Palaeontological Impact Assessment for the Proposed Prospecting Rights Application on Farm Koegas, Northern Cape Province

Phase 1 Study

For

Mavu Group (Pty) Ltd

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1. EXECUTIVE SUMMARY

Dr. Nonhlanhla Vilakazi was appointed by Mavu Group (Pty) Ltd to conduct a PIA for the proposed prospecting rights as part of specialists (inputs) Impact Assessment studies required to fulfil the BAR process and its requirements. No fossils where discovered during the impact assessment phase of the project.

2. INTRODUCTION

Nonhlanhla Vilakazi was appointed to undertake a Phase 1 Palaeontological Impact Assessment (PIA), assessing the potential Palaeontological Impact of the proposed prospecting rights within the Siyathemba Local Municipality, Pixley ka Seme District Municipality, Northern Province.

3. PROJECT BACKGROUND

The aim of this project is to prospect for minerals in the Pixley ka Seme District. The project is situated in the Siyathemba Local Municipality (see Figure 1).

4. LEGISLATIVE FRAMEWORK

4.1 Constitution of the Republic of South Africa, Act 108 of 1996

Section (24) sets out the right of all to an environment that is not harmful to their health or wellbeing and to have an environment protected for the benefit of present and future generations

4.2 National Environmental Management Act No. 107 of 1998

Everyone has the right to have the environment protected, for the benefit of present and future generations through reasonable legislative and other measures that—

- prevent pollution and ecological degradation;
- promote conservation; and
- secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development

4.3 National Heritage Resources Act, No. 25 Of 1999

This Act provides for the preservation of heritage resources which, according to the Act, are places or objects of cultural significance, including places or objects of esthetic, architectural, geographical, science, social, spiritual, linguistic and technological value. Permits are required for the disruption, demolition or destruction of any heritage site, archeological site or palaeontological site, burial ground, grave or any public monument or memorial that may be found during the construction process.

The Act identifies what is defined as a heritage resource, the criteria for establishing its significance and lists specific activities for which a heritage specialist study may be required. In this regard, categories of development listed in Section 38 (1) of the NHR Act are:

- The construction of a road, wall, powerline, pipeline, canal or other similar form of linear development or barrier exceeding 300m in length;
- The construction of a bridge or similar structure exceeding 50m in length;
- Any development or other activity which will change the character of the site;
- Exceeding 5000 m² in extent;
- Involving three or more existing erven or subdivisions thereof;
- Involving three or more subdivisions thereof which have been consolidated within the past five years;
- Costs of which will exceed a sum set in terms of regulations by the South African Heritage Resources Agency (SAHRA).
- The rezoning of a site exceeding 10 000 m²
- Any other category of development provided for in regulations by the South
- African Heritage Resources Agency (SAHRA).

All excavation related activities are to be stopped if any objects exposed during this activity, in addition, the archaeologist must be called to the site for inspection and potential rescue. Under no conditions will any item be damaged or removed without the permission of the South African Heritage Resources Agency.

5. ASSESSMENT METHODOLOGY (IN COMPLIANCE WITH THE NHRA (ACT NO. 25 OF 1999) AND SAHRA GUIDELINES):

- Identify, map & provide background to heritage finds/localities within the vicinity of the affected area via desktop assessment.
- Provide an assessment, with Field Rating criteria, of the significance of heritage resources in the region via desktop assessment.
- Identify and map all possible heritage finds/localities within the affected area / footprint via pedestrian survey.
- Provide an assessment with Field Rating criteria, of the potential impact by the development on heritage resources within the affected area.
- Provide appropriate mitigation measures and recommendations for heritage resources identified within the area of impact, including providing of identification training workshop to ECO's, chance find protocols and monitoring procedures

6. PROJECT AREA DESCRIPTION

Siyathemba Local Municipality is a municipality in Pixley ka Seme, South Africa's Northern Cape Province. This local municipality incorporates the previous municipal areas of Prieska, Marydale and Niekerkshoop.

Figure 1: Map of areas in the Siyathemba Local Municipality.

