Palaeontological Impact Assessment for the proposed construction of water pipelines and infrastructure as part of the emergency water supply scheme for Mashishing, Thaba Chweu Local Municipality, Limpopo Province.

Desktop Study

For

AFRIKA Enviro & Biology

01 April 2017

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Expertise of Specialist

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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, AFRIKA Enviro & Biology, White River, South Africa. The views expressed in this report are entirely those of the author and AFRIKA Enviro & Biology and no other interest was displayed during the decision making process for the project.

Specialist: …….. Prof Marion Bamford……..

Signature: …….

Executive Summary

The desktop Palaeontological Impact Assessment for the area in and around Lydenburg (Mashishing, Thaba Chweu Local Municipality) where they propose to construct emergency water piping from boreholes for the residents is presented here. The underlying rocks are of the Palaeoproterozoic Pretoria Group and are predominantly sandstones and shales of the Silverton Formation with some quartzites, siltstones, conglomerates shales and andesites of the Daspoort, Strubenkop and Dwaalheuvel Formations. There is a very small chance that trace fossils (ripple marks and microbial mats) could be discovered when excavations or drilling commences so a Chance Find protocol and monitoring programme has been added to the report. It is concluded that the project may continue as far as the paleontology is concerned.

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1. Background

The applicant, Thaba Chweu Local Municipality (TCLM) intends to fit existing boreholes and construct water pipelines in order to make provision for water shortages faced by the Local Municipality. The Environmental Assessment Practitioner (EAP), Afrika Enviro & Biology (environmental and biodiversity consultants) was appointed to identify listed activities that are subject to- and to obtain authorization in terms of Chapter 5 of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations as published in 2014. An application will be submitted with the Mpumalanga Department of Agriculture Rural, Development, Land & Environmental Affairs (DARDLEA) for the authorization of the regulated activities.

The total project entails the fitting of 22 existing boreholes with pumps where necessary and to construct water pipelines with diameters ranging from 90mm-250mm that will be constructed within the reserves of main and secondary roads in and around the town. The construction of the pipelines themselves does not require environmental authorization but associated activities do. E.g. seven watercourse crossing sites have to be authorized as well as the upgrading of access roads. Five of these boreholes are located in the Gustav Klingbiel Nature Reserve immediately to the east of town and to the north of the Long Tom Pass.

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.

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, page 3
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 fossils

A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2, page 4
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, page 9
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	n/a
Any conditions for inclusion in the environmental authorisation	n/a
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 8, page 10
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised and	n/a
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	n/a
A description of any consultation process that was undertaken during the course of carrying out the study	Section 3 page5
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.

