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PALAEONTOLOGICAL ASSESSMENT REQUESTED IN TERMS OF SECTION 38 OF THE NATIONAL HERITAGE RESOURCES ACT NO 25/1999 FOR MINING RIGHTS AT THE 2005 AND 2007 RETRENCHEES – KIMBERLEY MINES TRUST, KIMBERLEY, NORTHERN CAPE PROVINCE

Prepared by

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DECLARATION OF INDEPENDENCE

AHSA is an independent consultancy: I hereby declare that I have no interest, be it business, financial, personal or other vested interest in the undertaking of the proposed activity, other than fair remuneration for work performed, in terms the National Heritage Resources Act (No 25 of 1999).

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1. INTRODUCTION

This desktop palaeontological impact assessment (PIA) has been conducted in support of an application by the Kimberley Mines Trust for Mining Rights at the 2005 and 2007 Retrenchees –Kimberley, Northern Cape Province. The palaeontological assessment is in fulfilment of the requirements for a Heritage Impact Assessment (HIA) as stipulated in Section 38 of the National African Heritage Resources Act (Act No. 25 of 1999).

In terms of the Act, palaeontological resources are fossilised remains or traces of animals or plants which lived in the geological times other than fossil fuels or fossiliferous rocks intended for industrial use. Palaeontology is the scientific study of all forms of ancient life on the basis of their fossil remains and their geological context (Almond and Pether 2009). It is the scientific study of life forms that existed in the earth's distant past as revealed though the examination of fossils of plants, animals, and other organisms. This also includes the study of body fossils, tracks (ichnites), burrows, cast-off parts, fossilized faeces (coprolites), palynomorphs and chemical residues. Palaeontology is therefore important in that it allows us to place living organisms in both evolutionary (life-historical) and geological (earth-historical) context. The significance of palaeontology is also demonstrated by the fact that it represents the desire of mankind to better understand the history of life on Earth, and in so doing to understand themselves and the world around them. The horizon of palaeontological research has been expanding to also determine long-term physical changes of global geography (paleogeography) and climate (paleoclimatology) that have affected the history of life, to show how ecosystems have responded to these changes and have changed the planetary environment in turn, and how these mutual responses have affected today's patterns of biodiversity. Through palaeontological studies it is possible to determine the age and nature of the rocks that contain them or the layers above or below. This information is vital to the mining industry and especially the petroleum industry.

There is growing awareness of the natural environment, and in order to understand current ecosystems it is essential to understand the development of life as well as the interaction of organisms with each other, and their interdependence on each other in

order to survive. Palaeontological studies help to identify key moments that led to our current patterns of biodiversity, and understand humanity's role in the story of life. South Africa is replete with palaeontological, paleoanthropological and archaeological heritage resources that document this extraordinarily vast story. Furthermore palaeontology is the only discipline that can provide empirical data relevant to how and why biodiversity has changed in the past. The fossil record of South Africa also provides broad public appeal and present an expedient means of opening discussions about humanity's role in extinctions, evolution, and Earth History.