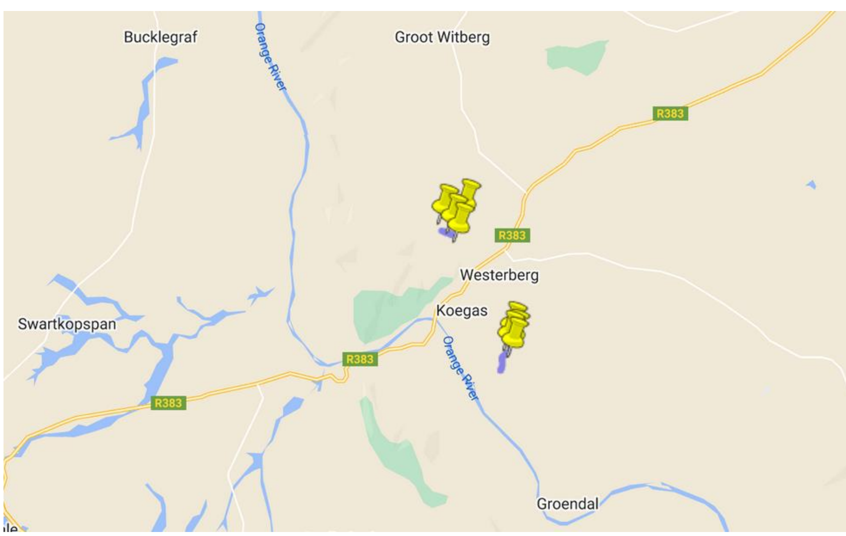

Figure 2: Map of proposed site and relevant areas (marked with yellow pins).

7 GEOLOGICAL CONTEXT

7.1 Kaapvaal Craton

Assuming some form of plate tectonics was at work, the formation of the core of the approximately 3.1 Ga Kaapvaal craton can be attributed to initial (approximately 3.6-3.4 Ga) thin-skinned overthrusts within ocean - and arc adjustments and subsequent (ca. 3.3-3.2Ga) merging of displaced oceanic and arcuate terranes accompanied by significant granitoid magmatism (de Wit et al. 1992). It is thought that most of the terraneous accretion that formed the Kaapvaal craton occurred along two prominent ENE-WSW suture zones, the Barberton Lineament (BL) and the Thabazimbi-Murchison Lineament (TML) between 3.23 and 2.9 Ga (Poujol et al 2003; Anhaeusser 2006; Robb et al. 2006). U-Pb and Lu-Hf isotope data from zircons indicate that the Kaapvaal craton consists of at least four different terranes (Barberton-North [BN] and Barberton-South [BS] on either side of the BL; Murchison- Northern Kaapvaal [MNK] north of the TML and Limpopo Central Zone [LCZ] see Figure 1) which underwent different crustal evolutions and successively accreted at c.3.23 (BN and BS), 2.9 (composite BN-BS and MNK) and 2.65-2.7 became Ga (three existing terranes and LCZ) (Zeh et al. 2009).

The Murchison greenstone belt, accumulating from approximately N to S along the NE margin of the Kaapvaal core, was denoted by c. 3.1 2.9 Ga Ga mafic and granitic magmatism within an arc subduction system (Poujol and Robb 1999; Poujol et al. 2003; Robb et al. 2006; Zeh et al. 2009) and formed part of the MNK composite terrane (Figure 1).), along with the greenstone belt of Pietersburg. between c. 2.7 and 2.6 Ga, further accretion occurred from the north, with the juxtaposition of an exotic terrane, the Limpopo Mobile Belt (LMB) Central Zone, along an ENE-WSW trending inward-dipping leaf-slip shear zone, the Palala -Zoetfontain shear zone. Rocks of the Southern Marginal Zone (SMZ) of this mobile belt, representing high-grade equivalents of the granitic-greenstone craton sequences, have been thrust onto the Kaapvaal craton along the Hout River shear zone at 2691–2620 Ma (Barton and Van Reenen 1992; Barton et al 1992; Kreissig et al 2001). Western accretion onto the Kaapvaal core took place around c. 2-8-2.72 Ga, along a suture zone now preserved as the Colesburg magnetic lineament (Tinker et al. 2002).

7.2 Ghaap Group

The Transvaal Supergroup in the western Griqualand Basin in Northern Cape Province has conventionally been subdivided into the basal Ghaap Group and the overlying Postmasburg Group. The two groups have been correlated with the Chuniespoort and Pretoria groups, respectively, in the Transvaal Basin and are said to be separated by a major unconformity (Beukes, 1983 and Beukes and Smit, 1987). The Ghaap Group is divided into the Schmidtsdrif, Campbellrand, Asbestos Hills and Koegas subgroups.

