PALAEONTOLOGICAL ASSESSMENT: DESKTOP STUDY

Proposed Metsimatala Photovoltaic Power and Concentrated Solar Power Facilities on Farm Groenwater, Siyanda District Municipality near Postmasburg, Northern Cape

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March 2012

1. SUMMARY

Afri-Devo Energy are proposing to develop both a Photovoltaic Power (PV) and a Concentrated Solar Power (CSP) facility, each of 50 MW generating capacity, on Portion 453 of Groenwater Farm, Siyanda District Municipality, some 20 km ENE of the town of Postmasburg in the Northern Cape Province.

The proposed Metsimatala PV and CSP solar power facility study area is underlain by Precambrian iron-rich, basinal sediments of the Ghaap Group (Kuruman and Daniëlskuil Formations) as well as by glacial and volcanic rocks of the younger Postmasburg Group (Makganyene and Ongeluk Formations). These rocks are all extremely ancient - some 2.2 to 2.5 billion years old – and in most cases are unlikely to contain substantial macrofossil remains. Cherty layers (fine grained siliceous rocks) and carbonate rocks here may contain microfossil assemblages but these have not yet been recorded in the scientific literature.

Large stromatolites (microbial mounds) within the Makganyene Formation are of special scientific interest because they are intimately associated with cold-water glacial rocks (tillites), suggesting that tropical warm waters are not, as previously supposed, a pre-requisite for stromatolite reef development in early Precambrian times. Aeolian (wind-blown) sands of the Gordonia Formation (Kalahari Group) and other Quaternary to Recent superficial deposits overlying Precambrian bedrocks in the study region (e.g. alluvium, colluvium) are generally sparsely fossiliferous.

A field assessment of the Metsimatala project study area by a professional palaeontologist is required to document any stromatolite-bearing rock exposures associated with glacial tillites. The study should make appropriate recommendations for the mitigation and / or conservation of significant fossil sites during the construction and later phases of the development. These recommendations should be incorporated into the Environmental Management Plan of the development.

Should substantial fossil remains be exposed during construction, the ECO should safeguard these, preferably in situ, and alert SAHRA as soon as possible so that appropriate action (e.g. recording, sampling or collection) can be taken by a professional palaeontologist.
2. INTRODUCTION & BRIEF

The company Afri-Devo Energy are proposing to develop both a Photovoltaic Power (PV) and a Concentrated Solar Power (CSP) facility, each of 50 MW generating capacity, on Portion 453 of Groenwater Farm, Siyanda District Municipality, some 20 km ENE of the town of Postmasburg in the Northern Cape Province (Fig. 1). The land is owned by the Metsimatala CPA communities. The proposed projects have been named the Metsimatala PV Solar Farm and the Metsimatala CSP Solar Farm. The proposed activities would include the construction and operation of a Solar Energy facility and associated infrastructure.

The following main infrastructural components are envisaged for these solar energy projects:

- PV panels & inverters
- CSP mirrors and power block
- On-site Substation
- Transmission Line linking the facility with Eskom
- Wiring between PV panels/CSP Mirror and on-site substation
- Internal access roads
- Security infrastructure
- Storage Area

The proposed study area (Groenwater Farm) overlies Precambrian bedrocks of the Ghaap Group that is famous for its microfossils and stromatolites (microbial mounds and columns) as well as the overlying Postmasburg Group (Fig. 4). A desktop palaeontological impact assessment for the project has therefore been commissioned by Enviroworks (contact details: Suite 116, Private Bag X01, Brandhof 9324; 2 Chris Botha Street, Westdene; tel 086 198 8895; e-mail elbi@enviroworks.co.za) in accordance with the requirements of the National Heritage Resources Act, 1999. This palaeontological study forms part of a comprehensive HIA to be compiled by Ms Karen van Ryneveld of ArchaeoMaps (Postnet Suite 239, Private Bag X3, Beacon Bay, 5205; e-mail kvanryneveld@gmail.com; tel 084 871 1064).

2.1. National Heritage Resources Act

The extent of the proposed development (over 5000 m²) falls within the requirements for a Heritage Impact Assessment (HIA) as required by Section 38 (Heritage Resources Management) of the South African National Heritage Resources Act (Act No. 25 of 1999). The various categories of heritage resources recognised as part of the National Estate in Section 3 of the National Heritage Resources Act include, among others:

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

Minimum standards for the palaeontological component of heritage impact assessment reports are currently being developed by SAHRA. The latest version of the SAHRA guidelines is dated August 2011.

