

**Palaeontological Impact Assessment for the proposed
Elders Colliery near Bethal,
Mpumalanga Province.**

Desktop Study

For

SRK Consulting (South Africa) (Pty) Ltd

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Expertise of Specialist

The Palaeontologist Consultant is: Prof Marion Bamford

Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf

Experience: 30 years research; 20 year PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by SRK Consulting, South Africa, (Pty) Ltd. The views expressed in this report are entirely those of the author and SRK Consulting and no other interest was displayed during the decision making process for the project.

Specialist: Prof Marion Bamford.....

Signature:



Executive Summary

The Palaeontological Impact Assessment for the proposed development of the Elders Colliery, east of Kriel and north of Bethal, in Mpumalanga Province, concludes that there is very little likelihood of any fossils of scientific interest being found during the excavations for the infrastructure because the coal seams are more than 30m below surface. Once underground mining operations have begun there is a small chance of finding some fossil plants of the Ecca glossopterid flora in the shales between coal seams and lenses. The occurrence of these fossils is unpredictable and very patchy. A monitoring programme is recommended. Based on the palaeontological and geological information recorded, it is the opinion of the specialist that mining activities may proceed, as far as the paleontology is concerned.

Palaeontological Impact Assessment for the proposed Elders Colliery near Bethal, Mpumalanga Province.

1. Background

Elders Colliery is a proposed underground mine for Anglo Operations (Pty) Limited. The project is located approximately 25 km north of Bethal and 17km east of Kriel. Coal will be mined by means of the bord and pillar mining method. Coal will be transported via an existing portion and new overland conveyor system to the existing Goedehoop Colliery where the coal will be processed.

The colliery will be located on the farms Middelkraal 50 IS and Vlakkuielen 76 IS, in Govan Mbeki Local Municipality of Mpumalanga Province. The proposed construction will include a conveyor belt to the Goedehoop processing plant, and the mine shaft access roads and laydown areas. SRK Consulting was appointed by Anglo Operations to conduct the application for environmental authorisation in terms of the National Environmental Management Act (Act 107 of 1998). Initially the Elders Colliery was to include both open cast mining method and underground mining methods, however, this has changed to underground mining only, due to overland environmental sensitive areas which were going to be affected by opencast mining.

The National Heritage Resources Act (Act 25 of 1999) and the National Environmental Management Act (Act 107 of 1998) requires that the proposed development must be preceded by the relevant impact assessment, in this case for palaeontology. SAHRA has requested a desktop palaeontological assessment **Case ID: 9647**

This report complies with the requirements of the NEMA and environmental impact assessment (EIA) regulations (GNR 982 of 2014). The table below provides a summary of the requirements, with cross references to the report sections where these requirements have been addressed.

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (2014)

A specialist report prepared in terms of the Environmental Impact Regulations of 2014 must contain:	Relevant section in report
Details of the specialist who prepared the report	Prof Marion Bamford
The expertise of that person to compile a specialist report including a curriculum vitae	Palaeontologist (PhD Wits 1990) CV attached
A declaration that the person is independent in a form as may be specified by the competent authority	Page 2
An indication of the scope of, and the purpose for which, the report was prepared	Section 1
The date and season of the site investigation and the relevance of the season to the outcome of the assessment	n/a Seasons make no difference to buried coals
A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2

The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	See table 2
An identification of any areas to be avoided, including buffers	n/a
A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	n/a
A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 6
A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	n/a
Any mitigation measures for inclusion in the EMPr	Section 8
Any conditions for inclusion in the environmental authorisation	Section 8
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 8
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised and	Section 7
If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Section 7
A description of any consultation process that was undertaken during the course of carrying out the study	n/a
A summary and copies if any comments that were received during any consultation process	n/a
Any other information requested by the competent authority.	n/a

2. Methods and Terms of Reference

1. In order to determine the likelihood of fossils occurring in the affected area geological maps, literature, palaeontological databases and published and unpublished records must be consulted.
2. If fossils are likely to occur then a site visit must be made by a qualified palaeontologist to locate and assess the fossils and their importance.
3. Unique or rare fossils should either be collected (with the relevant South African Heritage Resources Agency (SAHRA) permit) and removed to a suitable storage and curation facility, for example a Museum or University palaeontology department or protected on site.
4. Common fossils can be sacrificed if they are of minimal or no scientific importance but a representative collection could be made if deemed necessary.

