

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

### **PROPOSED EXTENSION OF AN EXISTING BORROW PIT ALONG THE MR280 NEAR BONNIEVALE, SWELLENDAM DISTRICT, WESTERN CAPE**

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

The existing MR00280/6.1/L/10/A/R1 borrow pit situated some 6.75 km southwest of Bonnievale is excavated into non-marine sandstones and mudrocks of the Middle Devonian Adolphspoor Formation (Upper Bokkeveld Group) that elsewhere are well-known for their Middle Devonian fish fauna, molluscs, vascular plants and trace fossils. However, the Bokkeveld sediments in the study area are highly tectonised, as shown by pervasive cleavage, quartz veining and folding, and there is no evidence here of fossiliferous ferruginous nodules. The palaeontological sensitivity of the site is correspondingly LOW and, pending the discovery of substantial new fossil material such as shelly fossil, fish or plant remains, no further studies or mitigation of fossil heritage for this borrow pit and its possible expansion to the west are considered necessary.

#### **2. INTRODUCTION**

The Department of Transport, Western Cape, is applying to the Department of Mineral Resources for approval to extend and exploit road material from an existing borrow pit located to the southwest of the town of Bonnievale in the Worcester – Robertson Karoo region (Swellendam District). Pit MR00280/6.1/L/10/A/R1 (33°59'17.8" S, 20°03'22.2" E) on Swellendam Farm No. 175 (Rietfontein), is situated on the western side of the MR280 unpaved road about 6.75 km southwest of Bonnievale, 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 Adolphspoor Formation (Upper Bokkeveld Group, Traka Subgroup), but noted that fossil preservation here might be compromised by tectonic cleavage. A palaeontological field assessment of the pit as part of an HIA was requested by Heritage Western Cape (HWC Case Ref. case 1902 - 1989 120726JL29E, 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: 3<sup>rd</sup> Floor, Guarantee House, 37 Burg Street, Greenmarket Square, Cape Town; tel: 021-424 8432; e-mail: Quahnita@vidamemoria.co.za). This is Vidamemoria pit no. 157. Fieldwork for this project was carried out on 16 September 2012.

