

PALAEONTOLOGICAL SPECIALIST STUDY: FIELD ASSESSMENT

PROPOSED EXTENSION OF AN EXISTING BORROW PIT ON THE FARM DOORNBOSCHFONTEIN 96 NEAR MURRAYSBURG, CENTRAL KAROO DISTRICT MUNICIPALITY, WESTERN CAPE

John E. Almond PhD (Cantab.)
Natura Viva cc,
PO Box 12410 Mill Street,
Cape Town 8010, RSA
naturaviva@universe.co.za

July 2015

1. EXECUTIVE SUMMARY

The DR02403/44,5/0.02R borrow pit site on Farm Doornboschfontein 96 c. 33 km to the southeast of Murraysburg is excavated into mudrocks within the upper part of the Balfour Formation (Lower Beaufort Group / Adelaide Subgroup) of Late Permian age. The fluvial sediments of the Balfour Formation in the Graaff-Reinet – Murraysburg area are highly fossiliferous, containing a range of reptiles, therapsids (“mammal-like reptiles”), plants and trace fossils (including large vertebrate burrows) that are assigned to the *Cistecephalus* and *Dicynodon* Assemblage Zones. 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 an existing borrow pit site situated on the Farm Doornboschfontein 96 along the DR2403 to the southeast of Murraysburg, Central Karoo District Municipality, Western Cape. The existing pit DR02403/44,5/0.02R (32° 4' 55.19" S, 24° 4' 51.76" E) lies on the east side of a dust road 7.7 km south of the R63 tar road and 33 km ESE of Murraysburg, Central Karoo District, Western Cape (Fig. 1).

This is Vidamemoria pit no. 325 and NID ref. no. 239. 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. 15040120GT0422E, 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: 3rd 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.

