

## PALAEONTOLOGICAL SPECIALIST STUDY: FIELD ASSESSMENT

### PROPOSED EXTENSION OF AN EXISTING BORROW PIT ON THE FARM RIETFONTEIN 139 NEAR MURRAYSBURG, CENTRAL KAROO DISTRICT MUNICIPALITY, WESTERN CAPE

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#### 1. EXECUTIVE SUMMARY

The MR599/41.0/0.02R borrow pit site on Farm Rietfontein 139, situated c. 26 km to the SSW of Murraysburg, is excavated into mudrocks within the Teekloof Formation (Lower Beaufort Group / Adelaide Subgroup) of Late Permian age. The fluvial sediments of the Teekloof Formation in the Beaufort West– Murraysburg area are highly fossiliferous, containing a range of reptiles, therapsids (“mammal-like reptiles”), plants and trace fossils (including large vertebrate burrows) that in the study region are probably assigned to the *Cistecephalus* Assemblage Zone. However, no fossil material of any sort was recorded during the present field assessment and it is concluded that further specialist palaeontological studies or mitigation for this project are not warranted.

The Environmental Control Officer (ECO) responsible for the borrow development should be aware of the possibility of important fossils (notably vertebrate bones and teeth) being present or unearthed on site and should monitor fresh (*i.e.* unweathered) sedimentary bedrock for fossil remains. In the case of any significant fossil finds made during construction, these should be safeguarded - preferably *in situ* - and reported by the ECO as soon as possible to the relevant heritage management authority (Heritage Western Cape. Protea Assurance Building, Green Market Square, Cape Town 8000. Private Bag X9067, Cape Town 8001. Tel: 086-142 142. Fax: 021-483 9842. Email: hwc@pgwc.gov.za) so that appropriate mitigation (*i.e.* recording, sampling or collection) by a palaeontological specialist can be considered and implemented, at the developer’s expense. These recommendations should be incorporated into the Environmental Management Plan (EMP) for the borrow pit project.

#### 2. INTRODUCTION

The Department of Transport, Western Cape, is applying to the Department of Mineral Resources for approval to exploit road material from and to extend an existing borrow pit site situated on the Farm Rietfontein 139 along the MR559 to the southwest of Murraysburg, Central Karoo District Municipality, Western Cape. The existing pit MR599/41.0/0.02R (32° 10' 52.26" S, 23° 40' 17.19" E) lies on the east side of a dust road c. 26 km SSW of Murraysburg, Central Karoo District, Western Cape (Fig. 1).

This is Vidamemoria pit no. 332 and NID ref. no. 246. An initial desktop basic assessment of the original pit site by the author assessed its palaeontological heritage sensitivity as high due to the presence here of potentially fossiliferous sediments of the Lower Beaufort Group. A palaeontological field assessment of the pit as part of an HIA was requested by Heritage Western Cape (HWC case ref. no. 15040128GT0422E, Interim comment 13 May 2015) in accordance with the requirements of the National Heritage Resources Act, 1999 (Section 38).

This palaeontological heritage field assessment and short report has accordingly been commissioned by Vidamemoria Heritage Consultants, Cape Town (Address: 3<sup>rd</sup> Floor, Guarantee House, 37 Burg Street, Greenmarket Square, Cape Town; tel: 021-424 8432; e-mail: yunus@vidamemoria.co.za). Fieldwork for this project was carried out on 15 June 2015.



Fig. 1. Extract from topographical sheet 3222 Beaufort West (Courtesy of the Chief Directorate: National Geo-spatial Information, Mowbray) showing the location of the existing borrow pit MR599/41.0/0.02R on the Farm Rietfontein 139, c. 26 km SSW of Murraysburg, Western Cape (blue dot).