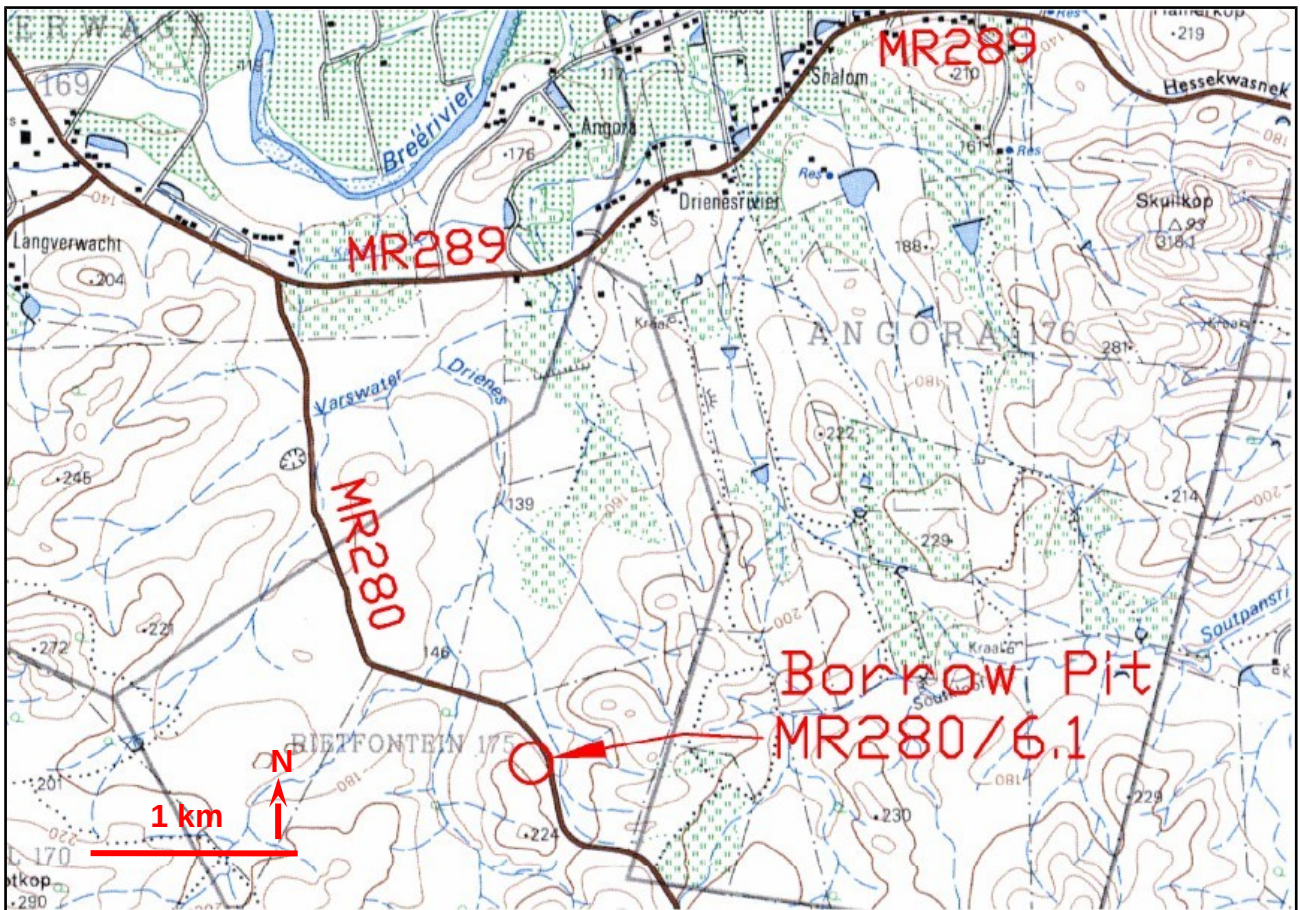
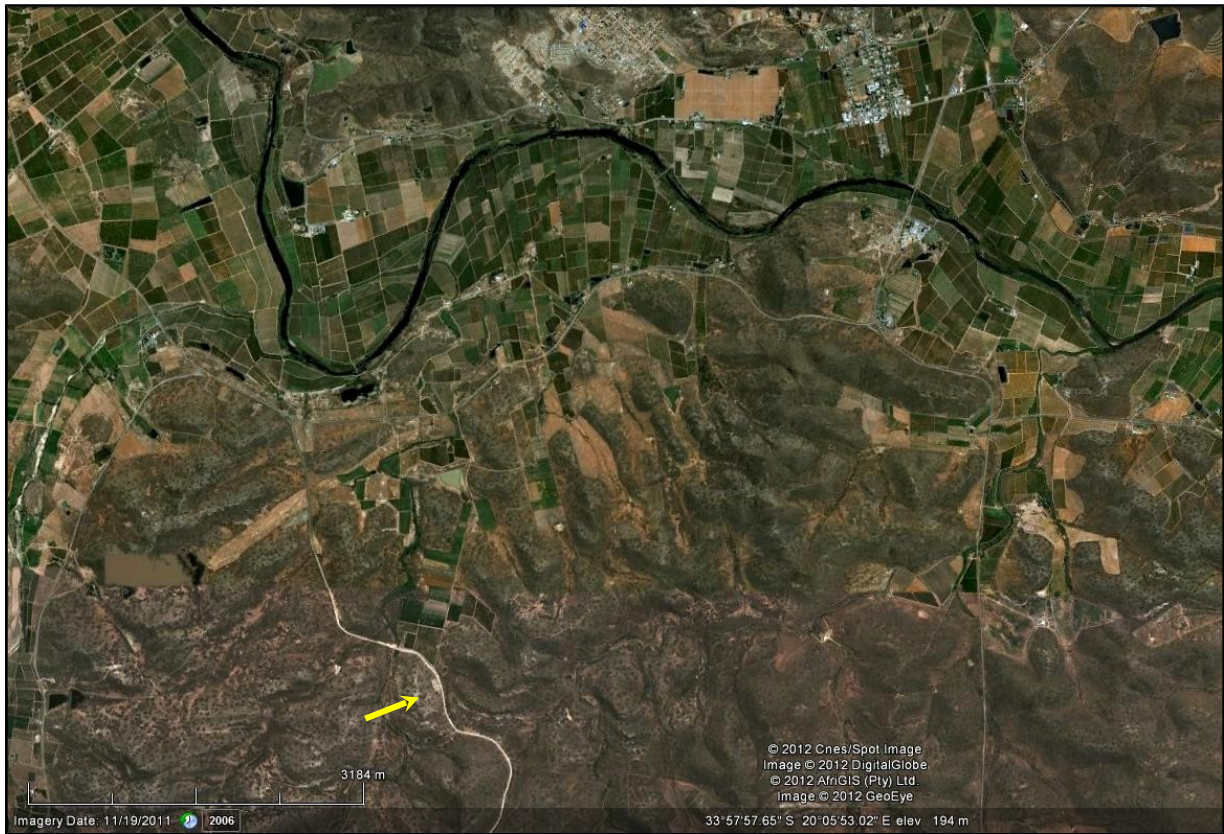


