PURE SOURCE MINE

PALAEONTOLOGICAL SCOPING REPORT

PREPARED ON BEHALF OF:

Monte Cristo Commercial Park (Pty) Ltd

DMR REFERENCE NUMBER:

FS 30/5/1/2/2/10048 MR

8 OCTOBER 2018

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PALAEONTOLOGICAL SCOPING REPORT

Compiled by: Prof. Terence McCarthy
Principal Geologist, Shango Solutions
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EXECUTIVE SUMMARY

According to the South African Heritage Resources Agency (SAHRA) website and the South African Heritage Information System (SAHRIS) Fossil Sensitivity Map, the application area is depicted having very high (red), high (orange/yellow) and moderate (green) fossil sensitivity and therefore, warrants careful scrutiny.

Conclusion

The rocks underlying the application area were deposited between 3 000 million and 2 400 million years ago, well before the appearance of animals and plants. As a consequence, no fossils as such can be expected to occur on the property. The dominant life form that prevailed at that time was various species of bacteria, and in fact bacterial growth was largely responsible for the precipitation of the dolomite of the Transvaal Supergroup. Under very special conditions these bacteria were sometimes fossilized, but the fossils are so small they can only be seen using and electron microscope. The structures formed by bacterial colonies are often found preserved, much like abandoned coral reefs and are known as stromatolites. These provide information on the conditions which prevailed at the time of deposition and are useful to sedimentologists, but have very limited palaeontological value. The dolomite of the Transvaal Supergroup is very widespread, so it is very unlikely that the dolomite that occurs onsite has any special value.

Recommendations

During the course of the mining of sand and gravel, archaeological material may be uncovered in which case an Archaeologist should be engaged to assess the importance of the material and its context for possible conservation.

DECLARATION OF INDEPENDENCE

I, Terence S McCarthy, emeritus Professor in Earth Sciences at the University of the Witwatersrand, Johannesburg, qualified at the Universities of the Witwatersrand and Cape Town, where I obtained my BSc, BScHons, MSc and PhD degrees. I served for a period of 41 years as Lecturer, Senior Lecturer, and Professor at the University of the Witwatersrand, including 17 years as Head of the Geology Department (later the School of Earth Sciences). I served on numerous university and national committees related to the earth sciences. I am a Fellow of the Geological Society of South Africa and the Royal Society of South Africa, and am a recipient of the Jubilee and Draper Medals of the Geological of South Africa. I have very wide research interests and have published peer-reviewed, research articles dealing with many different aspects of the earth sciences. These include the study of ancient rocks, in particular extraterrestrial materials (lunar rocks and asteroids), igneous rocks of the Bushveld Complex, metamorphic rocks of the Namaqualand area, the origin and development of the Witwatersrand Basin and its overlying palaeo-Proterozoic rocks, including the relationship between the Witwatersrand Supergroup and the Vredefort Dome. I have also been involved in research into the geomorphological history of the southern African interior, notably the evolution of the Vaal and Orange Rivers, the origin of their alluvial deposits, and the geomorphological processes underpinning the ecology of the Okavango Delta and other river systems in southern Africa. Because of my broad interests in earth sciences, as well as my interests in geological education, I have developed a broad perspective of the geological evolution of southern Africa, and together with several colleagues, wrote a very successful book synthesising Southern Africa's geological history, which as published by Struik Nature under the title: "The Story of Earth and Life".

I am not a palaeontologist, but was invited to undertake the palaeontological assessment of the Goosebay area because of my very wide interests and knowledge, which was well suited to the project because of the considerable range in age and types of rocks and sediments present in the project area.

I declare that I have no commercial or other interests in the project area and am not in any way connected with the developers.

TERMS AND DEFINITIONS

Archeological Resources

These include:

- Material remains resulting from human activities which are in a state of disuse and are in or on land and which are older than 100 years including artefacts, human and hominid remains and artificial features and structures.
- Rock art, being any form of painting, engraving or other graphic representation on a fixed rock surface or loose rock or stone, which was executed by human agency and which is older than 100 years, including any area within 10m of such representation.
- Wrecks, being any vessel or aircraft, or any part thereof which was wrecked in South Africa, whether on land, in the internal waters, the territorial waters or in the maritime culture zone of the republic as defined in the Maritimes Zones Act, and any cargo, debris or artefacts found or associated therewith, which is older than 60 years or which SAHRA considers to be worthy of conservation.
- Features, structures and artefacts associated with military history which are older than 75 years and the site on which they are found.