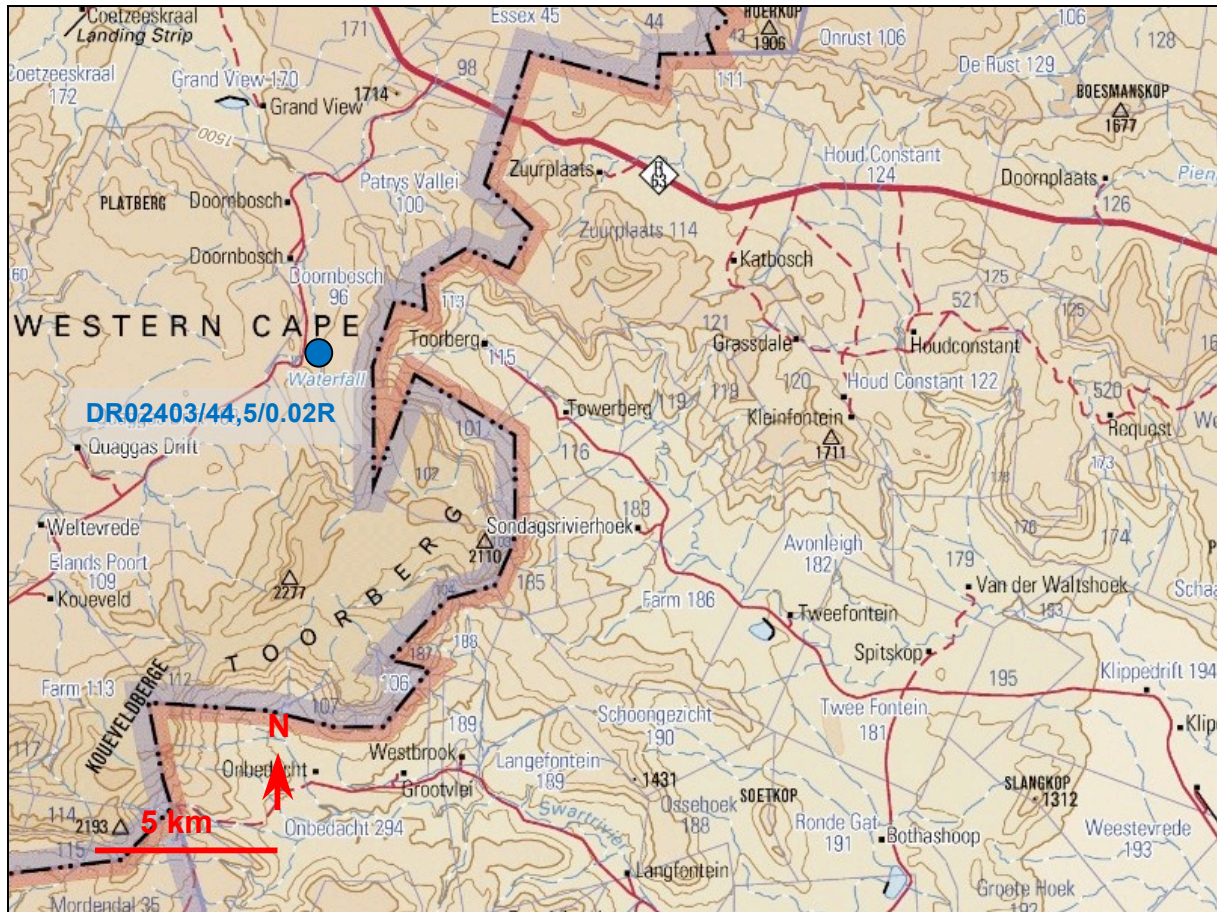


Fig. 1. Extract from topographical sheet 3224 Graaff-Reinet (Courtesy of the Chief Directorate: National Geo-spatial Information, Mowbray) showing the location of the existing borrow pit DR02403/44,5/0.02R on Farm Doornboschfontein 96, c. 33 km ESE of Murraysburg, Western Cape (blue dot).

3. GEOLOGICAL CONTEXT

The small existing DR02403/44,5/0.02R borrow pit is situated at c. 1600 m amsl in the mountainous Toorberg region between Murraysburg and Graaff-Reinet (Fig. 1). The site lies on a north-facing slope that extends down to the Buffelrivier some 200 m to the northeast.

The geology of the study area near Murraysburg is outlined on the 1: 250 000 geology sheet 3224 Graaff-Reinet (Hill 1993) (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 **Balfour Formation (Pb)** of Late Permian age. Bedding dips are not indicated on the geological map, suggesting that the Beaufort Group succession is largely flat-lying and undeformed. However, these Permian sediments are extensively intruded and thermally metamorphosed (baked) by sills and dykes of the Early Jurassic

Karoo Dolerite Suite (Jd). A north-south extending dolerite intrusion is mapped just to the west of the present study area.

Hackly-weathering, purple-brown and grey-green overbank mudrocks of the Balfour Formation are well-exposed at the borrow pit study site (Fig. 3). Pale grey to rusty, crumbly, altered palaeocalcrete nodules are common within the mudrocks, the latter probably affected by local dolerite intrusion, and there are also several thin crevasse-splay sandstones.

The Beaufort Group bedrocks are mantled with sandy soils as well as poorly-sorted, downwasted cobbly to bouldery gravels of sandstone and dolerite (Fig. 4). The reddish-brown surface gravels contain several crudely-flaked stone artefacts of sandstone / quartzite (MSA, possible ESA). A section through several meters of gravelly colluvial deposits is seen at the western end of the pit study area (Fig. 5).