2.2. Approach used for this palaeontological desktop study

This report provides an assessment of the observed or inferred palaeontological heritage within the Groenwater study area, with recommendations for any specialist palaeontological mitigation where this is considered necessary. The report is based on (1) a review of the relevant scientific literature, (2) geological maps, (3) previous palaeontological heritage assessments for alternative energy and other developments in the region (e.g. Almond 2010a, 2010b, 2012).
In preparing a palaeontological desktop study the potentially fossiliferous rock units (groups, formations etc) represented within the study area are determined from geological maps. The known fossil heritage within each rock unit is inventoried from the published scientific literature, previous palaeontological impact studies in the same region, and the author’s field experience (Consultation with professional colleagues as well as examination of institutional fossil collections may play a role here, or later during the compilation of the final report). This data is then used to assess the palaeontological sensitivity of each rock unit to development (Provisional tabulations of palaeontological sensitivity of all formations in the Western, Eastern and Northern Cape have already been compiled by J. Almond and colleagues; e.g. Almond & Pether 2008). The likely impact of the proposed development on local fossil heritage is then determined on the basis of (1) the palaeontological sensitivity of the rock units concerned and (2) the nature of the development itself, most notably the extent of fresh bedrock excavation envisaged.

When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a field assessment study by a professional palaeontologist is usually warranted. Most detrimental impacts on palaeontological heritage occur during the construction phase when fossils may be disturbed, destroyed or permanently sealed-in during excavations and subsequent construction activity. Where specialist palaeontological mitigation is recommended, this may take place before construction starts or, most effectively, during the construction phase while fresh, portentially fossiliferous bedrock is still exposed for study. Mitigation usually involves the judicious sampling, collection and recording of fossils as well as of relevant contextual data concerning the surrounding sedimentary matrix. It should be emphasised that, provided appropriate mitigation is carried out, many developments involving bedrock excavation actually have a positive impact on our understanding of local palaeontological heritage. Constructive collaboration between palaeontologists and developers should therefore be the expected norm.

2.3. Assumptions & limitations

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

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

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

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

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

5. Absence of a comprehensive computerized database of fossil collections in major RSA institutions which can be consulted for impact studies. A Karoo fossil vertebrate database is now accessible for impact study work.
In the case of palaeontological desktop studies without supporting Phase 1 field assessments these limitations may variously lead to either:
(a) *underestimation* of the palaeontological significance of a given study area due to ignorance of significant recorded or unrecorded fossils preserved there, or
(b) *overestimation* of the palaeontological sensitivity of a study area, for example when originally rich fossil assemblages inferred from geological maps have in fact been destroyed by tectonism or weathering, or are buried beneath a thick mantle of unfossiliferous “drift” (soil, alluvium etc).

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

The major limitation on this study is the lack of published work on the palaeontology of the region.
Fig. 1. Extract from 1: 250,000 topographical sheet 2822 Postmasburg showing location of the study area on Farm Groenwater, c. 20 km ENE of Postmasburg, Northern Cape Province (Map courtesy of the Chief Directorate of Surveys & Mapping, Mowbray). Important fossil stromatolite localities are recorded at Lime Acres to the south-east of the study area.
Fig. 2. *Google Earth*® satellite image showing the dissected hilly terrain within the Groenwater Farm study area (black polygon) for the proposed new photovoltaic and CSP power stations c. 20 km ENE of Postmasburg, Northern Cape Province.
The Groenwater Farm study area situated some 20 km ENE of Postmasburg straddles the R385 tar road and rail link between Postmasberg and Daniëlskuil (Figs. 1, 2). It comprises highly dissected, arid, rocky terrain between approximately 1400 and 1600m amsl on the western flanks of the Asbesberge range that runs north-south to the southwest of the towns of Daniëlskuil and Kuruman. The area is drained by intermittently flowing streams that flow westwards into the Groenwaterspruit at Postmasburg. There are two defunct asbestos mines on the property: the Postmasburg Mine in the west and the Groenwater Mine in the north-central part of the property.

The geology of the study area near Postmasburg is shown on the 1: 250 000 geology map 2822 Postmasburg (Council for Geoscience, Pretoria; Fig. 3 herein). A separate explanation for the Postmasburg geological map has not yet been published, while a short account of the geology is printed on the map itself.

