BRYPAAL SOLAR POWER (PV) PROJECT NOVEMBER 2017

Geological Report

Remainder of Portion 4 of the

farm Brypaal No. 134

Prepared for:

Vintage Energy Pty (Ltd)

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TITLE AND APPROVAL PAGE

Project Name	EIA for the proposed development of a 100 MW PV Solar Facility on the farm Brypaal, Northern Cape Province.
Report Title	Geological Report
DEA Reference	14/12/16/3/3/2/1019
Report Status	Final

Client	Vintage Energy Pty Ltd
Client Representative	Mr. Jan Du Preez

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Report Reference		2017/BES/SR/12

Authorisation	Name	Signature	Date
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Author's Affiliations	See Annexure A		

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Dear Ms Faul

EIA for the proposed PV Solar Plant Facility: Kakamas, Northern Cape, South Africa – Geological Report

I have reviewed your report and find it to be a well written and thorough work and well suited for the purpose of a specialist report to inform an Environmental Impact Assessment.

The purpose of a Geological Report is to provide the right information in the best way to inform the EIA: from predicting through assessing and evaluating the potential significance of impacts, to recommending management actions (including mitigation, enhancement) and monitoring programmes and reporting.

I am of the opinion that you have met the above-mentioned criteria and will contribute to the thorough assessment of impacts related to the development.

Kind Regards,

P.W. van Deventer [Pr.Sci.Nat.[2]: 400075/08]

Declaration of Consultant's Independence

I Cindy Faul, as the appointed independent specialist hereby declare that I:

- Acted as the independent specialist in this application;
- Regard the information contained in this report as it relates to my specialist input/study to be true and correct;
- Do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2010 and any specific environmental management Act;
- Have disclosed any information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the Environmental Impact Assessment Regulations, 2010 and any specific environmental management Act;
- Am fully aware of the NEMA, the Environmental Impact Assessment Regulations, 2010 and any specific environmental management Act;
- Have provided the competent authority with access to all information at my disposal regarding the application;
- Am aware that a false declaration is an offence in terms of regulation 71 of GN No. R. 543.

Cindy Faul (Hons. Environmental Sciences at NWU)
30 November 2017

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Vintage Energy Pty Ltd has appointed Boscia Environmental Solutions as an Independent Environmental Consultant to undertake the Environmental process for the proposed (Photovoltaic) Solar Energy Facility, on remainder of Portion 4 of the farm Brypaal No.134, located approximately 60 km south south-west of Kakamas in the Kai !Garib Local Municipality in the Northern Cape of South Africa. The proposed development area is 320 ha. The soil survey will be conducted on the entire segment of Portion 4 of the farm Brypaal No. 134 situated south-east of the Kenhardt-Loeriesfontein road (Road No. 2972) (total of 1032 ha).

In terms of the EIA regulations published in terms of Section 24 (5) of the National Environmental Management Act (NEMA, No. 107 of 1998), the applicant (Boscia Environmental Solutions) requires authorisation from the National Department of Environmental Affairs (DEA) for the undertaking of the proposed project.

Legislation relating to the geological environment is contained within the Minerals and Petroleum Resources Development Act 28 of 2002. According to this Act, an EMPr is acquired for operations that may obtain local construction materials for access roads etc.

This report discusses the approach, findings and conclusion of a Geological Report carried out for the proposed development area. The main aim of this investigation is to assess the likelihood of geological sensitive areas in the study area, in an effort to identify issues regarding the degradation of parent material that may arise from the proposed development which should be mitigated accordingly.

The purpose of the Geological Report is to describe the area that may be affected by the proposed activity, describe the manner in which the environment may be affected by the proposed facility and provide a detailed description of the mitigation measures.

No environmentally fatal flaws are associated with the recommended development area and associated footprint. The specialist’s opinion is that the development may be authorised.

2 General Information

2.1 Applicant

Vintage Energy Pty Ltd has appointed Boscia Environmental Solutions as an Independent Environmental Consultant to undertake the Environmental process for the proposed (Photovoltaic) Solar Energy Facility, on remainder of Portion 4 of the farm Brypaal No.134, located approximately 60 km south south-west of Kakamas in the Kai !Garib Local Municipality in the Northern Cape of South Africa.

2.2 Development Aspects

The proposed Solar Facility will have a peak power generating capacity of approximately 100 MW, and will consist of the following:

- Module Mounting structures 2 tier;
- String Inverters – 60 KVA;
- PV Modules – 250 WP;
- Meteor stations;
- Power reducer Boxes;
- Power Plant Controllers;
- Cluster Controllers;
- LV Substations;
- MV Substations;
- Access roads (temporary & permanent roads);
- Permanent office/workshop building.

A temporary laydown area was identified [workshops, mobile offices, mobile ablution facilities, material storage area, vehicle parking area, water tanks for drinking, construction and dust suppression) fencing, etc.]. The main activities during the construction phase area:

- Permanent living quarters for operational phase workers (only for residential staff). The rest of the staff will stay in Kakamas;
- Equipment (Trucks & front-end loaders, excavators, cranes, etc.);
- Topsoil/Overburden stockpiles/fill material. Topsoil stripping and stockpiling will be required only for the service roads and sub-station foundations. No concrete slabs or foundations are required for the screw-in pylons;
- Opencast quarries/excavations for cut and fill material. Very limited for roads and sub-station only, the rest of the construction site will follow a non-destructive-surface-topography approach because no foundations are required for the screw-in pylons;

- Water storage facilities (reservoir, tanks, etc.) mainly for construction phase;
- Water Desalination plant (pipelines towards water storage and power plant). Very small, just for standby water supply. The rest of the operational water will be transported from Kakamas or extracted from boreholes. Limited water is required for the washing of the PV-panels because nano-technology will be applied to the surface of the panels, which keeps it virtually clean for very long periods of time and washing of the panels will be required only once a year or even longer intervals;
- Waste handling facilities (for construction & operational phase). Solid, hydrocarbon and liquid waste to be sorted on site and keep in certified appropriate containers and to be removed to certified land fill sites.
- Surface run-off control systems. A non-destructive surface topography will be followed during the construction phase, drainage systems will be avoided, therefore surface runoff structures for instance trenches, canals, etc. will not be implemented and no large scale desalination plants and evaporation ponds will be constructed because of low water requirements for operational phase.
- A 400kV high voltage overhead grid connection of approximately 500 m between the substation at the solar facility and the Aries – Kokerboom 400 KV line.

Total footprint of the 100 MW PV solar farm will be approximately 320 ha. The terms of the land owner agreement for this project provides allowance for a 36 month construction period and foresees the use as a PV Solar facility for up to 25 years. During this period, it is anticipated that the PV modules may be replaced, however the primary plant and electrical infrastructure would be suitable for this intended project life.

2.3 Location

The proposed location is on remainder of Portion 4 of the farm Brypaal No.134, approximately 60 km south south-west of Kakamas in the Kai !Garib Local Municipality in the Northern Cape of South Africa.

2.4 Scope of Report

The following activities are included in the scope of the study:

- A description of the affected area, as well as the degree to which the proposed project may affect the environment;
- A description and evaluation of the identified environmental concerns as well as potential impacts;
- A statement based on the evaluation of the concerns/impacts regarding the potential significance of these concerns/impacts;
- A description of the methodology used during this study;
- The identification and mapping of the present geology;

- An evaluation of the significance of direct, indirect, and cumulative impacts in terms of the following criteria:
  - The **nature** of the impact, cause of impact, what will be affected and how it will be affected.
  - The **extent** of the impact (local, regional, national, or international). A value between 1 and 5 must be assigned as appropriate, with 1 being low and 5 being high.
  - Impact **duration**
    - Very short-term (0-1 years) with a score of 1;
    - Short-term (2-5 years) with a score of 2;
    - Medium-term (5-15 years) with a score of 3;
    - Long-term (>15 years) with a score of 4;
    - Permanent, with a score of 5.
  - **Probability**
    - Very improbable (probably will not happen = 1);
    - Improbable (some possibility, but low likelihood = 2);
    - Probable (distinct possibility = 3);
    - Highly probable (most likely = 4);
    - Definite (impact will occur regardless of any prevention measures = 5).
  - **Magnitude** scale
    - Small magnitude with no effect on the environment = 0;
    - Minor magnitude and will not result in an impact on processes = 2;
    - Low magnitude and will cause a slight impact on processes = 4;
    - Moderate magnitude and will result in processes continuing but in a modified way = 6;
    - High magnitude and therefore processes are altered to the extent that they must be ceased temporary = 8;
    - Very high magnitude with complete destruction of patterns and permanent cessation of processes = 10.
  - The **status** can be described as either positive, negative or neutral.
  - The **significance** can be described as **LOW**, **MEDIUM,** or **HIGH**, and are calculated through:

$$S=(E+D+M)P$$

Where:

S = Significance weighting

E = Extent

D = Duration

M = Magnitude

P = Probability

S = <30	LOW	The impact would not have a direct influence on the decision to develop in the area.
S = 30-60	MEDIUM	The impact could influence the decision to develop in the area unless it is effectively mitigated.
S = >60	HIGH	The impact must have an influence on the decision process to develop in the area.

  - The reversibility of the impact.
  - Possibility of irreplaceable loss of resources.
  - The degree of impact mitigation.
- Recommendation regarding practical mitigation measures for potentially significant impacts.

2.5 Legislation

In terms of the EIA regulations published in terms of Section 24 (5) of the National Environmental Management Act (NEMA, No. 107 of 1998), the applicant (Boscia Environmental Solutions) requires authorisation from the National Department of Environmental Affairs (DEA) for the undertaking of the proposed project.

Legislation relating to the geological environment is contained within the Minerals and Petroleum Resources Development Act 28 of 2002. According to this Act, an EMPr is acquired for operations that may obtain local construction materials for access roads etc.

3 Introduction

Vintage Energy Pty Ltd has appointed Boscia Environmental Solutions as an Independent Environmental Consultant to undertake the Environmental process for the proposed (Photovoltaic) Solar Energy Facility, on remainder of Portion 4 of the farm Brypaal No.134, located approximately 60 km south south-west of Kakamas in the Kai !Garib Local Municipality in the Northern Cape of South Africa (see Figure 1). The proposed development area is 320 ha. The geological survey will be conducted on the entire segment of Portion 4 of the farm Brypaal No. 134, that is situated south-east of the Kenhardt-Loeriesfontein road (Road No. 2972) (total of 1032 ha).

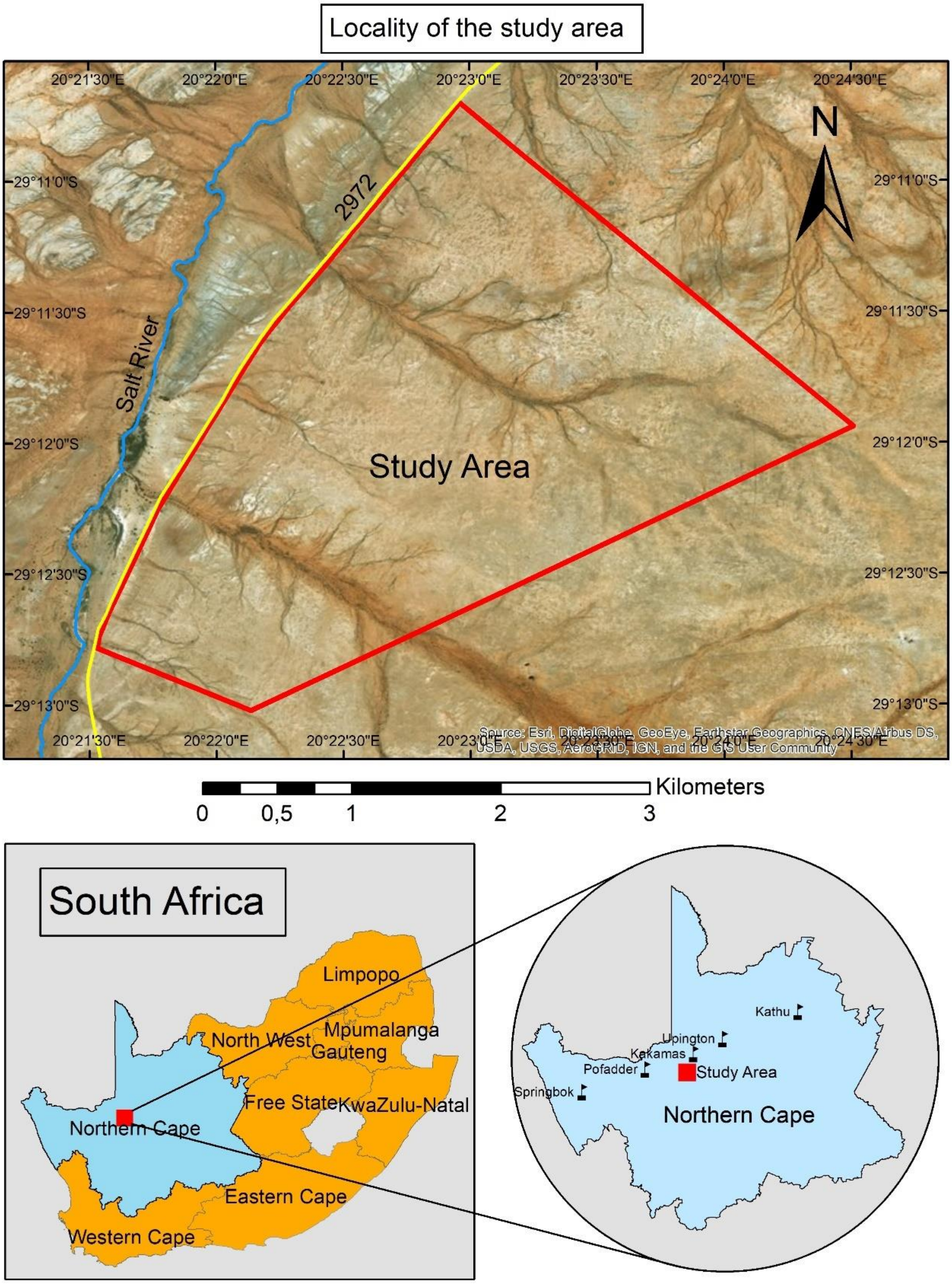


Figure 1: Locality map of the study area (Red line: The boundaries of the area where the geological survey was conducted) (Google Earth, 2016).

