BASIC PALAEONTOLOGICAL ASSESSMENT

PROPOSED MINING OF SILLIMANITE ON THE FARM WORTEL 42

VAN ZYL SILLIMANITE

Letter of Recommendation for Exemption from Palaeontological Studies

Khâi-Ma Local Municipality, Namakwa District Municipality, Namaqualand Magisterial District, Northern Cape Province

REFERENCE NUMBER: NC 30/5/1/1/2/1/10771 MP

SAHRA CASE ID: 14046

By

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Prepared at the Request of

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CLIENT

Van Zyl Sillimanite

12 NOVEMBER 2019

SUMMARY

Van Zyl Mining (Pty) Ltd. proposes to mine the sillimanite resources on the farm Wortel 42 near Aggeneys (Figure 1).

The Mining Right Application Area is near the southern corner of Wortel 42 (Figure 2) and is approximately 5 ha in extent. The proposed mining is a continuation and extension of previous sillimanite mining in the disturbed area. Sites Alternative 1 and Alternative 2 (Preferred) have similar footprints in this existing mining area. Alternative 3 is an area of previous mining to the north, but is considered unsuitable.

The proposed mining targets the sillimanite mineralization in the bedrock of the Aggeneys Subgroup which is mainly in the Wortel Formation (Figure 2). The very old bedrock, and the stockpiled material from previous mining, is unfossiliferous.

The mining will involve some shallow disturbance of the surficial deposits. However, such disturbance is of a relatively minor nature and the anticipated impact on palaeontological resources is rated as LOW (Appendix 1), due to the expected, very sparse occurrence of fossil bone material in the thin regolith cover of the bedrock outcrops.

No additional palaeontological interventions are required, due to the unfossiliferous nature of the bedrock and the limited palaeontological resource potential of surficial cover on the bedrock outcrops.

Notwithstanding, although improbable, a chance occurrence of archaeological or fossil material cannot be entirely dismissed.

It is recommended that a requirement to be alert for possible fossil materials and buried archaeological material be included in the Environmental Management Plan (EMP) for the proposed mining operations. As part of Environmental and Health & Safety awareness training, personnel must be instructed to be alert for the occurrence of fossil bones, archaeological material and of unrecorded burials.

Should Stone Age artefacts and fossil bone and teeth fragments be encountered in the surficial deposits, work must cease at the site. SAHRA and/or the McGregor Museum, Kimberley, must be informed and supplied with contextual information. SAHRA and an appropriate specialist palaeontologist will assess the information and liaise with the mine owner, the environmental consultants and the ECO and a suitable response will be established.

CONTENTS

1 BACKGROUND

Van Zyl Mining (Pty) Ltd. proposes to mine the sillimanite resources on the farm Wortel 42 near Aggeneys (Figure 1). Heritage Contracts and Archaeological Consulting CC (HCAC) has been appointed to undertake the Heritage Impact Assessment (HIA) for the proposed mining. This brief report is part of the HIA and its intention is to provide a summary of the main aspects of the geology and the palaeontological sensitivity of the affected formations.

