

PALAEONTOLOGICAL SPECIALIST STUDY: FIELD ASSESSMENT

DEVELOPMENT OF TWO EXISTING BORROW PITS ALONG THE DR1470 IN THE KOUE BOKKEVELD REGION NEAR PRINCE ALFRED HAMLET, WITZENBERG DISTRICT, WESTERN CAPE

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

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1. EXECUTIVE SUMMARY

Two existing borrow pits along the DR1470 in the Koue Bokkeveld region to the northeast of Ceres (Witzenberg District), Western Cape are excavated into potentially fossiliferous sediments of the Cape Supergroup. The large DR01470/14.73/L/50/A/C33 pit on Portion 2 of farm Vrystaat No. 331 is excavated into non-marine post-glacial mudrocks of the Kweekvlei Formation (upper Witteberg Group) of Early Carboniferous age. This is one of the few known localities in the Western Cape where comparatively abundant land plant remains and complex trace fossils have been recorded from the Kweekvlei succession, recording the early recovery of aquatic and terrestrial biotas following the short-lived latest Devonian Gondwana glaciation. The palaeontological sensitivity of the site is therefore assessed as HIGH. It is therefore recommended that recording and judicious sampling of fossil remains here be undertaken by a professional palaeontologist once the pit has been opened up to expose fresh bedrock but before the excavated material has been removed for road construction.

The small DR01470/6.39/L/50 pit on Ceres Farm No. 332 (Olckersia) is excavated into impure sandstones and deeply-weathered mudrocks of the Tra Tra Formation (Lower Bokkeveld Group) of Middle Devonian age. This formation has yielded a range of shelly invertebrate fossils elsewhere in the Koue Bokkeveld region but due to extensive chemical weathering of the bedrocks the palaeontological sensitivity of the study site is rated as LOW. Therefore, pending the discovery of substantial new fossil material such as shelly fossil, fish or plant remains, no further mitigation of fossil heritage for this second borrow pit development is recommended.

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 two existing borrow pits located along unpaved DR1470 that runs through the Koue Bokkeveld region along the northern side of the Gydoberg – Waboomborg escarpment near the town of Ceres (Witzenberg / Ceres District), Western Cape (Figs. 1 & 2).

The existing large borrow pit **DR01470/14.73/L/50/A/C33** (= Vidamemoria Pit No. 128) lies on Portion 2 of farm Vrystaat No. 331 approximately 24.65 km NNE of Ceres. The pit is situated at c. 1030 m amsl on the south-east side of a sandstone ridge (33° 11' 18.2" S, 19° 27' 49.9" E) and in future may be extended to the northwest. A narrow north-flowing stream valley is located c. 250 m to the east.

The small existing borrow pit **DR01470/6.39/L/50** (= Vidamemoria Pit No. 123) is situated on Ceres Farm No. 332 (Olckersia) approximately 26.5 km northeast of Ceres, on the southern side of the

Baviaansberg range. The pit lies at c. 1060 m amsl on the south side of the DR1470 just east of its junction with the DR1467 (33° 13' 34.7" S, 19° 32' 06.1" E). The pit is bordered to the south by agricultural lands and there are two large dams just to the west.

A previous desktop basic assessment of the two borrow pit sites by the author assessed their palaeontological heritage sensitivity as moderate to high due to the presence here of potentially fossiliferous sediments of the Lower Bokkeveld Group (Ceres Subgroup) and upper Witteberg Group (Lake Mentz Subgroup). Palaeontological field assessments of the pit sites as part of an HIA were requested by Heritage Western Cape (HWC case 1934 – 2047 ref 120726TS27, Interim Comment 15 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 28 December 2012.

