

## **PALAEONTOLOGICAL SPECIALIST STUDY: FIELD ASSESSMENT**

### **EXISTING BORROW PIT ALONG THE DR1441 ROAD NEAR DE DOORNS IN THE HEX RIVER VALLEY, BREEDEVALLEI DISTRICT, WESTERN CAPE**

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#### **1. EXECUTIVE SUMMARY**

The shallow existing pit DR01441/1.4/L/200/A/W18 located c. 2.6 km east of De Doorns in the Hex River Valley, Breedevallei District, Western Cape, is excavated into mudrocks of the Middle Devonian Voorstehoek Formation (Lower Bokkeveld Group / Ceres Subgroup). Elsewhere in the Hex River Valley region (e.g. Hex River Pass, Matroosberg Station area) these marine sediments contain abundant, well-preserved moulds of molluscs, trilobites, echinoderms and articulate brachiopods. Only sparse shelly fossils (rare terebratulid brachiopods) and trace fossils were recorded at the De Doorns study site but bedrock exposure here is currently very limited and richer invertebrate fossil assemblages may well be present beneath the weathered surface material. The palaeontological sensitivity of the site is therefore assessed as MODERATE. 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.

#### **2. INTRODUCTION**

The Department of Transport, Western Cape, is applying to the Department of Mineral Resources for approval to exploit road material from a shallow existing borrow pit along the unsealed DR1441 road in the Hex River Valley (Breedevallei District), Western Cape. Pit DR01441/1.4/L/200/A/W18 (33° 28' 36.3" S, 19° 41' 59.8" E) on Portion 1 of Worcester Farm No. 180 is situated on a gentle SE-facing hill slope at 590 m amsl, about 2.6 km east of the town of De Doorns and one kilometer SE of the N1 trunk road, Western Cape (Figs. 1 & 2).

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 Voorstehoek Formation (Lower Bokkeveld Group, Ceres Subgroup). A palaeontological field assessment of the pit as part of an HIA was requested by Heritage Western Cape (HWC case 1933 – 2046 ref 120726TS25, 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: 3<sup>rd</sup> 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 30 December 2012.

