PALAEONTOLOGICAL SPECIALIST STUDY: FIELD ASSESSMENT

TWO EXISTING BORROW PITS ALONG THE DR1347 ROAD NEAR LEMOENPOORT, WORCESTER DISTRICT, WESTERN CAPE

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

March 2013

1. EXECUTIVE SUMMARY

This assessment concerns two existing pits along the DR1347 near Lemoenpoort, *c*. 22 km SSE of Worcester, Western Cape. Pit DR01347/17.22/L/500/A/W3 is excavated into micaceous siltstones and thin sandstones of the upper Kweekvlei and / or the Floriskraal Formation (upper Witteberg Group) of Early Carboniferous age. The shallow marine bedrocks here are folded, cleaved and deeply weathered. The only fossils observed were low diversity trace fossil assemblages on sandstone bedding planes. Pit DR01347/18.51/L/50/A/W38 is excavated into highly weathered and cleaved mudrocks of the Prince Albert Formation (Ecca Group) and the uppermost tillites of the underlying Dwyka Group (Elandsvlei Formation) of Early Permian age. The tillites are unfossiliferous and the mudrocks contain only poorly-preserved trace fossils. The palaeontological heritage sensitivity of both borrow pit sites is assessed as LOW. Pending the discovery of significant new fossil material here, no further studies or mitigation of palaeontological heritage for these borrow pit projects are recommended.

2. INTRODUCTION

The Department of Transport, Western Cape, is applying to the Department of Mineral Resources for approval to exploit road material from two existing borrow pits along the unsealed DR1347 road near Lemoenpoort, some 22 km SSE of Worcester, Western Cape (Fig. 1). These two pits are:

- Pit **DR01347/18.51/L/50/A/W38** situated directly adjacent to the DR1347 on Worcester Farm No. 641 (Lemoenpoort) (33º 50’ 16.9” S, 19º 28’ 39.9” E);
- Pit **DR01347/17.22/L/500/A/W3** located *c*. 600 m west of the DR1347 on Worcester Farm No. 641 (Lemoenpoort) (33º 50’ 59.7” S, 19º 28’ 11.9” E).

These are Vidamemoria pit nos. 151 and 149 respectively, covered by Vidamemoria NID no. 81. A previous desktop basic assessment of the two pits by the author assessed their palaeontological heritage sensitivity as medium to low due to the presence here of potentially fossiliferous sediments of the upper Witteberg Group (Pit 149) and Elandsvlei Formation (Dwyka Group) (Pit 151). However, the latter pit is in fact excavated into the potentially fossiliferous Prince Albert Formation (“Upper Dwyka Shales”).

Palaeontological field assessments of the pits as part of an HIA were requested by Heritage Western Cape (HWC case 1925 - 2016 ref. 120726JL24E , 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 17 September 2012.