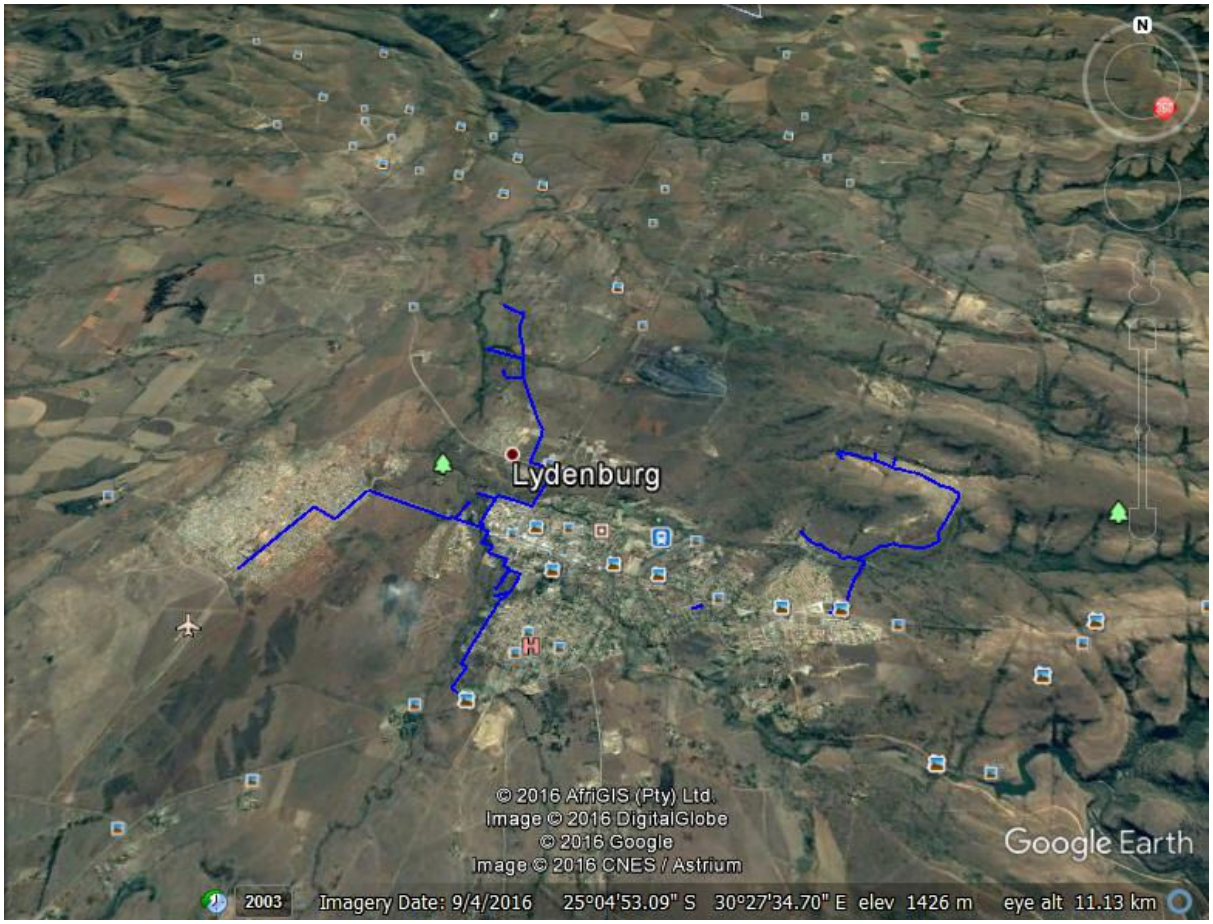

Figure 1: Locality of proposed routes for the pipelines and boreholes for the supply of water to the town of Lydenburg. Google Earth map supplied by Afrika Enviro and Biology.

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

<u>Project location and geological setting</u>

The routes for the proposed piping between established boreholes are given in Figure 1. The piping will follow roads and existing infrastructure but access to some parts may be on new ground so it is important to know what chance there is of uncovering fossils.