The published geological and palaeontological literature, unpublished records of fossil sites, catalogues and reports housed in the Evolutionary Studies Institute, University of the Witwatersrand, and SAHRA databases were consulted to determine if there are any records of fossils from the sites and the likelihood of any fossils occurring there.

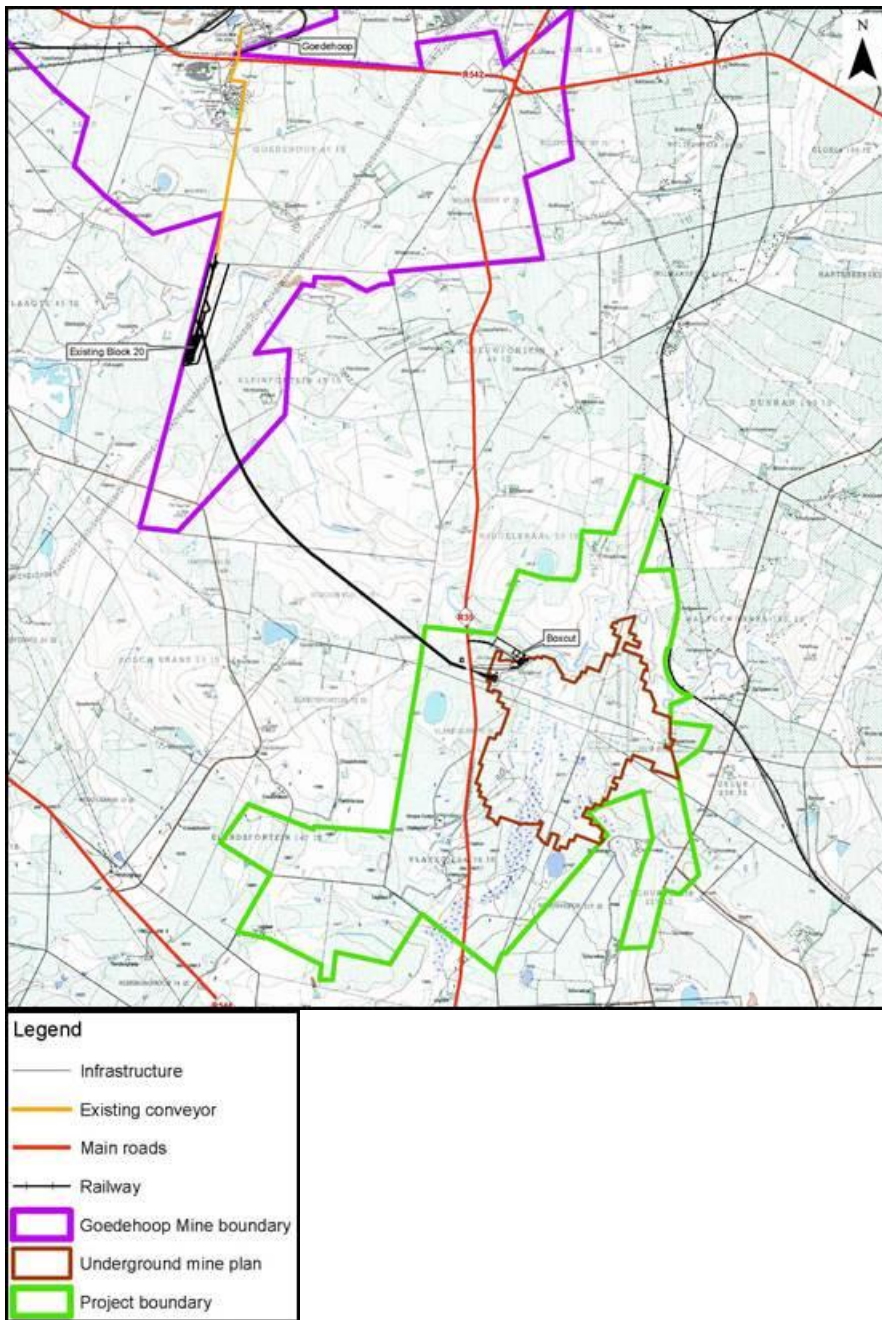


Figure 1: Locality of proposed Elders Colliery, Mpumalanga Province. Map provided by SRK.

