PALAEONTOLOGICAL HERITAGE ASSESSMENT: COMBINED DESKTOP & FIELD-BASED STUDY (BASIC ASSESSMENT)

PROPOSED EXPANSION OF THE EXISTING KOMSBERG MAIN TRANSMISSION SUBSTATION ON FARM STANDVASTIGHEID 210 NEAR SUTHERLAND, NORTHERN CAPE PROVINCE

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EXECUTIVE SUMMARY

Eskom Holdings SOC Ltd is proposing to expand the existing Komsberg Main Transmission Substation (MTS) situated on the Farm Standvastigheid 210 on the eastern side of the R354 tar road some 60 km south of Sutherland, Northern Cape. The substation expansion area (approximately 19.8 ha) will fit within the Eskom property, and is located next to and between the existing capacitor banks installation. The existing capacitor banks will form part of the expanded substation footprint. The total footprint of the expanded Komsberg MTS is likely to be 440 m x 450 m, all on Eskom property.

The fluvial Abrahamskraal Formation (Lower Beaufort Group, Karoo Supergroup) that underlies the Komsberg Substation study area is known for its diverse fauna of Permian fossil vertebrates - notably various small- to large-bodied therapsids and reptiles - as well as fossil plants of the *Glossopteris* Flora and low diversity trace fossil assemblages. However, desktop analysis of known fossil distribution within the Main Karoo Basin shows a marked paucity of fossil localities in the study region between Matjiesfontein and Sutherland where sediments belonging only to the lower part of the thick Abrahamskraal Formation succession are represented. Bedrock exposure levels in the broader study region are generally very poor due to the pervasive cover by superficial sediments (colluvium, alluvium, soils, calcrete) and vegetation. Nevertheless, a sufficiently large outcrop area of Abrahamskraal Formation sediments, exposed in stream and riverbanks, borrow pits, erosion gullies as well as road cuttings along the R354, has been examined during the present field study (as well as recent fieldwork for the adjacent Kareebosch and Karusa Wind Farms) to infer that macroscopic fossil remains of any sort are very rare indeed here. Exceptions include common trace fossil assemblages (invertebrate burrows) and occasional fragmentary plant remains (horsetail ferns). Levels of bedrock tectonic deformation are generally low, although folding, faulting and cleavage development associated within the Cape Fold Belt are locally apparent, and baking by Early Jurassic dolerite intrusions is very minor. It is concluded that the Lower Beaufort Group bedrocks in the study area are generally of low palaeontological sensitivity and this also applies to the overlying Late Caenozoic superficial sediments (colluvium, alluvium, calcrete, surface gravels, soils *etc*).

Construction of the proposed expanded Komsberg MTS is unlikely to entail significant impacts on local fossil heritage resources. Due to the general great scarcity of fossil remains as well as the extensive superficial sediment cover observed within the study area, the overall impact significance of the construction phase of the proposed expanded substation is assessed as

LOW. This assessment applies equally to (a) the two alternative locations for the substation expansion area, neither of which is preferred on palaeontological heritage grounds, and (b) proposed widening of a short section of access road. The operational and decommissioning phases of the substation are very unlikely to involve further adverse impacts on local palaeontological heritage.

Given the low impact significance of the proposed Komsberg MTS development near Sutherland as far as palaeontological heritage is concerned, no further specialist palaeontological heritage studies or mitigation are considered necessary for this project, pending the discovery or exposure of substantial new fossil remains during development. During the construction phase all deeper (> 1 m) bedrock excavations should be monitored for fossil remains by the responsible ECO. Should substantial fossil remains such as vertebrate bones and teeth, plant-rich fossil lenses, fossil wood or dense fossil burrow assemblages be exposed during construction, the responsible Environmental Control Officer should safeguard these, preferably *in situ*, and alert SAHRA, *i.e.* The South African Heritage Resources Authority, as soon as possible (Contact details: Mrs Colette Scheermeyer, P.O. Box 4637, Cape Town 8000. Tel: 021 462 4502. Email: cscheermeyer@sahra.org.za) so that appropriate action can be taken by a professional palaeontologist, at the developer's expense. Mitigation would normally involve the scientific recording and judicious sampling or collection of fossil material as well as associated geological data (*e.g.* stratigraphy, sedimentology, taphonomy) by a professional palaeontologist.

These mitigation recommendations should be incorporated into the Environmental Management Plan (EMP) for the Komsberg MTS expansion project.

Please note that:

- All South African fossil heritage is protected by law (South African Heritage Resources Act, 1999) and fossils cannot be collected, damaged or disturbed without a permit from SAHRA or the relevant Provincial Heritage Resources Agency;

- The palaeontologist concerned with mitigation work will need a valid fossil collection permit from SAHRA and any material collected would have to be curated in an approved depository (*e.g.* museum or university collection); and

- All palaeontological specialist work would have to conform to international best practice for palaeontological fieldwork and the study (*e.g.* data recording fossil collection and curation, final report) should adhere as far as possible to the minimum standards for Phase 2 palaeontological studies recently developed by SAHRA (2013).

1. INTRODUCTION & BRIEF

1.1. Project outline

Eskom Holdings SOC Ltd is proposing to expand the existing Komsberg Main Transmission Substation (MTS) situated on the Farm Standvastigheid 210 on the eastern side of the R354 tar road some 60 km south of Sutherland, Northern Cape (Figs. 1 & 2). The substation expansion area (approximately 19.8 ha) will fit within the Eskom property, and is located next to and between the existing capacitor banks installation. Two location alternatives are under consideration: Alternative 1 (orange rectangle in Fig. 2) and the preferred Alternative 2 (blue rectangle in Fig. 2). The existing capacitor banks will form part of the expanded substation footprint. The total footprint of the expanded Komsberg MTS is likely to be 440 m x 450 m, all on Eskom property. Widening of a short section of access road is also envisaged (green line in Fig. 2).

The Komsberg MTS study area is located in an area that is underlain by potentially fossiliferous sedimentary rocks of Late Palaeozoic and younger, Late Tertiary or Quaternary, age (Sections 2 & 3). The construction phase of the proposed substation will entail excavations into the superficial sediment cover and locally into the underlying bedrock as well. The development may adversely affect potential fossil heritage within the study area by destroying, disturbing or permanently sealing-in fossils preserved at or beneath the surface of the ground that are then no longer available for scientific research or other public good. The operational and decommissioning phases of the substation are unlikely to involve further adverse impacts on local palaeontological heritage, however.

The present palaeontological heritage assessment of the Komsberg MTS study area has been commissioned as part of the Basic Assessment for this development that is being co-ordinated by Savannah Environmental (Pty) Ltd, Woodmead (Contact details: Ms Tebogo Mapinga. Savannah Environmental (Pty) Ltd. 1st Floor, Block 2, 5 Woodlands Drive Office Park, Woodlands Drive, Woodmead, 2191. Tel: +27 11 656 3237. Fax: +27 86 684 0547. Cell: +27 72 738 3836. Email: tebogo@savannahsa.com. Postal address: P.O. Box 148, Sunninghill, 2157).

1.2. Legislative context for palaeontological assessment studies

The Komsberg MTS project area is located in an area that is underlain by potentially fossiliferous sedimentary rocks of Late Palaeozoic and younger, Late Tertiary or Quaternary, age (Sections 2 & 3). The construction phase of the proposed substation will entail shallow excavations into the superficial sediment cover and locally into the underlying bedrock as well. This development may adversely affect potential fossil heritage within the study area by destroying, disturbing or permanently sealing-in fossils preserved at or beneath the surface of the ground that are then no longer available for scientific research or other public good. The operational and decommissioning phases of the substation are unlikely to involve further adverse impacts on local palaeontological heritage, however.

The present combined desktop and field-based palaeontological heritage report contributes to the Basic Assessment for the Komsberg MTS project and falls under the South African Heritage Resources Act (Act No. 25 of 1999). It will also inform the Environmental Management Plan for this project.

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; and
- palaeontological objects and material, meteorites and rare geological specimens.

According to Section 35 of the National Heritage Resources Act, dealing with archaeology, palaeontology and meteorites:
(1) The protection of archaeological and palaeontological sites and material and meteorites is the responsibility of a provincial heritage resources authority.

(2) All archaeological objects, palaeontological material and meteorites are the property of the State.
(3) Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.
(4) No person may, without a permit issued by the responsible heritage resources authority—
(a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;
(b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;
(c) trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or
(d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.
(5) When the responsible heritage resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for a permit has been submitted and no heritage resources management procedure in terms of section 38 has been followed, it may—
(a) serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order;
(b) carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary;
(c) if mitigation is deemed by the heritage resources authority to be necessary, assist the person on whom the order has been served under paragraph *(a)* to apply for a permit as required in subsection (4); and
(d) recover the costs of such investigation from the owner or occupier of the land on which it is believed an archaeological or palaeontological site is located or from the person proposing to undertake the development if no application for a permit is received within two weeks of the order being served.

Minimum standards for the palaeontological component of heritage impact assessment reports (PIAs) have recently been published by SAHRA (2013).

1.3. Approach to the palaeontological heritage study

The approach to a Phase 1 palaeontological heritage study is briefly as follows. Fossil bearing rock units occurring within the broader study area are determined from geological maps and satellite images. Known fossil heritage in each rock unit is inventoried from scientific literature, previous assessments of the broader study region, and the author's field experience and palaeontological database. Based on this data as well as field examination of representative exposures of all major sedimentary rock units present, the impact significance of the proposed development is assessed with recommendations for any further studies or mitigation.

In preparing a palaeontological desktop study the potentially fossiliferous rock units (groups, formations *etc*) represented within the study area are determined from geological maps and satellite images. 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 following field assessment 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 and scale of the development itself, most significantly the extent of fresh bedrock excavation envisaged. When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a Phase 1 field assessment study by a professional palaeontologist is usually warranted to identify any palaeontological hotspots and make specific recommendations for any mitigation required before or during the construction phase of the development.

On the basis of the desktop and Phase 1 field assessment studies, the likely impact of the proposed development on local fossil heritage and any need for specialist mitigation are then determined. Adverse palaeontological impacts normally occur during the construction rather than the operational or decommissioning phase. Phase 2 mitigation by a professional palaeontologist – normally involving the recording and sampling of fossil material and associated geological information (*e.g.* sedimentological data) may be required (a) in the pre-construction phase where important fossils are already exposed at or near the land surface and / or (b) during the construction phase when fresh fossiliferous bedrock has been exposed by excavations. To carry out mitigation, the palaeontologist involved will need to apply for a palaeontological collection permit from the relevant heritage management authorities, *i.e.* SAHRA for the Northern Cape (Contact details: Mrs Colette Scheermeyer, P.O. Box 4637, Cape Town 8000. Tel: 021 462 4502. Email: cscheermeyer@sahra.org.za) and Heritage Western Cape for the Western Cape (Contact details: Heritage Western Cape. Protea Assurance Building, Green Market Square, Cape Town 8000. Private Bag X9067, Cape Town 8001. Tel: 086-142 142. Fax: 021-483 9842. Email: hwc@pgwc.gov.za). It should be emphasized that, *providing appropriate mitigation is carried out*, the majority of developments involving bedrock excavation can make a *positive* contribution to our understanding of local palaeontological heritage.

1.4. 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 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.

In the case of the Komsberg Substation study area near Sutherland in the Northern Cape preservation of potentially fossiliferous bedrocks is favoured by the semi-arid climate and sparse vegetation but bedrock exposure is largely compromised by extensive superficial deposits, especially in areas of low relief, as well as pervasive Karoo *bossieveld* vegetation (Central Mountain Shale Renosterveld). Comparatively few academic palaeontological studies or field-based fossil heritage impact have been carried out in the region, so any new data from impact studies here are of scientific interest.

