Palaeontological desktop assessment of the proposed Hidden Valley Wind Energy Facility near Sutherland, Northern Cape Province.

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Contents

Executive Summary

- African Clean Energy Developments (ACED) is proposing the establishment of the Hidden Valley Wind Energy Facility (WEF) located approximately 40 km south of Sutherland in the Northern Cape Province.
- The proposed WEF is entirely underlain by sediments and rocks of the Karoo Supergroup, which are assigned to the Beaufort Group. The affected area lies entirely within the Abrahamskraal Formation (*Pa*) of the Adelaide Subgroup.
- The desktop study indicates that the construction phase of the proposed development will impact on fossil-bearing bedrock (Late Permian) and potentially fossil-bearing alluvial and valley fill sediments (Late Quaternary).
- These sediments are regarded as of high overall palaeontological significance, especially with regard to potential impact on vertebrate, invertebrate, plant and trace fossils.
- Late Quaternary alluvial and valley fill deposits in the area, especially near water courses and drainage lines, are of moderate overall palaeontological significance and have the potential to yield fossil mammal remains as well as Early Stone Age artefacts.
- It is recommended that, as part of a **Phase 1** impact assessment, an on-site inspection be conducted at the earliest practicable opportunity **before the commencement of any development** in order to identify, map and report exposed palaeontological material and to suggest alternative areas for development where applicable.
- It is also recommended that, as part of **a Phase 2 follow-up assessment,** fresh exposures and bedrock excavations into the fossil-bearing strata should be monitored during the construction phase of development.

Glossary

Assemblage Zone: unit of geological strata that contain a unique association of fossil taxa.
Fossil: Mineralised bones of vertebrates, invertebrates, plant remains trace fossils. A trace fossil is the track way, burrow or footprint of a fossil animal that is preserved in stone or consolidated sediment.
Heritage: That which is inherited and forms part of the National Estate (Historical places, objects, fossils as defined by the National Heritage Resources Act 25 of 1999.
Permian: A geological time period dated between 299 – 251 Ma (million years ago).
Palaeontology: Any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains or traces.
Quaternary: Geological time period spanning the last 2.6 million years.
Supergroup / Group: A group of rock strata formed during a single, major and widespread episode of rock accumulation.

Introduction

The report is a preliminary assessment of potential palaeontological impact with regard to the establishment of a commercial Wind Energy Facility (WEF) and associated infrastructure on fourteen adjoining farm properties located approximately 40 km south of Sutherland (**Fig. 1**). The assessment was carried out in accordance with National Heritage Resources Act 25 of 1999 with the aim to assess impact on potential palaeontological heritage resources.

The project area (hereafter called the *affected area*) is proposed on portions of the farms Zwanepoelshoek 184, Leeuwe Hoek 183, Annex Orange Fontein 185, Orange Fontein Re/203, Orange Fontein 1/203, Orange Fontein 2/205, Kentucky 206, De Hoop 202, Rheebokke Fontein 1/209, Rheebokke Fontein 2/209, Rheebokke Fontein 3/209, Rheebokke Fontein Re/209, Wolvenkop 1/207 and Standvastigheid 210 (1:50 000 topographic maps 3220 DA Verlatekloof, 3220 DC Swartland, 3220 DD Koringplaats; **Fig. 2 & 3**).

An area of more than 35 000 ha is being considered within which the facility is to be constructed in three phases. It is understood that the facility will have a maximum generating capacity of 600 MW to be generated by approximately 300 turbines (**Fig. 4**). It is expected that each turbine will have a hub height of approximately 80 - 100 m and a rotor diameter of approximately 100 m. It is envisaged that the facilities would include concrete foundations

for each turbine measuring approximately 15 m x 15 m; underground electrical cabling of 20 kV connecting the turbines with the switching station/electrical substation; a connection via an existing switching station to the 400 kV lines that cross the site; a 400 kV substation; an electrical building for housing the switchgears and the office facilities and access roads providing access to each turbine site.

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

Geological Background

As indicated on the 1: 250 000 scale geological map 3220 Sutherland in **Figure 5**, (Published by the Council for Geoscience, Pretoria, 1983), the proposed WEF is entirely underlain by sediments and rocks of the Karoo Supergroup, which are assigned to the Beaufort Group. The affected area lies entirely within the Abrahamskraal Formation (*Pa*) of the Adelaide Subgroup. Relevant geological references include Theron (1983) and Johnson *et al*. (2006). The Adelaide Subgroup lies about halfway up the Karoo Supergroup sequence and comprise a 2000 m thick fluvio-lacustrine succession of late Permian age. The Abrahamskraal Formation is represented by fluvially derived sequences of sedimentary rocks, comprising fossiliferous siltstones, mudstones, subordinate sandstones and thin pedocretes (calcretes). Sandstone and the mudstone exposures respectively represent river channel and floodplain deposits. These features are considered to be typical of continental deposits derived primarily from fluvial and lacustrine sedimentation.

Jurassic-age dolerites (*Jd*), in the form of sills and dykes, occur sparsely in the region. Superficial deposits are made up of late Quaternary sheet wash, river channel alluvium, colluvium and pedocretes.