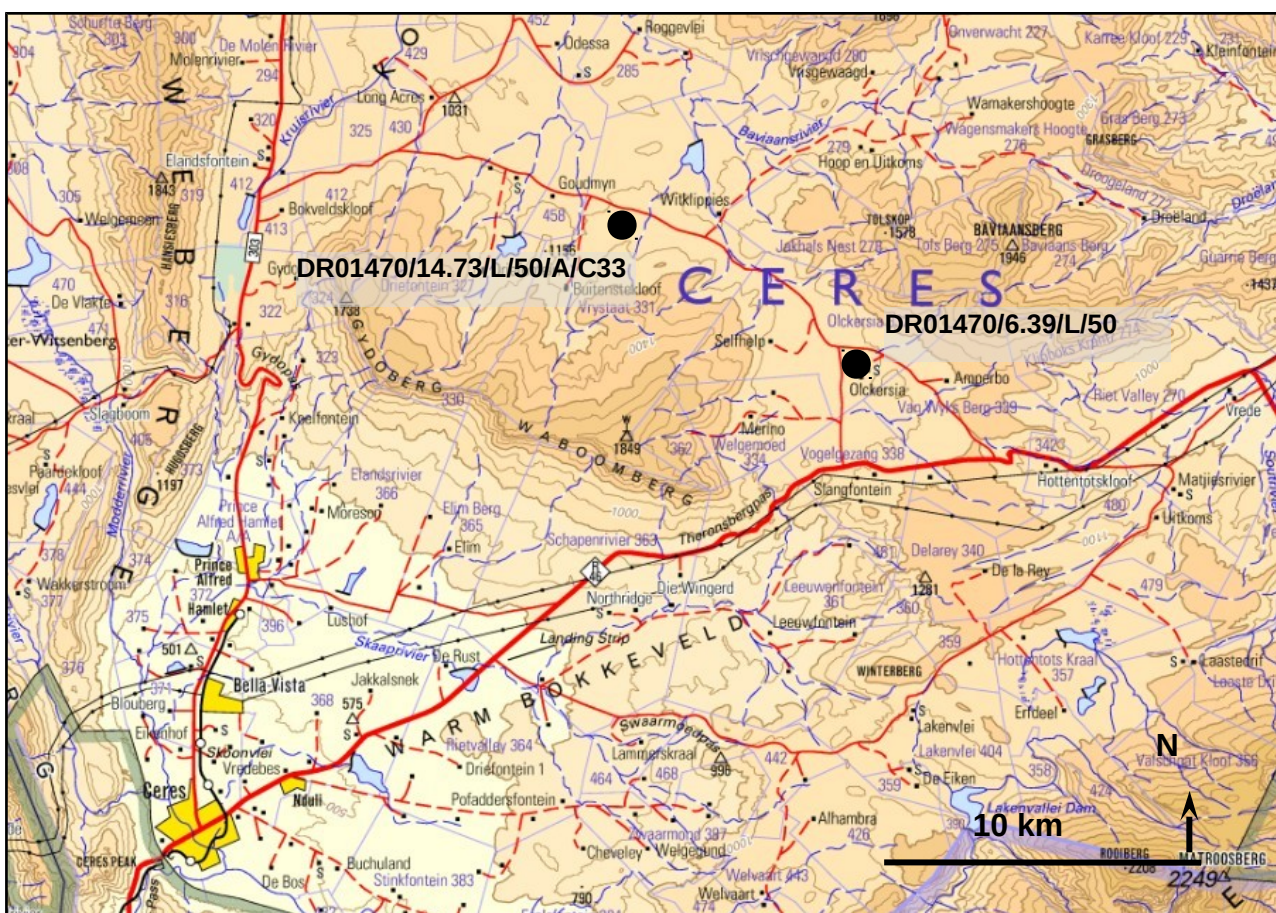


Fig.1. Extract from 1: 250 000 topographical sheet 3319 Worcester (Courtesy of the Chief Directorate: National Geo-spatial Information, Mowbray) showing the location of the existing borrow pit sites DR01470/14.73/L/50/A/C33 and DR01470/6.39/L/50 located along the DR1470 in the Koue Bokkeveld region to the NE of Ceres, Western Cape.