2. GEOLOGICAL TIME SCALE

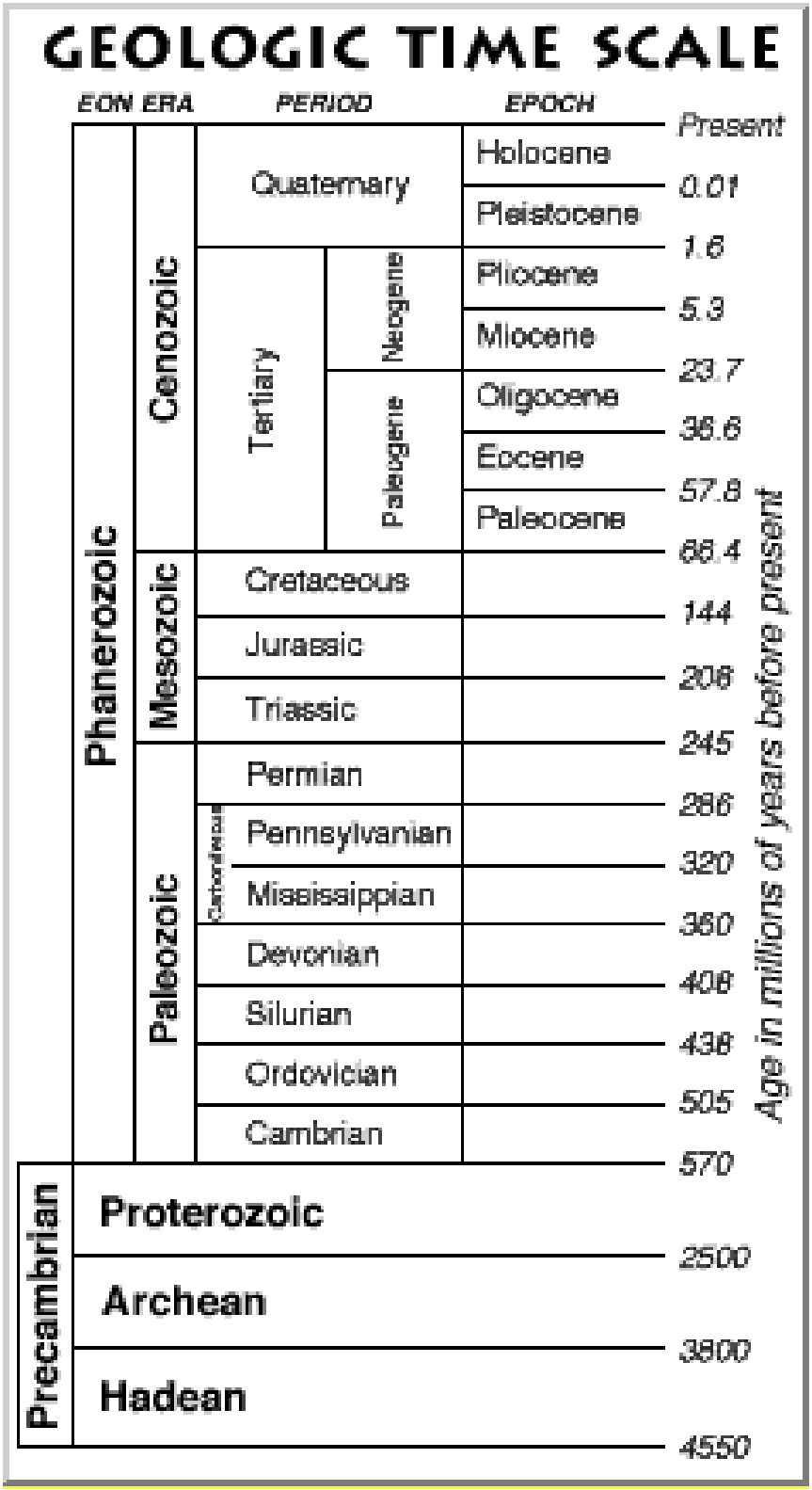

Figure 1: Table of Geological Time Scale

3. LOCATION AND PHYSICAL SETTING

The study area is located in the City of Kimberley which is one of the oldest towns in the North Cape Province. Kimberley is situated between the Orange and Vaal Rivers. The project area is a property north of the suburb of Colville in the northern outskirts of the city. The area has been modified by mining for approximately more than a century and a half (See Google-Earth map, Figs 1 & 2).