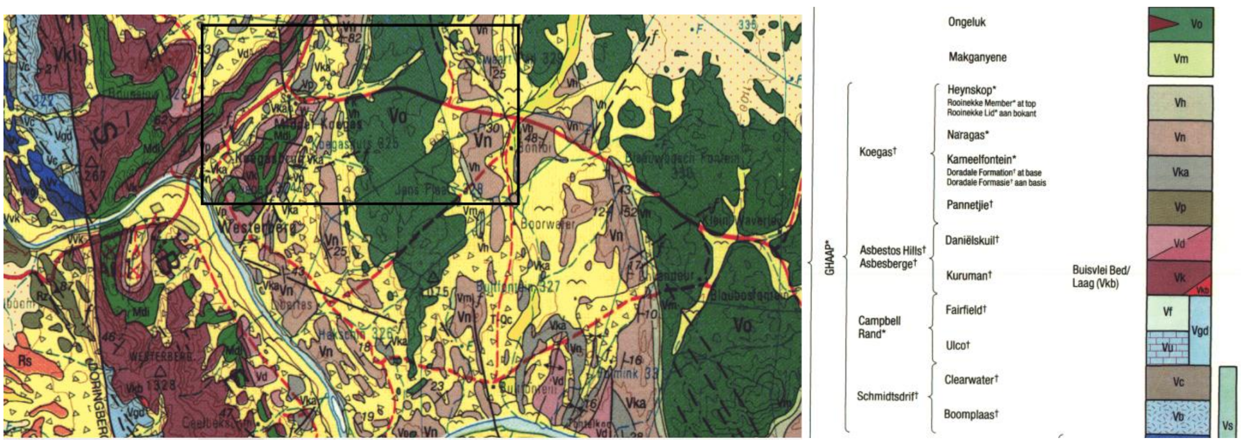

Figure 3: Geological Map of the area around the Farm Koegas. The location of the proposed project is indicated with the black rectangle. Map enlarged from the Geological Survey 1: 250 000 Map 2922 Prieska.

7.3 Schmidtsdrif Subgroup

The base of the Schmidtsdrif subgroup unconformably overlies either the crystalline Archean basement or lavas of the Ventersdorp supergroup (Beukes, 1983). This subgroup consists of shale, quartzites, siltstones and lavas. The latter gave a single zircon Pb evaporation age of 2642 ±3 Ma (Walraven and Martini, 1995). The predominantly clastic nature of the Schmidtsdrif Subgroup contrasts with the rest of the Ghaap Group, which consists of a thick succession of stromatolitic carbonates (Campbellrand Subgroup dolomites and limestones) overlain by transgressive banded iron formations (BIFs) of the Asbestos Hills Subgroup (Grobbelaar et al., 1995).

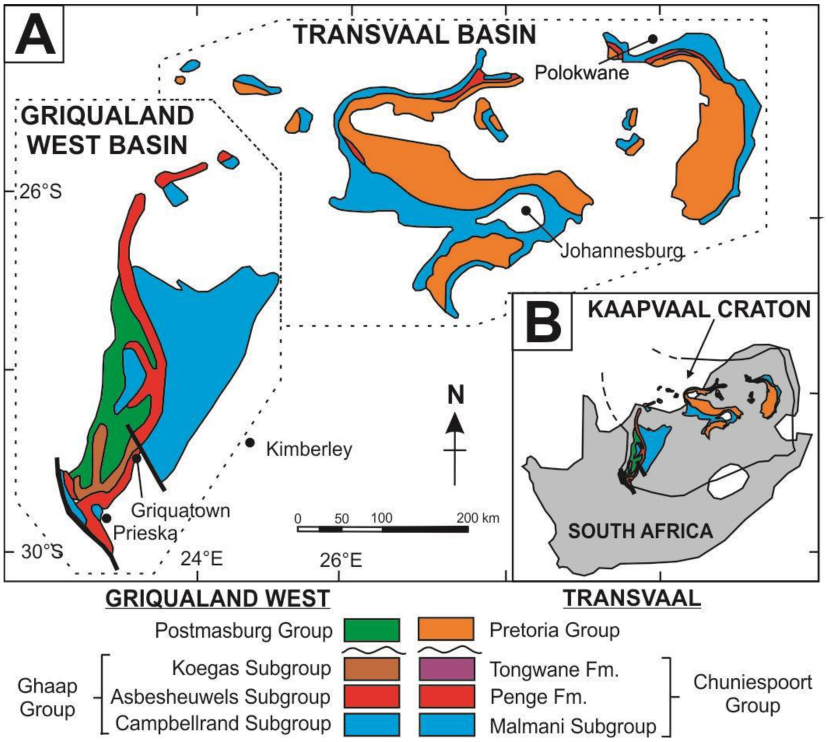

Figure 4: Regional map of the Transvaal Supergroup; (A) the major stratigraphic subdivisions of the Transvaal Supergroup in South Africa; (B) position of the Transvaal and Griqualand West basins on the Kaapvaal Craton (modern day South Africa shaded). Adapted from Sumner and Grotzinger, 2004.