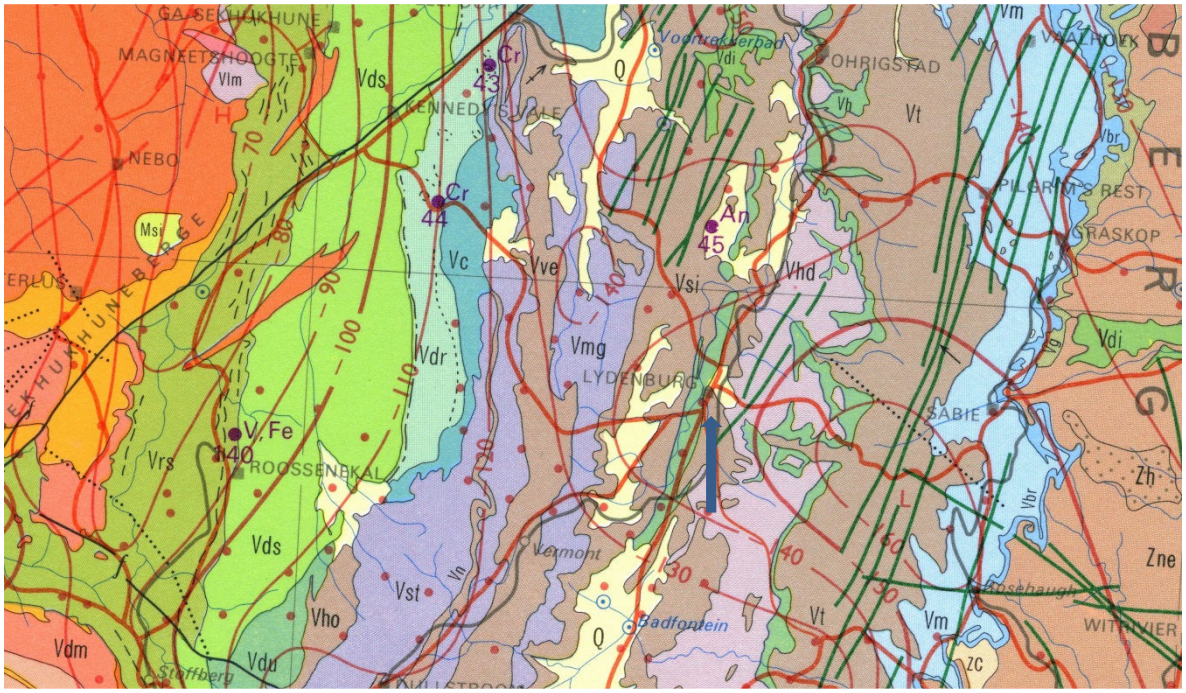

Figure 2: Geological map of the area around Lydenburg (Mashishing, Thaba Chweu Local Municipality). The approximate location of the proposed project is indicated with the arrow. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 1 000 000 map 1984.

Table 2: Explanation of symbols for the geological map and approximate ages (Vervoerd and de Beer, 2006; Anhaeusser, 2006; Brandl et al., 2006; Duncan and Marsh, 2006). SG = Supergroup; Fm = Formation.

Symbol	Group/Formation	Lithology	Approximate Age
Q	Quaternary	Aeolian sands	Last 2.5 Ma
Vrs	Roossenkraal subsuite, upper zone of Rusternburg Layered Suite; Bushveld Complex	Olivine diorite, ironstone, magnetite, gabbro, gabbronorite	>2050 Ma
Vds	Dsjate subsuite, main zone of Rusternburg Layered Suite; Bushveld Complex	Gabbronorite, anorthosite	>2050 Ma
Vdr	Dwars River subsuite, critical zone of Rusternburg Layered Suite; Bushveld Complex	Anorthosite, pyroxenite	>2050 Ma
Vc	Croyden subsuite, Lower zone of Rusternburg Layered Suite; Bushveld Complex	Harzbergite, bronzitite	>2050 Ma
Vdu	Dullstroom Fm, Rooiberg Group	Basalt, andesite	Ca 2000 Ma
Vho	Houtenbek Fm, Pretoria	Mudrock, sandstone,	

Symbol	Group/Formation	Lithology	Approximate Age
	Group, Transvaal SG	limestone	
Vst	Steenkampsberg Fm, Pretoria Group	sandstone	
Vn	Nederhorst Fm, Pretoria Group	Mudrock, Hornfels, quartzite, arkose	
Vve	Vermont Fm, Pretoria Group	Mudrock, hornfels	
Vmg	Magaliesberg Fm, Pretoria Group	quartzite	
Vsi	Silverton Fm, Pretoria Group	Basalt, tuff, shale	Ca 2150 Ma
Vhd	Dwaalheuvel, Strubenkop and Daspoort Fms; Pretoria Group	Andesite, sandstone, shale	
Vh	Hekpoort Fm, Pretoria Group	Basaltic andesite, pyroclastic rocks	2224 Ma
Vti	Timeball Hill and Rooihoogte Fm, Pretoria Group	Shale, quartzite, conglomerate, breccia, diamictite	Ca 2420 Ma
Vm	Malmani subgroup, Chuniespoort Group	Dolomite, chert	2642 – 2500 Ma
Vbr	Black Reef Fm	Quartzite, conglomerate, shale, basalt	>2642 Ma