According to the EIA Regulations published in terms of Section 24 (5) of the National Environmental Management Act (NEMA, Act No. 107 of 1998), authorization from the National Department of Environmental Affairs (DEA) is required before development can proceed. For the development of this Solar Energy Facility, a geological assessment is required to describe the stability of the site and provide an assessment of the likely impacts associated with the development. Impacts are assessed for the preconstruction, construction and operation phases. In order to reduce the likely impact of the development, a variety of avoidance and mitigation measures associated with the identified impacts are recommended. These recommendations should also be included in the EMPr for the development.

These aims will be accomplished with:

- The description of the proposed site;
- A geological description, regional and local;
- An assessment of the potential environmental impacts on geological features;
- EMPr with mitigation measures.

A geotechnical report will accompany this EIA to provide recommendations for the engineering design of access roads and foundations of the associated infrastructure and also include issues like founding conditions, problem soils, excavatability, sources of natural construction material and more.

4 Methodology

A randomised survey approach was used for geological surveying. Each geological outcrop observed within the study area was identified and mapped (see Figure 2) by means of a GPS (Garmin Etrex 20).

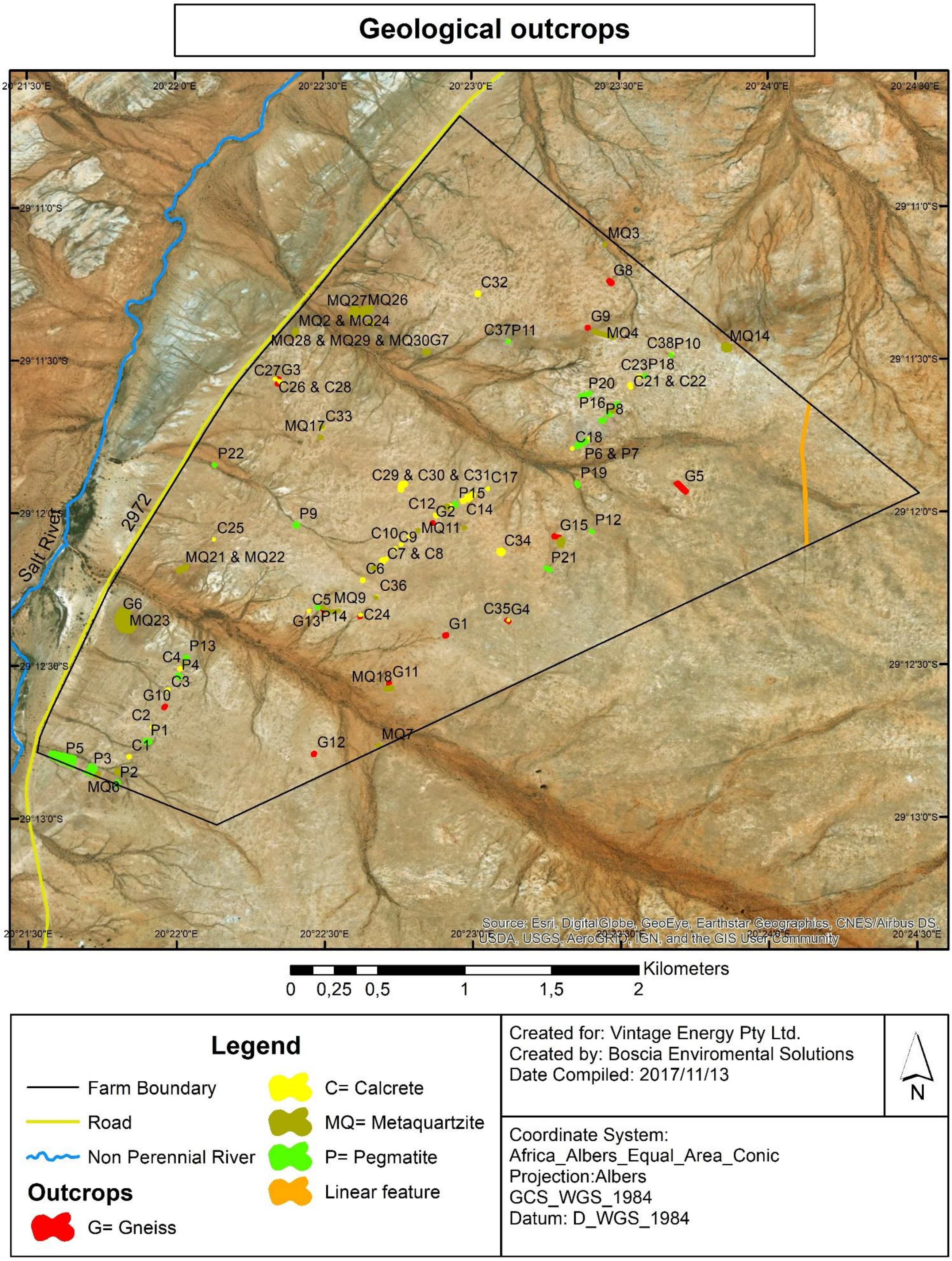


Figure 2: Map indicating the localities of the identified geological outcrops (Google Earth, 2016).

5 Description of the Affected Environment

5.1 Climate and Rainfall

As illustrated in Figure 3, the study area forms part of the semi-arid Bushmanland region and falls within the very late summer rainfall region (Schulze, 1997). According to meteorological statistics from the South African Weather Services (Weather Bureau, 2016) (Figure 4 – Figure 7) the average annual rainfall for this area, from 1992 up to 2015, was between 140 mm and 250 mm per annum.

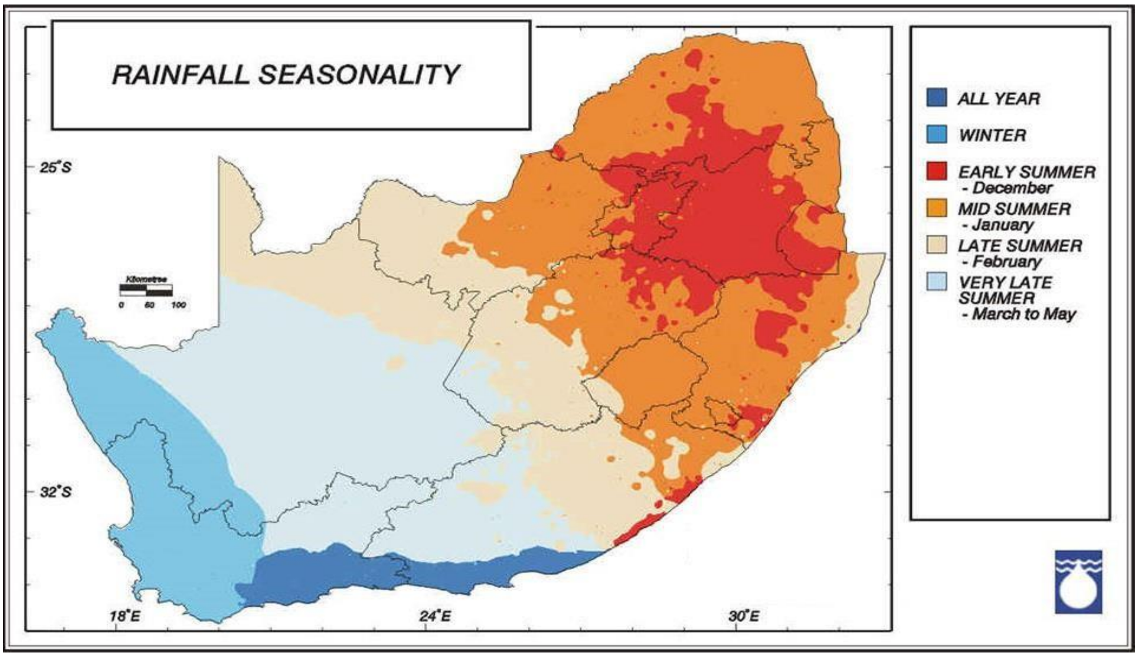


Figure 3: Map indicating the rainfall seasonality in South Africa (Schulze, 1997).

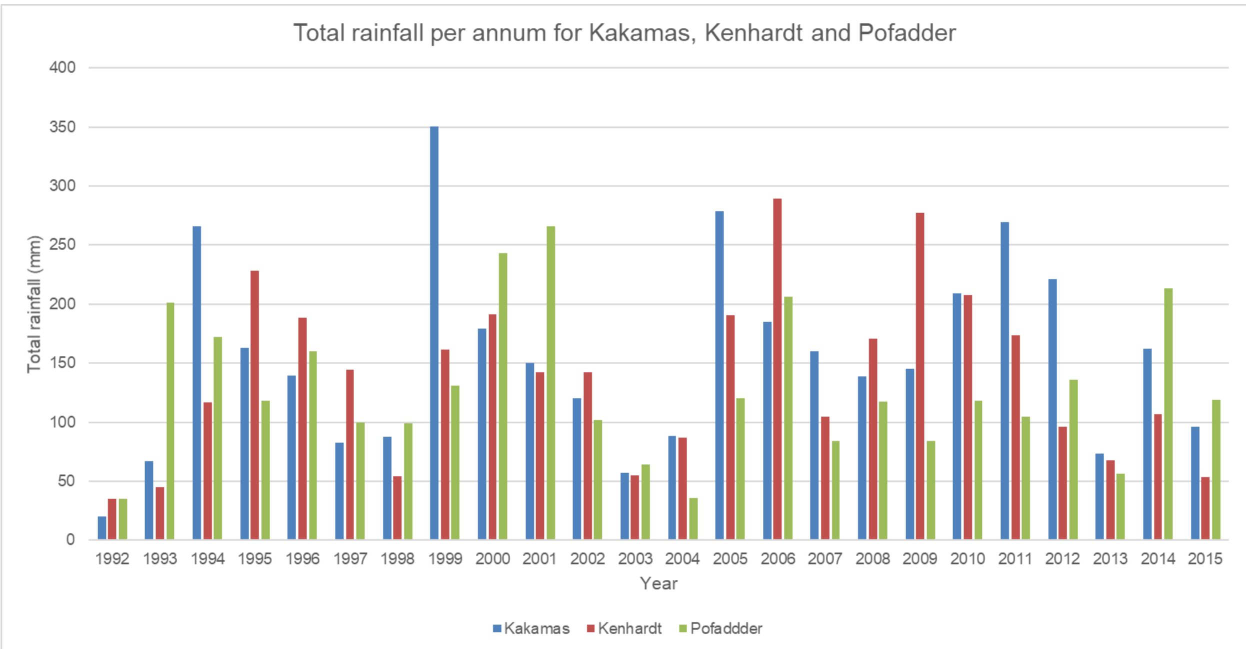


Figure 4: Total rainfall per annum for Kakamas, Kenhardt and Pofadder respectively (Weather Bureau, 2016).

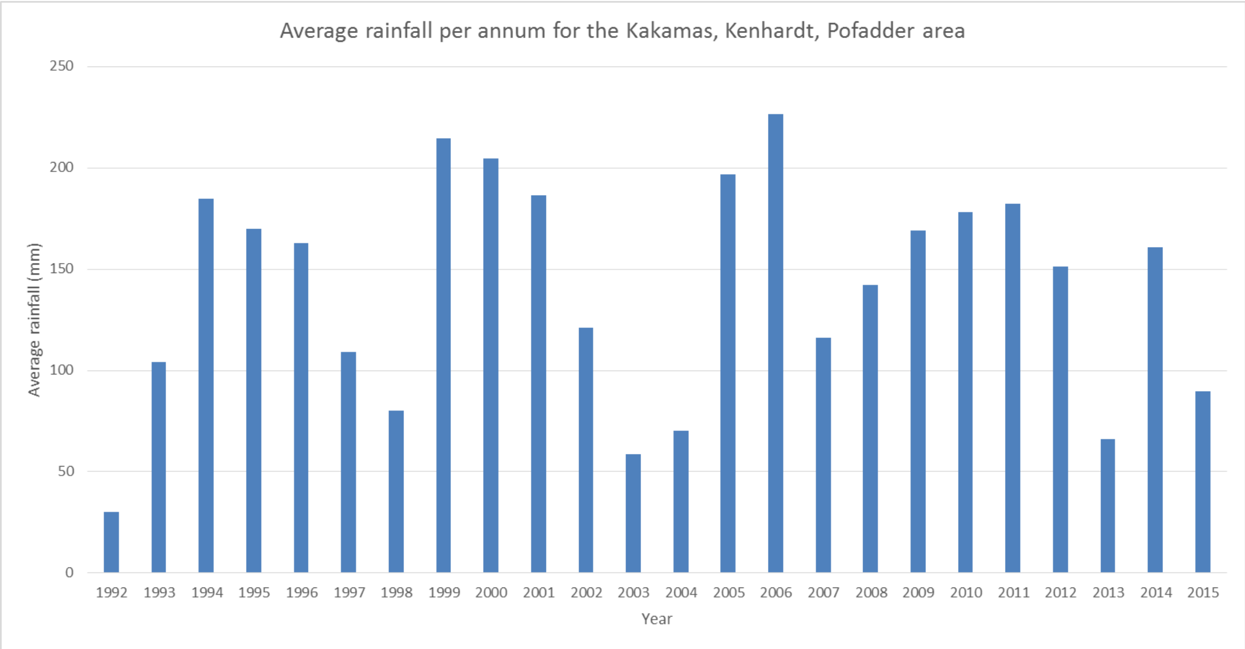


Figure 5: Average rainfall per annum for the Kakamas, Kenhardt and Pofadder area (Weather Bureau, 2016).

Figure 4 and Figure 5 revealed that severe drought conditions were experienced during 1992, 2003, 2004 and 2013. The variation in average temperatures within this area is extreme with maximum temperatures during the summer reaching up to 40.8 °C and minimum temperatures as low as -3 °C. Figure 6 illustrates the daily maximum temperatures (°C) for the Pofadder area while the daily minimum temperatures (°C) (measured at 8 am in the morning) for the same area are illustrated in Figure 7.