1.5. Information sources

The present combined desktop and field-based palaeontological study was largely based on the following sources of information:

1. A brief project outline kindly supplied by Savannah Environmental (Pty) Ltd;

2. Relevant geological maps and sheet explanations (*e.g.* Theron 1983) as well as Google earth© satellite imagery;

3. Several palaeontological heritage assessment reports by the present author for proposed developments in the Karoo region to the south of Sutherland, including the

Eskom Gamma – Omega 765 kV transmission line that runs just to the south (Almond 2010a) and several alternative energy facilities (Almond 2010b, 2010c, 2011, 2014);

4. A one-day palaeontological field assessment of the region around the Komsberg MTS (20 August 2015) within the context of a broader-based review of fossil heritage resources for the Karusa Wind Farm project area (work in progress);

5. The author's previous field experience with the formations concerned and their palaeontological heritage (*cf* Almond & Pether 2008 and references listed above).

GPS data for all numbered localities mentioned in the text are provided in the Appendix.

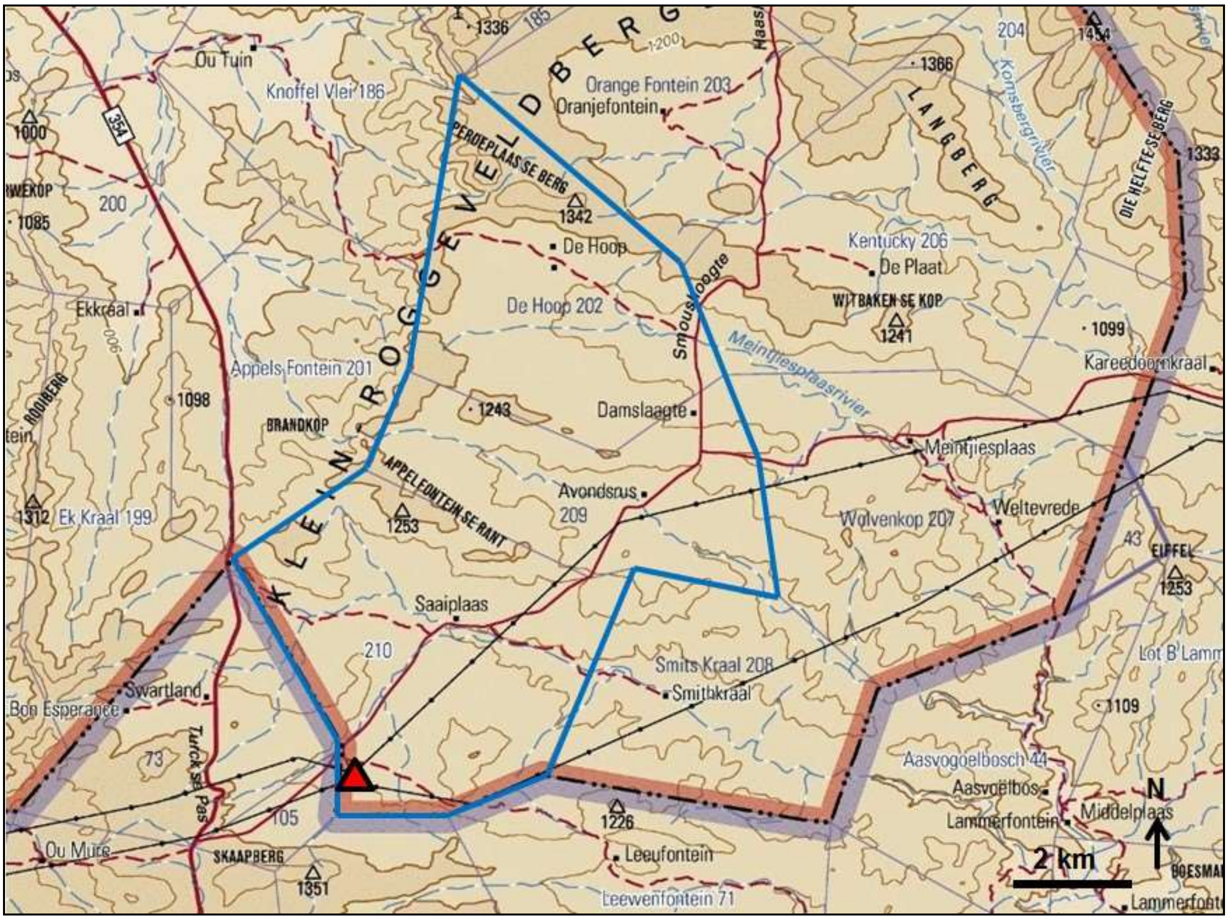

Figure 1. Extract from 1: 250 000 topographical sheet 3220 Sutherland showing the location of the Komsberg MTS on the Farm Standvastigheid 210 (red triangle). The study area is situated on the eastern side of the Klein-Roggeveldberge and *c*. 32 km north of Matjiesfontein, close to the Northern Cape / Eastern Cape provincial boundary. The blue polygon indicated the study area for the proposed Karusa Wind Farm that is the subject of a separate palaeontological heritage assessment (Base map courtesy of the Chief Directorate of Surveys and Mapping, Mowbray).

Figure 2. Google earth© satellite image of the Komsberg MTS study area (yellow = affected land portion; red = development area; orange = Alternative 1 location for high voltage yard; blue = Alternative 2 location for high voltage yard (preferred; green – access road to be widened). Bedrock trends suggest the existence of a narrow, west-east orientated anticlinal structure crossing through the study area.

2. GEOLOGICAL BACKGROUND

The Komsberg MTS study area is situated within hilly to mountainous terrain to the south of Sutherland and the Great Escarpment (Roggeveldberge) and just east of the main Klein-Roggeveldberge range (Figs. 1 & 3), *c*. 32 km to the north of Matjiesfontein and *c*. 60 km south of Sutherland, Great Karoo region. The Northern Cape – Western Cape provincial boundary lies just to the south. The existing Eskom Komsberg MTS lies on the eastern side of a minor dust road towards the south-western corner of the farm Standvastigheid 210, some 4.8 km southwest of the Saaiplaas farmstead. The R354 tar road between Matjiesfontein and Sutherland (at Turck se Pas) runs about 4 km to the west. Several small, non-perennial stream beds run to the west, north and east within a 1-2 km radius of the study area. Away from these shallow drainage lines bedrock exposure in the area is generally low in this region, due to extensive cover by alluvial and colluvial deposits as well as karroid *bossieveld* vegetation (Figs. 4 & 5).

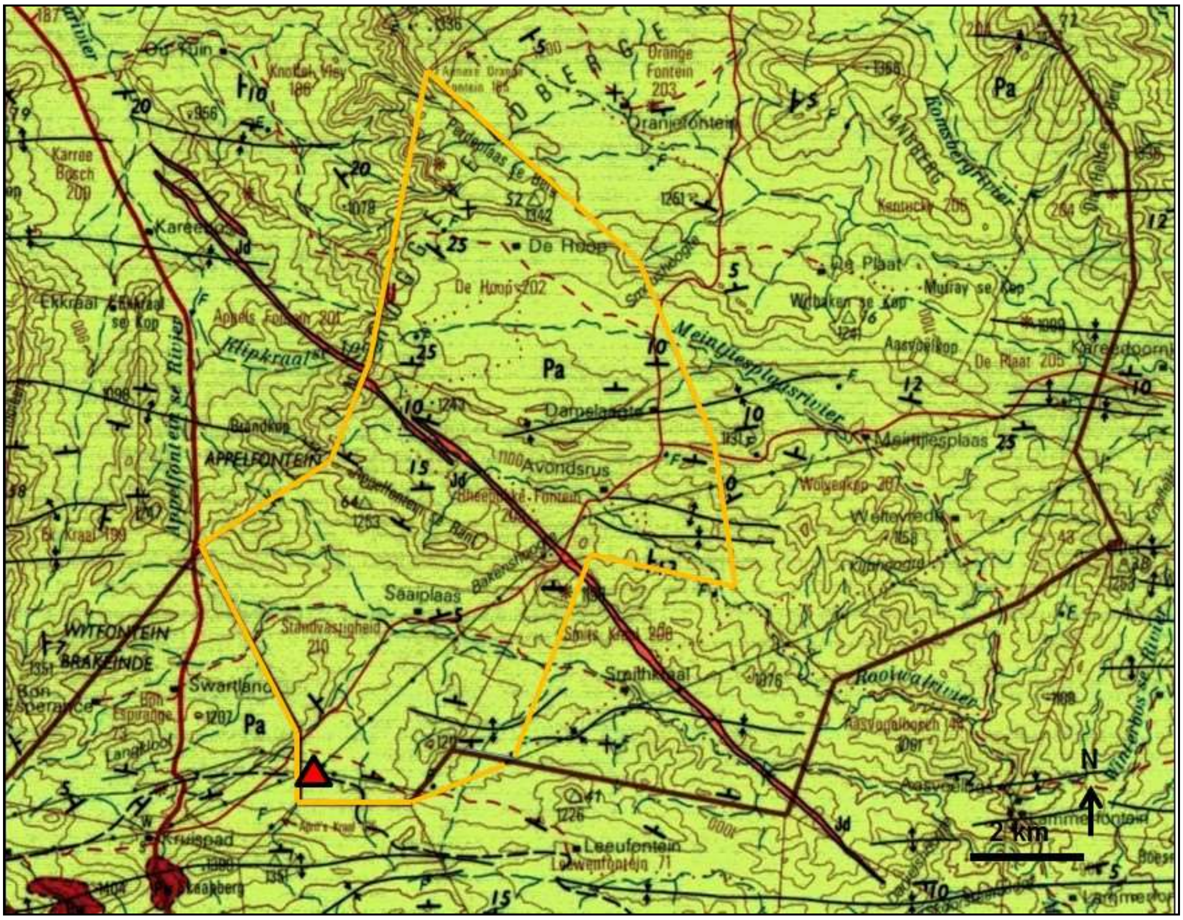

Figure 3. Extract from the 1: 250 000 scale geology sheet 3220 Sutherland (Council for Geoscience, Pretoria, 1999) showing the location of the proposed Komsberg MTS study area, *c*. 60 km south of Sutherland, Northern Cape Province (red triangle). The study area is entirely underlain by Middle Permian sediments of the Abrahamskraal Formation, Lower Beaufort Group (Pa, pale green). The black dashed line marks the incoming of maroon mudrocks within the Abrahamskraal Formation succession.

2.1. Geological setting

The geology of the Sutherland region is outlined on the 1: 250 000 scale geology sheet 3220 Sutherland (Theron 1983) (Fig. 3)as well as the updated 1: 250 000 Sutherland metallogenic map that includes important new stratigraphic detail for the Beaufort Group succession (Cole & Vorster 1999). The study area is entirely underlain by Middle Permian continental sediments of the **Lower Beaufort Group** (Adelaide Subgroup, Karoo Supergroup), and in particular the **Abrahamskraal Formation** (Pa) at the base of the Beaufort Group succession (Johnson *et al.* 2006 and references cited below). In the Sutherland area to the north, situated just north of the Great Escarpment, the Lower Beaufort Group sediments have been extensively intruded and thermally metamorphosed (baked) by dolerite sills and dykes of the **Karoo Dolerite Suite** of Early Jurassic age (*c*. 182 Ma = million years ago; Duncan & Marsh 2006). These igneous rocks were intruded during an interval of crustal uplift and stretching that preceded the break-up of the supercontinent Gondwana. They show up on satellite images as rusty-brown areas. In the present study region well to the south of the Great Escarpment the only major dolerite intrusions are a set of laterally persistent, NW-SE trending dykes that transect the adjoining Karusa Wind Farm area and that can be well seen in road cuttings along the R354 (Jd, pink in Fig. 3). The Karoo dolerites are entirely unfossiliferous and will not be treated further in this report. The Palaeozoic and Mesozoic bedrocks in the study area are very extensively overlain by Late Caenozoic **superficial deposits** such as scree and other slope deposits (colluvium and hillwash), stream alluvium, down-wasted surface gravels, calcretes and various soils. These geologically youthful sediments are generally of low palaeontological sensitivity.