Palaeontological

This means any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial.

Cultural Significance

This means aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance.

Development

This means any physical intervention, excavation, or action, other than those caused by natural forces, which may in the opinion of the heritage authority in any way result in the change to the nature, appearance or physical nature of a place or influence its stability and future well-being, including:

- Construction, alteration, demolition, removal or change in use of a place or a structure at a place.
- Carrying out any works on or over or under a place.
- Subdivision or consolidation of land comprising a place, including the structures or airspace of a place.
- Constructing or putting up for display signs or boards; any change to the natural or existing condition or topography of land.
- And any removal or destruction of trees, or removal of vegetation or topsoil.

Heritage Resources

This means any place or object of cultural significance.

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1 INTRODUCTION

Monte Cristo Commercial Park (Pty) Ltd (MCCP, wholly owned by the VLDC Group-to be empowered according to the BEE requirements) submitted an application for a Mining Right and Environmental Authorisation to the Department of Mineral Resources (DMR), Free State Regional Manager. MCCP, the Applicant, proposes to establish an opencast mine which will involve the development of open pits and associated mine infrastructure. The project will be known as Pure Source Mine. Commodities to be mined include sand, aggregate/gravel and diamond (alluvial).

The application area borders the Vaal River and covers an actual aerial extent of 858.5825 hectares (ha). However, the overall surface area to be disturbed is only approximately 363.5 ha. The application area extends over three farm portions, namely the (i) Remaining extent (Re), (ii) Remainder of Portion 1 and (iii) Portion 3 of the farm Woodlands 407, and is situated in the Free State Province of South Africa (Figure 1).