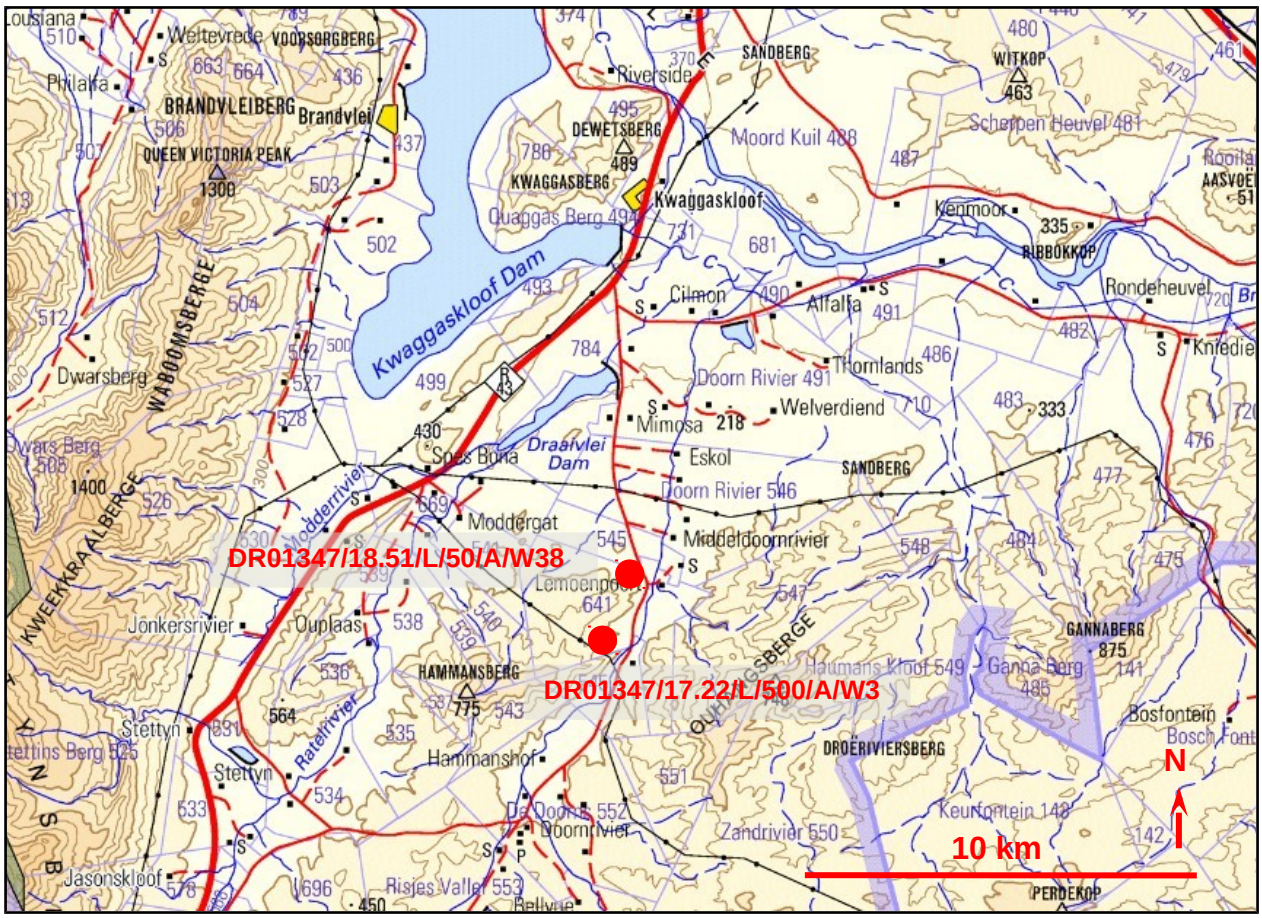

Fig.1. Extract from topographical sheet 3319 Worcester (Courtesy of the Chief Directorate: National Geo-spatial Information, Mowbray) showing the approximate location of the two existing pits along the DR1347 in the Lemoenpoort area, approximately 22 km SSE of Worcester, Western Cape.