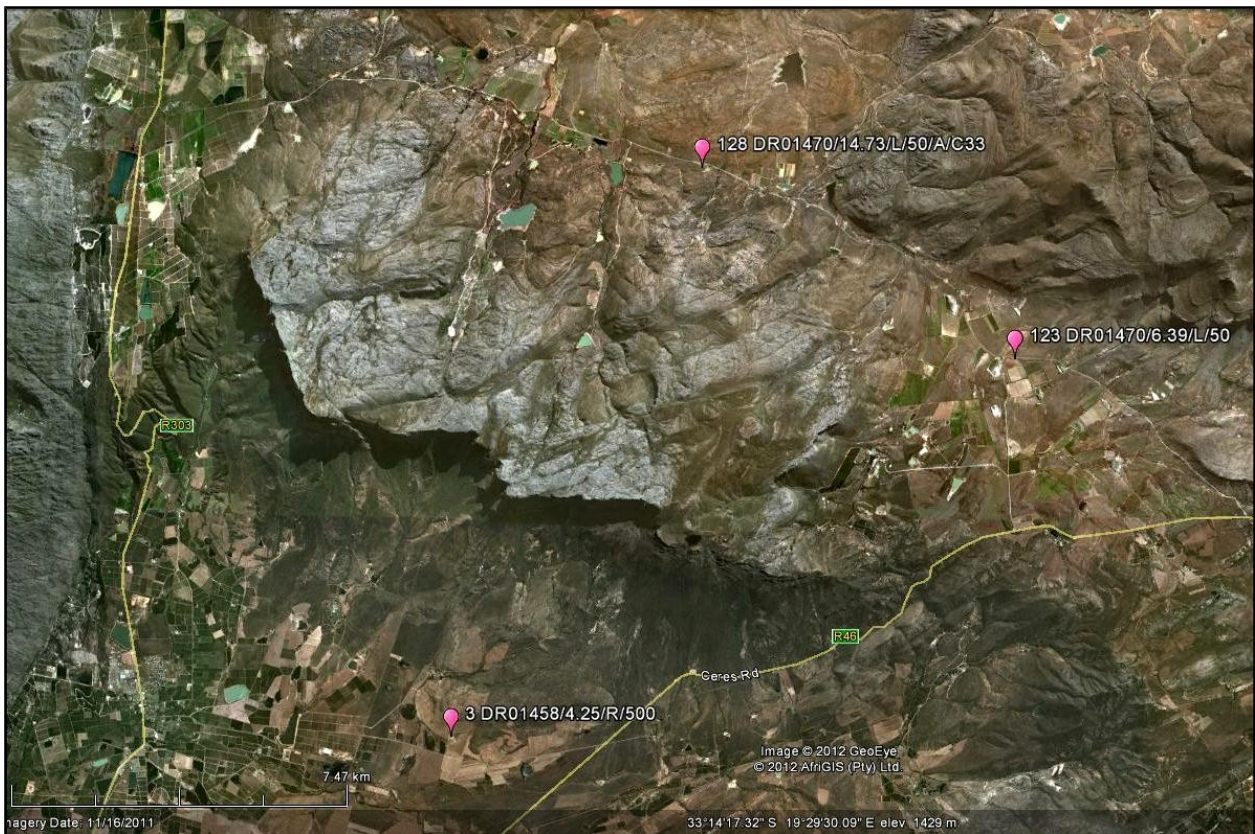


Fig. 2. Google earth© satellite image of the Koue Bokkeveld study area NE of Prince Alfred Hamlet, showing the location of the DR01470/14.73/L/50/A/C33 and DR01470/6.39/L/50 borrow pit study areas (Vidamemoria pit nos. 128 and 123). Pit 3 also shown here is the subject of a separate palaeontological assessment.

3. GEOLOGICAL HERITAGE

The geology of the Koue Bokkeveld region near Ceres, Western Cape, is outlined on 1: 250 000 geology sheet 3319 Worcester (Council for Geoscience, Pretoria) and is shown here in Fig. 3. A short geological sheet explanation has been published by Gresse and Theron (1992).

The large existing **DR01470/14.73/L/50/A/C33** borrow pit is excavated into Early Carboniferous mudrocks of the **Kweekvlei Formation (Ck, Witteberg Group, Lake Mentz Subgroup)** that here form part of a fault-bounded sliver of upper Witteberg Group rocks that are tectonically juxtaposed between lower Witteberg Group sediments to the south and the Dwyka Group to the north (Fig. 3). The sandstone ridge to the northwest of the borrow pit and of its proposed westerly extension is formed by the stratigraphically overlying Floriskraal Formation of the Witteberg Group (Note that these two rock units were misidentified as the Karoopoort and Osberg Formations of the upper Bokkeveld Group in the 2010 geotechnical report for this pit).

