

PALAEONTOLOGICAL SPECIALIST STUDY: FIELD ASSESSMENT

EXISTING BORROW PIT ALONG THE DR2244 ROAD NEAR OP DIE BERG, CERES DISTRICT, WESTERN CAPE

John E. Almond PhD (Cantab.)

Natura Viva cc,

PO Box 12410 Mill Street,

Cape Town 8010, RSA

naturaviva@universe.co.za

January 2013

1. EXECUTIVE SUMMARY

The existing DR02244/33.4/R/30 borrow pit, located on the farm Bo Sneekop No. 473 in the Ceres District, Western Cape, about 17.5 km northeast of the Op Die Berg, is excavated into marginal marine to deltaic sediments of the Klipbokkop Formation (upper Bokkeveld Group / Bidouw Subgroup). This is one of a handful of sites in the Western Cape that have yielded well-preserved remains of placoderm fish fossils as well as low diversity trace fossil assemblages of Middle Devonian age. Fragmentary fossil fish remains are still visible in the pit and because the sedimentary rocks here are not cleaved or deeply weathered it is likely that further scientifically valuable specimens will be obtained here in future. The palaeontological sensitivity of the borrow pit site is considered to be HIGH. It is therefore recommended that a professional palaeontologist be commissioned to record and judiciously sample any fossil assemblages exposed once the pit has been re-excavated and before the material is removed for road construction

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 along the unsealed DR2244 road in the southern Cederberg region. Pit **DR02244/33.4/R/30** (= Vidamemoria Pit No. 127) is situated on gently west-sloping ground north of the road on the farm Bo Sneekop No. 473 in the Ceres District, Western Cape, about 17.5 km northeast of the small community of Op Die Berg and 1.8 km ENE of the junction between the DR2244 (Katbakkies / Skitterykloof road across the Swartruggens) and the DR1487 (32° 55' 51.6" S, 19° 28' 09.8" E) (Figs. 1 & 2). A large, shallow farm dam lies just to the west.

A previous desktop basic assessment of the pit by the author assessed its palaeontological heritage sensitivity as high due to the presence here of potentially fossiliferous sediments of the Klipbokkop Formation (Upper Bokkeveld Group, Bidouw Subgroup). A palaeontological field assessment of the pit as part of an HIA was requested by Heritage Western Cape (HWC case 1921 - 2012 ref 120726TS33, Interim Comment 8 August 2012) in accordance with the requirements of the National Heritage Resources Act, 1999 (Section 38). The present palaeontological heritage field assessment and short report were accordingly 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: Quahnita@vidamemoria.co.za). Fieldwork for this project was carried out on 29 December 2012.