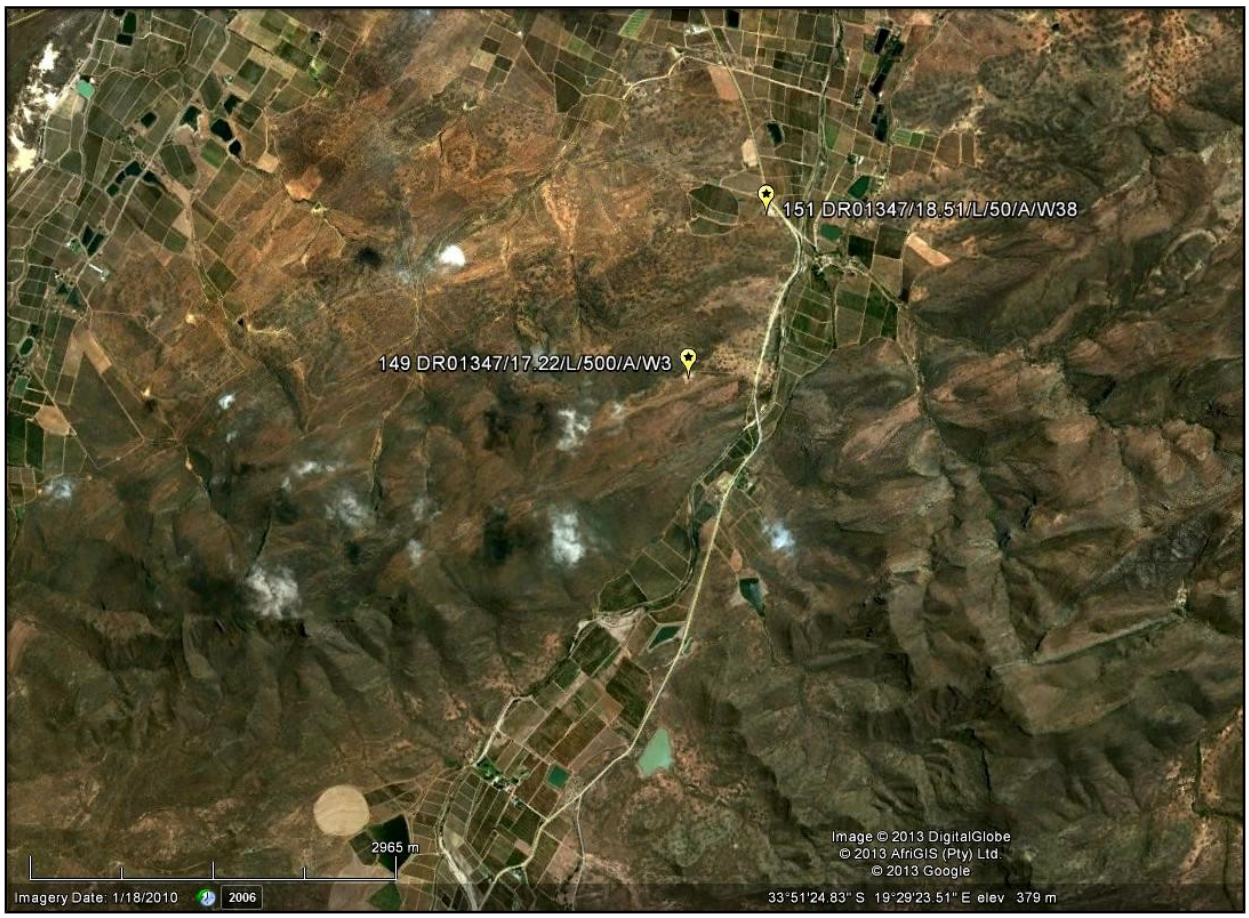

Fig. 2. Google earth© satellite image of the study area around Lemoenpoort, *c*. 22 km south of Worcester, showing the location of the two existing borrow pits.

3. GEOLOGICAL HERITAGE

The geology of the study region to the south of Worcester, 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 pit **DR01347/18.51/L/50/A/W38** is situated at *c*. 300 m amsl in an intensely folded zone of the Cape Fold Belt involving sediments of the upper Witteberg Group. Fold axes here trend broadly SW-NE with overfolding locally towards the north (Fig. 2). The stratigraphy in the pit area is complex and can only be resolved by detailed mapping. The main pit is probably excavated into Early Carboniferous mudrocks of the **Kweekvlei Formation** (**Ck**, upper Witteberg Group, Lake Mentz Subgroup) and overlying rubbly colluvial slope deposits. Along the pit margins it appears that sandstone packages of the **Floriskraal Formation** (**Cf**, upper Witteberg Group) are also affected by the pit development, although they are probably not the primary focus of quarrying here. An alternative interpretation is that the main pit is largely excavated into a mudrock-rich heterolithic interval within the Floriskraal Formation.

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 Early Carboniferous (Tournaisian) **Kweekvlei Formation** is some 30 to 50 m thick in the Worcester sheet area. It 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).

