Palaeontological Impact Assessment for Majuba Underground Coal Gasification Project, Mpumalanga

Phase 1 Report

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30 November 2012.

INTRODUCTION

As requested by Royal HaskoningDHV, who have been appointed by Eskom Holdings SOC Ltd., here is the Phase 1 or desktop study of Palaeontological Impact Assessment for the proposed Underground Coal Gasification (UCG) Project and associated infrastructure on Portions 1, 2, 3 and remaining extent of the farm Roodekopjes 67 HS, Portions 17 and 21 of the farm Bergvliet 65HS and Portions 4 and 5 of the farm Rietfontein 66HS in Mpumalanga Province, associated with Majuba Power station and Amersfoort Power Station.

GEOLOGY AND PALAEONTOLOGY

The site is in the north eastern part of the Karoo Basin in Permian Ecca deposits, ranging in age from approximately 280 to 260 million years old. The formations present in this area are the middle Ecca Vryheid Formation, the upper Ecca Volksrust formation and the Lower Beaufort Adelaide Formation. Much of this area has economically important coal seams and these were formed in mostly fluvial settings, where peat swamps developed in broad abandoned alluvial plains and interfluves (Cadle et al., 1993; Cairncross, 2001; Johnston et al., 2006). The lithologies comprise shales, sandstones, mudstones and coals but are interrupted by Jurassic aged intrusive dolerite dykes (see Figure 1 and Table 1.)

By their nature coals are plant rich. Good quality coals do not preserve the anatomy of the original plant matter, but the shales between the sequences do. Here it is possible to find well preserved *Glossopteris* leaves, roots and inflorescences, lycopod and sphenophyte stems, ferns, cordaitaleans and early gymnosperms (Table 2). Bones of the vertebrates that occurred at this time are seldom if ever preserved with the plants but insects are often abundant.

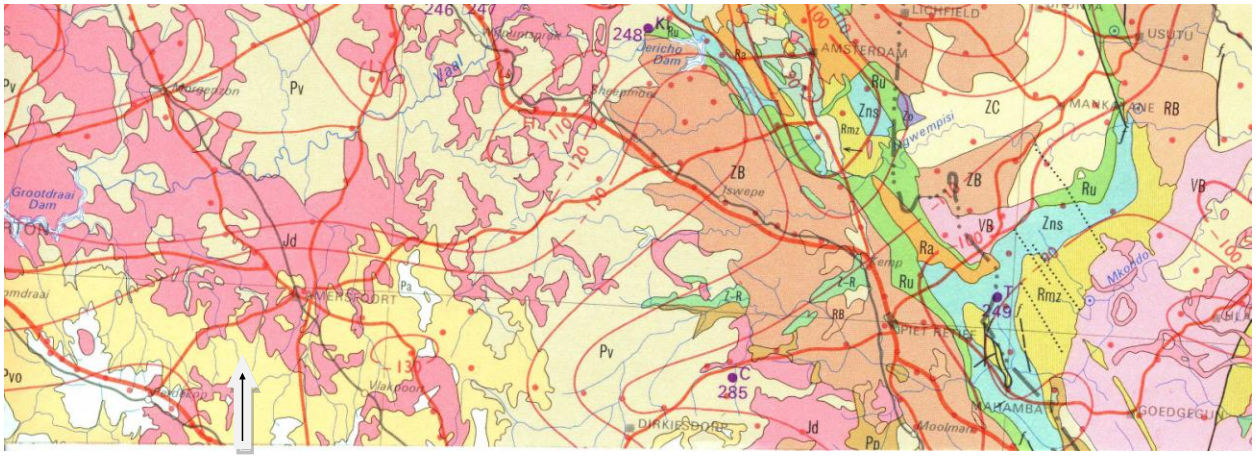

Figure 1: Geology of the Majuba-Amersfoort area. Arrow marks the proposed development area. Abbreviations and lithology in Table 1. Map from the Geolological Survey, Pretoria; 1984, 1: 1 000 000.

