PALAEONTOLOGICAL SPECIALIST STUDY: FIELD ASSESSMENT

THREE EXISTING BORROW PITS ALONG THE DR2262, CLANWILLIAM MAGISTERIAL DISTRICT, WESTERN CAPE

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1. EXECUTIVE SUMMARY

It is proposed to re-excavate and extend three existing borrow pits along the DR2262 between the R364 Pakhuis Pass to Botterkloof Pass road at Klipfonteinrand and Wuppertal in the northern Cederberg region to the east of Clanwilliam, Western Cape. The sites lie north and south as well as within the Biedouw Valley.

All three pits under consideration are excavated into marine mudrocks and sandstones of the Gydo Formation (Lower Bokkeveld Group) that are well known in the northern Cederberg region for their rich fossil heritage – especially shelly invertebrates and trace fossils – from the Early Devonian Period.

The Gydo mudrocks at pit site DR2262/16.42/L/50 (Mertenhof 586) are highly weathered and so contain little fossil material of value. Only sparse shelly invertebrates and low diversity trace fossil assemblages occur at pit site DR2262/11.13/L/100 (Mertenhof 586). Pit site DR2262/7.48/L/20 (Nodewee 141)) is excavated into sandstone-rich successions high up in the Gydo Formation that are typically fossil-poor, apart from shallow marine trace fossils associated with storm-deposited sandstones. The palaeontological sensitivity of all three sites is rated as LOW and therefore no further specialist fossil studies or mitigation are recommended here.

2. INTRODUCTION

The Department of Transport, Western Cape, is applying to the Department of Mineral Resources for approval to exploit road material from three existing borrow pits along the unsealed road DR2262 between the R364 Pakhuis Pass – Botterkloof road and Wuppertal in the Clanwilliam Magisterial District, as well as to extend these pits (Fig. 1). Pit DR2262/16.42/L/50 (32º 10' 36.1" S, 19º 10' 34.4" E) is located on the farm Mertenhof 586 on the east side of the road some 3 km SSW of the Biedouw Valley. Pit DR2262/11.13/L/100 is situated on the same farm but on the floor of the Biedouw Valley some 2.3 km north of Mertenhof farmstead and 100m east of the road (32º 08' 16.8" S, 19º 11' 03.5" E). Finally, Pit DR2262/7.48/L/20 (road reserve on Farm Nodewee 141) lies on the east side of the road at the top of Uitkyk Pass overlooking the Biedouw Valley (32º 07' 04.0" S, 19º 10' 28.4" E).

A previous desktop basic assessment of the three DR2262 pits by the author assessed their palaeontological heritage sensitivity as high due to the presence here of potentially fossiliferous sediments of the Lower Bokkeveld Group (Gydo Formation). A palaeontological field assessment of the pits as part of an HIA was requested by Heritage Western Cape (HWC Case Nos. 111115JB25, Interim Comment 18 November 2011) 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 14 August 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 three DR2262 borrow pits in the Biedouw Valley area east of Clanwilliam, Clanwilliam Magisterial District, Western Cape (blue dots).

3. GEOLOGICAL CONTEXT

The geology of the borrow pit study area is shown on 1: 250 000 geology sheet 3218 Clanwilliam (See brief sheet explanation printed on the map) (Fig. 8). All three pits exploit marine mudrocks and thin sandstones of the Gydo Formation at or close to the base of the Bokkeveld Group (Fig. 2). The **Gydo Formation** is a marine siliciclastic shelf succession of Emsian or Early Devonian age, some 400 million years old (Theron 1999, Theron & Johnson 1991, Thamm & Johnson 2006). In its northern outcrop area it reaches thicknesses of about 130 m (Botterkloof Pass section) and consists of a clearly upward-coarsening, shallowing succession of dark grey to black mudrocks, fine-grained sandstones and medium-grained wackes (dark, impure sandstones). These sedimentary rocks were deposited in a cool shallow seaway, the Agulhas Sea, on the south-western margins of Gondwana some 400 million years ago. Offshore mudrocks were deposited in quiet, deeper waters and may be massive or well-laminated. Pyrite-rich horizons indicate episodes of anoxia at or shortly below the sea floor. Near-shore sandstones were laid down in more turbulent settings and often show the influence of major storms (*e.g.* well-developed wave ripples, hummocky cross-stratification, mudflake breccio-conglomerates). The Gydo Formation is consistently the most fossil-rich formation within the Bokkeveld Group (Section 4). The overlying

sandstone-dominated **Gamka Fm** (**Dga**) is more resistant weathering and forms a steep cliff or *kranz* on hill slopes above the borrow pits.