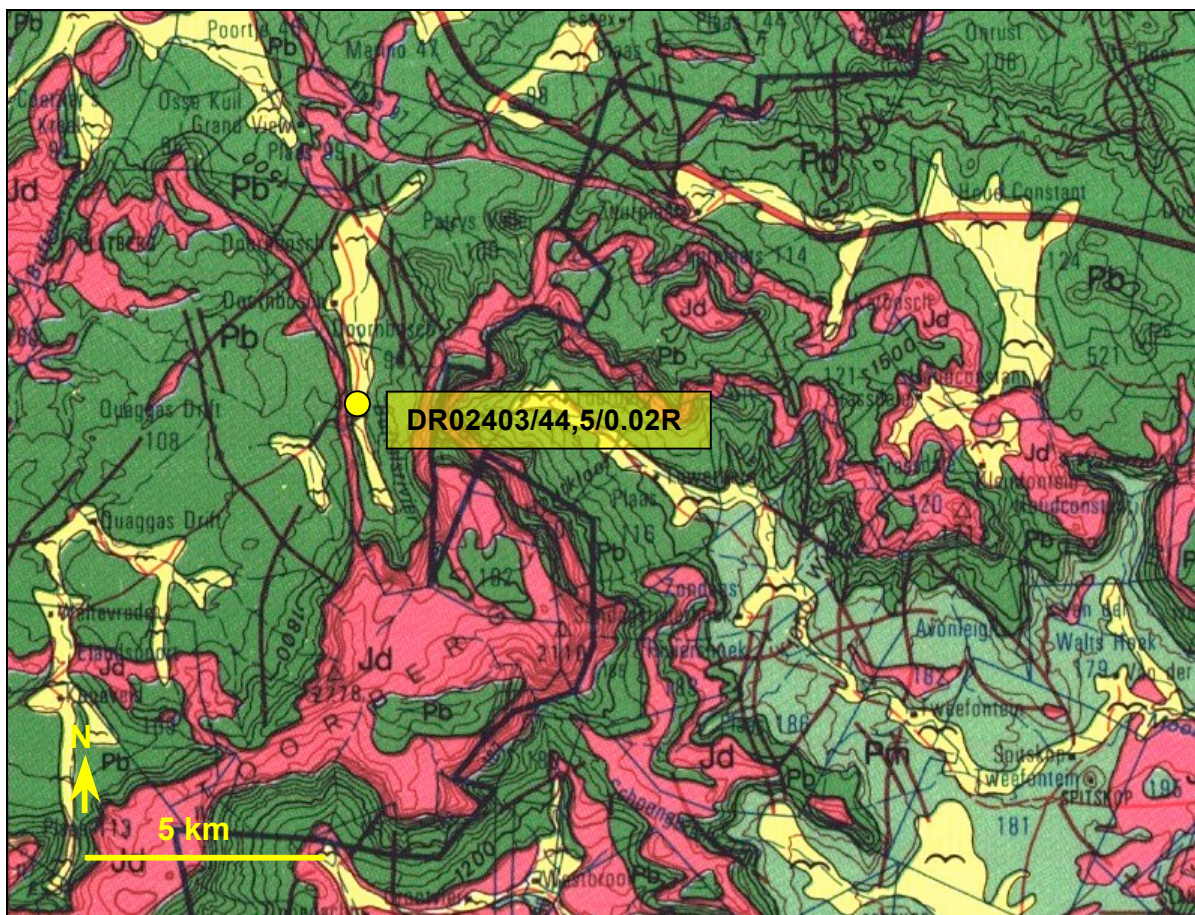


Fig. 2. Extract from 1: 250 000 geology sheet 3224 Graaff-Reinet (Council for Geoscience, Pretoria) showing the location of the DR02403/44,5/0.02R borrow pit c. 33 km to the ESE of Murraysburg, Central Karoo District Municipality, Western Cape (yellow dot). The pit site is underlain by mudrocks within the upper part of the Balfour Formation (Adelaide Subgroup, Lower Beaufort Group) (Pb, green). The Beaufort Group rocks in this area are extensively intruded and baked by Early Jurassic dolerites of the Karoo Dolerite Suite (Jd, pink) such as shown just west of the borrow pit site.



Fig. 3. View south-westwards across the DR02403/44,5/0.02R study area showing gullied hillslope exposures of purple-brown Balfour Formation mudrocks, with Karoo dolerite on the skyline.



Fig. 4. Hackly-weathering Balfour Formation overbank mudrocks overlain by orange-brown sandy soils with downwasted sandstone and dolerite colluvial gravels (Hammer = 30 cm).



Fig 5. Thick sandy and gravelly alluvial deposits overlying the Beaufort Group bedrocks at the western end of the borrow pit study area.

4. PALAEOLOGICAL HERITAGE

According to the latest biostratigraphic map of the Main Karoo Basin published by Van der Walt *et al.* (2010) the Balfour Formation bedrocks in the northwestern corner of the 1: 250 000 Graaff-Reinet sheet are assigned to the Late Permian *Dicynodon* Assemblage Zone and this certainly applies to the greater part of the Balfour Formation (Rubidge 1995, Cole *et al.*, 2004 p. 21). This younger biozone has been assigned to the Changhsingian Stage (= Late Tartarian), right at the end of the Permian Period, with an approximate age range of 253.8-251.4 million years (Rubidge 1995, 2005).