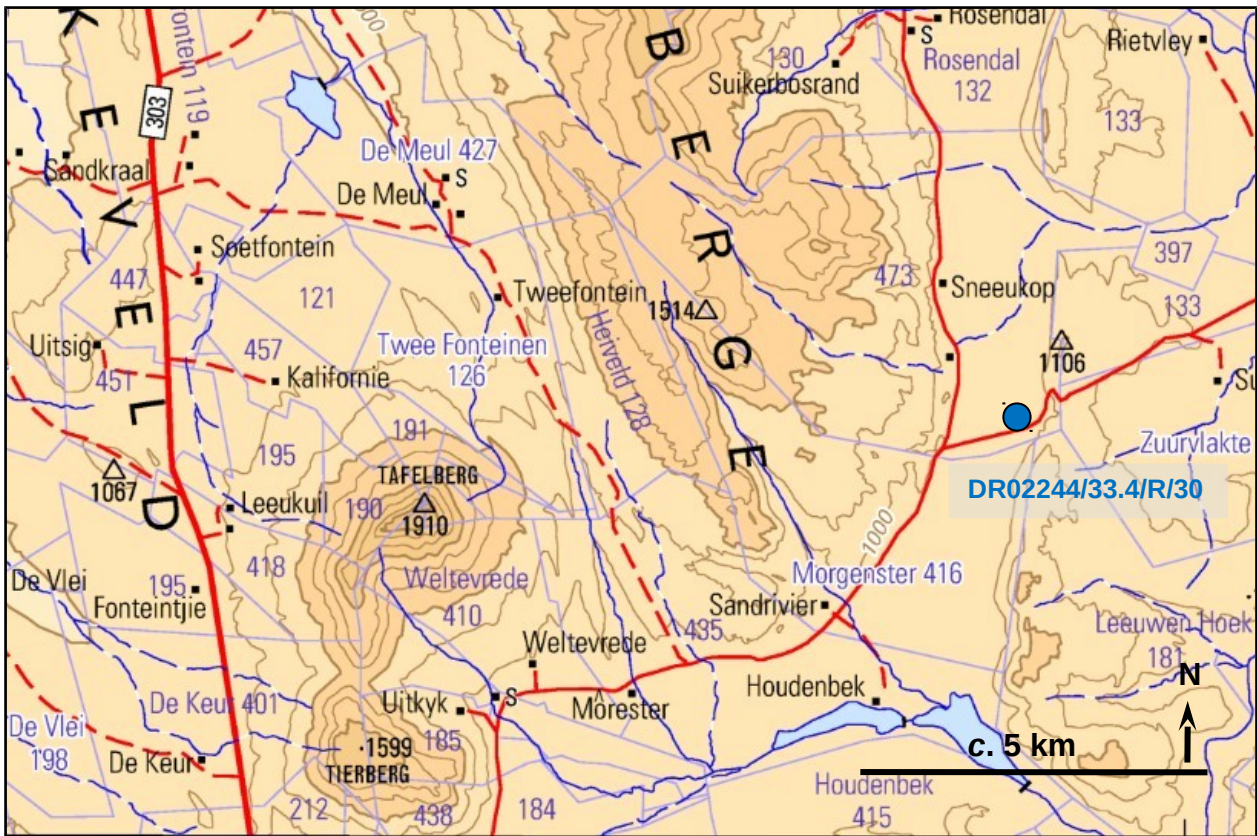


Fig.1. Extract from topographical sheet 3218 Clanwilliam (Courtesy of the Chief Directorate: National Geo-spatial Information, Mowbray) showing the approximate location of the existing pit DR02244/33.4/R/30 located on the farm Bo Sneekop No. 473 in the southern Cederberg region, c. 17.5 km northeast of Op Die Berg, Ceres District, Western Cape (blue dot).

