

**Palaeontological Impact Assessment for development
of an opencast mine by
Canyon Springs Investments 82 (Pty) Ltd
near Bela-Bela,
Mpumalanga**

Phase 1

For: *Prime Resources (Pty) Ltd*
PO Box 2316
Parklands
2121

By: Prof **Marion Bamford**
Evolutionary Studies Institute
University of the Witwatersrand
Private Bag 3, WITS 2050
Johannesburg
Tel: +27 11 717 6690
Fax: +27 11 717 6694
Email: marion.bamford@wits.ac.za

20 August 2013

Figure 1: Geological map indicating position of proposed open cast mine southeast of Bela Bela (Warmbaths). Symbols as indicated in Table 1 below. Map enlarged from the Geological Survey, Pretoria; 1984, 1: 1 000 000.

Symbol	Formation/Group	Lithology	Age
Pe	Ecca (Lower Permian)	Shale, coal	~270 – 260 Ma
P-Tri	Irrigasie Formation	Shale, sandstone, mudstone coal	Triassic? (250-200Ma)
Vse	Rooiberg	Red porphyritic rhyolite	2050 Ma
Q	Quaternary	Alluvium, sand, calcrete	12 ka and younger

Table 1: Geology of the region surrounding the proposed development area. Refer to map in Figure 1.

Palaeontological Record

According to the published and unpublished records at my disposal coal seams have been demonstrated in a number of cores placed in the Springbok Flats Basin in the northeastern part of the main Karoo Basin (Visser and van der Merwe, 1959; Johnson et al., 2006; van Wyk and van Wyk, 2012) but fossil plants have not been recorded specifically from Springbok Flats Basin. The coal seam at the proposed site for the open cast mine lies between the Hammanskraal Formation and the Irrigasie Formation (ibid). The underlying Hammanskraal Formation at Hammanskraal has an excellent record of fossil plants (Smithies, 1978; Kovacs-Endrody, 1976, 1991; Anderson and Anderson, 1985) comprising fructifications, leaves and roots of *Glossopteris*, ferns, sphenophytes and lycopods (Table 2). The overlying Irrigasie Formation is predominantly fluvial and floodplain sandstones and conglomerates (Johnson et al., 2006) that are oxidized and have no recorded fossil plants or animals.

There is a strong possibility that the Springbok Flats coal has some or all of the fossils that occur in the slightly older Hammanskraal Formation as this flora continued through the Permian. However, since there is no exposure or outcrop in the relatively flat area any fossils will only be revealed once excavations for the infrastructure and then for mining have begun.

Plant group	Plant part	Genus and species
Lycopodophyta (club mosses)	Stem and strobili	<i>Azaniadendron fertile</i>
	stem	<i>Cyclodendron leslii</i>
Sphenophyta (horsetails)	Leaves	<i>Sphenophyllum hammanskraalensis</i>
	Leaves	<i>Sphenophyllum mesoccaense</i>
	Leaves	<i>Annularia hammanskraalensis</i>
Pterophyta (ferns)	Leaves	<i>Asterotheca hammanskraalensis</i>
	leaves	<i>Sphenopteris lobifolia</i>
Glossopteridales	Leaves	<i>Palaeovittaria kurzii</i>
	Fructification	<i>Ottokaria hammanskraalensis</i>
	Fructification	<i>Hirsutum leslii</i>
	Fructification	<i>Arberia madagascariensis</i>

	Leaf	<i>Glossopteris ampla</i>
	leaf	<i>Glossopteris browniana</i>
	leaf	<i>Glossopteris communis</i>
	leaf	<i>Glossopteris damudica</i>
	leaf	<i>Glossopteris divergens</i>
	leaf	<i>Glossopteris indica</i>
	leaf	<i>Glossopteris pseudocommunis</i>
	leaf	<i>Glossopteris taeniopteroides</i>
	Scale leaf	<i>No name</i>
Cordaitales (conifer)	Leaf	<i>Noeggerathiopsis hislopii</i>
Incertae sedis (unknown)	Leaf	<i>Botrychiopsis valida</i>

Table 2 – list of fossil plants and insects from the Hammanskraal Formation (from Smithies, 1978; Kovacs- Endrody, 1976; Anderson and Anderson, 1985). Note: there are several schools of thought on naming *Glossopteris* leaf species. Traditionally new species names were assigned to leaves with minor differences resulting in numerous species being named. The Anderson's assigned leaves to the species of fructifications when they commonly occurred together but this is questioned by other palaeobotanists as several leaf types may occur with one fructification type. Currently researchers realise that there is much variation within biological species so instead they morphotype the leaves.

Recommendation

Fossils have not been recorded from the area of the proposed Canyon Springs open cast coal mine but there is a chance that they may occur. Macrofossils will not have been recognized from the cores unless someone was specifically looking for fragments in the relatively narrow diameter cores. Since there is no outcrop or exposure in the area I strongly recommend that as part of the Environment Management Plan (EMP) the responsible person monitors the excavations and later the mining operation. If fossil plants (very likely to occur – see appendix for photographs), insects or vertebrates (unlikely to occur) are found then he must either remove the fossils to a safe place or immediately call a palaeontologist to collect and protect the fossils. In this way there will be no or minimal delay to operations but the fossils will be protected and collected for future research.

