drainage depressions (Figs. 4 & 7). No volcanic rocks were encountered here.

4.2. Boomplaas Formation

No surface exposures of Boomplaas Formation carbonates were observed within the study area. Large angular blocks of greyish-green sandstone embedded within pan deposits are probably float from the underlying Boomplaas Formation (Fig. 9).

4.3. Superficial sediments

Most of the study area is mantled in pale orange-brown sandy soils, probably in part of aeolian origin on the margins of the Kalahari Basin, with sparse surface gravels of calcrete, ferricrete and quartzite (Figs. 3 & 4).

Thick creamy to pale greyish-green calcretised pan deposits overlain by pale brown calcareous soils are exposed at the southern end of a large elongate pan, stretching north-south across the western corner of the study area (Figs. 8 to 11). The calcretised deposits contain sizeable irregular glaebules and a near-surface horizon of angular gravels – presumably alluvial - composed mainly of angular to rounded quartzite clasts with subordinate dark grey cherts (some anthropogenically flaked) and also ferricrete and calcrete glaebules. The material at the southern end of the pan has been disturbed by quarrying but there has clearly been local development of substantial ferricrete horizon, probably in association with an ancient drainage line into the pan or marshy deposits on the pan margin. *In situ* pebbly ferricretes as well as large float blocks of similar material are also seen elsewhere along the pan margins (Fig. 12).

Calcrete occurs widely in the Vryburg area, especially overlying the Ventersdorp, Boomplaas and Dwyka outcrop areas, notably in association with ancient drainage lines and pans. The most extensive calcrete deposits occur on the south-western side of pans as a consequence of the prevailing northwest winds (Keyser & Du Plessis 1993). Schutte (1994) notes that terraces of well-indurated calcrete occur in the valley of the Dröe Harts River to the southeast of the present study area. The calcretes there contain rounded clasts of various rock types that have a probable Dwyka provenance. Calcretes on Rosendal just south of Vryburg contain embedded “palaeolithic stone tools” indicating a Quaternary or younger age for these deposits.

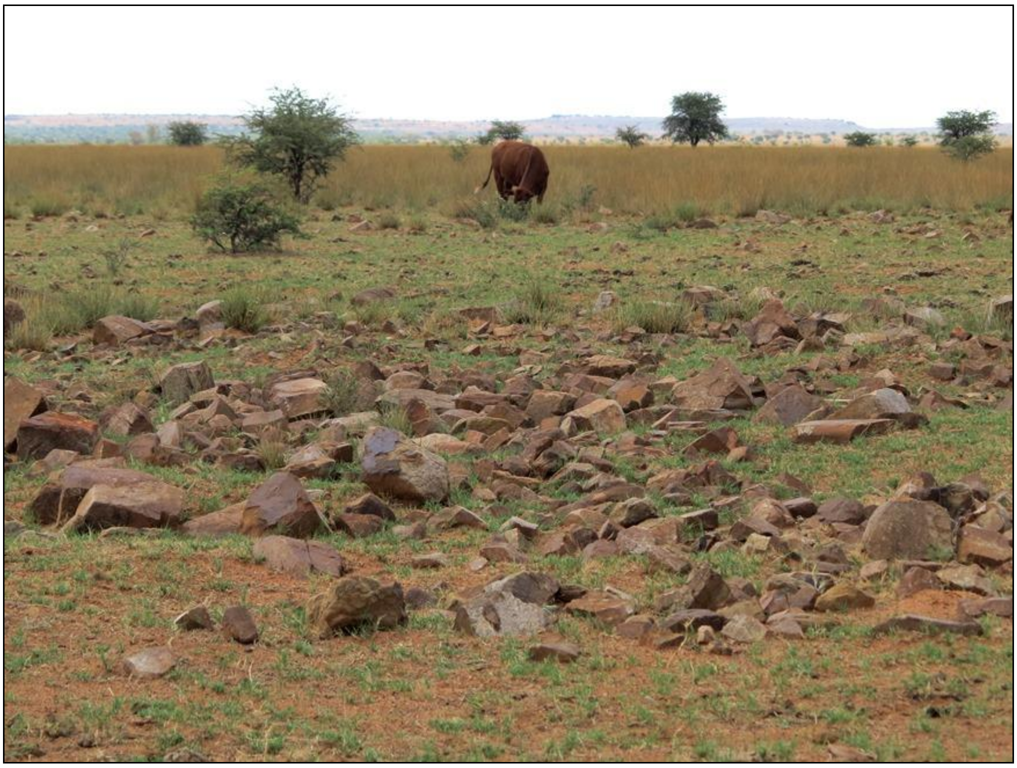

Fig. 7. Concentration of angular blocks of Vryburg Formation quartzites along a shallow drainage line, NE portion of study area.