Palaeontology

Sedimentary rocks in the affected area are assigned to the *Tapinocephalus* Assemblage Zone (AZ), which spans the middle part of the Abrahamskraal Formation. The *Tapinocephalus* AZ overlies the *Eodicynodon* AZ and underlies the *Pristerognathus* AZ **(Fig. 6)**. Relevant palaeontological references include Boonstra (1969), Kitching (1977), Keyser and Smith (1977-78), Rubidge (1995) and Mcrae (1999). The *Tapinocephalus* AZ is characterised by occurrence of a therapsid *Tapinocephalus*, the pareiasaur *Bradysaurus* and the absence of

taxa representative of the underlying biozone, namely *Eodicynodon* and *Tapinocaninus* (Smith and Keyser 1995). Vertebrate fossils are usually found as individual specimens in mudrock sequences and associated with brown-weathering calcareous nodular material. The faunal assemblage is mainly composed of small dicynodonts, large dinocephalians, pareiasaurs and therocephalians (**Fig. 7**). Molluscs, plant fossils (*Dadoxylon*, *Glossopteris*) and trace fossils (larval trails, arthropod tracks, therapsid footprints) have also been recorded in the *Tapinocephalus* AZ.

Late Quaternary sheet wash and channel related deposits are found along dry streams and annual river drainages in the affected area, including the Meintjiesplaas and Komberg Rivers. Although there are no records of late Quaternary fossil remains from geologically recent deposits within the affected area, fossil remains as well as Early Stone Age artefacts, are occasionally found in Late Quaternary alluvial terraces and dongas along rivers and streams dissecting the western Karoo basin.

Impact Statement

The geology and potential fossil heritage of the area is summarized in **Table 1**. Assessment of palaeontological impact in the affected area is presented in **Table 2**. The palaeontological footprint in the area is associated with continuous Permian-age sedimentary strata that cover large geographical areas, as well as more recent Quaternary- age alluvial and superficial valley fill deposits that occur as localized events. The area within which the WEF is to be constructed is primarily underlain by *in situ* strata of the fossil-bearing Abrahamskraal Formation (*Pa*). Quaternary alluvial deposits, especially near water courses and drainage lines, have the potential to yield microfossil and fossil mammal remains as well as Early Stone Age archaeological remains. Proposed development located within igneous bedrock (dolerite) represents no palaeontological impact.

Recommendation

The desktop study indicates that the construction phase of the proposed development will impact on fossil-bearing bedrock (Late Permian) and potentially fossil-bearing alluvial and valley fill sediments (Late Quaternary).

Consequently, any development that may potentially destroy or damage fossils or that conduct excavations exposing fresh bedrock or old superficial deposits are of conservation and research interest.

The intent of mitigation and lessening of impact is to identify fossil localities for future avoidance or to recover *in situ* fossils before possible damage or destruction. However, effective mitigation of potential palaeontological impact for this project is only feasible once the positions of all individual structures and access roads have been finalised.

Recommendation 1
Monitoring before the commencement of development

It is recommended that, as part of a **Phase 1** assessment, an on-site inspection be conducted

- where the concrete foundations for each turbine will be placed;
- where underground cables connecting the turbines with the substation will be placed;
- where the substation and office facilities will be constructed;
- where access roads will be located to provide access to each turbine site.

The Phase 1 assessment should be carried out at the earliest practicable opportunity **before the commencement of any development** in order to identify, map and report exposed palaeontological material and to suggest alternative areas for development where applicable.

Recommendation 2:
Monitoring during the construction phase of development

The rescue of fossil material can in most cases be done only after the commencement of the development (i.e. after excavation activities have started) when potentially fossil-bearing strata and sediments are freshly exposed. The most appropriate recommendation for mitigation in this regard will be to, as part of **a Phase 2 follow-up assessment,** monitor fresh exposures and bedrock excavations into the fossil-bearing strata during the construction phase of development. Inspection of fresh excavations should be conducted at the earliest practicable opportunity before new excavations are in-filled or backfilled or fresh bedrock have the chance to weather or be otherwise damaged by further development.

Excavations into sedimentary bedrock should be considered on condition that access by a palaeontologist is facilitated at the appropriate stage during development and that appropriate and effective mitigation measures such as inspection of fresh excavations are undertaken by a professional palaeontologist in order to determine whether, as is probable, palaeontological remains or features are exposed *in situ.* It is also advised that newly uncovered objects of palaeontological significance, found during the course of excavation activities into

sedimentary bedrock must be reported to SAHRA and may require the appropriate rescue procedures at the cost of the developer.

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Declaration

L. Rossouw does independent specialist consulting and is in no way connected with the proponents of the development, other than delivery of consulting services.

Tables and Figures

Table 1. Geology and fossil potential in the affected area.

Geological Unit	**Rock types and Age**	**Fossil Potential / Biostratigraphy**	**Potential impact**
Superficial deposits	Alluvium, colluvium, pedocretes and soils; Quaternary to Recent	Micromammal bones, large mammal bones, horncores and dentition; freshwater and terrestrial molluscs, coprolites, pollen and phytoliths	Moderate
Karoo Dolerite (*Jd*)	Intrusive igneous bedrock	No fossils	None
Adelaide Subgroup Abrahamskraal Formation (*Pa*)	Fluvial and lacustrine mudstones, sandstones, thin calcretes Late Permian	*Tapinocephalus* Assemblage Zone	High

Table 2. Impact table summarising the significance of impacts (with and without mitigation).