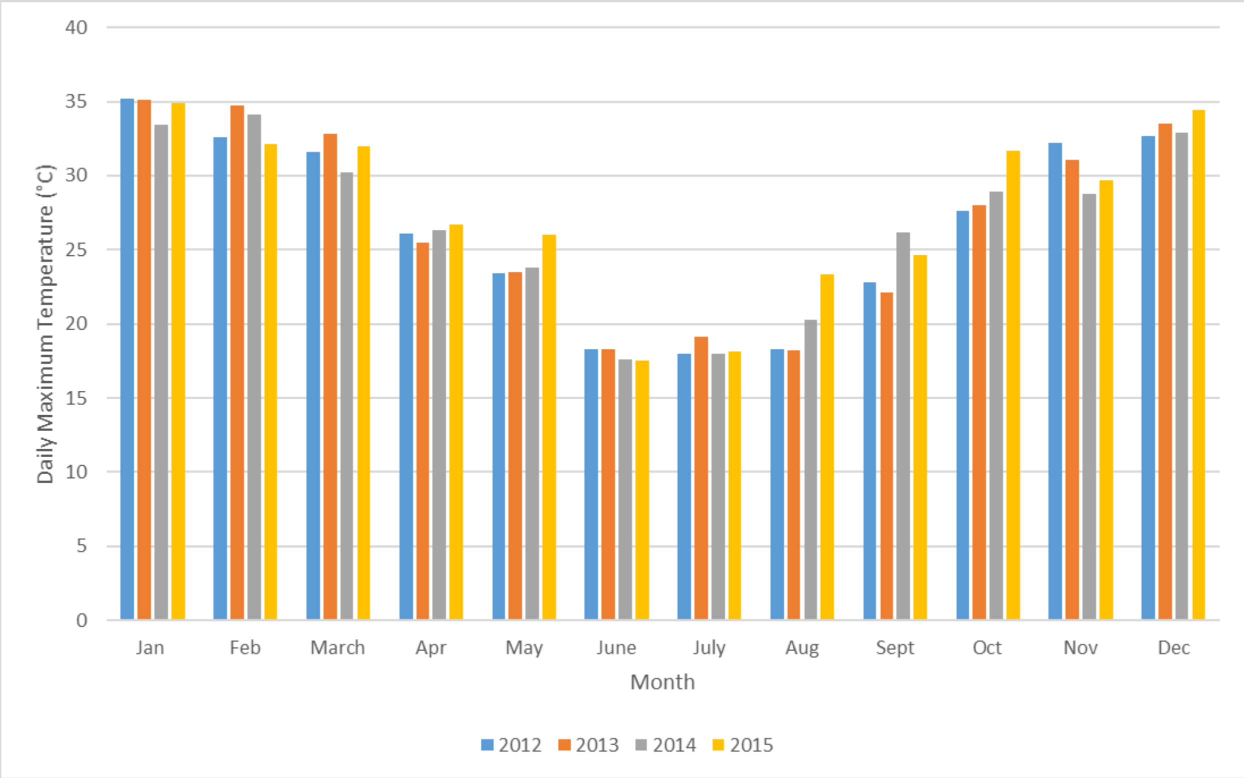


Figure 6: The daily maximum temperatures (°C) for the Pofadder area (Weather Bureau, 2016).

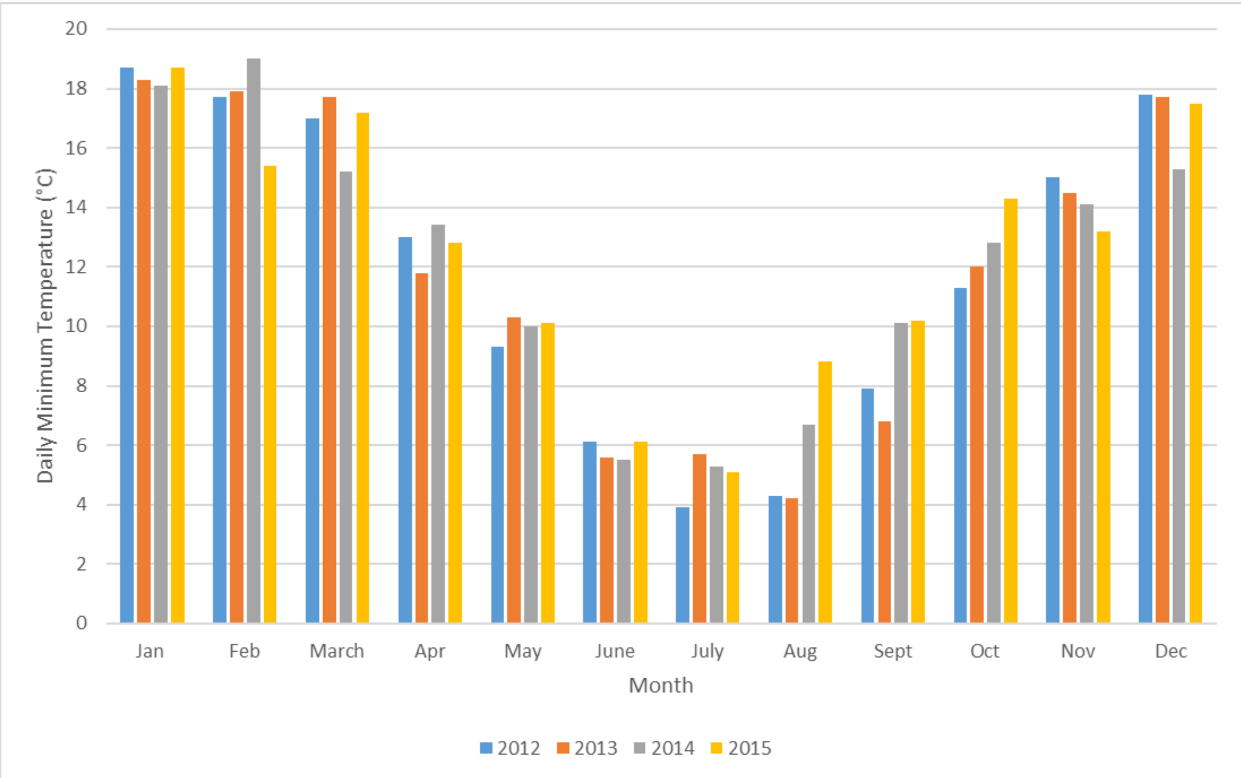


Figure 7: The daily minimum temperatures (°C) for the Pofadder area (Weather Bureau, 2016).

Daily maximum temperatures (Figure 6) range from an average of 35 °C (January) to 17 °C (June) with daily minimum temperatures (Figure 7) ranging from an average of 19 °C (February) to 4 °C

(July). According to Mucina and Rutherford (2006) this site forms part of an area with a mean annual evaporation potential of 2771 mm per annum, experiencing between 21 and 30 mean frost days per annum.

5.2 Topography

The overall topography of the site is relatively homogenous and ranges from 857 m to 880 m above mean sea level with the highest part of the landscape to the south-east and the lowest part to the north-west (Figure 8).

The area with the lowest elevation (north-west) lies south-east of the Salt River which is situated north-west of the study area. The Salt River flows to the north-east into the Hartbees River which eventually connects to the Gariep River.

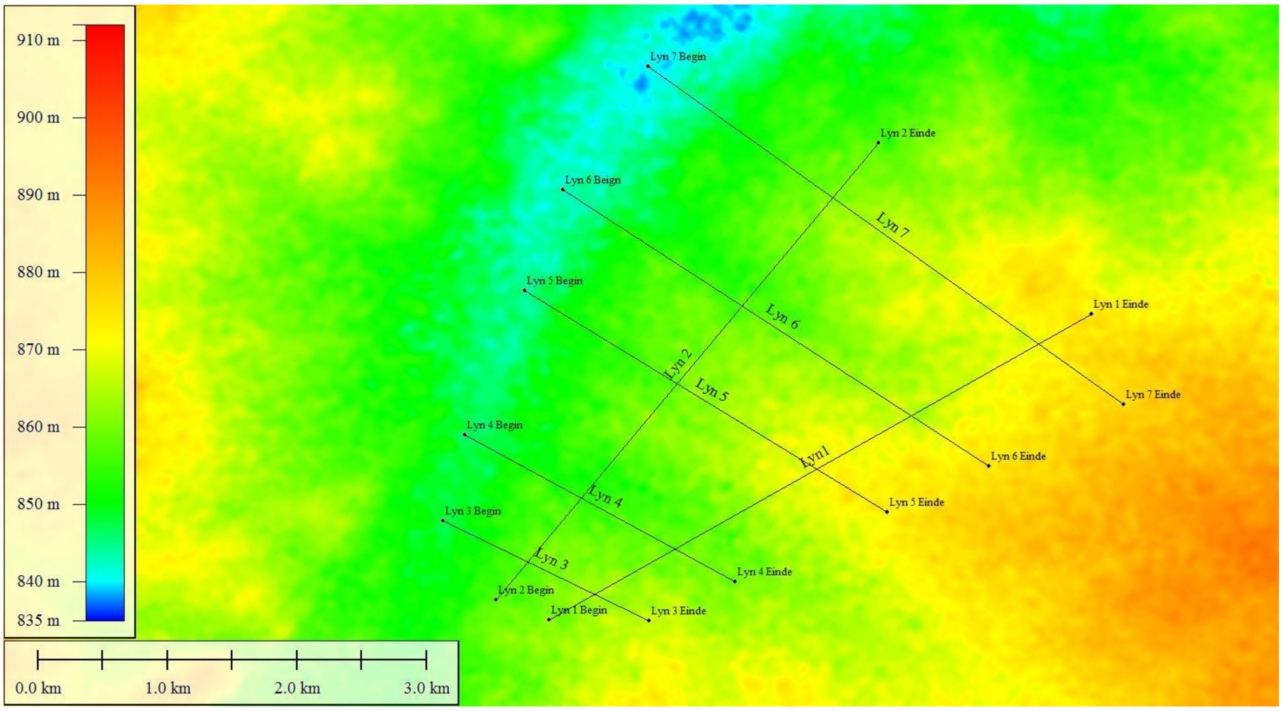


Figure 8: General elevation (above mean sea level) of the study area.

5.3 Soil

Note that since the information obtained from the land type survey is of a reconnaissance nature, only the general dominance of the soils in the landscape can be provided and not the actual area of occurrence within a specific land type. Land type data was obtained from the Agricultural Research Council (Land Type Survey Staff, 2003) and entails the division of land into land types, typical terrain cross sections and dominant soil types for each terrain unit. A land type can be defined as an area with similar climate, topography and soil distribution patterns.

One land type (Ag3) dominates the entire study area. According to the Land Type Survey Staff (2003), 40% of land type Ag3 consists of freely drained, shallow (< 300 mm deep), red, eutrophic, apedal soils with yellow-brown soils comprising less than 10% of this land type. The average depth of all soils is 280.5 mm. Approximately 77% of land type Ag3 consist of soils with a depth of ≤ 300 mm (depth class D1), whereas 12.5% consist of soil with a depth of 901 mm to 1200 mm (depth class D4). The average topsoil clay percentage of land type Ag3 is 10.7%. Around 88.5% of land type Ag3 consist of loamy sand soils (clay class C2) with an average clay percentage of 6.1% to 15% in the topsoil, whilst 1% consist of sandy loam soils (clay class C3) with an average clay percentage of 15.1% to 25% in the topsoil (Land Type Survey Staff, 2003).

The soils of land type Ag3 can be divided into three soil classes. Table 1 illustrates the different soil classes, description of soil classes, soil forms and percentage occupancy of each soil class within land type Ag3.

Table 1: Description of soil classes within land type Ag3 (Land Type Survey Staff, 2003).

Soil Classes	**Description**	**Soil Form**	**Percentage occupancy**
S2	Freely drained, structureless soils.	*Hutton, Clovelly, Griffen, Shortlands, Oakleaf.*	58,3%
S13	Lithic soil (shallow soils on hard weathering rocks).	*Mispah, Glenrosa.*	31,2%
S16	Non-soil land classes	*Pans, rivers, stream beds, erosion structures, marshes, reclaimed land, dunes, gravel, etc.*	0,5%

Approximately 58.3% of land type Ag3 consists of freely drained, structureless soils, whereas 31.2% consist of characteristic lithic soils. A small part (0.5%) of land type Ag3 is occupied by structures like pans, rivers, stream beds, erosion structures, marshes, reclaimed land, dunes and gravel.

Land capability and land use:

Mainly extensive grazing due to climatic constraints. Irrigation land uses are limited due to lack of large volumes of water.

Agricultural potential:

Low potential due to shallow soils and low and erratic rainfall. Dryland crop production is not viable in areas with rainfall lower than 500 mm unless significant groundwater is available (not the case for this specific survey site).

5.4 Hydrology and geohydrology

The study area is situated within the Lower Orange Management Area, Quaternary Drainage Area D53H. North-east of the site lies the non-perennial Salt River, with drainage lines running off in a north-eastern direction towards the Salt River. Due to the gradual decline in altitude (Figure 8), this area contains seasonal and ephemeral drainage lines. Based on vegetation, no wetland conditions occur along the drainage lines on site. There are also no pans on site. In the northern corner of the site there is a small earth dam which cannot be considered as a pan system. Different factors including domestic stock farming with sheep, dirt track crossings and weirs all affect the watercourses of the Salt River. However due to the low rainfall and seasonal nature of the river, there will be no significant impact on the river.

5.5 Existing Land Use

This area is predominantly used for livestock farming. The infrastructure present within the boundaries of the study area is limited to a feeding and water trough, border fences and a gravel pit. There is also a small earth dam (not considered as a pan system) in the northern corner of the site. Parallel to the north-western border of the site (located outside the study area) is the Loeriesfontein-Kakamas road.

5.6 Vegetation

The area under investigation (semi-arid Bushmanland region) forms part of the Nama Karoo Biome (Bezuidenhout, 2009). Based on the classification of Mucina and Rutherford (2006), it was concluded that the study area comprises mainly the Bushmanland Arid Grassland, the Bushmanland Sandy Grassland and the Bushmanland Basin Shrubland. The Bushmanland Arid Grassland is characterised by irregular plains dominated by *Stipagrostis* species. In some regions the vegetation structure is altered by low shrubs of *Salsola.* The Bushmanland Sandy Grassland is characterised by sandy grassland plains dominated by *Stipagrostis* and *Schmidtia* species. There is also a common occurrence of drought-resistant shrubs, and after rainfall the display of ephemeral spring flora including *Grielum humifusum* and *Gazania lichtensteinii.* The Bushmanland Basin Shrubland is characterised by irregular plains dominated by shrubs including *Rhigozum, Salsola, Pentzia* and *Eriocephalus* as well as different *Stipagrostis* grass species. After rainfall *Gazania* and *Leysera* species may also be present (Mucina & Rutherford, 2006).

