PALAEONTOLOGICAL SPECIALIST STUDY: DESKTOP ASSESSMENT

Proposed Solar Thermal Energy Power Park on Farm Arriesfontein, near Daniëlskuil, Postmasburg District, Northern Cape Province

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SUMMARY

The company SolarReserve SA (Pty) LTD is proposing to construct a 325 MW Solar Power Park on the Farm Arriesfontein, Barkley West Regional District, Siyanda District Municipal Region in the Northern Cape. The planned solar park will comprise both photovoltaic (PV) and concentrated solar power (CSP) components. The proposed development site is situated in flat terrain on the eastern side of the Asbesberge, approximately 24 km southeast of the town of Daniëlskuil and 110 km northwest of the city of Kimberley.

The study area for the proposed Arriesfontein solar power plant near Daniëlskuil is underlain at depth by Early Precambrian marine carbonate sediments of the Ghaap Group that are only sparsely fossiliferous (*e.g.* microbial mounds or stromatolites). Most of the study area is mantled by Late Caenozoic superficial deposits including Quaternary to Recent calcretes (pedogenic limestones) and downwasted rock rubble of comparable age, all of which are of low to very low palaeontological sensitivity. Extensive, deep excavations are unlikely to be involved in this sort of solar power plant project. The overall impact significance of the proposed development is therefore likely to be LOW and no fatal flaws, no-go areas or buffer zones for palaeontological heritage resources have been identified by this desktop study. No further specialist palaeontological studies, monitoring or mitigation are recommended for this development.

During the construction phase of the solar power plant the ECO responsible for the development should be aware of the possibility of important fossils being present or unearthed on site and should monitor all substantial excavations into fresh (*i.e.* unweathered) sedimentary bedrock for fossil remains. In the case of any significant fossil finds (*e.g.* vertebrate teeth, bones, burrows, petrified wood, calcretised termitaria) during construction, these should be safeguarded - preferably *in situ* - and reported by the ECO as soon as possible to the relevant heritage management authority (SAHRA) so that any appropriate mitigation by a palaeontological specialist can be considered and implemented, at the developer's expense.

These recommendations should be incorporated into the EMP for the solar power plant development.

1. INTRODUCTION

The company SolarReserve SA (Pty) LTD is proposing to construct a 325 MW Solar Power Park on the Farm Arriesfontein, Barkly West Regional District, Siyanda District Municipal Region in the Northern Cape. The planned solar park will comprise both photovoltaic (PV) and concentrated solar power (CSP) components. The proposed development site is situated in flat terrain on the eastern side of the Asbesberge, approximately 24 km southeast of the town of Daniëlskuil and 110 km northwest of the city of Kimberley (Figs. 1 & 2). The development site is located within the institutional boundaries of the Kgatelopele Local and Siyanda District Municipalities.