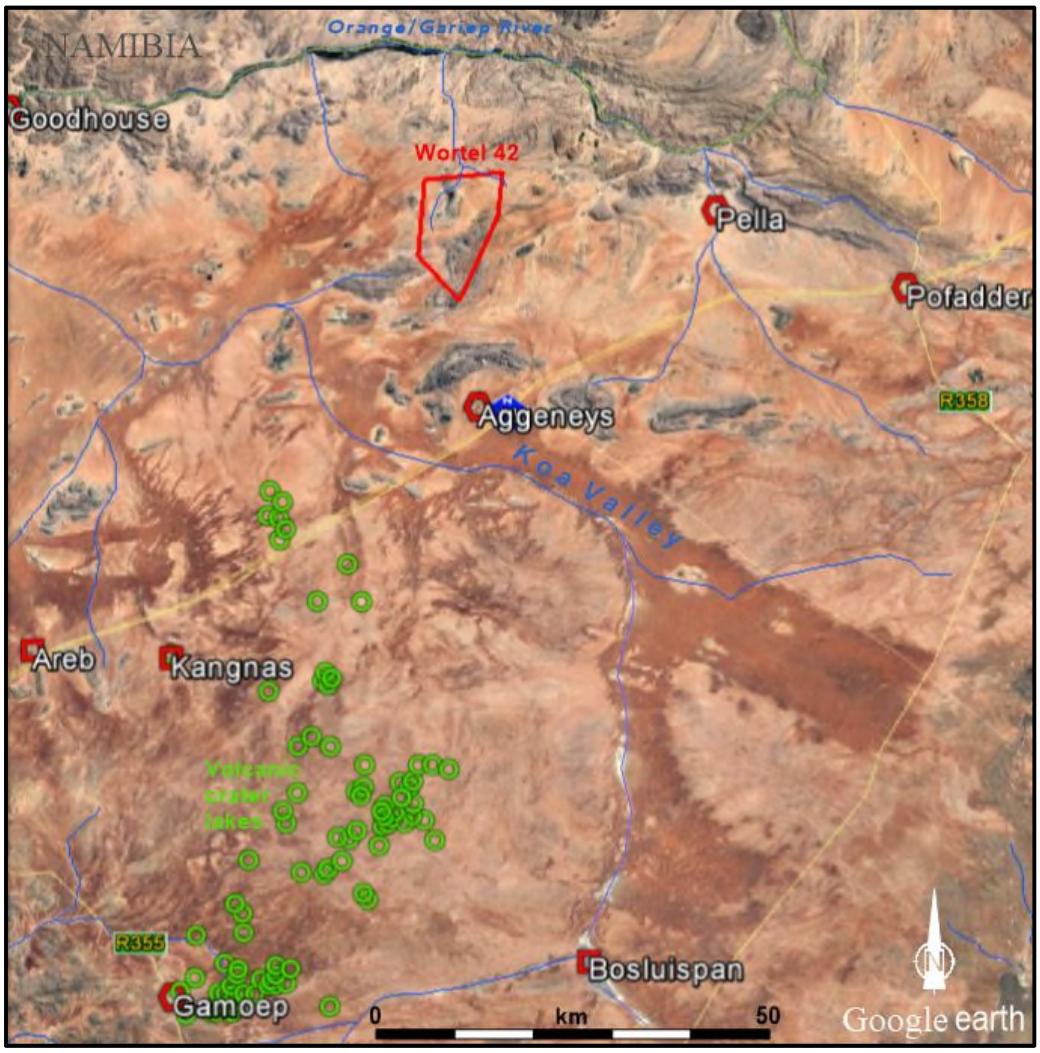

Figure 1. Location of the farm Wortel 42 in the wider setting of Bushmanland.

2 LOCATION

The property Wortel 42 is located ~15 km north of Aggeneys and ~30 km west of Pella. in the Khâi-Ma Local Municipality, Namakwa District Municipality, Namaqualand Magisterial District, Northern Cape.

1:50 000 Topo-cadastral Sheet 2918BB AGGENEYS. CD NGI.

1:250 000 Topo-cadastral Sheet 2918 POFADDER. CD NGI.

1:250 000 Geological Sheet 2918 POFADDER. Council for Geoscience (CGS).

Co-ordinate of Wortel homestead: -29.034653 °S / 18.842448 °E.

