Desktop Palaeontological Impact Assessment of the Proposed Development of a 150 MW Concentrated Solar Power Plant (Parabolic Trough) and Associated Infrastructure on Remaining Extent and Portions 4 and 5 of the Farm Groenwater 453 near Postmasburg, NC Province.

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Executive Summary

Potentially fossiliferous rocks within the proposed Concentrated Solar Power (CSP) plant and associated powerline footprints include carbonate and iron-rich rocks of the Cambellrand and Asbestos Hills Subgroups (Ghaap Group, Transvaal Supergroup). The CSP plant footprint largely underlain by Postmasburg Group strata that are unlikely to be directly impacted by the proposed development since they are mantled by geologically recent superficial deposits (windblown sand) considered to be of low palaeontological sensitivity. Powerline Route Alternatives 1 and 2 traverse Ghaap Group strata and Quaternary windblown sand, respectively considered to be of moderate and low palaeontological sensitivity. The 132 kV power line diversion route may potentially traverse Asbestos Hills Subgroup strata considered to be of moderate palaeontological sensitivity. However, the footprint is primarily mantled by a Quaternary windblown sand overburden that is underlain by Postmasburg Group lavas and subordinate siliclastic sediments of the Ongeluk Formation, considered to be of moderate palaeontological sensitivity. There are no major palaeontological grounds to halt the proposed development, but it is advised that sites marked for erection of pylons or construction of associated infrastructure, which will require excavation into fresh bedrock sediments of the Campbellrand and Asbestos Hills Subgroup, is mapped and recorded prior to the construction phase of the development.

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Introduction

A desktop palaeontological impact assessment was carried out for proposed development a 150 MW Concentrated Solar Power Plant (Parabolic Trough) and associated infrastructure on **the** Farm Groenwater 453 near Postmasburg in the Northern Cape Province**.** The final development footprint will cover a 500 ha – area (**Fig. 1)**. A new substation will be developed in the middle of the Concentrated Solar Power (CSP) plant to accommodate a new power line of which three alternative power line routes have been identified (**Fig. 2**):

- Route Alternative 1 (Preferred Alternative): 31.4 km – green line (run along the existing power line – red)
- Route Alternative 2: 26.0 km – pink line (running straight from Manganore Substation to the proposed Metsimatala substation)
- Diversion of existing 132 kV power line (blue line will be diverted): 4.64 km – red line indicating the diversion around the solar plant – this option is compulsory as the line should be diverted to accommodate the CSP Plant.

The heritage impact assessment is a pre-requisite for any development which will change the character of a site exceeding 5 000 m2 in extent, as prescribed by the National Heritage Resources Act (Act 25 of 1999). The task involved identification and mapping of possible heritage resources within the proposed project area, an assessment of their significance, related impact by the proposed development and recommendations for mitigation where relevant.

Methodology

The palaeontological significance of the affected area was evaluated through a desktop study and carried out on the basis of existing field data, database information and published literature.

Terms of Reference

- Identify and map possible palaeontological sites and occurrences using available resources.
- Determine and assess the potential impacts of the proposed development on potential heritage resources;

- Recommend mitigation measures to minimize potential impacts associated with the proposed development.

Field Rating

Site significance classification standards prescribed by SAHRA were used for the purpose of this report (**Table 1**).

Locality Data

1 : 50 000 scale topographic map: 2823 AD Lime Acres

1:250 000 scale geological map: 2823 Postmasburg

Site Coordinates of the proposed CSP plant development area (**Fig. 2):**

A) 28°17'49.51"S 23°17'14.41"E

B) 28°17'48.34"S 23°18'23.75"E

C) 28°16'22.94"S 23°18'21.91"E

D) 28°16'24.11"S 23°17'12.59"E

The affected area is located immediately north of the R31 provincial road and about 22 km east of Postmasburg.