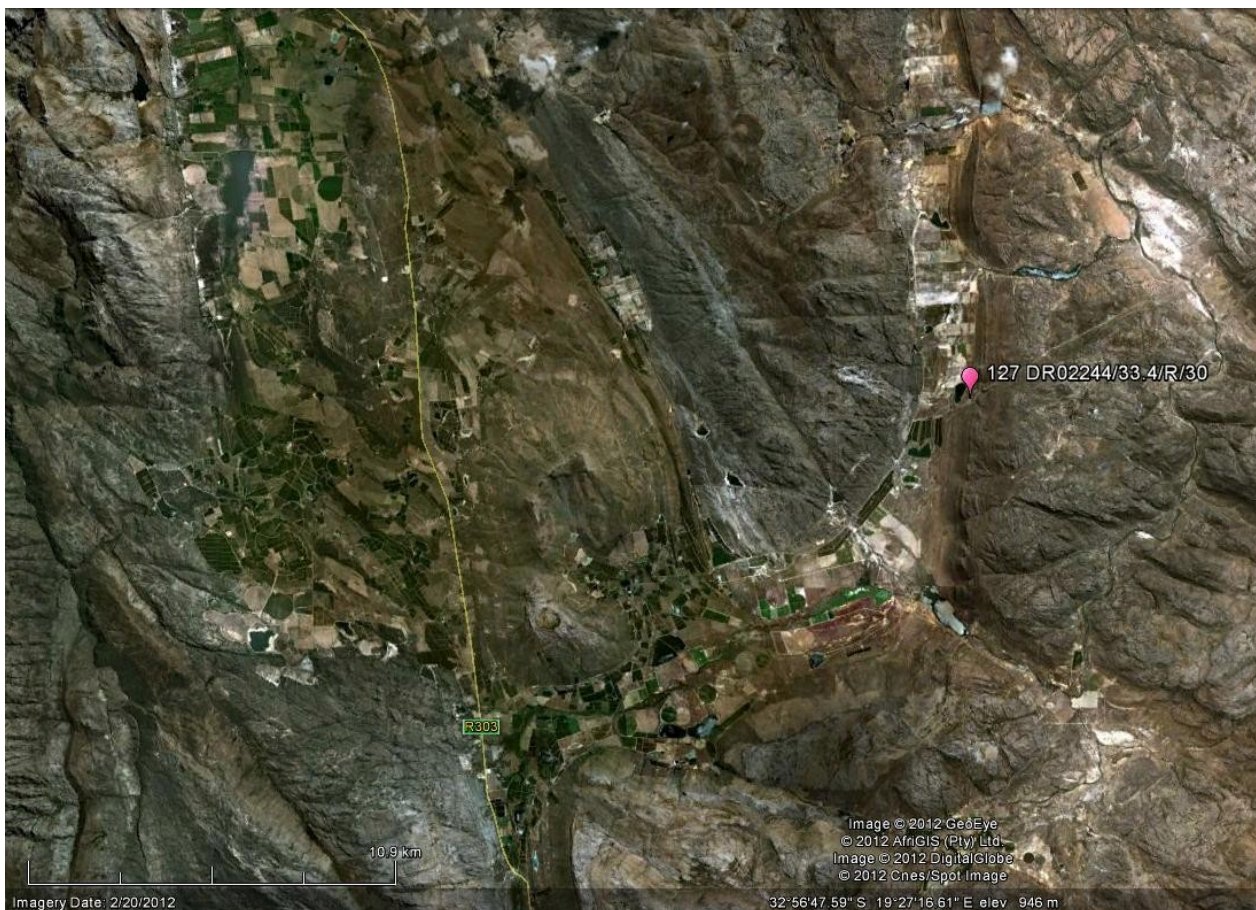


Fig. 2. Google earth© satellite image of the southern Cederberg study area showing the location of the existing pit DR02244/33.4/R/30 located in the southern Cederberg region, c. 17.5 km northeast of Op Die Berg.

3. GEOLOGICAL CONTEXT

The geology of the southern Cederberg study area north of Ceres is shown on 1: 250 000 geology sheet 3218 Clanwilliam (Council for Geoscience, Pretoria) and is illustrated here in Fig. 3. A very short sheet explanation is published on the geological map (This is currently being revised).

The existing DR02244/33.4/R/30 pit is located within the narrow, north-south trending outcrop area of the Bokkeveld Group (Cape Supergroup) that in this area lies between a major anticline of Table Mountain Group sandstones building the southern Cederberg range in the west and the gently east-dipping Witteberg Group succession of the Swaruggens in the east. The succession of thin formations of the Bokkeveld Group dip towards the east and crop out as a series of alternating prominent-weathering sandstones and recessive weathering mudrocks (These formations are not shown separately on the map in this area). The DR02244/33.4/R/30 borrow pit is excavated into Middle Devonian sediments of the **Klipbökkop Formation (Dk)** within the Upper Bokkeveld Group (= Bidouw Subgroup). The overlying Osberg Formation sandstones build a north-south trending ridge running across the DR2244 dust road. Short accounts of the Klipbökkop Formation in the Western Cape have been given by Theron *et al.* (1991), Gresse and Theron (1992) and Almond (2009). The depositional setting of this thick succession remains unresolved, but some authors prefer a restricted shallow inshore marine to delta platform environment.

The Klipbökkop rocks in the large existing DR02244/33.4/R/30 pit are poorly exposed (Fig. 4) but abundant, albeit somewhat weathered, previously excavated material is available for inspection in spoil heaps. They consist of thinly interbedded to laminated as well as massive, greyish to grey-green, micaceous wackes (impure sandstones) and darker grey micaceous siltstones. Primary

sedimentary structures such as wave ripple and horizontal lamination are often obscured by high levels of bioturbation (biogenic sediment mixing), causing colour mottling (Figs. 5 & 6). Some of the wackes contain horizons rich in small load balls (pseudonodules), pointing to sedimentary instability that probably resulted from rapid deposition of watery sediments following floods (Fig. 7). Occasional examples of possible swaley or hummocky cross-stratification, generated by storms, are also seen. Tectonic cleavage is not well developed at this site and despite weathering the bedrocks are still moderately well consolidated.

The Klipbokkop bedrocks are mantled with coarse, poorly-sorted, orange-brown, mixed sandy and gravelly colluvial material (Fig. 4), mainly angular to subangular clasts of quartzite and wacke derived from the Osberg and Witteberg units upslope to the east with an admixture of ferricrete clasts. Larger blocks are concentrated at the surface by downwasting.

