PALAEONTOLOGICAL ASSESSMENT OF THE FARM GRUISFONTEIN 230 LQ NEAR LEPHALALE, LIMPOPO PROVINCE, SOUTH AFRICA

FIELD TRIP, DESKTOP STUDY AND PROTOCOL FOR PALAEONTOLOGICAL FINDS

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EXECUTIVE SUMMARY

This report assesses the potential palaeontological impact of the proposed development of a coal mining operation on the farm Gruisfontein 230 LQ, near Lephalale, Limpopo Province. Since the Karoo hosts a number of coal seams, and coal is formed from plant remains it follows that these rocks host a well-documented palaeoflora. Fossil plants offer an opportunity to study palaeoecology and have been allocated a very high palaeontological sensitivity by the South African Heritage Resource Agency (SAHRA). This study indicates that there is a very high likelihood of the occurrence of fossils.

Due to the fact that coal beds will only be exposed during the mining operations, it is unlikely that fossils will be observed before the mining and associated infrastructure development takes place. For this reason, a medium palaeontological sensitivity is allocated to the study area

In mitigation, the following recommendations are proposed:

1. The developer of the mining project must be made aware of the fact that coal mining is by definition the mining of fossil plant material.
2. Once the open pit mining commences, the developer should appoint a recognised suitably qualified palaeontologist to re-assess the palaeontology of the operation in order to develop a protocol for further assessments and/or chance fossil finds.
3. Any fossils such obtained should be deposited with a recognised authority such as the Council for Geoscience, Bernard Price Institute for Palaeontology or the Department of Geology and Mining, University of Limpopo.

1. INTRODUCTION

This report assesses the potential palaeontological impact of the proposed development of a coal mining operation on the farm Gruisfontein 230 LQ, near Lephalale, Limpopo Province.

1.1 Desktop Study

The 1:250 000 geological map 2326 (Ellisras) was consulted to establish the regional and local geology. Information on palaeontology for the potentially fossiliferous geological formations was sourced from published scientific literature.

1.2 Site visit

A reconnaissance site visit was undertaken in January, 2019. However, there are no exposures on, or adjacent to, the farm Gruisfontein 230 LQ.

Figure 1: General view of vegetation and surface cover on Gruisfontein.

2. GEOLOGY

The 1:250 000 geological map 2326 (Ellisras) indicates the entire area is underlain by sedimentary rocks of the Karoo Supergroup.