Palaeontological Significance

The bedrock geology underlying the proposed CSP plant and associated powerline footprints are made up of carbonate, iron-rich and volcanic rocks of the Ghaap and Postmasburg Groups of the Transvaal Supergroup (Beukes 1980, 1983; Harding 2004; Erikson *et al*. 2006) (**Fig. 3 & 4**). The carbonate rocks of the ~2.5 Ga old Cambell Rand Subgroup (*Vgl*) underlie the western part of the development footprint, while outcrops of the ~2.4 Ga old, iron-rich Asbestos Hills Subgroup (Kuruman, *Vak* and Griquatown Formations, *Vad*), intrude along the central part of the footprint. The CSV footprint appears to be underlain by sedimentary bedrock (glacial diamictites, *Vm*) lavas, dolomites and ironstones of the basal Postmasburg Group (Makganyene *Vm* and Ongeluk *Vo* Formations). The carbonate rocks of the Cambell Rand Subgroup consist of stromatolite- and microfossil-bearing dolomite, dolomitic limestone and chert members that were formed by the precipitation of carbonate rocks when colonies of stromatolites thrived in shallow, tropical marine environments towards the end of the Archaean Eon, 2.6 billion years ago (Truswell & Eriksson 1973; Klein *et al*. 1987; Altermann & Schopf 1995). The Asbestos Hills Subgroup is represented by banded ironstone, haematite,

crocidolite and chert layers located. The banded iron formations (BIF) of the Kuruman and Griquatown Formations reflect significant early Proterozoic environmental conditions following massive iron deposition as a result of the build-up of free O^2 in the oceans by cyanobacterial photosynthesis. A major cold episode as a result of the resulting net removal of atmospheric CO^2, culminating in a glacial maximum at the Makganyene Formation diamictites (Postmasburg Group), is interpreted as evidence for major early Proterozoic glaciations at low palaeolatitudes around 2.4 Ga (De Villiers and Visser 1977; Moore *et. al* 2001). Superficial deposits within the proposed impact area include reddish-brown wind-blown sands (*Qs*) and alluvium.

Impact Statement and Recommendations

Potential impacts are summarized in **Table 2**. Potentially fossiliferous and palaeontologically significant rocks in the Postmasburg area are represented by carbonate metasediments of the Cambellrand Subgroup and the iron rich Kuruman and Griquatown formations of the Asbestos Hills Subgroup (**Fig. 4**). The basal Makganyene Formation (Postmasburg Group) represents an important record of climatic change during the early Proterozoic, while the overlying Ongeluk Formation within the overlying Postmasburg Group is not considered to be palaeontologically sensitive.

- The CSP plant footprint largely underlain by Postmasburg Group strata (subordinate siliclastic sediments, lava and tillites, *Vm, Vo)* that are unlikely to be directly impacted by the proposed development since they are mantled by geologically recent superficial deposits (windblown sand) considered to be of low palaeontological sensitivity. Direct impact on potential fossil heritage within the CSP plant footprint is considered to be low. There are no major palaeontological grounds to halt this development and it is exempted from further palaeontological investigation. There are no major palaeontological grounds to halt this development and it is exempted from further palaeontological investigation. The CSP plant footprint is assigned a site rating of Generally Protected C (GP.C).
- Route Alternative 1 (green line) will be a linear development that partly runs next to an existing powerline (red line). From direction southeast to northwest, the footprint traverses Asbestos Hills (*Vak, Vad*), Quaternary windblown sand and Campbellrand (*Vgl*) Subgroup strata, respectively considered to be of moderate, low and moderate palaeontological sensitivity. Given the nature of the

proposed development (erection of pylons and creation of road servitudes), direct impact on potential fossil heritage within the section mantled by Quaternary windblown sand is considered to be low. This section is assigned a site rating of Generally Protected C (GP.**C**). Direct impact on potential fossil heritage within the section underlain by Campbellrand (*Vgl*) and Asbestos Hills (*Vad, Vak*) Subgroup strata, is considered to be low to moderate (**Fig. 4, green A to B and C to B**). There are no major palaeontological grounds to halt the development of the preferred Alternative Route 1, but it is advised that sites marked for erection of pylons or construction of associated infrastructure, which will require excavation into fresh bedrock sediments of the Campbellrand and Asbestos Hills Subgroup, is mapped and recorded prior to the construction phase of the development. These sections are assigned a site rating of Generally Protected B (GP.**B**).