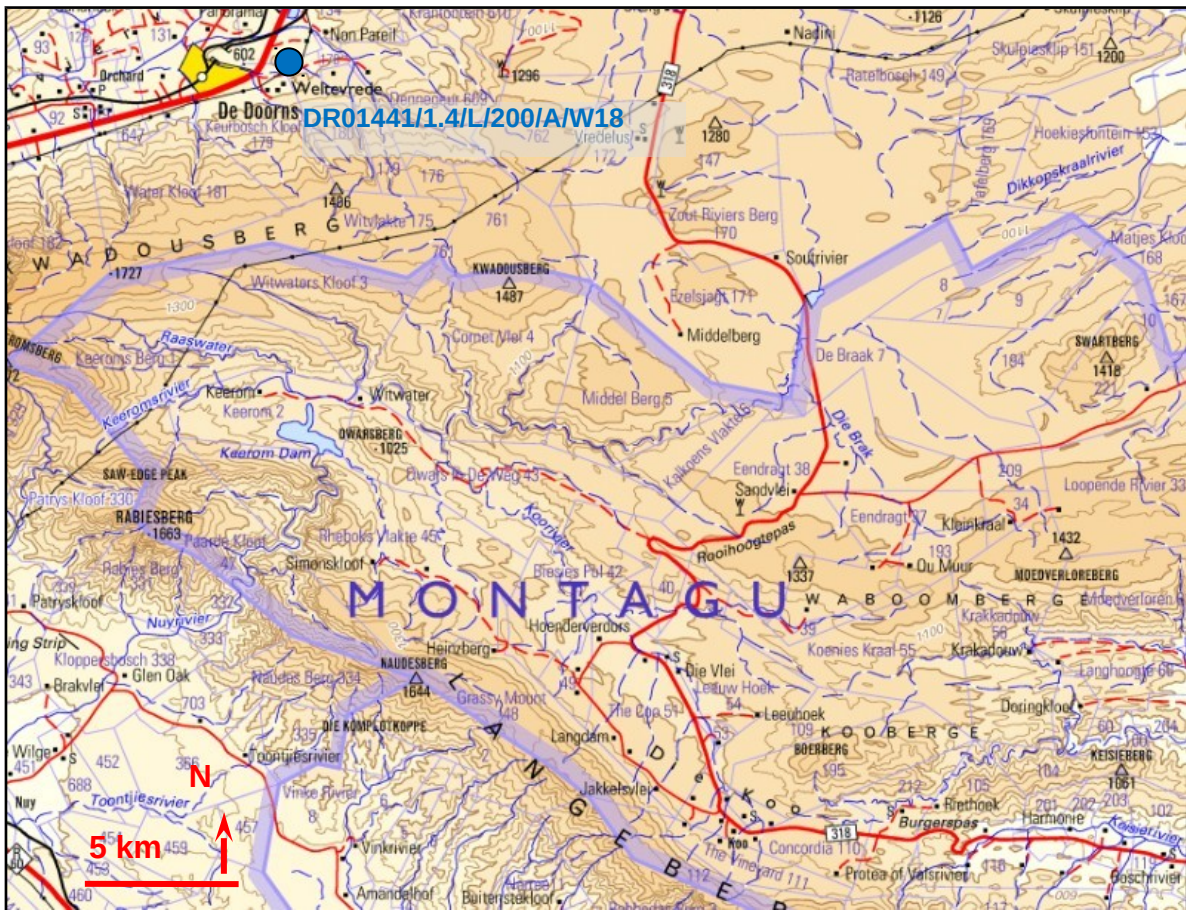
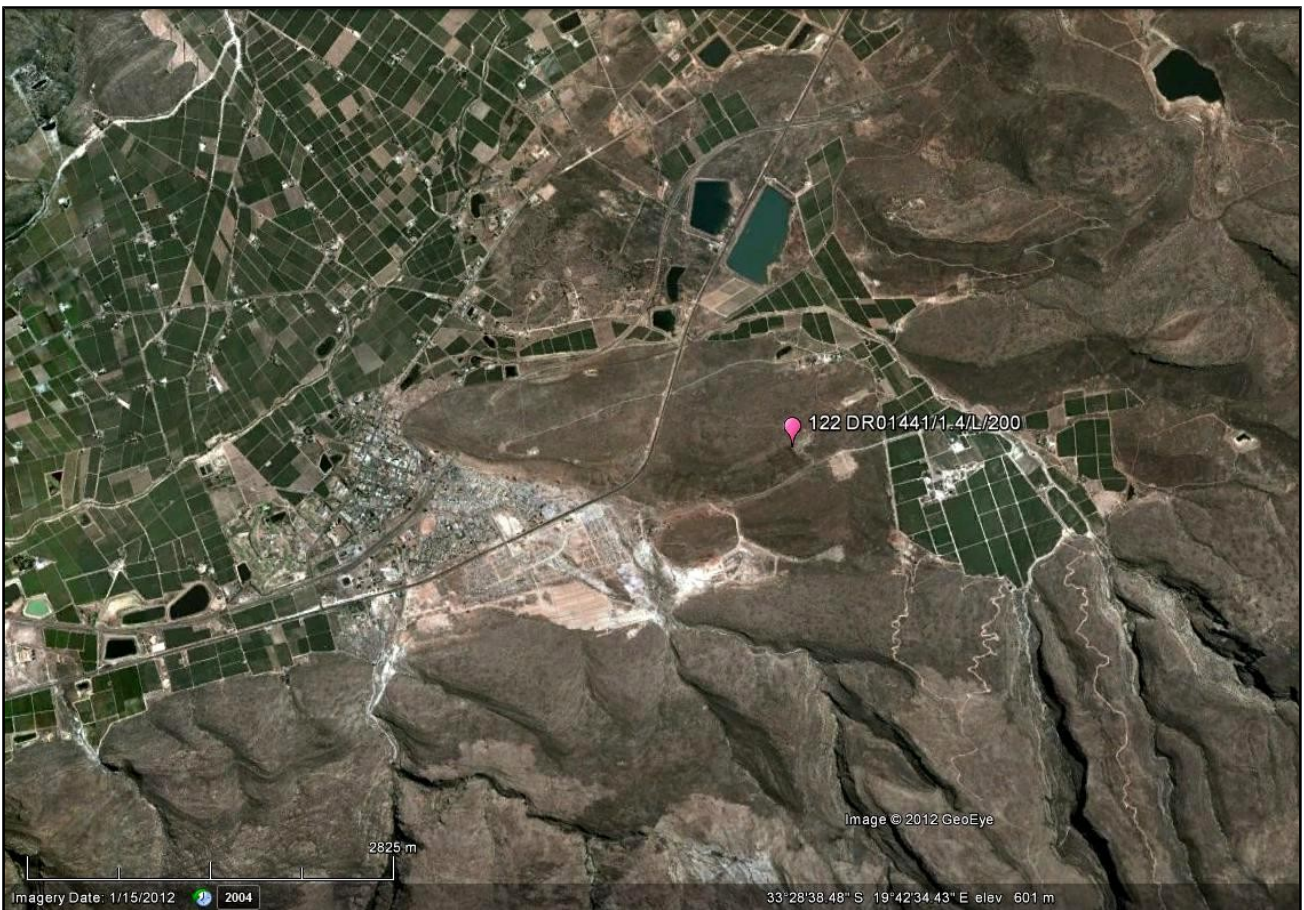