Figure 4. View towards the existing Eskom Komsberg MTS from the west.

Figure 5. General view of the gravel-mantled, low-relief terrain in the Komsberg MTS study area (The existing substation is seen in the background).

2.1.1. Lower Beaufort Group (Adelaide Subgroup)

A useful recent overview of the Beaufort Group continental succession has been given by Johnson *et al.* (2006). Geological and palaeoenvironmental analyses of the Lower Beaufort Group sediments in the western Great Karoo region have been conducted by a number of workers. Key references within an extensive scientific literature include various papers by Roger Smith (*e.g.* Smith 1979, 1980, 1986, 1987a, 1987b, 1988, 1989, 1990, 1993a, 1993b) and Stear (1978, 1980a, 1980b), as well as several informative field guides (*e.g.* Cole *et al.* 1990, Cole & Smith 2008) and two geological sheet explanations for the Sutherland area (Theron 1983, Cole & Vorster 1999). In brief, the thick Beaufort Group successions of clastic sediments were laid down by a series of large, meandering rivers within a subsiding basin over a period of some ten or more million years, largely within the Middle to Late Permian Period (*c*. 266-251 Ma). Sinuous sandstone bodies of lenticular cross-section represent ancient channel infills, while thin (<1.5m), laterally-extensive sandstone beds were deposited by crevasse splays during occasional overbank floods. The bulk of the Beaufort sediments are greyish-green to reddish-brown or purplish mudrocks ("mudstones" = fine-grained claystones and slightly coarser siltstones) that were deposited over the floodplains during major floods. Thin-bedded, fine-grained playa lake deposits also accumulated locally where water ponded-up in floodplain depressions and are associated with distinctive fossil assemblages (*e.g.* fish, amphibians, coprolites or fossil droppings, arthropod, vertebrate and other trace fossils, plant fossils).

Frequent development of fine-grained pedogenic (soil) limestone or calcrete as nodules and more continuous banks indicates that semi-arid, highly seasonal climates prevailed in the Middle Permian Karoo. This is also indicated by the common occurrence of sand-infilled mudcracks and silicified gypsum "desert roses" (Smith 1980, 1990, 1993a, 1993b, Almond 2010a). Highly continental climates can be expected from the palaeogeographic setting of the Karoo Basin at the time – embedded deep within the interior of the Supercontinent Pangaea and in the rainshadow of the developing Gondwanide Mountain Belt. Fluctuating water tables and redox processes in the alluvial plain soil and subsoil are indicated by interbedded mudrock horizons of contrasting colours. Reddish-brown to purplish mudrocks probably developed during drier, more oxidising conditions associated with lowered water tables, while greenish-grey mudrocks reflect reducing conditions in waterlogged soils during periods of raised water tables. However, diagenetic (post-burial) processes also greatly influence predominant mudrock colour (Smith 1990).

2.1.1.2. Abrahamskraal Formation

The Abrahamskraal Formation is a very thick (*c*. 2.5km) succession of fluvial deposits laid down in the Main Karoo Basin by meandering rivers on an extensive, low-relief floodplain during the Mid Permian Period, some 266-260 million years ago (Rossouw & De Villiers 1952, Johnson & Keyser 1979, Turner 1981, Theron 1983, Smith 1979, 1980, 1990, 1993a, 1993b, Smith & Keyser 1995a, Loock *et al*., 1994, McCarthy & Rubidge 2005, Johnson *et al*., 2006, Almond 2010a). These sediments include (a) lenticular to sheet-like channel sandstones, often associated with thin, impersistent intraformational breccio-conglomerates (larger clasts mainly of reworked mudflakes, calcrete nodules, *plus* sparse rolled bones, teeth, petrified wood), (b) well-bedded to laminated, grey-green, blue-grey to purple-brown floodplain mudrocks with sparse to common pedocrete horizons (calcrete nodules formed in ancient soils), (c) thin, sheet-like crevasse-splay sandstones, as well as more (d) localized playa lake deposits (*e.g.* wave-rippled sandstones, laminated mudrocks, limestones, evaporites). A number of greenish to reddish weathering, silica-rich "chert" horizons are also found. Many of these appear to be secondarily silicified mudrocks or limestones but at least some contain reworked volcanic ash (tuffs). A wide range of sedimentological and palaeontological observations point to deposition under seasonally arid climates. These include, for example, the abundance of pedogenic calcretes and evaporites (silicified gypsum pseudomorphs or "desert roses"), reddened mudrocks, sun-cracked muds, "flashy" river systems, sun-baked fossil bones, well-developed seasonal growth rings in fossil wood, rarity of fauna, and little evidence for substantial bioturbation or vegetation cover (*e.g.* root casts) on floodplains away from the river banks.

The 1: 250 000 Sutherland geological sheet 3220 (Theron 1983) shows a large area of undifferentiated Abrahamskraal Formation beds in the Sutherland area (Fig. 3). There have since been a number of attempts, only partially successful, to subdivide the very thick Abrahamskraal Formation succession in both lithostratigraphic (rock layering) and biostratigraphic (fossil) terms. Among the most recent and relevant of these was the study by Loock *et al.* (1994) in the Moordenaarskaroo area north of Laingsburg. Detailed geological mapping here led to the identification of six lithologically-defined members within the Abrahamskraal Formation (Fig. 6). Several of these members have since been mapped in the Sutherland area by Cole and Vorster (1999). Based on (1) the proximity of the Lower Beaufort Group rocks in the study area to the Ecca / Beaufort boundary as well as (2) the common occurrence of maroon mudrocks within the Karusa Wind Farm study area just to the north, and (3) the apparent scarcity or absence of vertebrate fossils here (as determined during the present and ongoing field studies), it is inferred that the bedrocks represented in the study area belong to the uppermost part of the **Combrinkskraal Member** and/or the lowermost part of the **Leeuvlei Member** (See red dotted bar in Fig. 6). They lie stratigraphically just above or below the dashed black line representing the incoming of maroon mudrocks that is shown on the 1: 250 000 geological map (Fig. 3). Very brief descriptions of these two stratigraphic members are given by Loock *et al.* (1994) but the interested reader should refer to earlier works by Le Roux (1985) and Jordaan (1990) for detailed sedimentological data that is beyond the scope of the present palaeontological heritage study. Closely-spaced, thick channel sandstone bodies appear to underlie the higher ground along the Klein-Roggeveld Escarpment to the northwest of the present study area (*e.g.* eastern margins of Appels Fontein 201). This sandstone-rich succession might constitute a separate member of the Abrahamskraal Formation, or perhaps represent the upper portion of the Leeuvlei Member.

The Abrahamskraal Formation in the study area is a succession of continental fluvial rocks characterized by numerous lenticular to sheet-like sandstones with intervening, more recessive-weathering mudrocks (Stear 1980, Le Roux 1985, Loock *et al.* 1994, Cole & Vorster 1999). The channel sandstone units are up to several (5 m) meters thick and vary in geometry from extensive, subtabular sheets to single-storey lenticles or multi-storey channel bodies with several partially superimposed, cross-cutting lenticular subunits, often demarcated at the base by thin mudrocks and / or basal breccio-conglomerates. Obliquely side-steeping, successively higher channel bodies of laterally-migrating river systems are also seen within some intervals. The prominent, laterally-persistent sandstone ledges generate a distinctive stepped or terraced topography on hill slopes in the area (Figs. 7 & 10). The sheet sandstones are generally pale-weathering (enhanced by epilithic lichens), fine- to medium-grained, well-sorted and variously massive or structured by horizontal lamination (flaggy, with primary current lineation), thin flaggy bedding, or tabular to trough cross-bedding. Greyish hues of some freshly broken sandstone surfaces suggest an "impure" clay-rich mineralogy (*i.e.* wackes). Current ripple cross-lamination is common towards the tops of the sandstone beds which may also feature undulose bars and swales. The lower contacts of the channel sandstones are erosive on a small scale, and only occasionally associated with lenticular basal breccias that may infill small-scale erosive gullies. The breccias, which may also occur within the body of the channel sandstone unit, are almost entirely composed of reworked mudflake intraclasts (Fig. 9). Reworked small calcrete nodules, as seen in basal breccias higher within the Abrahamskraal Formation (but not rolled vertebrate bones, teeth and plant debris) have been observed locally in the adjoining Karusa Wind Farm study area (Almond, in prep.). Heterolithic, thinly-interbedded sandstone and mudrock packages associated with some channel sandstone may represent delta-like levee deposits. An interesting feature of some of the finer-grained, homogeneous channel sandstones and darker grey, impure wackes is their tendency to be very well-jointed and show exfoliation weathering, leading to the formation of sphaeroidal corestones in a rather dolerite-like manner. These well-rounded sandstone corestones of cobble to boulder size form an important component of local colluvial and downwasted surface gravels.

The Abrahamskraal overbank mudrocks in the vicinity of the Komsberg Substation vary from grey-green to blue-grey in hue and are variously massive, medium- to thin-bedded or laminated and hackly-weathering (Figs. 8, 11 & 13). Occasional horizons of large (several dm diameter) ferruginous carbonate nodules and meter-scale lenticles occur within the mudrocks (Fig. 14), as do small (1-10 cm diameter) rounded, pale to dark greyish calcrete nodules, but these are generally not as abundant as they are higher up within the Abrahamskraal Formation. Pseudomorphs after gypsum roses as well as several examples of desiccation-cracked overbank mudrocks have been observed within the broader Karusa Wind Farm study area. Occasional examples of possible loading of fine-grained sandstones into the underlying mudrocks here are suggestive of local swampy conditions on the floodplain.

Satellite images of the present study area (Figure 2) show that the Karoo Supergroup bedrocks in this region have been gently folded along west-east axes, generating a marked striped appearance from above. According to the 1: 250 000 geological map, bedding dips vary from 5 to 25º in this general region. The Komsberg MTS study area appears to lie along a narrow west-east anticline within the Lower Beaufort Group. The thin, dashed black line shown on the geological map (Fig. 3) indicates the incoming of common purple-brown or maroon mudrocks within the Abrahamskraal Formation.

Extensive hillslope exposure of Lower Beaufort Group channel sandstones and overbank mudrocks can be seen on Farm Bon Esperance 73 to the west and north of the Komsberg MTS (Locs. 36, 37) (Figs. 7 & 8). At Loc. 36 a thick multi-storey channel sandstone package with sharp, erosive base is locally associated with basal channel lag breccio-conglomerates containing reworked mudflake intraclasts and small calcrete nodules. The predominantly grey-green overbank mudrocks are thin-bedded to massive with occasional pedogenic calcrete nodule horizons; the nodules are pale grey, generally pebble- to cobble-sized but occasionally larger, subrounded, sometimes rusty-brownish and secondarily ferruginised (Fig. 14). The mudrock packages also contain thin, tabular crevasse-splay sandstones as well as occasional thin, single-storey sandstone lenticles. Lenses of grey-green, thin-bedded mudrocks and lenticles of well-consolidated lag breccio-conglomerates occur interbedded with fine- to medium-grained, medium- to thick-bedded, tabular to lenticular sandstones within the channel facies (Fig. 9). Prominent-weathering tabular channel sandstone packages up to a few meters thick are also exposed on southeast-facing slopes at Loc. 37 but mudrock exposure here is rather limited due to colluvial and vegetation cover (Fig. 10). Good streambank exposures of thin-bedded, hackly-weathering overbank mudrocks as well as the top surface and vertical section through well-jointed channel sandstone bodies are seen at Loc. 39 (Fig. 13). Both the mudrock and sandstone facies are affected by a pervasive high-angle (subvertical) tectonic fracture (Fig. 13). Well-developed, regular fracture of Beaufort Group channel sandstones is also well seen at Loc. 553 (Fig. 12).