Nature: Construction of the turbines, underground electrical grid, substation, associated building structures and access roads will impact on fossil-bearing sediments composed of Abrahamskraal Formation strata (Adelaide Subgroup). These sediments are regarded as of high overall palaeontological significance, especially with regard to potential impact on vertebrate, invertebrate, plant and trace fossils. Late Quaternary alluvial and valley fill deposits in the area, especially near water courses and drainage lines, are of moderate overall palaeontological significance and have the potential to yield fossil mammal remains as well as Early Stone Age artefacts. Potential palaeontological heritage indentified in the affected area could be negatively affected during the construction phase of the development.		
	Without mitigation	**With mitigation**
Extent	Local High (5)	Local Low (1)
Duration	Permanent (5)	Permanent (5)
Magnitude	High (8)	Moderate (6)
Probability	Highly Probable (4)	Probable (3)
Significance	**72 (High)**	**36 (Medium)**
Status (positive or negative)	Negative	Positive
Reversibility	Improbable	Possibility
Irreplaceable loss of resources?	High	High
Can impacts be mitigated?	Yes	
Mitigation: 1) Monitoring of areas where the concrete foundations for each turbine will be placed, where underground cables connecting the turbines with the substation will be placed, where the substation and office facilities will be constructed and where access roads will be located to provide access to each turbine site, **before** the commencement of development. 2) Monitoring of fresh exposures and bedrock excavations into the fossil-bearing strata **during** the construction phase of development.		

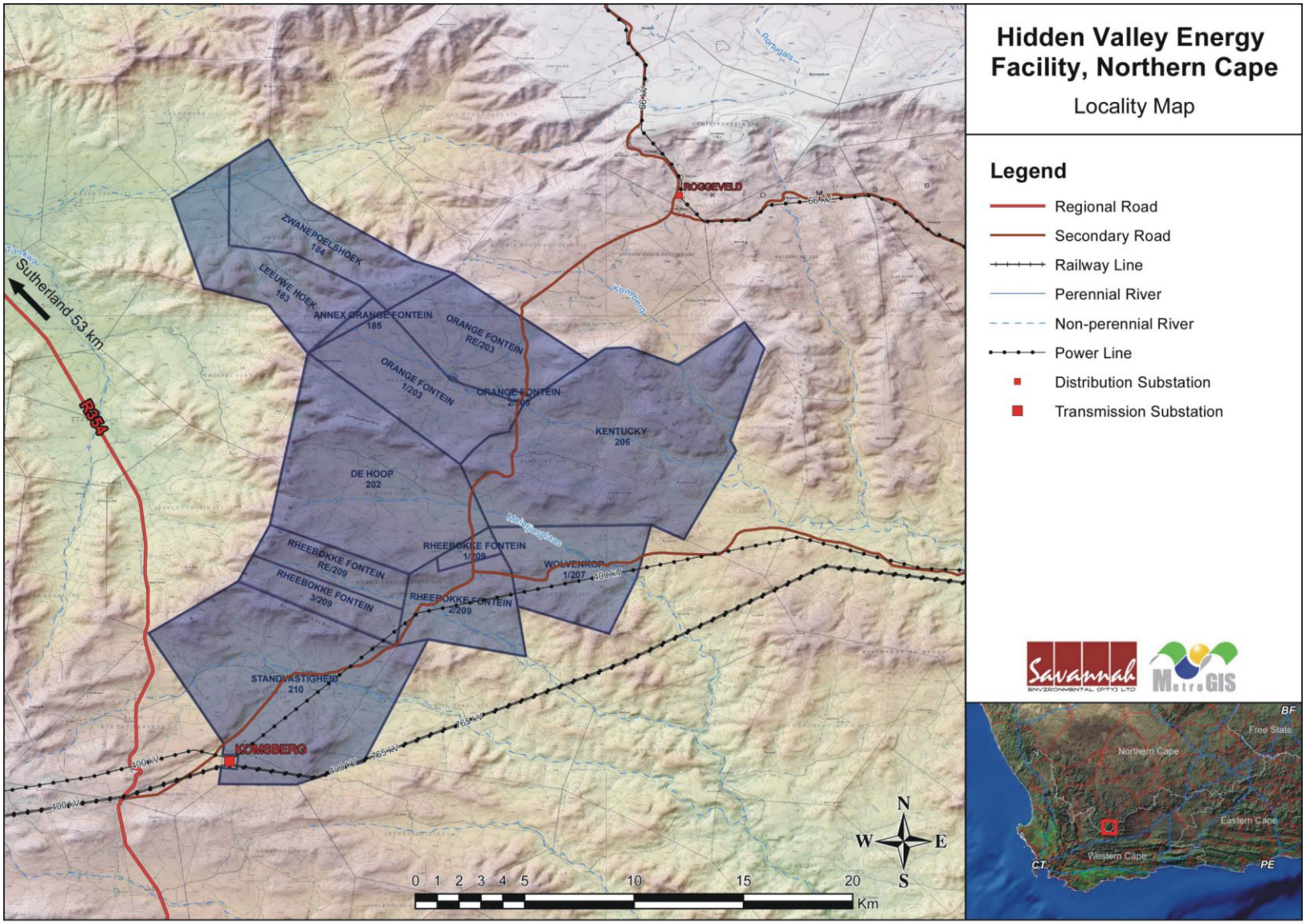


Figure 1. Locality map of the proposed development.