Fig.1. Extract from topographical sheets 3119 Worcester (Courtesy of the Chief Directorate: National Geo-spatial Information, Mowbray) showing the approximate location of the existing pit DR01441/1.4/L/200/A/W18 located in the Hex River Valley c. 2.6 km east of De Doorns, Western Cape (blue dot).



**Fig. 2. 2004 Google earth© satellite image of the study area in the Hex River Valley near De Doorns showing the location of the existing DR01441/1.4/L/200/A/W18 pit on a hill slope on the east side of the N1 trunk road some 2.6 km east of De Doorns.**

### **3. GEOLOGICAL HERITAGE**

The geology of the Hex River Valley study area near De Doorns is shown on 1: 250 000 geology sheet 3319 Worcester (Council for Geoscience, Pretoria) and is illustrated here in Fig. 3. A short sheet explanation has been published by Gresse & Theron (1992; see also the older 1: 125 000 Worcester- Hermanus map and sheet explanation by De Villiers *et al.* 1964).

The shallow existing DR01441/1.4/L/200/A/W18 pit is excavated into marine mudrocks of the **Voorstehoek Formation (Dv, Lower Bokkeveld Group / Ceres Subgroup)** of Middle Devonian (Eifelian) age. The sedimentology of this unit has been briefly described by Gresse and Theron (1992) and in more detail by Theron (2003). It comprises an upward-coarsening, shallowing succession of grey-green and grey mudrocks that are increasingly interbedded with wave-rippled wackes (impure sandstones) of tempestite origin towards the top. The Voorstehoek Formation is about 90 m thick near Touwsrivier, some 35 km northeast of the study area.

The Bokkeveld Group rocks in the study region are situated on the SE limb of a SW – NE trending megasyncline that underlies the Hex River Valley. In pit DR01441/1.4/L/200/A/W18 the Voorstehoek Formation bedrocks are only poorly exposed on the gentle hillslopes where they are incised by shallow stream gullies. They comprise crumbly to well-consolidated, pale to dark grey, mottled mudrocks and wackes that are quite highly weathered at surface, as indicated by secondary kaolinitisation and ferruginisation (Figs. 4 and 5). Tectonic cleavage is not notably well-developed here. The Bokkeveld Group bedrocks are mantled with reddish-brown silty to gravelly colluvial deposits up to 60 cm thick.