Geology

Lydenburg lies on the basalts and tuffs of the Silverton Formation which is one of nine formations in the Pretoria Group, of the Transvaal Supergroup, ranging in age from about 2400 to 2100 million years ago. Rocks of the Pretoria Group, many of which are exposed in the wider region of Lydenburg, comprise a variety of sandstones, shales, quartzites, breccia and conglomerates with some contemporaneous volcanic rocks (the Machadorp volcanic member in the Silverton Formation; Hekpoort Formation). The Silverton Formation extends to the west of Lydenburg; to the east are the group (Vdh on map, Fig 2) of the Daspoort, Strubenkop and Dwaalheuvel Formations which comprise mostly sandstone and mudrock.

The mafic rocks of the Bushveld Complex are thought to be a number of episodes of sill- like intrusions into the upper crust, i.e. the Pretoria group sedimentary and volcanic rocks (Cawthorn et al., 2006). The hot magma altered (metamorphosed) the host rocks up to a distance of 50km (Cawthorn et al., 2006) and formed, for example, quartzites from the arenaceous (sandy) sediments.

The oldest rocks in the area are the Black Reef Formation (quartzite, far east of Lydenburg) and the dolomites and cherts of the Malmani subgroup (far east). The youngest rocks in the region are Quaternary sands and calcretes to the west and also to the north of Lydenburg.

Palaeontology
(Refer to Figure 4 for SAHRIS palaeosensitivity)

There are two models proposed for the formation of the Pretoria Group, that of sedimentation in a shallow marine setting or deposition in a closed basin, but there are no invertebrate fossils to support the models. More recent workers have suggested that initially there was a closed basin (Rooihooghte to Strubenkop Formations) followed by alternating transgressive and regressive cycles in a shallow marine setting (Erikssen et al., 2006), or deep marine (Erikssen et al., 2012).

Trace fossils, in the form of microbial mats that have formed on/helped to preserve ripple marks, have been found in the Daspoort and Magaliesberg Formations (underlying and overlying the Silverton Formation, respectively; Erikssen et al., 2012; Parizot et al., 2005) but they do not provide localities. According to the authors the trace fossils would have formed on the shores of the sea (Erikssen et al., 2012), but no body fossils have been found as the rocks are too old. To date no microbial mats have been reported from the Silverton Formation.

The Black Reef Formation and Malmani Subgroup banded ironstone and dolomites, although formed by the chemical activities of ancient algae, photosynthesis and oxygen production, are not known to have preserved fossil algae near Lydenburg.

There are also no records of fossils from the Quaternary alluvium in this region.

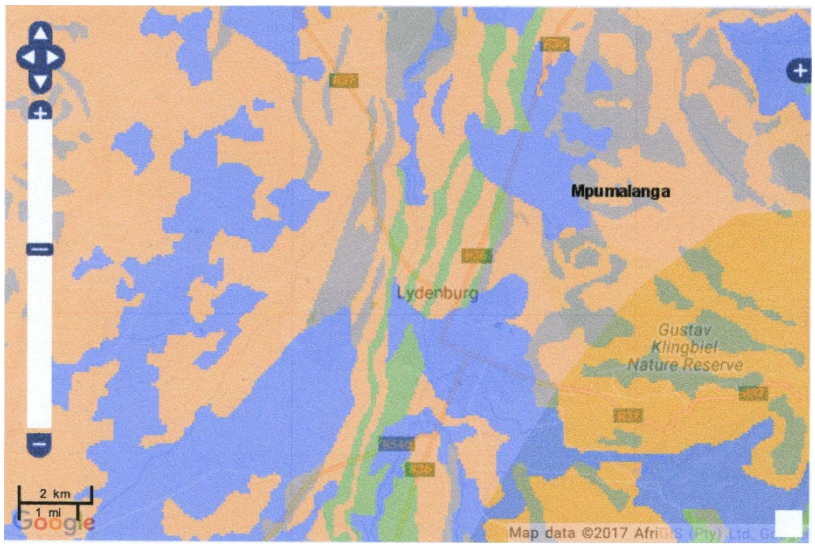

Figure 4: SAHRIS palaeosensitivity map. Colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

5. Impact assessment

Using the criteria in the table below, the impact of the access to piping routes between boreholes has been assessed.