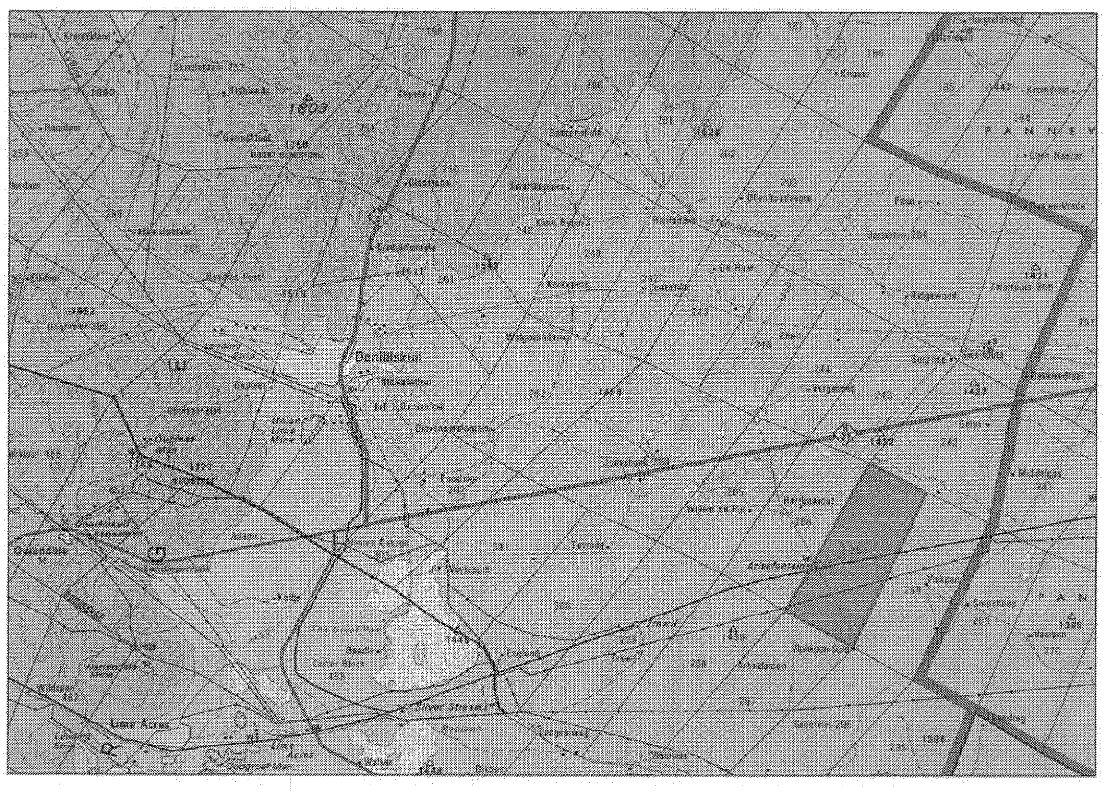

Fig. 1. Extract from 1: 250 000 topographical map 3822 Postmasburg showing location of the proposed Arriesfontein Solar Power Plant study area (red polygon) located *c.* 24 km southeast of Daniëlskuil, Northern Cape (Image kindly provided by PGS (Pty) Ltd).

The following brief project description for the solar plant has been abstracted from the Background Information Document prepared by WorleyParsons RSA (Pty) Ltd, PO Box 93155, Menlo Park 0102, South Africa, dated October 2011:

1. The **CSP plant** being considered is a molten salt-type, central receiver (tower) technology. The plant requires approximately 6 km^2 of low-relief terrain and will primarily comprise the following four components:

   - **Solar Field** - consists of all services and infrastructure related to the management and operation of the heliostats (reflective mirrors). It is estimated that approximately 17 000 heliostats with an area of approximately 65 m^2 each will be required for the solar field in order to obtain a power output of approximately 100 MW;

- **Molten Salt Circuit** - includes the thermal storage tanks for storing liquid salt, a concentration receiver/tower, pipelines and heat exchangers;

- **The Power Block** – housing the steam turbine;

- **Auxiliary facilities and infrastructure** - includes a condenser-cooling system, electricity transmission lines to allow for grid connection, access routes, water treatment and supply amenities and a CSP plant start-up energy supply unit (gas or diesel generators).

2. The **PV development** will consist of photo-voltaic solar panels that will occupy up to 450 ha of the site area in total. The PV will be developed in three blocks of 150 ha. Each block of 150 ha will produce 75 MW. The PV development will produce 225 MW of power in total. The panels will be situated in rows extending across the site in lines. PV panels are typically up to 15 m^2 in size and the rows will be approximately 1 km in length, made up of approximately 100 m sections depending on the final design and layout of the development. The panels will be mounted on metal frames with a maximum height of approximately 3 m above the ground, supported by concrete or screw pile foundations, and they will face north in order to capture the maximum sunlight. The facility will either be a fixed PV plant where the solar panels are stationary or a tracking PV plant where the solar panels rotate to track the sun's movement (the exact type of PV plant system will be determined following on-site solar resource modelling and detailed development design). A detailed technical description for this project has not yet been developed.

The proposed development area is underlain at depth by Early Precambrian marine sediments but also features a variety of Late Caenozoic superficial sediments, some of which may contain sparse fossil remains.

The extent of the proposed development (over 5000 m^2) falls within the requirements for a Heritage Impact Assessment (HIA) as required by Section 38 (Heritage Resources Management) of the South African Heritage Resources Act (Act No. 25 of 1999). The various categories of heritage resources recognised as part of the National Estate in Section 3 of the 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 May 2007.

SolarReserve SA (Pty) LTD has appointed Worley Parsons RSA as independent Environmental Assessment Practitioners in support of an application for Environmental Authorisation and a Waste Management License. The Heritage Impact Assessment for this project is being conducted by Professional Grave Solutions (Pty) Ltd, PO Box 32542, Totiusdal, 0134, RSA who have commissioned the present desktop palaeontological study.