7.4 Campbellrand Subgroup

The onset of widespread carbonate accumulation was reported to be diachronic across the Kaapvaal craton. Based on radiometric ages (2555 ±19 Ma, SHRIMP U-Pb zircon) recovered from volcanic tuff layers, Altermann (1997) and Altermann and Nelson (1998) concluded that drowning began in the southwestern Prieska Subbasin of what was then Griqualand West Basin from the east Ghaap platform by a 950 m high escarpment resulting from active faulting in the Griquatown area. As relative sea levels rose, deep-sea shales of the Naute Formation were deposited in the Prieska sub-basin, while shallow-water carbonate precipitation began on the Ghaap Platform and Transvaal Basin (Altermann, 1997).

7.5 Asbestos Hills Subgroup

The conformably overlying Asbestos Hills subgroup is predominantly BIFs and has been subdivided by Beukes (1983) into a lower orthochemical, rhythmically banded Kuruman Formation and an upper allochemical, clastic-textured, and shallow-water Griquatown Formation. A tuff layer from the Kuruman Formation has a SHRIMP UPb zircon age of 2465 ±5 Ma (Pickard, 2003) and the Griquatown Formation has a calculated SHRIMP UPb zircon age of 2432 ±31 Ma (Trendall et al., 1990).

7.6 Koegas Subgroup

The Koegas Subgroup is only developed in the southwestern part of the Prieska Basin and consists of a mixed succession of terrigeneous clastic sediments with ancillary iron formations and dolomitic bioherms (Beukes, 1983). A Pb/Pb age of 2415 ±6 Ma was determined for the Rooinekke Formation (Kirschvink et al., 2008). The ~2.4 Ga Koegas Subgroup (Transvaal Supergroup, South Africa) comprises terrigenous siliciclastic rocks intercalated with iron-rich rocks and some carbonates (Beukes, 1983). Deposition of continental siliciclastics in the Koegas Subgroup ended a period of about 150 Ma in which about 23 km of chemical sediments were deposited on the Kaapvaal craton (Ghaap Group, Beukes, 1984, 1987). Furthermore, the Koegas subgroup was deposited around the time or some time before the first postulated Paleoproterozoic glacial period (Evans et al., 1997) and the rise in oxygen during the Great Oxidation Event (Bekker et al., 2004). Clear evidence of oxygen in the atmosphere comes from red beds in the ~2.3 Ga Timeball Hill Formation (Coetzee et al., 2006) and lateritic palaeosoils at ~2.2 Ga (Beukes et al., 2002). Koegas iron formations and carbonates are typically Mn-enriched and predate the large Mn deposits of the Hotazel Formation in the Griquanland West Structural Basin (Cairncross et al., 1997). In this stratigraphic and sedimentary context, the Koegas subgroup occupies a transitional position. Koegas iron formations are similar in composition and genetics to the thick iron formations that precede it (Beukes, 1983; Moore et al., 2001).

Rocks of the Koegas Subgroup form multiple up-coarse depositional cycles from mudstones (including Fe- and Mn-rich units) to siltstones and sandstones (Beukes, 1978, 1983). The oldest cycle begins at the sharp contact between the Griquatown Iron Formation and the Pannetjie

Formation. A prominent conglomerate marks this contact (Beukes and Gutzmer, 2008). The Pannetjie Formation (50 m thick) contains an upward coarsening mudstone to sandstone sequence with increasing sandstone components from SW to NE (Beukes, 1978, 1983). Above a sharp contact, the next cycle begins with the Doradale Iron Formation (23m thick) and progresses up to the Kwakwas Formation. The latter (mudstones containing Minnesotaite and Greenalite) are 0 to 80 m wide and restricted to the distal parts of the basin. The upward coarsening siliciclastic Naragas Formation (thickness 355 m) forms the peak of the cycle. Along a SW-NE cross-section of the Naragas Formation, sandstones increase at the expense of mudstones, and sandstone grain size increases towards the NE (Beukes, 1978).

