PALAEONTOLOGICAL IMPACT ASSESSMENT: DESKTOP STUDY

Proposed upgrade of the N2 near Mthatha, O.R. Tambo District Municipality, Eastern Cape Province

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1. SUMMARY

The proposed upgrade of an approximately 20km - long stretch of the N2 near Mthatha, southwest of Umtata, Eastern Cape Province transects Early Triassic fluvial sediments of the Katberg Formation (Beaufort Group, Tarkastad Subgroup). These are extensively intruded by unfossiliferous igneous intrusions of the Early Jurassic Karoo Dolerite Suite. The Katberg Formation sediments are potentially fossiliferous, having yielded elsewhere a limited range of terrestrial vertebrates (bones and teeth of therapsids, primitive reptiles, amphibians *et al*.), trace fossils and vascular plants. However, in the study region some of the sediments will have been baked by the adjacent dolerite intrusions, reducing their palaeontological heritage value. Apart from fossil wood, there are few palaeontological records for the Katberg succession in the Umtata area. For these reasons, further mitigation by a professional palaeontologist is not regarded as necessary. However, the responsible ECO should be alerted to the possibility of important fossil finds, especially vertebrate teeth and bones, in new exposures of fresh (unweathered) Beaufort Group sediments. Should substantial fossil remains be found, the ECO should alert SAHRA or a professional palaeontologist at the earliest opportunity so that the fossils can be examined *in situ* and, if necessary, properly excavated.

2. INTRODUCTION & BRIEF

It is proposed to upgrade an approximately 20km long sector of the N2 freeway near Mthatha southwest of Umtata, O.R. Tambo District Municipality, Eastern Cape Province (Fig. 1). The following details have been provided by Mr Conroy van der Riet (Biotechnology & Environmental Specialist Consultancy cc, East London), who has commissioned a desktop palaeontological impact assessment for the project in accordance with the requirements of the National Heritage Resources Act, 1999:

> The proposed section to be upgraded starts approximately 41km north-east of Idutywa at S 31^{o} 50.914'; E 28^{o} 31.172', and ends approximately 10 km south-west of Mthatha at S 31^{o} 40.624'; E 28^{o} 42.465'. The project will involve the upgrading of the National Road 2 between Sitebe Komkhulu and Viedgesville located near Mthatha, to

a standard cross section with 2 x 3,7m lanes and 2 x 2,5m shoulders and a 0,5m rounding for a total formation width of 13,4m. The substandard geometric standards require that portions of the road be realigned horizontally and/or vertically in places and could exceed the current road prism and reserve. The new horizontal alignment will be on the existing alignment for most of the road except for a 2km section which will require re-alignment with a potential new or extended road prism and reserve, but still close to the existing alignment and possibly utilising existing structures, including bridges.