2. APPROACH & METHODOLOGY

2.1. Details of specialist

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, Free State and Mpumalanga 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 as well as the Free State, Gauteng and Limpopo for SAHRA and HWC. Dr Almond is an accredited member of PSSA and APHP (Association of Professional Heritage Practitioners – Western Cape).

2.2. General approach used for palaeontological impact desktop studies

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-based assessment 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 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. Information sources

The information used in this fossil heritage screening study was based on the following:

1. A short project outline in the BID document prepared by WorleyParsons RSA (Pty) Ltd ;

2. A review of the relevant scientific literature, including published geological maps and accompanying sheet explanations;

3. Previous palaeontological assessments for developments in the Postmasburg region by the author (*e.g.* Almond 2010a, 2010b).

2.4. 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 field assessments these limitations may variously lead to either:

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

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

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

In the present case the main factor constraining the reliability of the assessment of fossil heritage within the development area is the lack of geological information concerning the rock unit mapped as "rubble" within the study area (but not described in the brief sheet explanation printed on the map).

3. DESCRIPTION OF THE STUDY AREA

3.1. Location and brief description of study area

The Arriesfontein Farm study area is located in very flat-lying terrain at 1420-1430m amsl extending from the eastern edge of the Asbesberge near the mining town of Daniëlskuil. It is transected by the Kimberley – Postmasburg – Sishen railway line and lies some 6 km south of the R31 road between Barkly West and Postmasburg (Figs. 1, 2). The shallow WNW-ESE trending water courses of the Steenbokrivier and Klein-Rietrivier run across the semi-arid plains some 12 km to the north and south of the study area. Several small pans are visible on satellite images of the area (Fig. 2), designated as *panneveld* on many maps, and the much larger Groot Pan and Rooipan lie less than 20 km to the west.

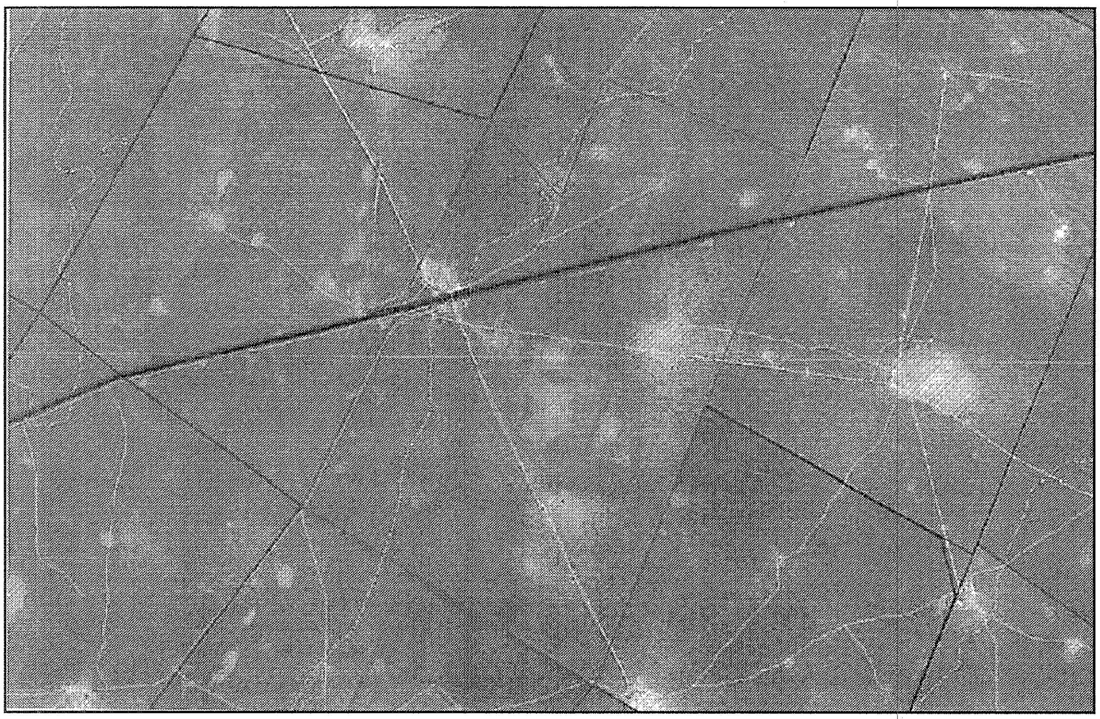

Fig. 2. Satellite image of the Arriesfontein Solar Power Plant study area (red polygon) showing flat terrain, the Kimberley-Sishen railway (black line) and numerous small pans (pale blue-grey areas) (Image abstracted from BID prepared by Worley Parsons RSA (Pty) Ltd).