3. Consultation Process

No consultations were carried out during the desktop study. Apart from reviewing interested and/or affected party (IAP) comments received by the EIA consultant during the EIA process, no other consultation took place as part of the paleontological study.

4. Geology and Palaeontology

Project location and geological setting

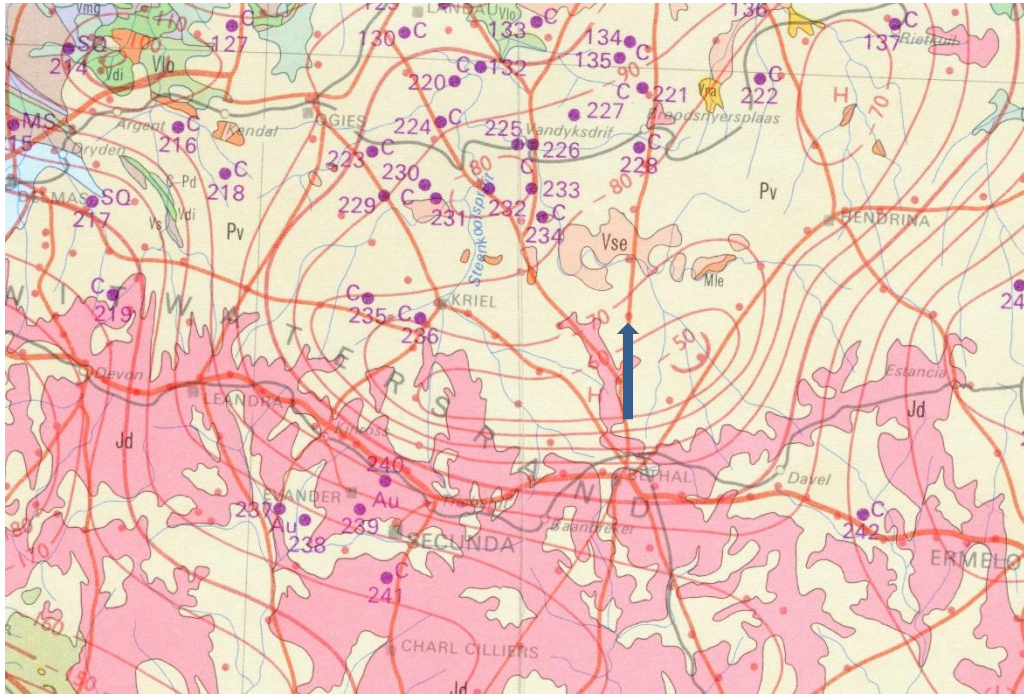


Figure 2: Geological map of the area around the proposed Elders Colliery on the farms Middelkraal 50 IS and Vlakkuiilen 76 IS, in Govan Mbeki Local Municipality of Mpumalanga Province. The approximate location of the proposed project is indicated with the arrow. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 1 000 000 map 1984.

Table 2: Explanation of symbols for the geological map and approximate ages (Cairncross, 2001; Johnson et al., 2006; Snyman, 1998).

Symbol	Group/Formation	Lithology	Approximate Age
Jd	Jurassic dolerite dykes	dolerite	Ca 180 Ma
Pv	Vryheid Formation	Shales, sandstone, coal	Lower Permian, Middle Ecca

Geology

The proposed Elders Colliery is in the Vryheid Formation of the Ecca Group, Early Permian which comprises sandstone, siltstone, shale, mudstone and coals from fluvio-deltaic depositional settings (Snyman, 1998; Cairncross, 2001). In the Kriel-Bethal area (Highveld coalfield) there are six coal seams separated by shales and sandstones and the uppermost seam, No 6, is more than 30m below the surface (Snyman, 1998). It is overlain by shales and

sandstones. To the south are numerous dolerite dykes of Jurassic age and these will have destroyed any fossils in their near vicinity.

Palaeontology

The Vryheid Formation has patchy occurrences of the Glossopterid flora, including many species/types of *Glossopteris* leaves, *Noeggerathiopsis* leaves, lycopods, sphenophytes, ferns and plants of unknown affinity (see figure and table in Appendix at end). In the coal seams all plant matter has been compressed and altered so is unrecognizable. In the shales between the coal and coal lenses it is possible to find good impressions of members of the *Glossopteris* flora, however these occurrences are patchy and unpredictable (Plumstead, 1969; pers. obs.). Coal deposits are widespread in the northwest and northeast of the Karoo basin and so the fossil plants are very common.

