PALAEONTOLOGICAL IMPACT ASSESSMENT: DESKTOP STUDY

Application for prospecting on Farm 202, Fort Beaufort District, Amatole District Municipality, Eastern Cape

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1. SUMMARY

The proposed prospecting area lies c. 10km southwest of Fort Beaufort within the outcrop area of the Lower Beaufort Group (Adelaide Subgroup). These Late Permian fluvial sediments contain a rich fossil biota assigned to the *Cistecephalus* Assemblage Zone, notably a range of terrestrial groups such as therapsids and pareiasaurs. Fossils have been recorded in the Fort Beaufort area since the 1830s when Andrew Geddes Bain collected near this town the first scientifically described specimens of two-tusked dicynodont therapsids ("bidentals") and pareiasaur reptiles (the famous "Blinkwater Monster" specimen). The Lower Beaufort Group sediments in the study area therefore have an overall high palaeontological sensitivity. The impact of geological prospecting itself on local fossil heritage is likely to be very low, and no further palaeontological mitigation is recommended for this phase. However, should mining of Beaufort Group bedrock be approved, then SAHRA should be notified and a professional palaeontologist commissioned to undertake appropriate palaeontological mitigation before mining commences.

2. INTRODUCTION & BRIEF

An application for prospecting rights for Farm 202, Fort Beaufort District (Eastern Cape Province) has been made by Amatola Quarry Products cc, PO Box 153, Komgha, Eastern Cape. The prospecting area (Fig. 1) overlies potentially fossiliferous bedrock of the Beaufort Group. A desktop palaeontological heritage impact study has therefore been commissioned by Mr Roy Hagemann of Amatola Quarry Products cc.

Fig. 1. Approximate extent of study area, Farm 202 *c.* 10km southwest of Fort Beaufort, Eastern Cape (Abstracted from1: 50 000 map 3226 DC, courtesy of the Chief Directorate of Surveys and Mapping, Mowbray)

3. GEOLOGICAL BACKGROUND

As shown on the 1: 250 000 geological map sheet 3226 King William's Town (Fig. 2), the Fort Beaufort area overlies Late Permian rocks of the Lower Beaufort Group (Adelaide Subgroup), in particular the **Balfour Formation** (Johnson *et al.*, 2006). According to the sheet explanation (printed on the map itself), this formation is some 2150m thick north of Fort Beaufort. The fluvial Balfour Formation comprises recessive weathering, grey to greenish-grey overbank mudrocks with subordinate resistant-weathering, grey, fine-grained channel sandstones deposited by large meandering river systems in the Late Permian Period. Thin wave-rippled sandstones were laid down in transient playa lakes on the flood plain. Reddish mudrocks are comparatively rare, but increase in abundance towards the top of the Adelaide Subgroup succession near the upper contact with the Katberg Formation. The base of the Balfour succession is defined by a sandstone-rich zone, some 50m thick, known as the **Oudeberg Member.**

Dips of Beaufort Group sediments in the study region are generally shallow (< 10°), with small-scale E-W fold axes mapped to the south of Fort Beaufort, so low levels of tectonic deformation and cleavage development are expected here (favouring fossil preservation). To the north and south of the study area the Beaufort Group sediments are extensively intruded by major intrusions of the **Karoo Dolerite Suite (Jd)** of Early Jurassic age (*c.* 183

Ma). These will have thermally metamorphosed (baked) and altered the adjacent country rocks.