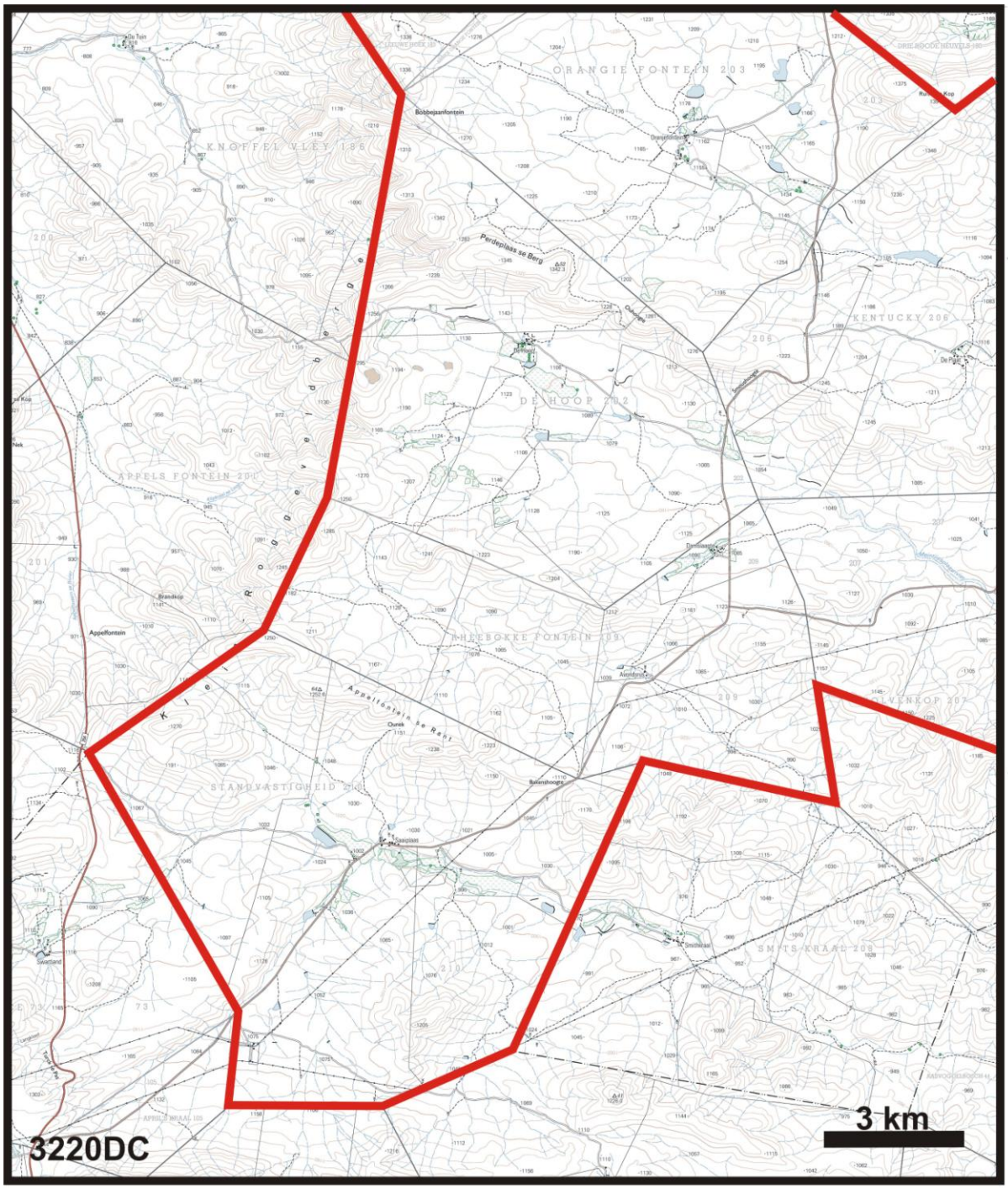
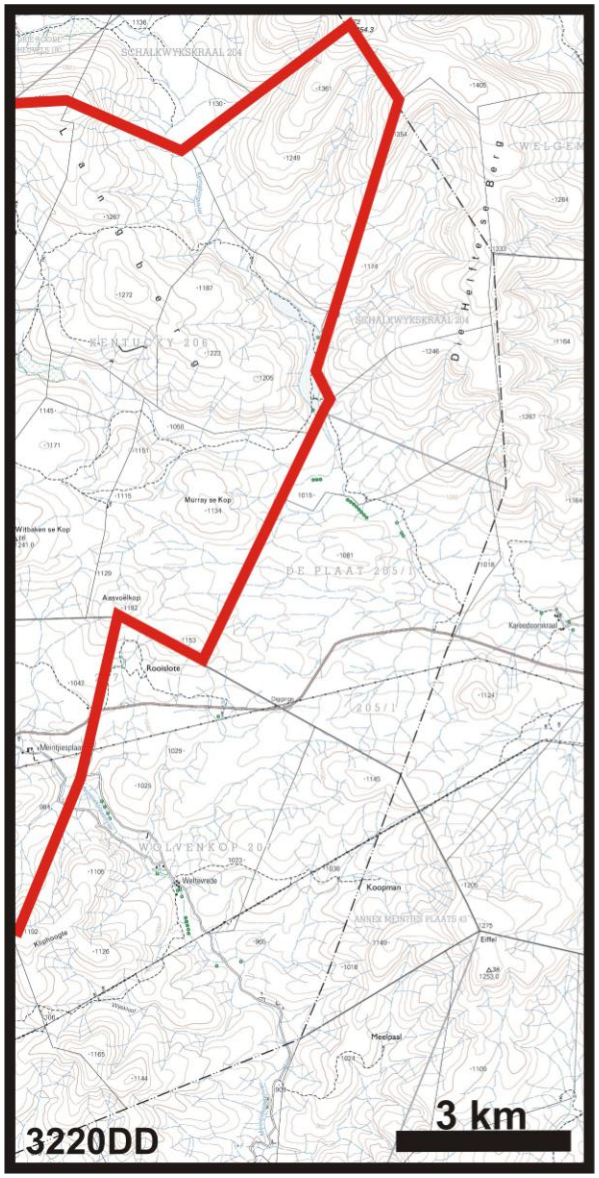