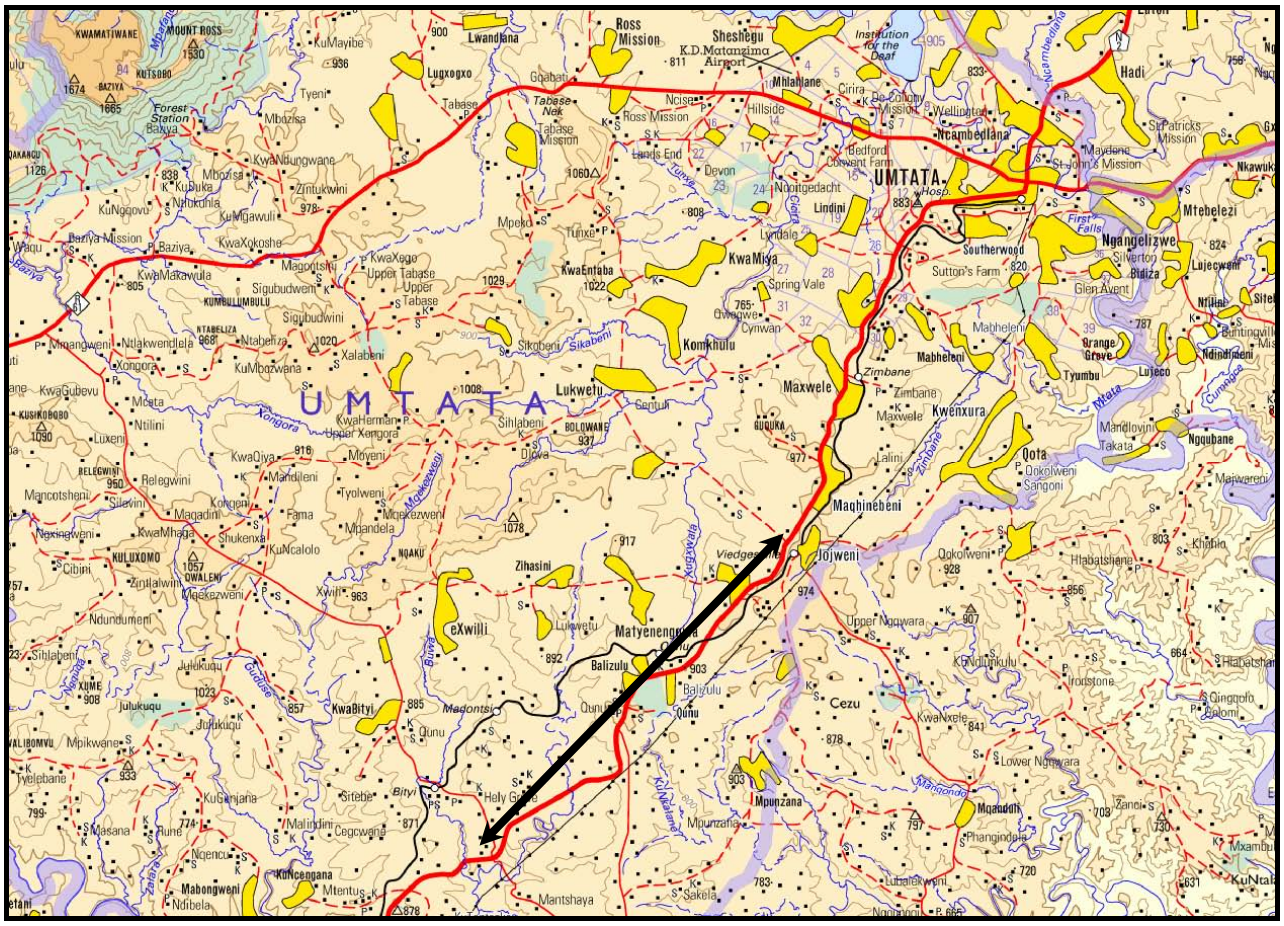

Fig. 1. Extract from 1: 250 000 map 3128 Umtata (Courtesy of The Chief Directorate of Surveys & Mapping, Mowbray) showing sector of N2 freeway southwest of Umtata to be upgraded (black arrow).

3. GEOLOGICAL BACKGROUND

The geology of the study area is shown on 1: 250 000 sheet 3128 Umtata (Karpeta & Johnson 1979) (Fig. 2). The sector of the N2 to be upgraded is underlain by Early Triassic (*c*. 250 Ma = million years old) fluvial sediments of the **Katberg Formation** (**TRk**; Tarkastad Subgroup, upper Beaufort Group). These Karoo rocks are extensively intruded here by Early Jurassic (183 ± 2 Ma) igneous intrusions of the **Karoo Dolerite Suite** (**Jd**) (Duncan & Marsh 2006). The sills and dykes have thermally metamorphosed or baked the adjacent sediments. Levels of tectonic deformation in this region are low.

Brief descriptions of the Katberg Formation in general are given by Johnson *et al.* (2006) and for the Umtata sheet area by Karpeta and Johnson (1979). The more detailed accounts by Stavrakis (1980), Hiller and Stavrakis (1980, 1984), Haycock *et al.* (1994) and Cole *et al.* (2004) also apply in part to the study area. The Katberg succession near Umtata is characterized by thick, greyish lithofeldspathic sandstones and subordinate, much thinner, often lenticular bluish- to reddish-grey mudrocks as well as intraformational mudflake conglomerates. Spheroidal calcareous concretions and evidence for soft-sediment deformation are common. These sediments were deposited by north-flowing braided river systems. The proportion of mudrocks becomes more important towards the north, where braided rivers merge into meandering river systems.