The sedimentology of the northern outcrop area of the Gydo Formation has been briefly described by Theron *in* De Beer *et al.* (2002) and a schematic column is shown in Fig. 2. As outlined below, two of the three borrow pits covered by this report are excavated into the basal mudrock-dominated to heterolithic succession (*c*. 40 m thick) of the formation which is characterised by various diagenetic nodules, some of which are fossiliferous. Large (up to 60cm across), subrounded, boulder-sized concretions of brownish, slightly ferruginous carbonate are common at this stratigraphic level. The third pit is excavated into the uppermost Gydo Formation close to its contact with the overlying Gamka sandstones.

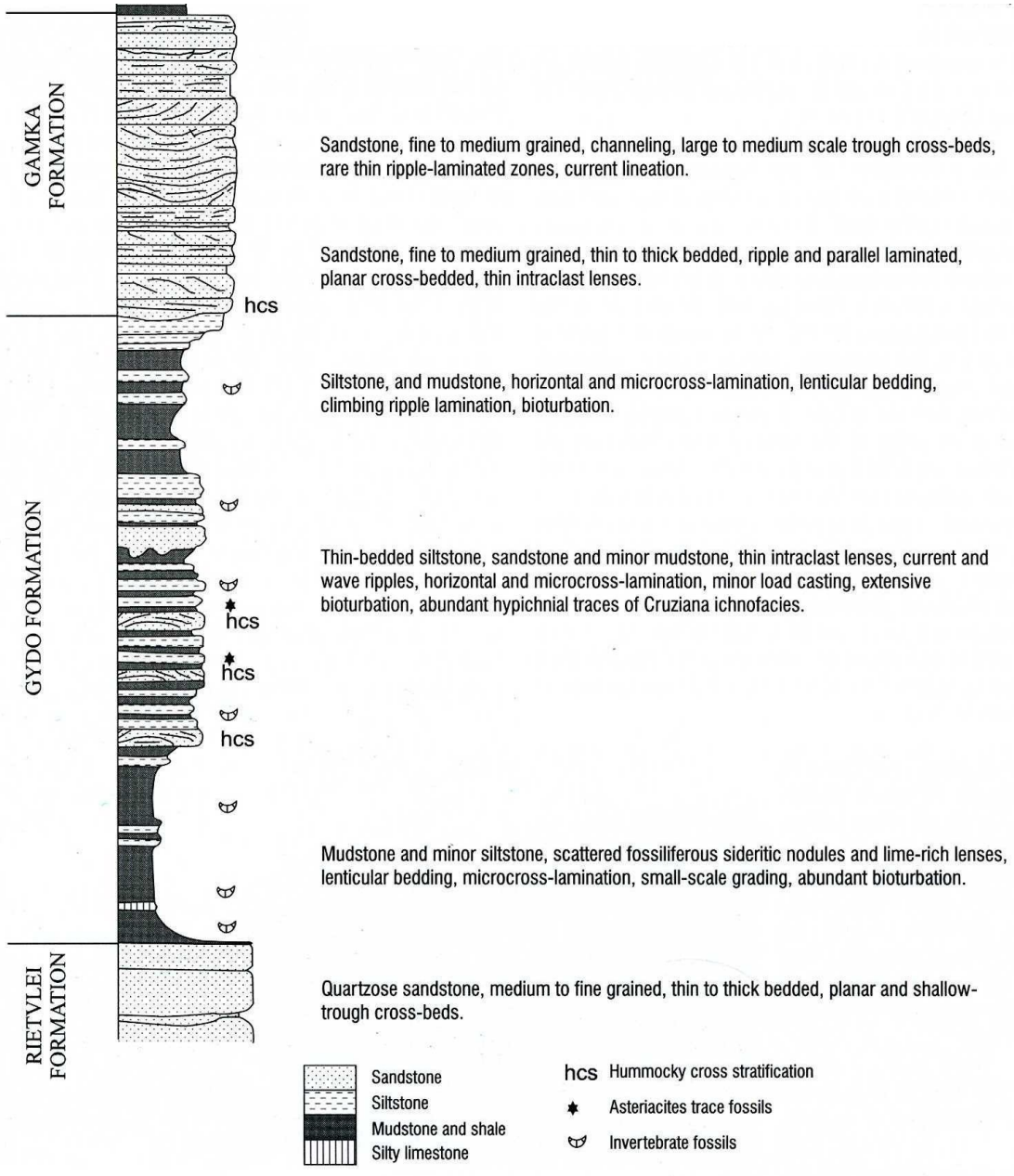

Fig. 2. Schematic section through the lower Bokkeveld Group (Ceres Subgroup) succession in the northern outcrop area (Modified from De Beer *et al.* 2002). Two of the borrow pits concerned here are excavated into the lowermost mudrock-dominated beds shortly above the basal contact with the Rietvlei Formation (top of Table Mountain Group). The third pit is excavated into the heterolithic upper part of the Gydo Formation (see text).

3.1. Pit DR2262/16.42/L/50

This pit is situated on a narrow, northwest-facing plateau at about *c*. 520m amsl that lies along the foot of the Witkrans – Taaibosberg range (Tra Tra Mountains) between the Biedouw Valley and Wuppertal and that looks out over the Klein Doring stream valley (Fig. 3). The slopes of the Tra Tra mountains are built of the entire Bokkeveld Group succession and capped by quartzite-rich beds of the lowermost Witteberg Group. The pit is excavated into marine sediments of the **Gydo Formation** (**Dg**) (Lower Bokkeveld Group, Cape Supergroup), just above its conformable sedimentary (*i.e.