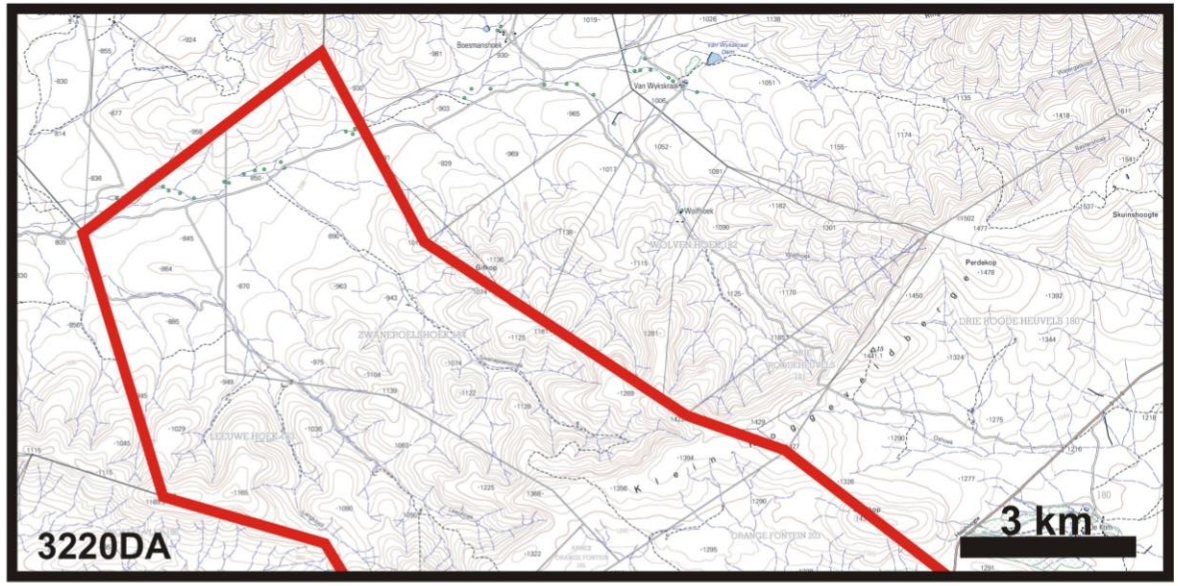


