A PALAEONTOLOGICAL DESKTOP STUDY OF THE AREAS TO BE AFFECTED BY THE PROPOSED SOLAR POWER PLANTS NEAR BLOEMFONTEIN AND NEAR THEUNISSEN, FREE STATE PROVINCE:

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SUMMARY

- A desktop study of the potential of palaeontological impact on the three study areas was conducted by means of geological maps, satellite images and 1:50 000 topographical maps. This was informed by personal observations, in particular concerning Sites 1 & 2.

- Areas 1 & 2 have potential of preserving fossil materials of both pre-Cainozoic age and of late-Cainozoic age and are, therefore, palaeontologically sensitive.

- Area 3 has no potential for preserving fossil of pre-Cainozoic age and minimal potential for late-Cainozoic fossil preservation. Therefore, it is not considered sensitive from a palaeontological perspective.

- For Areas 1 & 2 it is recommended that in the case of fossil discoveries these should be reported to a specialist to allow assessment and mitigation.

INTRODUCTION

The aim of this study was to gather and describe the relevant information pertaining to the palaeontological potential of the study areas and to assess the likelihood of palaeontological materials being affected by the proposed developments by Subsolar Energy (Pty) Ltd. These developments are planned at three sites in the central Free State Province (Figure 1):

1) Sonneblom Solar Power Plant - on Portion 1 of the farm Blydschap no. 504, 5km southeast of the outskirts of Mangaung, Bloemfontein
2) Serurubele Solar Power Plant - on the Remaining extent of the farm Blydschap no. 504, 5km southeast of the outskirts of Mangaung, Bloemfontein
3) Sonvanger Solar Power Plant - on Portion 1 of the farm Karreebooms Vallei nr. 258, just beyond the south westerly outskirts of the town of Theunissen.

It should be noted that the sites were not visited, but that the study is based on geological maps, published references and on unpublished information from surveys of the Modder River, Free State Province. For the present purpose the areas of Sonneblom (Site 1) and Serurubele (Site 2) are discussed as one entity, since they are adjacent.

BACKGROUND TO THE GEOLOGY AND PALAEONTOLOGY OF THE FREE STATE PROVINCE

The geological history of the interior of southern Africa is such that vertebrate fossil preservation is mainly from two broad time periods; from pre-Cainozoic Karoo-aged sedimentary rocks or from the later Cainozoic. This reflects the Gondwana and post-Gondwana geological history of southern Africa (SACS 1980; McCarthy & Rubidge 2005). The interior of southern Africa is mostly underlain by Karoo-aged rocks, which were formed before the breakup of the Gondwana supercontinent. The Karoo basin acted as an important catchment for the preservation of early vertebrates, early plants and invertebrates. During the Karoo phase, the Beaufort Group and the overlying Molteno, Elliot and Clarens Formations of the Karoo Supergroup were accumulated and contain a rich fossil record. After the separation of Africa from the other southern continents, various events of tectonic uplift, such as during the end-Mesozoic and early Cainozoic (Partridge & Maud 2000; McCarthy 2013), caused much or most of the early- to mid-Cainozoic deposits to be eroded away. Thus, fossil preservation in the interior of southern Africa can be expected to either predate the late Mesozoic or to postdate the mid-Cainozoic. This is reflected in a substantial hiatus in the southern African fossil record, including the end-Cretaceous extinction event and the early mammal radiation. In this way late Cainozoic fossils can be found either preserved in cave sites or in the sedimentary deposits associated with drainages. In the interior of southern Africa the latter are often exposed due to down-cutting of the rivers and wetlands (Tooth *et al.* 2004), causing natural areas of erosion, also known as ‘dongas’. Such exposures can be prolific sources of late Cainozoic fossils.

The underlying bedrock of the three study sites are rocks of the Beaufort Group (Figure 1), which is consolidated rock. The overlying deposits are mostly unconsolidated clays and sands,

often forming duplex soils (see report by J. Lanz for more detail on the soils). Thus, there are essentially two possible contexts for fossil preservation in the study sitesv1) within the Beaufort sedimentary rock and in the overlying late Cainozoic sediments and soils.