Recent accounts of the geology of the upper Witteberg Group succession are given by Broquet (1992), Johnson *et al.* (2006), Thamm and Johnson (2006), and for the Worcester sheet area by Gresse and Theron (1992). The Kweekvlei Formation in the Koue Bokkeveld region is approximately 30 m thick and consists essentially of an upward-coarsening, shoaling succession of dark grey micaceous mudrocks with an increasing proportion of thin-bedded sandstones towards the top. Dominant sedimentary structures include horizontal, lenticular, flaser and wavy lamination, with storm-generated hummocky cross-stratification occurring within thicker, well-sorted sandstones in the uppermost part of the succession. The Kweekvlei Formation represents a laterally extensive, non-marine sedimentary package recording a major post-glacial flooding event following the latest Devonian Gondwana glaciation (Almond *et al.* 2002).

Good, fresh-exposed vertical sections through the Kweekvlei Formation mudrocks are available within the DR01470/14.73/L/50/A/C33 borrow pit which has recently been re-excavated (Fig. 4). The horizontally laminated to thinly-bedded, micaceous basal mudrocks within the lower Kweekvlei show an alternation of pale buff and dark grey laminae (Fig. 5). These are possibly related to seasonal varves, as often seen in modern periglacial lakes. Higher up in the succession the coarser-grained pale laminae show flaser, lenticular and wavy ripple lamination as well as micro-loading features. They were deposited in shallower water under the influence of episodic storms (Fig. 6). Thicker, fine-grained, buff micaceous sandstones within the uppermost Kweekvlei show swaley or hummocky cross-lamination and were laid down near shore within a major non-marine water body. Fine sandstone bedding planes with synaeresis cracks are also quite common at this level.