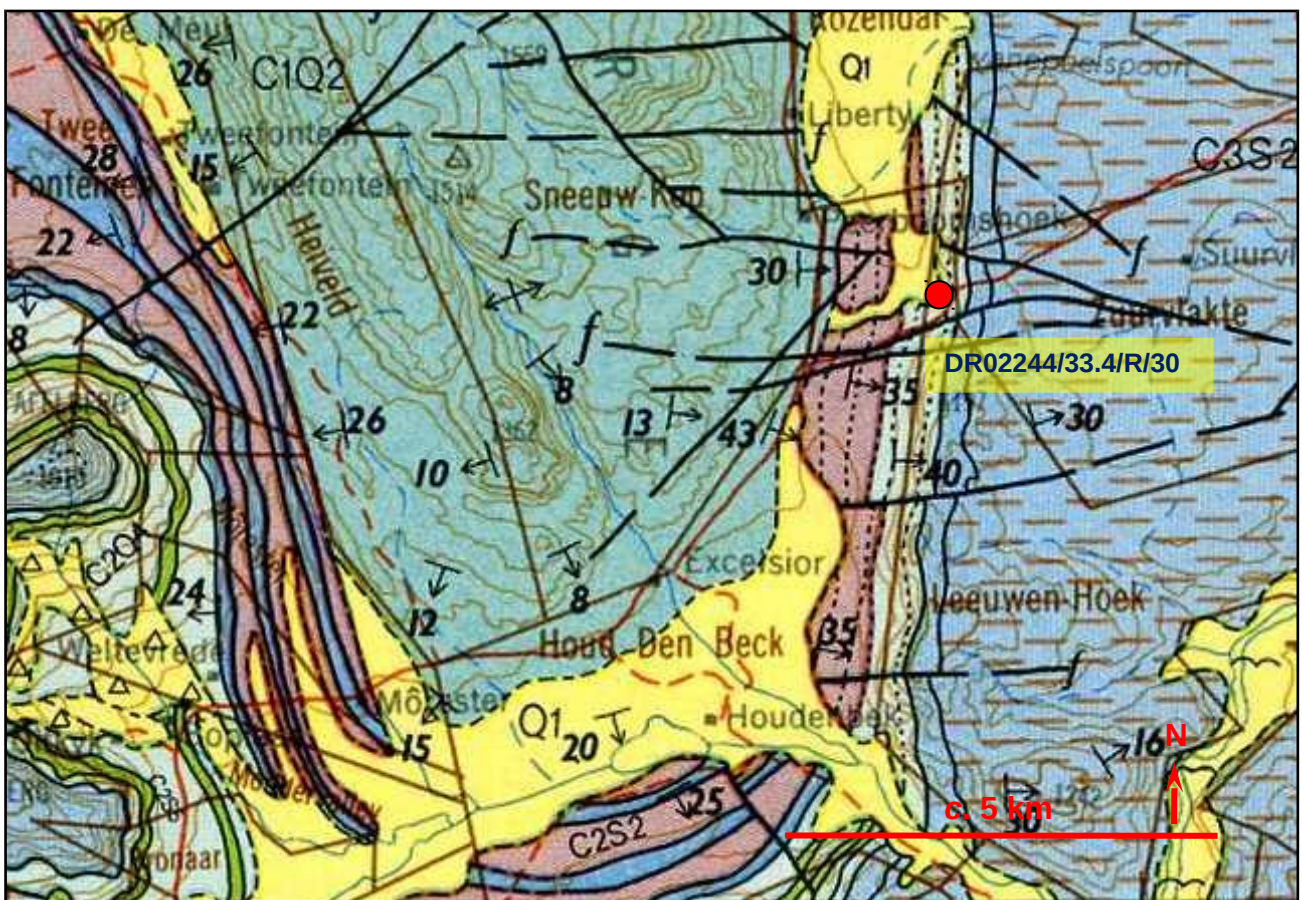


Fig. 3. Extract from 1: 250 000 geology sheet 3218 Clanwilliam (Council for Geoscience, Pretoria) showing location of the DR02244/33.4/R/30 borrow pit c. 17.5 km northeast of Op Die Berg. The pit is excavated into siltstones and wackes of the Klipbokkop Formation (Dk, Upper Bokkeveld Group, Bidouw Subgroup) (pale blue).