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 the rocks are ancient and volcanic so there are no fossils present. The IMPACT is nil (according to the scheme in Table 3).

Excavation for the roads to borehole sites would penetrate only a few metres below ground surface so there would be minor deterioration of the surface of sites and an impact on any potential fossils. Therefore the SEVERITY/NATURE of the environmental impact would be L.

DURATION of the impact would be permanent: H.

Since only the possible fossils within the area would be trace fossils such as microbial mats and ripple marks where any new roads are built, the SPATIAL SCALE will be localised within the site boundary: L.

There is a very small chance of finding trace fossils on the surface as these have been reported from older and younger Formations, but not the Silverton Formation which is the one on which most of the development will take place. 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 basement rocks, dolomites, sandstones, shales, quartzites, basalts and gabbros are typical for the country and do not contain any fossil material. The sediments of the Silverton Formation could contain trace fossils of algal mats and ripple marks, however, they have yet to be recorded from the proposed site for prospecting.

7. Recommendation

It is unlikely that any fossils occur in the sites for the proposed access to boreholes and water pipes to the west and east of because mostly the rocks are much too old and volcanic in origin. There is a very small chance that there are unexplored exposures of the Daspoort Formations on the sites. As there is a chance find, a monitoring protocol is recommended.

As far as the palaeontology is concerned the proposed development can go ahead. Any further palaeontological assessment would only be required after excavations and drilling have commenced and if fossils are found by the geologist or environmental personnel. The procedure can be added to the EMPr.

8. Monitoring Programme for Palaeontology – to commence once the excavations begin.

1. The following procedure is only required if fossils are seen on the surface and when excavations commence.
2. When excavations begin the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (trace fossils, plants, insects, bone, coal) should be put aside in a suitably protected place. This way the construction activities will not be interrupted.
3. Photographs of similar fossil plants must be provided to the developer to assist in recognizing the fossil plants in the shales and mudstones (for example see Figure 5). This information will be built into the EMP's training and awareness plan and procedures.
4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.
5. On a regular basis, to be agreed upon by the developer and the qualified palaeontologist sub-contracted for this project, the palaeontologist should visit the site to inspect the selected material and check the dumps where feasible. The frequency of inspections should be monthly. However, if the onsite designated person is diligent and extracts the fossil material then inspections can be less frequent.
6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist 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 site a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.

7. If no good fossil material is recovered then the site inspections by the palaeontologist can be reduced to annual events until construction has ceased. Annual reports by the palaeontologist must be sent to SAHRA.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

9. References

Cawthorn, R.G., Eales, H.V., Walraven, F., Uken, R., Watkeys, M.K., 2006. The Bushveld Complex. 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 261-281.

Erikssen, P.G., Altermann, W., Hartzer, F.J., 2006. The Transvaal Supergroup and its pre-cursors. 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 237-260.

Eriksson, P.G., Bartman, R., Catuneanu, O., Mazumder, R., Lenhardt, N., 2012. A case study of microbial mats-related features in coastal epeiric sandstones from the Palaeoproterzoic Pretoria Group, Transvaal Supergroup, Kaapvaal craton, South Africa); the effect of preservation(reflecting sequence stratigraphic models) on the relationship between mat features and inferred palaeoenvironment. Sedimentary Geology 263, 67-75.

Parizot, M., Eriksson, P.G., Aifa, T., Sarkar, S., Banerjee, S., Catuneanu, O., Altermann, W., Bumby, A.J., Bordy, E.M., Louis van Rooy, J., Boshoff, A.J., 2005. Suspected microbial mat-related crack-like sedimentary structures in the Palaeoproterozoic Magaliesberg Formation sandstones, South Africa. Precambrian Research 138, 274–296.