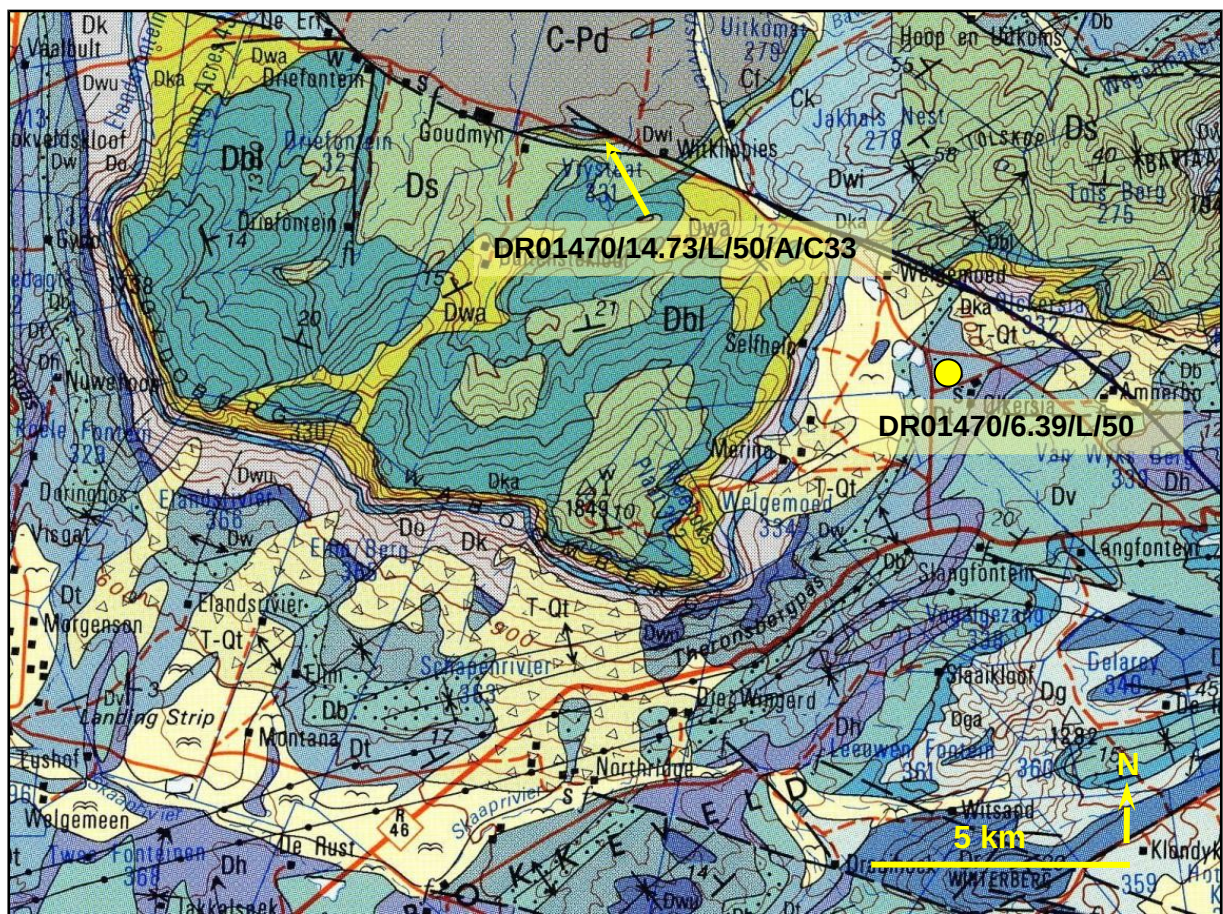


Fig. 3. Extract from 1: 250 000 geology sheet 3319 Worcester (Council for Geoscience, Pretoria) showing location of the DR01470/14.73/L/50/A/C33 and DR01470/6.39/L/50 borrow pit study sites in the Koue Bokkeveld region northeast of Prince Alfred Hamlet. The DR01470/14.73/L/50/A/C33 pit site is excavated into fossiliferous mudrock-dominated successions of the Kweekvlei Formation (Ck, dark green, upper Witteberg Group) while the DR01470/6.39/L/50 borrow pit site is excavated into the Tra Tra Formation (Dt, dark blue) (Lower Bokkeveld Group / Ceres Subgroup).



Fig. 4. Steep cut face through mudrocks and heterolithic beds within the upper Kweekvlei Formation in the NW portion of borrow pit DR01470/14.73/L/50/A/C33.

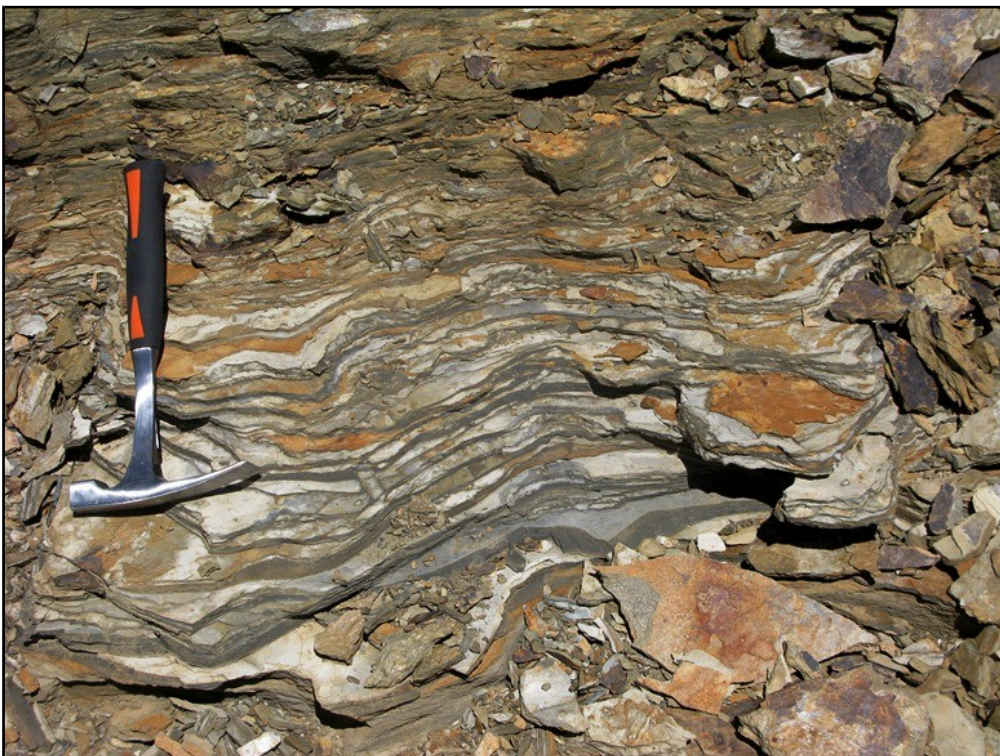


Fig. 5. Alternating pale (organic-poor) and dark (organic-rich) laminae within the lower portion of the Kweekvlei succession, possibly related to seasonal glacial varves (Hammer = 33 cm).