The vegetation differences on this site reflects the substrate conditions including soil depth, soil texture and geology. The areas with coarse material (for instance the deep, sandy soils in the drainage systems) are dominated by shrubby vegetation while the areas with fine material or abundant geological outcrops (for instance the calcic soils) are dominated by grasses.

The north-western part of the study area consists of abundant outcrops with the following order of abundancy: Gneiss > metaquartzite > pegmatite > surficial calcrete deposits. This area has a large proportion of grasses (to a lesser extent than the south-eastern parts), combined with shrubs and rocky outcrops with no vegetation. The south-eastern part of the study area consists of surficial calcrete deposits with occasional gneiss outcrops and a dominating grassland. The drainage systems consist of alluvial and aeolian sandy material and are dominated by shrubs.

5.7 Critical Biodiversity Area

For this study area no Critical Biodiversity Areas have been defined and no fine-scale conservation planning has been done. This area does not fall within a National Protected Areas Expansion Strategy Focus Area (NPAES), and therefore is **not** characterised:

- With exceptional biodiversity;
- As significant for the maintenance of ecological processes; or
- As significant to climate change buffering.

According to Mucina and Rutherford (2006) the Bushmanland Arid Grassland, Bushmanland Sandy Grassland as well as the Bushmanland Basin Shrubland are considered as least threatened. According to the Department of Environmental Affairs, there are no proposed renewable energy facilities in the immediate surrounding area. The renewable energy project closest to the proposed Brypaal PV Project, is situated near Kenhardt. Figure 9 illustrates the map, generated by the Department of Environmental Affairs, indicating all registered renewable energy projects.

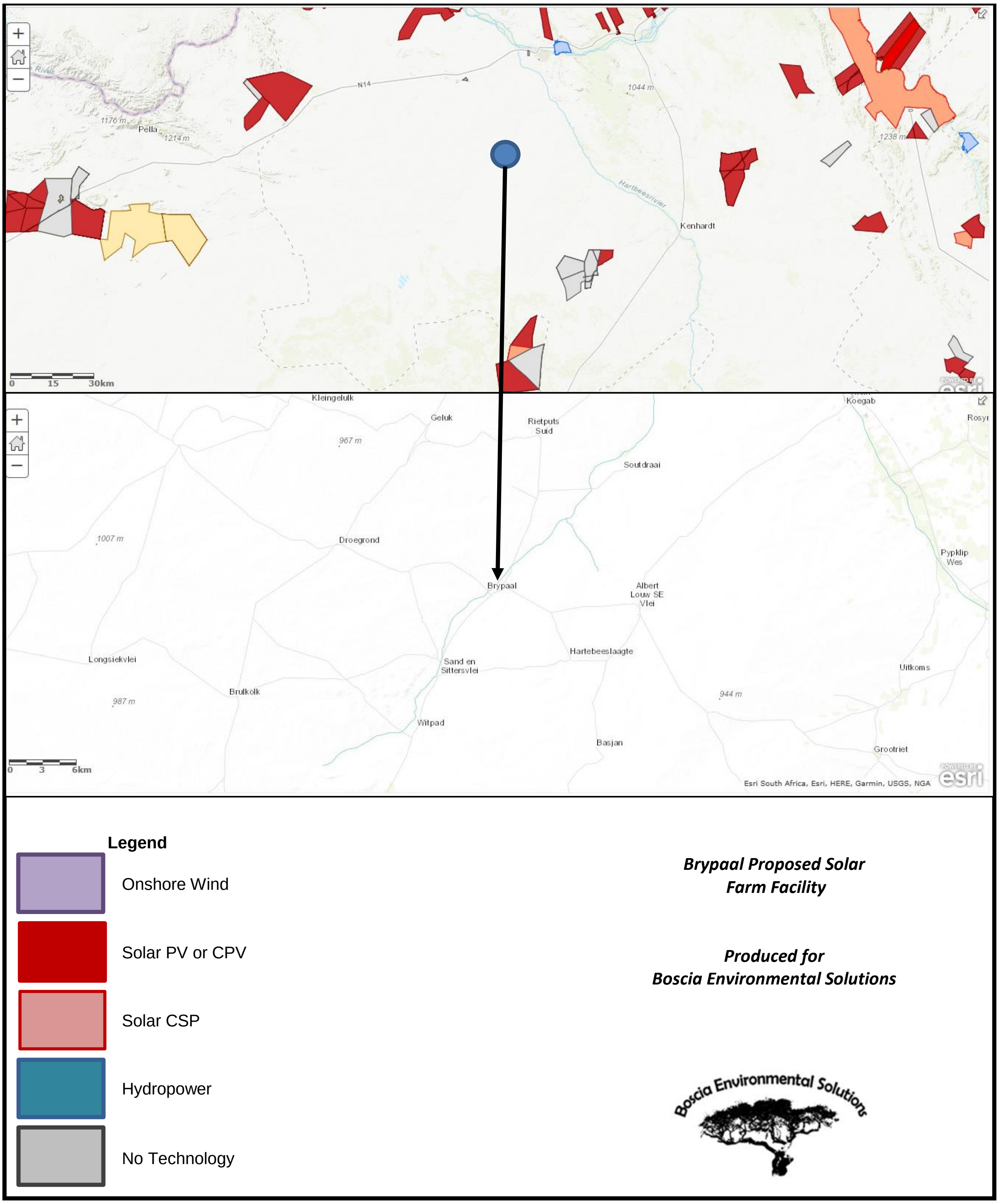


Figure 9: Map of DEA-registered renewable energy projects as seen on 30 November 2017.

6 Results of Geological Survey

The study area falls within the geological province known as the Bushmanland Terrane which forms part of the Namaqua Sector within the Namaqua-Natal Metamorphic Province. The Namaqua-Natal Metamorphic Province is a large area of contiguous structural fabric which formed during a tectonic metamorphic event. The Bushmanland Terrane covers approximately 60 600 km^2 and is known as the largest crustal block in the Namaqua Sector. It is comprised of granitic gneisses (~2000 Ma), supracrustal rocks of amphibolite to granulite grade (1600 – 1200 Ma) and granitoids (1200 – 1000 Ma). The Groothoek Thrust and Wortel Belt form the northern boundary of the Bushmanland Terrane and the Hartbees River Thrust the eastern boundary (Cornell *et al.*, 2006).

The Bushmanland Terrane is divided into three age groups known as the Kheisian strata (1700 – 2050 Ma), the young, deformed supracrustal and plutonic rocks (1200, 1600 and ~1900) and the syn-tectonic and late-tectonic Namaquan intrusive rocks (Cornell *et al.*, 2006; Moore *et al.*, 1990; SACS, 1980; Thomas *et al.*, 1994).

This particular area of interest lays south-west of the Kaapvaal Craton and west of the Hartbees River Thrust. All geological localities (Figure 2), field descriptions and photographs are illustrated in Figure 10. These localities and descriptions were used to construct a geological map of the area (Figure 11).

Based on the information obtained during the geological survey a lithostratigraphic column was constructed for this area (Table 2).

MAPPING UNIT A

Mapping Unit	Coordinates		Geological Identification	Properties
	Latitude	Longitude		
A1	29°12'42,9" S	20°22'43,7" E	No visible outcrops.	Mixture of aeolian and fluvial sedimentary deposits.
A2	29°11'18,5" S	20°22'26,7" E	No visible outcrops.	Mixture of aeolian and fluvial sedimentary deposits.

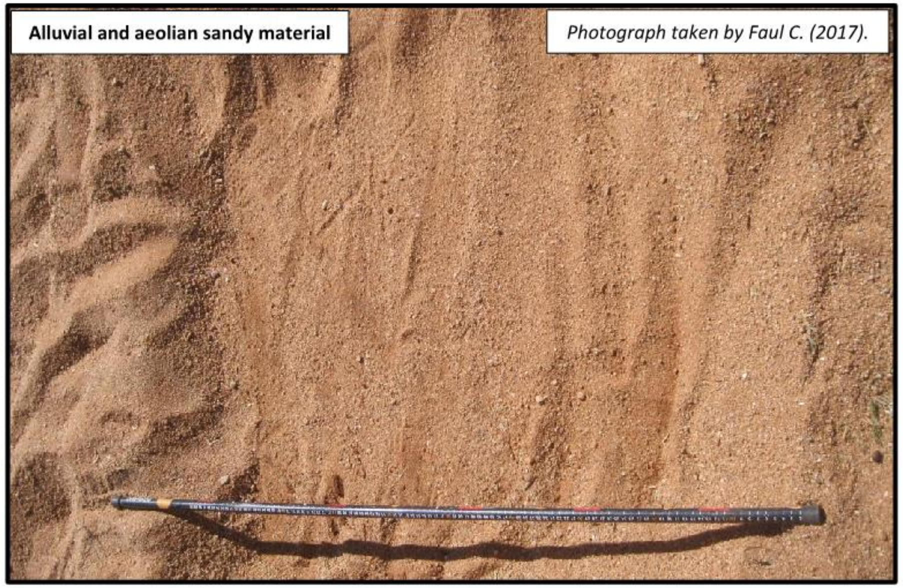
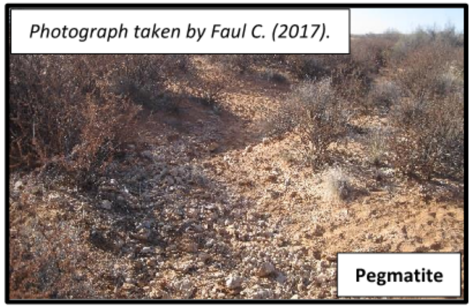


Figure 10: Geological identification and description.

MAPPING UNIT B

Mapping Unit	Coordinates		Geological Identification	Properties
	Latitude	Longitude		
B6	29°12'49,1"S	20°21'38,4"E	Pegmatite outcrop (**P5 in Figure 2**).	No properties recorded.
B8	29°11'12.3" S	20°22'35.6" E	No visible outcrops.	Small fragments of hydrothermal quarts and plagioclase present on the surface. Mixture of aeolian and fluvial sedimentary deposits.
B9	29°11'33.0" S	20°23'06.9" E	No visible outcrops.	Mixture of aeolian and fluvial sedimentary deposits.
B12-In riverbed	29°11'50.9" S	20°22'07.6" E	No visible outcrops.	Mixture of aeolian and fluvial sedimentary deposits.
B12-On riverbank	29°11'50.8" S	20°22'07.6" E	No visible outcrops.	Mixture of aeolian and fluvial sedimentary deposits.
B12	29°11'50.6" S	20°22'7.83" E	Pegmatite outcrop (**P22 in Figure 2**).	More weathered than in other localities.
B13-In riverbed	29°12'17.9" S	20°22'14.5" E	No visible outcrops.	Mixture of aeolian and fluvial sedimentary deposits.
B13-On riverbank	29°12'18.0" S	20°22'15.2" E		
B14	29°11'05.4" S	20°23'26.3" E	No visible outcrops.	Dorbank visible on the north-eastern side of the study area.
	29°11'07,4" S	20°23'27,0" E	Metaquartzite outcrop (**MQ3 in Figure 2**).	No properties recorded.



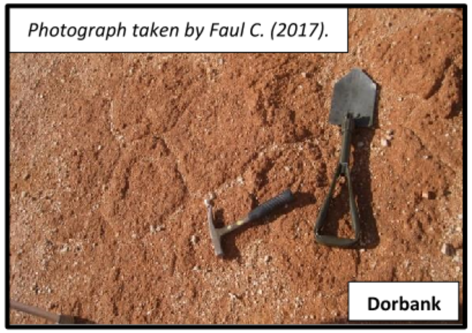
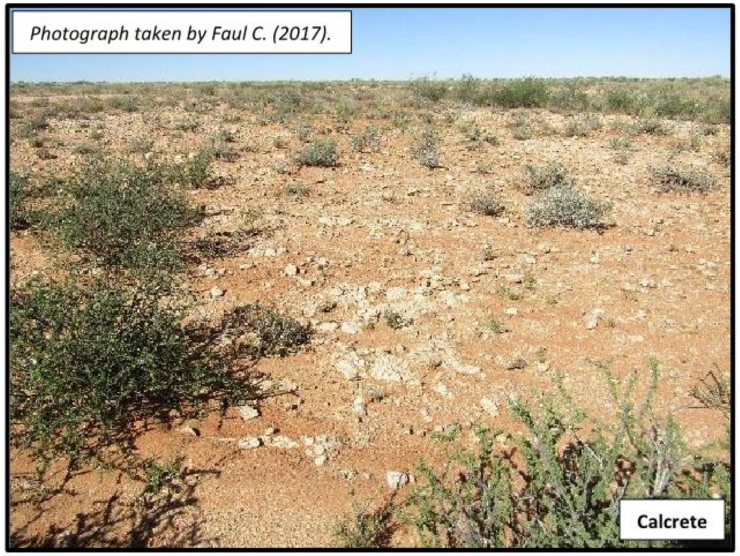


Figure 10 (continued): Geological identification and description.

MAPPING UNIT C

Mapping Unit	Coordinates		Geological Identification	Properties
	Latitude	Longitude		
C7	29°12’50,9” S	20°21'48,1” E	Metaquartzite outcrop (**MQ5 in Figure 2**).	No properties recorded.
	29°12’51,6” S	20°21’43,9” E	Metaquartzite outcrop (**MQ6 in Figure 2**).	No properties recorded.
C14	29°12’20.2” S	20°22’37.2” E	No visible outcrops.	Small fragments of hydrothermal quarts and plagioclase present on the surface. Mixture of aeolian and fluvial sedimentary deposits.
	29°12’20.1” S	20°22’37.3” E	Calcrete outcrop (**C24 in Figure 2**).	Total outcrop is approximately 4 m by 4 m in diameter.
	29°12’20.5” S	20°22’37.2” E	Gneiss outcrop (**G14 in Figure 2**).	Total outcrop is approximately 4 m by 4 m in diameter. No strike or dip visible.