Fig. 8. Excavation in cream-coloured calcretised pan sediments on the southern end of a large pan, western margin of study area.

Fig. 9. Cut face in the borrow pit illustrated above excavated showing thick calcretised pan deposits with dispersed boulder-sized blocks of Boomplaas Formation bedrocks (Hammer = 30 cm).

Fig. 10. Horizon of angular quartzitic gravels within the calcretised pan sediment succession (Hammer = 30 cm).

Fig. 11. Gravels weathering out of the upper portion of the calcretised pan succession, including rounded to angular brown quartzites, dark grey cherts (some flaked) and ferricrete glaebules.

Fig. 12. *In situ* pebbly ferricrete horizon along the margin of the main pan in the study area (Hammer = 30 cm) – probably evidence of ancient marshy conditions.

5. SIGNIFICANCE OF POTENTIAL IMPACTS ON PALAEONTOLOGICAL HERITAGE

A brief assessment of the impact significance of the construction phase of the proposed Meerkat Solar Power Plant on local fossil heritage resources in the study area on Farm Vyflings Pan 598 is presented here. Please note that further impacts are not anticipated during the operational and decommissioning phase of the development.

- **Nature of the impact**

Bedrock excavations and site clearance for the proposed PV panels, control building, any buried cables, the electrical substation as well as the internal site roads and powerline infrastructure may adversely affect potential fossil heritage within the study area by damaging, destroying, disturbing or permanently sealing-in fossils at or below the ground surface that are then no longer available for scientific research or other public good.

- **Geographical extent and duration of the impact**

Any significant impacts on fossil heritage are limited to the development site and to the construction phase when site clearance and excavations into fresh, potentially fossiliferous bedrock may take place. No further significant impacts are anticipated during the operational or decommissioning phases of the solar facility. Impacts on fossil heritage are generally permanent.

- **Probability of the impact occurring**

Following field assessment, the bedrocks in the study area are inferred to comprise non-fossiliferous quartzites and thick superficial deposits (*e.g.* sandy soils, pan sediments). No evidence was found for stromatolitic carbonate bedrocks here. The probability of significant impacts on palaeontological heritage during the construction phase is therefore very low.

- **Intensity / magnitude of impact**

Given the apparent absence of fossil-rich bedrocks in the study area, the magnitude of impacts on palaeontlogical heritage is rated as very low.

- **Degree to which the impact can be reversed**

Impacts on fossil heritage are generally irreversible. Well-documented new records and further palaeontological studies of any fossils revealed during construction would represent a positive impact from a scientific viewpoint.

- **Degree to which the impact may cause irreplaceable loss of resources**

Irreplaceable loss of fossil heritage resources is not anticipated here.

- **Degree to which the impact can be mitigated**

Given the lack of evidence for vulnerable fossils on site, there are no recommendations for specialist monitoring or mitigation for the Meerkat Solar Power Plant project on Vyflings Pan 598.

Should significant fossil remains - such as well-preserved stromatolites - be exposed during construction, the responsible Environmental Control Officer should safeguard these, preferably *in situ*. The South African Heritage Resources Authority (SAHRA) should be alerted as soon as possible (Contact details: Mrs Colette Scheermeyer, P.O. Box 4637, Cape Town 8000, Tel: 021 462 4502, Email: cscheermeyer@sahra.org.za), so that appropriate action can be taken by a professional palaeontologist, at the developer's expense. Mitigation would normally involve the scientific recording and judicious sampling or collection of fossil material as well as associated geological data (*e.g.* stratigraphy, sedimentology, taphonomy) by a professional palaeontologist. The palaeontologist concerned with mitigation work will need a valid fossil collection permit from SAHRA and any material collected would have to be curated in an approved depository (*e.g.* museum or university collection). These recommendations should be included within the EMPr for the proposed solar power plant development.

- **Cumulative impacts**

Cumulative impacts could arise as other similar projects are constructed in the area. According to the Energy Blog's database only one other solar PV plant has been granted preferred bidders status within close proximity to the proposed Meerkat PV plant:

Waterloo Solar Park with a capacity of 75MW near Vryburg, North West Province (Approvals, planning and financing phase) .

According to the Department's database numerous other solar plants have been proposed in relative close proximity to the proposed activity, namely:

- The proposed Carocraft Solar Park near Vryburg, North West Province (14/12/16/3/3/2/374);
- Construction of the 75MW Photovoltaic facility and associated infrastructure in Naledi (14/12/16/3/3/2/390).
- The proposed Tiger Kloof Solar Photovoltaic energy facility near Vryburg, North West Province (14/12/16/3/3/2/535).
- The proposed Keren Energy Bosh Pan Solar Plant, Northern Cape Province (14/12/16/3/3/1/563);
- The proposed renewable energy generation project. Carocraft Solar Park in North West Province (14/12/16/3/3/2/699);
- The proposed Renewable Energy Genertion Project rem farm Elda, North West (14/12/16/3/3/2/750);
- The proposed Renewable Energy Project on Farm Doornbult 29 and Doornbult 33, North West (14/12/16/3/3/2/751);

Environamics and other environmental consultants are also in the process of applying for Environmental Authorisation for other PV projects in the area, namely:

- The proposed Protea Solar Power Plant near Vryburg, North West Province.
- The proposed Gamma Solar Power Plant near Vryburg, North West Province.
- The proposed Alpha Solar Power Plant near Vryburg, North West Province.
- The proposed Meerkat Solar Power Plant near Vryburg, North West Province.