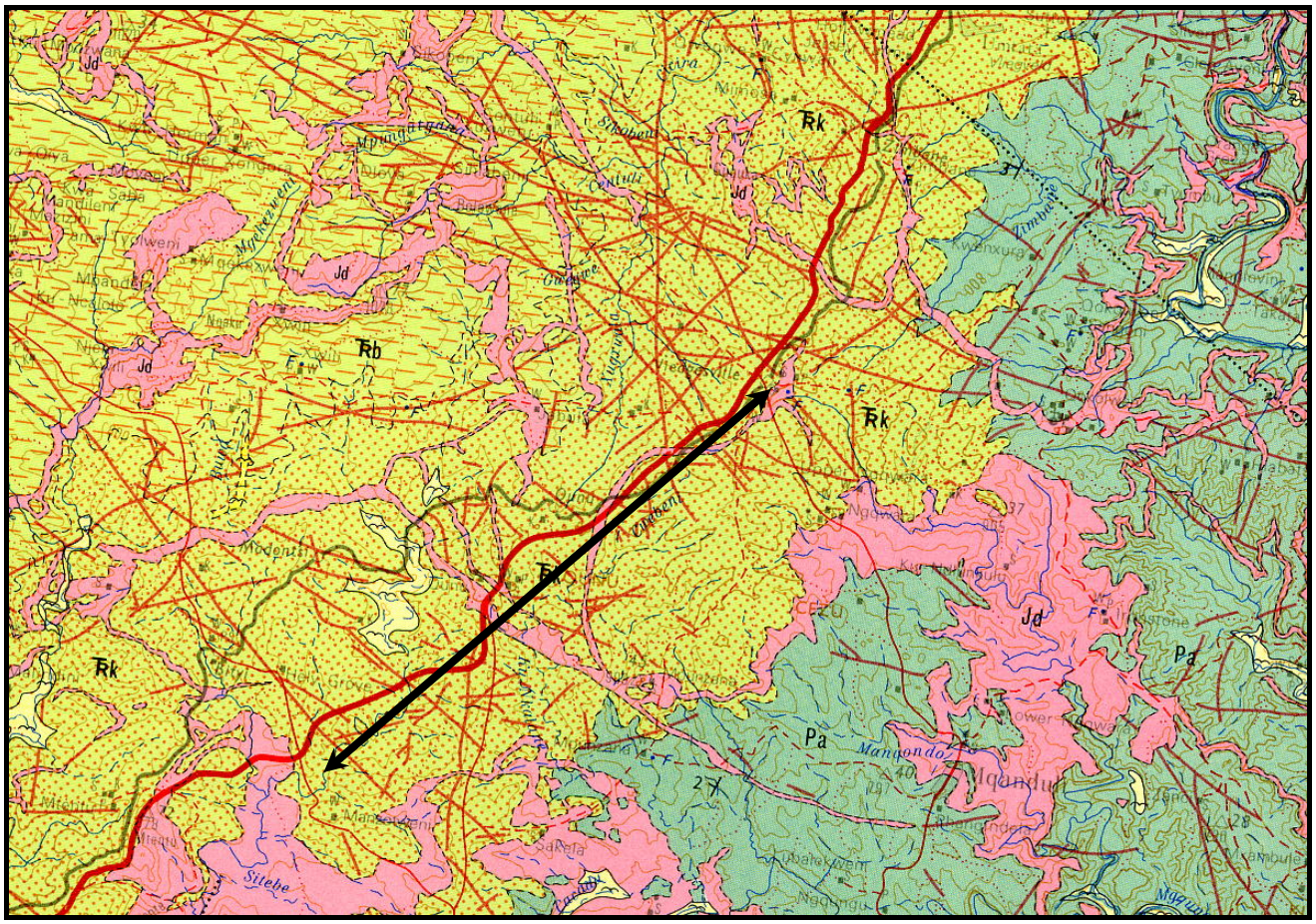

Fig. 2. Extract from 1: 250 000 geology sheet 3128 Umtata with sector of N2 to be upgraded indicated by the black arrow. Geological units in the study area include: TRk (yellow with red dots) = Katberg Formation Jd = Karoo Dolerite Suite (pink areas are sills, thin red line are dykes)

4. PALAEONTOLOGICAL HERITAGE

The Karoo dolerites that occur intermittently along the N2 near Mthatha are unfossiliferous igneous rocks. The palaeontological sensitivity of the Beaufort Group has been assessed as high overall (Almond *et al*. 2008). However, Karpeta and Johnson (1979) record that fossils within the Tarkastad (upper Beaufort Group) succession in the Umtata area are generally uncommon. The Katberg Formation is known to host a low-diversity but important terrestrial fossil biota of Early Triassic (Scythian / Induan-Olenekian) age, *c*. 250 million years old (Rubidge 2005). The biota is dominated by a range of therapsids ("mammal-like reptiles"), amphibians and other tetrapods, with rare vascular plants and trace fossils, and has been assigned to the ***Lystrosaurus* Assemblage Zone**. Useful illustrated accounts of fossils from this palaeontologically significant biozone, which documents the recovery phase of terrestrial life following the catastrophic end-Permian Mass Extinction, are given by Kitching (1977), Keyser and Smith (1977-1978), Groenewald and Kitching (1995), MacRae (1999), Hancox (2000), Cole *et al*. (2004) and Rubidge (2005 *plus* refs therein).