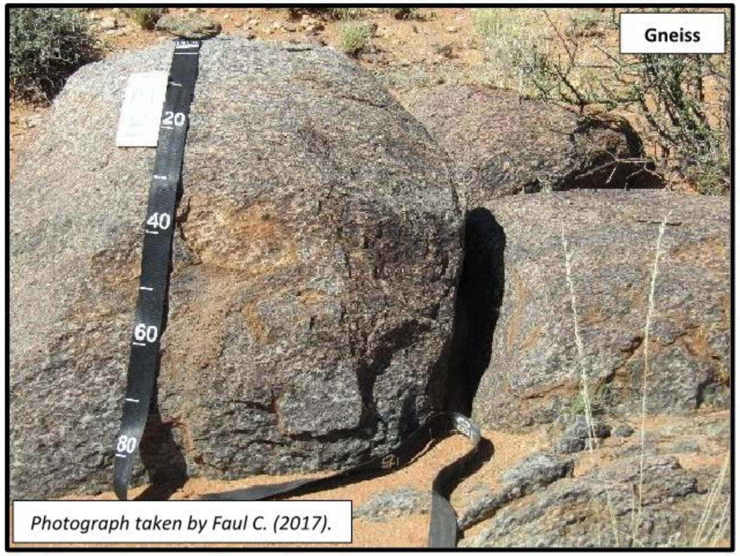


Figure 10 (continued): Geological identification and description.

Mapping Unit	Coordinates		Geological Identification	Properties
	Latitude	Longitude		
C15	29°12’19,4” S	20°22’31,5” E	Metaquartzite outcrop (**MQ9 in Figure 2**).	No properties noted.
	29°12’18,8” S	20°22’29,6” E	Gneiss outcrop (**G13 in Figure 2**).	Total outcrop is approximately 10 m by 10 m in diameter. The strike was measured as 140° with a dip of 60° SW.
	29°12’18,7” S	20°22’28,9” E	Pegmatite outcrop (**P14 in Figure 2**).	No properties noted.
C30	29°11'19.68"S	20°23'31.51"E	No visible outcrops.	Small fragments of hydrothermal quarts and plagioclase present on the surface. Mixture of aeolian and fluvial sedimentary deposits.
C35-In riverbed	29°11’54.4” S	20°23’20.8” E	No visible outcrops.	Small fragments of hydrothermal quarts and plagioclase present on the surface. Mixture of aeolian and fluvial sedimentary deposits.
C35-On riverbank	29°11’54.4” S	20°23’20.8” E		
C35	29°11’54.6” S	20°23’21.4” E	Pegmatite outcrop (**P19 in Figure 2**).	Total outcrop is approximately 4 m by 4 m in diameter. No strike or dip visible.
C37-In riverbed	29°12’02.3” S	20°22’24.7” E	No visible outcrops.	Hydrothermal quarts boulders present on the surface.
C37-On riverbank	29°12’02.3” S	20°22’24.7” E		
C37	29°12’02.3” S	20°22’24.5” E	Pegmatite outcrop (**P9 in Figure 2**).	The length of the outcrop is 1 m in a WSW (240°) to a ENE (60°) direction. The width is 40 cm perpendicular to the length.
C41-In riverbed	29°12’13.7” S	20°22’09.8” E	No visible outcrops.	Hydrothermal quarts and plagioclase fragments present on the surface, with underlying calcrete boulders.
C41-On riverbank	29°12’13.7” S	20°22’09.8” E		

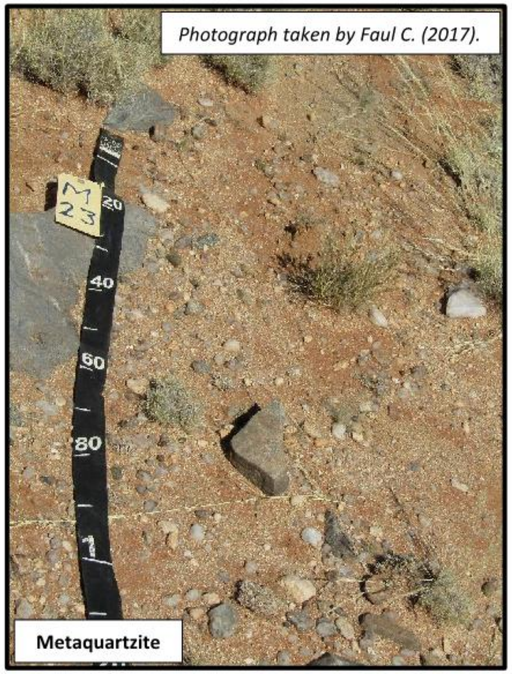
Figure 10 (continued): Geological identification and description.

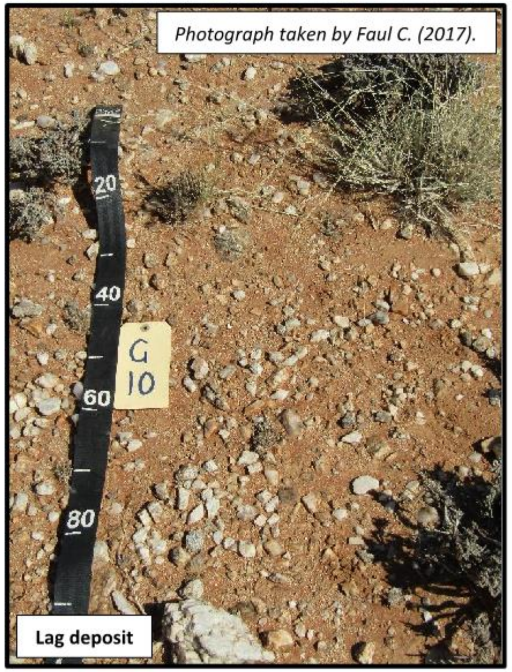
MAPPING UNIT D

Mapping Unit	Coordinates		Geological Identification	Properties
	Latitude	Longitude		
D5	29°11'29,1" S	20°23'40,5" E	Calcrete outcrop (**C38 in Figure 2**).	No properties recorded.
			Pegmatite outcrop (**P10 in Figure 2**).	No properties recorded.
D10	29°11'57.6" S	20°24'10.1" E	No visible outcrops.	Mixture of aeolian and fluvial sedimentary deposits.
D13	29°11'59.9" S	20°23'39.9" E	No visible outcrops.	Mixture of aeolian and fluvial sedimentary deposits.
D15	29°12'02.2" S	20°22'57.5" E	No visible outcrops present.	Mixture of aeolian and fluvial sedimentary deposits.
	29°11'57,2" S	20°22'59,3" E	Calcrete outcrop (**C15 & C16 in Figure 2**).	Total outcrop is approximately 25 m by 25 m in diameter.
	29°12'03,0" S	20°22'58,4" E	Metaquartzite outcrop (**MQ19 & MQ20 in Figure 2**).	The length of the outcrop is approximately 40 m in a ESE (120°) to a WNW (300°) direction. The width is 12 m perpendicular to the length.
D17	29°12'04.6" S	20°23'16.8" E	No visible outcrops.	Boulders present underneath the orthic A horizon.
	29°12'04.9" S	20°23'17.5" E	Pegmatite outcrop (**P21 in Figure 2**).	The length of the outcrop is approximately 43 m in a S (170°) to a N (350°) direction. The width is 28 m perpendicular to the length.

Figure 10 (continued): Geological identification and description.

Mapping Unit	Coordinates		Geological Identification	Properties
	Latitude	Longitude		
D17	29°12'06.2" S	20°23'18.1" E	Metaquartzite outcrop (**MQ15 in Figure 2**).	The length of the outcrop is approximately 23 m in a E (74°) to a W (254°) direction. The width is 17 m perpendicular to the length. The strike was noted as 112°, with a 60° dip to the north.
	29°12'04,8" S	20°23'16,6" E	Gneiss outcrop (**G15 in Figure 2**).	No properties recorded.
D19	29°12'05.0" S	20°22'07.5" E	No visible outcrops.	Mixture of aeolian and fluvial sedimentary deposits.
	29°12'05.2" S	20°22'07.7" E	Calcrete outcrop (**C25 in Figure 2**).	The length of the outcrop is approximately 10 m in a S (170°) to a N (340°) direction. The width is 5 m perpendicular to the length.





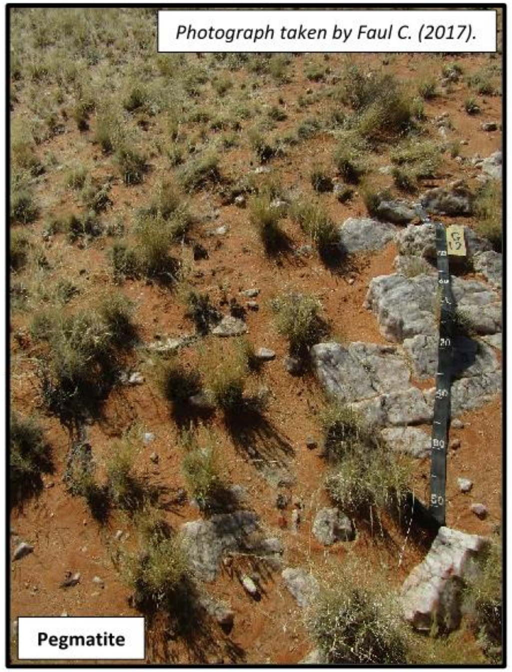


Figure 10 (continued): Geological identification and description.

MAPPING UNIT E

Mapping Unit	Coordinates		Geological Identification	Properties
	Latitude	Longitude		
E1	29°11’24.5” S	20°23’13.9” E	No visible outcrops.	Calcrete boulders present on surface, as well as smaller fragments of hydrothermal quartz and plagioclase.
	29°11’26.4” S	20°23’07.4” E	Pegmatite outcrop (**P11 in Figure 2**).	No properties recorded.
			Calcrete outcrop (**C37 in Figure 2**).	No properties recorded.
	29°11’25.1” S	20°23’26.7” E	Metaquartzite outcrop (**MQ4 in Figure 2**).	The length of the outcrop is approximately 115 m in a E (110°) to a W (290°) direction. The width is 2 m perpendicular to the length. The strike was noted as 110°, with a 60° dip to the west.
	29°11’23.8” S	20°23’23.5” E	Gneiss outcrop (**G9 in Figure 2**).	Total outcrop is approximately 4 m by 4 m in diameter. No strike or dip visible.
E2	29°11’27.5” S	20°23’51.6” E	Metaquartzite outcrop (**MQ14 in Figure 2**).	No properties recorded.
	29°11’35,5” S	20°23’32,1” E	Calcrete outcrop (**C21 & C22 in Figure 2**).	No properties recorded.
	29°11’33,3” S	20°23’33,9” E	Calcrete outcrop (**C23 in Figure 2**).	Total outcrop is approximately 6 m by 6 m in diameter.
	29°11’29,1” S	20°23’40,5” E	Calcrete outcrop (**C38 in Figure 2**) and pegmatite outcrop (**P10 in Figure 2**).	No properties recorded.
	29°11’33,2” S	20°23’35,1” E	Pegmatite outcrop (**P18 in Figure 2**).	No properties recorded.
E3	29°11’45.4” S	20°23’24.4” E	No visible outcrops.	Calcrete boulders present on surface, as well as smaller fragments of hydrothermal quartz and plagioclase.
	29°11’47.5” S	20°23’20.3” E	Calcrete outcrop (**C18 in Figure 2**).	No properties recorded.

Figure 10 (continued): Geological identification and description.

Mapping Unit	Coordinates		Geological Identification	Properties
	Latitude	Longitude		
E3	29°11’45.9” S	20°23’23.5” E	Calcrete outcrop (**C19 & C20 in Figure 2**).	No properties recorded.
	29°11’47.1” S	20°23’21.4” E	Pegmatite outcrop (**P6 & P7 in Figure 2**).	No properties recorded.
	29°11’41.9” S	20°23’26.5” E	Pegmatite outcrop (**P8 in Figure 2**).	No properties recorded.
E5	29°12’34.5” S	20°21’42.2” E	No visible outcrops.	Calcrete boulders present on surface, as well as smaller fragments of hydrothermal quartz and plagioclase.
E6	29°12’52.8” S	20°21’48.0” E	Pegmatite outcrop (**P2 in Figure 2**).	No properties recorded.
E7	29°11’33.8” S	20°22’18.4” E	No visible outcrops.	Mixture of aeolian and fluvial sedimentary deposits.
	29°11’33.7” S	20°22’20.1” E	Calcrete outcrop (**C26 & C28 in Figure 2**).	Total outcrop is approximately 5 m by 5 m in diameter.

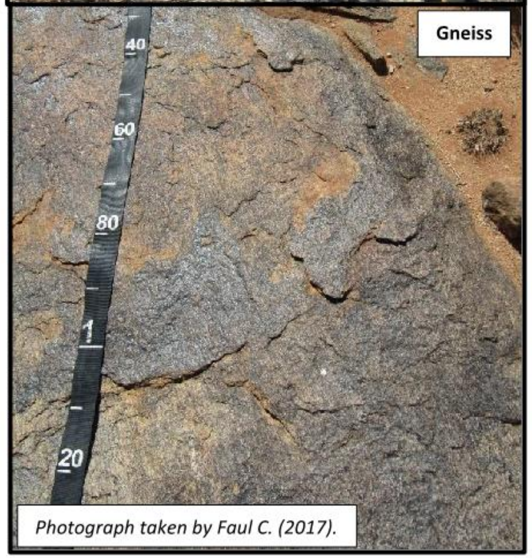
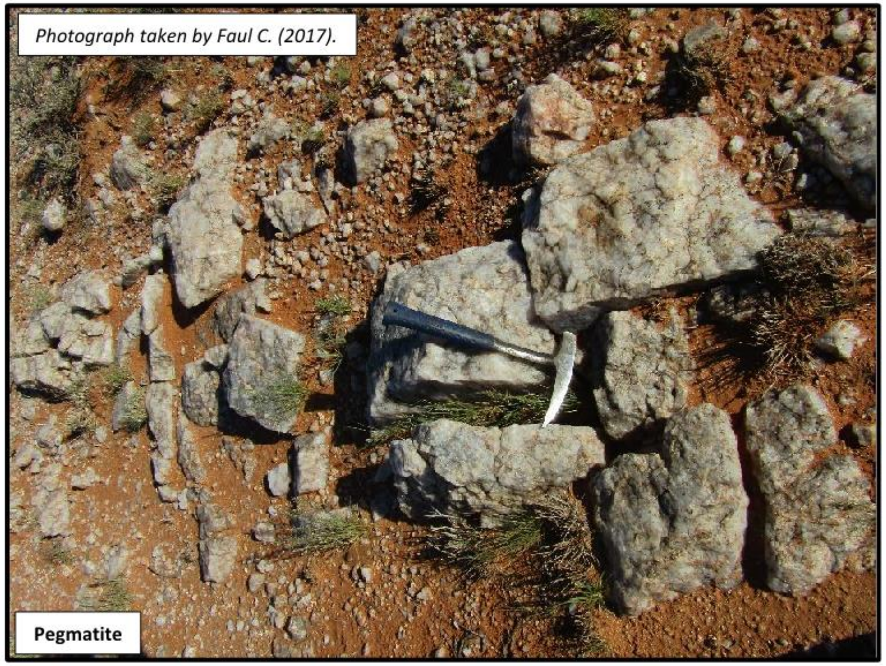


Figure 10 (continued): Geological identification and description.