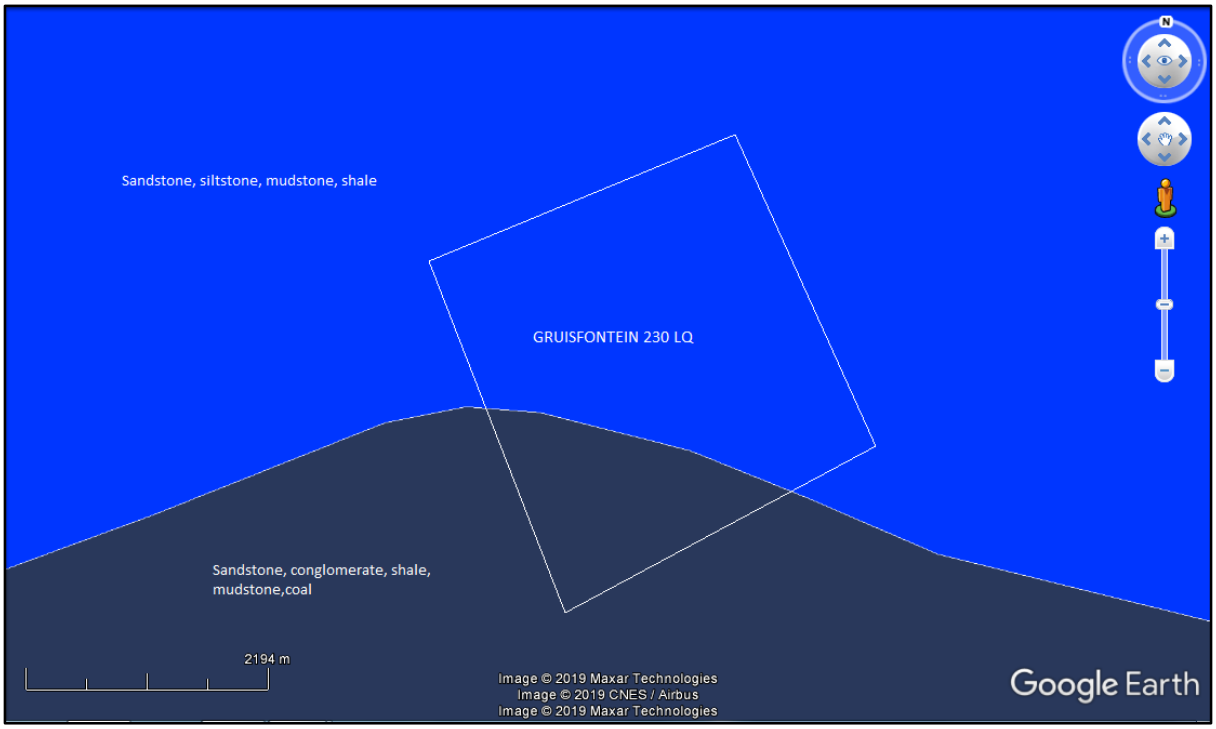

Figure 2. Geology of the farm Gruisfontein 230 LQ. There are no surface exposures. The black area consists of the coal-bearing Grootegeluk Formation. The light blue area are the younger strata.

2.1 The Karoo Supergroup

Rocks of Karoo age were laid down between the late Carboniferous and mid Jurassic. Deposition was on a stable floor, the Kaapvaal Craton to the north and the Namaqua-Natal Metamorphic Belt to the south. The main Karoo Basin is approximately 700,000 km^2 in extent, but must have been significantly more extensive during Permian times. The Karoo Supergroup reflects changing sedimentary environments, from glacial, fluvial, lacustrine, through to aeolian. Sedimentation abruptly ceased with the extrusion of extensive basaltic lavas, heralding the break-up of the Gondwana landmass.

The main Karoo Basin covers much of the Free State, KwaZulu Natal and Northern Cape, but smaller depositories, developed in the north. Towards the end of Karoo times, these basins became blanketed by aeolian deposits of the Clarens Formation. The study area is underlain by such a depositary, the Ellisras Basin, which extends across the border to Botswana.

2.1.1 The Ellisras Basin

The Ellisras Basin is separate from the Main Karoo Basin and spans the South Africa – Botswana border near the South African town of Lephalale (formerly Ellisras). The basin includes the economically important coalfields of Waterberg (in South Africa) and Mmamabula (in Botswana).