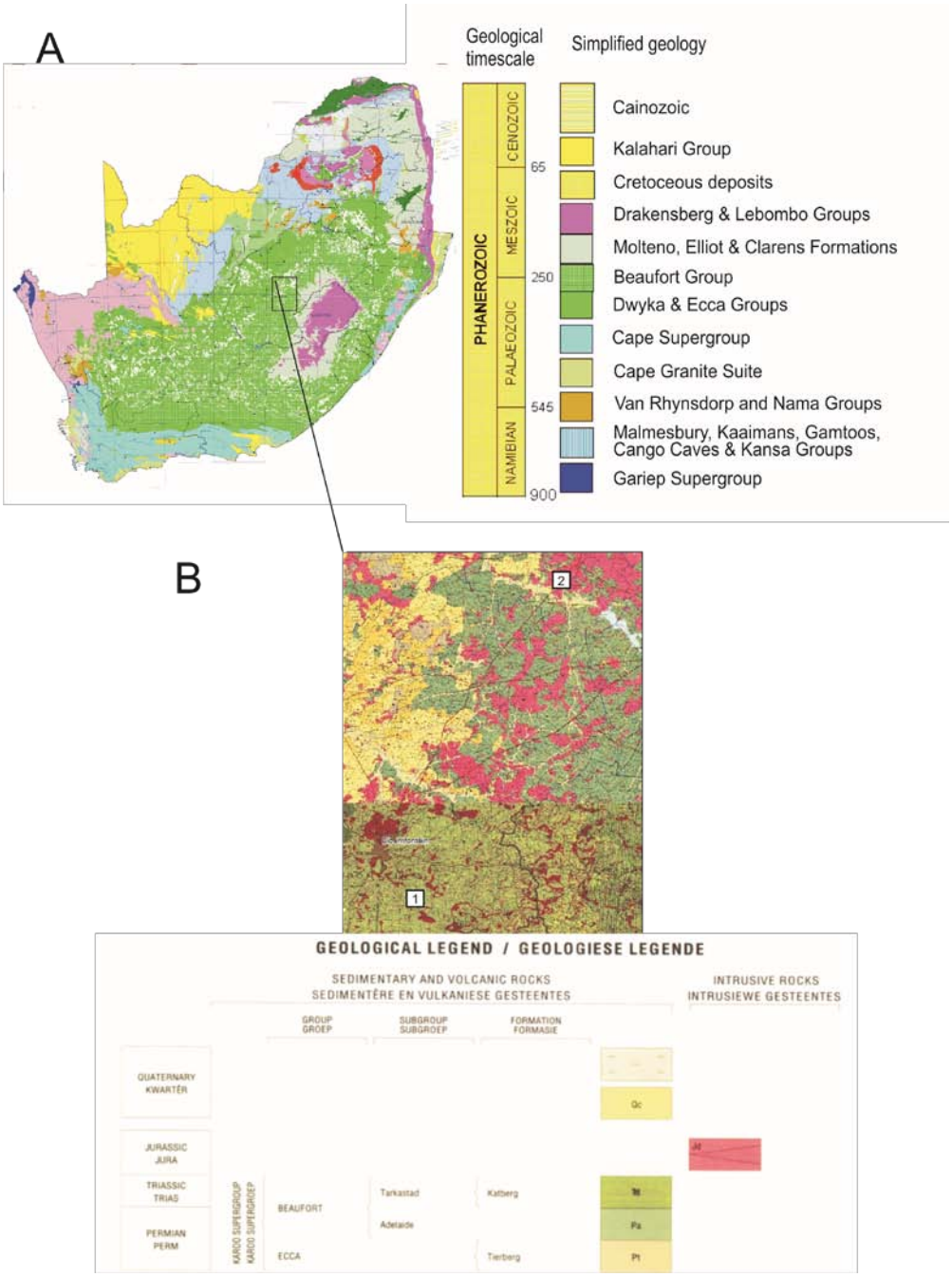

Figure 1. A simplified geological map of South Africa (A) and an extract (B) of the 1:250 000 geological maps (2926 and 2826), showing the position of the study areas as white rectangles within the Beaufort Group of the Karoo Supergroup. Rectangle 1 includes Sites 1 & 2 and rectangle 2 includes Site 3. The late Cainozoic record is not indicated here and is illustrated in Figures 2B and 3B.

METHODS

Since there are no published records of fossil occurrences in the study areas the present study was conducted by:

1. superimposing the areas to be developed on the 1:250 000 scale geological maps, 2926 for areas 1 & 2 and 2826 for area 3 (Figures 1, 2A, 3A). This provided some indication of the pre-Cainozoic palaeontological potential of the area, i.e. the likelihood of finding fossils in the Karoo-aged bedrock.

2. by noting the modern drainages (Figures 2B & 3B). These drainages reflect late Cainozoic sedimentation and can provide some indication of the likelihood of late Cainozoic fossil preservation. It should be noted that South African geological maps contain mainly information on the older "hard rock" deposits and besides on-foot surveys, the study of drainage lines on satellite images provides the best alternative for assessing the likelihood of late Cainozoic fossil preservation.

The analyses of the late Cainozoic drainages are informed by surveys of the drainages of the Modder River, which form part of a continuing project of the author, but which are as yet unpublished.