The overlying Early Carboniferous (Tournaisian / Visean) **Floriskraal Formation** (**Cf**) consists of several sandstone-dominated shoaling cycles that tend to form prominent, laterally persistent, yellowish-brown ridges sandwiched between the recessive weathering Kweekvlei and Waaipoort Formations. Tabular cross-bedding as well as tempestite-related sedimentary features (*e.g.* hummocky and swaley cross-stratification, interference ripples, flaggy sandstones with primary current lineation, wave ripple lamination of micaceous siltstones) and frequent winnowed pebbly horizons suggest deposition in an extensive but shallow, storm-influenced lake or lagoon (Broquet 1992). Sandstones here are often texturally and compositionally less mature than those of the lower Witteberg formations. Poorly-sorted gritty and feldspathic facies are common, and wackes may grade into diamictite-like rocks where the Floriskraal is directly overlain by the Dwyka Group (Gresse & Theron 1992). Occasional pebbles of exotic (extra-basinal) lithologies such as granites hint at a possible reworking of glacial debris in the provenance area (Loock 1967).

Heterolithic sediments exposed within the main pit include buff, pinkish and grey-green siltstones as well as interbedded, thin-bedded micaceous sandstones or wackes (Fig. 4). Finer-grained shaley facies are generally deeply weathered with pastel hues. Fresh dark Kweekvlei mudrocks are not exposed here. Sandstone bedding planes occasionally display well-developed synaeresis cracks (Fig. 13). Bedding within heterolithic and sandstone-dominated packages shows local small scale folding, tectonic disruption and brecciation (Fig. 5 and 6) while bedding plane slip is marked by mineral lineation. The upper Witteberg Group bedrocks are overlain by a thick blanket of coarse, rubbly colluvial deposits dominated by angular blocks of quartzite and sandstone in a reddish-brown sandy matrix (Fig. 7).