- Route Alternative 2 (pink line) will be a linear development that from direction southeast to northwest, will travel across Asbestos Hills *(Vak, Vad*), Quaternary windblown sand and Campbellrand Subgroup strata, respectively considered to be of moderate, low and moderate palaeontological sensitivity. Given the nature of the proposed development (erection of pylons and creation of road servitudes), direct impact on potential fossil heritage within the section mantled by Quaternary windblown sand is considered to be low. This section is assigned a site rating of Generally Protected C (GP.**C**). Direct impact on potential fossil heritage within the section underlain by Campbellrand (*Vgl*) and Asbestos Hills (*Vad, Vak*) Subgroup strata, is considered to be low to moderate (**Fig. 4, pink A to B and C to D**). There are no major palaeontological grounds to halt the development of Alternative Route 2, but it is advised that sites marked for erection of pylons or construction of associated infrastructure, which will require excavation into fresh bedrock sediments of the Campbellrand and Asbestos Hills Subgroup, is mapped and recorded prior to the construction phase of the development. These sections are assigned a site rating of Generally Protected B (GP.**B**).
- From direction northwest to southeast the existing 132 kV power line diversion (red line flanking the northern and eastern boundaries of the solar plant) may potentially traverse Griquatown Formation iron stones *(Vad*) considered to be of

moderate palaeontological sensitivity. The footprint is primarily mantled by a Quaternary windblown sand overburden that is underlain by Postmasburg Group lavas and subordinate siliclastic sediments of the Ongeluk Formation *(Vo*), considered to be of moderate palaeontological sensitivity. Given the nature of the proposed development (erection of pylons and creation of road servitudes), direct impact on potential fossil heritage within the section underlain by Griquatown Formation, and mantled by Quaternary windblown sand is considered to be low. Direct impact on potential fossil heritage within the section underlain by Postmasburg Group strata is considered to be low. There are no major palaeontological grounds to halt this development and it is exempted from further palaeontological investigation. The proposed footprint is assigned a site rating of Generally Protected C (GP.C).

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Tables and Figures

Table 1. Field rating categories as prescribed by SAHRA.

Field Rating	**Grade**	**Significance**	**Mitigation**
National Significance (NS)	Grade 1	-	Conservation; national site nomination
Provincial Significance (PS)	Grade 2	-	Conservation; provincial site nomination
Local Significance (LS)	Grade 3A	High significance	Conservation; mitigation not advised
Local Significance (LS)	Grade 3B	High significance	Mitigation (part of site should be retained)
Generally Protected A (GP.A)	-	High/medium significance	Mitigation before destruction
Generally Protected B (GP.B)	-	Medium significance	Recording before destruction
Generally Protected C (GP.C)	-	Low significance	Destruction

T**able 2**. Summary of potential impacts.

PROJECT PHASE	POTENTIAL IMPACT	ENVIRONMENTAL SIGNIFICANCE																		MITIGATION SUMMARY
		BEFORE MITIGATION									AFTER MITIGATION									
		DURATION	EXTENT	IRREPLACEABILITY	REVERSIBILITY	MAGNITUDE	PROBABILITY	**TOTAL (SP)**	**SIGNIFICANCE**	**CUMULATIVE**	DURATION	EXTENT	IRREPLACEABILIT	REVERSIBILITY	MAGNITUDE	PROBABILITY	**TOTAL (SP)**	**SIGNIFICANCE**	**CUMULATIVE**	
Aspect:	**Palaeontological Heritage**																			
Activity	**CSP Plant**																			
Construction	Early Proterozoic palaeontolgical heritage	5	1	4	5	6	3	**63**	**M**	**M**	5	1	2	5	4	2	**34**	**L**	**M**	No further action required
Operational	Early Proterozoic palaeontolgical heritage	5	1	2	3	0	2	**22**	**L**	**M**	5	1	2	2	0	2	**20**	**L**	**M**	No further action required
Activity	**Power Line Alternative 1 (Preferred Alternative)**																			
Construction	Early Proterozoic palaeontolgical heritage	5	1	4	5	6	3	**63**	**H**	**M**	5	1	4	4	4	2	**38**	**L**	**M**	Specialist to be appointed to map and record sites marked for erection of pylons or construction of associated infrastructure, which will require excavation into fresh bedrock sediments of the Campbellrand and Asbestos Hills Subgroups
Operational	Early Proterozoic palaeontolgical heritage	5	1	2	3	0	2	**22**	**L**	**M**	5	1	2	2	0	2	**20**	L	M	No further action required