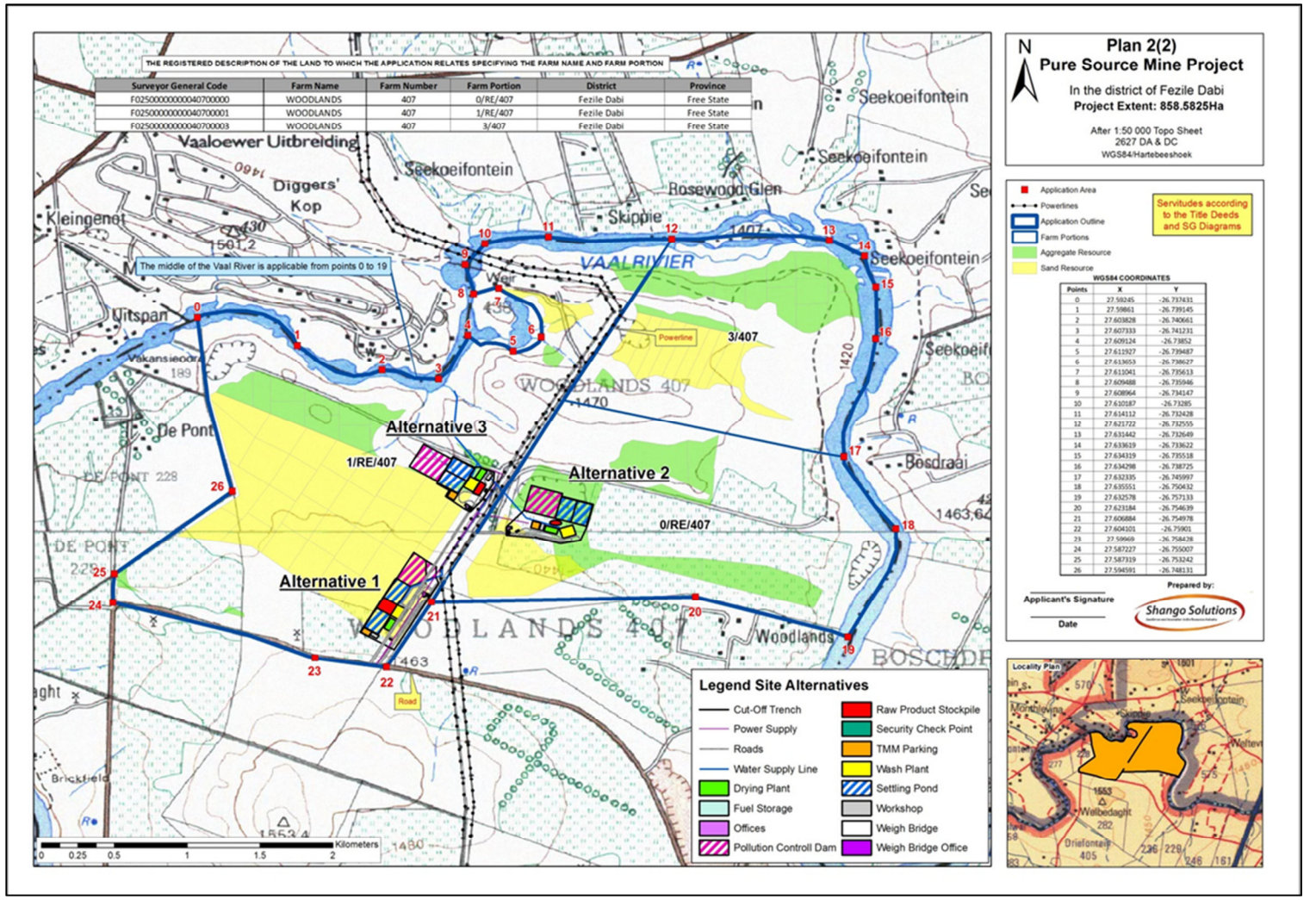

Figure 1: Locality map.

Mining under the Mining Right will be undertaken by a “truck and shovel” method utilising suitably sized diesel driven equipment, and a 363.5 ha area will be demarcated for opencast mining and associated infrastructure. The planned open pit mine will comprise three distinct open pit areas for the silica sand (main pit, north pit and east pit) and four open pit areas for the aggregate (northern pit, central pit, south eastern pit and south western pit), each pit to a maximum depth of 12 m.

This palaeontological report was written in support of the application for a Mining Right and Integrated Environmental Authorisation.

2 METHODOLOGY AND TERMS OF REFERENCE

The Terms of Reference (ToR) for this study were to undertake a PIA and provide feasible management measures to comply with the requirements of SAHRA. The methods employed to address the ToR included:

1. Consultation of geological maps, literature, palaeontological databases, published and unpublished records to determine the likelihood of fossils occurring in the affected areas. Sources included records housed at the Evolutionary Studies Institute at the University of the Witwatersrand and SAHRA databases.
2. Where necessary, site visits by a qualified palaeontologist to locate any fossils and assess their importance (not applicable to this assessment).
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (not applicable to this assessment).
4. Determination of fossils’ representivity or scientific importance to decide if the fossils can be destroyed or a representative sample collected.

2.1 Background

The project area is situated in the collar rocks of the Vredefort Dome northeast of the Vredefort Dome World Heritage Site. In the latter part of the 19th Century, the Vredefort Dome was recognized as being geologically unusual by G. W. Stow (1879) of the Geological Survey of the Orange Free State, and has been the focus of geological study since that time. This interest was further stimulated after the discovery of gold on the Witwatersrand in 1886, because rocks identical in appearance to the Witwatersrand gold-bearing strata occur at Vredefort. The Vredefort rocks were indeed found to be gold-bearing as well, and the Venterskroon Goldfield was established near Vredefort.

The discovery of gold prompted the Department of Mines of the Union of South Africa to undertake geological mapping in the area, which was carried out by L. T. Nel between 1923 and 1925 at a scale of 1:60 000 (published in 1927). The early workers, notably Drs. Hall and Molengraff, realized that the Vredefort structure had formed as a result of up-doming of basement granite (work published in 1925), which uplifted and overturned the formerly horizontally bedded overlying strata, ultimately punching through them to form a rink-like feature about 150 km in diameter, known as the Vredefort collar. This enigmatic structure has generated intense scientific interest amongst scientists around the world. As a result of the almost unique geology, excellent exposure of the rocks, the very scenic surrounds, and its great scientific value, a portion of the collar of the Vredefort Dome has been declared a World Heritage Site.