* unfaulted) lower contact with the sandstone-dominated succession of the Rietvlei Formation (uppermost Table Mountain Group). The Gydo rocks here comprise deeply-weathered, hackly, massive to thin-bedded, grey-green to khaki-brown siltstones with sporadic greyish, leached phosphatic nodules as well as calcrete concretions of much younger (probably Quaternary) age. The Bokkeveld bedrocks are mantled with up to a meter of more of coarse gravelly colluvium, largely composed of angular to subrounded wackes with a finer gravely matrix, in part formed by a slurry of reworked siltstone flakes (probable debris flow deposits). A good section through a meter-thick erosion channel infilled with coarse colluvial gravels is exposed on the eastern edge of the pit (Fig. 4). Good exposures of fresher-looking, dark grey Gydo mudrocks are seen in stream gullies incising the escarpment some 300m to the southeast of the pit; these were also examined for fossil remains.

Fig. 3. View northeast across the existing Pit DR2262/16.42/L/50 that is excavated into highly weathered lower Gydo Formation mudrocks at the foot of the Tra Tra Mountains. The sandstone-dominated *krans* capping the slope in the background is the Gamka Formation.

Fig. 4. Section through a meter-thick erosional channel infilled with coarse colluvial gravels incised into Gydo mudrocks, eastern side of Pit DR2262/16.42/L/50 (Hammer = 27 cm).

3.2. Pit DR2262/11.13/L/100

This existing shallow borrow pit lies on the floor of the Biedouw Valley at *c*. 370m amsl and only 70m or so to the northeast of a very prominent NNW-SSE trending fault scarp at the head of the valley. This major fault separates downfaulted Bokkeveld Group rocks to the east from upfaulted Table Mountain Group quartzites to the west (Geological map Fig. 8). The fault plane is well-exposed here as a steep cliff (Fig. 5). The pit is excavated into hackly-weathering silty mudrocks within the lower part of the Gydo Formation (the exact stratigraphic horizon is unclear). These beds are not well exposed due the extensive cover of sandy and gravelly alluvial and colluvial deposits mantling them, together with material dumped from elsewhere (sand, large quartzite blocks). The mudrocks are strongly bioturbated and mottled with secondary iron and manganese minerals. Large, boulder-sized ferruginous carbonate concretions also occur here.