PROJECT PHASE	POTENTIAL IMPACT	ENVIRONMENTAL SIGNIFICANCE																		MITIGATION SUMMARY
		BEFORE MITIGATION									AFTER MITIGATION									
		DURATION	EXTENT	IRREPLACEABILITY	REVERSIBILITY	MAGNITUDE	PROBABILITY	**TOTAL (SP)**	**SIGNIFICANCE**	**CUMULATIVE**	DURATION	EXTENT	IRREPLACEABILIT	REVERSIBILITY	MAGNITUDE	PROBABILITY	**TOTAL (SP)**	**SIGNIFICANCE**	**CUMULATIVE**	
Activity	**Power Line Alternative 2**																			
Construction	Early Proterozoic palaeontolgical heritage	5	1	4	5	6	3	**63**	**H**	**M**	5	1	4	4	4	2	**38**	**L**	**M**	Specialist to be appointed to map and record sites marked for erection of pylons or construction of associated infrastructure, which will require excavation into fresh bedrock sediments of the Campbellrand and Asbestos Hills Subgroups
Operational	Early Proterozoic palaeontolgical heritage	5	1	2	3	0	2	**22**	**L**	**M**	5	1	2	2	0	2	**20**	L	M	No further action required
Activity	**Diversion of existing 132 kV power line**																			
Construction	Early Proterozoic palaeontolgical heritage	5	1	4	5	6	3	**63**	**M**	**M**	5	1	2	5	4	2	**34**	**L**	**M**	No further action required
Operational	Early Proterozoic palaeontolgical heritage	5	1	2	3	0	2	**22**	**L**	**M**	5	1	2	2	0	2	**20**	**L**	**M**	No further action required