RESULTS

Karoo geology

All three study areas fall within the Karoo Supergroup (Figure 1). Sites 1 and 2 are on sedimentary rocks of the Beaufort Subgroup (Figures 1, 2A) and these may be fossiliferous (McCarthy & Rubidge 2005; SACS 1980). Site 3 is entirely situated within intrusive volcanic rock (dolerite), which is not fossiliferous (Figure 3).

The Late Cainozoic

Sites 1 & 2

In Figure 2B the modern-day drainages are indicated. Two streams, which join and flow into the Modder River some distance downstream, originate in the northern part of Site 1. Site 2 has no sign of drainage. The neutral to high pH status of the soils generated by the rocks in the Karoo basin allows favourable conditions for late Cainozoic fossil preservation in the study areas, as has been seen in the nearby Renosterspruit and Modder River. Given that the Modder River and its tributaries are richly fossiliferous, containing materials that can be dated to approximately the last 200 000 years, but mostly younger, within the c. 1000 000 years, the northern part of Site 1 may be considered to be potentially fossiliferous. However, late Cainozoic fossil preservation cannot be ruled out from the parts of Sites 1 & 2 where there are no obvious signs of surface drainage. The clay layer mentioned in the soils report by J. Lanz in particular may be fossiliferous in certain areas.

A

B

Figure 2. An enlargement of the 1:250 000 geological map (2926) (A) showing the Beaufort Group rocks underlying Sites 1 & 2. A Google Earth satellite image is overlain by a 1:50 000 topographic map to indicate the surficial deposits and the drainage lines (B).

Sites 3

The soils of the area are thin (see report by J. Lanz) and overlying dolerite bedrock. In the northern corner of the area (Figure 3B) a drainage line is visible, which flows into an intermittent stream that feeds the Vet River. However, given the nature of the soil in this area, the potential for late Cainozoic fossil preservation is limited.