Fig. 4. View towards the NE across borrow pit DR02244/33.4/R/30 showing grey-green Klipbokkop wackes and siltstones overlain by orange-brown colluvial gravels. The sandstones in the background belong to the Osberg and Wagen Drift Formations.

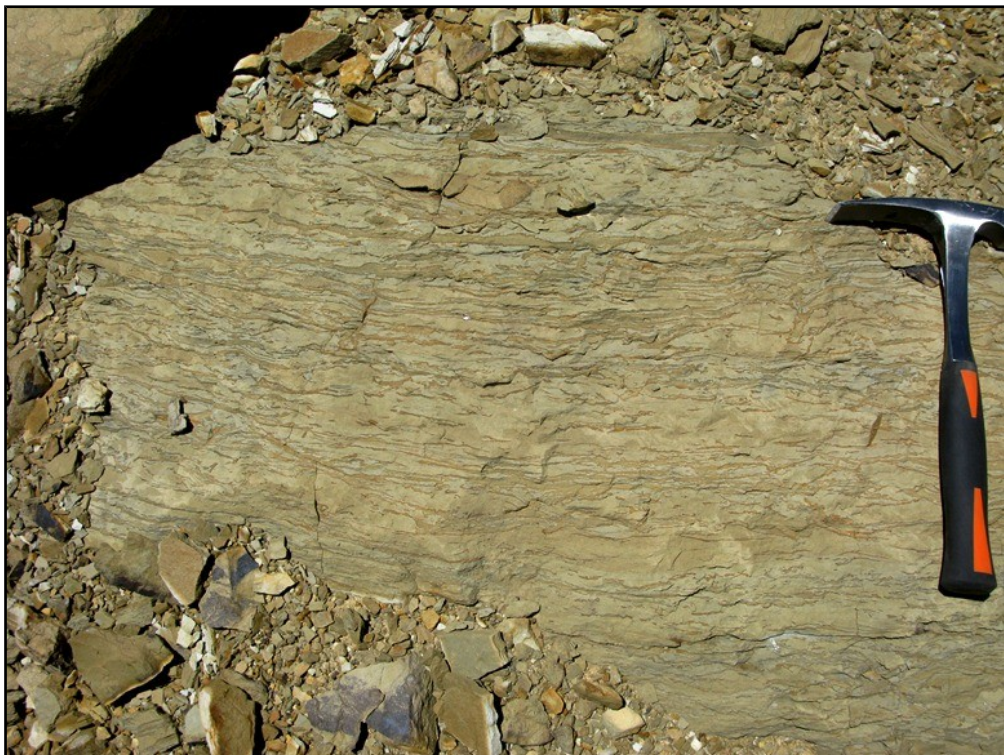


Fig. 5. Interlaminated darker siltstone and lighter fine sandstone layers within the Klipbokkop Formation showing ripple lamination and bioturbation by trace fossils (Hammer = 33 cm).



Fig. 6. Excavated block of grey-green Klibokkop wacke with massive and mottled (heavily bioturbated) horizons (Hammer = 33 cm).



Fig. 7. Grey-green laminated wacke showing horizon of spheroidal load balls or pseudonodules, indicative of sediment instability (e.g. dewatering). The largest balls seen here are approximately 5 cm across.

4. PALAEOONTOLOGICAL HERITAGE

An important, albeit low-diversity, non-marine fossil biota has been recorded from the Bidouw Subgroup (Klipbökkop and upper Kanies Formations in the western Bokkeveld outcrop area) as well as from laterally equivalent Middle Devonian sediments to the east – *i.e.* the Adolphspoor Formation of the Traka Subgroup (Plumstead 1977, Chaloner *et al.* 1980, Anderson & Anderson 1985, Almond 1997, Anderson *et al.* 1999a, 1999b, Anderson *in* MacRae 1999, Almond 2008a, 2008b, 2009). The Klipbökkop / Adolphspoor fossil assemblages are mainly preserved as moulds and comprise:

- Fragmentary vascular plants, including several species of lycopods (the club mosses *Archaeosigillaria*, *Haplostigma*) plus possible psilopsids;
- Non-marine, thin-shelled bivalves (possibly unionids), often preserved in dense clumps;
- Rare marine invertebrates (*e.g.* the articulate brachiopod *Australospirifer*);
- A limited variety of trace fossils including rare trilobite burrows (*Cruziana*), and unusually small versions of the complex helical burrow *Spirophyton*;
- A low-diversity assemblage of bony and cartilaginous fish, including acanthodians (“spiny sharks”), several primitive sharks, bony-plated jawed fish known as placoderms (Fig. 8), and rare crossopterygians (lobe-finned bony fish). These important Middle Devonian fossil fish have been described and illustrated in detail by Chaloner *et al.* (1980), Almond (1997), Anderson *et al.* (1999a, 1999b) and Long *et al.* (in prep). General accounts of Devonian fish groups from Gondwana are given by Anderson *in* MacRae (1999) and Long (1995).

Klipbökkop / Adolphspoor fish fossils mainly consist of disarticulated placoderm plates as well as isolated teeth and fin spines of antarctilamid sharks and acanthodians. The fossils are found scattered throughout the succession within silty mudrocks and occasionally within ferruginous carbonate-rich concretions. Thin conglomeratic layers of transported mudflakes mixed with fish teeth, spines and other skeletal elements are recorded from the mid to upper Klipbökkop Formation in the Cederberg region and elsewhere. Those parts of the succession with unionid-like bivalves, low-diversity trace assemblages dominated by small *Spirophyton*, vascular plants and fish fossils are considered to be non-marine in origin, perhaps accumulated on an extensive delta platform or prograding (advancing) shoreline zone. A mixture of fish originally from brackish to freshwater bodies near to the coastline (estuaries, lagoons, rivers, lakes) as well as salinity-tolerant marine forms may be represented in the fossil assemblages.

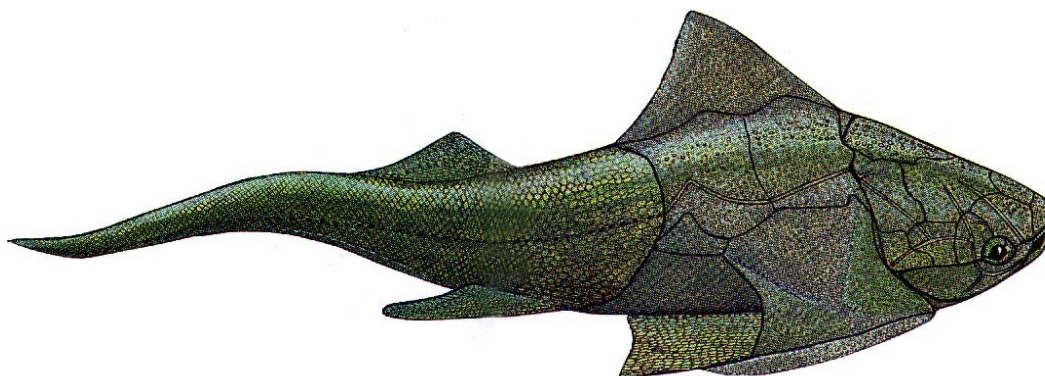


Fig. 8. Reconstruction of the armour-plated placoderm fish *Groenlandaspis*, which is recorded from Middle to Late Devonian sediments worldwide, including the Bidouw and Traka Subgroups of South Africa (From Long 1995).

Several fragmentary remains of placoderm fish dermal armour showing the characteristic fine pustular surface ornament – notably moulds of two spinal plates that are probably from groenlandaspids (Figs. 9 and 10) – were recorded within pit DR02244/33.4/R/30 during the present field assessment. This site has previously yielded several specimens of fragmentary to well-articulated placoderm fish from the late 1990s onwards (Almond 1997, Anderson *et al.* 1999b, Almond unpublished obs.). Given the lack of tectonic cleavage, further well-preserved fossil fish material can be expected here in future and the palaeontological sensitivity of this site is rated as HIGH. Although trace fossils are abundant, due to high levels of bioturbation most of them are not identifiable to ichnogenus, with the exception of typical small forms of the helical spreiten burrow *Spirophyton* (Fig. 11) whose small size probably reflects ecological restriction in a non-marine (possibly brackish or fluctuating salinity) setting.



Fig. 9. Mould of an isolated spinal plate of a placoderm fish (probably groenlandaspid) from the Klipbokkop Formation in pit DR02244/33.4/R/30, showing the characteristic pustular ornament (width c. 1 cm).