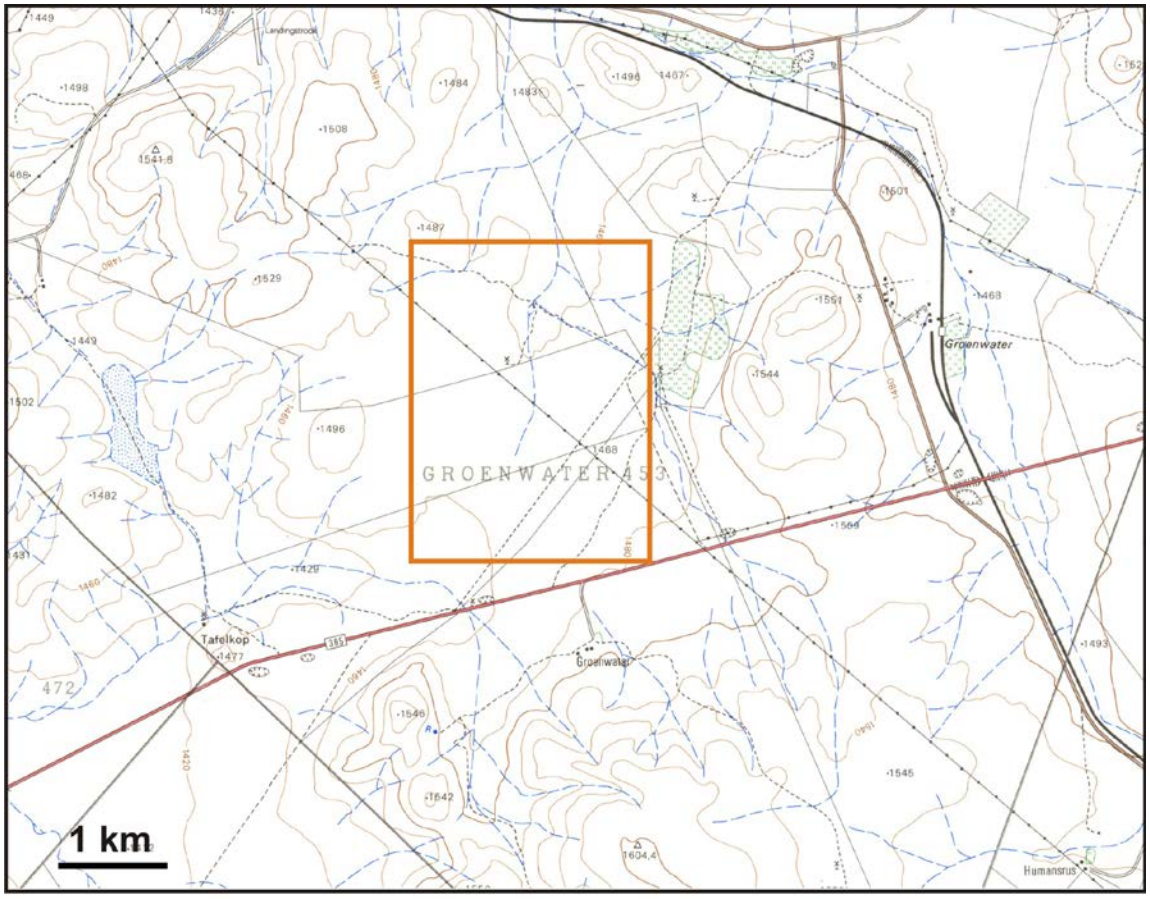

Figure 1. Location of the proposed Groenwater CSP plant facility marked on portion of 1:50 000 scale topographical map 2823 AD Lime Acres).

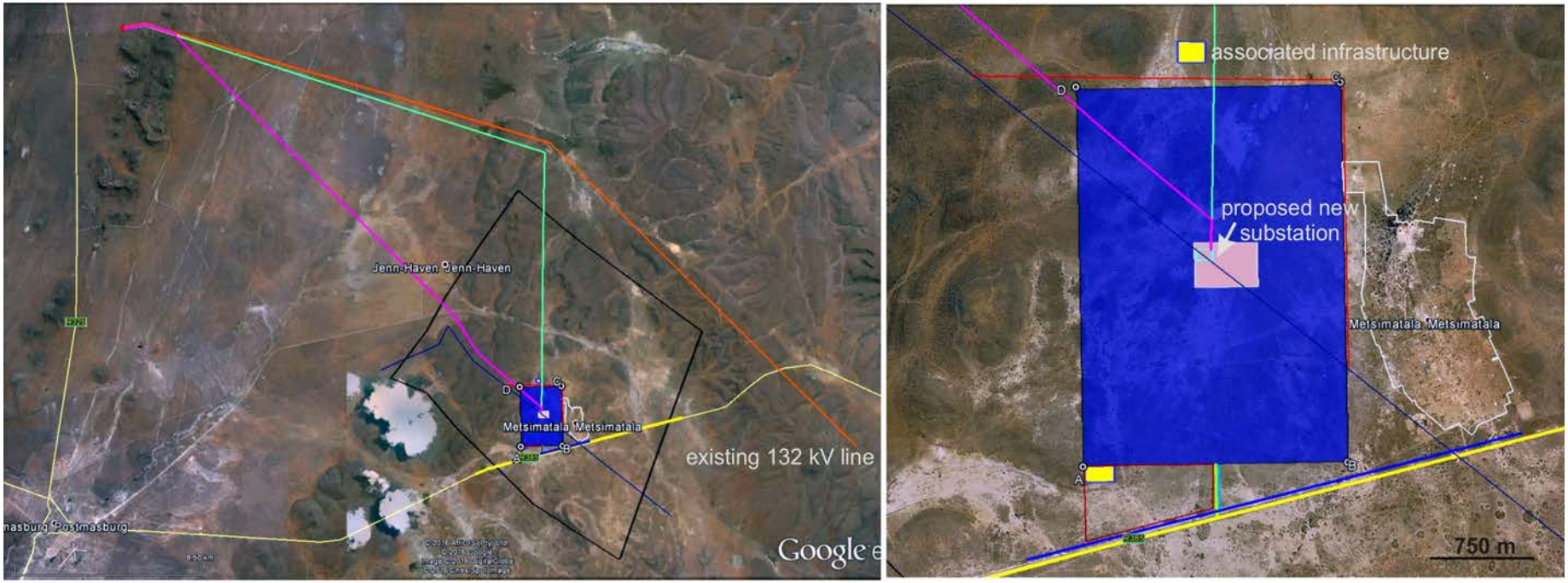

Figure 2. Aerial view and layout of the development footprint including the CSP plant powerline options and associated infrastructure.