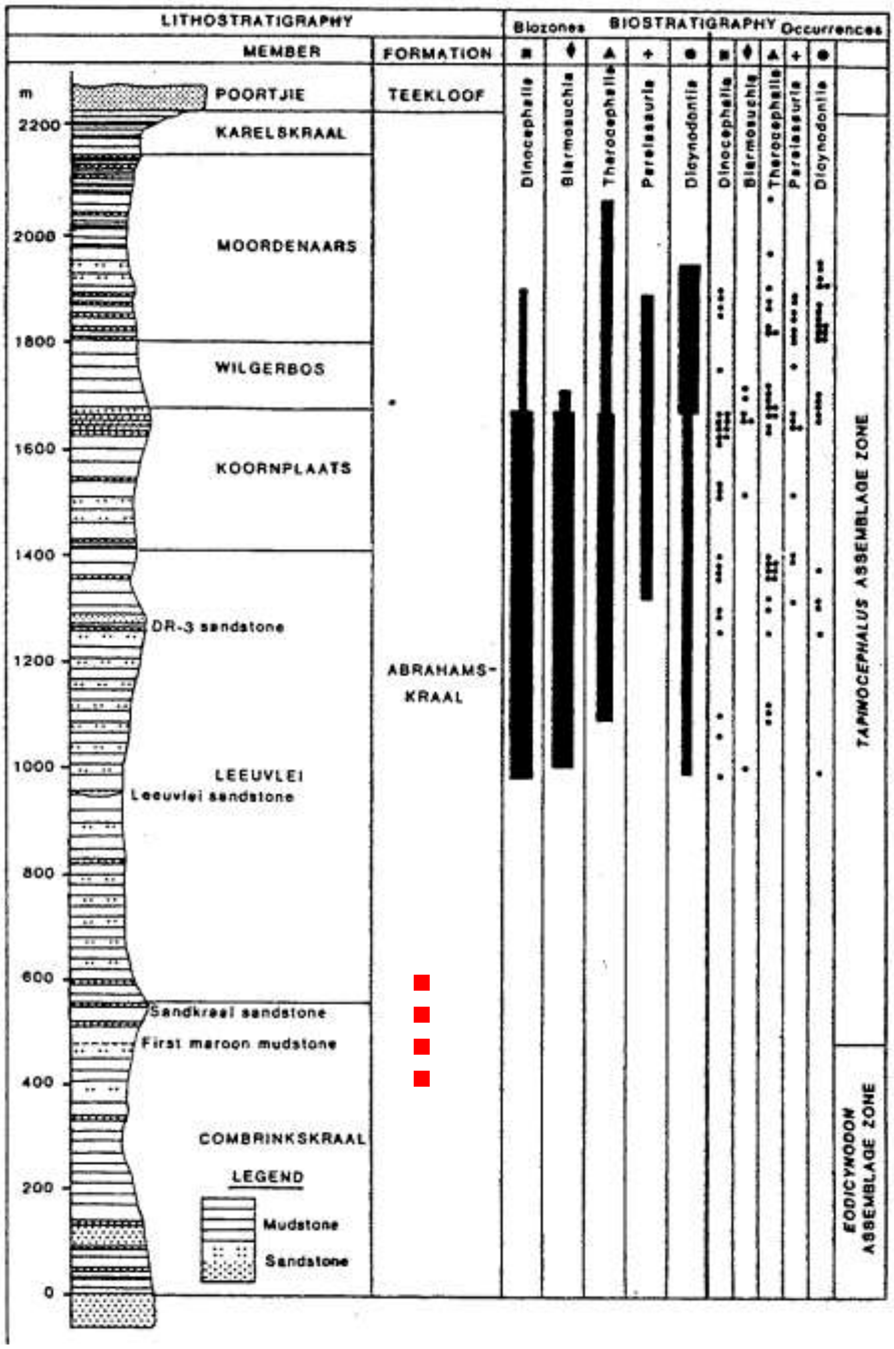

Figure 6. Chart showing the subdivision of the Abrahamskraal Formation in the western Karoo region with stratigraphic distribution of the major fossil vertebrate groups (Loock *et al*. 1994). The Komsberg Substation study area is probably underlain by sediments within the upper portion of the Combrinkskraal Member, or perhaps within the lower portion of the Leeuvlei Member (dotted red bar), around about the first appearance of maroon mudstones but below the incoming of abundant vertebrate fossils.

Figure 7. Hillslope exposures of Abrahamskraal Formation channel sandstones and overbank mudrocks on Bon Espirance 73, due west of Komsberg MTS (Loc. 36).

Figure 8. Close-up of exposures seen in the previous figure. Dark blue-grey overbank mudrocks with thin crevasse-splay sandstone interbeds are sharply overlain by a tabular, multi-storey channel sandstone package (Loc. 36).

Figure 9. Lenticle of well-consolidated intraformational lag breccia within the channel sandstone package seen above (Loc. 36). The breccia unit is *c*. 50 cm thick here.

Figure 10. Partial hillslope and gulley exposure of tabular channel sandstone and overbank mudrock facies of the Abrahamskraal Formation to the northwest of Komsberg Substation, Bon Espirance 73 (Loc. 37).

Figure 11. Roadside stream bed and bank exposures of Abrahamskraal Formation channel sandstones and blue-grey mudrocks, Standvastigheid 210 (Loc. 38).

Figure 12. Upper bedding surface of highly-jointed channel sandstones, Abrahamskraal Formation, stream banks on Standvastigheid 210 (Loc. 553).

Figure 13. Pervasive high-angle fracture (spaced cleavage) within thin-bedded Abrahamskraal Formation mudrocks and sandstones, Standvastigheid 210 (Loc. 38) (Hammer = 30 cm).

Figure 14. Palaeosol horizon marked by rusty-brown calcrete nodules within overbank mudrocks of the Abrahamskraal Formation, Standvastigheid 210 (Loc. 553) (Hammer = 30 cm).

2.1.2. Late Caenozoic Superficial Deposits

Exposure of Lower Beaufort Group sediments within the area surrounding the Komsberg MTS is generally poor and mainly confined to shallow non-perennial stream beds. Stream bank sections (Locs. 552, 554) show that the Karoo Supergroup bedrocks here are mantled with basal coarse-grained breccio-conglomerates overlain by thin to thick (0.5 – 3 m) silty to sandy alluvial deposits (Figs. 16 to 18). Older, semi-consolidated, poorly-sorted alluvial gravels up to one or two meters or so in thickness and situated up to 2 m above the present stream bed are seen at Loc. 553. These terrace "High Level Gravels" may be of Pleistocene age. The modern stream alluvium mainly comprises angular to subrounded gravels of Lower Beaufort Group sandstones, ferruginised sandstone, wackes and indurated mudrocks, with minor vein quartz and calcrete. Finer-grained alluvial sediments are incipiently calcretised locally. The less well-consolidated younger alluvium is pale brown to buff, sparsely- to highly gravelly with a sparse, well-dispersed to dense veneer of poorly-sorted, downwasted surface gravels of Beaufort Group sandstone, varying from pebbles to boulders in size (Figs. 15). The degree of rounding of the surface gravels is very variable, and many clasts are lichen-covered.

Figure 15. Surface concentration of poorly-sorted, downwasted sandstone gravels on sandy alluvial soils, Komsberg MTS study area, Standvastigheid 210 (Loc. 552) (Scale = 15 cm).

Figure 16. Coarse alluvial gravels and overlying sandy alluvium exposed in a shallow drainage line just north of the Komsberg MTS study area, Standvastigheid 210 (Loc. 551).

Figure 17. Blue-grey Abrahamskraal Formation bedrocks overlain by poorly-sorted High Level Gravels, stream banks on Standvastigheid 210 (Loc. 553) (Hammer = 30 cm).

Figure 18. Close-up of poorly- to semi-consolidated High Level Gravels seen in previous figure, with thick gravelly younger alluvial deposits on top (Hammer = 30 cm).

3. PALAEONTOLOGICAL HERITAGE

In this section of the report the fossil heritage recorded elsewhere within the main rock units that are represented within the Komsberg MTS study area, together with any fossils observed here during the present field assessment, are outlined.

3.1. Fossil biotas of the Lower Beaufort Group (Adelaide Subgroup)

The overall palaeontological sensitivity of the Beaufort Group sediments is high to very high (Almond & Pether 2008). These continental sediments have yielded one of the richest fossil records of land-dwelling plants and animals of Permo-Triassic age anywhere in the world (MacRae 1999, Rubidge 2005, McCarthy & Rubidge 2005, Smith *et al.* 2012). Bones and teeth of Late Permian tetrapods have been collected in the western Great Karoo region since at least the 1820s and this area remains a major focus of palaeontological research in the South Africa.

A chronological series of mappable fossil biozones or assemblage zones (AZ), defined mainly on their characteristic tetrapod faunas, has been established for the Main Karoo Basin of South Africa (Rubidge 1995, 2005, Van der Walt *et al.* 2010). Maps showing the distribution of the Beaufort Group assemblage zones within the Main Karoo Basin have been provided by Keyser and Smith (1979, Fig. 19 herein) and Rubidge (1995, 2005). A recently updated version is now available (Nicolas 2007, Van der Walt *et al.* 2010). The assemblage zone represented within the present study area is probably the Middle Permian ***Tapinocephalus* Assemblage Zone** (Theron 1983, Rubidge 1995), although it is also possible that the bedrocks here lie within the fossil-poor uppermost part of the *Eodicynodon* Assemblage Zone (See Fig. 6).

The main categories of fossils recorded within the *Tapinocephalus* fossil biozone (Keyser & Smith 1977-78, Anderson & Anderson 1985, Smith & Keyser 1995a, MacRae 1999, Rubidge 2005, Nicolas 2007, Almond 2010a, Smith *et al.* 2012, Day 2013a, Day 2013b, Day *et al.* 2015b) include:

- isolated petrified bones as well as rare articulated skeletons of tetrapods (*i.e.* air-breathing terrestrial vertebrates) such as true **reptiles** (notably large herbivorous pareiasaurs like *Bradysaurus* (Fig. 21), small insectivorous millerettids), rare pelycosaurs, and diverse **therapsids** or "mammal-like reptiles" (*e.g.* numerous genera of large-bodied dinocephalians (Figs. 21 & 22), herbivorous dicynodonts, flesh-eating biarmosuchians, gorgonopsians and therocephalians);

- aquatic vertebrates such as large **temnospondyl amphibians** (*Rhinesuchus*, usually disarticulated), and **palaeoniscoid bony fish** (*Atherstonia*, *Namaichthys*, often represented by scattered scales rather than intact fish);

- freshwater **bivalves** (*Palaeomutela*);

- **trace fossils** such as worm, arthropod and tetrapod burrows and trackways, coprolites (fossil droppings) and plant root casts;

- **vascular plant remains** (usually sparse and fragmentary), including leaves, twigs, roots and petrified woods ("*Dadoxylon*") of the *Glossopteris* Flora, especially glossopterid trees and arthrophytes (horsetail ferns).