3.3. Pit DR2262/7.48/L/20

This existing pit, located at *c*. 700m amsl, is excavated into a heterolithic succession of interbedded impure sandstones (wackes) and thin-bedded, grey-green, micaceous siltstones towards the top of the Gydo Formation, close to the upper contact with the overlying Gamka Formation (Fig. 6). The major NNW-SSE fault between the Table Mountain and Bokkeveld Groups mentioned above runs along the valley less than 50m to the southeast. The sediments in the pit were deposited close to the storm-influenced shoreline as shown by evidence for tempestite sandstone deposition (flaggy sandstones up to 40cm thick with wave rippled tops, wavy cross lamination, sharp erosive bases with tool marks, wash-out traces of the *Cruziana* ichnofacies and thin mudflake conglomerates, occasional hummocky cross stratification). Coarse colluvial gravels, mainly of secondarily ferruginised Bokkeveld wacke blocks, mantle the ground surface outside the existing pit (Fig. 7).

Fig. 5. View south-eastwards across Pit DR2262/11.13/L/100. The steep escarpment in the background marks a major fault scarp at the head of the Biedouw Valley along which the Bokkeveld Group sediments in the foreground have been downfaulted.

Fig. 6. View to the northwest across Pit DR2262/7.48/L/20 at the top of Uitkyk Pass.

Fig. 7. Ferruginised coarse colluvial gravels mantling the Bokkeveld Group sediments along the margins of Pit DR2262/7.48/L/20.

4. PALAEONTOLOGICAL HERITAGE

The lower part of the **Bokkeveld Group** in the Western Cape (Ceres Subgroup *plus* lowermost Bidouw Subgroup) – and in particular the **Gydo Formation** - is known for its rich fossil assemblages of shallow marine invertebrates of the Malvinokaffric Faunal Province of Gondwana (Cooper 1982, Oosthuizen 1984, Hiller & Theron 1988, Theron & Johnson 1991, MacRae 1999, Almond *in* De Beer *et. al*. 2002, Thamm & Johnson 2006, Almond 2008). Key fossil groups here include trilobites, brachiopods, various subgroups of molluscs (bivalves, gastropods, nautiloids *etc*), and echinoderms (starfish, brittle stars, crinoids, carpoids, sea cucumbers *etc*), with several minor taxa including corals, conulariids, tentaculitids, bryozoans and rare fish remains, among others (Almond 1997, Anderson *et al.* 1999). These shelly fossil assemblages – generally preserved as impressions or moulds, but occasionally in the Gydo Formation also embedded within phosphatic, limestone or siliceous nodules – are especially abundant within the mudrock-dominated units such as the Gydo, Voorstehoek and Waboomberg Formations in their more distal (offshore) outcrop areas. Thin lenticles of shelly debris, known as *coquinas*, have been concentrated by storm activity and mainly consist of disarticulated specimens.

Fossils from various localities in the Gydo Formation within the northern Cederberg study region have been treated by Oosthuizen (1984), Almond in De Beer *et al.* (2002) and Almond (2008), among others. Of particular note are rich trace fossil assemblages of the shallow marine *Cruziana* ichnofacies from heterolithic, tempestite-dominated successions within the Gydo and Voorstehoek Formations (Almond 1998) and rare fish remains such as acanthodian fin spines from the Clanwilliam area (Almond 1997, Anderson *et al.* 1999).