- The proposed Sonbesie Solar Power Plant near Vryburg, North West Province.
- Three PV Solar Energy facilities on the farm Klondike - AMDA Developments

The potential for cumulative impacts may therefore exist. The Environmental Impact Assessment (EIA) Report will include a detailed assessment of the potential cumulative impacts associated with the proposed development.

6. CONCLUSIONS & RECOMMENDATIONS

The Meerkat Solar Power Plant study area is entirely underlain by late Archaean (*c*. 2.6 billion year-old) sedimentary rocks of the Schmidtsdrif Subgroup (Ghaap Group, Transvaal Supergroup). These mainly comprise shallow marine siliciclastic sediments and possible lavas of the Vryburg Formation *plus* carbonate sediments of the Boomplaas Formation.

Field assessment suggests that stromatolite-bearing carbonate rocks are not present at surface within the Vryburg and Bomplaas Formation outcrop areas in the study area. The overlying superficial sediments (*e.g.* sandy soils, calcretised pan deposits) are of low palaeontological sensitivity. It is concluded that, with or without mitigation, the overall impact of the proposed Meerkat Solar Power Plant on Farm Vyflings Pan 598 is of **NEGATIVE LOW SIGNIFICANCE** in palaeontological heritage terms.

7. ACKNOWLEDGEMENTS

Mr Dick Berlijn of Meerkat Solar Power Plant (RF) (Pty) Ltd is thanked for commissioning this study. I am grateful to his colleague Ms Claire Phutieagae for kindly providing all the necessary background information, for facilitating our field visit, as well as for introducing us to the study area. Field assistance, logistical backup and companionship from Ms Madelon Tusenius is, as always, much appreciated.

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9. QUALIFICATIONS & EXPERIENCE OF THE AUTHOR

Dr John Almond has an Honours Degree in Natural Sciences (Zoology) as well as a PhD in Palaeontology from the University of Cambridge, UK. He has been awarded post-doctoral research fellowships at Cambridge University and in Germany, and has carried out palaeontological research in Europe, North America, the Middle East as well as North and South Africa. For eight years he was a scientific officer (palaeontologist) for the Geological Survey / Council for Geoscience in the RSA. His current palaeontological research focuses on fossil record of the Precambrian - Cambrian boundary and the Cape Supergroup of South Africa. He has recently written palaeontological reviews for several 1: 250 000 geological maps published by the Council for Geoscience and has contributed educational material on fossils and evolution for new school textbooks in the RSA.

Since 2002 Dr Almond has also carried out palaeontological impact assessments for developments and conservation areas in the Western, Eastern and Northern Cape, Limpopo, Northwest and the Free State under the aegis of his Cape Town-based company *Natura Viva* cc. He has served as a long-standing member of the Archaeology, Palaeontology and Meteorites Committee for Heritage Western Cape (HWC) and an advisor on palaeontological conservation and management issues for the Palaeontological Society of South Africa (PSSA), HWC and SAHRA. He is currently compiling technical reports on the provincial palaeontological heritage of Western, Northern and Eastern Cape for SAHRA and HWC. Dr Almond is an accredited member of PSSA and APHP (Association of Professional Heritage Practitioners – Western Cape).

Declaration of Independence

I, John E. Almond, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed development project, application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

Dr John E. Almond
Palaeontologist
***Natura Viva* cc**

APPENDIX: GPS LOCALITY DATA FOR NUMBERED SITES LISTED IN TEXT

All GPS readings were taken in the field using a hand-held Garmin GPSmap 60CSx instrument. The datum used is WGS 84.

Loc number	GPS data	Comments
210	S26° 55' 18.7" E24° 28' 45.4"	Borrow pit exposure of thick calcretised pan deposits at southern end of pan with subsurface gravels and large float blocks of Boomplaas Fm sandstone.
211	S26° 55' 03.6" E24° 28' 42.9"	Float blocks of coarse ferricrete breccia near wind pump.
212	S26° 54' 42.8" E24° 28' 47.1"	Small patches and float blocks of Vryburg Fm quartzites emerging through sandy soils.
213	S26° 54' 48.2" E24° 29' 30.0"	Concentration of angular blocks of Vryburg Fm quartzite.