No vertebrate fossils are known to occur with coals deposits and no reports from this area have been published to indicate that the flora is unusual.

5. Impact assessment

TABLE 3: CRITERIA FOR ASSESSING IMPACTS

PART A: DEFINITION AND CRITERIA		
Criteria for ranking of the SEVERITY/NATURE of environmental impacts	H	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	L	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	L	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national
PROBABILITY (of exposure to impacts)	H	Definite/ Continuous
	M	Possible/ frequent
	L	Unlikely/ seldom

The surface activities would not impact on the fossil heritage as any fossils would have been destroyed when the area was first developed for agriculture. The IMPACT is nil (according to the scheme in Table 3).

Once excavation for the colliery infrastructure, access roads, conveyor lines and mine shafts has started there would be minor deterioration of the site and no impact on people. Therefore the SEVERITY/NATURE of the environmental impact would be L.

DURATION of the impact would be permanent: L.

Only the possible fossils within the colliery would be impacted upon. When underground mining begins and the non-fossiliferous shales are removed to gain access to the coal seams only those will be affected, therefore the SPATIAL SCALE will be localised within the site boundary: L.

There is a chance of finding fossils in the shales associated with coal seams, but their occurrence is unpredictable and patchy and their significance is minor because fossils of the coal flora are common types. However, the PROBABILITY of affecting any fossils is unlikely or seldom: L

6. Assumptions and uncertainties

Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the shales are typical of other deposits in the Karoo Basin, so no fossil animals will occur there. Coal is made from fossil plants but compressed and altered to such an extent that the original plant material is unrecognizable. Fossil plants may be associated with the adjacent shales and shale lenses but are assumed to be the same as other coal deposits and therefore very common. Until the coal seams and shales are exposed and examined this remains an uncertainty, but a minor one. The same applies for any shales or clay deposits.

7. Recommendation

While it is possible that plant fossils occur in the proposed mining and infrastructure area they will not be detected until excavations and mining operations begin. A site visit is therefore not feasible until such stage.

If fossil plant material is discovered during the development or mining operations, then it is strongly recommended that a professional palaeontologist, preferably a palaeobotanist, be called to assess the importance and to rescue them if necessary (with the relevant SAHRA permit).

If the fossil material is deemed to be of scientific interest then further visits by a professional palaeontologist would be required to collect more material. Given the shortage of such qualified people in South Africa and the stringent safety laws for access by the mining companies, any long term monitoring of the fossils is impractical. Nonetheless a monitoring programme is outlined below.

As far as the palaeontology is concerned, the proposed development can proceed. Any further palaeontological assessment would only be required after mining has commenced and if fossils are found by the geologist or environmental personnel.

8. Monitoring Programme for Palaeontology – to commence once the mine is operational.

1. The following procedure is only required if and when underground mining commences. The surface activities would not impact on the fossil heritage as the coal and any associated fossil plants are below ground.

2. When mining operations commence the shales and mudstones (of no economic value) that will be cut through in order to reach the coal seam must be given a cursory inspection by the mine geologist or designated person before being added to the waste rock dump used by the mine. Any fossiliferous material should be put aside in a suitably protected place. This way the mining activities will not be interrupted.

3. Photographs of similar fossil plants must be provided to the mine to assist in recognizing the fossil plants in the shales and mudstones (for example see Figure 1.3). This information will be built into the mine's training and awareness plan and procedures.

4. On a regular basis, to be agreed upon by the mine management and the qualified palaeontologist/palaeobotanist sub-contracted for this project, the person should visit the mine to inspect the selected material and check the dumps where feasible. The frequency of inspections should be monthly. However, if the geologist/deputy is diligent and extracts the fossil material then inspections can be less frequent.

5. Fossil plants that are considered to be of good quality or scientific interest by the palaeobotanist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the mine property a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.

6. If any underground inspection is deemed necessary then the normal safety procedures that the mine management endorses, must be followed by the palaeontologist and associated mine employees.