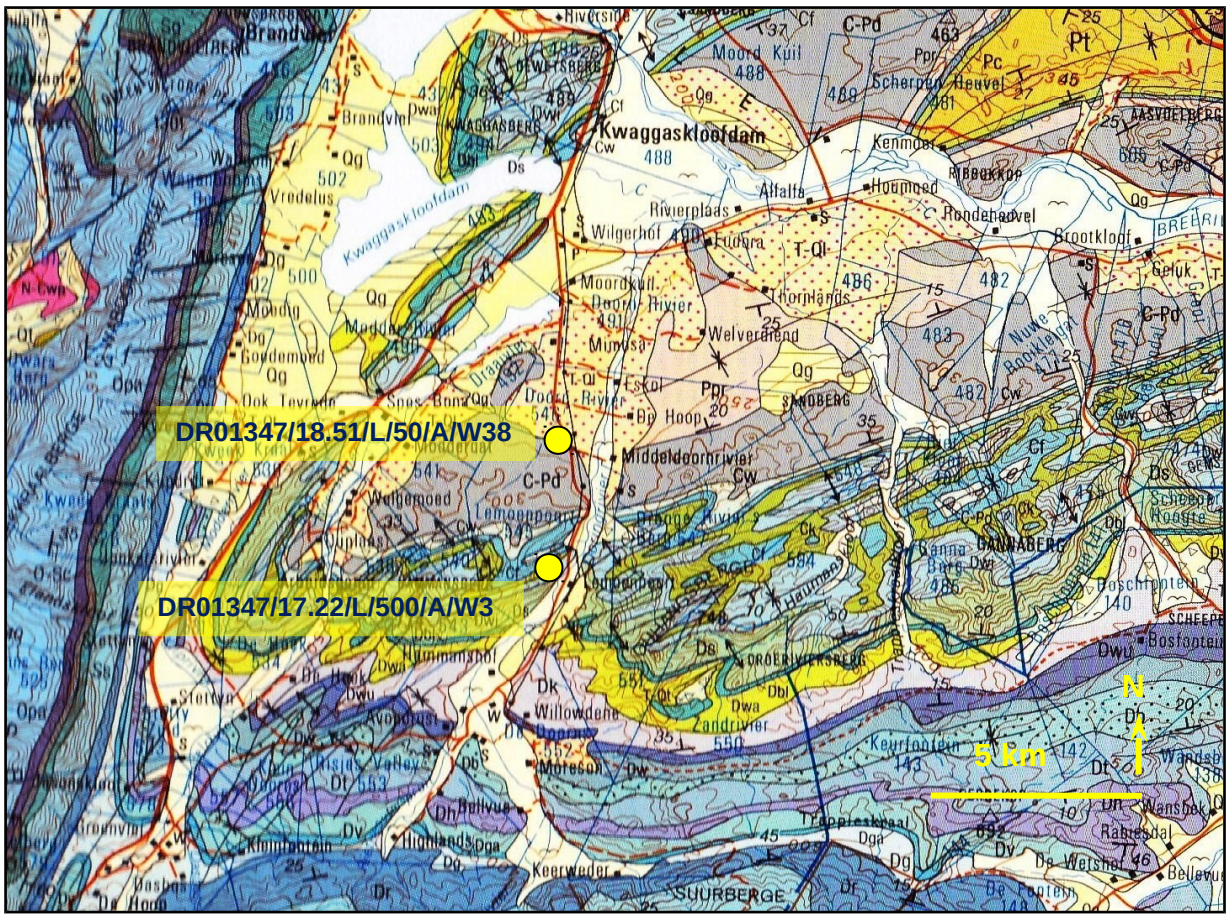

Fig. 3. Extract from 1: 250 000 geology sheet 3319 Worcester (Council for Geoscience, Pretoria) showing location of the two borrow pit study areas near Lemoenpoort to the south of Worcester, Western Cape. Pit DR01347/17.22/L/500/A/W3 is excavated into mudrocks of the Kweekvlei Formation (Ck, dark green) and / or Floriskraal Formation (Cf, middle blue) within the upper part of the Witteberg Group (Lake Mentz Subgroup). Pit DR01347/18.51/L/50/A/W38 is excavated into mudrocks of the lowermost Prince Albert Formation of the lower Ecca Group (Ppr, buff; here overlain by loamy soils T-Ql, yellow with red stipple) at the contact with the underlying Dwyka Group (C-Pd, grey).

Fig. 4. View towards the southeast of the existing pit DR01347/17.22/L/500/A/W3 showing weathered micaceous siltstones in the foreground and brown-weathering sandstones of the Floriskraal Formation in the cut face behind.

Fig. 5. Small-scale folding in sandstone packages of the Floriskraal Formation in pit DR01347/17.22/L/500/A/W3 (Hammer = 30 cm).

Fig. 6. Highly disrupted, tectonised micaceous wackes and siltstones in pit DR01347/17.22/L/500/A/W3 (Hammer = 30 cm).

Fig. 7. Reddish-brown, rubbly colluvial mantle overlying Witterberg Group bedrocks in pit DR01347/17.22/L/500/A/W3 (Hammer = 30 cm).

The Dwyka Group of the Main Karoo Basin is conformably overlain by post-glacial basinal mudrocks of the **Prince Albert Formation** (**Pp** in part), the lowermost subunit of the Ecca Group. This thin-bedded to laminated mudrock-dominated succession of Early Permian (Asselian / Artinskian) age was previously known as "Upper Dwyka Shales". Key geological accounts of this formation are given by Visser (1992) and Cole (2005). Useful overviews of the geology of the Ecca Group are given by Johnson *et al.* (2006) and Johnson (2009). The fossil record of the Ecca Group in the Western Cape has recently been reviewed by Almond (2008a, b). The Prince Albert succession consists mainly of thin-, tabular-bedded mudrocks of blue-grey, olive-grey to reddish-brown colour with occasional thin (dm) buff sandstones and even thinner (few cm), soft-weathering layers of yellowish water-lain tuff (*i.e.* volcanic ash layers). Extensive diagenetic modification of these sediments has led to the formation of thin cherty beds, pearly- blue phosphatic nodules, rusty iron carbonate nodules, as well as beds and elongate ellipitical concretions impregnated with iron and manganese minerals. These last occur within prominent-weathering, metallic-looking beds, some of which display well-developed snuffbox weathering and concentric *Liesegang* rings. As a result of their rich iron and manganese ore content, surface gravels derived from the Prince Albert Formation often develop a metallic "desert varnish".