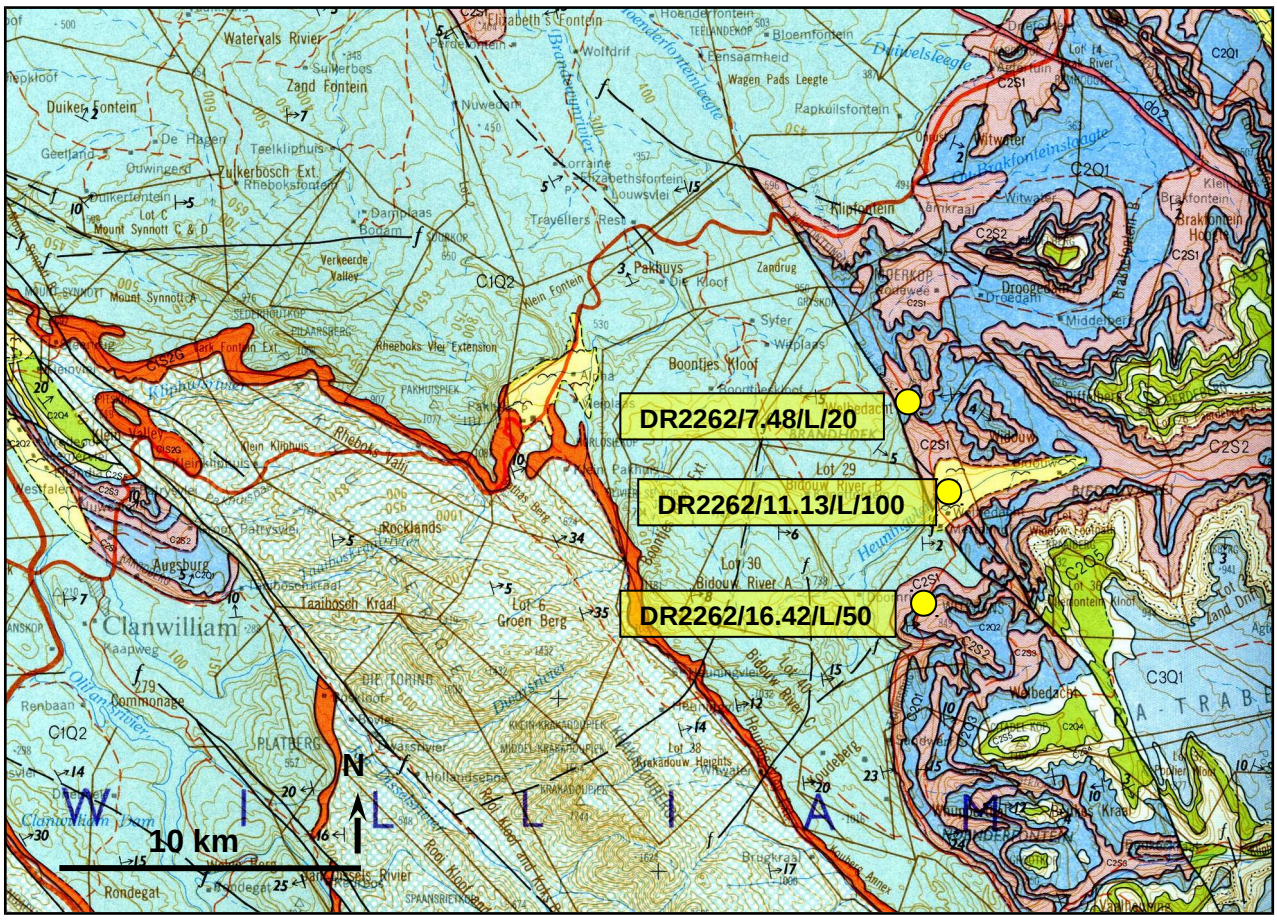

Fig. 8. Extract from 1: 250 000 geology sheet 3218 Clanwilliam (Council for Geoscience, Pretoria) showing location of the three DR2262 borrow pits in the Biedouw Valley area, Clanwilliam District Municipality. The pits are all excavated into marine sediments of the Early Devonian Gydo Formation (C2S1, pink) at the base of the Bokkeveld Group.

4.1. Fossil heritage in Pit DR2262/16.42/L/50

The mudrocks within the pit area are highly weathered and hence poorly fossiliferous. Potentially fossiliferous phosphatic nodules are highly leached and degraded. High levels of bioturbation are suggested by sediment mottling, and occasionally identifiable trace fossil taxa such as *Phycosiphon* tubular burrows can be recognised (Fig. 12).