Mapping Unit	Coordinates		Geological Identification	Properties
	Latitude	Longitude		
E7	29°11'34.3" S	20°22'21.2" E	Gneiss outcrop (**G3 in Figure 2**).	The length of the outcrop is approximately 40 m in a N (10°) to a S (190°) direction. The width is 20 m perpendicular to the length.
	29°11'34.3" S	20°22'21.2" E	Calcrete outcrop (**C27 in Figure 2**).	The length of the outcrop is approximately 17 m in a SSE (150°) to a NNW (330°) direction. The width is 5 m perpendicular to the length.
	29°11'33.4" S	20°22'18.4" E	Calcrete outcrop (**C39 in Figure 2**).	No properties recorded.
E9	29°11'55.3" S	20°22'06.0" E	No visible outcrops.	Calcrete boulders present on surface, as well as smaller fragments of hydrothermal quartz and plagioclase.



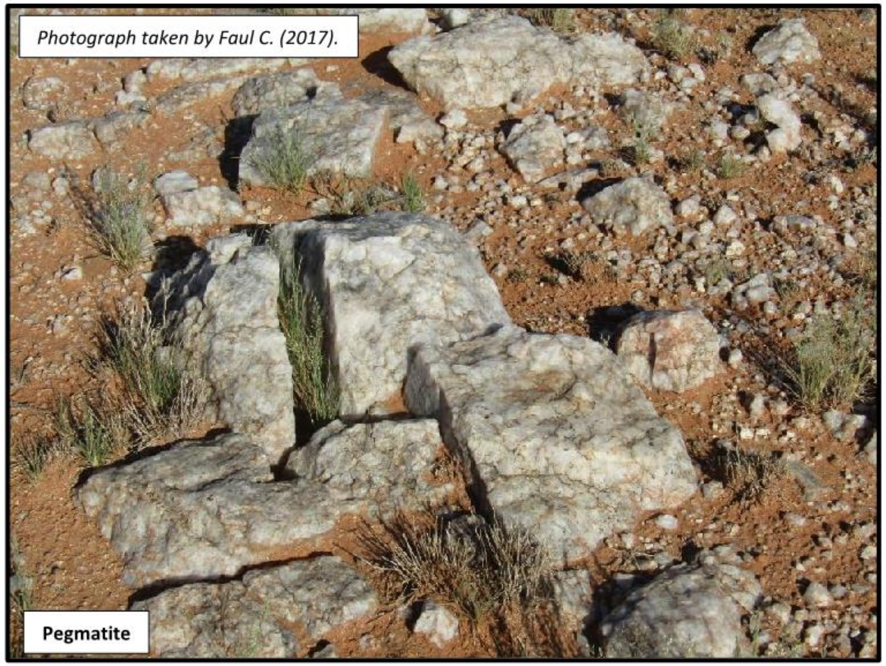


Figure 10 (continued): Geological identification and description.

MAPPING UNIT F

Mapping Unit	Coordinates		Geological Identification	Properties
	Latitude	Longitude		
F3	29°11'54.3" S	20°22'46.0" E	No visible outcrops.	Fragments of hydrothermal quartz on surface.
	29°11'54.5" S	20°22'46.1" E	Calcrete outcrop (**C29 in Figure 2**).	Total outcrop is approximately 4 m by 4 m in diameter.
	29°11'54.6" S	20°22'45.9" E	Calcrete outcrop (**C30 in Figure 2**).	Total outcrop is approximately 3 m by 3 m in diameter.
	29°11'55.4" S	20°22'45.5" E	Calcrete outcrop (**C31 in Figure 2**).	Total outcrop is approximately 3 m by 3 m in diameter.
	29°12'09,5" S	20°22'41,9" E	Calcrete outcrop (**C7 & C8 in Figure 2**).	Total outcrop is approximately 15 m by 15 m in diameter.
	29°12'07,1" S	20°22'44,4" E	Calcrete outcrop (**C9 in Figure 2**).	Total outcrop is approximately 1 m by 1 m in diameter.
	29°12'06,3" S	20°22'45,6" E	Calcrete outcrop (**C10 in Figure 2**).	Total outcrop is approximately 2 m by 2 m in diameter.
	29°12'04,7" S	20°22'47,2" E	Calcrete outcrop (**C11 in Figure 2**).	Total outcrop is approximately 1 m by 1 m in diameter.
	29°12'00,5" S	20°22'52,7" E	Calcrete outcrop (**C12 in Figure 2**).	Total outcrop is approximately 2 m by 2 m in diameter.
	29°11'58,9" S	20°22'55,5" E	Calcrete outcrop (**C13 in Figure 2**).	Total outcrop is approximately 3 m by 3 m in diameter.
	29°12'16,6" S	20°22'40,6" E	Calcrete outcrop (**C36 in Figure 2**) and Metaquartzite outcrop (**MQ21 in Figure 2**).	No properties recorded.

Figure 10 (continued): Geological identification and description.

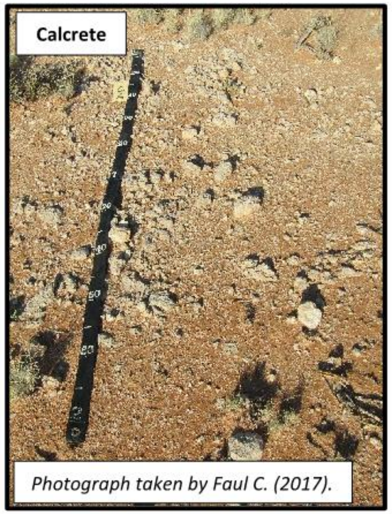
Mapping Unit	Coordinates		Geological Identification	Properties
	Latitude	Longitude		
F3	29°12’13,3” S	20°22’37,8” E	Calcrete outcrop (**C6 in Figure 2**).	Total outcrop is approximately 30 m by 2 m in diameter.
	29°12’19,4” S	20°22’31,5” E	Metaquartzite outcrop (**MQ9 in Figure 2**).	No properties recorded.
	29°12’10,9” S	20°22’40,1” E	Metaquartzite outcrop (**MQ10 in Figure 2**).	No properties recorded.
	29°12’03,5” S	20°22’49,0” E	Metaquartzite outcrop (**MQ11 in Figure 2**).	No properties recorded.
	29°11’59,1” S	20°22’55,0” E	Metaquartzite outcrop (**MQ12 in Figure 2**).	No properties recorded.
	29°12’02,0” S	20°22’52,0” E	Gneiss outcrop (**G2 in Figure 2**).	No properties recorded.
F4	29°11’57,8” S	20°22’58,2” E	Calcrete outcrop (**C14 in Figure 2**).	Total outcrop is approximately 4 m by 4 m in diameter.
	29°11’57,2” S	20°22’59,3” E	Calcrete outcrop (**C15 & C16 in Figure 2**).	Total outcrop is approximately 25 m by 25 m in diameter.
	29°11’55,4” S	20°23’03,2” E	Calcrete outcrop (**C17 in Figure 2**).	Total outcrop is approximately 1 m by 1 m in diameter.
	29°11’58,4” S	20°22’56,7” E	Pegmatite outcrop (**P15 in Figure 2**).	No properties recorded.
F5	29°12’40.4” S	20°22’12.4” E	No visible outcrops.	Fragments of hydrothermal quartz and plagioclase on surface.
	29°12’47,4” S	20°22’27,9” E	Gneiss outcrop (**G12 in Figure 2**).	Total outcrop is approximately 4 m by 4 m in diameter.

Photograph taken by Faul C. (2017).

Figure 10 (continued): Geological identification and description.

MAPPING UNIT G

Mapping Unit	Coordinates		Geological Identification	Properties
	Latitude	Longitude		
G1	29°11'17.1" S	20°23'01.2" E	Calcrete outcrop (**C32 in Figure 2**).	No properties recorded.
G5	29°11'36.8" S	20°23'22.1" E	No visible outcrops.	Fragments of calcrete, hydrothermal quartz and plagioclase on surface.
	29°11'40,7" S	20°23'27,8" E	Pegmatite outcrop (**P16 in Figure 2**).	Total outcrop is approximately 10 m by 10 m in diameter.
	29°11'38,7" S	20°23'29,5" E	Pegmatite outcrop (**P17 in Figure 2**).	Total outcrop is approximately 1 m by 1 m in diameter.
	29°11'36,9" S	20°23'22,9" E	Pegmatite outcrop (**P20 in Figure 2**).	The length of the outcrop is approximately 60 m in a SE (140°) to a NW (320°) direction. The width is 4 m perpendicular to the length.
	29°11'39,8" S	20°23'28,5" E	Metaquartzite outcrop (**MQ13 in Figure 2**).	No properties recorded.
G6	29°11'43.3" S	20°22'29.6" E	No visible outcrops.	Fragments of calcrete, hydrothermal quartz and plagioclase on surface.
	29°11'43.3" S	20°22'29.6" E	Metaquartzite outcrop (**MQ16 in Figure 2**).	The length of the outcrop is approximately 15 m in a ENE (76°) to a WSW (256°) direction. The width is 3 m perpendicular to the length.
	29°11'43.3" S	20°22'29.6" E	Calcrete outcrop (**C33 in Figure 2**).	The length of the outcrop is approximately 5 m in a ENE (76°) to a WSW (256°) direction. The width is 2 m perpendicular to the length.
	29°11'45,2" S	20°22'29,4" E	Metaquartzite outcrop (**MQ17 in Figure 2**).	No properties recorded.

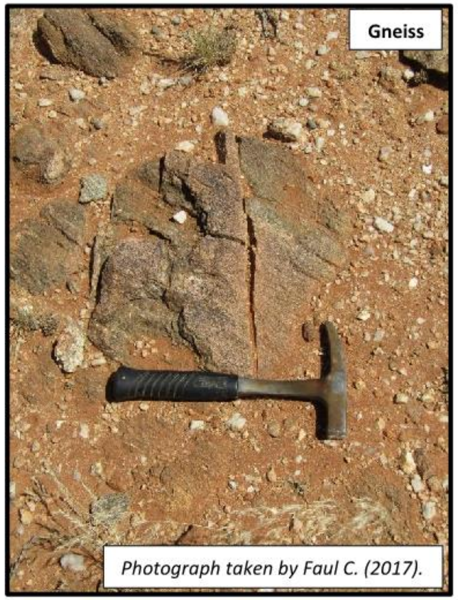


Photograph taken by Faul C. (2017).

Photograph taken by Faul C. (2017).

Figure 10 (continued): Geological identification and description.

Mapping Unit	Coordinates		Geological Identification	Properties
	Latitude	Longitude		
G7	29°12’05.4” S	20°22’14.8” E	No visible outcrops.	Fragments of calcrete, hydrothermal quartz and plagioclase on surface.
G10	29°12’31.8” S	20°21’58.3” E	No visible outcrops.	Fragments of calcrete, hydrothermal quartz and plagioclase on surface.
	29°12’34,8” S	20°21’58,3" E	Calcrete outcrop (**C3 in Figure 2**).	Total outcrop is approximately 5 m by 5 m in diameter.
	29°12’30,6” S	20°22’00,8" E	Calcrete outcrop (**C4 in Figure 2**).	Total outcrop is approximately 5 m by 5 m in diameter.
	29°12’42,0” S	20°21’55,1" E	Calcrete outcrop (**C2 in Figure 2**).	Total outcrop is approximately 4 m by 4 m in diameter.
	29°12’29,7” S	20°22’01,5" E	Metaquartzite outcrop (**MQ8 in Figure 2**).	No properties recorded.
	29°12’38,1” S	20°21’57,7" E	Gneiss outcrop (**G10 in Figure 2**).	No properties recorded.
	29°12’28,5” S	20°22’02,0" E	Pegmatite outcrop (**P13 in Figure 2**).	No properties recorded.
	29°12’44,9” S	20°21’54,0" E	Pegmatite outcrop (**P1 in Figure 2**).	No properties recorded.
	29°12'32,0" S	20°22'32,0" E	Pegmatite outcrop (**P4 in Figure 2**).	No properties recorded.
G12	29°12'51,1" S	20°21'42,4" E	Pegmatite outcrop (**P3 in Figure 2**).	No properties recorded.
	29°12'49,1" S	20°21'38,4" E	Pegmatite outcrop (**P5 in Figure 2**).	No properties recorded.



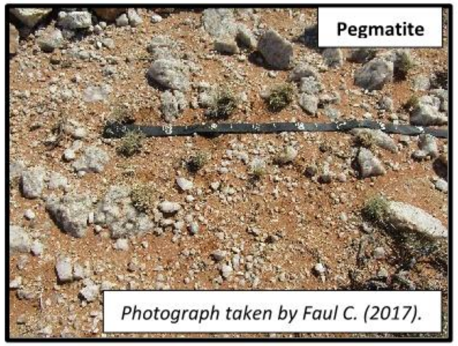


Figure 10 (continued): Geological identification and description.