### 3. GEOLOGICAL CONTEXT

The MR599/41.0/0.02R borrow pit is situated in semi-arid Karoo terrain at c. 1040 - 1055 m amsl in the region west of the Ondersneeuwberg Range and southwest of Murraysburg (Fig. 1). The site lies on the southern foot slopes of a NW-SE trending ridge, centred along a resistant-weathering dolerite intrusion, and north of a west-flowing tributary stream of the Aasvoelkrans se Loop whose main course runs c. 1.4 km to the west. A larger existing borrow pit is situated adjacent to the MR599 some 300 m to the north.

The geology of the study area near Murraysburg is outlined on the 1: 250 000 geology sheet 3222 Beaufort West, for which a separate sheet explanation has not yet been published (Fig. 2). The area is largely underlain by Late Permian continental sediments of the **Lower Beaufort Group** (Adelaide Subgroup, Karoo Supergroup). A useful overview of this internationally famous rock succession has been given by Johnson *et al.* (2006). The bedrocks in the study area are assigned to the fluviially-dominated **Teekloof Formation (Pt)** of Late Permian age. Bedding dips shown on the geological map are generally low, suggesting that the Beaufort Group succession here is largely flat-lying and undeformed. However, the Permian sediments are extensively intruded and



thermally metamorphosed (baked) by sills and dykes of the Early Jurassic **Karoo Dolerite Suite (Jd)**. A major dolerite intrusion (inclined sill) is mapped just to the north of the present study area.

The existing MR599/41.0/0.02R borrow pit is excavated to a depth of several meters into hackly-weathering purple-brown and grey-green overbank mudrocks of the Teekloof Formation, well-exposed along the pit margins, with a laterally-extensive, tabular crevasse-splay or shallow channel sandstone (c. 40 cm thick) also present within the succession (Figs. 3 & 4). Palaeosol horizons marked by calcrete nodules are not well-represented here. Around portions of the pit margin semi-consolidated, incipiently calcretised silty to gravelly alluvium mantles the Karoo bedrocks; larger clasts are predominantly sandstone/quartzite or dolerite (Fig. 5). Much of the study area away from the pit, notably the flat-lying region to the south, is mantled by unconsolidated younger alluvium with angular to subrounded downwasted surface gravels of sandstone, quartzite, dolerite, calcrete and hornfels (Fig. 7). The thick (2-3 m) alluvial gritty sands and gravel lenticles are well-exposed in vertical section in dongas to the east of the main pit area where they show sparse calcrete veining (Fig. 6). To the north of the pit the slopes are mantled by poorly-sorted, angular dolerite and sandstone / quartzitic colluvial gravels (Some of the darker, patinated quartzite clasts are crudely flaked). The Karoo bedrocks in the region have been locally disrupted and secondarily mineralised as a result of dolerite intrusion; this is the probable cause of disturbed, convolute lamination among large sandstone / quartzite float blocks seen here.