The geology of the northern half of the study area on the western edge of the Asbesberge is dominated by ancient Precambrian sediments of the Asbestos Hills Subgroup (also referred to in the older literature as the Asbesheuwels Subgroup). This succession forms the upper part of the Late Archaean to Early Proterozoic Ghaap Group (Transvaal Supergroup) of the Griqualand West Basin (Ghaap Plateau Sub-basin) (See stratigraphic column in Fig. 4). Useful reviews of the stratigraphy and sedimentology of these Transvaal Supergroup rocks have been given by Moore et al. (2001) and Eriksson et al. (2006). The Ghaap Group represents some 200 Ma of chemical sedimentation - notably iron and manganese ores, cherts and carbonates - within the Griqualand West Basin that was situated towards the western edge of the Kaapvaal Craton (Fig. 4; see also fig. 4.19 in McCarthy & Rubidge 2005).

The Kuruman Formation (Vak in Fig. 3) of the Asbestos Hills Subgroup consists predominantly of banded iron formations (BIF) overlying the stromatolite-rich carbonate succession of Campbell Rand Subgroup (Fig. 4). These BIF rocks consist of rhythmically bedded, thinly composition- and colour-banded cycles of fine-grained mudrock, chert and iron minerals (siderite, magnetite, haematite) that were deposited in an offshore, intermittently anoxic basin. In the Ghaap Plateau Sub-basin to the north of the Griquatown Fault Zone the Kuruman BIF reaches thicknesses of up to 250 m (Eriksson et al. 2006, their fig. 2). BIF deposition characterizes the Late Archaean – Early Proterozoic interval (2600-2400 Ma) before the onset of well-oxygenated atmosphere and seas.

The overlying iron–rich succession of the Daniëlskuil Formation (Vad in Fig. 3), up to 200m-thick, is interpreted as a current- or wave-reworked banded iron formation, as suggested by the abundance of BIF intraclasts and sedimentary structures (Beukes 1983, Klein & Beukes 1989, Beukes & Klein 1990). The base of the Daniëlskuil Formation has been radiometrically dated to 2.43-2.49 Ga, i.e. Early Proterozoic (Eriksson et al. 2006).

The southern half of the study area is underlain by glacial and volcanic rocks of the 2.4-2.2 Ga Postmasburg Group (Transvaal Supergroup) that overlie the older Ghaap Group rocks in the core of a broad NNE-SSW trending synclinal structure (Figs. 3 and 4). Two contrasting rock units are mapped here. Basal diamictites of the Makganyene Formation (Vm), which reaches a thickness of 500m near Postmasburg, reflect a 250 million year glacial event of Palaeoproterozoic age (c. 2.3-2.2 Ga; Evans et al. 1997). This has been interpreted by some authors as a catastrophic Snowball Earth event triggered by the destruction of preceding methane-rich greenhouse atmospheres by oxygenic cyanobacterial photosynthesis (Kopp et al. 2005; but see also Coetzee et al. 2006). Sedimentary facies include massive to coarsely bedded diamictites, sandstones, shales, BIF and even stromatolitic bioherms (reefs) (Kopp et al. 2005, Polteau 2000, 2005, Polteau et al. 2006). Most of the clasts are derived from the older Transvaal Supergroup succession. These glacial rocks are overlain by basaltic to andesitic lavas of the Ongeluk Formation (Vo) dated to 2.2 Ga. The first part of this major flood basalt succession was extruded sub-aerially, but later lava flows show evidence of sub-aqueous extrusion (e.g. pillow lavas; Eriksson et al. 2006).
Unconsolidated aeolian \( (i.e. \) wind-blown) sands of the Quaternary **Gordonia Formation (Kalahari Group)** \( (\text{Qs} \text{ in Fig. 3}) \), whose thickness here is uncertain, are also mapped in the central part of the Groenwater study area. The geology of the Late Cretaceous to Recent Kalahari Group is reviewed by Thomas (1981), Dingle et al. (1983), Thomas & Shaw 1991, Haddon (2000) and Partridge et al. (2006). The Gordonia dune sands are considered to range in age from the Late Pliocene / Early Pleistocene to Recent, dated in part from enclosed Middle to Later Stone Age stone tools (Dingle et al., 1983, p. 291). Note that the recent extension of the Pliocene - Pleistocene boundary from 1.8 Ma back to 2.588 Ma would place the Gordonia Formation almost entirely within the Pleistocene Epoch. The intermittent water courses of the Groenwaterspruit drainage system are associated with various alluvial deposits \( (e.g. \) gravels, sands and silts) of probable Quaternary to Recent age. These superficial deposits, likewise the colluvial and downwasted surface gravels and calcrete pedocretes that can be expected to mantle much of the bedrock here, are not mapped separately at 1: 250 000 scale.