Fig. 10. Secondarily ferruginised mould of an isolated spinal plate of a placoderm fish (probably groenlandaspid) from the Klipbokkop Formation in pit DR02244/33.4/R/30 (width c. 1 cm).



Fig. 11. Typical small form of helical *Spirophyton* burrow seen in the Klipbokkop Formation.

5. CONCLUSIONS & RECOMMENDATIONS

The existing DR02244/33.4/R/30 borrow pit, located on the farm Bo Sneekop No. 473 in the Ceres District, Western Cape, about 17.5 km northeast of the Op Die Berg, is excavated into marginal marine to deltaic sediments of the Klipbokkop Formation (upper Bokkeveld Group / Bidouw Subgroup). This is one of a handful of sites in the Western Cape that have yielded well-preserved remains of placoderm fish fossils as well as low diversity trace fossil assemblages of Middle Devonian age. Fragmentary fossil fish remains are still visible in the pit and because the sedimentary rocks here are not cleaved or deeply weathered it is likely that further scientifically valuable specimens will be obtained here in future. The palaeontological sensitivity of the borrow pit site is considered to be HIGH. It is therefore recommended that a professional palaeontologist be commissioned to record and judiciously sample any fossil assemblages exposed once the pit has been re-excavated and before the material is removed for road construction.

6. ACKNOWLEDGEMENTS

Ms Quahnita Samie of Vidamemoria Heritage Consultants, Cape Town, is thanked for commissioning this specialist study and for kindly providing the necessary background information. I am also very grateful to Ms Madelon Tusenius for logistical support and assistance with these borrow pit projects.

7. REFERENCES

- ALMOND, J.E. 1997. Fish fossils from the Devonian Bokkeveld Group of South Africa. *Stratigraphy, African Anthropology, Archaeology, Geology and Palaeontology* 1(2): 15-28.
- ALMOND, J.E. 1998a. Trace fossils from the Cape Supergroup (Early Ordovician – Early Carboniferous) of South Africa. *Journal of African Earth Sciences* 27 (1A): 4-5.
- ALMOND, J.E. 1998b. Early Palaeozoic trace fossils from southern Africa. *Tercera Reunión Argentina de Icnología, Mar del Plata, 1998, Abstracts* p. 4.
- ALMOND, J.E. 2008a. Palaeozoic fossil record of the Clanwilliam Sheet area (1: 250 000 geological sheet 3218), 42 pp. Report produced for the Council for Geoscience, Pretoria.
- ALMOND, J.E. 2009. Geology and fossils of the Sanbona Nature Reserve, Little Karoo, 244 pp. *Natura Viva cc*, Cape Town.
- ALMOND, J.E. 2010a. Eskom Gamma-Omega 765Kv transmission line: Phase 2 palaeontological impact assessment, 95pp. *Natura Viva cc.*, Cape Town.
- ALMOND, J.E. 2010b. Phase 2 palaeontological heritage impact assessment: Gama-Omega 765 kV transmission line. Sector 2: Omega to Kappa Substation, Western Cape, 100 pp. *Natura Viva cc.*, Cape Town.
- ALMOND, J.E. & PETHER, J. 2008. Palaeontological heritage of the Western Cape. Interim SAHRA technical report, 20 pp. *Natura Viva cc.*, Cape Town.
- ANDERSON, J.M. & ANDERSON, H.M. 1985. Palaeoflora of southern Africa. *Prodromus of South African megaflores, Devonian to Lower Cretaceous*, 423 pp, 226 pls. Botanical Research Institute, Pretoria & Balkema, Rotterdam.