Better exposures of lower Gydo mudrocks are exposed in stream valleys incising hill slopes some 300m to the east. Large, boulder-sized ferruginous carbonate nodules occurring at intervals within the lower Gydo succession are apparently not fossiliferous. Sparse phosphatic nodules (some secondarily ferruginised) here contain well-preserved homalonotid trilobites, orbiculoid brachiopods, nuculoid bivalves, and the distinctive four-sided conical skeletons of conulariids (intact or semi-disarticulated cones) (Fig. 9). This last group, possibly related to scyphozoan coelenterates, is fairly rare in the western outcrop area of the Bokkeveld Group.

Due to high levels of weathering, the Bokkeveld mudrocks in this pit are of LOW palaeontological sensitivity.

Fig. 9. Phosphatic nodule containing the four-sided, conical, phosphatic shell or test of a conulariid, a problematic group of sessile invertebrates that may be related to coelenterates. The specimen here is *c*. 3.5 cm long. Pit DR2262/16.42/L/50.

4.2. Fossil heritage in Pit DR2262/11.13/L/100

The bioturbated Gydo mudrocks in this pit are only sparely fossiliferous. Moulds of invertebrate fossils recorded here include the trilobites *Burmeisteria* and *Metacryphaeus* as well as the common nuculid bivalves *Nuculites* and *Palaeoneilo* and the bellerophontid mollusc *Plectonotus*. These taxa characterise shelly assemblages of soft muddy bottoms in the Early Devonian Agulhas Sea. Fragments of sandy coquinas (shell lenses) contain dense storm-concentrated accumulations of crinoidal debris. Numerous unidentified horizontal and oblique burrows with ferruginised (probably mud-lined) walls were also observed (Fig. 11). The palaeontological sensitivity of this site is LOW.

Fig. 10. Fossil moulds from pit DR2262/11.13/L/100: a small specimen of the trilobite *Metacryphaeus* (left) and a crushed example of the nuculoid bivalve *Palaeoneilo* (right). Both fossils are *c*. 2.5 cm across as orientated here.

4.3. Fossil heritage in Pit DR2262/7.48/L/20

No body fossils were observed at this pit; they are generally scarce within the heterolithic upper parts of the Gydo Formation where *Cruziana* ichnofacies traces, as here, tend to predominate heavily over body fossils. Most traces seen are non-descript horizontal burrows on tempestite sandstone soles (often partially washed out). Identifiable ichnotaxa include fine tubular burrow systems and meniscate back-filled burrows of *Phycosiphon* and *Lophoctenium* respectively as well as the bivalve trace *Lockeia*. The palaeontological sensitivity of this site is LOW.

Fig. 11. Mud-lined horizontal burrows of unknown infaunal invertebrates within dark mudrocks (Pit DR2262/11.13/L/100) (Scale in cm).