**Fig. 3.** Extract from 1: 250 000 geological map 2822 Postmasburg (Council for Geoscience, Pretoria) showing the location of the Metsimatala solar power project study area (yellow polygon) in the Asbesberge region to the east of Postmasburg. The locations of two defunct asbestos mines (Postmasburg and Groenwater Mines) within the study area are indicated in Fig. 1. The rock units mapped within the study area are:

**GHAAP GROUP (ASBESTOS HILLS SUBGROUP)**
- Dark purple (Vak) = Kuruman Formation.
- Pale purple (Vad) = Daniëlskuil Formation.

**POSTMASBURG GROUP**
- Vm (middle green) = Makganyene Formation \( (\text{stromatolites & glacial tillites}) \)
- Vo (dark green) = Ongeluk Formation

**SUPERFICIAL DEPOSITS**
- Pale yellow (Qs) = aeolian sand of Gordonia Formation (Kalahari Group).
Fig. 4. Stratigraphy of the Late Archaean to Early Proterozoic Ghaap and Postmasburg Groups of the Transvaal Supergroup (From Eriksson et al. 2006). The stratigraphic position of the Precambrian bedrocks represented in the study area is indicated by the red rectangle (Ghaap Plateau Sub-basin of Griqualand West Basin).
4. PALAEONTOLOGICAL HERITAGE

The fossil heritage recorded within each of the main sedimentary rock successions occurring within the study region near Postmasburg is briefly outlined here (See also Table 1, and Almond & Pether 2008).

4.1. Fossils within the Ghaap Group

The fossil record of the Precambrian sediments of the Northern Cape has been briefly reviewed by Almond & Pether (2008). The shallow shelf and intertidal sediments of the carbonate-dominated lower part of the Ghaap Group (i.e. Schmidtsdrif and Campbell Rand Subgroups), outside the present study area, are famous for their rich fossil biota of stromatolites or microbiologically-generated, finely laminated mounds and branching structures. Some stromatolite occurrences on the Ghaap Plateau of the Northern Cape are spectacularly well-preserved (e.g. Boetsap locality figured by McCarthy & Rubidge 2005, Eriksson et al. 2006). Detailed studies of these 2.6-2.5Ga carbonate sediments and their stromatolitic biotas have been presented by Young (1932), Beukes (1980, 1983), Eriksson & Truswell (1974), Eriksson & Altermann (1998), Eriksson et al. (2006), Altermann and Herbig (1991), Altermann and Wotherspoon (1995).

An important fossil stromatolite site occurs at Lime Acres situated only some 15-20 km to the southeast of the Groenwater study area (see map Fig. 1 and satellite image Fig. 2) (Altermann & Wotherspoon 1995). Some of the oldest known (2.6 Ga) fossil microbial assemblages with filaments and coccoids have been recorded from stromatolitic cherty limestones of the Lime Acres Member, Kogelbeen Formation at Lime Acres (Altermann & Schopf 1995). The Archaean stromatolite occurrences from the Ghaap Group have been reviewed by Schopf (2006, with full references therein). The Tsineng Formation just below the base of the Asbestos Hills succession has yielded both stromatolites (previously assigned to the Tsineng Member of the Gamohaan Formation) as well as filamentous microfossils named Siphonophycus (Klein et al. 1987, Altermann & Schopf 1995).

The overlying deep water BIF facies of the Asbestos Hills Subgroup (Kuruman and Daniëlskuil Formations) have not yielded stromatolites which are normally restricted to the shallow water photic zone since they are constructed primarily by photosynthetic microbes. However, there are several reports of microfossils from cherty sediments within the Kuruman Formation, just below the Daniëlskuil Formation, according to MacRae (1999) and Tankard et al. (1982 – see refs. therein by Fockema 1967, Cloud & Licari 1968, La Berge 1973. N.B. the stratigraphic position of these older records may require confirmation). It is likely that cherts within the Daniëlskuil Formation also contain scientifically interesting Early Proterozoic microfossil assemblages.