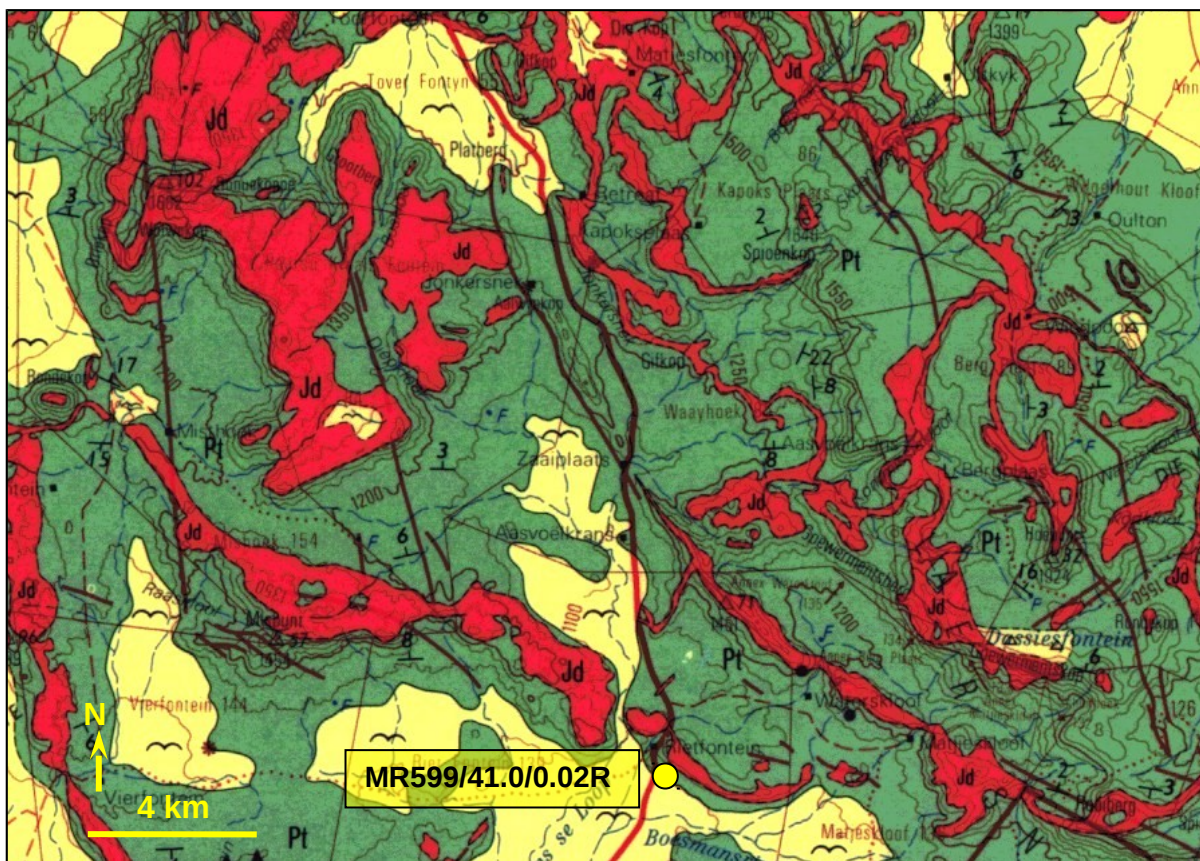


Fig. 2. Extract from 1: 250 000 geology sheet 3222 Beaufort West (Council for Geoscience, Pretoria) showing the location of the MR599/41.0/0.02R borrow pit c. 26 km to the SSW of Murraysburg, Central Karoo District Municipality, Western Cape (yellow dot). The pit site is underlain by mudrocks within the Teekloof Formation (Adelaide Subgroup, Lower Beaufort Group) (Pt, green). The Beaufort Group rocks in this area are extensively intruded and baked by Early Jurassic dolerites of the Karoo Dolerite Suite (Jd, red), such as shown just to the north of the borrow pit site, and mantled with Late Caenozoic alluvium (pale yellow with flying bird symbol) near major water courses.





**Fig. 3. View north-eastwards across the existing MR599/41.0/0.02R borrow pit showing marginal exposures of Teekloof Formation bedrocks mantled by mixed alluvial and colluvial gravels. The ridge in the background is capped by Karoo dolerite.**



**Fig. 4. Close-up of thin channel or crevasse-splay sandstone within interbedded purple-brown and grey-green overbank mudrocks of the Teekloof Formation on the borrow pit margin (Hammer = 30 cm).**





Fig. 5. Thick, pale brown silty alluvial cover over Teekloof Formation bedrocks, with a partially-calcretised basal gravel horizon (Hammer = 30 cm).



Fig. 6. Thick gravelly to sandy alluvium exposed by *donga* erosion to the east of the main pit area.