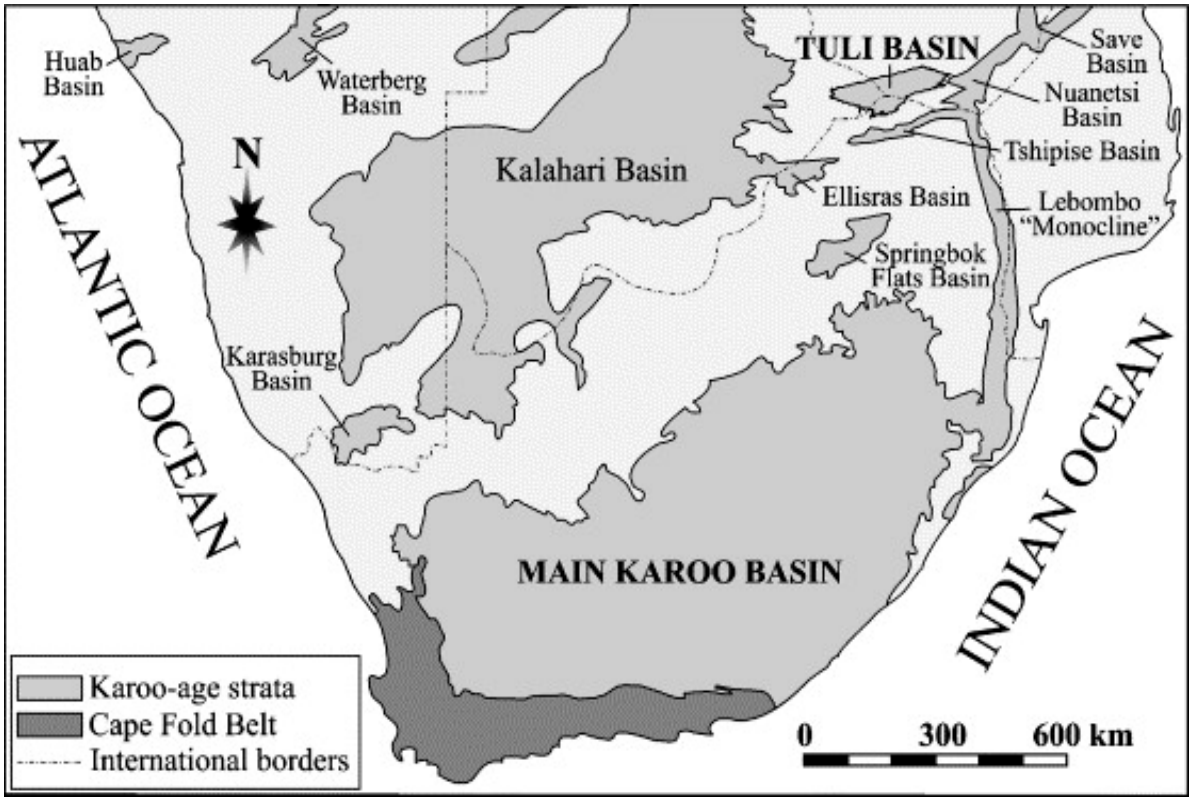

Figure 3. Location of Karoo rocks in southern Africa.

2.1.2 Geology of the Ellisras Basin

2.1.2.1 Waterkloof Formation

The base of the succession is represented by the Waterkloof Formation, considered to be the equivalent of the Dwyka Group tillite of the Main Karoo Basin. It consists of diamictites and other sediments of glacial origin which are unconformable on the Waterberg Group and Archaean basement rocks. They are interpreted as fluvio-lacustrine glacial deposits formed by retreating glaciers.

2.1.2.2 Wellington Formation

These are mainly laminated mudstones. They are interpreted as glacial lacustrine sediments. They are interpreted as being equivalent to the Ecca Group of the Main Karoo Basin.

2.1.2.3 Swartrant Formation

These consist of alternating sandstone and siltstone units with coal and mudstone horizons, consistent with a deltaic and swampy sedimentary environment. They are considered to be Ecca Group equivalents.

2.1.2.4 Goedgedacht Formation

These mudstones thin out towards the south of the basin and may not be present in the study area.

2.1.2.5 Grootegeluk Formation

Economically, this is the most important formation as it consists of cyclical coal seams, carbonaceous shale and mudstone. These sediments are interpreted as large floodplains and swamps where plant material accumulated before being buried by mudstone. These deposits are probably also Ecca equivalents.

2.1.2.6 Eendragtpan Formation

This consists of reddish, oxidised mudstones likely formed in a floodplain environment. This unit does not contain coal and is likely an equivalent of the Triassic Beaufort Group.

2.1.2.7 Greenwich Formation

These consist of sandstones formed in braided rivers and is equivalent of the Molteno sandstone of the Main Karoo Basin.