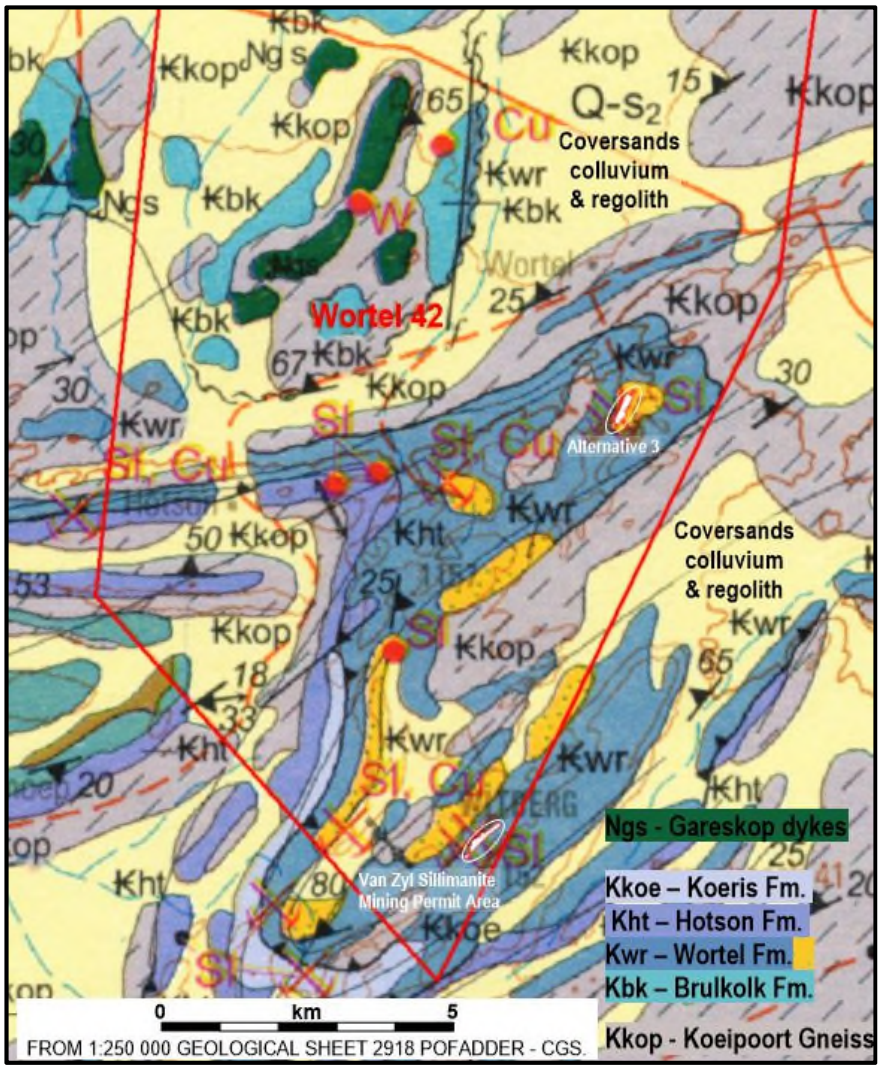

Figure 2. Geology of the Project Area, with mining sites indicated.

3 LOCALITY PLAN

The Mining Right Application Area is near the southern corner of Wortel 42 (Figure 2) and is approximately 5 ha in extent. The proposed mining is a continuation and extension of previous sillimanite mining in the disturbed area. Sites Alternative 1 and Alternative 2 (Preferred) have similar footprints in this existing mining area. Alternative 3 is an area of previous mining to the north, but is considered unsuitable due to the low grades of sillimanite and ecological constraints (in a Critical Biodiversity Area and an ecological support area).

4 DESCRIPTION OF THE PROPOSED ACTIVITY

The hard rock of the Wortel Formation will be fragmented by blasting and the liberated material is then loaded and hauled to the static crushing and screening plants. The sillimanite will be stockpiled and transported to clients via trucks and trailers. All mining activities will be contained within the boundaries of the site.

5 PALAEONTOLOGICAL HERITAGE RESOURCES

The bedrock of the area comprises the basement Koeipoort Gneiss, dating from ~1800 Ma (Ma = million years ago) and the metamorphosed (cooked up) sediments (metasediments) of

the Bushmanland Group, Aggeneys Subgroup, *viz*. the Brulkolk, Wortel, Hotson and Koeris formations (Figure 2), which date to between 1600-1200 Ma (Bailie *et al*., 2007). These rocks were then intruded by molten-rock forming the Gareskop dykes.

Between the outcrops of bedrock inselbergs is a buried bedrock topography of ancient drainages that are now filled with a variety of deposits, depicted on the geological map in pale yellow and labelled Q-s_2 (Figure 2). These deposits include fluvial gravels and sands, local lacustrine and pan deposits, alluvial fan deposits, colluvial deposits and aeolian sands. Within these deposits are fossil soils (palaeosols) marking palaeosurfaces formed during periods of surface stability when pedocretes such as calcrete formed in the soil profile. Boreholes in these palaeovalleys reveal thicknesses of sand and grit up to ~140 m (Rogers, 1915a). The fossil finds discovered within these deposits in the wider area enrich the appreciation of the culturally sacred nature of the Bushmanland landscape.

The ancientness of the landscape is evident in the preservation of numerous volcano crater lake deposits in the Kangnas-Gamoep area (Figure 1). Radiometric dating indicates a late Cretaceous to Paleocene age range of ~80 to 56 Ma for these volcanoes (Verwoerd & De Beer, 2006). Incredibly, this implies that the essentials Bushmanland landscape are that old and not much erosion has occurred subsequent to the volcanic eruptions. This is the main subcontinental palaeosurface formed after the breakup of Gondwana and massive erosion since ~120 Ma, dubbed the 'African Surface' (Partridge & Maud, 1987).

The crater lake mudstones from the Banke pipe (near Platbakkies) have provided a rich fossil pollen floral assemblage, fossil leaves and wood, insects and frogs. The fossil pollen indicates a dry subtropical forest of podocarps (yellowwoods) and araucarians (monkey puzzle trees now extinct in Africa), with an understorey of Restionaceae, Proteaceae and Ericaceae representing early Cape Floristic Region taxa (Scholtz, 1985).