**Fig. 7. Fine-grained alluvium with a veneer of small downwasted gravels on the gently undulating *vlaktes* to the south of the present borrow pit.**

#### **4. PALAEOLOGICAL HERITAGE**

According to the latest biostratigraphic map of the Main Karoo Basin published by Van der Walt *et al.* (2010) the MR599/41.0/0.02R borrow pit study area *probably* lies within the Late Permian *Cistecephalus* Assemblage Zone (= upper *Cistecephalus* Biozone or *Aulacephalodon-Cistecephalus* Assemblage Zone of earlier authors). The following major categories of fossils might be expected within *Cistecephalus* AZ sediments in the study area (Kitching 1977, Keyser & Smith 1977-78, Anderson & Anderson 1985, Smith & Keyser 1995, MacRae 1999, Cole *et al.*, 2004, Rubidge *et al.* 1995, 2005, Smith *et al.* 2012; Almond 2012 & 2014):

- isolated petrified bones as well as rare articulated skeletons of terrestrial vertebrates such as true reptiles (e.g. large herbivorous pareiasaurs like *Pareiasaurus*, small insectivorous owenettids) and therapsids or “mammal-like reptiles” (e.g. diverse herbivorous dicynodonts, notably *Cistecephalus*, *Oudenodon* and *Aulacephalodon*, a wide range of flesh-eating gorgonopsians such as *Lycaenops*, and insectivorous therocephalians like *Ictidosuchoides*) (Fig. 8);
- aquatic vertebrates such as large temnospondyl amphibians (*Rhinesuchus*, usually disarticulated), and palaeoniscoid bony fish (*Atherstonia*, *Namaichthys*); these are often represented by scattered scales rather than intact fish;
- freshwater bivalves (*Palaeomutela*);
- trace fossils such as worm, arthropod and tetrapod burrows and trackways (e.g. of the large dicynodont *Aulacephalodon*), coprolites (fossil droppings), plant roots;
- vascular plant remains including leaves, twigs, roots and silicified woods (“*Dadoxylon*”) of the *Glossopteris* Flora, especially glossopterid trees and arthropytes (horsetails). Plant remains are usually sparse and fragmentary.

Authoritative lists of vertebrate genera and species recorded so far from the *Cistecephalus* Assemblage Zone are given by Smith and Keyser (1995) as well as Smith *et al.* (2012). Faunal lists for fossil sites in the Victoria West map area are given by Kitching (1977). The marked increase in fossils of the small dicynodont *Cistecephalus* at the top of the AZ in the Victoria West area and elsewhere is noted by these authors. Vertebrate fossils recorded in the Oudeberg Member in particular include the dicynodont genera *Cistecephalus* (the commonest form), *Aulacephalodon* and *Oudenodon* (Le Roux & Keyser 1988).

As far as the biostratigraphically important tetrapod remains are concerned, the best fossil material is generally found within overbank mudrocks. In contrast, fossils preserved within channel sandstones (e.g. channel lag breccio-conglomerates of reworked mudflakes and calcrete nodules) tend to be fragmentary and water-worn (Smith & Keyser 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. The fossil bones are isolated and disarticulated for the most part, and are typically permineralised and encrusted in a mantle of calcrete (often brown-weathering). Fossil bone embedded in mudrocks adjacent to major dolerite intrusions may be modified by thermal metamorphism; for example, bones in the Graaff-Reinet District may acquire a smooth, white “porcellanite” pallor, while bones recorded near Bedford may be black (Smith & Keyser 1995).

No vertebrate, plant or other fossil remains were recorded at the MR599/41.0/0.02R borrow pit site during the present field assessment.