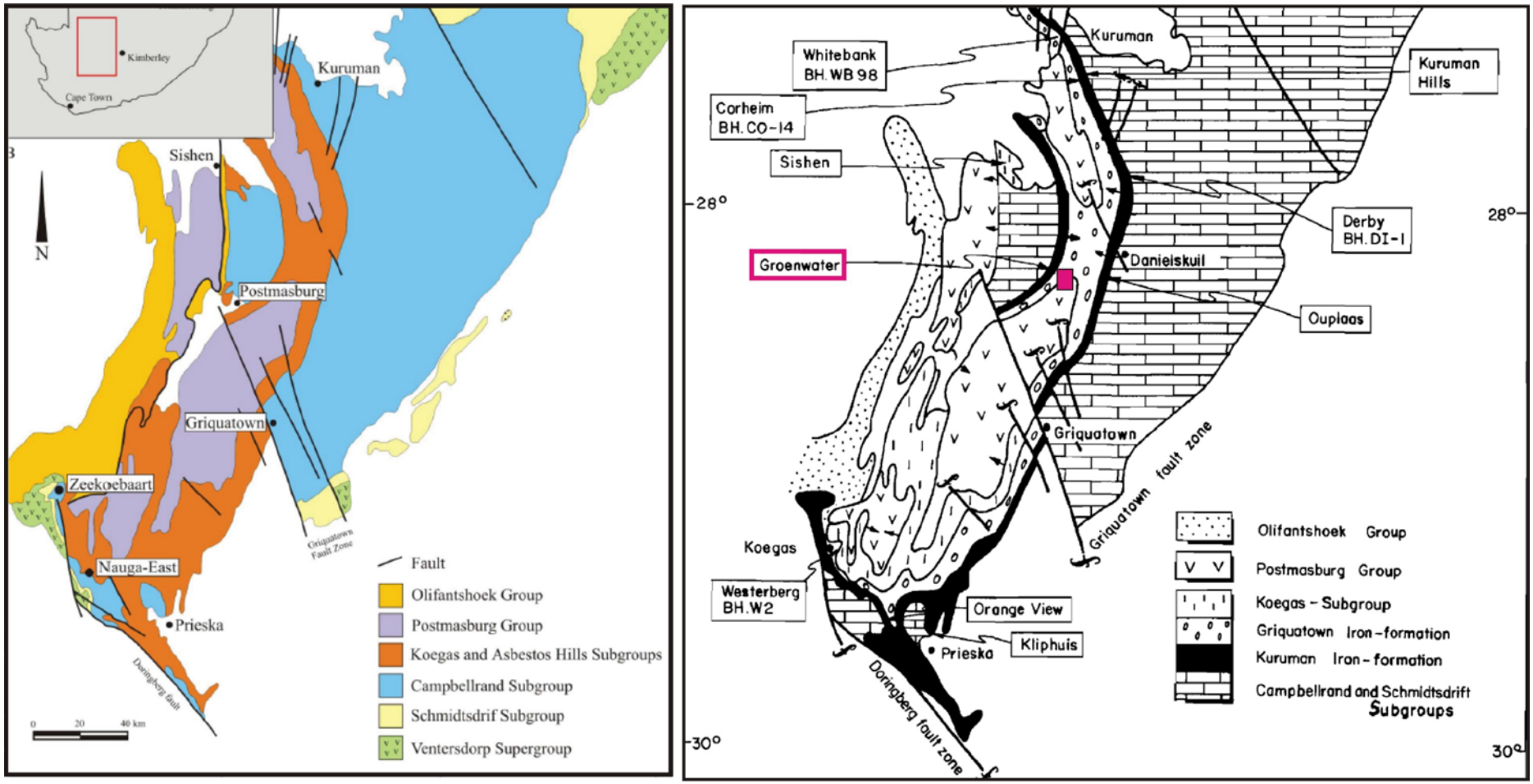

Figure 3. Regional geology according to Harding 2004 (left) and Beukes 1980 (right).