Key tetrapods in the *Lystrosaurus* Assemblage Zone biota are various species of the medium-sized, shovel-snouted dicynodont *Lystrosaurus* (by far the commonest fossil form in this biozone. contributing up to 95% of fossils found), the small captorhinid reptile *Procolophon*, the crocodile-like early archosaur *Proterosuchus*, and a wide range of small armour-plated "labyrinthodont" amphibians such as *Lydekkerina* (Fig. 3). Also present are several genera of small-bodied true reptiles (*e.g.* owenettids), therocephalians, and early cynodonts (*e.g. Galesaurus, Thrinaxodon*). Animal burrows are attributable to various aquatic and land-living invertebrates, including arthropods (*e.g. Scoyenia* scratch burrows), as well as several subgroups of burrowing tetrapods such as cynodonts, procolophonids and even *Lystrosaurus* itself. Vascular plant fossils are sparse and include petrified wood ("*Dadoxylon*") as well as leaves of glossopterid progymnosperms and arthrophyte ferns (*Schizoneura*). Pebbles of reworked silicified wood of possible post-Devonian age occur within the Katberg sandstones (Hiller & Stavrakis 1980).

Most vertebrate fossils are found in the mudrock facies rather than channel sandstones. Articulated skeletons enclosed by calcareous diagenetic nodules are locally common, while intact procolophonids, dicynodonts and cynodonts have been recorded from burrow infills (Groenewald and Kitching, 1995).

Because of their situation close to dolerite intrusions, it is likely that many Katberg Formation fossils in the study area, together with their sedimentary matrix, will have been altered by thermal metamorphism. In general, this makes the fossils very difficult to prepare out mechanically, somewhat compromising their palaeontological value. However, the palaeontology and biostratigraphic zonation of the Katberg of the Eastern Cape is still poorly known, with very few fossils apart from fossil wood so far recorded in this area (Kitching 1977, Dingle *et al.* 1983). Therefore any fossil material recovered during development, especially tetrapod bones and teeth, would be of considerable scientific value.

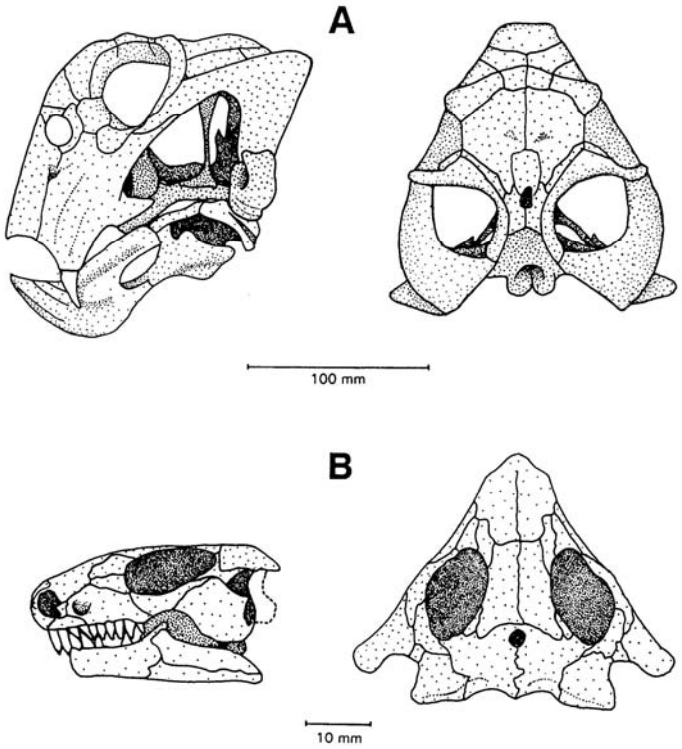

FIG. 3. Skulls of two key tetrapod genera from the Early Triassic *Lystrosaurus* Assemblage Zone of the Main Karoo Basin: the dicynodont *Lystrosaurus* (A) and the primitive reptile *Procolophon* (B) (From Groenewald and Kitching, 1995).