MAPPING UNIT H

Mapping Unit	Coordinates		Geological Identification	Properties
	Latitude	Longitude		
H1	29°10’45.3” S	20°22’57.3” E	No visible outcrops.	Fragments of calcrete, hydrothermal quartz, orthoclase, and plagioclase on surface.
	29°11’14,8” S	20°23’28,1” E	Gneiss outcrop (**G8 in Figure 2**).	No properties recorded.
H3	29°12’33.6” S	20°22’41.2” E	No visible outcrops.	Fragments of calcrete, hydrothermal quartz, orthoclase, and plagioclase on surface.
	29°12’34.5” S	20°22’43.1” E	Metaquartzite (**MQ18 in Figure 2**).	The length of the outcrop is approximately 10 m in a ENE (80°) to a WSW (260°) direction. The width is 3 m perpendicular to the length.
	29°12’33.6” S	20°22’43.2” E	Gneiss outcrop (**G11 in Figure 2**).	Total outcrop is approximately 25 m by 25 m in diameter.
H4	29°12’05.7” S	20°21’53.7” E	No visible outcrops.	Fragments of calcrete, hydrothermal quartz, orthoclase, and plagioclase on surface.
H5	29°12’07.9” S	20°23’06.5” E	No visible outcrops.	Fragments of calcrete, hydrothermal quartz, orthoclase, and plagioclase on surface. Various calcrete outcrops in the surrounding area.
	29°12’07.8” S	20°23’05.8” E	Calcrete outcrop (**C34 in Figure 2**).	Total outcrop is approximately 30 m by 30 m in diameter.
H6	29°12’48.5” S	20°22’28.5” E	No visible outcrops.	Fragments of calcrete, hydrothermal quartz, orthoclase, and plagioclase on surface.
	29°12’45,7” S	20°22’40,9” E	Metaquartzite outcrop (**MQ7 in Figure 2**).	No properties recorded.

Figure 10 (continued): Geological identification and description.

<u>MAPPING UNIT I</u>

Mapping Unit	Coordinates		Geological Identification	Properties
	Latitude	Longitude		
I1	29°12'21.5" S	20°23'07.1" E	No visible outcrops.	Some orthoclase and quartz fragments on surface.
	29°12'21.3" S	20°23'07.2" E	Gneiss outcrop (**G4 in Figure 2**).	The length of the outcrop is approximately 2 m in a SE (132°) to a NW (312°) direction. The width is 30 cm perpendicular to the length. The strike is noted as 132° with a 40° dip in a north-eastern direction.
	29°12'24,2" S	20°22'54,6" E	Gneiss outcrop (**G1 in Figure 2**).	No properties recorded.
I2	29°11'54.1" S	20°23'40.7" E	No visible outcrops.	Some orthoclase and quartz fragments on surface.
	29°11'55.1" S	20°23'42.6" E	Gneiss outcrop (**G5 in Figure 2**).	The length of the outcrop is approximately 10 m in a SSE (150°) to a NNW (330°) direction. The width is 3 m perpendicular to the length.
	29°12'03,8" S	20°23'24,3" E	Pegmatite outcrop (**P12 in Figure 2**).	The strike is noted as 120° (ESE) with a 60° dip in a north-eastern direction.

Photograph taken by Faul C. (2017).

Photograph taken by Faul C. (2017).

Figure 10 (continued): Geological identification and description.

MAPPING UNIT J

Mapping Unit	Coordinates		Geological Identification	Properties
	Latitude	Longitude		
J1	29°12’10.9” S	20°22’01.5” E	Metaquartzite outcrops.	No properties recorded.
	29°12’11.1” S	20°22’01.1” E	Metaquartzite outcrop (**MQ21 in Figure 2**).	The strike is noted as 116° (ESE) with an 82° dip in a south-eastern direction.
	29°12’10.7” S	20°22’01.9” E	Metaquartzite outcrop (**MQ22 in Figure 2**).	Mylonite in metaquartzite.
J2	29°12’20.1” S	20°21’48.5” E	Metaquartzite outcrops.	No properties recorded.
	29°12’20.1” S	20°21’48.7” E	Metaquartzite outcrop (**MQ23 in Figure 2**).	The strike is noted as 91° (E) with an 45° dip in a south-eastern direction.
	29°12’20,1” S	20°21’48,5” E	Gneiss outcrop (**G6 in Figure 2**).	No properties recorded.
J3	29°11’24.4” S	20°22’24.3” E	Metaquartzite (**MQ24 in Figure 2**).	The strike is noted as 50° (NE) with an 50° dip in a south-eastern direction.
	29°11’24.8” S	20°22’24.3” E	Metaquartzite outcrop (**MQ2 in Figure 2**).	No properties recorded.
J4	29°11’22.9” S	20°22’39.5” E	Metaquartzite outcrops (**MQ1 & MQ25 in Figure 2**).	No properties recorded.
	29°11’20.3” S	20°22’38.3” E	Metaquartzite outcrop (**MQ26 in Figure 2**).	No properties recorded.
	29°11’20.6” S	20°22’36.1” E	Metaquartzite outcrop (**MQ27 in Figure 2**).	No properties recorded.
J5	29°11’28.4” S	20°22’50.7” E	Metaquartzite outcrop (**MQ28 in Figure 2**).	No properties recorded.
	29°11’28.5” S	20°22’50.8” E	Gneiss outcrop (**G7 in Figure 2**).	No properties recorded.
	29°11’28.6” S	20°22’51.0” E	Metaquartzite outcrop (**MQ29 in Figure 2**).	The strike is noted as 128° (NE) with an 40° dip in a south-eastern direction.
	29°11’28.4” S	20°22’51.0” E	Metaquartzite outcrop (**MQ30 in Figure 2**).	The strike is noted as 118° (ENE) with an 52° dip in a south-eastern direction.

Figure 10 (continued): Geological identification and description.

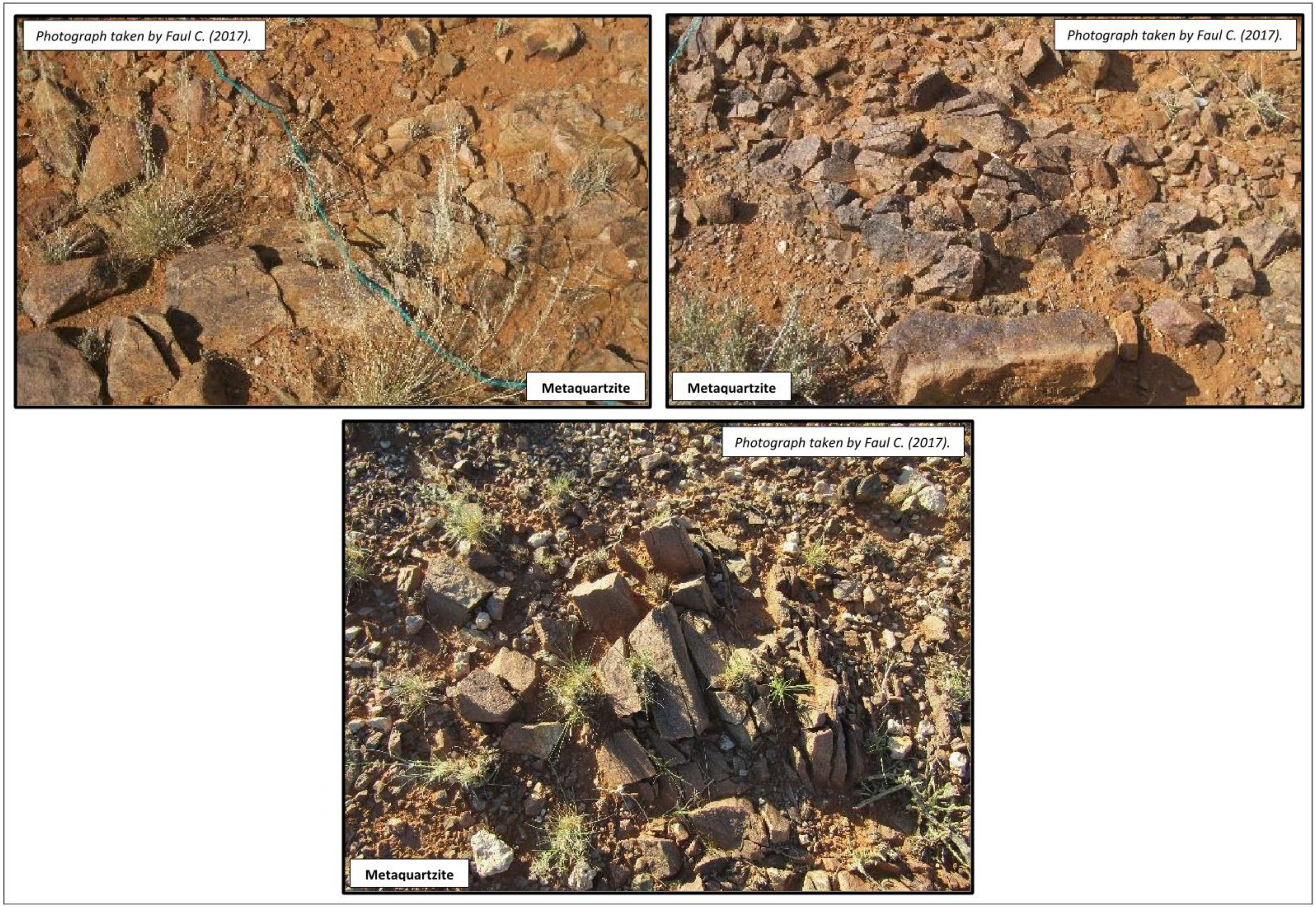


Figure 10 (continued): Geological identification and description.

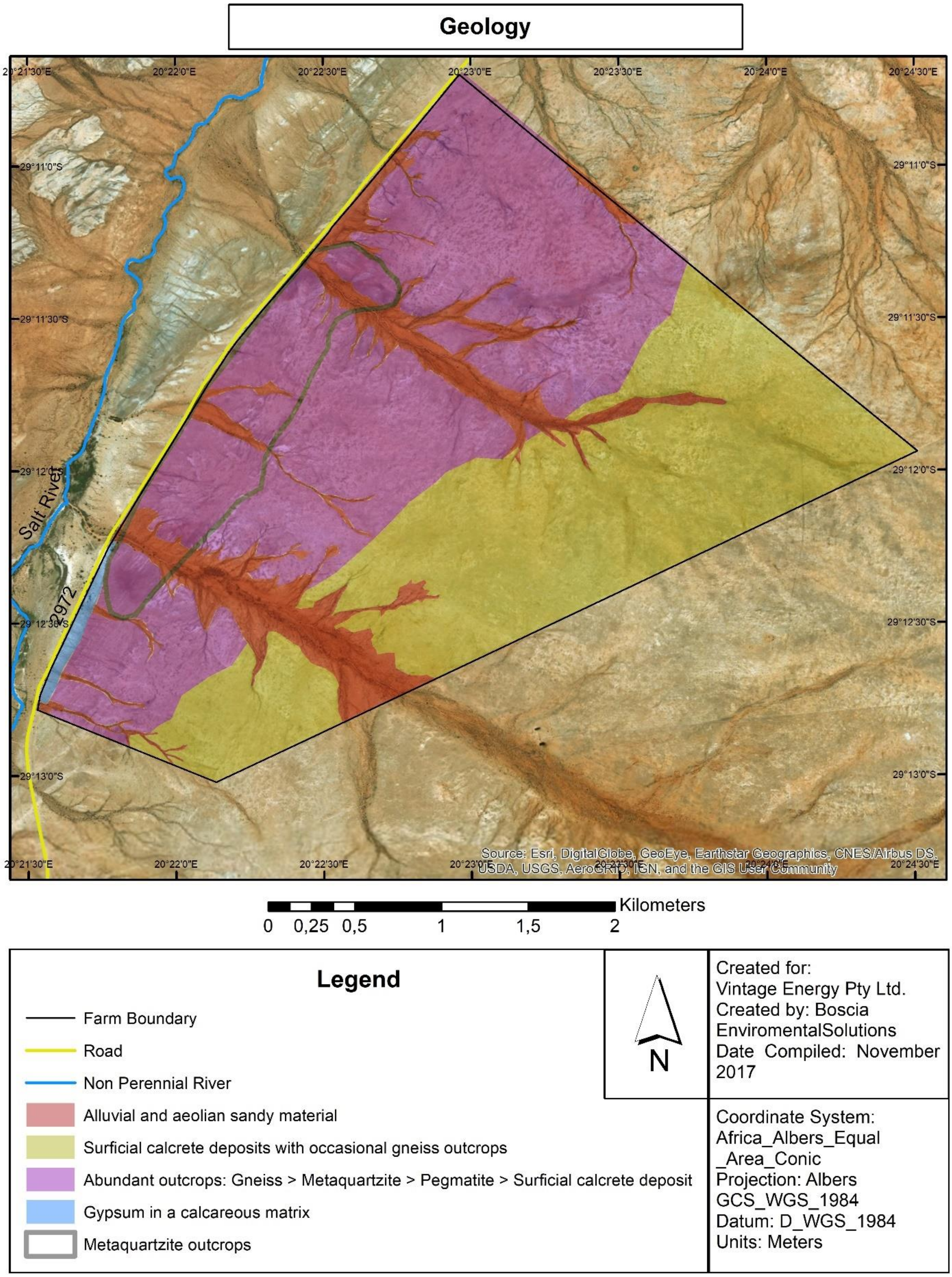


Figure 11: Map indicating the geology of the study area (Google Earth, 2016).

Table 2: Lithostratigraphic column of the study area (Bailie *et al.*, 2007; Colliston *et al.,* 2008; Cornell *et al.,* 2009; Cornell *et al.,* 2006; Eglington, 2006; Haddon, 2005; McClung, 2006; Reid *et al.,* 1997; Von M Harmse & Hatting, 2012; Watts, 1980).