2.1.2.8 Lisbon Formation

The Lisbon Formation consists of a sequence of mud- and siltstones, probably formed by meandering rivers. However some of the upper horizons are interpreted as aeolian rather than fluvial. The lower horizons are regarded as an equivalent of the Elliot Formation.

2.1.2.9 Clarens Formation

Although the geological formations discussed above are considered to be equivalent to formations of the Main Karoo Basin, the Ellisras Basin is not considered to have been connected to the Main Karoo Basin. However, the aeolian sandstones of the Clarens Formation appears to have blanketed the entire basin.

2.1.2.10 Quaternary Deposits

Fine grained wind-blown and fluvial sand deposits are present throughout South Africa.

3. PALAEONTOLOGY

Rocks of the Karoo Supergroup are internationally acclaimed for their rich palaeontological heritage. In particular the Karoo documents the catastrophic End Permian Extinction and subsequent proliferation of life, early dinosaurs and the emergence of mammals. Since the Karoo hosts a number of coal seams, and coal is formed from plant remains it follows that these rocks host a well-documented palaeoflora. Fossil plants offer an opportunity to study palaeoecology and have been allocated a very high palaeontological sensitivity by the South African Heritage Resource Agency (SAHRA).

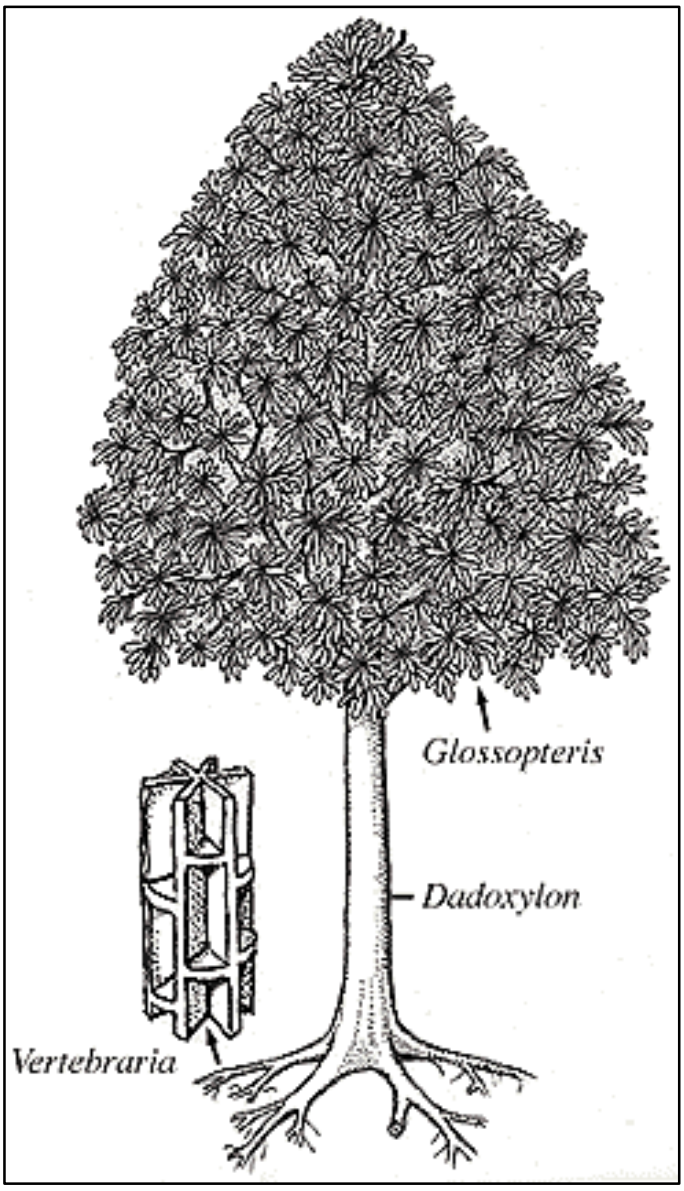

Figure 4. Reconstruction of *Glossopteris* (leaves), *Dadoxylon (*stem) and *Vertebraria* (roots), considered to be part of the same plant (From Arens, *et.al.* 1998).