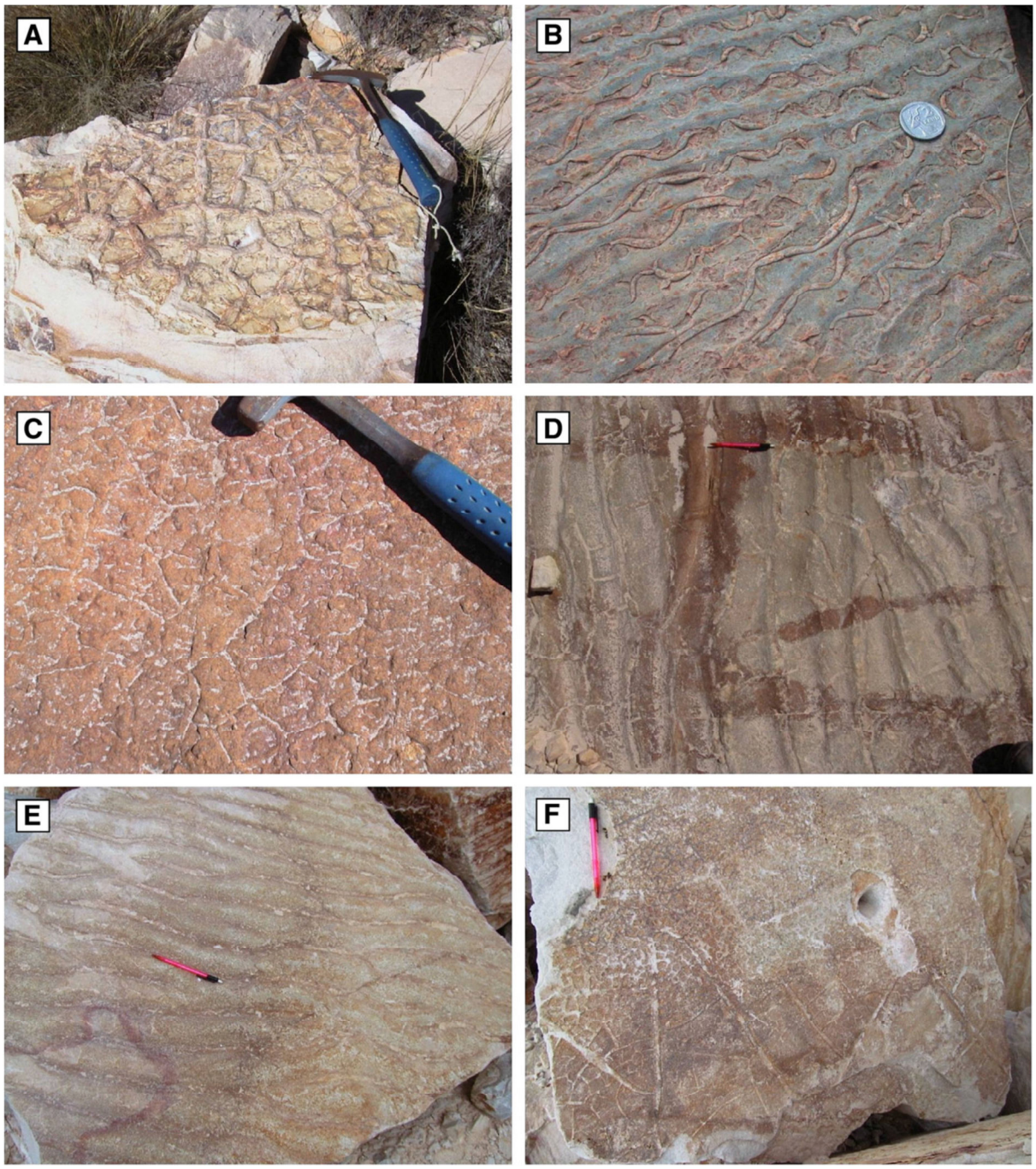

Figure 5: Examples of trace fossils such as ripple marks and microbial mats that could be found in the Daspoort or Magaliesberg Formations, Pretoria Group. (Figure copied from Erikssen et al., 2012, their figure 6).