Fig. 6. Flaser and ripple laminated, dark mudrocks of the middle Kweekvlei succession. The coarser-grained pale laminae occasionally show micro-loading features (Scale in cm and mm). Many of the small oval pale spots seen here are probably cross-sections through burrows.

According to the geological map (Fig. 3) the **DR01470/6.39/L/50** borrow pit site is entirely underlain by the **Tra Tra Formation** (Dt, Bokkeveld Group, Ceres Subgroup), a mudrock-dominated succession of marine rocks that were deposited on the offshore continental shelf in Middle Devonian (Eifelian) times. Details of the sedimentology and palaeontology of the Tra Tra succession are provided by Theron *et al.* (1991), Gresse and Theron (1992) and more recently by Almond (2009b). The Tra Tra succession typically contains several thin, prominent-weathering sandstone packages (tops of upward-shallowing parasequences) and wackes are indeed well represented in the borrow pit excavation. These sandstones were erroneously attributed to the Hexrivier Formation in the geotechnical report, but this unit crops out as a prominent ridge about one kilometre to the southeast.

The contact between a steeply N- to NW-dipping sandstone-dominated package and overlying mudrock dominated sequence is exposed in the DR01470/6.39/L/50 borrow pit (Figs. 7 and 8). The silty mudrocks are colour banded (cream / buff / grey), deeply-weathered, ferruginised and incised by dongas. The underlying impure sandstones or wackes are reddish to buff, thin-bedded and tabular (Fig. 9). The beds are gently folded and locally traversed by thin quartz veins. The Lower Bokkeveld Group bedrocks are overlain by up to 50 cm of pale buffgravelly soils with abundant fine ferricrete and vein quartz clasts as well as larger angular blocks of quartzite and wacke (Fig. 10).



Fig. 7. View towards the east across the DR01470/6.39/L/50 borrow pit site with Baviaansberg in the background.



Fig. 8. Thin-bedded, steeply-sipping wackes of the Tra Tra Formation on the right overlain by deeply-weathered, colour-banded mudrocks of the same formation on the left.



Fig. 9. Packet of thin, tabular-bedded wackes within the Tra Tra Formation (Hammer = 33 cm).



Fig. 10. Silty, gravel-rich soils overlying the Bokkeveld bedrocks at the DR01470/6.39/L/50 borrow pit site (Hammer = 33 cm).

4. PALAEOONTOLOGICAL HERITAGE

4.1. Fossils in the Tra Tra Formation (Bokkeveld Group)

Shelly fossils from the **Tra Tra Formation** (Dt, Middle Devonian / Eifelian) in the Worcester and adjacent Ladismith sheet areas are generally scarce (Gresse & Theron 1992, Theron *et al.*, 1991, Table III, Almond 2009b). The only area in the Western Cape where diverse marine invertebrate assemblages have been recorded from this unit is on or near the Wageboomberg / Theronberg Pass near Ceres (Oosthuizen 1984, Gresse & Theron 1992). Fairly abundant, well-preserved shelly assemblages have recently been recorded from borrow pits within the lowermost Tra Tra Formation on the Sanbona and Anysberg Nature Reserves in the western Klein Karoo (Almond 2009b, unpublished observations 2011). Fossils moulds here are fairly well preserved and comprise a small range of bivalves (*Palaeoneilo*, *Nuculites* and unidentified forms), plectonotid bellerophontids, orbiculoid inarticulate brachiopods, occasional articulate brachiopods, disarticulated crinoids, tentaculitids and simple, horizontal, mudlined, secondarily mineralised burrows. Sparse nuculid bivalves and possible vertical burrows are recorded from the Tra Tra Formation near Prince Alfred Hamlet (Almond, pers. obs. 2012).

No trace or body fossils were recorded from the **DR01470/6.39/L/50** borrow pit site during the present field assessment, probably due to the high levels of chemical weathering seen here.