References

- Anderson, J.M., Anderson, H.M., 1985. Palaeoflora of Southern Africa: Prodrum of South African megafloras, Devonian to Lower Cretaceous. A.A. Balkema, Rotterdam. 423 pp.
- Johnson, M.R., van Vuuren, C.J., Visser, J.N.J., Cole, D.I., Wickens, H.deV., Christie, A.D.M., Roberts, D.L., Brandl, G., 2006. Sedimentary rocks of the Karoo Supergroup. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. Pp 461 – 499.
- Kovacs-Endrody, E., 1976. Notes on some *Glossopteris* species from Hammanskraal (Transvaal). *Palaeontologia africana* 19, 67-95.
- Kovacs-Endrody, E. 1991. On the Late Permian age of Ecca *Glossopteris* floras in the Transvaal Province with a key to and descriptions of twenty five *Glossopteris* species. Memoir of the Geological Survey of South Africa, 77, 111pp.
- Smithies, S.J., 1978. Studies on a Middle Ecca (Lower Permian) flora from Hammanskraal, Transvaal, South Africa, with emphasis on the glossopterid fructification *Ottokaria* Zeiller. Unpublished MSc dissertation, University of the Witwatersrand, Johannesburg.
- Visser, H.N., van der Merwe, S.W. 1959. The northeastern Springbok flats Coal-field: records of boreholes 1 to 27 drilled for the Department of Mines. Bulletin of the Geological Survey of South Africa 31, 1-97.
- Van Wyk, D., le Roux van Wyk, D., 2012. Canyon Springs Feasibility Study, Geology. Unpublished Internal Report for CSI by GeoCoal Services. ??

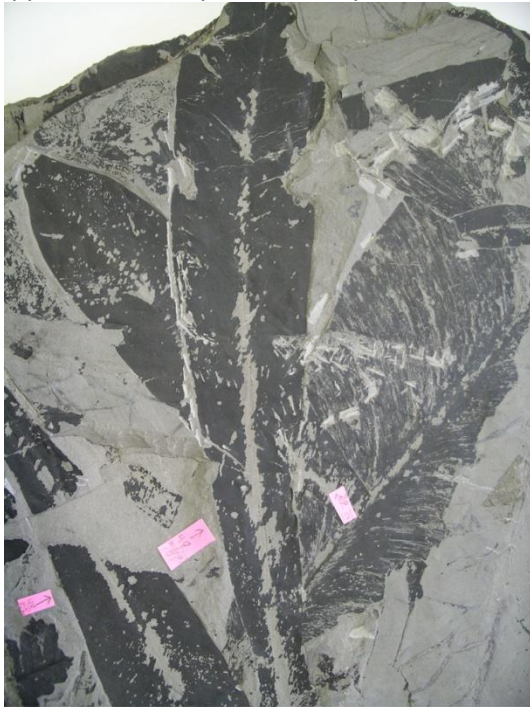
Appendix captions

Fig A1 – photographs of fossil plants from Hammanskraal currently housed in the Evolutionary Studies Institute, University of the Witwatersrand.

Fig A2 – *Glossopteris* fructifications.

Fig A3 – Comparison of leaf venation types.

Appendix – examples of fossil plants from the Hammanskraal Formation



Wide and narrow Glossopteris leaves



Narrow Glossopteris leaves



Lycopod stem with leaf abscission scars



Asterotheca (fern)