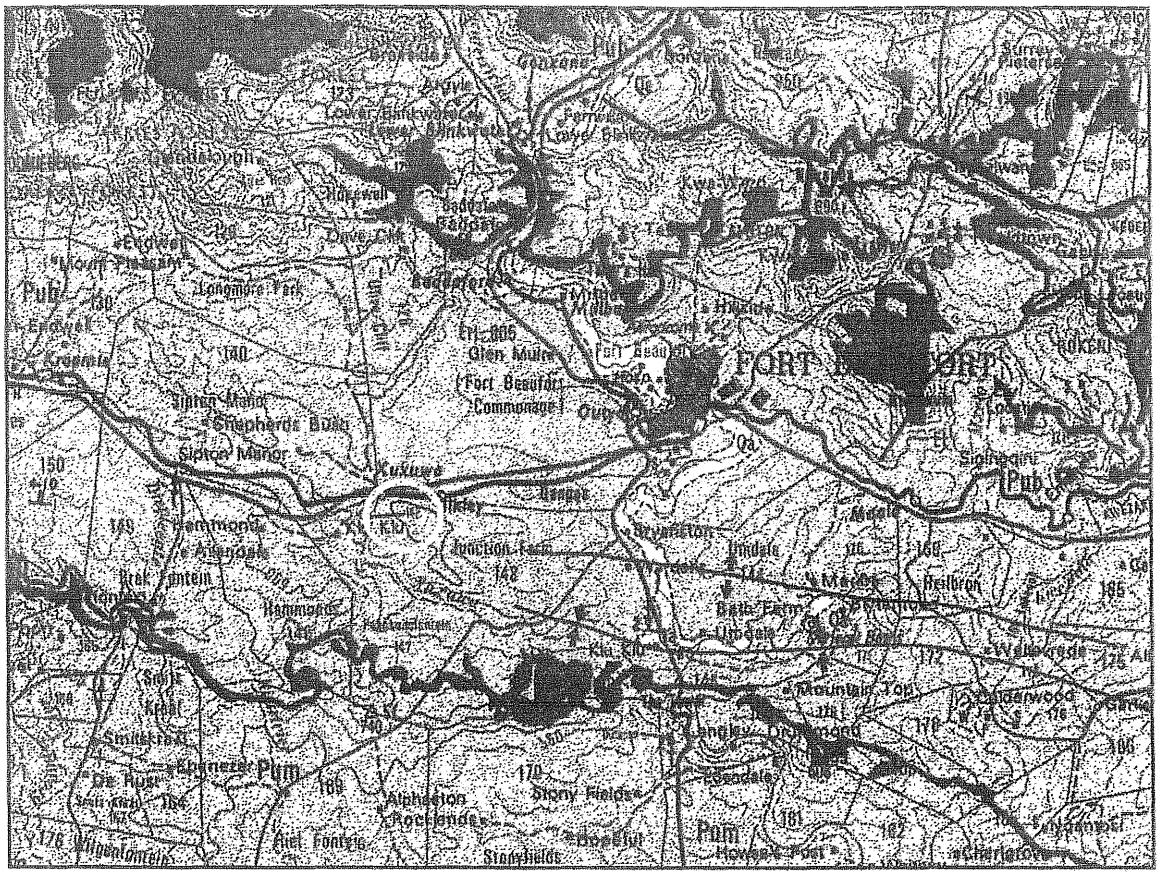

Fig. 2. Extract from 1: 250 000 geology sheet 3226 King William's Town showing approximate location of the study area *c.* 10km SW of Fort Beaufort. Pale green = Lower Beaufort Group (Pum = Middleton Fm, Pub = Balfour Fm) Dark brown = Karoo Dolerite Suite intrusions.

4. PALAEONTOLOGICAL HERITAGE

The overall palaeontological sensitivity of the Beaufort Group sediments is *high* (Almond *et al.* 2008). These continental sediments have yielded one of the richest fossil records of land-dwelling plants and animals of Permo-Triassic age anywhere in the world. A chronological series of mappable fossil biozones or assemblage zones (AZ), defined mainly on their characteristic tetrapod faunas, has been established for the Main Karoo Basin of South Africa (Rubidge 1995). Maps showing the distribution of the Beaufort assemblage zones within the Main Karoo Basin have been provided by Keyser and Smith (1979) and Rubidge (1995). The maps in the first publication do not extend as far east as the study area, whereas the biozone map of Rubidge (1995, fig. 1) shows that Fort Beaufort and the study area lie within the ***Cistecephalus* Assemblage Zone** (= upper *Cistecephalus* Biozone or *Aulacephalodon-Cistecephalus* Assemblage Zone of earlier authors; see table 2.2 in Hill 1993). This biozone corresponds to the lowermost subunit of the Balfour Formation, the Oudeberg Member, as well as to the upper portion of the underlying Middleton Formation (*ibid.*, fig. 3. *NB* The precise stratigraphic level within the Lower Beaufort Group of the prospecting area involved here would need to be confirmed

in the field). The *Cistecephalus* Assemblage Zone has been assigned to the Wuchiapingian Stage of the Late Permian Period, with an approximate age range of 260-254 million years (Rubidge 2005).