3.2. Geology of the study area

The geology of the study area to the east of Daniëlskuil is shown on the 1: 250 000 geology map 2822 Postmasburg (Council for Geoscience, Pretoria; Fig. 3 herein). This map is now out of print is not accompanied by a detailed geological sheet explanation (A very brief explanation is printed on the map, however). Relevant earlier 1: 125 000 sheet explanations include those by Truter *et al.* (1938) on the Olifantshoek area and by Visser (1958) on the Griquatown area.

Geological units represented within the study area are listed below the geological map in Fig. 3. Since these various geological maps were published, there have been considerable revisions to the stratigraphic subdivision and assignment of the Precambrian rock units represented within the Postmasburg study region. Where possible, the recent stratigraphic account for the Transvaal Supergroup given by Eriksson *et al.* (2006) is followed here, but correlations for all the subdivisions indicated on the older maps are not always clear.
According to the 1: 250 000 geology map (Fig. 3) the flat-lying region within which the proposed Arriesfontein solar power plant is to be situated is underlain at depth by Early Precambrian sedimentary rocks of the **Ghaap Group** of the Griqualand West Basin, Ghaap Plateau Subbasin (Late Archaean to Early Proterozoic; **Vgl** on geological map). Useful reviews of the stratigraphy and sedimentology of these Transvaal Supergroup rocks have been given by Moore *et al.* (2001), Eriksson and Altermann (1998) as well as Eriksson *et al.* (1993, 1995, 2006). The Ghaap Group represents some 200 Ma of chemical sedimentation - notably iron and manganese ores, cherts and carbonates - within the Griqualand West Basin that was situated towards the western edge of the Kaapvaal Craton (See also fig. 4.19 in McCarthy & Rubidge 2005).

The **Campbell Rand Subgroup** (previously included within the Ghaapplato Formation) of the Ghaap Group is a very thick (1.6-2.5 km) carbonate platform succession of dolomites, dolomitic limestones and cherts with minor tuffs that was deposited on the shallow submerged shelf of the Kaapvaal Craton roughly 2.6 to 2.5 Ga (billion years ago; see readable general account by McCarthy & Rubidge, pp. 112-118 and Fig. 4.10 therein). A range of shallow water facies, often forming depositional cycles reflecting sea level changes, are represented here, including stromatolitic limestones and dolomites, oolites, oncolites, laminated calcilutites, cherts and marls, with subordinate siliclastics (shales, siltstones) and minor tuffs (Eriksson *et al.* 2006). Exposure levels of these rocks are often very low.

Campbell Rand carbonates (Vgl) underlie the entire Arriesfontein study area at depth. Underlying bedded cherts and chert breccia are mapped some 5km to the southeast (Vgl, dark green on the geological map, Fig. 3) but not within the study area itself. The outcrop area of the latter chert-rich unit is largely covered in downwasted, siliceous rock rubble (Key to Postmasburg sheet).

Note that since the 1: 250 000 geological maps were produced, the Campbell Rand succession has been subdivided into a series of formations, some of which were previously included within the older Schmidtsdrift Formation or Subgroup (Beukes 1980, 1986, Eriksson *et al.* 2006). It is unclear exactly which of these newer units are represented in the Arriesfontein study areas. However, this resolution is not critical for the current report since the carbonate facies are only seen at surface in a small part of the study area, around Arriesfontein station, and they are unlikely to be seriously impacted by the proposed development.

The greater part of the Arriesfontein study area is mantled by **superficial sediments** of probable Late Caenozoic (*i.e.* Late Tertiary or Neogene to Recent) age, mapped as surface limestone (**Ql**, yellow; *i.e.* calcrete and downwasted limestone rubble) as well as *"verweringspuin"* or downwasted rock rubble (pale buff with triangle symbol on map).