Fig.1. Extract from 1: 50 000 topographical sheet 3320 CC (Courtesy of the Chief Directorate: National Geo-spatial Information, Mowbray) showing the location of the existing pit MR00280/6.1/L/10/A/R1 on Swellendam Farm No. 175 (Rietfontein), about 6.75 km southwest of Bonnievale, Western Cape (Image abstracted from geotechnical report by Aurecon).





**Fig. 2. Google earth© satellite image of the study area south of Bonnievale and the Breede River showing the location of the existing MR00280/6.1/L/10/A/R1 pit (yellow arrow) situated on the western side of the MR280 unpaved road about 6.75 km southwest of Bonnievale, Western Cape**

### 3. GEOLOGICAL HERITAGE

The geology of the study area near Bonnievale is shown on 1: 250 000 geology sheet 3320 Ladismith (Council for Geoscience, Pretoria) and is shown here in Fig. 3. A short sheet explanation has been published by Theron *et al.* (1991).

The large existing pit is situated at c. 190 m amsl in gently hilly terrain some three km to the south of the Breede River in the eastern portion of the Worcester – Robertson Karoo region (Figs. 2, 4). The pit and its proposed extension to the west are excavated into Middle Devonian sediments of the **Adolphspoor Formation (Da**, Upper Bokkeveld Group / Traka Subgroup. *N.B.* The Traka Subgroup succession in this area is not subdivided into several formational subunits). The succession youngs northwards towards the contact with the Witteberg Group to the west of Bonnievale. The Devonian bedrocks are mantled with Late Caenozoic alluvium of the Breede River three km to the north of the borrow pit study area (pale yellow area in Fig. 3). The sedimentology and palaeontology of the Adolphspoor Formation in the Ladismith sheet area, dominated here by greyish micaceous siltstones and wackes, have been summarised by Theron *et al.* (1991) as well as Almond (2005, 2009). The depositional setting of these marginal marine sediments has not yet been resolved, although some authors favour a restricted delta platform setting.

Adolphspoor Formation rocks exposed on the steeper north-western faces of the MR00280/6.1/L/10/A/R1 pit (Fig. 4) consist of thin- to medium-bedded greyish, grey-green and brown weathering siltstones and wackes. Ferruginous carbonate diagenetic concretions (occasionally fossiliferous) that are often typical of the Adolphspoor succession are not seen here. Primary sedimentary structures include horizontal lamination and wave ripple lamination, locally disrupted by bioturbation. The sediments are transected by a pervasive tectonic cleavage that dips at a low angle towards the south (Fig. 5) and are locally affected by small-scale folds as well as



extensive quartz veining (milky quartz veins up to 20 cm thick) (Fig. 6). Some of the quartz veins themselves show evidence of later phase folding. Almost no primary bedding planes are available for inspection. Weathering is not markedly advanced so the rocks are still well consolidated. Float blocks at surface as well as abundant stockpiled Bokkeveld material in the southern part of the study area are bounded by cleavage surfaces and therefore do not readily reveal fossil remains.