Hammanskraal fossil plants

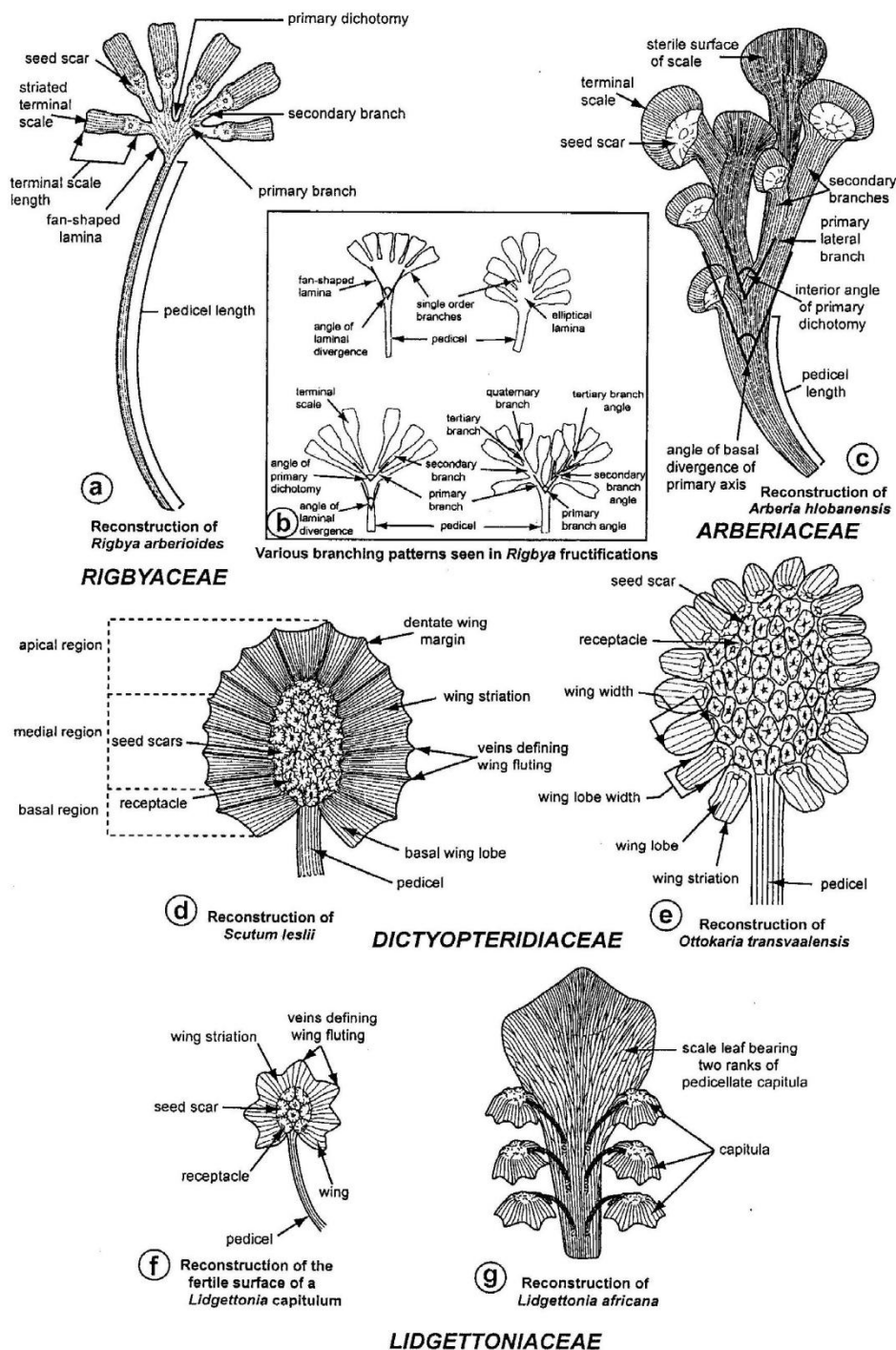


Fig A2: Diagrams of the various female fructifications associated with the South African *Glossopteris* flora. Although they may look very different there is a common theme: a capitulum holding seeds and surrounded by a wing. The capitulum is big in E and the wing is divided; the capitulum is medium sized and the wing is complete in D; the capitulum and wings are divided in A, C and G. From Adendorff (2005).

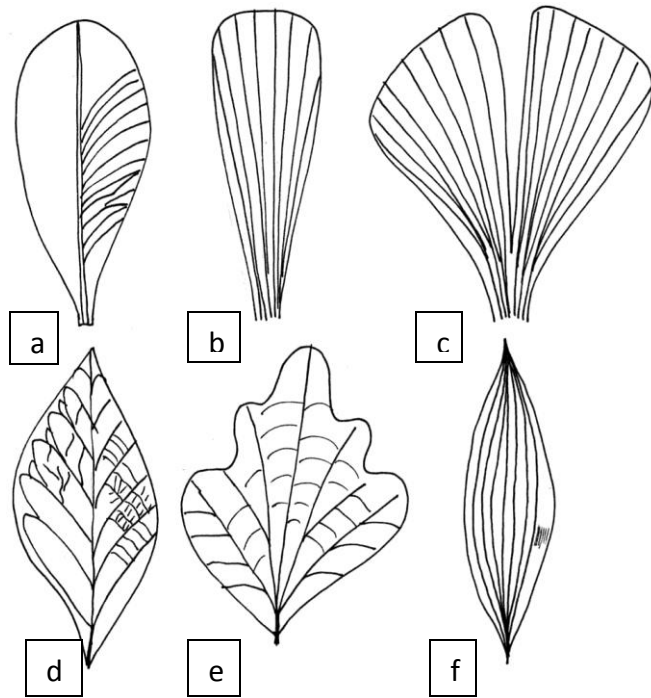


Fig A3 – diagrams of different leaf venation types:

A -Glossopterid type with midvein and almost parallel secondary veins

B -Cordaitalean type with almost parallel veins arising and diverging from the base.

C- Ginkgoalean type with divided lamina and veins like b.

D – dicot type with primary, secondary and tertiary veins forming a network (most modern plants have this type: d-f.)

E – dicot type

F – monocot type with parallel veins.