Mappable exposures of **surface limestone (Ql)** occur along the eastern edge of the study area. Patches of pedogenic calcrete occur extensively overlying the Campbell Rand carbonates and may also underlie Kalahari sands in the Postmasburg region. These deposits reflect seasonally arid climates in the region over the last five or so million years and are briefly described by Truter *et al.* (1938) as well as Visser (1958). The surface limestones may reach thicknesses of over 20m, but are often much thinner, and are locally conglomeratic with clasts of reworked calcrete as well as exotic pebbles. The limestones may be secondarily silicified and incorporate blocks of the underlying Precambrian carbonate rocks.

Little can be said at the desktop level concerning the geology of the **rock rubble** that is mapped over most of the western and central portions of the Arriesfontein study area, since this is not described in the very short geological explanation for the Postmasburg 1: 250 000 sheet. It is likely that downwasted siliceous blocks weathered out from cherty horizons within the underlying Campbell Rand Subgroup make up a large proportion of this surface rubble. Other, more exotic, resistant lithologies represented in the broader region that might also be found here include quartzite, agate, jasper and banded ironstone (*cf* Truter *et al.* 1938, p. 40). A degree of secondary silicification and impregnation by manganese minerals might be expected here.

Pan sediments in the Northern Cape and elsewhere have been briefly treated by Partridge & Scott (2000) and Partridge *et al.* (2006). They typically comprise pale, fine-grained silts, sands and clays, sometimes with an evaporite component. Most are of Pleistocene age or younger. Truter et al. (1938, p. 39) refer to a "tuffaceous limestone" that is usually found in small pans in the Olifants Hoek area.

Much of the arid terrain within the study area is doubtless mantled with a spectrum of other coarse to fine-grained **surface deposits** such as rocky soils, sheet wash and alluvium of intermittently flowing streams. Since these deposits are generally young and largely unfossiliferous, they will not be treated further here.