The Bokkeveld bedrocks are mantled by orange-brown surface deposits generated by downwasting and colluvial processes and dominated by poorly-sorted, angular clasts of vein quartz and Adolphspoord wackes (Fig. 7).

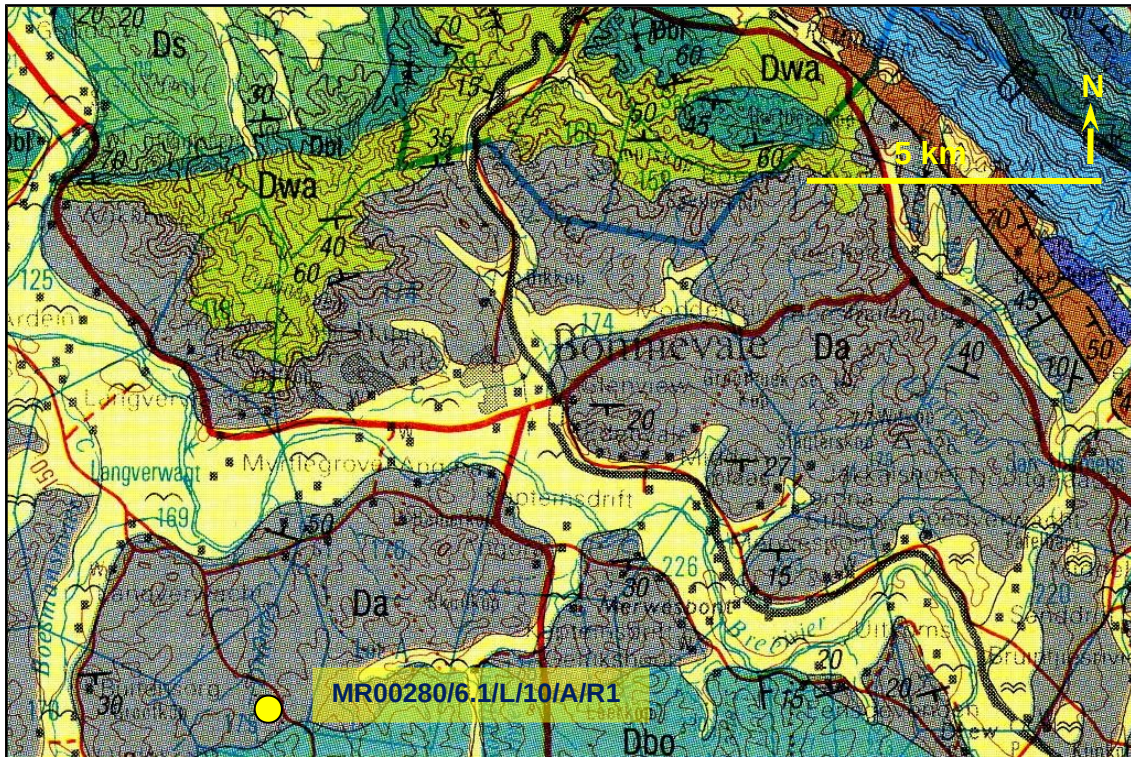


Fig. 3. Extract from 1: 250 000 geology sheet 3320 Ladismith (Council for Geoscience, Pretoria) showing location of the MR00280/6.1/L/10/A/R1 pit southwest of Bonnievale. The pit and its proposed western extension (yellow dot) are excavated into highly cleaved sandstones and siltstones of the Adolphspoord Formation (Da, Upper Bokkeveld Group) (dark grey).