4.2. Fossils within the Postmasburg Group

The fossil record of the Postmasburg Group of the Transvaal Supergroup is still poorly known. Stromatolitic bioherms up to 5m long and 3m thick that are made up of manganese-rich laminated carbonates are recorded from the glacially-influenced Makganyene Formation by Polteau et al. (2006). These carbonate rocks are interbedded with glacial diamicites in the Prieska Subbasin. The intimate association of supposed warm-water carbonates and cold-water glacial deposits at low palaeolatitudes is of considerable palaeoclimatic and palaeobiological significance (See also Polteau 2000, 2005). An alternative view is that these Early Proterozoic stromatolites actually developed within cold, glacial waters, rather than in tropical Bahamas-like settings as previously assumed. Large conical stromatolites generated by cyanobacteria (“blue-green algae”) have recently been discovered growing at depths of up to 100m beneath permanent ice cover in an Antarctic alkaline freshwater lake, a possible modern analogue for the Makganyene fossils (Andersen et al. 2011). Any fossil occurrences of Makganyene stromatolites in association with glacial rocks are therefore of special research and conservation significance.
There are contested records of possible trace fossils from contemporary 2.2 Ga sediments of the Postmasburg Group in the Transvaal Basin (Pretoria Group; Almond & Pether 2008).

No fossils are recorded from the volcanic Ongeluk Formation. Stromatolitic dolomites are recorded from the Moooidraai Formation at the top of the Postmasburg Group succession (Beukes 1986, Eriksson et al. 2006), but these younger rocks are not represented within the present study area.

4.3. Fossils within the Kalahari Group

The fossil record of the Kalahari Group is generally sparse and low in diversity. The Gordonia Formation dune sands were mainly active during cold, drier intervals of the Pleistocene Epoch that were inimical to most forms of life, apart from hardy, desert-adapted species. Porous dune sands are not generally conducive to fossil preservation. However, mumification of soft tissues may play a role here and migrating lime-rich groundwaters derived from underlying lime-rich bedrocks may lead to the rapid calcretisation of organic structures such as burrows and root casts. Occasional terrestrial fossil remains that might be expected within this unit include calcretized rhizoliths (root casts) and termitearia (e.g. Hodotermes, the harvester termite), ostrich egg shells (Struthio), tortoise remains and shells of land snails (e.g. Trigonephrus) (Almond 2008, Almond & Pether 2008). Other fossil groups such as freshwater bivalves and gastropods (e.g. Corbula, Unio) and snails, ostracods (seed shrimps), charophytes (stonewort algae), diatoms (microscopic algae within siliceous shells) and stromatolites (laminated microbial limestones) are associated with local watercourses and pans. Microfossils such as diatoms may be blown by wind into nearby dune sands (Du Toit 1954, Dingle et al., 1983). These Kalahari fossils (or subfossils) can be expected to occur sporadically but widely, and the overall palaeontological sensitivity of the Gordonia Formation is therefore considered to be low. Underlying calcrites might also contain trace fossils such as rhizoliths, termite and other insect burrows, or even mammalian trackways. Mammalian bones, teeth and horn cores (also tortoise remains, and fish, amphibian or even crocodiles in wetter depositional settings) may be expected occasionally expected within Kalahari Group sediments and calcrites, notably those associated with ancient alluvial gravels.

Younger (Quaternary to Recent) surface gravels and colluvium are probably unfossiliferous.

5. CONCLUSIONS & RECOMMENDATIONS

Impacts on fossil heritage are normally confined to the construction phase of a solar power development. This phase development will normally entail shallow excavations into the superficial sediment cover (soils, alluvial gravels etc) and perhaps also into the underlying potentially fossiliferous bedrock. These notably include excavations for the PV panel support structures, buried cables, access roads, any new power line pylons and foundations for associated infrastructure. All these developments may adversely effect potential fossil heritage within the study area by destroying, disturbing or permanently sealing-in fossils that are then no longer available for scientific research or other public good. Once constructed, the operational and decommissioning phases of the PV power station will not involve further adverse impacts on palaeontological heritage, however.