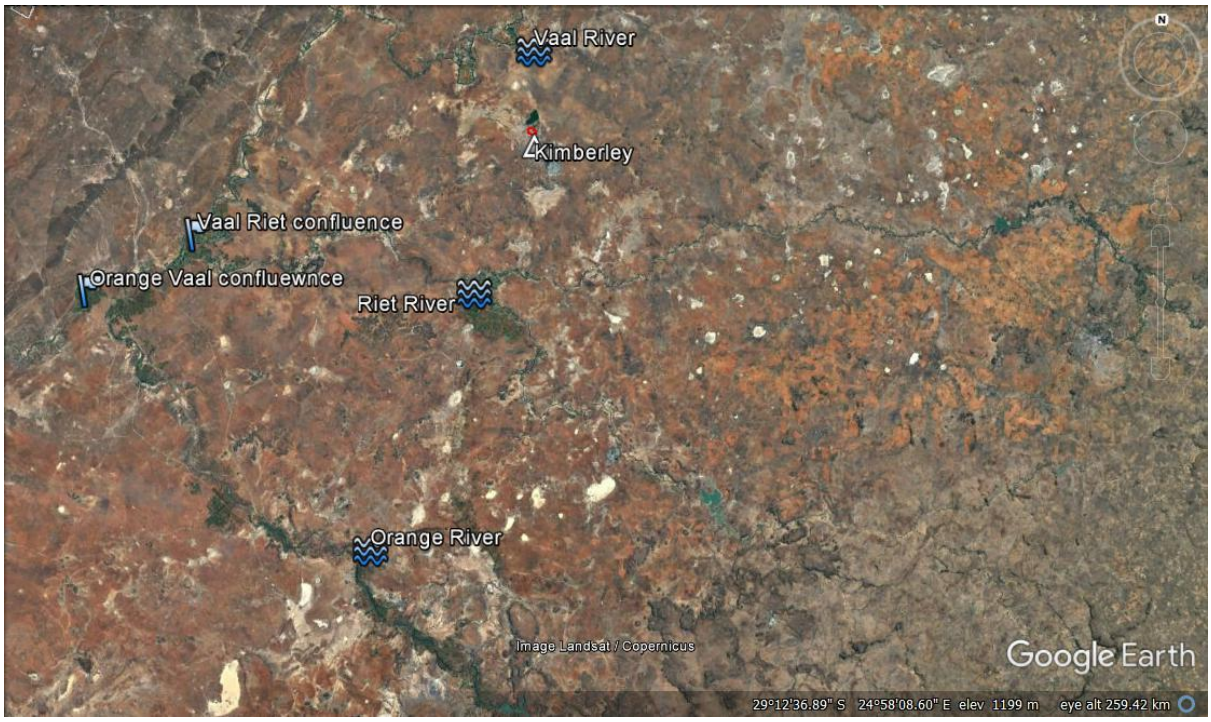

Fig 1. Google-Earth map shows the location of Kimberley between the Vaal and Orange Rivers.

Fig 2. Google-Earth view of the Retrenchees 2005 & 2007 and Colville Township, Kimberley

4. RELEVANT LEGISLATION

Various categories of heritage resources recognised as part of the National Estate in Section 3 of the National Heritage Resources Act (25/1999) include, among others:

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

A palaeontological impact assessment (PIA) was therefore commissioned as part of an EIA for the proposed mining at the Kimberley Retrenchees 2005 & 2007. Under the NHRA fossils are treated as a category of heritage – palaeontological heritage - and are regarded as part of the National Estate (section 32.1(a)).

Sections 35 and 38 of the National Heritage Resources Act (No 25 of 1999) form the legal context in which Heritage Impact Assessments are prescribed. As statutory reference they guided fieldwork and preparation of this report. The PIA has been conducted in tandem with a Heritage Impact Assessment (HIA) to locate sites of heritage significance and assess potential adverse or positive impacts of the proposed

mining. Section 38 of the NHRA states the nature and scale of development which triggers a HIA:

38. (1) Subject to the provisions of subsections (7), (8) and (9), any person who intends to undertake a development categorised as—

(a) the construction of a road, wall, powerline, pipeline, canal or other similar form of linear development or barrier exceeding 300m in length;

(b) the construction of a bridge or similar structure exceeding 50 m in length;

(c) any development or other activity which will change the character of a site— exceeding 5 000 m2 in extent2; or

(ii) involving three or more existing erven or subdivisions thereof; or

(iii) involving three or more erven or divisions thereof which have been consolidated within the past five years; or

(*iv) the costs of which will exceed a sum set in terms of regulations by*

SAHRA or a provincial heritage resources authority;

(d) the re-zoning of a site exceeding 10 000 m2 in extent; or

(e) any other category of development provided for in the regulations by SAHRA or a provincial heritage resources authority, must at the very earliest stages of initiating such a development, notify the responsible heritage resources authority and furnish it with details regarding the location, nature and extent of the proposed development.

Section 35 (4) of the NHRA prohibits the destruction of archaeological, palaeontological and meteorite sites:

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. APPROACHES AND METHODOLOGY

A review of all available relevant literature included reports of previous HIAs conducted in the general locality, books, and project planning documents. This was followed by ground fieldwork. The survey was carried out on foot with a vehicle used to move between survey areas. In preparing a palaeontological desktop study the potentially fossiliferous rock units (groups, formations etc.) represented within the study area were determined from geological maps. The known fossil heritage within each rock unit is inventoried from the published scientific literature, previous palaeontological impact studies in the same region, and the author's field observations. The data was then used to assess the palaeontological sensitivity of each rock unit to development (Provisional tabulations of palaeontological sensitivity of all formations in the Western, Eastern and Northern Cape have already been compiled by J. Almond and colleagues; e.g. Almond & Pether 2008). The likely impact of the proposed development on local fossil heritage is then determined on the basis of (1) the palaeontological sensitivity of the rock units concerned and (2) the nature of the development itself, most notably the extent of fresh bedrock excavation envisaged. When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a field survey by a professional palaeontologist is usually warranted to identify fossil hotspots as a basis for further specialist mitigation.