4.2. Fossils in the Kweekvlei Formation (Witteberg Group)

The fossil record of the Kweekvlei Formation has been briefly reviewed by Almond (2008). Dark, post-glacial mudrocks of the Kweekvlei Formation in the southern Cederberg (*e.g.* Karoopoort, Skitterykloof, Kaffirskraal, Koue Bokkeveld) and elsewhere contain sparse to abundant low diversity trace fossil assemblages, notably *Teichichnus* and horizontal back-filled burrows, especially in the upper, silty to sandy parts of the upward shoaling succession (Almond 1998a, 1998b). Transported fragments of vascular plants, preserved in some cases within nodules, are also found in the upper Kweekvlei (Anderson & Anderson 1985, Evans 2005, J.C. Loock pers. comm., J. Almond pers. obs.). Simply branched, leafless woody stems, some of them with fine striations, have been provisionally assigned to the problematic genus *Praeramunculus*. This is possibly a propteridophyte (McLoughlin & Long 1994) or a progymnosperm (Gess & Hiller 1995). Lycopods are referred to the genus *Archaeosigillaria*. Fish fossils referred to the Kweekvlei by Anderson and Anderson (1985) are misassigned, although fish remains may indeed be present here. Restricted salinities, low temperatures at high palaeolatitudes and perhaps also bottom anoxia may be implicated in the paucity of body and trace fossils within this post-glacial mudrock unit (*cf* Broquet 1992, Almond 1998b). Attempts to isolate organic-walled microfossils from black mudrock facies towards the base of the formation have so far proved unsuccessful.

Locally abundant to sparse fragmentary plant remains, mainly longitudinally-striated woody stems up to a cm or so in diameter, occur within the Kweekvlei mudrocks at the **DR01470/14.73/L/50/A/C33** borrow pit site (Fig. 11). No animal body fossils have been recorded here so far but low diversity, high density trace fossil assemblages are seen within the upper, more heterolithic portions of the succession. The traces include various unidentified horizontal burrows as well as numerous examples of the subhorizontal, downward-convex spreiten burrow *Teichichnus* (Fig. 12) and broader meniscate back-filled horizontal burrows of the *Scolicia* Group (some with an unsegmented central core or strand; Fig. 13). Notably, *Spirophyton* burrows such as characterise the underlying Witteberg Group are not recorded from the Kweekvlei Formation, supporting a non-marine setting for these Early Carboniferous post-glacial beds. This pit is one of the few known localities in the Western Cape where comparatively abundant land plant remains and complex trace fossils have been recorded from the Kweekvlei succession, recording the early recovery of aquatic and terrestrial biotas following the short-lived latest Devonian Gondwana glaciation.



Fig. 11. Striated wood stems of unidentified land plants from the lower Kweekvlei Formation at the Koue Bokkeveld pit site DR01470/14.73/L/50/A/C33.



Fig. 12. Gently down-curved, cm-wide spreiten burrows of the ichnogenus *Teichichnus* from heterolithic successions of the upper Kweekvlei Formation (Scale in cm and mm).



Fig. 13. Complex meniculate back-filled horizontal burrows of the *Scolicia* group with a central softer-weathering core from the upper Kweekvlei Formation. These burrows are c. 1.5 cm wide.

5. CONCLUSIONS & RECOMMENDATIONS

Two existing borrow pits along the DR1470 in the Koue Bokkeveld region to the northeast of Ceres (Witzenberg District), Western Cape are excavated into potentially fossiliferous sediments of the Cape Supergroup. The large DR01470/14.73/L/50/A/C33 pit on Portion 2 of farm Vrystaat No. 331 is excavated into non-marine post-glacial mudrocks of the Kweekvlei Formation (upper Witteberg Group) of Early Carboniferous age. This is one of the few known localities in the Western Cape where comparatively abundant land plant remains and complex trace fossils have been recorded from the Kweekvlei succession, recording the early recovery of aquatic and terrestrial biotas following the short-lived latest Devonian Gondwana glaciation. The palaeontological sensitivity of the site is therefore assessed as HIGH. It is therefore recommended that recording and judicious sampling of fossil remains here be undertaken by a professional palaeontologist once the pit has been opened up to expose fresh bedrock but before the excavated material has been removed for road construction.

The small DR01470/6.39/L/50 pit on Ceres Farm No. 332 (Olckersia) is excavated into impure sandstones and deeply-weathered mudrocks of the Tra Tra Formation (Lower Bokkeveld Group) of Middle Devonian age. This formation has yielded a range of shelly invertebrate fossils elsewhere in the Koue Bokkeveld region but due to extensive chemical weathering of the bedrocks the palaeontological sensitivity of the study site is rated as LOW. Therefore, pending the discovery of substantial new fossil material such as shelly fossil, fish or plant remains, no further mitigation of fossil heritage for this second borrow pit development is recommended.

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.

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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 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**