Good accounts, with detailed faunal lists, of the rich Late Permian fossil biotas of the *Dicynodon* Assemblage Zone have been given by Kitching (*in* Rubidge 1995) and by Cole *et al.* (2004). See also the reviews by MacRae (1999) and Smith *et al.* (2012). In general, the following broad categories of fossils might be expected within the Balfour Formation in the Murraysburg study area:

- isolated petrified bones as well as articulated skeletons of terrestrial vertebrates such as true **reptiles** (notably large herbivorous pareiasaurs, small lizard-like millerettids and younginids) and **therapsids** (diverse dicynodonts such as *Dicynodon* and the much smaller *Diictodon*, carnivorous gorgonopsians, therocephalians such as *Theriongnathus* (= *Whaitsia*), primitive cynodonts like *Procynosuchus*, and biarmosuchians) (See Fig. 6 herein).
- aquatic vertebrates such as large, crocodile-like temnospondyl **amphibians** like *Rhinesuchus* (usually disarticulated), and palaeoniscoid **bony fish** (*Atherstonia*, *Namaichthys*)
- 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 glossopterids and arthropytes (horsetails)

The abundance and variety of fossils within the *Dicynodon* Assemblage Zone decreases towards the top of the succession (Cole *et al.*, 2004). From a palaeontological viewpoint, these diverse *Dicynodon* AZ biotas are of extraordinary interest in that they provide some of the best available evidence for the last flowering of ecologically-complex terrestrial ecosystems immediately preceding the catastrophic end-Permian mass extinction.

No vertebrate, plant or other fossil remains were recorded at the DR02403/44,5/0.02R borrow pit site during the present field assessment.

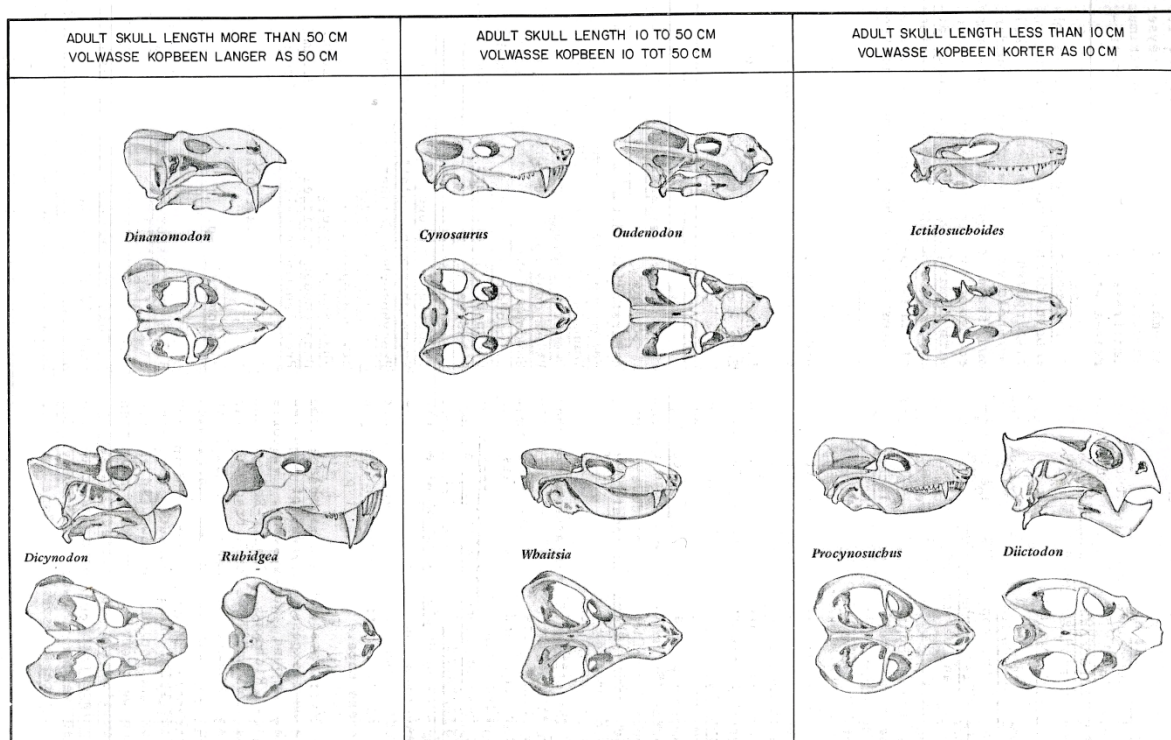


Fig. 6. Skulls of characteristic fossil vertebrates – all therapsids - from the *Dicynodon* Assemblage Zone (From Keyser & Smith 1977-1978). Among the dominant therapsids (“mammal-like reptiles”), *Rubidgea* and *Cynosaurus* are carnivorous gorgonopsians, *Waitsia* (now *Theriognathus*) is a predatory therocephalian while *Ictidosuchooides* is a small insectivorous member of the same group, *Procynosuchus* is a primitive cynodont, and the remainder are large- to small-bodied dicynodont herbivores.