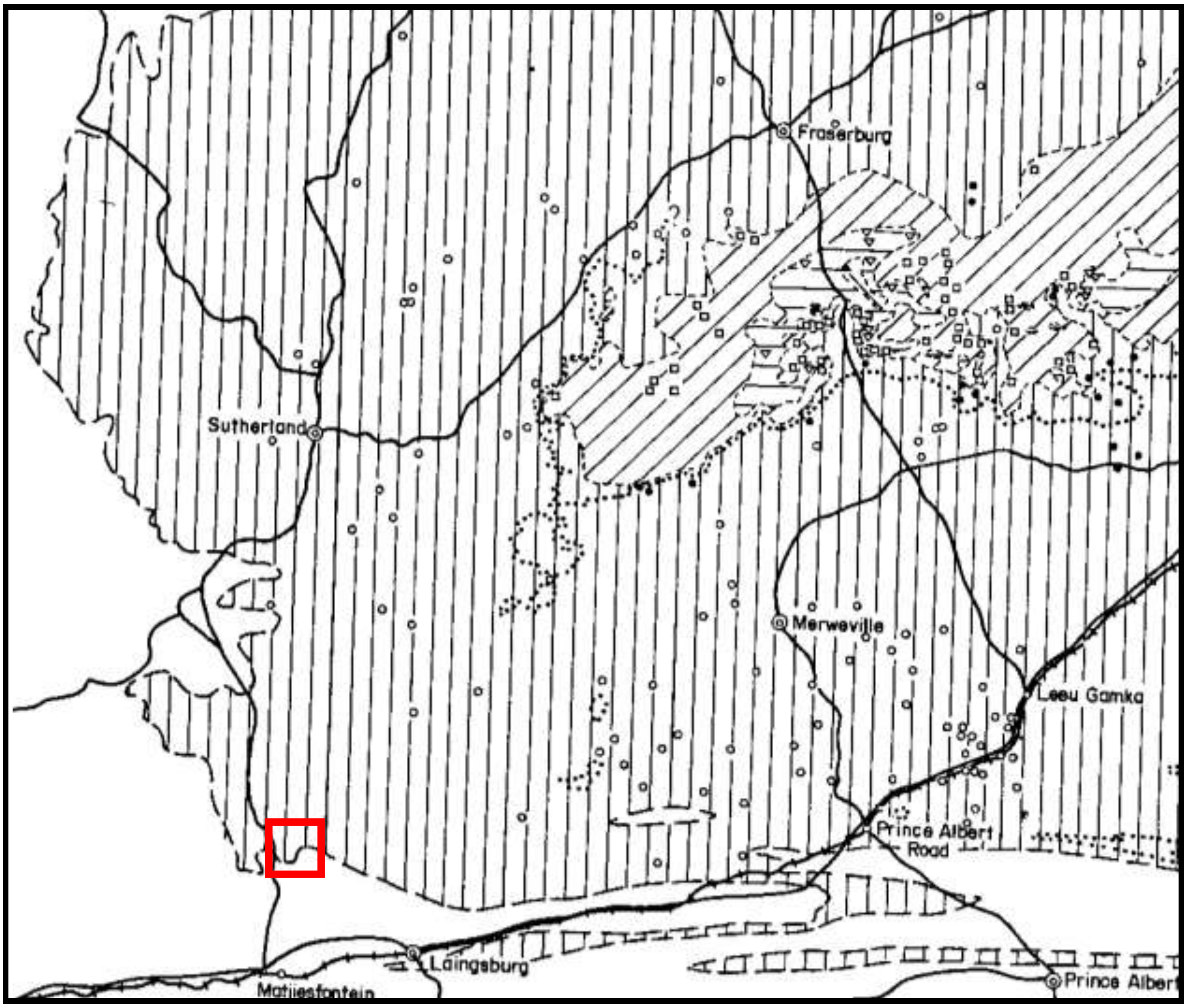

Figure 19. Vertebrate fossil localities within the Lower Beaufort Group in the southwestern Karoo region (Map abstracted from Keyser & Smith 1977-78). Outcrop areas with a vertical lined ornament are assigned to the Middle Permian *Tapinocephalus* Assemblage Zone. Note the absence of fossil records from the lowermost part of the Abrahamskraal Formation in the present Komsberg Substation study area to the south of Sutherland (red rectangle).

In general, tetrapod fossil assemblages in the *Tapinocephalus* Assemblage Zone are dominated by a wide range of dinocephalian genera and small therocephalians *plus* pareiasaurs while relatively few dicynodonts can be expected (Day & Rubidge 2010, Jirah & Rubidge 2010 and refs. therein). Vertebrate fossils in this zone are generally much rarer than seen in younger assemblage zones of the Lower Beaufort Group, with almost no fossils to be found in the lowermost beds (Loock *et al.* 1994) (Fig. 6).

Despite their comparative rarity, there has been a long history of productive fossil collection from the *Tapinocephalus* Assemblage Zone in the western and central Great Karoo area, as summarized by Rossouw and De Villiers (1952), Boonstra (1969) and Day (2013b). Numerous fossil sites recorded in the region are marked on the published 1: 250 000 Sutherland geology sheet 3220 (Fig. 3), Beaufort West sheet 3222, and on the map in Keyser and Smith (1977-78; Fig. 19). Vertebrate fossils found in the Sutherland sheet area are also listed by Kitching (1977) as well as Theron (1983). They include forms such as the pareiasaur *Bradysaurus*, tapinocephalid and titanosuchid dinocephalians *plus* rarer dicynodonts, gorgonopsians and therocephalians (*e.g.* pristerognathids, *Lycosuchus*) as well as land plant remains (*e.g.* arthrophyte stems and leaves). Numerous fossil sites were recorded along the eastern edge of the Moordenaarskaroo in the key biostratigraphic study of the Abrahamskraal Formation by Loock *et al.* (1994). A recent palaeontological heritage study was carried out by the author within the Abrahamskraal Formation of the Moordenaarskaroo to the east of the present study area (Almond 2010a). This fieldwork yielded locally abundant dinocephalian and other therapsid skeletal remains, large, cylindrical vertical burrows or plant stem casts, *Scoyenia* ichnofacies trace fossil assemblages and sphenophytes (horsetail ferns) associated with probable playa lake deposits, as well as locally abundant petrified wood.

Fossils in the *Tapinocephalus* Assemblage Zone occur in association with both mudrocks and sandstones, most notably in thin intraformational conglomerates (*beenbreksie*) at the base of channel sandstones (Rossouw & De Villiers 1952, Turner 1981, Smith & Keyser 1995a). Tetrapod bones actually occur in a wide range of taphonomic settings in the *Tapinocephalus* Assemblage Zone (2010a). For example they are recorded as:

1. Disarticulated bones within thin intraformational conglomerates at the base of shallow (unistorey) channel sandstones. The bones are often impregnated with secondary iron and manganese minerals (coffee brown and black respectively). They vary from highly-weathered and rounded fragments to intact and well-preserved specimens. Bones occur at the base of, within, or floating at the top of the conglomerates in association with calcrete nodules, mudflakes, petrified wood and gypsum pseudomorphs. Bones in these channel lags were variously eroded out of riverbanks or washed into drainage channels from upland areas, riverine areas and floodplains during floods or episodes of landscape denudation.

2. Disarticulated bones within or at the top of channel sandstones.

3. Bones coated with calcrete or embedded within calcrete nodules associated with arid climate palaeosols (ancient soils). These bones are often suncracked, showing that lay exposed on the land surface for a long time before burial.

4. Isolated bones or articulated skeletons (possible mummies) embedded within levee or floodplain mudrocks.

5. Well-articulated skeletons preserved within fossil burrows (Botha-Brink & Modesto, 2007).

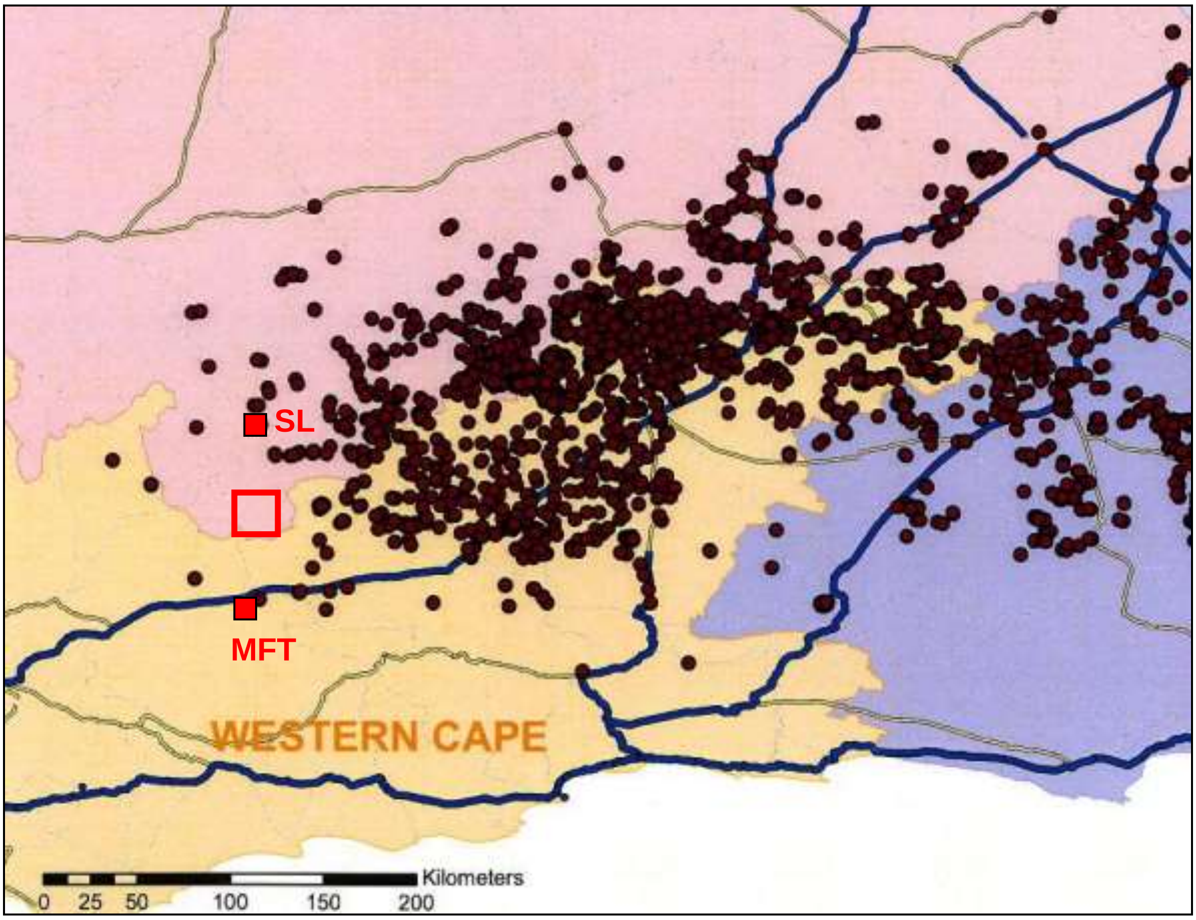

Figure 20. Distribution of recorded vertebrate fossil sites within the south-western portion of the Main Karoo Basin (modified from Nicolas 2007). The approximate location of the Komsberg Substation study area is indicated by the red square. Note the lack of known fossil sites here. SL = Sutherland. MFT = Matjiesfontein.

Intensive fossil collection within the middle part of the Abrahamskraal Formation succession has suggested that a significant faunal turnover event may have occurred at or towards the top of the sandstone-rich Koornplaats Member, with the replacement of a more archaic, dinocephalian-dominated fauna (with primitive therapsids like the biarmosuchians) by a more advanced, dicynodont-dominated one at this level (Loock *et al.* 1994; Fig. 6 herein). This is the "faunal reversal" previously noted by Boonstra (1969) as well as Rossouw and De Villiers (1953). Other fossil groups such as therocephalians and pareiasaurs do not seem to have been equally affected. Problems have arisen in trying to correlate the lithologically-defined members recognized within the Abrahamskraal Formation by different authors across the whole outcrop area, with evidence for complex lateral interdigitation of the sandstone-dominated packages (D. Cole, pers. com., 2009). A research project is currently underway to subdivide the Abrahamskraal Formation on a biostratigraphic basis, emphasizing the range zones of various genera of small dicynodonts such as *Eodicynodon, Robertia* and *Diictodon* (Day & Rubidge 2010, Jirah & Rubidge 2010, 2014, Day 2013a, 2013b, Day *et al.* 2015a, 2015b).