7. If no good fossil material is recovered then the site inspections by the palaeontologist can be reduced to annual events until mining operations cease. Annual reports by the palaeontologist must be sent to SAHRA.

9. 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.

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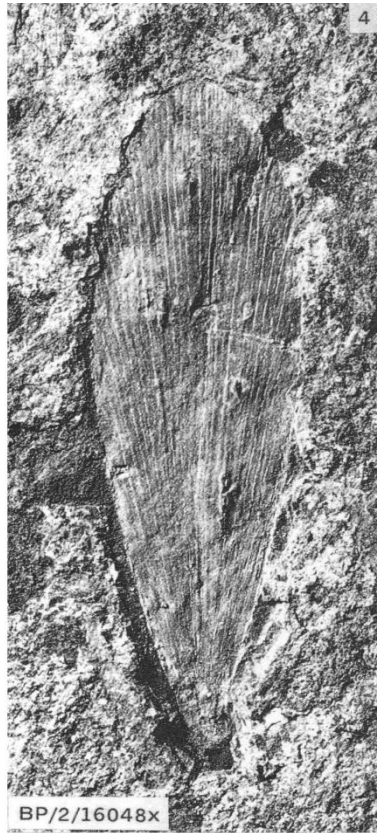
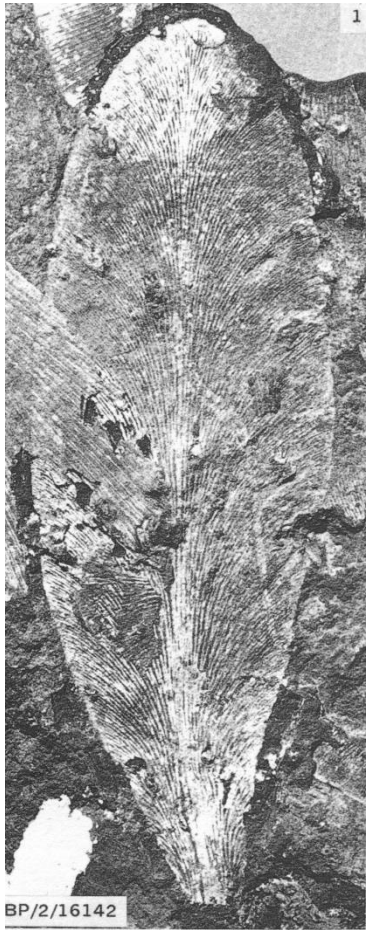
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Taylor, T.N., Taylor, E.L., Krings, M., 2009. *Palaeobotany. The biology and evolution of fossil plants*. Academic Press, Burlington MA, USA. 1230pp

Appendix – Figure of some fossil plants and list of plants.



Noeggerathiopsis and
Glossopteris leaves

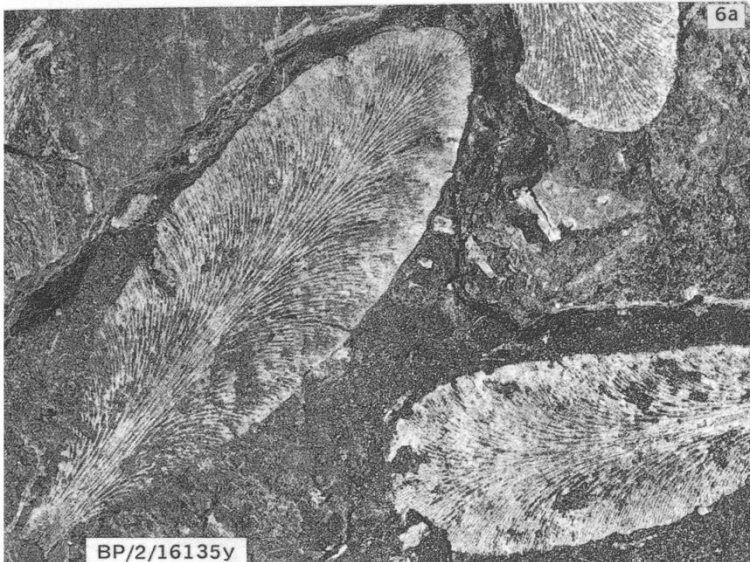


Figure showing leaf impressions of some examples of the glossopterid flora.

Table: 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.

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

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