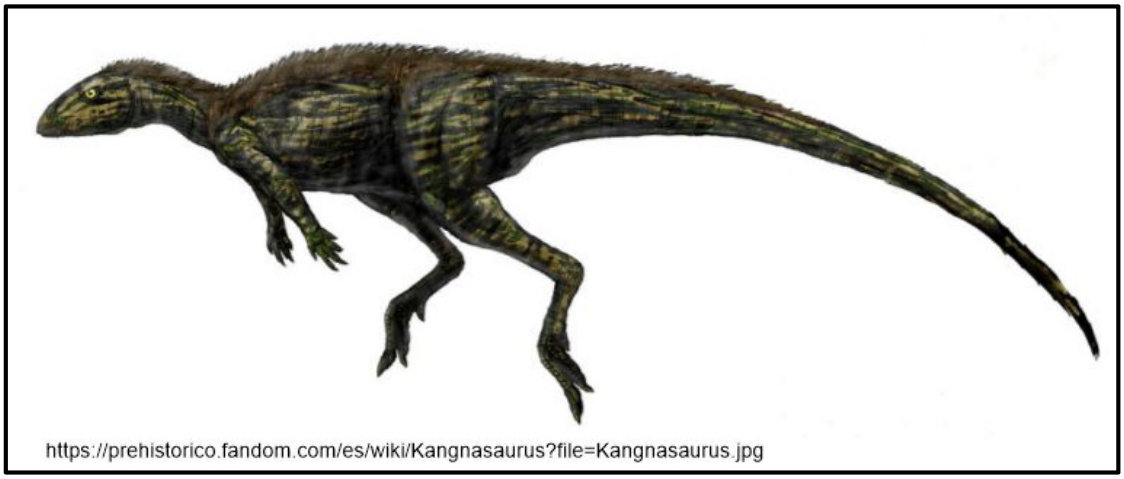

Figure 3. The bipedal, herbivorous dryosaurid dinosaur *Kangnasaurus*.

The teeth and bones of a dinosaur named *Kangnasuarus coetzeei* (Figure 3) were found in a well dug on the farm Kangnas 77 (Figure 1) (Rogers, 1915; Haughton, 1915). It was first thought that this find dated the initial infill of the Bushmanland palaeo-drainages to the Late Cretaceous (Rogers, 1915b). Subsequent investigations of the spoil from the well and a magnetic survey of the site have revealed that the occurrence is in fact in the crater lake of a volcano and not related to a buried palaeodrainage (De Wit *et al*., 1992).

A prominent, broad “fossil” valley, the Koa River, traverses the region, its course marked by red dunes and a series of pans, of which Bosluispan is prominent (Figure 1). The Koa River was either a major tributary of the Proto-Orange River or was the course of the actual Orange River when it took a southerly route to the Atlantic (De Wit *et al*., 2000). The basal fluvial deposits are fossiliferous. At Bosluispan the basal fluvial gravels and sands contain a faunal assemblage that indicates a mid-Miocene age of ~16 Ma for the sediments. The fossils include *Gomphotherium*, an extinct proboscidean, bovids, giraffids, a rhinocerotid, tortoises, rodents, crocodile teeth and catfish (Macey *et al.*, 2011). The fauna indicates a warmer and more humid climate and the presence of both browsers and grazers suggests riverside woodlands with grassland in the wider area. To the east in the linked Geelvloer palaeovalley the basal gravels contain bones of Miocene anthracotheres, an extinct hippo-like amphibious herbivore. Fossil wood indicates a tropical/subtropical wet climate with low seasonality (Bamford, 2000).

The ~16 Ma age of the Koa River fauna corresponds with the Mid Miocene Climatic Optimum, a warm interval recognized globally (Zachos *et al*., 2001). During this period of global warming substantial melting of polar ice raised sea level and the corresponding palaeoshoreline of the highest sea level elevation attained at ~16 Ma is now uplifted to 90 m asl. along the West Coast, as exemplified by sea cliffs and the marine deposits of Kleinzee Formation which contain an extinct tropical molluscan fauna. The lower Orange River valley was flooded by the rising sea level forming a large estuary, while upstream the valley was backfilled by accumulating sediments, some of which are preserved as the high-level “Proto-Orange” terraces in which a world-renowned, rich fossil fauna has been found at Arrisdrift and Auchas on the north bank (Pickford & Senut, 2003).

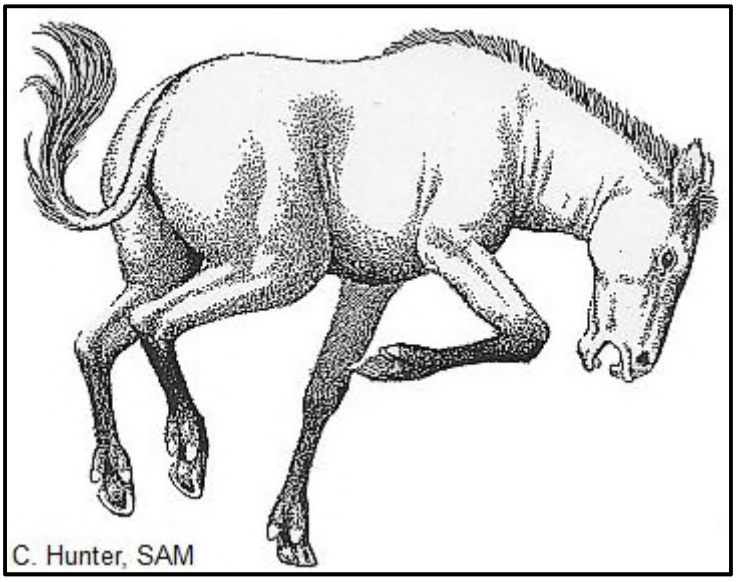

Figure 4. *Hipparion*. (By Cedric Hunter, Iziko South African Museum).