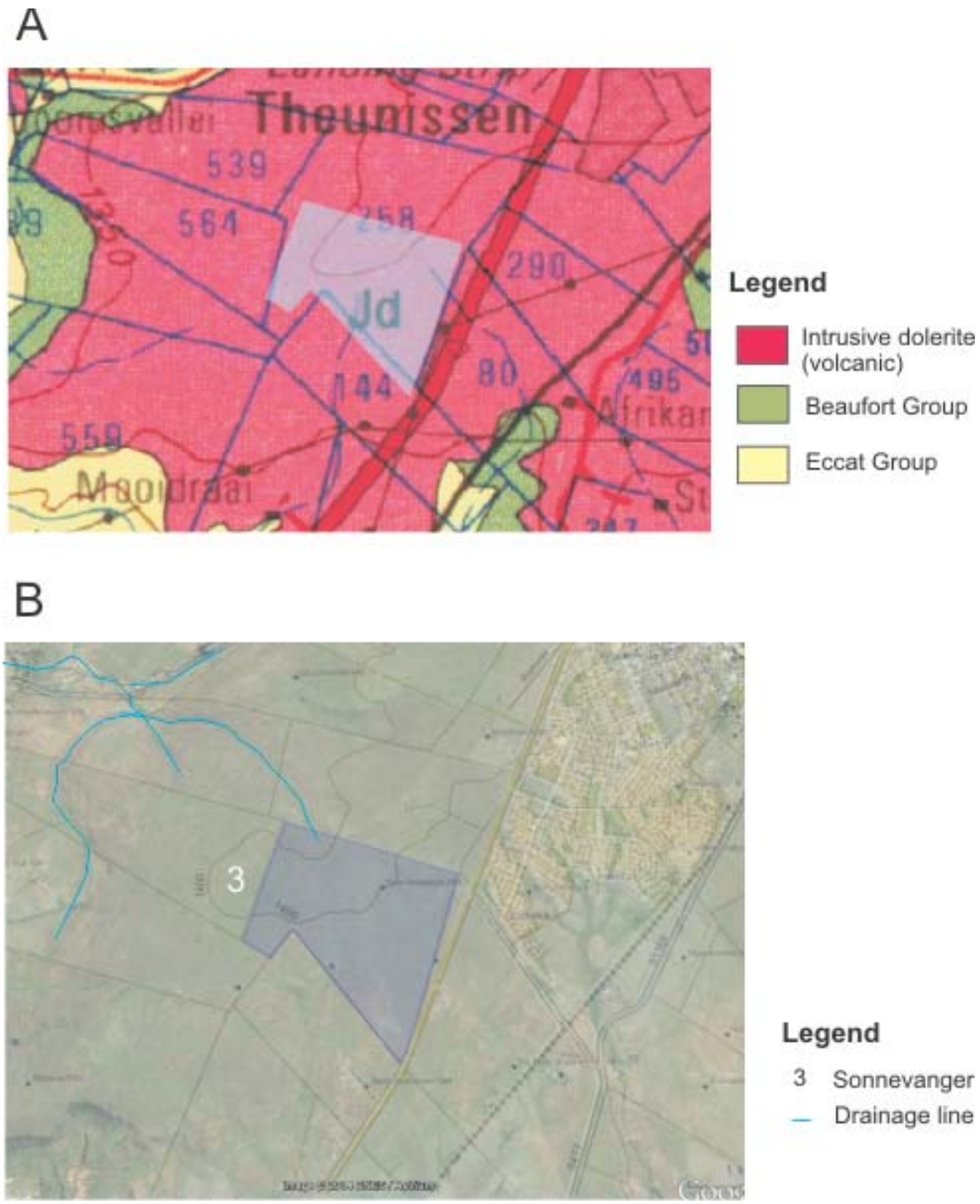

Figure 3. An enlargement of the 1:250 000 geological map (2826) (A) showing the intrusive volcanic rock (dolerite) underlying Site 3. A Google Earth satellite image is overlain by a 1:50 000 topographic map to indicate the surficial deposits and the drainage lines (B).

DISCUSSION

The likelihood of fossil material in the proposed area of development

Sites 1 & 2

It is known that the rocks of the lower Beaufort are fossil-bearing (McCarthy & Rubidge 2005) and thus the area indicated in Figure 2A may contain Karoo-aged fossils. However, the density of such fossil occurrences can be quite low and the likelihood of encountering such fossils cannot be predicted.

The likelihood of encountering late Cainozoic fossils in Sites 1 & 2 is high, given the presence of drainage lines in the northern part of Site 1 and the proximity of the fossil-rich Renosterspruit and the Modder River.

Site 3

This area has no potential for Karoo-aged fossil preservation, since it is entirely underlain by intrusive volcanic rock (dolerite). Also, there is limited potential for late Cainozoic fossil preservation, given the thin nature of the surficial sediments and the virtual absence of drainage lines in the area.

ASSESSMENT OF IMPACT

1. Placement of the photovoltaic panels

If a piled system for mounting the panels is to be used, there will be some disturbance of the substrate for creating the foundations and this will have potential impact on the younger, surficial deposits in Sites 1 & 2, which are most likely to contain late Cainozoic fossil-occurrences. It is not foreseen that this activity will impact on the Karoo-aged deposits of Sites 1 & 2.

The palaeontological impact on Site 3 will be negligible.

2. Excavations for internal road construction

Excavations for the internal roads are seen as having the potential for impacting on both the Karoo-aged rocks and the surficial late Cainozoic sediments of Sites 1 & 2.

The palaeontological impact on Site 3 will be negligible.

3. Excavations for the foundations of the inverter structures, support facilities and substations

Excavations for the foundations of these structures may impact on both the Karoo-age and the surficial late Cainozoic sediments of Sites 1 &2, but this will depend on the depth of such excavations, which is not indicated in the scoping report.

The palaeontological impact on Site 3 will be negligible.

RECOMMENDATIONS

Any impact on the palaeontological heritage of Sites 1 & 2 will be permanent, since the disturbance cannot be reversed. However, although the likelihood of disturbance cannot be predicted in any exact way, because of the unknown nature the spatial variability of local sedimentary conditions, it is likely that the impact will mainly affect the younger late Cainozoic record of Sites 1 & 2. If the proposed developments are to proceed, and in the less likely case of encountering Karoo-aged or in the more likely case of encountering late Cainozoic fossil materials in Sites 1 &2, it is recommended that a suitable specialist be approached to assess the situation in order to recover and record any fossil materials. The cost of this process will have to be covered by the developer.

It is not foreseen that any significant palaeontological materials will be encountered in Site 3. In the unlikely case of encountering fossils in the process of construction, the fossils will be of late Cainozoic age. In such a case the fossils should be reported to a specialist for further assessment.

REFERENCES

McCarthy T.S. 2013. The Okavango delta and its place in the geomorphological evolution of southern Africa. *South African Journal of Geology* 116: 1- 54.

McCarthy T.S. & B.S. Rubidge. 2005. *The Story of Earth & Life*. Struik, Cape Town.

Partridge, T.C. & R.R. Maud. 2000. Macro-scale geomorphic evolution of southern Africa. In T.C. Partridge & R.R. Maud (eds.) *The Cenozoic of southern Africa*. Oxford University Press, pp. 1-18.

SACS. 1980. Stratigraphy of South Africa. Part1 (Complied by L.E. Kent). : Lithostratigraphy of the Republic of South Africa, South West Africa/Namibia and the Republics of Boputhatswana, Transkei and Venda. *Handbook of the Geological Survey of South Africa*, vol. 8. Pretoria, Government Printer.

Tooth, S., Brandt, D., Hancox, P.J., McCarthy, T.S. 2004. Geological controls on alluvial river behaviour: a comparative study of three rivers on the South African Highveld. *Journal of African Earth Sciences* 38, 79–97.