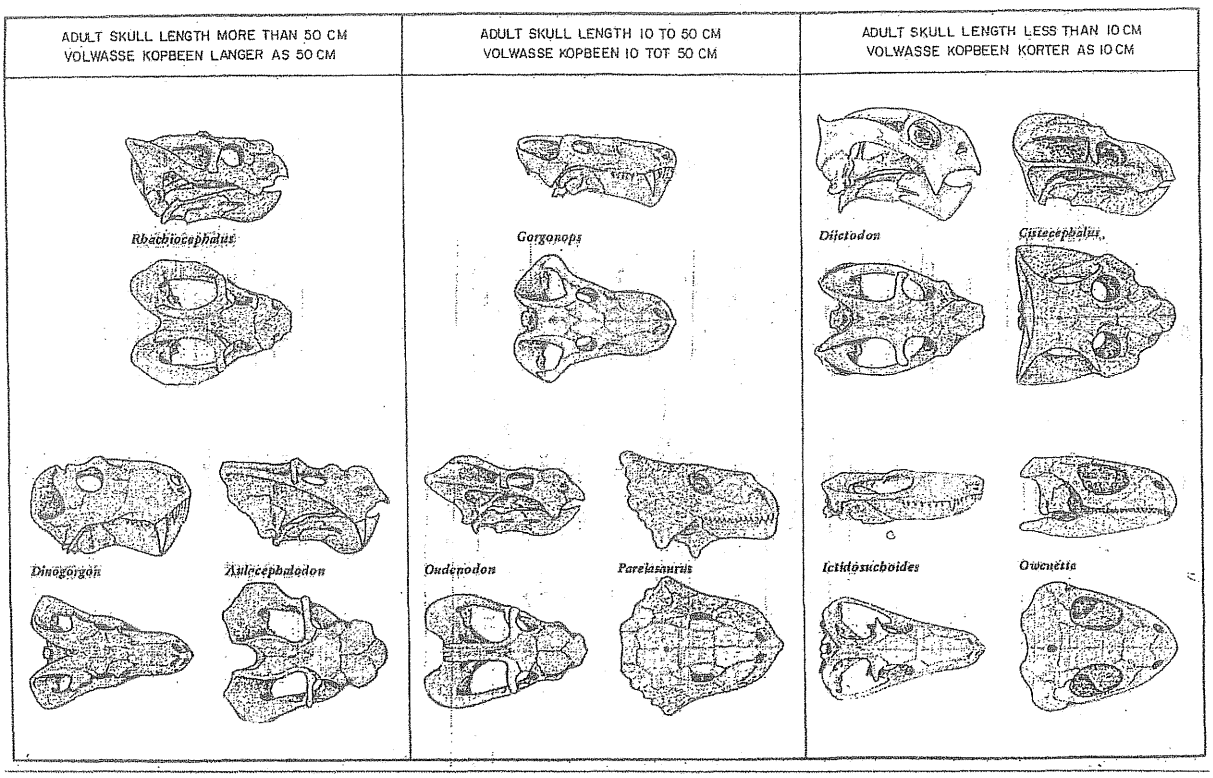

Fig. 3. Skulls of characteristic fossil vertebrates from the *Cistecephalus* Assemblage Zone (From Keyser & Smith 1979). *Pareiasaurus*, a large herbivore, and *Owenetta*, a small insectivore, are true reptiles. The remainder are therapsids or "mammal-like reptiles". Of these, *Gorgonops* and *Dinogorgon* are large flesh-eating gorgonopsians, *Ictidosuchoides* is an insectivorous therocephalian, while the remainder are small – to large-bodied herbivorous dicynodonts.