It was revealed from the scoping ground survey that the whole area has been disturbed as a result of mining activities since the 19th Century and more recent excavations by unlicensed miners (Fig 3) (see the main HIA Report). Should substantial fossil remains be exposed during the implementation of the project, SAHRA should be notified so that appropriate mitigation can be undertaken.

Fig 3. Evidence of extensive earthmoving in the study area.

6. ASSUMPTIONS MADE FOR THIS PIA

Assumptions were made that palaeontological sensitivity of rock units underlying the study area and from field and other data obtained outside the study area is fairly uniformly distributed. However factors such as variations in the deposition setting across a formation, tectonic deformation as well as the intensity and nature of metamorphism and weathering experienced by a given formation may change markedly across its outcrop area. A scoping survey may thus fail to predict variations present within a sedimentary rock unit so that there might be highly fossiliferous localities where the rating has been determined to be low, or low sensitivity localities where the rating has been determined to be high (Almond and Pether 2009).

7. GEOLOGY AND PALAEONTOLOGICAL PROFILE OF THE STUDY AREA

A palaeontological profile of this part of the Northern Cape can be gleaned from the work of Almond (2011, 2012 and 2014). According to Almond et al. (2009), large areas of the vast Northern Cape Province have barely been examined for fossils. The

geological and fossil heritage of the Northern Cape covers over 2.7 billion years of Earth History. Surface exposure of fresh, unweathered rocks that have well-preserved fossils because of the prevailing semi-arid to arid climates. According to Almond (2009), fossil remains, including marine shells and animal burrows, have been noted by travelling European naturalists in the Northern Cape since the late eighteenth century. Generally the area is underlain by Pre-Cambrian marine carbonate sediments of the Ghaap Group, which are moderately fossilferous, containing microbial mounds or stromatolites. The Pre-Cambrian limestones, dolomites, and cherts (the Campbell Rand Supergroup) and the Caenozoic calcretes (Kalahari Group) potentially fossiferous units that are found within this broad classification.

According to Almond and Pether (2009), a large area of the Northern Cape is underlain by granites and gneisses of the Namaqua Metamorphic Province that are between one and two billion years old. These formations do not contain fossils. However, the remaining area contains older and younger sedimentary rocks or low grade metasediments with fossils. The Ventersdorp Subgroup (oldest metasediments that are about 2.7 billion years old) in the Northern Cape contain complex biosedimentary structures known as stromatolites ("algal domes"). A wide range of fossils have been recorded from rocks of the Northern Cape that include ancient microbes, trace fossils and invertebrate shells, fish and tetrapods (four-legged vertebrates like reptiles), mammals, vascular plants, etc. Carbonate rocks in the Ventersdorp Supergroup in the north-eastern part of the province contain multi-layered, branching stromatolites constructed by lacustrine cyanobacteria around 2.7 billion years ago have only been observed in borehole cores (Almond and Pether 2009). A much greater variety of stromatolites flourished. Almond and Pether (2009) further state that carbonate sediments of the Transvaal Supergroup deposited during that time represent one of the earliest continental shelf successions in Earth history. Stromatolites persisted as the only large biogenic (organically-made) structures during deposition of the 1.9 billion year old Olifantshoek Supergroup (and for the remainder of the Precambrian).

There are several successions of deep to shallow marine and near-coastal sediments that represent the latest Precambrian time interval (or Neoproterozoic) in the Northern Cape (Almond and Pether 2008). The rocks show a period of dramatically fluctuating environments (including several global glaciations) and rapidly evolving biotas that

finally led to the Cambrian development of multicellular life around 540 million years ago. Fossils of early phytoplankton and protozoans, as well the stromatolites, are recorded from the Gariep Supergroup that extends from southern Namibia into the Richtersveld and also occurs in southern Namaqualand (Almond 2010, 2011; Almond and Pether 2009; Marais et al. 2001). In both geological and palaeontological terms the Nama Group is one of the world's most important sedimentary successions that span the palaeobiologically critical Precambrian / Cambrian boundary. Some of the oldest known fossil shells, trace fossils and vendobiontans are found there. There is also fossil microplankton and a range of bacterially formed structures such as giant dome-shaped stromatolites, biomats, and "algal strings" or vendotaenids (Almond and Pether 2009). These fossil groups are best known from Nama outcrops north of the Orange River. The Vanrhynsdorp Group of southern Namaqualand contains prolific trace fossil assemblages that reflect the evolution of large body size and complex behavioural patterns among burrowing invertebrates across the Precambrian / Cambrian boundary. Equivocal traces of vendobiontans (tool marks) and shelly fossils have also been recorded here recently (Almond and Pether 2008).