Figure 2. Portion of 1:50 000 scale topographical map (3220 DC Swartland) showing part of the area marked for development.





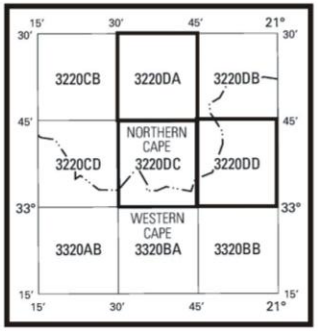


Figure 3. Portion of 1:50 000 scale topographical maps (3220 DA Verlatekloof and 3220 DD Koringplaats) showing part of the area marked for development.

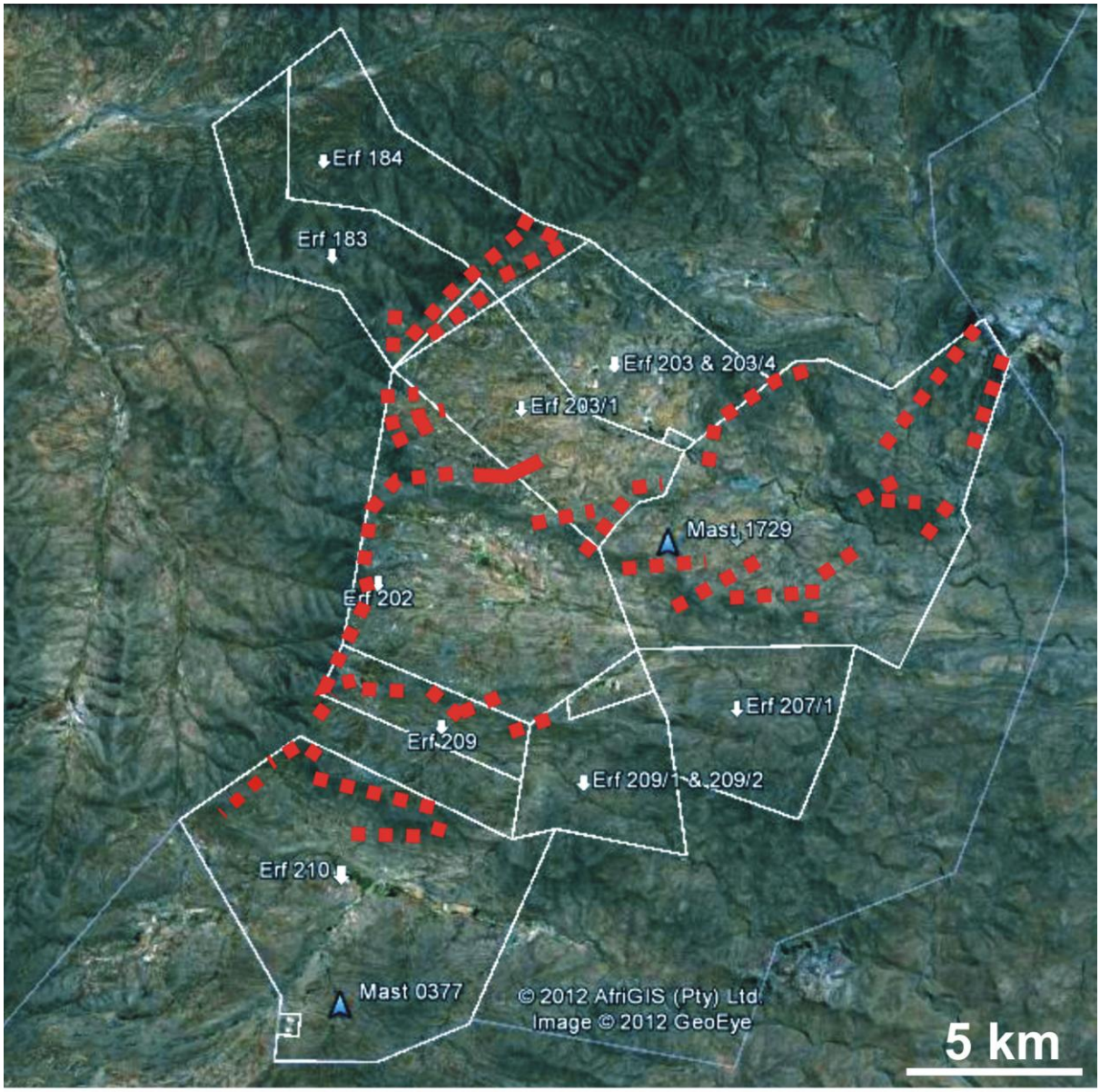


Figure 4. Aerial view of the affected area showing general location of the turbines and associated structures.