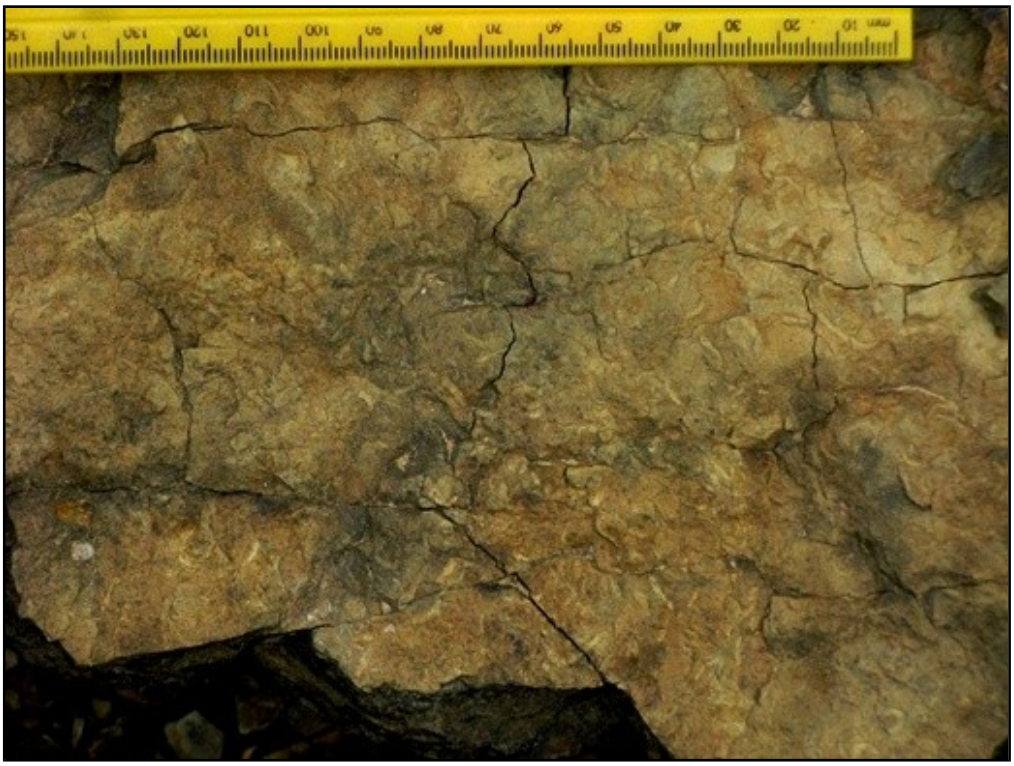

Fig. 12. Fine tubular, mud-lined burrow systems of the ichnogenus *Phycosiphon* (Pit DR2262/16.42/L/50) (Scale in cm and mm).

5. CONCLUSIONS & RECOMMENDATIONS

All three pits under consideration are excavated into mudrocks of the Gydo Formation that is well known in the northern Cederberg region for its rich fossil heritage – especially shelly invertebrates and trace fossils – from the Early Devonian Period.

The Gydo mudrocks at pit site DR2262/16.42/L/50 are highly weathered and so contain little fossil material of value. Only sparse shelly invertebrates and low diversity trace fossil assemblages occur at pit site DR2262/11.13/L/100. Pit site DR2262/7.48/L/20 is excavated into sandstone-rich successions high up in the Gydo Formation that are typically fossil-poor, apart from shallow marine trace fossils associated with storm-deposited sandstones. The palaeontological sensitivity of all three sites is rated as LOW and therefore no further specialist fossil studies or mitigation are recommended here.

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. 1998. 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. 2005. Geology of the Gamkaberg-Rooiberg Conservation Area, Little Karoo, 255pp. Unpublished report for Cape Nature, Natura Viva cc., Cape Town.

ALMOND, J.E. 2008. Palaeozoic fossil record of the Clanwilliam Sheet area (1: 250 000 geological sheet 3218), 42 pp. Report produced for the Council for Geoscience, Pretoria.

ANDERSON, M.E., ALMOND, J.E., EVANS, F.J. & LONG, J.A. 1999. Devonian (Emsian-Eifelian) fish from the Lower Bokkeveld Group (Ceres Subgroup), South Africa. Journal of African Earth Sciences 29: 179-194.

COOPER, M.R. 1982. A revision of the Devonian (Emsian – Eifelian) Trilobita from the Bokkeveld Group of South Africa. Annals of the South African Museum 89: 1-174.

DE BEER, C.H., GRESSE, P.G., THERON, J.N. & ALMOND, J.E. 2002. The geology of the Calvinia area. Explanation to 1: 250 000 geology Sheet 3118 Calvinia. 92 pp. 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, Paleoecology and Biostratigraphy. Canadian Society of Petroleum Geologists, Memoir No. 14, pp 229-242.

JELL, P.A. & THERON, J.N. 1999. Early Devonian echinoderms from South Africa. Memoirs of the Queensland Museum 43: 115-199.

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

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.

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. 1999. Lithostratigraphy of the Gydo Formation (Bokkeveld Group). SACS Lithostratigraphic Series No. 33, 1-11. Council for Geoscience, Pretoria.

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.

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 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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