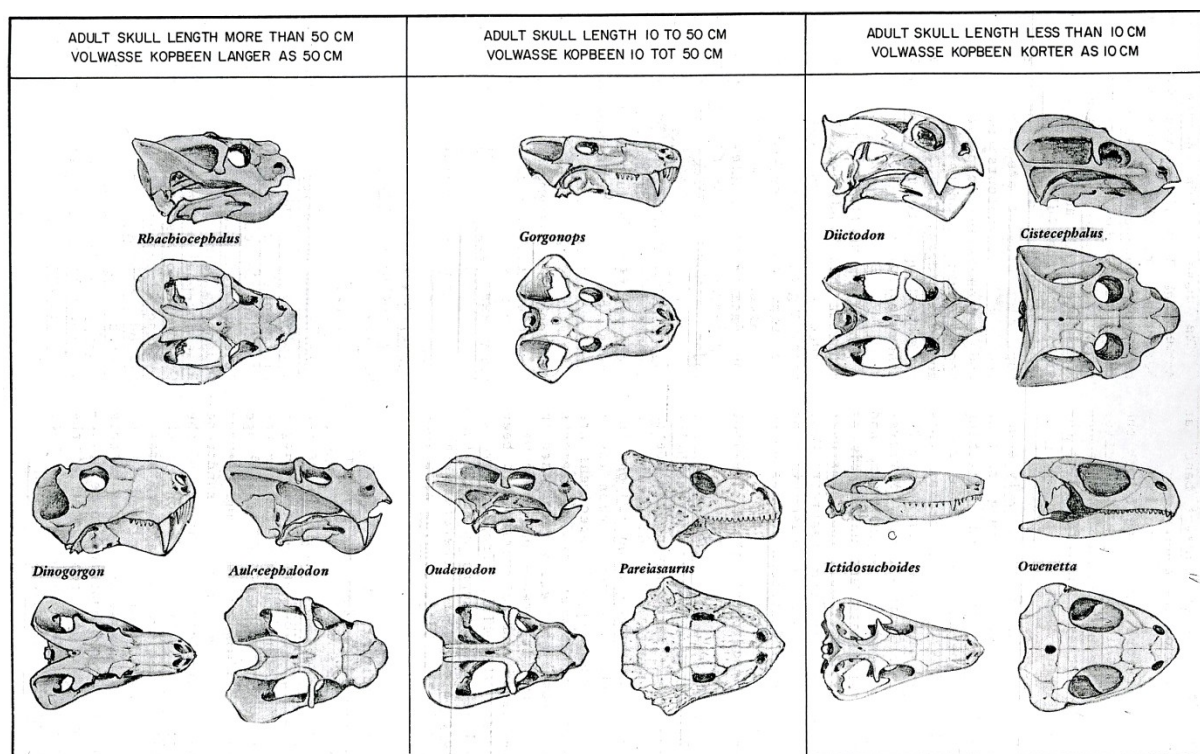


Fig. 8. Skulls of characteristic fossil vertebrates from the *Cistecephalus* Assemblage Zone (From Keyser & Smith 1977-1978). *Pareiasaurus* a large herbivore, and *Owenetta*, a small insectivore, are true reptiles. The remainder are therapsids or “mammal-like reptiles”. Of these, *Gorgonops* and *Dinogorgon* are large flesh-eating gorgonopsians, *Ictidosuchoides* is an insectivorous therocephalian, while the remainder are small – to large-bodied herbivorous dicynodonts.

## 5. CONCLUSIONS & RECOMMENDATIONS

The MR599/41.0/0.02R borrow pit site on Farm Rietfontein 139, situated c. 26 km to the SSW of Murraysburg, is excavated into mudrocks within the Teekloof Formation (Lower Beaufort Group / Adelaide Subgroup) of Late Permian age. The fluvial sediments of the Teekloof Formation in the Beaufort West– Murraysburg area are highly fossiliferous, containing a range of reptiles, therapsids (“mammal-like reptiles”), plants and trace fossils (including large vertebrate burrows) that in the study region are probably assigned to the *Cistecephalus* Assemblage Zone. However, no fossil material of any sort was recorded during the present field assessment and it is concluded that further specialist palaeontological studies or mitigation for this project are not warranted.

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## 6. ACKNOWLEDGEMENTS

Ms Quahnita Samie and Mr Yunus Samodien of Vidamemoria Heritage Consultants, Cape Town, is thanked for commissioning this specialist study and for kindly providing the necessary background information.

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## **8. 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, Gauteng, Limpopo and Free State for SAHRA and HWC. Dr Almond is an accredited member of PSSA and APHP (Association of Professional Heritage Assessment Practitioners – Western Cape).

### **Declaration of Independence**

I, John E. Almond, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed borrow pit project, application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.



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