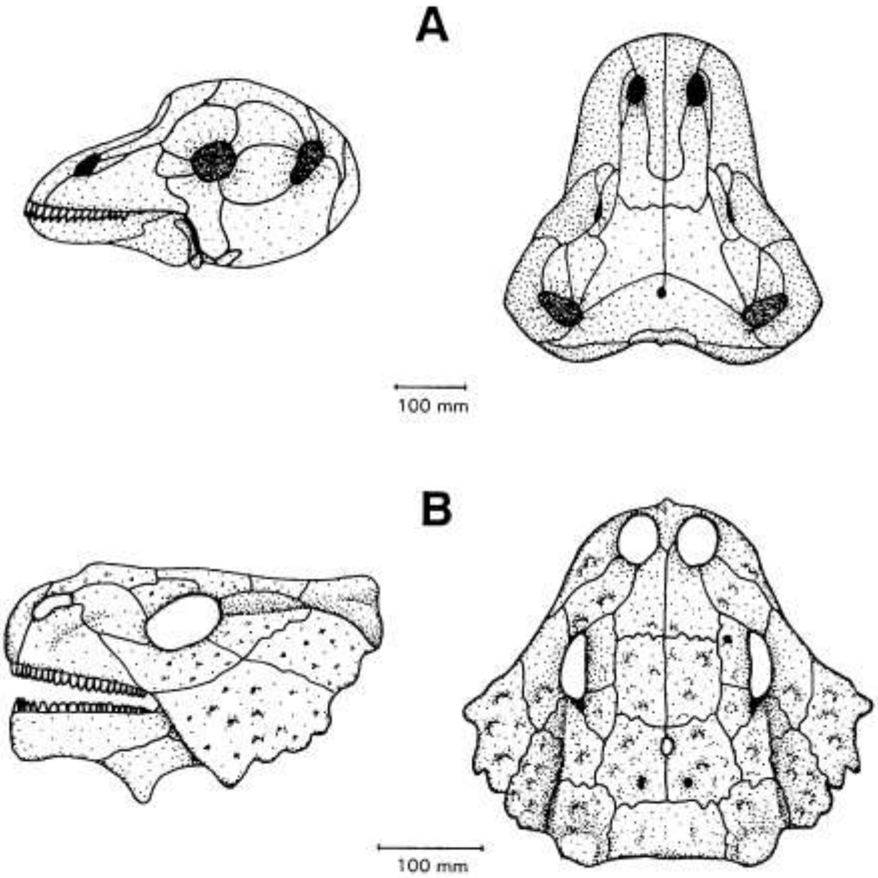

Figure 21. Skulls of two key large-bodied tetrapods of the *Tapinocephalus* Assemblage Zone: A – the dinocephalian therapsid *Tapinocephalus*; B – the pareiasaur *Bradysaurus* (From Smith & Keyser 1995b).

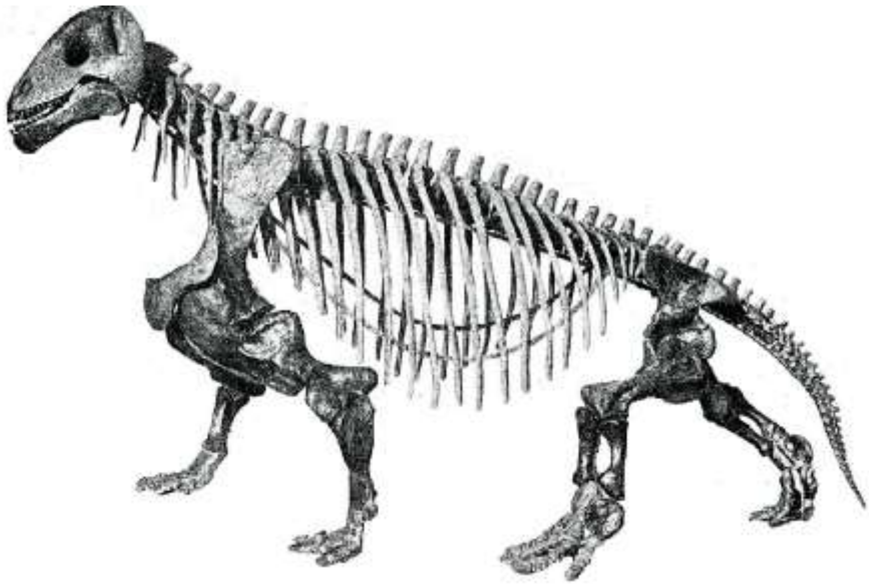

Figure 22. Skeleton of the tapinocephalid (thick-skulled) dinocephalian *Moschops*, a rhino-sized herbivorous therapsid that reached lengths of 2.5 to 3 m and may have lived in small herds.

Selected fossil sites recorded within the *Tapinocephalus* Assemblage Zones in the Sutherland region are indicated on outline maps by Kitching (1977), Keyser and Smith (1977-78) (Fig. 19) and Nicolas (2007) (Fig. 20). Several fossil sites near Sutherland are also shown on the 1: 250 000 geological sheet 3220 Sutherland published by the Council for Geoscience, Pretoria (Fig. 3). In addition Kitching (1977) provides palaeofaunal lists for specific localities within the Great Karoo region. It is notable that these works suggest a profound paucity of vertebrate fossil finds in the present study area to the south of Sutherland, although a few localities are indicated in stratigraphically lower-lying beds of the Lower Beaufort Group to the west and south of the study area. This palaeontological impoverishment seems to apply even to the excellent exposures of Abrahamskraal Formation sediments within the Verlatekloof Pass near Sutherland. The reasons for the lack of fossils even here - despite appropriate facies and good bedrock exposure - is currently unresolved and may have a palaeoenvironmental component. A previous palaeontological field assessment of Mordenaars Member rocks on the outskirts of Sutherland by Almond (2005) yielded only transported plant remains (arthrophytes including *Phyllotheca*, glossopterid and other, more strap-shaped leaves, possible wood tool marks), sparse trace fossil assemblages of the damp-ground *Scoyenia* ichnofacies, and rare fragments of rolled bone. Reworked silicified wood from surface gravels, scattered, fragmentary plant remains associated with channel sandstones and rare disarticulated bones were reported from a Moordenaars Member study site *c*. 1 km south of Sutherland by Almond (2011). A traverse through the Combrinkskraal and Leeuvlei Members along the Gamma – Omega 765 kV transmission line corridor through the present study area did not yield fossil vertebrate remains in this area, although locally abundant plant material (*e.g.* sphenophytes, possible floating log tool marks) and sizeable vertical burrows (possibly casts of plant stems / roots) were seen, mainly further to the east in the Moordenaarskaroo region (Almond 2010a).

The only fossil remains recorded from the Abrahamskraal Formation within the Karreebosch Wind Farm study area just to the west of the present study area (Almond 2014) include rare, fragmentary remains of vascular plants - notably disarticulated sphenophyte (horsetail fern) stems embedded within massive siltstones – as well as widely occurring, low-diversity trace fossil assemblages of the *Scoyenia* ichnofacies that have been attributed to earthworms and / or insect larvae (*cf* Seilacher 2007). Current fieldwork within the Karusa Wind Farm study area to the north of Komsberg Substation has only yielded sparse sphenophyte plant stems, *Scoyenia* ichnofacies burrows and unidentified large cylindrical vertical burrows, but no vertebrate remains (Almond, in prep.). No fossil material was recorded within any of the Lower Beaufort Group facies reported within the vicinity of Komsberg Substation during the present field study, including the channel lag deposits, apart from ill-defined low-diversity trace fossil assemblages on limited exposed siltstone palaeosurfaces at Loc. 553 (Fig. 23).

Figure 23. Limited bedding plane exposure of palaeosurface with vague fossil burrows, probably of the *Scoyenia* ichnofacies, Standvastigheid 210 (Loc. 553) (Hammer = 30 cm).

3.2. Fossils within the superficial deposits

The diverse superficial deposits within the South African interior have been comparatively neglected in palaeontological terms. However, sediments associated with ancient drainage systems, springs and pans in particular may occasionally contain important fossil biotas, notably the bones, teeth and horn cores of mammals as well as remains of reptiles like tortoises (*e.g.* Skead 1980, Klein 1984b, Brink, J.S. 1987, Bousman *et al.* 1988, Bender & Brink 1992, Brink *et al*. 1995, MacRae 1999, Meadows & Watkeys 1999, Churchill *et al*. 2000, Partridge & Scott 2000, Brink & Rossouw 2000, Rossouw 2006). Other late Caenozoic fossil biotas that may occur within these superficial deposits include non-marine molluscs (bivalves, gastropods), ostrich egg shells, trace fossils (*e.g.* calcretised termitaria, coprolites, invertebrate burrows, rhizocretions), and plant material such as peats or palynomorphs (pollens) in organic-rich alluvial horizons (Scott 2000) and diatoms in pan sediments. In Quaternary deposits, fossil remains may be associated with human artefacts such as stone tools and are also of archaeological interest (*e.g.* Smith 1999 and refs. therein). Ancient solution hollows within extensive calcrete hardpans may have acted as animal traps in the past. As with coastal and interior limestones, they might occasionally contain mammalian bones and teeth (perhaps associated with hyaena dens) or invertebrate remains such as snail shells.

No fossils were observed within the various superficial deposits represented within the Komsberg Substation study area during the present field study.

4. CONCLUSIONS & RECOMMENDATIONS

The fluvial Abrahamskraal Formation (Lower Beaufort Group, Karoo Supergroup) that underlies the Komsberg MTS study area is known for its diverse fauna of Permian fossil vertebrates - notably various small- to large-bodied therapsids and reptiles - as well as fossil plants of the *Glossopteris* Flora and low diversity trace fossil assemblages. However, desktop analysis of known fossil distribution within the Main Karoo Basin shows a marked paucity of fossil localities in the study region between Matjiesfontein and Sutherland where sediments belonging only to the lower part of the thick Abrahamskraal Formation succession are represented. Bedrock exposure levels in the broader study region are generally very poor due to the pervasive cover by superficial sediments (colluvium, alluvium, soils, calcrete) and vegetation. Nevertheless, a sufficiently large outcrop area of Abrahamskraal Formation sediments, exposed in stream and riverbanks, borrow pits, erosion gullies as well as road cuttings along the R354, has been examined during the present field study (as well as recent fieldwork for the adjacent Kareebosch and Karusa Wind Farms) to infer that macroscopic fossil remains of any sort are very rare indeed here. Exceptions include common trace fossil assemblages (invertebrate burrows) and occasional fragmentary plant remains (horsetail ferns). Levels of bedrock tectonic deformation are generally low, although folding, faulting and cleavage development associated within the Cape Fold Belt are locally apparent, and baking by Early Jurassic dolerite intrusions is very minor. It is concluded that the Lower Beaufort Group bedrocks in the study area are generally of low palaeontological sensitivity and this also applies to the overlying Late Caenozoic superficial sediments (colluvium, alluvium, calcrete, surface gravels, soils *etc*).

Construction of the proposed expanded Komsberg MTS is unlikely to entail significant impacts on local fossil heritage resources. Due to the general great scarcity of fossil remains as well as the extensive superficial sediment cover observed within the study area, the overall impact significance of the construction phase of the proposed expanded substation is assessed as LOW. This assessment applies equally to (a) the two alternative locations for the substation expansion area, neither of which is preferred on palaeontological heritage grounds, and (b) proposed widening of a short section of access road. The operational and decommissioning phases of the substation are very unlikely to involve further adverse impacts on local palaeontological heritage.