At Areb (Figure 1) the teeth of the extinct three-toed horse *Hipparion namaquense* (Figure 4) were found in granitic grits underlying a 15 m thickness of multiple calcretes (Haughton, 1932; Pickford *et al*., 1999). In East Africa similar teeth occur in deposits dated to 6-4 Ma (latest Miocene/early Pliocene). Pickford *et al*. (1999) suggest that the Pliocene Bushmanland was still relatively humid and characterized by fluvial erosion and that the main accumulation of

sediments in the palaeovalleys commenced in the Quaternary and was associated with aridification. This accords with the global palaeoclimatic record of the commencement of Ice Age climates since ~2.6 Ma and the intensification of cold upwelling at the coast. Fluvial deposits in the Carnarvon Leegte contain teeth of *Hipparion* and *Equus* (zebra), the latter indicating that these deposits are younger than 2.6 Ma, *i.e*. are of Quaternary age

6 ANTICIPATED IMPACTS ON PALAEONTOLOGICAL HERITAGE RESOURCES

The mining targets the sillimanite mineralization in the bedrock of the Aggeneys Subgroup which is mainly in the schistose parts of the Wortel Formation (Figure 2, deep yellow with dots). The very old bedrock is unfossiliferous.

The mining will involve some shallow disturbance of the surficial deposits. However, such disturbance is of a relatively minor nature and the anticipated impact on palaeontological resources is rated as LOW (Appendix 1), due to the expected, very sparse occurrence of fossil bone material in the thin regolith cover of the bedrock outcrops.