The following major categories of fossils might be expected within *Cistecephalus* AZ sediments in the study area (Keyser & Smith 1979, Anderson & Anderson 1985, Hill 1993, Smith & Keyser *in* Rubidge 1995, MacRae 1999, Cole *et al.*, 2004, Almond *et al.* 2008):

- isolated petrified bones as well as rare articulated skeletons of **terrestrial vertebrates** such as true **reptiles** (notably large herbivorous pareiasaurs, small insectivorous owenettids) and **therapsids** or "mammal-like reptiles" (*eg* diverse herbivorous dicynodonts, flesh-eating gorgonopsians, and insectivorous therocephalians) (Fig. 3)
- aquatic vertebrates such as large **temnospondyl amphibians** (*Rhinesuchus*, usually disarticulated), and **palaeoniscoid bony fish** (*Atherstonia*, *Namaichthys*, often represented by scattered scales rather than intact fish)
- freshwater **bivalves** (*Palaeomutela*)
- **trace fossils** such as worm, arthropod and tetrapod burrows and trackways, coprolites (fossil droppings)

- **vascular plant remains** including leaves, twigs, roots and petrified woods ("*Dadoxylon*") of the *Glossopteris* Flora (usually sparse, fragmentary), especially glossopterid trees and arthrophytes (horsetails).

As far as the biostratigraphically important tetrapod remains are concerned, the best fossil material is generally found within overbank mudrocks, whereas fossils preserved within channel sandstones tend to be fragmentary and water-worn (Rubidge 1995, Smith 1993). Many fossils are found in association with ancient soils (palaeosol horizons) that can usually be recognised by bedding-parallel concentrations of calcrete nodules.

As a consequence of their proximity to large dolerite intrusions in the Great Escarpment zone, the Beaufort Group sediments in the study area might have been thermally metamorphosed or "baked" (*ie.* recrystallised, impregnated with secondary minerals). Embedded fossil material of phosphatic composition, such as bones and teeth, is frequently altered by baking – bones may become blackened, for example - and can be very difficult to extract from the hard matrix by mechanical preparation (Smith & Keyser, p. 23 *in* Rubidge 1995). Thermal metamorphism by dolerite intrusions therefore tends to reduce the palaeontological heritage potential of Beaufort Group sediments.