Given the low impact significance of the proposed Karusa Facility Substation near Sutherland as far as palaeontological heritage is concerned, no further specialist palaeontological heritage studies or mitigation are considered necessary for this project, pending the discovery or exposure of substantial new fossil remains during development. During the construction phase all deeper (> 1 m) bedrock excavations should be monitored for fossil remains by the responsible ECO. Should substantial fossil remains such as vertebrate bones and teeth, plant-rich fossil lenses, fossil wood or dense fossil burrow assemblages be exposed during construction, the responsible Environmental Control Officer should safeguard these, preferably *in situ*, and alert SAHRA, *i.e.* The South African Heritage Resources Authority, as soon as possible (Contact details: Mrs Colette Scheermeyer, P.O. Box 4637, Cape Town 8000. Tel: 021 462 4502. Email: cscheermeyer@sahra.org.za) so that appropriate action can be taken by a professional palaeontologist, at the developer's expense. Mitigation would normally involve the scientific recording and judicious sampling or collection of fossil material as well as associated geological data (*e.g.* stratigraphy, sedimentology, taphonomy) by a professional palaeontologist.

These mitigation recommendations should be incorporated into the Environmental Management Plan (EMP) for the Komsberg MTS expansion project.

Please note that:

- All South African fossil heritage is protected by law (South African Heritage Resources Act, 1999) and fossils cannot be collected, damaged or disturbed without a permit from SAHRA or the relevant Provincial Heritage Resources Agency;
- The palaeontologist concerned with mitigation work will need a valid fossil collection permit from SAHRA and any material collected would have to be curated in an approved depository (*e.g.* museum or university collection);
- All palaeontological specialist work would have to conform to international best practice for palaeontological fieldwork and the study (*e.g.* data recording fossil collection and curation, final report) should adhere as far as possible to the minimum standards for Phase 2 palaeontological studies recently developed by SAHRA (2013).

5. ACKNOWLEDGEMENTS

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6. REFERENCES

ALMOND, J.E. 2005. Palaeontological scoping report: Proposed golf estate, Sutherland, Northern Cape, 10 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2010a. Eskom Gamma-Omega 765kV transmission line: Phase 2 palaeontological impact assessment. Sector 1, Tanqua Karoo to Omega Substation (Western and Northern Cape Provinces), 95 pp + Appendix. Natura Viva cc, Cape Town.

ALMOND, J.E. 2010b. Palaeontological impact assessment: desktop study – Proposed Suurplaat wind energy facility near Sutherland, Western Cape, 33 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2010c. Proposed Mainstream wind farm to the southeast of Sutherland, Northern Cape and Western Cape Provinces. Palaeontological impact assessment: pre-scoping desktop study, 19 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2011. Proposed photovoltaic solar energy facility on the farm Jakhals Valley (RE/99) near Sutherland, Karoo Hoogland Municipality, Northern Cape Province. Palaeontological specialist study: combined desktop and field assessment, 34 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2014. Proposed Karreebosch Wind Farm (Roggeveld Phase 2) near Sutherland, Northern Cape Province. Palaeontological heritage assessment: combined desktop & field-based study, 63 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. & PETHER, J. 2008. Palaeontological heritage of the Western Cape. Interim SAHRA technical report, 20 pp. Natura Viva cc., Cape Town.

ANDERSON, J.M. & ANDERSON, H.M. 1985. Palaeoflora of southern Africa. Prodromus of South African megafloras, Devonian to Lower Cretaceous, 423 pp. Botanical Research Institute, Pretoria & Balkema, Rotterdam.

ATAYMAN, S., RUBIDGE, B.S. & ABDALA, F. 2009. Taxonomic re-evaluation of tapinocephalid dinocephalians. Palaeontologia africana 44, 87-90.

BAMFORD, M. 1999. Permo-Triassic fossil woods from the South African Karoo Basin. Palaeontologia africana 35, 25-40.

BENDER, P.A. 2004. Late Permian actinopterygian (palaeoniscid) fishes from the Beaufort Group, South Africa: biostratigraphic and biogeographic implications. Council for Geoscience Bulletin 135, 84 pp.

BENDER, P.A. & BRINK, J.S. 1992. A preliminary report on new large mammal fossil finds from the Cornelia-Uitzoek site. South African Journal of Science 88: 512-515.

BOONSTRA, L.D. 1969. The fauna of the Tapinocephalus Zone (Beaufort Beds of the Karoo). Annals of the South African Museum 56: 1-73.

BOTHA-BRINK, J. & MODESTO, S.P. 2007. A mixed-age classed "pelycosaur" aggregation from South Africa: earliest evidence of parental care in amniotes? Proceedings of the Royal Society of London (B) 274, 2829-2834.

BOUSMAN, C.B. *et al.* 1988. Palaeoenvironmental implications of Late Pleistocene and Holocene valley fills in Blydefontein Basin, Noupoort, C.P., South Africa. Palaeoecology of Africa 19: 43-67.

BRINK, J.S. 1987. The archaeozoology of Florisbad, Orange Free State. Memoirs van die Nasionale Museum 24, 151 pp.

BRINK, J.S. et al. 1995. A new find of *Megalotragus priscus* (Alcephalini, Bovidae) from the Central Karoo, South Africa. Palaeontologia africana 32: 17-22.

BRINK, J.S. & ROSSOUW, L. 2000. New trial excavations at the Cornelia-Uitzoek type locality. Navorsinge van die Nasionale Museum Bloemfontein 16, 141-156.

CHURCHILL, S.E. et al. 2000. Erfkroon: a new Florisian fossil locality from fluvial contexts in the western Free State, South Africa. South African Journal of Science 96: 161-163.

COLE, D.I., SMITH, R.M.H. & WICKENS, H. DE V. 1990. Basin-plain to fluvio-lacustrine deposits in the Permian Ecca and Lower Beaufort Groups of the Karoo Sequence. Guidebook Geocongress '90, Geological Society of South Africa, PO2, 1-83.

COLE, D.I., NEVELING, J., HATTINGH, J., CHEVALLIER, L.P., REDDERING, J.S.V. & BENDER, P.A. 2004. The geology of the Middelburg area. Explanation to 1: 250 000 geology Sheet 3124 Middelburg, 44 pp. Council for Geoscience, Pretoria.

COLE, D. & SMITH, R. 2008. Fluvial architecture of the Late Permian Beaufort Group deposits, S.W. Karoo Basin: point bars, crevasse splays, palaeosols, vertebrate fossils and uranium. Field Excursion FT02 guidebook, AAPG International Conference, Cape Town October 2008, 110 pp.

COLE, D.I. & VORSTER, C.J. 1999. The metallogeny of the Sutherland area, 41 pp. Council for Geoscience, Pretoria.

DAY 2013a. Middle Permian continental biodiversity changes as reflected in the Beaufort Group of South Africa: a bio- and lithostratigraphic review of the *Eodicynodon*, *Tapinocephalus* and *Pristerognathus* assemblage zones. Unpublished PhD thesis, University of the Watwatersrand, Johannesburg, 387 pp plus appendices.

DAY, M. 2013b. Charting the fossils of the Great Karoo: a history of tetrapod biostratigraphy in the Lower Beaufort Group, South Africa. Palaeontologia Africana 48, 41-47.

DAY, M. & RUBIDGE, B. 2010. Middle Permian continental biodiversity changes as reflected in the Beaufort group of South Africa: An initial review of the *Tapinocephalus* and *Pristerognathus* assemblage zones. Proceedings of the 16th conference of the Palaeontological Society of Southern Africa, Howick, August 5-8, 2010, pp. 22-23.

DAY, M., RUBIDGE, B., ALMOND, J. & JIRAH, S. 2013. Biostratigraphic correlation in the Karoo: the case of the Middle Permian parareptile *Eunotosaurus*. South African Journal of Science 109, 1-4.

DAY, M.O., GÜVEN, S., ABDALA, F., JIRAH, S., RUBIDGE, B. & ALMOND, J. 2015b. Youngest dinocephalian fossils extend the *Tapinocephalus* Zone, Karoo Basin, South Africa Research Letter, South African Journal of Science 111, 5 pp.

DAY M.O., RAMEZANI J, BOWRING S.A., SADLER P.M., ERWIN D.H., ABDALA F. & RUBIDGE B.S. 2015a. When and how did the terrestrial mid-Permian mass extinction occur? Evidence from the tetrapod record of the Karoo Basin, South Africa. Proceedings of the Royal Society B282: 20150834. http://dx.doi.org/10.1098/rspb.2015.0834.

DE WET, J.J. 1975. Carbonatites and related rocks at Salpetre Kop, Sutherland, Cape Province. Annals of the University of Stellenbosch Series A1 (Geology) 1, 193-232.

DUNCAN, A.R. & MARSH, J.S. 2006. The Karoo Igneous Province. Pp. 501-520 in Johnson. M.R., Anhaeusser, C.R. & Thomas, R.J. (eds.) The geology of South Africa. Geological Society of South Africa, Johannesburg & the Council for Geoscience, Pretoria.

ERWIN, D.H. 2006. Extinction. How life on Earth nearly ended 250 million years ago, 296 pp. Princeton University Press, Princeton.

JIRAH, S. & RUBIDGE, B.S. 2010. Sedimentological, palaeontological and stratigraphic analysis of the Abrahamskraal Formation (Beaufort Group) in an area south of Merweville, South Africa. Proceedings of the 16th conference of the Palaeontological Society of Southern Africa, Howick, August 5-8, 2010, pp. 46-47.

JIRAH, S. & RUBIDGE, B.S. 2014. Refined stratigraphy of the Middle Permian Abrahamskraal Formation (Beaufort Group) in the southern Karoo Basin. Journal of African Earth Sciences 100, 121–135.

JOHNSON, M.R. & KEYSER, A.W. 1979. The geology of the Beaufort West area. Explanation of geological Sheet 3222, 14 pp. Council for Geoscience, Pretoria.

JOHNSON, M.R., VAN VUUREN, C.J., VISSER, J.N.J., COLE, D.I., WICKENS, H. DE V., CHRISTIE, A.D.M., ROBERTS, D.L. & BRANDL, G. 2006. Sedimentary rocks of the Karoo Supergroup. In: Johnson. M.R., Anhaeusser, C.R. & Thomas, R.J. (eds.) The geology of South Africa, pp. 461-499. Geological Society of South Africa, Johannesburg & the Council for Geoscience, Pretoria.

JORDAAN, M.J. 1990. Basin analysis of the Beaufort Group in the western part of the Karoo Basin. Unpublished PhD thesis, University of the Orange Free State, Bloemfontein, 271 pp.

KEYSER, A.W. & SMITH, R.M.H. 1977-78. Vertebrate biozonation of the Beaufort Group with special reference to the Western Karoo Basin. Annals of the Geological Survey of South Africa 12: 1-36.

KITCHING, J.W. 1977. The distribution of the Karroo vertebrate fauna, with special reference to certain genera and the bearing of this distribution on the zoning of the Beaufort beds. Memoirs of the Bernard Price Institute for Palaeontological Research, University of the Witwatersrand, No. 1, 133 pp (incl. 15 pls).

KLEIN, R. 1980. Environmental and ecological implications of large mammals from Upper Pleistocene and Holocene sites in southern Africa. Annals of the South African Museum 81, 223-283.

KLEIN, R.G. 1984. The large mammals of southern Africa: Late Pliocene to Recent. In: Klein, R.G. (Ed.) Southern African prehistory and paleoenvironments, pp 107-146. Balkema, Rotterdam.

LE ROUX, J.P. 1985. Palaeochannels and uranium mineralization in the main Karoo Basin of South Africa. Unpublished PhD thesis, University of Port Elizabeth, 250 pp.