3.1 Waterkloof Formation

There are no macrofossils in this unit.

3.2 Wellington Formation

These laminated mudstones also formed in cold to freezing water and fossils have not been reported in this unit

3.3 Swartrant Formation

There is a presence of *Glossopteris* flora, in coal seams and sand partings.

3.4 Goedgedacht Formation

There is a possibility of *Glossopteris* flora, although it is doubtful if these sediments extend as far south as this study area.

3.5 Grootegeluk Formation

There is a strong presence of *Glossopteris* flora throughout the unit.

3.6 Greenwich Formation

This formation is unfossiliferous.

3.7 Lisbon Formation

This formation is potentially rich in invertebrate trace fossils such as *Cruziana* and *Skolithos* with termitaria and rhyzoliths (plant roots). The probable correlation with the Elliot Formation indicates the possibility of dinosaur skeletons such as *Euskelesaurus* and *Massospondylus*.

3.8 Clarens Formation

There is a possibility of dinosaur trackways and in playa lake sediments rhizoliths and crustacea have been reported.

3.9 Quaternary Deposits

The reconnaissance site visit did not reveal any Quaternary deposits.

4. SOUTH AFRICAN PALAEONTOLOGY LEGISLATION

The National Heritage Resources Act (25 of 1999) (NHRA)

This Palaeontological Assessment forms part of the Heritage Impact Assessment (HIA) and complies with the requirements of the South African National Heritage Resource Act No 25 of 1999. A HIA is required under Section 38 (Heritage Resources Management) to assess any potential impact to the palaeontology of the area by a proposed development. The term *palaeontological* in this context is defined by the NHRA as "…any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rocks intended for industrial use and any site which contains such fossilised remains or traces" (NHRA, 1999, p.10). The following clauses detailed below are relevant to palaeontological aspects for a terrain suitability assessment.

Subsection 35 (4)

- No person may, without a permit issued by the responsible heritage resource authority:
- (a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological of palaeontological site or 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 assists with the detection or recovery of metals or archaeological material or objects, or use such equipment for the recovery of meteorites.

Subsection 35 (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 procedures 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.

5. CONCLUSION

This study indicates that there is a very high likelihood of the occurrence of fossils, typically palaeoflora of *Glossopteris*, *Dadoxylon* and *Vertebraria* within the lower Karoo strata. The Lisbon Formation may contain trace fossils such as *Cruziana* and *Skolithos*, with also a possibility of dinosaur fossils such as *Euskelsaurus* and *Massospondylus*.

The property contains no outcrops or disturbances which exposes the underlying rock formations. The shales and coal beds will only be exposed during the mining operations, and it is therefore unlikely that fossils will be observed before the mining and associated infrastructure development takes place.

6. RECOMMENDATIONS

1. The developer of the mining project must be made aware of the fact that coal mining is by definition the mining of fossil plant material.

2. Once the open pit mining commences, the developer should appoint a recognised suitably qualified palaeontologist to re-assess the palaeontology of the operation in order to develop a protocol for further assessments and/or chance fossil finds.
3. Any fossils such obtained should be deposited with a recognised authority such as the Council for Geoscience, Bernard Price Institute for Palaeontology or the Department of Geology and Mining, University of Limpopo.

7. REFERENCES

Johnson, M.R.; Van Vuuren, C.J.; Hegenberger,W.F.; Key, R. & Shoko, U. (1996) Stratigraphy of the Karoo Supergroup in southern Africa: an overview. *J. Afr. Earth Sci.,* 23(1),3-15.

Smith, R.H.M.; Eriksson, P.G. & Botha, W.J. (1993) A review of the stratigraphy and sedimentary environments of the Karoo-aged basins of Southern Africa. *J.Afr. Earth Sci.,* 16, 143-169.

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