Symbol	Formation	Lithology	Age
Jd		Dolerite dykes	Jurassic
Pa	Adelaide and Estcourt	Mustdtone, sandstone	Beaufort; Late Permian
Pva	Volksrust	Shale	Upper Ecca; Late Permian
Pv	Vryheid	Sandstone, shale, coal	Middle Ecca; middle Permian

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

Fossil plants from the Permian

Fossil plants have been collected by Edna Plumstead, Stephanus Le Roux, Heidi and John Anderson, Shirley Smithies and many others from the northeastern Karoo Basin and are now housed in the Palaeobotany Herbarium of the Bernard Price Institute for Palaeontological Research, University of the Witwatersrand. These plants are typical examples from fossil floras of this age in Gondwana. In Table 1 is a full list of plants from this age and the species that occur in the Early to middle Permian and the Upper Permian of the Karoo Basin are indicated. Although the species will have little meaning to non-palaeobotanists, they give an indication of the richness of these floras. Coal floras tend to be comparable at the generic level but there are many differences at the species level and there is much research still to be done on South African coal floras.

Plant group/common name	***Genus and species***	**Early to Middle**	**Upper**
Lycopods (clubmosses)	*Haplostigma permianica*	+	
	Leptophloem santae-helenae	+	
	Azaniadendron fertile	+	
	Cyclodendron leslii	+	
Sphenopsids (horsetails)	*Sphenophyllum hammanskraalensis*	+	
	Sphenophyllum mesoccaense	+	
	Sphenohyllum speciosum	+	+
	Annularia hammanskraalensis	+	
	Raniganjia kilburnensis	+	+
	Raniganjia rayneri	+	
	Raniganjia lanceolate	+	
	Phyllotheca australis		+
	Phyllotheca lawleyensis	+	+
	Phyllotheca westensis		+
	Schizoneura gondwanansis		+
Ferns	*Asterotheca hammanskraalensis*	+	
	Asterotheca leeuwkuilensis	+	
	Sphenopteris lobifolia	+	+
	Liknopetalon enigmata	+	
Glossopteridales	*Numerous leaves – morphotypes, not species*	+++++	+++
- Female fructifications	*Arberia hlobanensis*	++	
-	*Arberia madagascariensis*	+	
-	*Bifariala intermittens*	+	
-	*Dictyopteridium natalensis*	+	
-	*Dictyopteridium flabellatum*	+	
-	*Elatra leslii*	+	

-	*Estcourtia bergvillensis*		+
-	*Estcourtia conspicua*	+	
-	*Estcourtia vandijkii*		+
-	*Gladiopomum acadarense*	+	
-	*Gonophylloides strictum*	+	
-	*Gonophylloides waltonii*	+	
-	*Lidgettonia africana*	+	+
-	*Lidgettonia elegans*	+	+
-	*Lidgettonia inhluzanensis*		+
-	*Lidgettonia lidgettonioides*	+	+
-	*Lidgettonia mooiriverensis*		+
-	*Ottokaria buriadica*	+	
-	*Ottokaria hammanskraalensis*	+	
-	*Ottokaria transvaalensis*	+	+
-	*Plumsteadia gibbosa*	+	+
-	*Plumsteadia natalensis*		+
-	*Plumsteadia lerouxii*	+	
-	*Rigbya arberioides*	+	+
-	*Scutum leslii*	+	
-	*Vereenia leeukuilensis*	+	
- -male fructifications	*Eretmonia spp.*	+	
Ginkgoales	*Sphenobaiera eccaensis*	+	
	Metreophyllum lerouxii	+	
	Ginkgophyllum kidstonii	+	
	Ginkgophyllum spatulifolia	+	
	Flabellofolium leeukuilensis	+	
Conifers	*Noeggerathiopsis hislopii*	+	
	Noeggerathiopsis spathulata		+
	Walkomiella transvaalensis	+	
	Podozamites hlobanensis	+	
	Pagiophyllum vandijkii		+
	Benlightfootia mooiensis		+
	Cyparissidium sp.	+	
Incertae sedis	*Taeniopteris gemmina*	+	
	Taeniopteris estcourtiana		+
	Botrychiopsis valida	+	
	Various seeds	+	

Table 2: List of Early to middle Permian and Upper Permian plants from the Karoo Basin, South Africa. Compiled from Plumstead, 1969; Anderson and Anderson, 1985; Adendorff, 2004; Adendorff et al., 2003; Prevec et al., 2008, Taylor et al., 2009.