The Heynskop formation follows with a sharp base. It is 75 m thick and forms the third depositional cycle. Iron-rich lithologies dominate, but coarser siliciclastic units are more prominent in the upper section and to the NE. Above a sharp contact, the final cycle consists of the Rooinekke Iron Formation (45 m thick) and the Nelani Iron Formation (mudstone, chert, Sideritcherty gritstone and fractured clast breccias). The incision increases to the NE and the Koegas subgroup is absent on the NE of the Griquatown fault zone.

8. PALAEONTOLOGICAL CONTEXT

Carbonate rock deposits in the Late Archean Ghaap Group, South Africa, consist mainly of microbialites and stromatolites of different morphologies (Truswell and Eriksson, 1972, 1975; Beukes, 1979, 1980, 1987; Altermann, 2008). Dolomites and limestones of various non-stromatolitic facies, such as oolities and marginal conglomerates with interspersed marls, carbonate arenites and siliciclastic sediments (Altermann and Wotherspoon, 1995; Altermann and Siegfried, 1997) are also abundant. Stromatolites and the carbonate sediments in their immediate vicinity can be used for facies analysis. The morphology of stromatolites often shows vertically changing growth patterns as an expression of laterally migrating facies changes. The aggregation of these carbonate rocks implies a diverse depositional palaeoenvironment that evolved on the Late Archean platform in South Africa (Altermann, 2008).

Numerous early evidences of life have been preserved in the marine carbonates (Altermann and Schopf, 1995; Altermann, 2008). The primary mineralogy of Archean and Proterozoic carbonate rocks reflects the paleo-bioecological and carbonate saturation of seawater (Veizer et al., 1992a;

Sumner and Grotzinger, 2004; Polteau et al., 2006; Fischer et al., 2009) and the morphology of Archean **stromatolites** captures the energetic conditions of the environment (Klein et al., 1987; Altermann and Siegfried, 1997; Kazmierczak and Altermann, 2002; Altermann, 2008).Columnar stromatolites were plentiful and widespread in the Precambrian but are rare in modern marine environments (Awramik and Riding, 1988). Columnar forms represent more than half of the morphological forms described from Precambrian stromatolite assemblages (Raaben, 2006) and are usually formed in shallow subtidal to intertidal marine environments. These stromatolites of various morphologies are preserved throughout the Campbellrand Subgroup carbonate platform.

9. PALAEONTOLOGICAL IMPACT/MITIGATION

The colour scheme shown below is suggested for indicating palaeontological sensitivity classifications. This classification of sensitivity is adapted from that of Almond et al (2008, 2009) (Loock, 2014).

HIGH IMPACT	Areas where fossil bearing rock units are present with a very high possibility of finding fossils of a specific assemblage zone. Fossils will most probably be present in all outcrops and the chances of finding fossils during a field-based assessment by a professional palaeontologist are very high. Palaeontological mitigation measures need to be incorporated into the Environmental Management Plan
MODERATE SENSITIVITY	Areas where fossil bearing rock units are present but fossil finds are localised, within thin or scattered sub-units. Pending the nature and scale of the proposed development, the chances of finding fossils are moderate. A field-based assessment by a professional palaeontologist is usually warranted.

LOW SENSITIVITY	Areas where there is likely to be a negligible impact on the fossil heritage. This category is reserved largely for areas underlain by igneous rocks. However, development in fossil bearing strata with shallow excavations or with deep soils or weathered bedrock can also form part of this category.

10. RECOMMENDATION

Based on the survey and the information above, there is a probability that fossils can be found far deeper. It is therefore, **recommended that prospecting continue**. The EMPr should include a Fossil Find Protocol: if fossils are discovered after prospecting has begun, they should be rescued and a palaeontologist be asked to appraise and gather a representative sample.

11. Exposure of palaeontological material

The following protocol must be followed in the case of prospecting revealing new palaeontological material, such as a big fossil find:

The responsible officer (e.g. the ECO or contractor manager) shall inform the relevant Palaeontologist of major or unusual discoveries during prospecting, found by the Contractor Staff.

If a major *in situ* occurrence is exposed, the excavation will immediately **cease** in that area so that the discovery will not be disturbed or altered in any way until the designated specialist or scientists from the KwaZulu-Natal National Museum or their designated representatives have had a reasonable opportunity to investigate the finding.

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