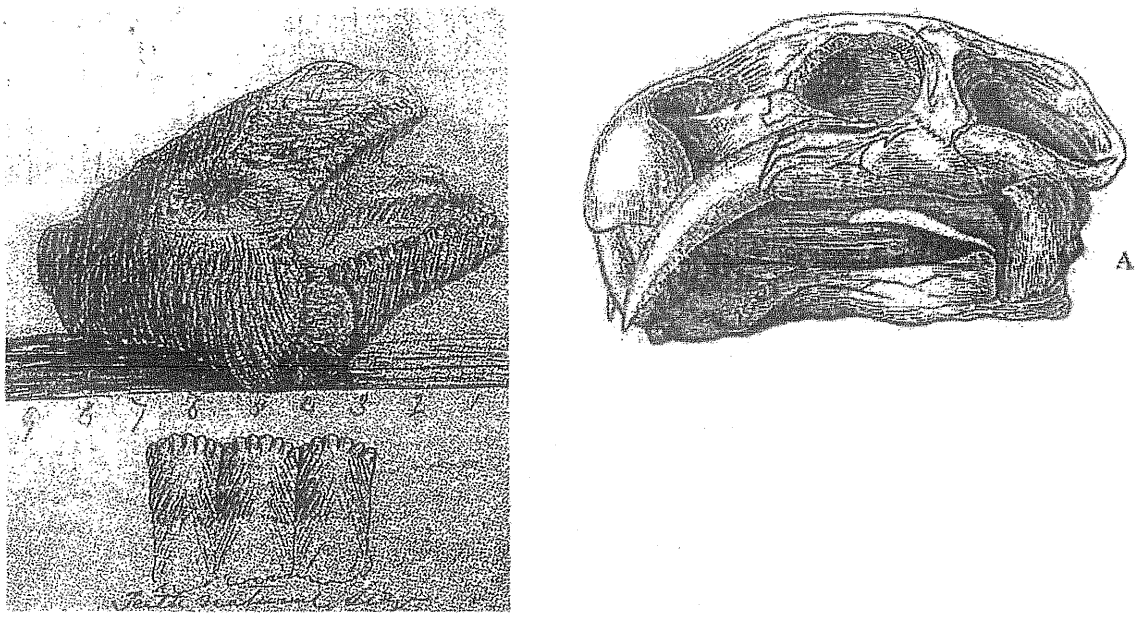

Fig. 4. Two famous fossil skulls collected by Andrew Geddes Bain from the Lower Beaufort Group near Fort Beaufort: LHS – the "Blinkwater Monster" skull, type specimen of the reptilian genus *Pareiasaurus*, described by Richard Owen in 1876. RHS - the type specimen of the first dicynodont therapsid, *Dicynodon*, described by Owen in 1845.

From the point of view of the early history of palaeontology in South Africa, the Fort Beaufort area of the Eastern Cape occupies a very special place. It was close to this town in the 1830s that the pioneering amateur geologist and palaeontologist Andrew Geddes Bain discovered not only the first "bidental" or dicynodont therapsid (*Dicynodon*) to be scientifically named but also the first pareiasaur reptile (*Pareiasaurus*. See Fig. 4 herein and the interesting account in MacRae 1999, pp. 6-7). Both taxa were described and named by the outstanding Victorian palaeontologist Professor Richard Owen, based in

London. Bain's *Pareiasaurus* skull was the famous "Blinkwater Monster" specimen that he discovered just north of Fort Beaufort. Bain suggested to the local church elders, tongue-in-cheek, that these were the remains of an animal that fell out of Noah's Ark as it was floating overhead during the biblical Flood.

5. CONCLUSIONS & RECOMMENDATIONS

The Lower Beaufort Group sediments in the study area have an overall high palaeontological sensitivity, especially in terms of the rich vertebrate fauna that has been recorded from these rocks. The impact of geological prospecting itself on local fossil heritage is likely to be very low, and no further palaeontological mitigation is recommended for this phase. However, should mining of Beaufort Group bedrock be approved, then SAHRA should be notified and a professional palaeontologist commissioned to undertake appropriate mitigation. This would probably take the form of a scoping and sampling study before mining commences.

6. ACKNOWLEDGEMENTS

Mr Roy Hagemann of Amatola Quarry Products cc, Komgha, is thanked for commissioning this study and for kindly providing the necessary background information.

7. REFERENCES

Almond, J.E., De Klerk, W.J. & Gess, R. 2008. Palaeontological heritage of the Eastern Cape. Draft report for SAHRA, 20 pp. *Natura Viva* cc, Cape Town.

Anderson, J.M. & Anderson, H.M. 1985. Palaeoflora of southern Africa. Prodromus of South African megafloras, Devonian to Lower Cretaceous, 423 pp. Botanical Research Institute, Pretoria & Balkema, Rotterdam.

Cluver, M.A. 1978. Fossil reptiles of the South African Karoo, 54pp. South African Museum, Cape Town.

Cole, D.I., Neveling, J., Hattingh, J., Chevallier, L.P., Reddering, J.S.V. & Bender, P.A. 2004. The geology of the Middelburg area. Explanation to 1: 250 000 geology Sheet 3124 Middelburg, 44 pp. Council for Geoscience, Pretoria.

Hill, R.S. 1993. The geology of the Graaff-Reinet area. Explanation to 1: 250 000 geology Sheet 3224 Graaff-Reinet, 31 pp. Council for Geoscience, Pretoria.

Johnson, M.R., Van Vuuren, C.J., Visser, J.N.J., Cole, D.I., De V. Wickens, H., Christie, A.D.M., Roberts, D.L. & Brandl, G. 2006. Sedimentary rocks of the Karoo Supergroup. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa, pp. 461-499. Geological Society of South Africa, Marshalltown.

Keyser, A.W. & Smith, R.M.H. 1979. Vertebrate biozonation of the Beaufort Group with special reference to the western Karoo Basin. Annals of the Geological Survey of South Africa 12, 1-35.