RECOMMENDATION

There is a strong likelihood of fossil plants occurring in the shales and mudstones associated with the coals. There are two aspects to the proposed development. The first is to take place underground and obviously associated with coal deposits (but no details provided by Royal HaskoningDHV). The second is a surface access road between the site office and the boundary of Roodekopjes 67 HS, passing through Bergvleit 65 HS and Rietfontein 65 HS. The latter is to take place in a region that has been used for agriculture and if there were any fossils on the surface they are likely to have been destroyed already.

The fossils associated with the underground coal seams will be poorly preserved as the plants are greatly altered by the natural process of coalification, from peat, through lignite to bituminous coal. Recognizable plant fossils are likely to occur in the non-economic shales and mudstone layers or lenses between the coal seams.

The National Heritage Resources Act (Act 25 of 1999) draft document **MINIMUM STANDARDS: PALAEONTOLOGICAL COMPONENT OF HERITAGE IMPACT ASSESSMENT REPORTS** (October 2011) states**:**
As states develop and landscapes are modified, heritage resources, including palaeontological resources, are threatened. As such, both the environmental and heritage legislation require that development activities must be preceded by an assessment of the impact undertaken by qualified professionals. Palaeontological Impact Assessments (PIAs) are specialist reports that form part of the wider heritage component of:

- Heritage Impact Assessments (HIAs) called for in terms of Section 38 of the National Heritage Resources Act, Act No. 25, 1999 by a heritage resources authority.
- Environmental Impact Assessment process as required in terms of other legislation listed in s. 38(8) of NHRA.
- Environmental Management Programmes (EMPs) required by the Department of Mineral Resources.

It is therefore recommended that the development may proceed BUT that a responsible person (geologist, environmental officer, or other) regularly monitors the excavations, removes and collects fossil material that is found. The fossils should then be given to an institute that is recognized by SAHRA as a repository for fossils. As there is no such repository in Mpumalanga the material could go to the Ditsong Museum or Council for Geosciences in Pretoria or the Bernard Price Institute for Palaeontological Research, University of the Witwatersrand in Johannesburg.

REFERENCES

Adendorff, R., 2004. A Revision of the Ovulate Fructifications of *Glossopteris* from the Permian of South Africa. Unpublished PhD thesis, University of the Witwatersrand, Johannesburg. 362 pp + 100 plates.

Adendorff. R. Bamford, M.K., McLoughlin, S. 2003. *Liknopetalon*: a review of a rare Gondwanan Permian pteridophyte. *Review of Palaeobotany and Palynology.* 126, 83-101.

Anderson, J.M., Anderson, H.M., 1985. Palaeoflora of Southern Africa: Prodromus of South African megafloras, Devonian to Lower Cretaceous. A.A. Balkema, Rotterdam. 423pp.

Cadle, A.B., Cairncross, B., Christie, A.D.M., Roberts., D.L., 1993. Cairncross, B., 2001. An overview of the Permian (Karoo) coal deposits of southern Africa. Journal of African Earth Sciences 33, 529-562.

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.

Plumstead, E.P., 1969. Three thousand million years of plant life in Africa. Geological Society of southern Africa, Annexure to Volume LXXII. 72pp + 25 plates.

Prevec, R., McLoughlin, S., Bamford, M.K., 2008. Novel double wing morphology revealed in a South African ovuliferous glossopterid fructification. *Review of Palaeobotany and Palynology* 150, 22-36.

Taylor, T.N., Taylor, E.L., Krings, M., 2009. Palaeobotany. The biology and evolution of fossil plants. Academic Press, Burlington MA, USA. 1230pp.

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30 November 2012