The existing **DR01347/18.51/L/50/A/W38** pit is excavated into highly weathered mudrocks of what is mapped as the Prince Albert Formation down to its basal contact with glaciogenic tillites of the **Elandsfontein Formation** (**Dwyka Group**). The Dwyka rocks with their typical tombstone weathering pattern build the ridge and cut face at the southern side of the borrow pit (Figs. 8). The reddish-brown tillites here are comparatively clast-poor, secondarily ferruginised and cleaved (Fig. 9). The overlying thin bedded, micaceous mudrocks with thin sandstone interbeds and laminae exposed within the pit are weathered, steeply cleaved and tectonically disturbed. They show various grey-green, grey, pinkish and reddish-brown hues, are cross-cut by irregular veins of purplish-brown secondary ferromanganese minerals (Fig. 10), and on the whole do not resemble typical dark-grey, thinly tabular-bedded Prince Albert shales (Fig. 11). The Palaeozoic bedrocks are mantled with poorly sorted, coarse, reddish-brown colluvial gravels containing a variety of rock types including sandstones, ferruginised wackes and vein quartz, among others (Fig. 10).

Fig. 8. View towards the south across the DR01347/18.51/L/50/A/W38 pit showing weathered mudrocks in the foreground and more resistant Dwyka Group tillites behind.

Fig. 9. Close up of the secondarily reddened, massive and cleaved tillites of the Dwyka Group along the southern edge of the DR01347/18.51/L/50/A/W38 pit. Note distinctive Dwyka tombstone weathering in the background.

Fig. 10. Highly cleaved, weathered and mineralised mudrocks within the DR01347/18.51/L/50/A/W38 pit, mantled by poorly sorted ferruginous colluvial gravels (Hammer = 30 cm).

Fig. 11. Close-up of float block of greyish-green mudrocks from the DR01347/18.51/L/50/A/W38 pit showing thin bedding and thin sandy laminae.

4. PALAEONTOLOGICAL HERITAGE

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.

The sparse body fossil record of the **Floriskraal Formation** includes reworked vascular plant debris, sometimes current-orientated, on the tops of flaggy sandstones. Occasional large lycopod fragments may belong to the peculiar genus *Longicicatrix* (*cf* Anderson & Anderson 1985). There are unconfirmed records of acanthodian fish (so-called spiny sharks) within “phosphatic limestone” nodules near Touwsrivier (Evans 1997, 2005). Dense, monospecific assemblages of horizontal burrows (*Palaeophycus*) are characteristic of the Floriskraal Formation and poorly-preserved wash-out traces, possibly including members of the *Scolicia* Group, are also widely seen (Almond 2008b). The low diversity of ichnogenera recorded from this formation as well as the absence of *Spirophyton* support a non-marine setting for the Floriskraal Formation.

The only fossils recorded from the upper Witteberg sediments in pit DR01347/17.22/L/500/A/W3 are low diversity ichnoassemblages dominated by a limited range of hypichnial trace fossils (Fig. 12). Prominent synaeresis crack infills mimic trace fossils and are often mistaken for them (Fig. 13).

The **Dwyka Group** in the southern portion of the Main Karoo Basin has a generally poor fossil record (McLachlan & Anderson 1973, Anderson & McLachlan 1976, Visser *et al*., 1990, Von Brunn & Visser 1999, Visser 2003, Almond 2008a, 2008b). This is hardly surprising given the glacial climates that prevailed during much of the Late Carboniferous to Early Permian Periods in southern Africa. However, most Dwyka sediments were deposited during periods of glacial retreat associated with climatic amelioration. Sparse, low diversity fossil biotas within interglacial or postglacial mudrocks mainly consist of arthropod trackways (*e.g. Umfolozia* - probably made by small crustaceans) and fish swimming trails associated with dropstone laminites. Sporadic vascular plant remains mainly comprise drifted wood and leaves of the *Glossopteris* Flora. Palynomorphs are also likely to be present within finer-grained mudrock facies. Glacial diamictites (tillites or "boulder mudstones") are normally unfossiliferous but do occasionally contain fragmentary transported plant material as well as palynomorphs in the fine-grained matrix. Occasional pale grey limestone glacial erratics from tillites along the southern margins of the Great Karoo (**Elandsvlei Formation**) contain Cambrian eodiscid trilobites as well as archaeocyathid sponges that have been sourced in Antarctica. Such derived fossils provide important data for reconstructing the movement of Gondwana ice sheets (Cooper & Oosthuizen 1974).