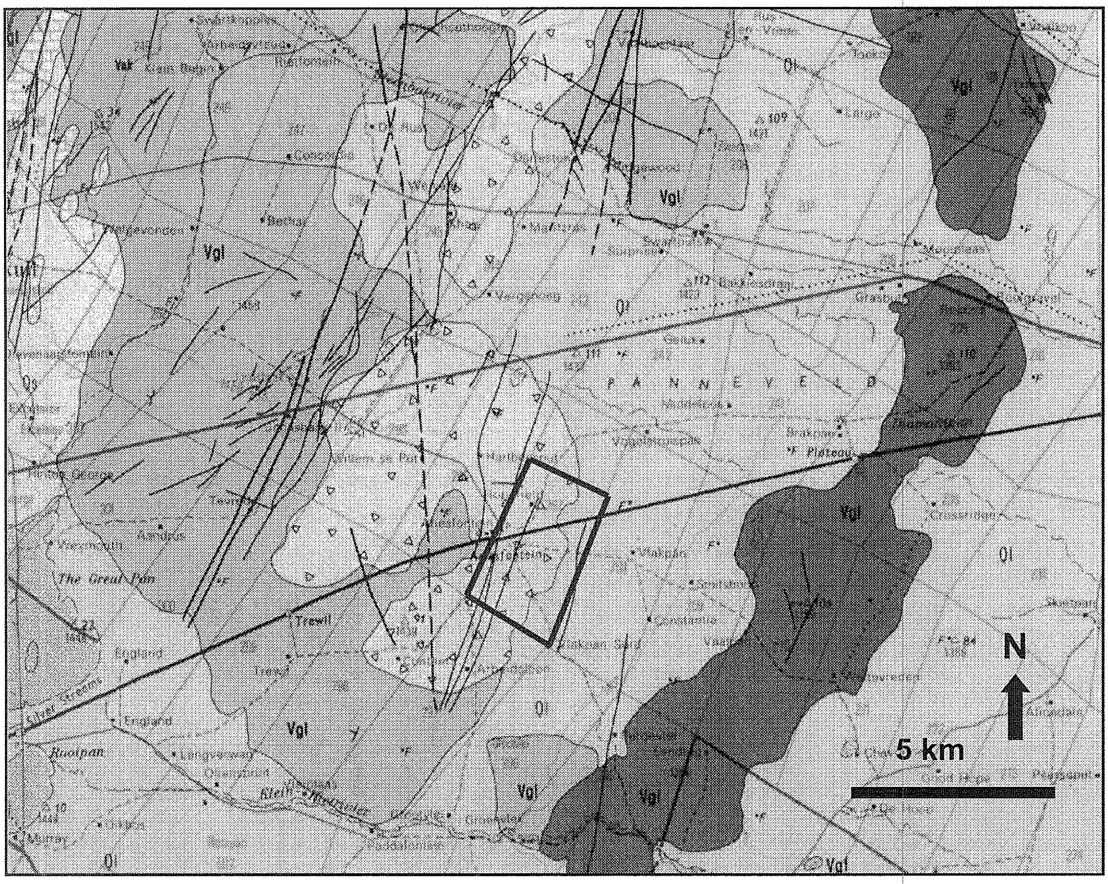

Fig. 3. Extract from 1: 250 000 geological map 2822 Postmasburg (Council for Geoscience, Pretoria) showing *approximate* location of proposed Arriesdrift Solar Power Plant study area *c.* 24 km southeast of Daniëlskuil, Northern Cape Province (blue polygon). Potentially fossiliferous sedimentary rock units mapped within the broader study region include:

Vgl (pale blue) = Precambrian limestones, dolomites and cherts of the Ghaap Group (Campbell Rand Subgroup)

Vgl (dark green) = Precambrian banded cherts and chert breccia of the Ghaap Group

Ql (yellow) = Late Caenozoic calcretes (Kalahari Group in part)

Buff with triangular symbols = superficial downwasted "rubble" (*verweringspuin*)

The overall palaeontological sensitivity of the entire study area is LOW.

4. PALAEONTOLOGICAL HERITAGE

The fossil record of the Precambrian and much younger Caenozoic sediments of the Northern Cape has been very briefly reviewed by Almond & Pether (2008).

4.1. Fossils within the Transvaal Supergroup

The shallow shelf and intertidal sediments of the carbonate-dominated lower part of the **Ghaap Group** (*i.e.* Schmidtsdrif and Campbell Rand Subgroups) are famous for their rich fossil biota of *stromatolites* or microbially-generated, finely laminated sheets, mounds and branching structures. Some stromatolite occurrences on the Ghaap Plateau of the Northern Cape are spectacularly well-preserved (*e.g.* Boetsap locality northeast of Daniëlskuil figured by McCarthy & Rubidge 2005, Eriksson *et al.* 2006; Fig. 4). Detailed studies of these 2.6-2.5 Ga 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), and Altermann and Wotherspoon (1995). Some of the oldest known (2.6Ga) fossil microbial assemblages with filaments and coccoids have been recorded from stromatolitic cherty limestones of the Lime Acres Member, Kogelbeen Formation at Lime Acres which is situated just south of Daniëlskuil (Altermann & Schopf 1995). The oldest, Archaean stromatolite occurrences from the Ghaap Group have been reviewed by Schopf (2006, with full references therein). The Tsineng Formation at the top of the Campbell Rand carbonate 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).

Fig. 4. Stromatolite domes (*c.* 1m diameter) within the Ghaap Group at the famous Boetsap locality, northeast of Daniëlskuil, Northern Cape Province (From Macarthy & Rubidge 2005).

4.2. Fossils within the Late Caenozoic superficial sediments

In areas underlain by Ghaap Group carbonate rocks migrating lime-rich groundwaters may have led to the rapid calcretisation within overlying "drift" deposits of organic structures such as burrows and root casts. Occasional terrestrial fossil remains that might be expected within surface limestones include calcretized rhizoliths (root casts) and termitaria (*e.g. Hodotermes*, the harvester termite), ostrich egg shells (*Struthio*) 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*), ostracods (seed shrimps), charophytes (stonewort algae), diatoms (microscopic algae within siliceous shells) and stromatolites (laminated microbial limestones) are associated with watercourses and pans. Abundant small terrestrial gastropod shells are recorded from pan sediments in the Olifantshoek area by Truter *et al.* (1938, p. 39), while coquinas of Late Pleistocene freshwater gastropods are reported from pans in the Loeriesfontein sheet area in the northern Cape (Almond 2008). Microfossils such as diatoms may be blown by wind into nearby dune sands (Du Toit 1954, Dingle *et al.*, 1983).

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 ancient alluvial gravels, downwasted rock rubble and pan sediments (*cf* Almond 2008, Partridge & Scott 2000). However, these fossil assemblages are generally sparse, low in diversity, and occur over a wide geographic area, so the palaeontological sensitivity of the superficial sediments within the study area is rated as low.