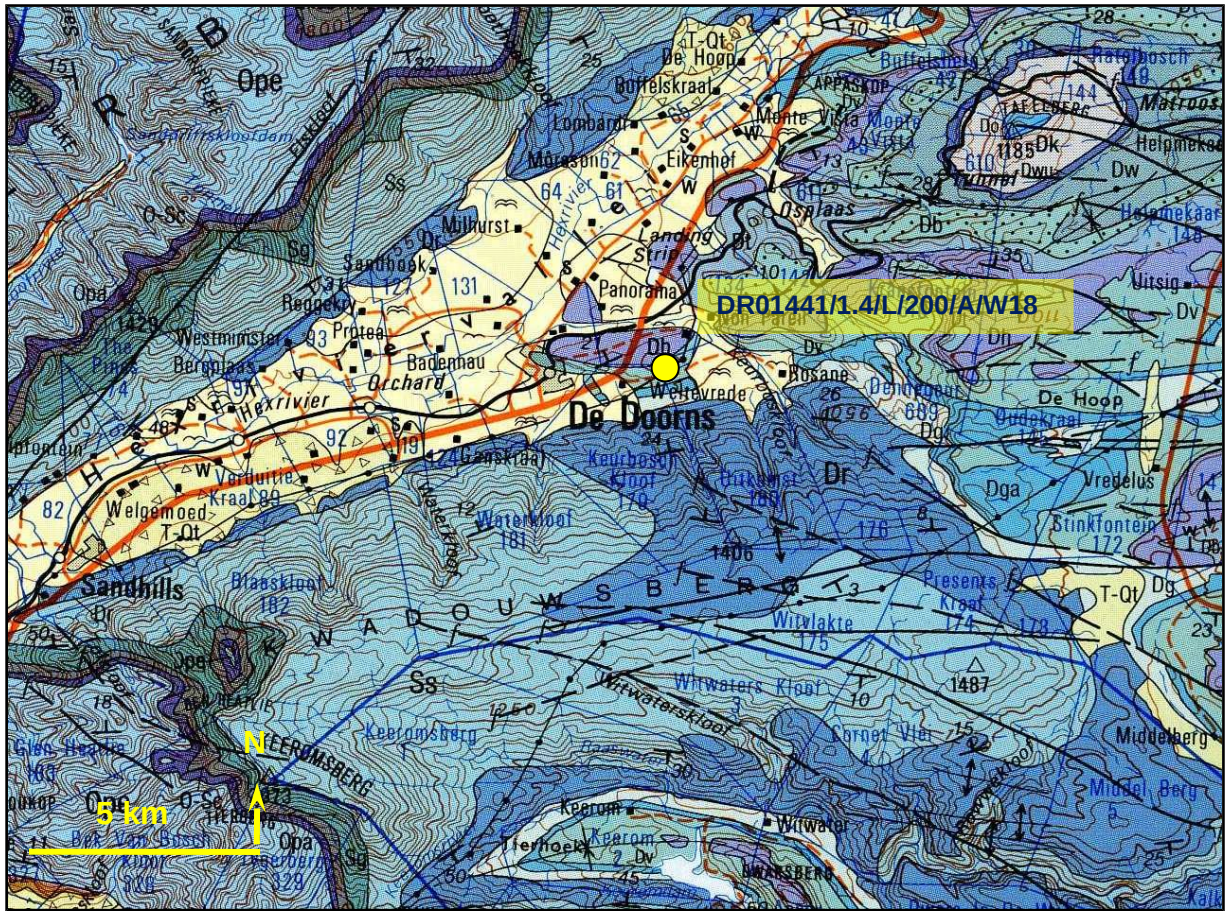


Fig. 3. Extract from 1: 250 000 geology sheet 3119 Worcester (Council for Geoscience, Pretoria) showing location of the DR01441/1.4/L/200/A/W18 borrow pit c. 2.6 km east of De Doorns. The pit is excavated into mudrocks of the Voorstehoek Formation (Dv, pale blue), Lower Bokkeveld Group.



Fig. 4. Weathered, kaolinitised and ferruginised siltstones of the Voorstehoek Formation exposed in shallow gully traversing pit site DR01441/1.4/L/200/A/W18 near De Doorns (Hammer = 33 cm).



Fig. 5. Well-consolidated fresher grey siltstones in the subsurface at pit site DR01441/1.4/L/200/A/W18 (Hammer = 33 cm).

#### 4. PALAEOLOGICAL HERITAGE

The fossil record of the mudrock-dominated **Voorstehoek Formation** (Dv, Middle Devonian / Eifelian) has been summarised by Oosthuizen (1984), Almond *et al.* (1996), Gresse and Theron (1992), Theron (2003) and Almond (2008, 2010). Generally fossil assemblages in this unit are much sparser and less diverse than in the underlying Gydo Formation, and they are correspondingly less well known. Rich trace fossil assemblages in the northern outcrop area attest to the presence of a flourishing invertebrate fauna at the time (Almond *in De Beer et al.*, 2002). Abundant shelly fossils are recorded from mudrocks in the lower half of this stratigraphic unit in the southwestern outcrop area including the Warm Bokkeveld, Matroosberg and Theron's Pass region (Theron 1972, Oosthuizen 1984, Gresse & Theron 1992, Theron 2003).