The fossil biota of the post-glacial mudrocks of the **Prince Albert Formation** is usefully summarized by Cole (2005). Typical trace fossil assemblages of the non-marine *Mermia* Ichnofacies commonly are dominated by delicate arthropod trackways (especially *Umfolozia*), scratch burrows or furrows (*Isopodichnus*), arthropod resting traces (*Gluckstadtella*) and undulose fish fin trails (*Undichna*) (*e.g.* Anderson 1974, 1976, 1981). More complex arthropod traces, some of them possible generated by small eurypterids, are also known. Diagenetic nodules containing the remains of palaeoniscoids (primitive bony fish), sharks, spiral bromalites (coprolites *etc*) and wood have been found in the Ceres Karoo and rare shark remains (*Dwykaselachus*) occur near Prince Albert on the southern margin of the Great Karoo (Oelofsen 1986). Microfossil remains in this formation include sponge spicules, foraminiferal and radiolarian protozoans, acritarchs and miospores.

Apart from vague, poorly preserved traces, no fossils were recorded within the Dwyka Group or Prince Albert Formation bedrocks, nor within the overlying superficial deposits (alluvium, colluvium) at borrow pit site DR01347/18.51/L/50/A/W38.

Fig. 12. Sole surface of micaceous sandstone from the Floriskraal Formation in pit DR01347/17.22/L/500/A/W3 showing sparse, low diversity assemblages of hypichnial trace fossils (Scale in cm).

Fig. 13. Sandstone bedding plane from the Floriskraal Formation in pit DR01347/17.22/L/500/A/W3 showing irregular, splindle-like synaeresis cracks, often mistaken for trace fossils (Scale in cm and mm).

5. CONCLUSIONS & RECOMMENDATIONS

This assessment concerns two existing pits along the DR1347 near Lemoenpoort, *c*. 22 km SSE of Worcester, Western Cape. Pit DR01347/17.22/L/500/A/W3 is excavated into micaceous siltstones and thin sandstones of the upper Kweekvlei and / or the Floriskraal Formation (upper Witteberg Group) of Early Carboniferous age. The shallow marine bedrocks here are folded, cleaved and deeply weathered. The only fossils observed were low diversity trace fossil assemblages on sandstone bedding planes. Pit DR01347/18.51/L/50/A/W38 is excavated into highly weathered and cleaved mudrocks of the Prince Albert Formation (Ecca Group) and the uppermost tillites of the underlying Dwyka Group (Elandsvlei Formation) of Early Permian age. The tillites are unfossiliferous and the mudrocks contain only poorly-preserved trace fossils. The palaeontological heritage sensitivity of both borrow pit sites is assessed as LOW. Pending the discovery of significant new fossil material here, no further studies or mitigation of palaeontological heritage for these borrow pit projects are 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.

7. REFERENCES

ALMOND, J.E. 1998a. Early Palaeozoic trace fossils from southern Africa. Tercera Reunión Argentina de Icnologia, Mar del Plata, 1998, Abstracts p. 4.

ALMOND, J.E. 1998b. 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. 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.

ALMOND, J., MARSHALL, J. & EVANS, F. 2002. Latest Devonian and earliest Carboniferous glacial events in South Africa. Abstracts, 16th International Sedimentological Congress, RAU, Johannesburg, pp 11-12.

ALMOND, J.E. & PETHER, J. 2008. Palaeontological heritage of the Western Cape. Interim SAHRA technical report, 20 pp. Natura Viva cc., Cape Town.

ANDERSON, A.M. 1974. Arthropod trackways and other trace fossils from the Early Permian lower Karoo Beds of South Africa. Unpublished PhD thesis, University of Witwatersrand, Johannesburg, 172 pp.

ANDERSON, A.M. 1975. Turbidites and arthropod trackways in the Dwyka glacial deposits (Early Permian) of southern Africa. Transactions of the Geological Society of South Africa 78: 265-273.

ANDERSON, A.M. 1976. Fish trails from the Early Permian of South Africa. Palaeontology 19: 397-409, pl. 54.

ANDERSON, A.M. 1981. The *Umfolozia* arthropod trackways in the Permian Dwyka and Ecca Groups of South Africa. Journal of Paleontology 55: 84-108, pls. 1-4.