The Cape Supergroup also occurs on the southwestern margins of the Northern Cape for example in the Bokkeveld Plateau and Onder Bokkeveld regions. These sediments of Early Ordovician to Early Carboniferous age (c. 480 – 375 million years ago) contain poor trace fossil assemblages of for example arthropod trackways and burrows. Thus, Early Ordovician to Early Devonian Table Mountain Group is characterised by sparse fossils throughout. In addition Post-glacial mudrocks of the Late Ordovician Cederberg Formation have yielded exceptionally well-preserved primitive jawless fish, water scorpions and other invertebrates in the Western Cape (Almond and Pether 2009). This unit also extends fractionally into the Northern Cape, where it is probably also highly fossiliferous. Alternating mudrocks and impure sandstones of the Early to Mid-Devonian Bokkeveld Group contain assemblages of shallow marine trace fossils attributed to trilobites, starfish, molluscs and various unidentified burrowing invertebrates. According to Almond and Pether (2009), moulds of invertebrate shells (trilobites, brachiopods, molluscs etc.) also found here closely resemble those from similar-aged beds elsewhere in Gondwana, such as present-day South America, Antarctica and the Falklands Islands. These once closely-connected areas all belong to what is known as the Malvinokaffric Faunal Realm or Province. Important remains of primitive fish (e.g. sharks, armour-plated placoderms, bony fish) and early land

plants occur in possible deltaic to estuarine beds within the upper Bokkeveld succession. The Mid to Late Devonian Witteberg Group sediments are characterised by an abundance of shallow marine trace fossils (notably Spirophyton), though fragmentary land plants (e.g. lycopods) and impoverished shelly invertebrates also occur locally.

Thick succession deposition of Karoo Supergroup sediments took place within a number of intra-continental basins in the Northern Cape from Late Carboniferous through to Early Jurassic times (Almond and Pether 2009). The Main Karoo Basin is the most extensive of these (Almond 2010; Almond and Pether 2009; Stear 190, 1978; Smith 1987, 1988). The earliest Karoo sediments – massive glacial tillites of the Permocarboniferous **Dwyka Group** – are largely unfossiliferous, although thin intervals of interglacial and post-glacial mudrocks yield sparse fossils of marine invertebrates and fish (e.g. near Douglas) as well a small range of trace fossils generated by arthropods and fish (the study area is underlain by this formation) (Bruce. n.d.; Almond and Pether 2009; Smith 1990). Reddish sandy and pebbly glacial outwash sediments contain plant fossils (leaves, wood and other debris) of the Glossopteris Flora. Post-glacial flooding of the Karoo Basin established the Mid Permian Ecca Sea, stretching from southern Africa across to, then closely adjacent, South America. Sediments of the **Ecca Group** in the Northern Cape contain a wide range of fossils, from petrified tree trunks, pollen, spores and other Glossopteris Flora plant debris that was blown or rafted offshore during storms to moderately diverse trace fossil assemblages (Almond and Pether 2008). Many of these traces are attributable to fish or non-marine arthropod groups such as crustaceans, king crabs and predatory eurypterids (water scorpions), the last of which reached lengths of two meters or more. There is also a small range of molluscan, crustacean and insect body fossils, primitive bony fish, and – best known of all – well-preserved skeletons of aquatic mesosaurids. These small swimming reptiles in Northern Cape were found near Kimberley in the late nineteenth and early twentieth centuries (Almond and Pether 2008). Infilling of most of the Ecca Sea by deltaic deposits established dry land across most of the Main Karoo Basin by Late Permian times. The fluvial and lacustrine deposits of the succeeding Beaufort Group are exceptionally a rich record of Permotriassic vertebrates that include various fish groups (notably palaeoniscoids), large amphibians which were the dominant aquatic predators, heavily-armoured,

rhino-like herbivorous reptiles called pareiasaurs and terrestrial animals that include herbivorous and carnivorous mammal-like reptiles or therapsids. These theraspids dominated terrestrial ecosystems for much of the Permotriassic interval. The vegetation for the Beaufort Group vegetation was dominated by the Glossopteris Flora (Almond and Pether 2009; Cadle *et al*. 1993; Cairncross 1989). The Beaufort sediments and their rich fossil biotas document the establishment of the oldest known complex ecosystems on land. In the Northern Cape post-extinction fossil biotas of Early Triassic age – including various amphibians, therapsids and crocodile-like reptiles - are preserved only in the easternmost parts of the province.