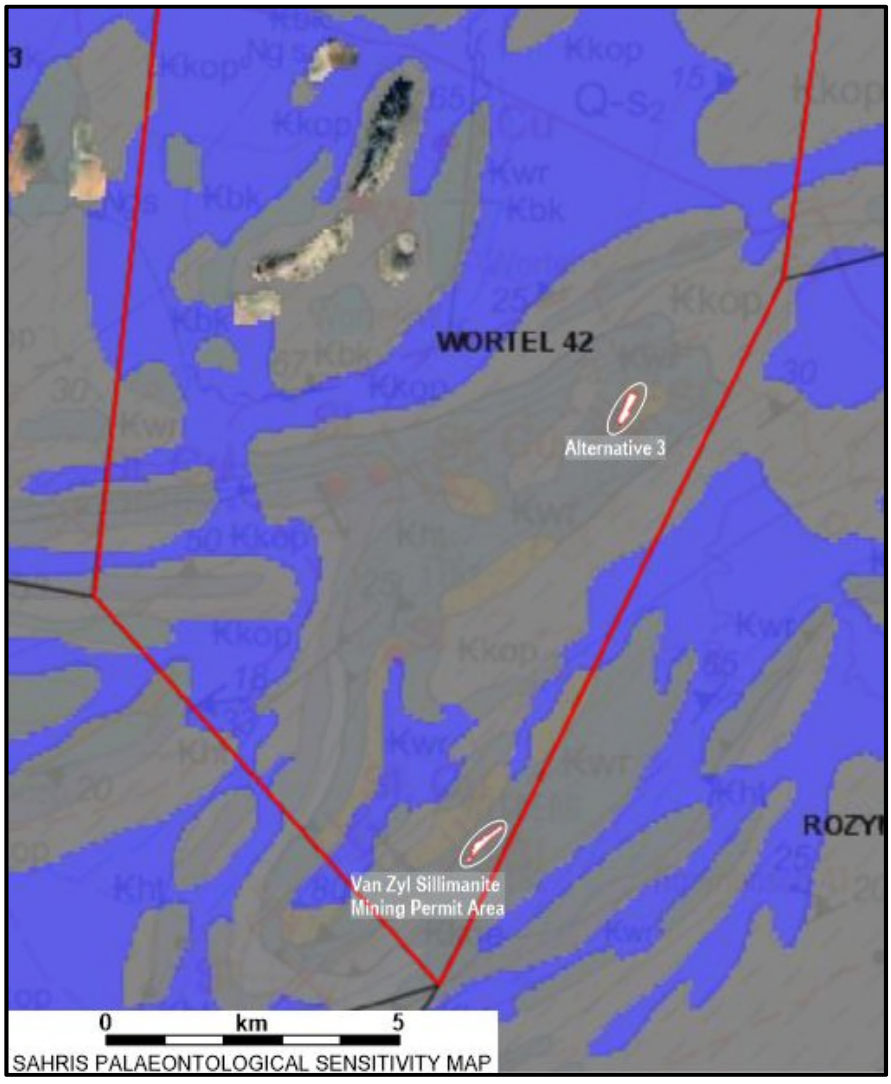

Figure 5. Palaeontological sensitivity of the Project Area. Grey – no palaeontological studies required. Blue - no palaeontological studies required, but a protocol for fossil finds is required. The clear patches in the north are unfossiliferous outcrops of the Gareskop intrusions.

7 RECOMMENDATIONS

No additional palaeontological interventions are required, due to the unfossiliferous nature of the bedrock and the limited palaeontological resource potential of surficial cover on the bedrock outcrops.

Notwithstanding, although improbable, a chance occurrence of archaeological or fossil material cannot be entirely dismissed.

It is recommended that a requirement to be alert for possible fossil materials and buried archaeological material be included in the Environmental Management Plan (EMP) for the proposed mining operations.

As part of Environmental and Health & Safety awareness training, personnel must be instructed to be alert for the occurrence of fossil bones, archaeological material and of unrecorded burials.

8 Fossil Finds Procedure

Should Stone Age artefacts and fossil bone and teeth fragments be encountered in the surficial deposits, work must cease at the site and the works foreman and the Environmental Control Officer (ECO) for the project must be informed immediately. Scattered, unearthed parts/fragments of the find must be retrieved and returned to the main find site which must be protected from further disturbance.

SAHRA and/or the McGregor Museum, Kimberley, must be informed and supplied with contextual information:

- A description of the nature of the find.
- Detailed images of the finds (with scale included).
- Position of the find (GPS) and depth.
- Digital images of the context. *i.e*. the excavation (with scales).

SAHRA and an appropriate specialist palaeontologist will assess the information and liaise with the mine owner, the environmental consultants and the ECO and a suitable response will be established.

9 REFERENCES

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Zachos, J., Pagani, M., Sloan, L., Thomas, E., Billups, K., 2001. Trends, rhythms, and aberrations in global climate 65 Ma to present. *Science* **292**: 686–693.

10 APPENDIX 1. PALAEONTOLOGICAL SENSITIVITY RATING

Palaeontological Sensitivity refers to the likelihood of finding significant fossils within a geologic unit.

VERY HIGH: Formations/sites known or likely to include vertebrate fossils pertinent to human ancestry and palaeoenvironments and which are of international significance.

HIGH: Assigned to geological formations known to contain palaeontological resources that include rare, well-preserved fossil materials important to on-going palaeoclimatic, palaeobiological and/or evolutionary studies. Fossils of land-dwelling vertebrates are typically considered significant. Such formations have the potential to produce, or have produced, vertebrate remains that are the particular research focus of palaeontologists and can represent important educational resources as well.

MODERATE: Formations known to contain palaeontological localities and that have yielded fossils that are common elsewhere, and/or that are stratigraphically long-ranging, would be assigned a moderate rating. This evaluation can also be applied to strata that have an unproven, but strong potential to yield fossil remains based on its stratigraphy and/or geomorphologic setting.

LOW: Formations that are relatively recent or that represent a high-energy subaerial depositional environment where fossils are unlikely to be preserved, or are judged unlikely to produce unique fossil remains. A low abundance of invertebrate fossil remains can occur, but the palaeontological sensitivity would remain low due to their being relatively common and their lack of potential to serve as significant scientific resources. However, when fossils are found in these formations, they are often very significant additions to our geologic understanding of the area. Other examples include decalcified marine deposits that preserve casts of shells and marine trace fossils, and fossil soils with terrestrial trace fossils and plant remains (burrows and root fossils)

MARGINAL: Formations that are composed either of volcaniclastic or metasedimentary rocks, but that nevertheless have a limited probability for producing fossils from certain contexts at localized outcrops. Volcaniclastic rock can contain organisms that were fossilized by being covered by ash, dust, mud, or other debris from volcanoes. Sedimentary rocks that have been metamorphosed by the heat and pressure of deep burial are called metasedimentary. If the meta sedimentary rocks had fossils within them, they may have survived the metamorphism and still be identifiable. However, since the probability of this occurring is limited, these formations are considered marginally sensitive.