ANDERSON, A.M. & MCLACHLAN, I.R. 1976. The plant record in the Dwyka and Ecca Series (Permian) of the south-western half of the Great Karoo Basin, South Africa. Palaeontologia africana 19: 31-42.

ANDERSON, J.M. & ANDERSON, H.M. 1985. Palaeoflora of southern Africa. Prodromus of South African megafloras, Devonian to Lower Cretaceous, 423 pp, 226 pls. Botanical Research Institute, Pretoria & Balkema, Rotterdam.

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.

COLE, D.I. 2005. Prince Albert Formation. SA Committee for Stratigraphy, Catalogue of South African Lithostratigraphic Units 8: 33-36.

EVANS, F.J. 1997. Palaeobiology of Early Carboniferous fishes and contemporary lacustrine biota of the Waaipoort Formation (Witteberg Group), South Africa. Unpublished MSc thesis, University of Stellenbosch, xii + 213 pp, 85 pls.

EVANS, F.J. 2005. Taxonomy, palaeoecology and palaeobiogeography of some Palaeozoic fish of southern Gondwana. Unpublished PhD thesis, University of Stellenbosch, 629 pp.

GESS, R.W. & HILLER, N. 1995. A preliminary catalogue of fossil algal, plant, arthropod, and fish remains from a Late Devonian black shale near Grahamstown, South Africa. Annals of the Cape Provincial Museums (Natural History) 19: 225-304.

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.

JOHNSON, M.R. 2009. Ecca Group. SA Committee for Stratigraphy Catalogue of South African lithostratigraphic units 10, 5-7. Council for Geoscience, Pretoria.

JOHNSON, M.R., THERON, J.N. & LOOCK, J.C. 2006. Witteberg Group. South African Committee for Stratigraphy, Catalogue of South African Lithostratigraphic Units 9: 47-49. Council for Geoscience, Pretoria.

LOOCK, J.C. 1967. The stratigraphy of the Witteberg – Dwyka contact beds. Unpublished MSc thesis, University of Stellenbosch, 139 pp, 2 pls.

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

MCLACHLAN, I.R. & ANDERSON, A. 1971. A review of the evidence for marine conditions in southern Africa during Dwyka times. Palaeontologia africana 15: 37-64.

McLOUGHLIN, S. & LONG, J.A. 1994. New records of Devonian plants from southern Victoria Land, Antarctica. Geological Magazine 131: 81-90.

OELOFSEN, B.W. 1986. A fossil shark neurocranium from the Permo-Carboniferous (lowermost Ecca Formation) of South Africa. In: Uyeno, T, Arai, R., Taniuchi, T & Matsuura, K. (Eds.) Indo-Pacific fish biology. Proceedings of the Second International Conference on Indo-Pacific Fishes. Ichthyological Society of Japan, Tokyo, pp 107-124.

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. & 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., 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.

VISSER, J.N.J. 1992. Deposition of the Early to Late Permian Whitehill Formation during a sea-level highstand in a juvenile foreland basin. South African Journal of Geology 95: 181-193.

VISSER, J.N.J. 1994. A Permian argillaceous syn- to post-glacial foreland sequence in the Karoo Basin, South Africa. In Deynoux, M., Miller, J.M.G., Domack, E.W., Eyles, N. & Young, G.M. (Eds.) Earth's Glacial Record. International Geological Correlation Project Volume 260, pp. 193-203. Cambridge University Press, Cambridge.

VISSER, J.N.J. 2003. Lithostratigraphy of the Elandsvlei Formation (Dwyka Group). South African Committee for Stratigraphy, Lithostratigraphic Series No. 39, 11 pp.

VISSER, J.N.J., VON BRUNN, V. & JOHNSON, M.R. 1990. Dwyka Group. South African Committee for Stratigraphy Catalogue of South African Lithostratigraphic Units 2, 15-17. Council for Geoscience, Pretoria.

VON BRUNN, V. & VISSER, J.N.J. 1999. Lithostratigraphy of the Mbizane Formation (Dwyka group). South African Committee for Stratigraphy, Lithostratigraphic Series No. 32, 10 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 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.

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