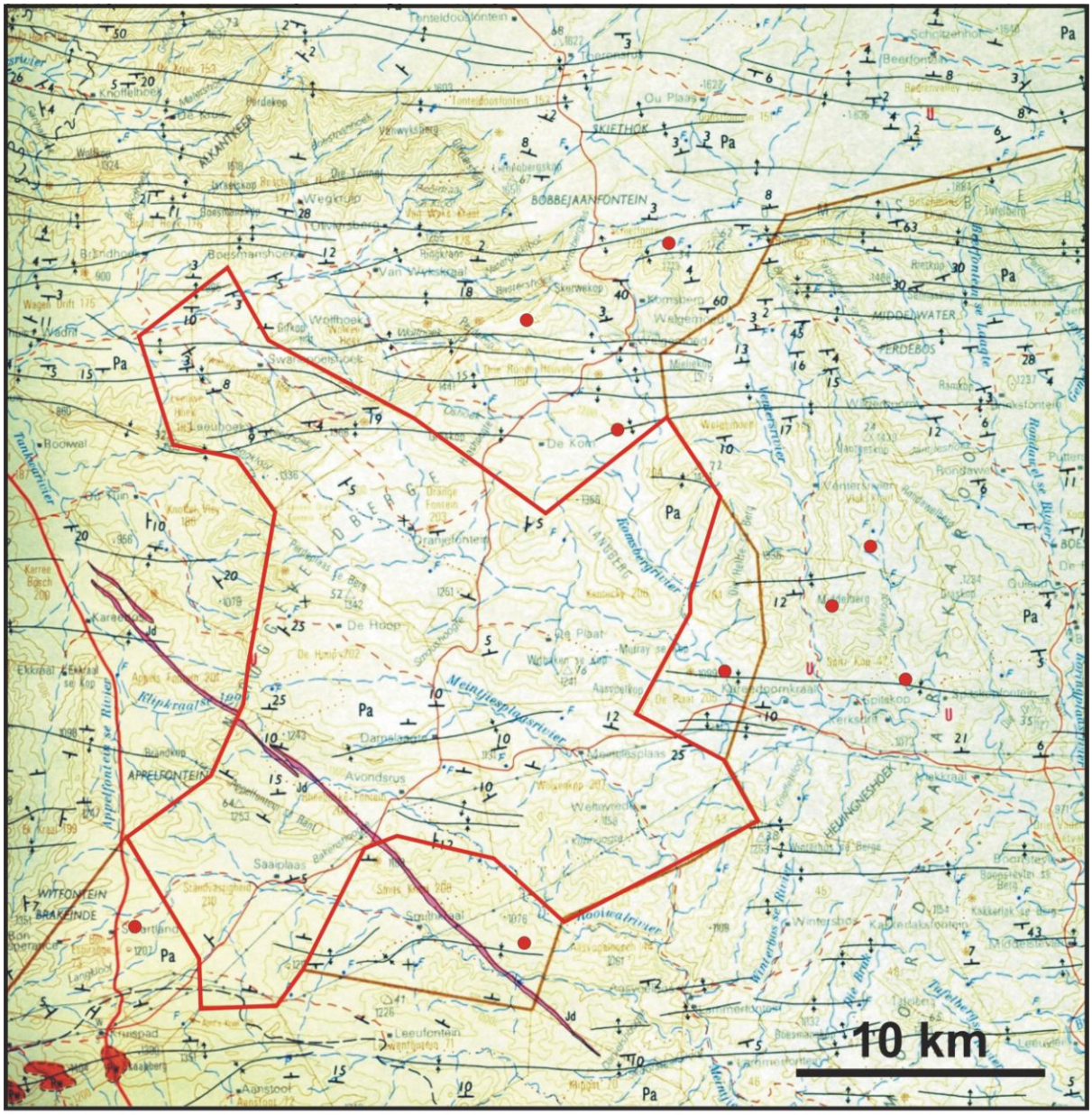


Figure 5. Portion of the 1:250 000 scale geological map of the affected area. The proposed WEF is entirely underlain by sediments and rocks of the Karoo Supergroup, which are assigned to the Beaufort Group and the affected area lies entirely within the Abrahamskraal Formation (*Pa*) of the Adelaide Subgroup. The red dots represent previously recorded vertebrate fossil localities (Kitching 1977).