<table>
<tr><th>Ma</th><th>Group</th><th>Subgroup</th><th>Formation</th><th>Intrusive Rocks</th><th>Lithological Description</th><th>Epoch</th><th>Period</th><th>Era</th><th>Eon</th><th>Ma</th></tr>
<tr><td>0 - 0.01</td><td rowspan="3">Kalahari Group</td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="8"></td><td>Kalahari calcrete, sandy material of mixed origin, lag deposit and gypsic deposits</td><td>Holocene</td><td rowspan="2">Quaternary</td><td rowspan="3">Cenozoic</td><td rowspan="3">Phanerozoic</td><td>0 – 0.01</td></tr>
<tr><td>0.01 – 1.6</td><td>Kalahari calcrete, sandy material of mixed origin, and lag deposit</td><td>Pleistocene</td><td>0.01 – 1.6</td></tr>
<tr><td>1.6 – 5.0</td><td>Kalahari calcrete (soft, hard bank, nodular, tabular)</td><td>Pliocene</td><td>Tertiary</td><td>1.6 – 5.0</td></tr>
<tr><td rowspan="4">~ 1130</td><td rowspan="5">Bushmanland Group</td><td rowspan="4">Kouboom Subgroup</td><td>Vaalkop Formation</td><td>Biotite-gneisses.</td><td rowspan="7"></td><td rowspan="7"></td><td rowspan="7">Mokolian</td><td rowspan="7">Proterozoic</td><td rowspan="7">900 - 2050</td></tr>
<tr><td>Driekop Formation</td><td>Metagreywacke comprised of grey quartzite.</td></tr>
<tr><td>Geelvloer Formation</td><td>Biotite-schist hosting calc-silicate and carbonate rich rocks. Emplacement of pegmatites.</td></tr>
<tr><td>Broken Hill Quartzite Formation</td><td>Typical purplish-red to dark grey glassy quartzite and metaquartzite.</td></tr>
<tr><td>~1640</td><td>Wortel Subgroup</td><td>Namies Schist Formation</td><td>Calc-silicate gneiss, biotite-rich schist, quartzite and metaquartzite.</td></tr>
<tr><td>~ 1650</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td>Hoogoor Suite</td><td>Pink gneiss</td></tr>
<tr><td>1700-2050</td><td>Achab Gneiss</td><td>Migmatitic leucogneiss</td></tr>
</table>

7 Geological Impact Assessment

The geological impact assessment aims to assess the impact that the proposed development will have on the geological environment. The geological assessment will be based on the weatherability and degradation of parent material. Geological features like caves, worship rocks etc. important for historical, cultural, archaeological and religious heritage will not be assessed in this report (assessed in the Heritage Impact Assessment). Geohydrological assessment will also not be part of this report (assessed in the Geohydrological Assessment).

7.1 Identification and Nature of Impact

The most important impact identified is the degradation of parent rock. Other impacts of priority include soil degradation and soil stability which will be addressed in the Soil Impact Assessment and Geotechnical Report respectively.

7.1.1 Impact 1: Degradation of parent rock

The technology used for this development is known as the Screw-In Pilon technology, which eliminates the problem of topsoil stripping. This technology ensures minimal environmental disturbance. If excavations do occur for the construction of the associated infrastructure it is important to note that deep and poorly planned excavation may potentially affect the stability of the surrounding area. It may also affect the geohydrology of an area.

This impact includes the degradation of parent material, which will consequently have an effect on the erosion within the surrounding area. The disturbance of more stable rocks, as in this case, is less of a concern. With the technology used for this project, minimal disturbance will occur on the site. If any excavation does occur, it will only be for the foundations of the associated infrastructure.

7.1.2 Impact 2: Cumulative impact of the degradation of parent rock

The cumulative impact on the degradation of parent rock as result of this proposed project will be low due to the Screw-In Pilon technology that will be used. Therefore, the contribution of this project to the cumulative impact is expected to be low. It is however important to implement appropriate mitigation measures during the construction phase, in order to minimize geological disturbances.

7.2 Assessment of Impacts

Impact 1: Degradation of parent rock

Impact Nature: Excavations and or blasting, during the construction of the associated infrastructure, causing degradation to local geology and instability.		
	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (4)	Minor (2)
Probability	Probable (3)	Probable (3)
Significance	MEDIUM (30)	LOW (24)
Status	Negative	Negative
Reversibility	Irreversible	Irreversible
Irreplaceable loss of resources	Yes, minor	Yes, minor
Can impacts be mitigated?	To a certain degree	
Mitigation	The zone of disturbance must be restricted, and excavations should be carefully planned. Taking contour lines into consideration, new access roads should be planned with precision, to minimise cutting and filling operations. Keep to existing roads to minimise impacts on undisturbed ground.	
Cumulative Impacts	The cumulative impact of rock degradation from all development in the area is considered low if mitigating measures are applied diligently.	
Residual Impacts	Minor – Some visual impact along access roads.	

Impact 2: Cumulative impact of the degradation of parent rock

Impact Nature: Land that is no longer able to be utilised (land associate the constructed permanent infrastructure).		
	The impact of the proposed project in isolation	**The cumulative impact of the project together with other projects within the area**
Extent	Local (1)	Local (1)
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (3)	Low (2)
Probability	Definite (4)	Definite (4)
Significance	MEDIUM (32)	LOW (28)
Status	Negative	Negative
Reversibility	Low	High
Irreplaceable loss of resources	Yes	Yes
Can impacts be mitigated?	No	
Mitigation	Associated infrastructure and access roads to be carefully planned and constructed to minimise the impacted area and prevent unnecessary excavation. Access roads will not cross any natural drainage lines.	

8 Discussion and Conclusion

Based on the information obtained, an area of 320 ha with the most favourable geological characteristics was selected. Figure 12 illustrates the recommended development area and footprint for the Brypaal Solar Power (PV) Project. The structures can be shifted within the broader study area to accommodate sensitive areas if applicable.

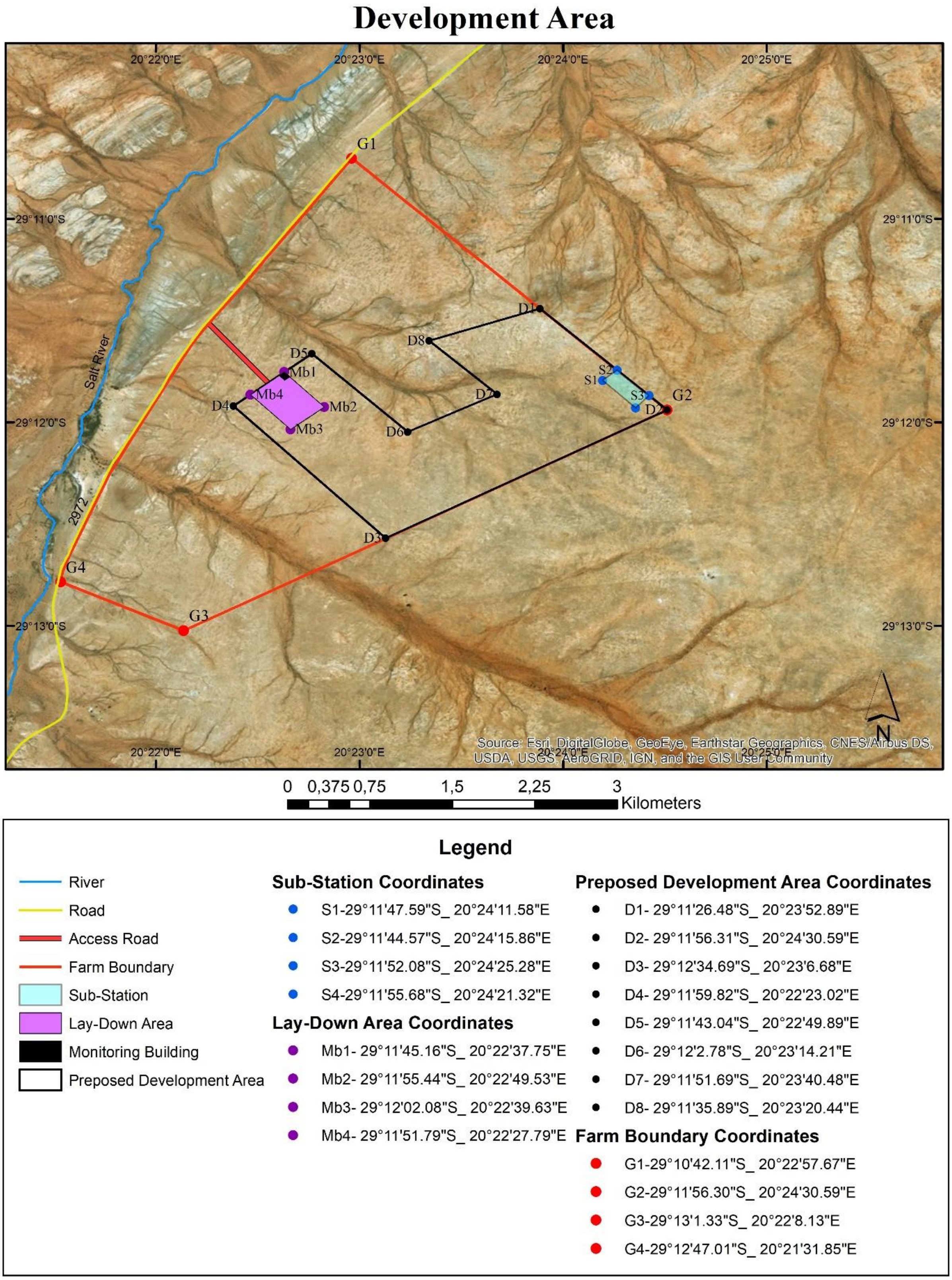


Figure 12: Map indicating the recommended development area (Google Earth, 2016).

During the field survey it was established that the north-western part of the study area consists of granitoids with the following order of abundancy: Gneiss > metaquartzite > pegmatite > surficial calcrete deposits. Surficial calcrete deposits with occasional gneiss outcrops dominate the south-eastern part of the study area. The drainage systems consist of alluvial and aeolian sandy material, while gypsic deposits coexist with a calcareous mixture.

The proposed development will have a low to moderate impact on the geological environment and these impacts can be largely mitigated with a resultant low overall significance due to the limited extent of the proposed earthworks as well as the layout of the proposed site being on an area dominated by gneisses with surficial calcrete deposits. The geology is favourable in terms of erodibility potential. The proposed layout has been selected to avoid areas with unfavourable topography and various variations in geology. The proposed layout is deemed acceptable in terms of this impact study.

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ANNEXURE A: CURRICULUM VITEA OF C FAUL

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CINDY FAUL

BSc ● BSc Hons (Environmental Sciences) ● MSc (Environmental Sciences)

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EXECUTIVE SUMMARY

Environmental Scientist

Offering ▪ New knowledge in the field of Environmental Sciences and Management ▪ Currently enrolled for PhD in Environmental Sciences at North-West University ▪ Experience in administrative coordination, project coordination, project management as well as Geological-, Soil- and Vegetation Surveying ▪ A self-motivated, loyal and market oriented approach ▪ With strong skills in managing and obtaining targets and objectives.

▪ BSc Soil Science, Botany and Geology ▪ BSc Hons Environmental Science ▪ MSc in Environmental Science

"Special value – well qualified up to MSc level; knowledge and exposure to international research; and 'hands-on' 'farm-girl' type understanding of farmers."

CAREER SUMMARY

Enrolled for PhD in Environmental Sciences	**2018**
Director: Boscia Environmental Solutions	**2016 - present**

- Project Coordinator – Environmental Impact Assessment for Solar Energy Facility.
- Conducting vegetation, soil and geological specialist studies.

Writing research proposals and managing budgets (Total of R 5 201 705,00)	**2015**
Student Member of the Land Rehabilitation Society of Southern Africa	**2015**
Administrative assistant at North-West University	**2015**
Successfully completed the Short Course Mining, Radiation, and the Environment	**2014**
Successfully completed the Short Course Mining and the Environment	**2014**
Successfully completed ArcGIS training course for Applied Geology and Soil Science	**2014**
Student internship at BHP Billiton	**2012**
Successfully completed the short course Introduction to Latin for Botany	**2012**

FELLOWSHIPS, AWARDS AND HONOURS

Award for 2nd best student poster presentation at the 11th International Phytotechnologies Conference; Heraklion; Crete; Greece (30 Sept – 3 Oct 2014).	**2014**
Member of the Golden Key Honour Society, since 2013, for exceptional academic performance.	**2013**

PROFESSIONAL ACTIVITIES

Publications:

K Koch,J., Chakraborty, S., Li, B., Moore-Kucera, J., Van Deventer, P., Daniell, A., Faul, C., Man, T., Pearson, D., Duda, B., Weindorf, C.A. & Weindorf, D.C. 2017. Proximal sensor analysis of mine tailings in South Africa: An exploratory study. *Journal of Geochemical Exploration,* 181: 45-57.

Poster at the 35th Land Rehabilitation Society of Southern Africa 2016 Conference; Kimberley; South Africa. *(The need for proper specialist studies in order to evaluate the impact of environmental processes on solar plant facilities.)* **2016**

Presentation at the 35th International Geological Congress; Cape Town; South Africa. *(Climate Change: A reality or a myth? Koa Dunefield case study, Northern Cape, South Africa.)* **2016**

Presentation at the South African Association of Botanists – 41st Annual Conference; Tshipise Forever Resort; South Africa. *(Physiological stress factors associated with different tailings materials on the Chlorophyll Fluorescence of plants).* **2015**

Presentation at the Combined Congress (Soil Science); Tramonto; George; South Africa. *(The influence of soil quality of anthropogenic mine soils on the chlorophyll fluorescence of some winter crops.)* **2015**

Attending the XIX INQUA Conference: Quaternary Perspectives on Climate Change, Natural Hazards and Civilization; Nagoya; Japan. **2015**

Presentation at the Land Rehabilitation Society of Southern Africa 2015 Conference; Glenburn Lodge; Muldersdrift; South Africa. *(Physiological stress factors associated with different tailings materials on the Chlorophyll Fluorescence of plants.)* **2015**

Presentation at the 12th Annual Kimberley Biodiversity Symposium; McGregor Museum; Kimberley; South Africa. *(The geo-environmental diversity of the Swartoup dune structures, Northern Cape Province; South Africa.)* **2015**

Poster & presentation at the 11th International Phytotechnologies Conference; Heraklion; Crete; Greece. *(Physiological stress factors associated with different tailings materials on the Chlorophyll Fluorescence of plants.)* **2014**

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MSc Environmental Sciences | North-West University, 2015 - 2017

BSc Hons Environmental Sciences | North-West University, 2014

BSc Soil Science, Botany, & Geology | North-West University,2010 – 2013

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RESEARCH INTERESTS

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- Correlations between vegetation, soil and geology.
- Project management

PERSONAL DETAILS

Full Name | Cindy Faul **Nationality** | South African
Languages | English & Afrikaans