NO POTENTIAL: Assigned to geologic formations that are composed entirely of volcanic or plutonic igneous rock, such as basalt or granite, and therefore do not have any potential for producing fossil remains. These formations have no palaeontological resource potential.

Adapted from Society of Vertebrate Paleontology. 1995. Assessment and Mitigation of Adverse Impacts to Nonrenewable Paleontologic Resources - Standard Guidelines. News Bulletin, Vol. 163, p. 22-27.

11 APPENDIX 2. DECLARATION OF INDEPENDENCE

BASIC PALAEONTOLOGICAL ASSESSMENT, PROPOSED MINING OF SILLIMANITE ON THE FARM WORTEL 42 - VAN ZYL SILLIMANITE.

Letter of Recommendation for Exemption from Palaeontological Studies.

Khâi-Ma Local Municipality, Namakwa District Municipality, Namaqualand Magisterial District, Northern Cape Province.

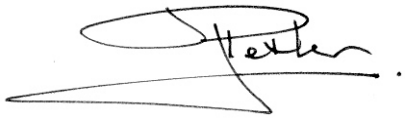
Terms of Reference

This assessment forms part of the Heritage Assessment and it assesses the overall palaeontological (fossil) sensitivities of formations underlying the Project Area.

Declaration

I …**John Pether**……, as the appointed independent specialist hereby declare that I:

- act/ed as the independent specialist in the compilation of the above report;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
- have and will not have any vested interest in the proposed activity proceeding;
- have disclosed to the EAP any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management act;
- have provided the EAP with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not; and
- am aware that a false declaration is an offence in terms of regulation 48 of the 2014 NEMA EIA Regulations.



Signature of the specialist

Date: 12 NOVEMBER 2019

12 APPENDIX 3. CURRICULUM VITAE

John Pether, M.Sc., Pr. Sci. Nat. (Earth Sci.)

Independent Consultant/Researcher recognized as an authority with 38 years' experience in the field of coastal-plain and continental-shelf palaeoenvironments, fossils and stratigraphy, mainly involving the West Coast/Shelf of southern Africa. Has been previously employed in academia (South African Museum) and industry (Trans Hex, De Beers Marine). At present an important involvement is in Palaeontological Impact Assessments (PIAs) and mitigation projects in terms of the National Heritage Resources Act 25 (1999) (~300 PIA reports to date) and is an accredited member of the Association of Professional Heritage Practitioners (APHP). Continues to be involved as consultant to offshore and onshore marine diamond exploration ventures. Expertise includes:

- Coastal plain and shelf stratigraphy (interpretation of open-pit exposures, on/offshore cores and exploration drilling).
- Sedimentology and palaeoenvironmental interpretation of shallow marine, aeolian and other terrestrial surficial deposits.
- Marine macrofossil taxonomy (molluscs, barnacles, brachiopods) and biostratigraphy.
- Marine macrofossil taphonomy.
- Sedimentological and palaeontological field techniques in open-cast mines (including finding and excavation of vertebrate fossils (bones).

Membership of Professional Bodies

- South African Council of Natural Scientific Professions. Earth Science. Reg. No. 400094/95.
- Geological Society of South Africa.
- Palaeontological Society of Southern Africa.
- Southern African Society for Quaternary Research.
- Association of Professional Heritage Practitioners (APHP), Western Cape. Accredited Member No. 48.

Past Clients Palaeontological Assessments

AECOM SA (Pty) Ltd.	Guillaume Nel Environmental Management Consultants.
Agency for Cultural Resource Management (ACRM).	Klomp Group.
AMATHEMBA Environmental.	Megan Anderson, Landscape Architect.
Anél Blignaut Environmental Consultants.	Ninham Shand (Pty) Ltd.
Arcus Gibb (Pty) Ltd.	PD Naidoo & Associates (Pty) Ltd.
ASHA Consulting (Pty) Ltd.	Perception Environmental Planning.
Aurecon SA (Pty) Ltd.	PHS Consulting.
BKS (Pty) Ltd. Engineering and Management.	Resource Management Services.
Bridgette O'Donoghue Heritage Consultant.	Robin Ellis, Heritage Impact Assessor.
Cape Archaeology, Dr Mary Patrick.	Savannah Environmental (Pty) Ltd.
Cape EAPrac (Cape Environmental Assessment Practitioners).	Sharples Environmental Services cc
CCA Environmental (Pty) Ltd.	Site Plan Consulting (Pty) Ltd.
Centre for Heritage & Archaeological Resource Management (CHARM).	SRK Consulting (South Africa) (Pty) Ltd.
Chand Environmental Consultants.	Strategic Environmental Focus (Pty) Ltd.
CK Rumboll & Partners.	UCT Archaeology Contracts Office (ACO).
CNdV Africa	UCT Environmental Evaluation Unit
CSIR - Environmental Management Services.	Urban Dynamics.
Digby Wells & Associates (Pty) Ltd.	Van Zyl Environmental Consultants
Enviro Logic	Western Cape Environmental Consultants (Pty) Ltd, t/a ENVIRO DINAMIK.
Environmental Resources Management SA (ERM).	Wethu Investment Group Ltd.
Greenmined Environmental	Withers Environmental Consultants.