5. CONCLUSIONS & RECOMMENDATIONS

The overall impact of the proposed development on palaeontological heritage is likely to be minor because:

- the Katberg Formation in the Umtata region is, as far as known, only sparsely fossiliferous (plant fragments and rare tetrapod bones, teeth).;
- many of the potentially fossiliferous Katberg Formation sediments have probably been extensively baked by nearby dolerite intrusions.

Specialist palaeontological mitigation of this development is therefore not regarded as necessary at this stage. However, deep excavations into fresh (unweathered) Beaufort Group bedrock during the proposed development may reveal palaeontologically useful fossil material of Early Triassic age. Fossil vertebrates (bones, teeth, traces such as burrows or trackways), vertebrate burrows or plants from these beds would be of particular interest because there has been little formal collection in this area and new finds may well help resolve current ambiguities regarding the Beaufort Group biostratigraphy in the Eastern Cape.

It is therefore recommended that any fresh exposures of Beaufort Group sediments created during development should be inspected for fossils at intervals by the responsible Environmental Control Officer (ECO). It is also strongly recommended that the ECO for this development visit a Karoo palaeontological display (*e.g.* at the Albany Museum, Grahamstown, or East London Museum) before the start of operations so that they acquire some familiarity with the appearance of typical Beaufort Group fossil material. Well-

illustrated and accessible accounts of Karoo fossils that may help in the recognition of Beaufort Group fossils have been published by Cluver (1978), MacRae (1999) and McCarthy and Rubidge (2005).

Should fossils be encountered during excavations, they should be carefully collected, with adherent matrix where necessary, given a provisional reference number (*e.g.* marked on masking tape) and carefully wrapped in newspaper. It is *essential* that the locality where the fossil is found be accurately marked on a 1: 50 000 map or recorded by GPS. Specimens without locality information are of limited scientific value. The fossils should be submitted for inspection by a professional palaeontologist at the earliest opportunity. Some of this material may be of scientific interest - in which case it should be deposited ultimately in an approved repository (*e.g.* Albany Museum, Grahamstown or East London Museum) – while other specimens may be of educational value and might be donated for display purposes.

If well-articulated skeletons or other substantial fossil remains are encountered during construction, they should *NOT* be informally excavated since this will almost invariably lead to damage and loss of useful contextual information (*e.g.* taphonomy – data on mode of death and burial of animals). If feasible, they should be photographed (with scale), covered with a protective layer of loose sediment, and the site marked and carefully recorded (GPS / 1: 50 000 map / aerial photograph). The Environmental Control Officer should immediately inform SAHRA or the responsible palaeontologist at the Albany Museum (Dr Billy de Klerk, 046-622 2312; b.deklerk@ru.ac.za) so that specimens can be examined and, if necessary, professionally excavated.

6. ACKNOWLEDGEMENTS

Mr Conroy van der Riet, Environmental Consultant for Biotechnology & Environmental Specialist Consultancy cc, East London, is thanked for commissioning this study and for kindly providing the necessary background information.

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QUALIFICATIONS & EXPERIENCE OF THE AUTHOR

Dr John Almond has an Honours Degree in Natural Sciences (Zoology) as well as a PhD in Palaeontology from the University of Cambridge, UK. He has been awarded post-doctoral research fellowships at Cambridge University and in Germany, and has carried out palaeontological research in Europe, North America, the Middle East as well as North and South Africa. For eight years he was a scientific officer (palaeontologist) for the Geological Survey / Council for Geoscience in the RSA. His current palaeontological research focuses on fossil record of the Precambrian - Cambrian boundary and the Cape Supergroup of South Africa. He has recently written palaeontological reviews for several 1: 250 000 geological maps published by the Council for Geoscience and has contributed educational material on fossils and evolution for new school textbooks in the RSA.

Since 2002 Dr Almond has also carried out palaeontological impact assessments for developments and conservation areas in the Western, Eastern and Northern Cape under the aegis of his Cape Town-based company *Natura Viva* cc. He is a long-standing member of the Archaeology, Palaeontology and Meteorites Committee for Heritage Western Cape (HWC) and an advisor on palaeontological conservation and management issues for the Palaeontological Society of South Africa (PSSA), HWC and SAHRA. He is currently compiling technical reports on the provincial palaeontological heritage of Western, Northern and Eastern Cape for SAHRA and HWC. Dr Almond is an accredited member of PSSA and APHAP (Association of Professional Heritage Assessment Practitioners – Western Cape).