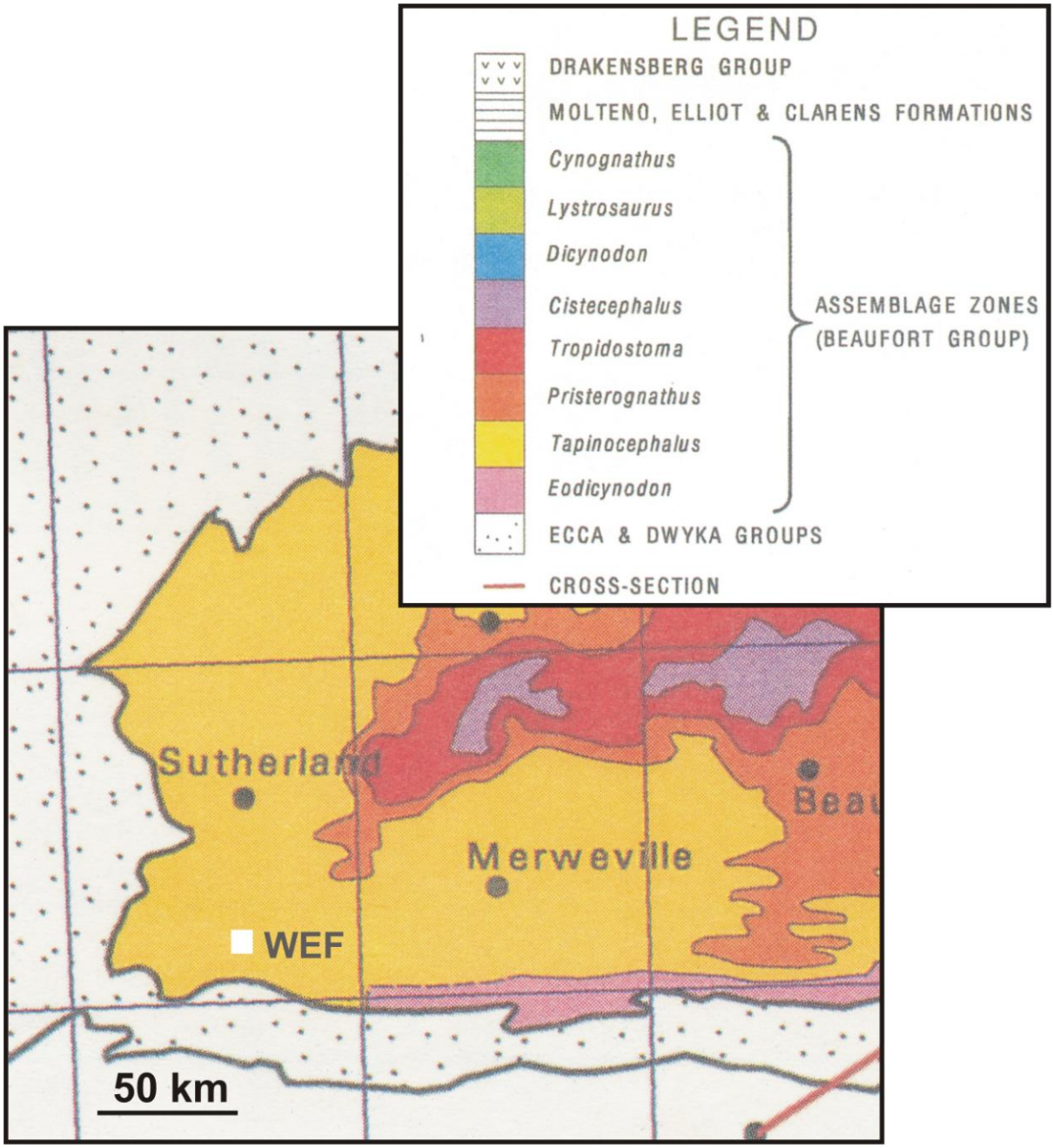


Figure 6. Geographical distribution of vertebrate biozones in the vicinity of the WEF (adapted from Rubidge 1995).

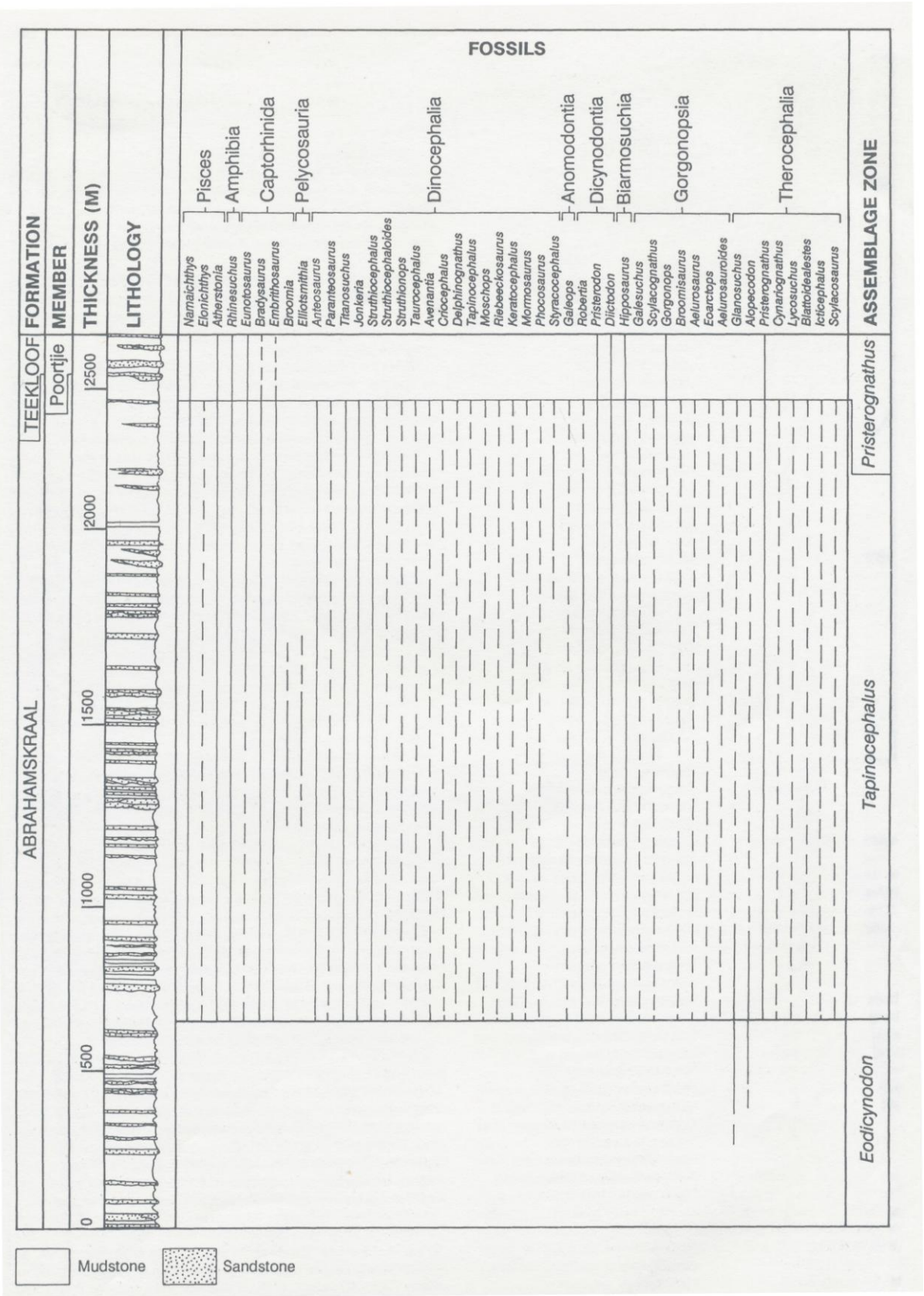


Figure 7. Stratigraphic section showing ranges of vertebrate taxa present in the Tapinocephalus AZ (after Smith and Keyser 1995).