**Fig. 4. View westwards across the existing, partially water-filled pit MR00280/6.1/L/10/A/R1 showing steep cut face of Adolphspoord siltstones and wackes in the NW.**



**Fig. 5. Greyish siltstones and wackes of the Adolphspoord Formation exposed in the NW portion of the pit showing pervasive south-dipping spaced tectonic cleavage (Hammer = 29 cm).**





**Fig. 6. Close-up of cleaved Adolphspoor mudrocks showing extensive network of milky quartz veins (Hammer = 29 cm). Some of the veins are themselves folded.**



**Fig. 7. Downwasted and colluvial gravel deposits, dominated by milky quartz, overlying the cleaved Bokkeveld Group bedrocks exposed on the margins of the existing pit (Hammer = 29 cm).**

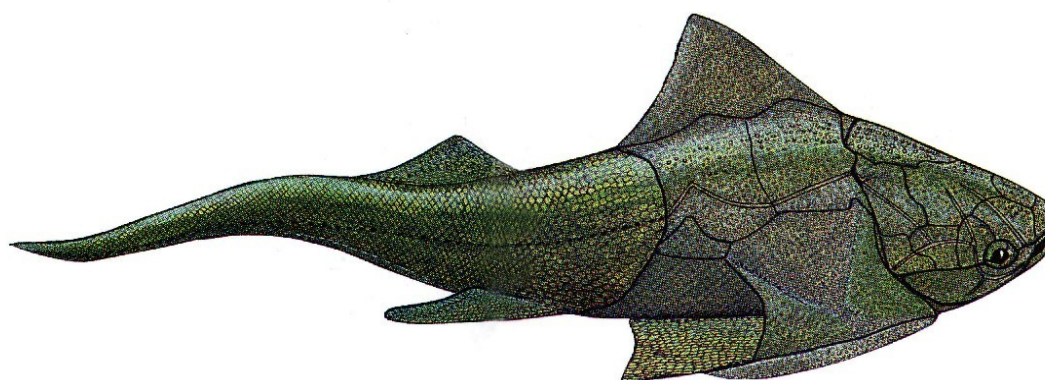


#### 4. PALAEOONTOLOGICAL HERITAGE

An important, albeit low-diversity, non-marine fossil biota has been recorded from the Middle Devonian sediments of the Adolphspoor Formation of the Traka Subgroup in the Ladismith sheet area (Plumstead 1977, Chaloner *et al.* 1980, Anderson & Anderson 1985, Almond 1997, Anderson *et al.* 1999a, 1999b, Anderson *in* MacRae 1999, Almond 2005, 2008a, 2008b, 2009). The 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).

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 stratigraphically equivalent mid to upper Klipbakkop 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).**

No body fossils were recorded within the MR00280/6.1/L/10/A/R1 borrow pit study area and to the author's knowledge there are no previous records of Adolphspoord Formation fossils from the Bonnievale area. Ferruginous diagenetic nodules of the sort that are commonly associated with fossil remains elsewhere in the Adolphspoord Formation outcrop area were not observed within the pit. There is evidence for extensive bioturbation of some horizons (e.g. colour mottling), but discrete trace fossil ichnogenera were not recognised.

## **5. CONCLUSIONS & RECOMMENDATIONS**

The existing MR00280/6.1/L/10/A/R1 **borrow** pit situated some 6.75 km southwest of Bonnievale is excavated into non-marine sandstones and mudrocks of the Middle Devonian Adolphspoord Formation (Upper Bokkeveld Group) that elsewhere are well-known for their Middle Devonian fish fauna, molluscs, vascular plants and trace fossils. However, the Bokkeveld sediments in the study area are highly tectonised, as shown by pervasive cleavage, quartz veining and folding, and there is no evidence here of fossiliferous ferruginous nodules. The palaeontological sensitivity of the site is correspondingly LOW and, pending the discovery of substantial new fossil material such as shelly fossil, fish or plant remains, no further studies or mitigation of fossil heritage for this borrow pit and its possible expansion to the west are considered necessary.

## **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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