Voorstehoek shelly fossils have often been concentrated by storm winnowing and currents into thin shelly lenses or *coquinas*. Fossil biotas are dominated by shelly invertebrates such as trilobites, articulate brachiopods, crinoids, ophiuroids, bivalves, bellerophontid "gasteropods", orthocone nautiloids, and problematic conical-shelled groups such as hyolithids and tentaculitids (Theron 1972, Oosthuizen 1984, Gresse & Theron 1992, Theron 2003, Almond 2008). Heterolithic, tempestite-dominated successions within the Voorstehoek Formation, especially in its northern outcrop area, have yielded rich shallow marine trace fossil assemblages of the *Cruziana* Ichnofacies (Almond 1998, Almond *in De Beer et al.* 2002, Theron 2003, Almond 2008).

The fairly impoverished Voorstehoek fossil assemblages are dominated by brachiopods and molluscs, with rarer echinoderms, trilobites, gastropods and nautiloids (Theron 2003). Fossils are often concentrated in thin coquinas and are usually, but far from invariably, disarticulated due to current action, notably by storm waves in nearshore sediments. Mudrocks often show high levels of bioturbation, *i.e.* churning by burrowing, sediment-feeding invertebrates such as homalonotid trilobites, nuculid bivalves, bellerophontid gastropods and other, unidentified invertebrate taxa. Remobilisation and re-suspension of soupy shelf muds may have limited or excluded larval settling and / or feeding by suspension-feeding taxa such as crinoids and brachiopods that are poorly represented in many offshore Voorstehoek fossil assemblages (Almond *et al.* 1996). Occasional thin, dense fossil *Lagerstätte* dominated by fully-articulated echinoderms (brittlestars, starfish, carpoids *etc*) are recorded from lower Bokkeveld mudrock units of the Warm Bokkeveld, Hex River Valley region and further east (Theron 1972, Oosthuizen 1984, Jell & Theron 1999). These so-called “starfish beds” are attributed to *obrution* or sudden smothering of benthic invertebrates by storm re-suspended muds and provide useful, albeit biased “snapshots” of offshore marine life on the Early Devonian seabed.

A variety of fossil invertebrates recorded from the De Doorns area, Hex River Valley, by previous workers are listed by Gresse and Theron (1992, Appendix A). They include, for example, the trilobite *Metacryphaeus caffer*, chonetid brachiopods, molluscs such as the bivalve *Janeia* and bellerophontid *Plectonotus*, tentaculitids, and carpoid echinoderms. Apart from indeterminate horizontal burrows, the only fossils recorded within the Voorstehoek Formation at pit site DR01441/1.4/L/200/A/W18 during the present field study were occasional moulds of the large articulate brachiopod *Scaphiocoelia* (a comparatively uncommon terebratulid in the Bokkeveld Group) (Fig. 6). However, bedrock exposure levels here are very low and since fresher sedimentary material below surface appears to be well-consolidated and uncleaved, there is a reasonably good chance that well-preserved shelly fossil assemblages may be exposed once the pit is re-excavated. The palaeontological sensitivity of the site is rated as MODERATE. 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.



**Fig. 6. Internal mould of the large terebratulid brachiopod *Scaphiocoelia* from the Voorstehoek Formation at pit site DR01441/1.4/L/200/A/W18 near De Doorns (Scale in cm and mm).**

## **5. CONCLUSIONS & RECOMMENDATIONS**

The shallow existing pit DR01441/1.4/L/200/A/W18 located c. 2.6 km east of De Doorns in the Hex River Valley, Breedevallei District, Western Cape, is excavated into mudrocks of the Middle Devonian Voorstehoek Formation (Lower Bokkeveld Group / Ceres Subgroup). Elsewhere in the Hex River Valley region (e.g. Hex River Pass, Matroosberg Station area) these marine sediments contain abundant, well-preserved moulds of molluscs, trilobites, echinoderms and articulate brachiopods. Only sparse shelly fossils (rare terebratulid brachiopods) and trace fossils were recorded at the De Doorns study site but bedrock exposure here is currently very limited and richer invertebrate fossil assemblages may be present beneath the weathered surface material. The palaeontological sensitivity of the site is therefore assessed as MODERATE. 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.

## **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.



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