The kimberlite pipes in the Northern Cape such as Kimberley from Early Jurassic to Late Cretaceous times is of palaeontological importance because they contain fossilised remains of fish, frogs, turtles, crustaceans etc. They also contain vegetation and fauna such as dinosaurs, birds, angiosperm leaves and pollens.

Almond (2013) and Almond and Pether (2009) found out that the Late Caenozoic biotas of Miocene age and younger are also recorded from relict bands and patches of sediments (e.g. consolidated gravels) deposited by ancient river networks that drained the subcontinental interior. The preserved thick fluvial gravels found along the Vaal, Orange and Olifants Rivers yielded sparse bones and teeth of large mammals like proboscideans for example elephants and mastodonts, rhinos, bovids, horses and carnivores), reptiles (crocodiles), freshwater molluscs and petrified wood that are well preserved. Early to Mid-Miocene age vertebrate fauna that are about 19 to 17 million years old have been found in the Arrisdrift Formation terrace gravels along the north bank of the lower Orange (Amolnd 2011; Almond and Pether 2009).

The offshore fossil record of the Northern Cape contain marine fossils dating from the early evolutionary phases of the Atlantic Ocean (Late Jurassic / Cretaceous). A two kilometre square area of Late Cretaceous (c. 86 Ma) outcrop featuring abundant tree trunks exposed in situ on the seabed of the Namaqualand shelf was discovered.

8. CONCLUSION AND RECOMMENDATIONS

The literature review has revealed that the study area is located within the **Dwyka and Ecca Group.** The Dwyka Group is largely unfossiliferous that contain thin intervals of interglacial and post-glacial mudrocks that yield sparse fossils of marine invertebrates

and fish (for example near Douglas) as well a small range of trace fossils generated by arthropods and fish. Reddish sandy and pebbly glacial outwash sediments contain plant fossils (leaves, wood and other debris) of the Glossopteris Flora. On the other hand sediments of the Ecca Group in the Northern Cape contain a wide range of fossils, from petrified tree trunks, pollen, spores and other Glossopteris flora plant debris that was blown or rafted offshore during storms to moderately diverse trace fossil assemblages (Almond and Pether 2008). Many of these traces are attributable to fish or non-marine arthropod groups such as crustaceans, king crabs and predatory eurypterids (water scorpions), the last of which reached lengths of two meters or more. There is also a small range of molluscan, crustacean and insect body fossils, primitive bony fish, and – best known of all – well-preserved skeletons of aquatic mesosaurids. These small swimming reptiles in Northern Cape were found near Kimberley in the late nineteenth and early twentieth centuries (Almond and Pether 2008).

The nature of the proposed development is such that in the few areas not disturbed by previous mining, and if there was to be deep level mining, there is always a chance of striking fossil-bearing rocks. The possibility of finding fossils in and around the proposed area is high and therefore the Environmental control officer should be aware of the potential to find important fossils and should periodically monitor all major excavations. In the event of major discovery of fossil finds, the fossils should be safeguarded preferably in situ and reported to the relevant heritage resources authority so that appropriate mitigation by a palaeontologist can be considered and implemented. These recommendations must form part of the environmental management planning (EMP).

A **Fossil Finds Procedure** is appended to this report.

9. QUALIFICATIONS & EXPERIENCE OF THE AUTHOR

Specialist Details- Specialised in Palaeobotany which is a branch of Palaeontology dealing with the recovery and identification of plant remains from geological contexts, and their place in the reconstruction of past environments and the history of life. Palaeobotany includes the study of terrestrial plant fossils as well as the study of

marine autotrophs, such as algae. A closely related field to palaeobotany is palynology, the study of fossil and extant spores and pollen. My PhD thesis was on the palaeoecology of based on anthracology from Great Zimbabwe. Paleoecology uses data from fossils and subfossils to reconstruct the ecosystems of the past. It includes the study of fossil organisms in terms of their life cycle, their living interactions, their natural environment, their manner of death, and their burial.

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