5. CONCLUSIONS & RECOMMENDATIONS

The DR02403/44,5/0.02R borrow pit site on Farm Doornboschfontein 96 c. 33 km to the southeast of Murraysburg is excavated into mudrocks within the upper part of the Balfour Formation (Lower Beaufort Group / Adelaide Subgroup) of Late Permian age. The fluvial sediments of the Balfour Formation in the Graaff-Reinet – Murraysburg area are highly fossiliferous, containing a range of reptiles, therapsids (“mammal-like reptiles”), plants and trace fossils (including large vertebrate burrows) that are assigned to the *Cistecephalus* and *Dicynodon* Assemblage Zones. 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.

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.

7. REFERENCES

ALMOND, J.E. 2012. Two borrow pit sites near Murraysburg, Central Karoo District Municipality, Western Cape. Palaeontological specialist study: field assessment, 16 pp. Natura Viva cc, Cape Town.

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

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., WICKENS, H. DE V., CHRISTIE, A.D.M., ROBERTS, D.L. & BRANDL, G. 2006. Sedimentary rocks of the Karoo Supergroup. Pp. 461-499 *in* Johnson. M.R., Anhaeusser, C.R. & Thomas, R.J. (eds.) The geology of South Africa. Geological Society of South Africa, Johannesburg & the Council for Geoscience, Pretoria.

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: 1-36.

KITCHING, J.W. 1977. The distribution of the Karoo vertebrate fauna, with special reference to certain genera and the bearing of this distribution on the zoning of the Beaufort beds. *Memoirs of the Bernard Price Institute for Palaeontological Research, University of the Witwatersrand, No. 1*, 133 pp (incl. 15 pls).

LE ROUX, F.G. & KEYSER, A.W. 1988. Die geologie van die gebied Victoria-Wes. Explanation to 1: 250 000 geology Sheet 3122, 31 pp. Council for Geoscience, Pretoria.

MACRAE, C. 1999. Life etched in stone. *Fossils of South Africa*, 305 pp. The Geological Society of South Africa, Johannesburg.

RUBIDGE, B.S. (Ed.) 1995. Biostratigraphy of the Beaufort Group (Karoo Supergroup). South African Committee for Biostratigraphy, Biostratigraphic Series No. 1., 46 pp. Council for Geoscience, Pretoria.

RUBIDGE, B.S. 2005. Re-uniting lost continents – fossil reptiles from the ancient Karoo and their wanderlust. 27th Du Toit Memorial Lecture. South African Journal of Geology 108, 135-172.

SMITH, R.M.H. 1993. Vertebrate taphonomy of Late Permian floodplain deposits in the southwestern Karoo Basin of South Africa. *Palaios* 8, 45-67.

SMITH, R.M.H. & KEYSER, A.W. 1995. Biostratigraphy of the *Cistecephalus* Assemblage Zone. In: Rubidge, B.S. (ed.) Biostratigraphy of the Beaufort Group (Karoo Supergroup). South African Committee for Stratigraphy, Biostratigraphic Series No. 1, pp. 23-28. Council for Geoscience, Pretoria.

SMITH, R., RUBIDGE, B. & VAN DER WALT, M. 2012. Therapsid biodiversity patterns and paleoenvironments of the Karoo Basin, South Africa. Chapter 2 pp. 30-62 in Chinsamy-Turan, A. (Ed.) Forerunners of mammals. Radiation, histology, biology. xv + 330 pp. Indiana University Press, Bloomington & Indianapolis.

VAN DER WALT, M., DAY, M., RUBIDGE, B., COOPER, A.K. & NETTERBERG, I. 2010. A new GIS-based biozone map of the Beaufort Group (Karoo Supergroup), South Africa. *Palaeontologia Africana* 45, 1-5.

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.

John E. Almond

Dr John E. Almond (Palaeontologist, *Natura Viva* cc)