5. INDENTIFICATION OF POTENTIAL IMPACTS *plus* RECOMMENDED MITIGATION

The proposed Arriesfontein solar power plant development near Daniëlskuil is located in an area that is in part underlain by at most sparsely fossiliferous sedimentary rocks of Precambrian and Late Caenozoic age, the latter comprising mainly Quaternary to Recent calcretes and downwasted rock rubble.

The construction phase of the solar power plant will entail fresh excavations into the superficial sediment cover (soils, alluvium *etc*) and perhaps also into the underlying bedrock. These notably include excavations for the solar panel foundations, buried cables (probably around 1m deep), new gravel roads with drainage trenches, and associated building infrastructure (*e.g.* concentration tower, power block, administration buildings). In addition, sizeable areas of bedrock may be sealed-in or sterilized by infrastructure such as the CSP solar field, ancillary buildings as well as a new gravel road system.

All these developments may adversely affect fossil heritage at or near the surface 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 solar energy facility will not involve further adverse impacts on palaeontological heritage, however.

The overall impact significance of the proposed solar park development is likely to be LOW because:

- Most of the study area is underlain by sparsely fossiliferous Precambrian sediments or mantled by superficial sediments (calcretes, rock rubble, alluvium *etc*) of low palaeontological sensitivity;

- Extensive, deep excavations are unlikely to be involved in this sort of solar park project.

Significant negative impacts on local fossil heritage are therefore unlikely to result from the proposed solar power plant development and in the author's opinion no further specialist palaeontological studies for this project are necessary.

During the construction phase of the solar power plant:

- The ECO responsible for the development should be aware of the possibility of important fossils being present or unearthed on site and should monitor all substantial excavations into fresh (*i.e.* unweathered) sedimentary bedrock for fossil remains;

- In the case of any significant fossil finds (*e.g.* vertebrate teeth, bones, burrows, petrified wood, calcretised termitaria) during construction, these should be safeguarded - preferably *in situ* - and reported by the ECO as soon as possible to the relevant heritage management authority (SAHRA) so that any appropriate mitigation by a palaeontological specialist can be considered and implemented, at the developer's expense;

- These recommendations should be incorporated into the EMP for the solar park development.

5. RELEVANT LEGISLATIVE AND PERMIT REQUIREMENTS

According to the National Heritage Resources Act (Act 25 of 1999, Sections 3 and 35) all geological sites of scientific or cultural importance, palaeontological sites, palaeontological objects and material, meteorites and rare geological specimens are regarded as part of the National Estate and are protected by law.

According to Section 35 of the Act, no person may, without a permit issued by the responsible heritage resources authority:

- destroy, damage, excavate, alter, deface or otherwise disturb any palaeontological site;
- destroy, damage, excavate, remove from its original position, collect or own any palaeontological material or object;
- trade in, sell for private gain, export or attempt to export from the Republic any category of palaeontological material or object; or
- bring onto or use at a palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of palaeontological material or objects.

The extent of the proposed solar park development (over 5000 m^2) falls within the requirements for a Heritage Impact Assessment (HIA) as required by Section 38 (Heritage Resources Management) of the South African Heritage Resources Act (Act No. 25 of 1999). Where fossil heritage may be present, a specialist palaeontological study forms an integral part of such a HIA and its conclusions and recommendations would need to be combined with those of other heritage specialists as an integrated heritage study.

6. DISCUSSION & CONCLUSIONS

The study area for the proposed Arriesfontein solar power plant near Daniëlskuil is underlain at depth by Early Precambrian marine carbonate sediments of the Ghaap Group that are only sparsely fossiliferous (*e.g.* microbial mounds or stromatolites). Most of the study area is mantled by Late Caenozoic superficial deposits including Quaternary to Recent calcretes (pedogenic limestones) and downwasted rock rubble of comparable age, all of which are of low to very low palaeontological sensitivity. Extensive, deep excavations are unlikely to be involved in this sort of solar power plant project. The overall impact significance of the proposed development is therefore likely to be LOW and no no-go areas or buffer zones for palaeontological heritage resources have been identified by this desktop study. No further specialist palaeontological studies, monitoring or mitigation are recommended for this development.

7. ACKNOWLEDGEMENTS

Mr Wouter Fourie of Professional Grave Solutions (Pty) Ltd, PO Box 32542, Totiusdal, is thanked for commissioning this study and for kindly providing all the necessary background information.8.

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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 solar power plant 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.

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