- ANDERSON, M.E., ALMOND, J.E., EVANS, F.J. & LONG, J.A. 1999a. Devonian (Emsian-Eifelian) fish from the Lower Bokkeveld Group (Ceres Subgroup), South Africa. *Journal of African Earth Sciences* 29: 179-194.
- ANDERSON, M.E., LONG, J.A., EVANS, F.J., ALMOND, J.E., THERON, J.N. & BENDER, P.A. 1999b. Biogeographic affinities of Middle and Late Devonian fishes of South Africa. *Records of the Western Australian Museum, Supplement No. 57*: 157-168.
- BROQUET, C.A.M. 1992. The sedimentary record of the Cape Supergroup: a review. In: De Wit, M.J. & Ransome, I.G. (Eds.) *Inversion tectonics of the Cape Fold Belt, Karoo and Cretaceous Basins of Southern Africa*, pp. 159-183. Balkema, Rotterdam.
- CHALONER, W.G., FOREY, P.L., GARDINER, B.G., HILL, A.J. & YOUNG, V.T. 1980. Devonian fish and plants from the Bokkeveld Series of South Africa. *Annals of the South African Museum* 81: 127-157.
- DE VILLIERS, J., JANSEN, H. & MULDER, M.P. 1964. Die geologie van die gebied tussen Worcester en Hermanus. Explanation of sheets 3319C (Worcester) and 3419A (Caledon) and parts of 3318D (Stellenbosch) and 3418B (Somerset West), 68 pp, 1 pl. Council for Geoscience, Pretoria.
- GRESSE, P.G. & THERON, J.N. 1992. The geology of the Worcester area. Explanation of geological Sheet 3319. 79 pp, tables. Council for Geoscience, Pretoria.
- HILLER, N. & THERON, J.N. 1988. Benthic communities in the South African Devonian. In: McMillan, N.J., Embry, A.F., & Glass, D.J. (Eds.) *Devonian of the World, Volume III: Paleontology, Paleogeology and Biostratigraphy*. Canadian Society of Petroleum Geologists, Memoir No. 14, pp 229-242.
- LONG, J.A. 1995. *The rise of fishes. 500 million years of evolution*, 223 pp. University of New South Wales Press, Sydney.
- LONG, J.A., ALMOND, J.E. & EVANS, F.J. (in prep.). Fish faunas from the Bokkeveld Group (Early – Middle Devonian) of South Africa.
- MACRAE, C. 1999. *Life etched in stone. Fossils of South Africa*. 305pp. The Geological Society of South Africa, Johannesburg.
- MILLER, M.F. 1991. Morphology and paleoenvironmental distribution of Paleozoic *Spirophyton* and *Zoophycos*: implications for the Zoophycos Ichnofacies. *Palaios* 6, 410-425.
- OOSTHUIZEN, R.D.F. 1984. Preliminary catalogue and report on the biostratigraphy and palaeogeographic distribution of the Bokkeveld Fauna. *Transactions of the Geological Society of South Africa* 87: 125-140.
- PLUMSTEAD, E.P. 1967. A general review of the Devonian fossil plants found in the Cape System of South Africa. *Palaeontologia africana* 10: 1-83, 25 pls.
- PLUMSTEAD, E.P. 1977. A new phytostratigraphical Devonian zone in southern Africa which includes the first record of *Zosterophyllum*. *Transactions of the Geological Society of South Africa* 80: 267-277.
- SEILACHER, A. 2007. *Trace fossil analysis*, xiii + 226 pp. Springer, Berlin etc.
- TANKARD, A.J. & BARWIS, J.H. 1982. Wave-dominated deltaic sedimentation in the Devonian Bokkeveld Basin of South Africa. *Journal of Sedimentary Petrology* 52, 0959-0974.

THAMM, A.G. & JOHNSON, M.R. 2006. The Cape Supergroup. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa, pp. 443-459. Geological Society of South Africa, Marshalltown.

THERON, J.N. 1972. The stratigraphy and sedimentation of the Bokkeveld Group. Unpublished DSc thesis, University of Stellenbosch, 175pp, 17pls.

THERON, J.N. & LOOCK, J.C. 1988. Devonian deltas of the Cape Supergroup, South Africa. In: McMillan, N.J., Embry, A.F. & Glass, D.J. (Eds.) Devonian of the World, Volume I: Regional syntheses. Canadian Society of Petroleum Geologists, Memoir No. 14, pp 729-740.

THERON, J.N. & JOHNSON, M.R. 1991. Bokkeveld Group (including the Ceres, Bidouw and Traka Subgroups). Catalogue of South African Lithostratigraphic Units 3: 3-5.

THERON, J.N., WICKENS, H. DE V. & GRESSE, P.G. 1991. Die geologie van die gebied Ladismith. Explanation of geological Sheet 3320, 99 pp. Council for Geoscience, Pretoria.

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 for SAHRA and HWC. Dr Almond is an accredited member of PSSA and AHP (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.



Dr John E. Almond
Palaeontologist
***Natura Viva* cc**