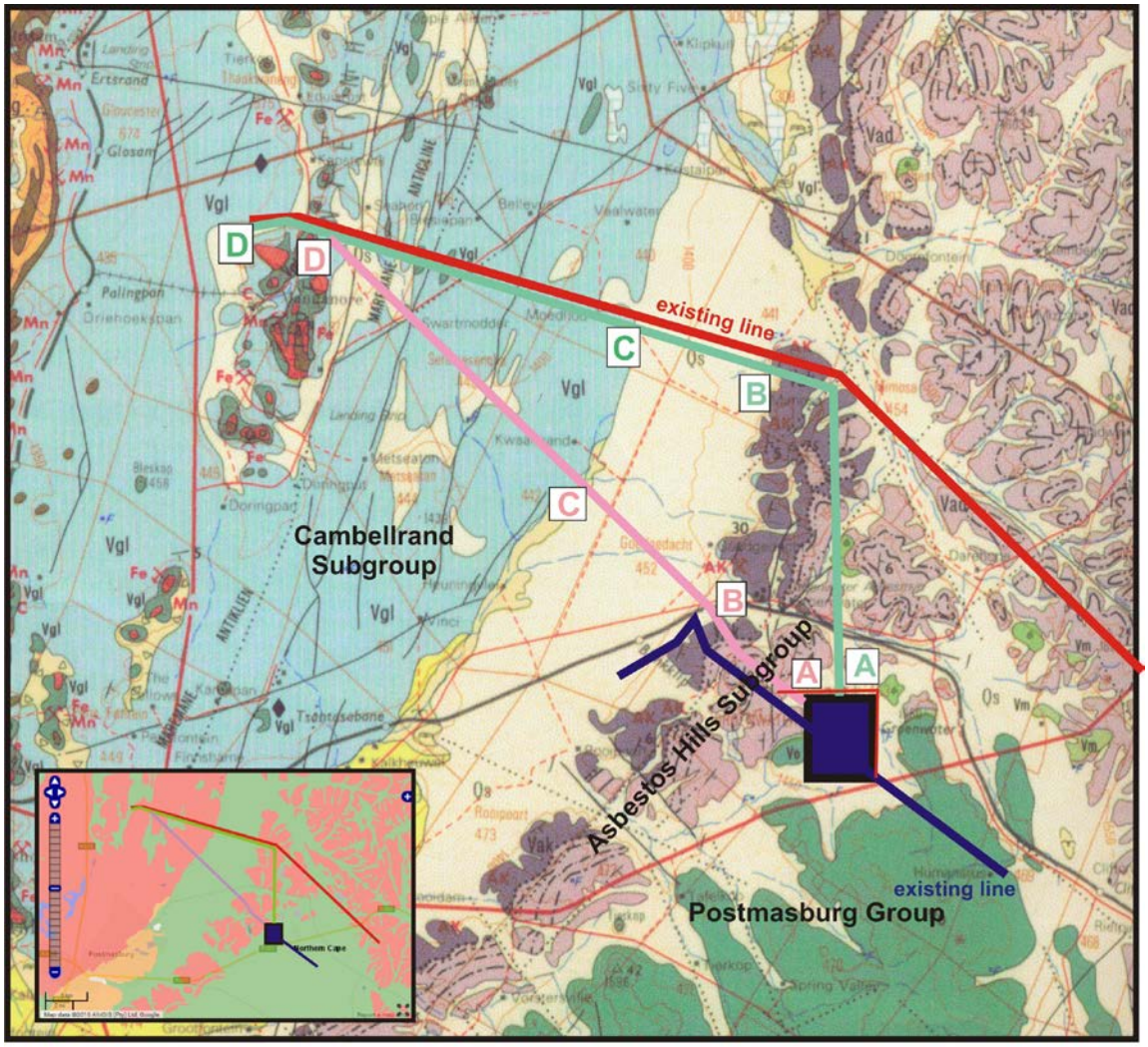

Figure 4. Proposed development footprint shown on 1:250 000 scale geological map 2823 Postmasburg (SAHRIS palaeontological sensitivity map is included in the lower lefthand corner - red = high sensitivity & green = moderate sensitivity).