LOOCK, J.C., BRYNARD, H.J., HEARD, R.G., KITCHING, J.W. & RUBIDGE, B.S. 1994. The stratigraphy of the Lower Beaufort Group in an area north of Laingsburg, South Africa. Journal of African Earth Sciences 18: 185-195.

LUCAS, D.G. 2009. Global Middle Permian reptile mass extinction: the dinocephalian extinction event. Geological Society of America Abstracts with Programs 41, No. 7, p. 360.

MACRAE, C. 1999. Life etched in stone. Fossils of South Africa, 305 pp. The Geological Society of South Africa, Johannesburg.

McCARTHY, T. & RUBIDGE, B. 2005. The story of Earth and life: a southern African perspective on a 4.6-billion-year journey. 334pp. Struik, Cape Town.

MEADOWS, M.E. & WATKEYS, M.K. 1999. Palaeoenvironments. In: Dean, W.R.J. & Milton, S.J. (Eds.) The karoo. Ecological patterns and processes, pp. 27-41. Cambridge University Press, Cambridge.

MILLER, D. 2011. Roggeveld Wind Farm: palaeontology study, 7 pp. Appendix to Archaeological, Heritage and Paleontological Specialist Report prepared by ACO Associates, St James.

NICOLAS, M.V. 2007. Tetrapod diversity through the Permo-Triassic Beaufort Group (Karoo Supergroup) of South Africa. Unpublished PhD thesis, University of Witwatersrand, Johannesburg.

PARTRIDGE, T.C. & MAUD, R.R. 1987. Geomorphic evolution of southern Africa since the Mesozoic. South African Journal of Geology 90: 179-208.

PARTRIDGE, T.C. & SCOTT, L. 2000. Lakes and Pans. In: Partridge, T.C. & Maud, R.R. (Eds.) The Cenozoic of southern Africa, pp.145-161. Oxford University Press, Oxford.

PARTRIDGE, T.C., BOTHA, G.A. & HADDON, I.G. 2006. Cenozoic deposits of the interior. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa, pp. 585-604. Geological Society of South Africa, Marshalltown.

PARTRIDGE, T.C. & SCOTT, L. 2000. Lakes and pans. In: Partridge, T.C. & Maud, R.R. (Eds.) The Cenozoic of southern Africa, pp.145-161. Oxford University Press, Oxford.

RETALLACK, G.J., METZGER, C.A., GREAVER, T., HOPE JAHREN, A., SMITH, R.M.H. & SHELDON, N.D. 2006. Middle – Late Permian mass extinction on land. GSA Bulletin 118, 1398-1411.

ROSSOUW, L. 2006. Florisian mammal fossils from erosional gullies along the Modder River at Mitasrust Farm, Central Free State, South Africa. Navorsinge van die Nasionale Museum Bloemfontein 22, 145-162.

ROSSOUW, P.J. & DE VILLIERS, J. 1952. Die geologie van die gebied Merweville, Kaapprovinsie. Explanation to 1: 125 000 geology sheet 198 Merweville, 63 pp. Council for Geoscience, Pretoria.

RUBIDGE, B.S. (Ed.) 1995. Biostratigraphy of the Beaufort Group (Karoo Supergroup). South African Committee for Biostratigraphy, Biostratigraphic Series No. 1., 46 pp. Council for Geoscience, Pretoria.

RUBIDGE, B.S. 2005. Re-uniting lost continents – fossil reptiles from the ancient Karoo and their wanderlust. 27th Du Toit Memorial Lecture. South African Journal of Geology 108, 135-172.

RUBIDGE, B.S., ERWIN, D.H., RAMEZANI, J., BOWRING, S.A. & DE KLERK, W.J. 2010. The first radiometric dates for the Beaufort Group, Karoo Supergroup of South Africa. Proceedings of the 16th conference of the Palaeontological Society of Southern Africa, Howick, August 5-8, 2010, pp. 82-83.

RUBIDGE, B.S., ERWIN, D.H., RAMEZANI, J., BOWRING, S.A. & DE KLERK, W.J. 2013. High-precision temporal calibration of Late Permian vertebrate biostratigraphy: U-Pb zircon constraints from the Karoo Supergroup, South Africa. Geology published online 4 January 2013. doi: 10.1130/G33622.1.

SAHRA 2013. Minimum standards: palaeontological component of heritage impact assessment reports, 15 pp. South African Heritage Resources Agency, Cape Town.

SCOTT, L. 2000. Pollen. In: Partridge, T.C. & Maud, R.R. (Eds.) The Cenozoic of southern Africa, pp.339-35. Oxford University Press, Oxford.

SEILACHER, A. 2007. Trace fossil analysis, xiii + 226pp. Springer Verlag, Berlin.

SKEAD, C.J. 1980. Historical mammal incidence in the Cape Province. Volume 1: The Western and Northern Cape, 903pp. Department of Nature and Environmental Conservation, Cape Town.

SKEAD, C.J. 1980. Historical mammal incidence in the Cape Province. Volume 1: The Western and Northern Cape, 903pp. Department of Nature and Environmental Conservation, Cape Town.

SMITH, R.M.H. 1979. The sedimentology and taphonomy of flood-plain deposits of the Lower Beaufort (Adelaide Subgroup) strata near Beaufort West, Cape Province. Annals of the Geological Survey of South Africa 12, 37-68.

SMITH, R.M.H. 1980. The lithology, sedimentology and taphonomy of flood-plain deposits of the Lower Beaufort (Adelaide Subgroup) strata near Beaufort West. Transactions of the Geological Society of South Africa 83, 399-413.

SMITH, R.M.H. 1986. Trace fossils of the ancient Karoo. Sagittarius 1 (3), 4-9.

SMITH, R.M.H. 1987a. Morphological and depositional history of exhumed Permian point bars in the southwestern Karoo, South Africa. Journal of Sedimentary Petrology 57, 19-29.

SMITH, R.M.H. 1987b. Helical burrow casts of therapsid origin from the Beaufort Group (Permian) of South Africa. Palaeogeography, Palaeoclimatology, Palaeoecology 60, 155-170.

SMITH, R.M.H. 1988. Fossils for Africa. An introduction to the fossil wealth of the Nuweveld mountains near Beaufort West. Sagittarius 3, 4-9. SA Museum, Cape Town.

SMITH, R.M.H. 1989. Fossils in the Karoo – some important questions answered. Custos 17, 48-51.

SMITH, R.M.H. 1990. Alluvial paleosols and pedofacies sequences in the Permian Lower Beaufort of the southwestern Karoo Basin, South Africa. Journal of Sedimentary Petrology 60, 258-276.

SMITH, R.M.H. 1993a. Sedimentology and ichnology of floodplain paleosurfaces in the Beaufort Group (Late Permian), Karoo Sequence, South Africa. Palaios 8, 339-357.

SMITH, R.M.H. 1993b. Vertebrate taphonomy of Late Permian floodplain deposits in the southwestern Karoo Basin of South Africa. Palaios 8, 45-67.

SMITH, R.M.H. & KEYSER, A.W. 1995a. Biostratigraphy of the *Tapinocephalus* Assemblage Zone. Pp. 8-12 in Rubidge, B.S. (ed.) Biostratigraphy of the Beaufort Group (Karoo Supergroup). South African Committee for Stratigraphy, Biostratigraphic Series No. 1. Council for Geoscience, Pretoria.

SMITH, R.M.H. & KEYSER, A.W. 1995b. Biostratigraphy of the *Pristerognathus* Assemblage Zone. Pp. 13-17 in Rubidge, B.S. (ed.) Biostratigraphy of the Beaufort Group (Karoo Supergroup). South African Committee for Stratigraphy, Biostratigraphic Series No. 1. Council for Geoscience, Pretoria.

SMITH, R.M.H. & ALMOND, J.E. 1998. Late Permian continental trace assemblages from the Lower Beaufort Group (Karoo Supergroup), South Africa. Abstracts, Tercera Reunión Argentina de Icnologia, Mar del Plata, 1998, p. 29.

SMITH, R., RUBIDGE, B. & VAN DER WALT, M. 2012. Therapsid biodiversity patterns and paleoenvironments of the Karoo Basin, South Africa. Chapter 2 pp. 30-62 in Chinsamy-Turan, A. (Ed.) Forerunners of mammals. Radiation, histology, biology. xv + 330 pp. Indiana University Press, Bloomington & Indianapolis.

STEAR, W.M. 1978. Sedimentary structures related to fluctuating hydrodynamic conditions in flood plain deposits of the Beaufort Group near Beaufort West, Cape. Transactions of the Geological Society of South Africa 81, 393-399.

STEAR, W.M. 1980a. The sedimentary environment of the Beaufort Group uranium province in the vicinity of Beaufort West, South Africa. Unpublished PhD thesis, University of Port Elizabeth, 188 pp.

STEAR, W.M. 1980b. Channel sandstone and bar morphology of the Beaufort Group uranium district near Beaufort West. Transactions of the Geological Society of South Africa 83: 391-398.

THERON, J.N. 1983. Die geologie van die gebied Sutherland. Explanation of 1: 250 000 geological Sheet 3220, 29 pp. Council for Geoscience, Pretoria.

TURNER, B.R. 1981. The occurrence, origin and stratigraphic significance of bone-bearing mudstone pellet conglomerates from the Beaufort Group in the Jansenville District, Cape Province, South Africa. Palaeontologia africana 24, 63-73.

VAN DER WALT, M., DAY, M., RUBIDGE, B., COOPER, A.K. & NETTERBERG, I. 2010. A new GIS-based biozone map of the Beaufort Group (Karoo Supergroup), South Africa. Palaeontologia Africana 45, 1-5.

VERWOERD, W.J. 1990. The Salpeterkop ring structure, Cape Province, South Africa. Tectonophysics 171, 275-285.

VERWOERD, W.J., VILJOEN, J.H.A. & VILJOEN, K.S. 1990. Olivine melilitites and associated intrusives of the southwestern Cape Province. Guidebook Geocongress '90, Geological Society of South Africa, PR3, 1-60.

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, Limpopo, Northwest and the Free State under the aegis of his Cape Town-based company *Natura Viva* cc. He has served as 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 for SAHRA and HWC. Dr Almond is an accredited member of PSSA and APHP (Association of Professional Heritage 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 project, 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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APPENDIX: GPS LOCALITY DATA

All GPS readings were taken in the field using a hand-held Garmin GPSmap 60CSx instrument. The datum used is WGS 84.

Locality Number	GPS data	Comments
36	S32º 56′ 3.4″ E20º 34′ 32.3″	Bon Espirance 73. Extensive hillslope exposure of Lower Beaufort Group channel sandstones and overbank mudrocks. Calcrete nodule horizons.
37	S32º 55′ 36.1″ E20º 35′ 29.4″	Bon Espirance 73. Hillslope and gulley exposure of Lower Beaufort Group channel sandstones and grey-green overbank mudrocks.
38	S32º 54′ 55.5″ E20º 36′ 14.5″	Standvastigheid 210. Roadside stream bed and bank exposures of Lower Beaufort Group channel sandstones and grey-green mudrocks.
551	S32° 55' 54.9" E20° 35' 48.6"	Standvastigheid 210. Shallow stream exposure of younger alluvial deposits, downwasted surface gravels near Komsberg Substation.
552	S32° 56' 01.4" E20° 35' 47.9"	Standvastigheid 210. Locally concentrated oligomict surface gravels near Komsberg Substation.
553	S32° 55' 59.2" E20° 36' 27.7"	Standvastigheid 210. Stream bed and bank exposure of Lower Beaufort Group bedrocks, pedogenic calcrete horizons, older High Level Gravels as well as younger alluvial deposits. Siltstone palaeosurfaces with vague trace fossil assemblages (probably *Scoyenia* Ichnofacies).