Stratigraphic consulting including palaeontology

Afri-Can Marine Minerals Corp	Council for Geoscience
De Beers Marine (SA) Pty Ltd.	De Beers Namaqualand Mines.
Geological Survey Namibia	IZIKO South African Museum.
Namakwa Sands (Pty) Ltd	NAMDEB

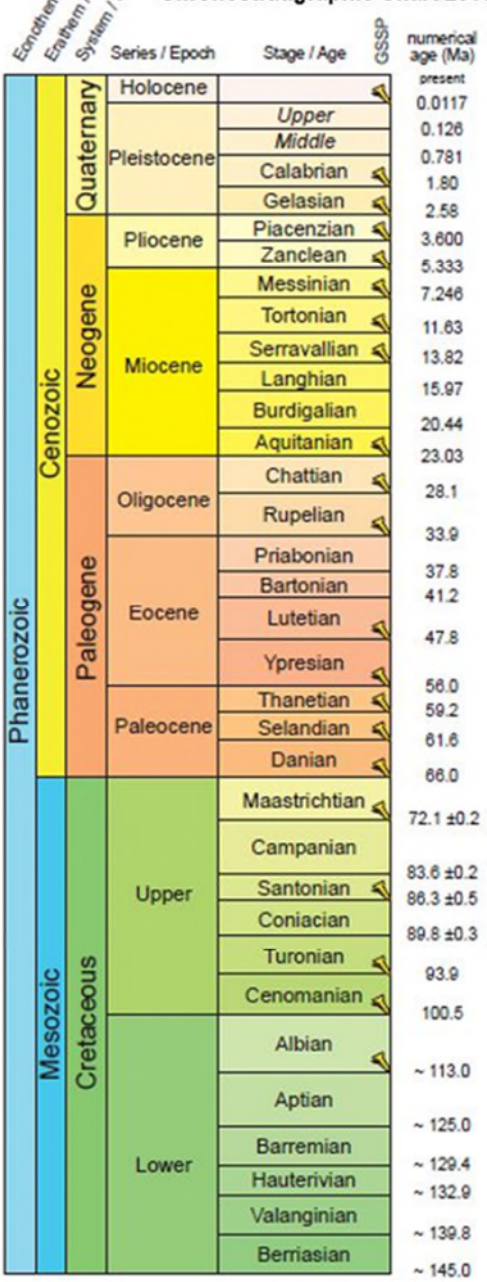
13 APPENDIX 4 – GEOLOGICAL TIME SCALE

For more detail see www.stratigraphy.org.

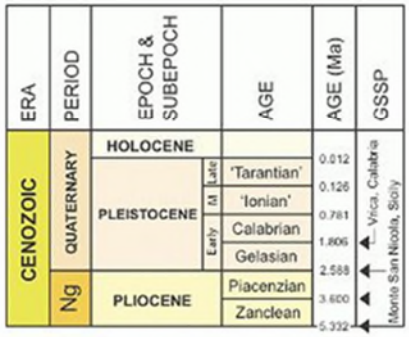
ka: Thousand years or kilo-annum (10^3 years). Implicitly means "ka ago" *i.e.* duration from the present, but "ago" is omitted. The "Present" refers to 1950 AD. Not used for durations not extending from the Present. For a duration only "kyr" is used.

Ma: Millions years, mega-annum (10^6 years). Implicitly means "Ma ago" *i.e.* duration from the present, but "ago" is omitted. The "Present" refers to 1950 AD. Not used for durations not extending from the Present. For a duration only "Myr" is used.

Mesozoic and Cenozoic Chronostratigraphy
From: International Commission on Stratigraphy.
Chronostratigraphic Chart 2016-12.pdf



ICS-approved 2009 Quaternary (SQS/INQUA) proposal



Holocene: The most recent geological epoch commencing 11.7 ka till the present.

Pleistocene: Epoch from 2.6 Ma to 11.7 ka.
Late Pleistocene 11.7–126 ka.
Middle Pleistocene 135–781 ka.
Early Pleistocene 781–2588 ka.

Quaternary: The current Period, from 2.6 Ma to the present, in the Cenozoic Era.
The Quaternary includes both the Pleistocene and Holocene epochs. As used herein, early and middle Quaternary correspond with the Pleistocene divisions, but late Quaternary includes the Late Pleistocene and the Holocene.