The proposed Metsimatala PV and CSP solar power facility study area is underlain by Precambrian iron-rich basinal sediments of the Ghaap Group (Kuruman andDaniëlskuil Formations) as well as by glacial and volcanic rocks of the younger Postmasburg Group (Makganyene and Ongeluk Formations) (Table 1). These rocks are extremely ancient - some 2.2 - 2.5 billion years old – and in most cases are unlikely to contain substantial macrofossil remains. Cherty layers (fine grained siliceous rocks) and carbonate rocks here may contain microfossil assemblages but these have not yet been recorded in the scientific literature. Large stromatolites (microbial mounds) within the Makganyene Formation have recently become the focus of research interest because they are intimately associated with cold-water glacial rocks, suggesting that tropical warm waters are not, as previously supposed, a pre-requisite for stromatolite reef
development in Proterozoic times. Aeolian (wind-blown) sands of the Gordonia Formation (Kalahari Group) and other Quaternary to Recent superficial deposits overlying Precambrian bedrocks in the study region (e.g. alluvium, colluvium) are generally sparsely fossiliferous.

A field assessment of the Metsimatala project study area by a professional palaeontologist is required to document any stromatolite-bearing rock exposures associated with glacial tillites. The study should make appropriate recommendations for the mitigation and / or conservation of significant fossil sites during the construction and later phases of the development. These recommendations should be incorporated into the Environmental Management Plan of the development.

Should substantial fossil remains be exposed during construction, the ECO should safeguard these, preferably *in situ*, and alert SAHRA as soon as possible so that appropriate action (e.g. recording, sampling or collection) can be taken by a professional palaeontologist.

**Table 1: Fossil heritage in the Postmasburg study area**

<table>
<thead>
<tr>
<th>GEOLOGICAL UNIT</th>
<th>ROCK TYPES &amp; AGE</th>
<th>FOSSIL HERITAGE</th>
<th>PALAEONTOLOGICAL SENSITIVITY</th>
<th>RECOMMENDED MITIGATION</th>
</tr>
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<tbody>
<tr>
<td><strong>Gordonia Formation</strong></td>
<td><strong>Mainly aeolian sands plus minor fluvial gravels, freshwater pan deposits, calcretes</strong></td>
<td>calcretised rhizoliths &amp; termite nests, ostrich egg shells, land snail shells, rare mammalian and reptile (e.g. tortoise) bones, teeth</td>
<td>LOW</td>
<td>none recommended any substantial fossil finds to be reported by ECO to SAHRA</td>
</tr>
<tr>
<td><strong>Kalahari Group</strong></td>
<td><strong>PLEISTOCENE to RECENT</strong></td>
<td>freshwater units associated with diatoms, molluscs, stromatolites etc</td>
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<tr>
<td><strong>plus Surface Calcrete</strong></td>
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<tr>
<td><strong>Makganyene &amp; Ongeluk Fms</strong></td>
<td><strong>Glacial diamictites (tillites), volcanic lavas, dolomites, ironstones</strong></td>
<td><strong>Stromatolites associated with glacial deposits within the Makganyene Formation</strong></td>
<td>GENERALLY LOW with exception of stromatolitic units</td>
<td>Documentation of ancient stromatolites in surface exposures of Makganyene Fm + recommendations for any appropriate conservation measures</td>
</tr>
<tr>
<td><strong>POSTMASBURG GROUP</strong></td>
<td><strong>EARLY PROTEROZOIC (c. 2.2 Ga)</strong></td>
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<tr>
<td><strong>Asbestos Hills Subgroup</strong></td>
<td><strong>BIF (banded iron formations) with cherty bands</strong></td>
<td><strong>important early microfossil biotas</strong></td>
<td>LOW</td>
<td>none recommended</td>
</tr>
<tr>
<td><strong>(Kuruman &amp; Daniëlskuil Fms)</strong></td>
<td><strong>EARLY PROTEROZOIC (c. 2.5-2.4 Ga)</strong></td>
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<td><strong>GHAAP GROUP</strong></td>
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6. ACKNOWLEDGEMENTS

Ms Karen van Ryneveld of ArchaeoMaps, Beacon Bay, and Ms Elbi Bredenkamp of Enviroworks, Bloemfontein, are both thanked for commissioning this study and for kindly providing all the necessary background information.

7. REFERENCES


QUALIFICATIONS & EXPERIENCE OF THE AUTHOR

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

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

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

Dr John E. Almond, Palaeontologist, Natura Viva cc