The Dome was remapped by A. A. Bisschoff in the 1990's at a scale of 1:50 000 to bring the stratigraphic nomenclature and correlations into line with the modern stratigraphic nomenclature of the Republic of South Africa. There is an extremely large body of literature on the Vredefort area, much of which has been listed in the bibliography by Reimold and Coney (2001) and is broadly reviewed in semi-popular form by Reimold and Gibson (2009).

The cause of up-doming at Vredefort was long debated, some scientists considering it to be a consequence of folding, others to be a result of a volcanic explosion (crypto-explosion) and yet others suggesting it was formed by the impact of a large asteroid. Evidence assembled in the last two to three decades has confirmed that the up-doming was caused by an asteroid impact as illustrated in Figure 2.

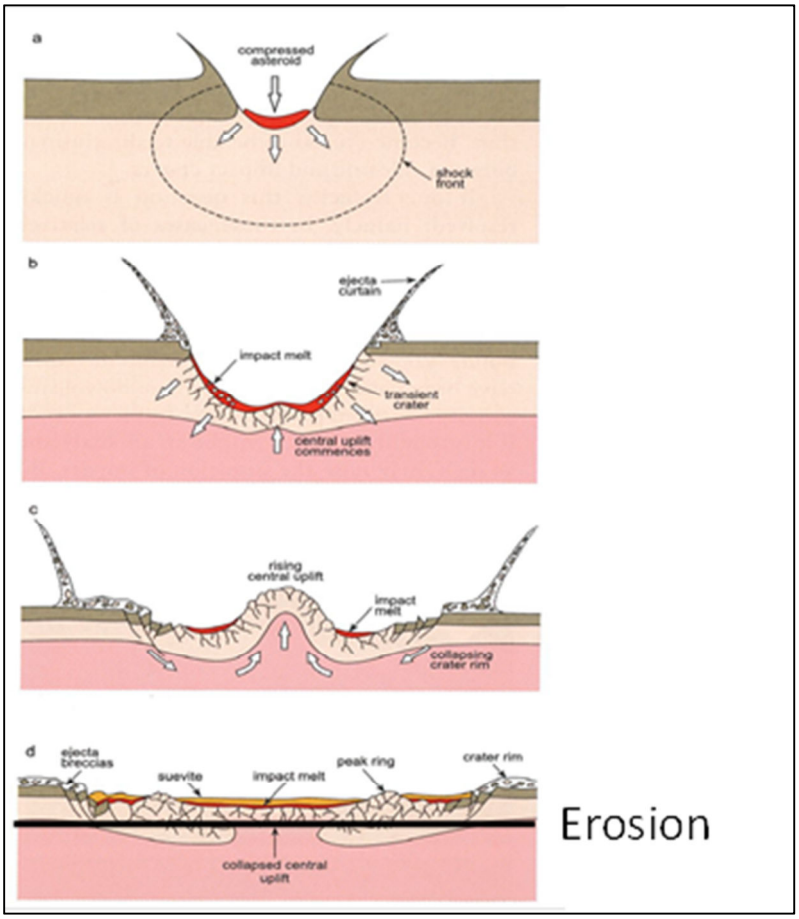

Figure 2: Diagrams illustrating stages in the development of the Vredefort impact. Erosion has removed the actual impact crater and only the depressed outer ring and central uplift are preserved (Reimold and Gibson, 2009).

The basement granite at Vredefort formed prior to 3 000 million years ago. The strata overlying the basement consist of volcanic and sedimentary rocks (quartzite, shale and dolomite) and were deposited between 3 000 and 2 400 million years ago. They are named (from the base upwards: the Witwatersrand, Ventersdorp and Transvaal Supergroups). The impact took place about 2 020 million year ago.

After the impact, erosion removed all traces of the actual impact crater, leaving only the deeper levels which form a ring-like collar around the central uplift as shown in the plan and section views in Figure 3 and 4. The penultimate phase of erosion occurred 300 million years ago under the influence of glaciers, at a time when southern Africa, then part of the supercontinent Gondwana, passed under the ice cap of the South Pole (Figure 5). Moving ice is a powerful erosive agent, and the ice sheets carved out the rocks of the Vredefort collar in accordance with their hardness – soft rocks formed valleys and harder rocks formed ridges.

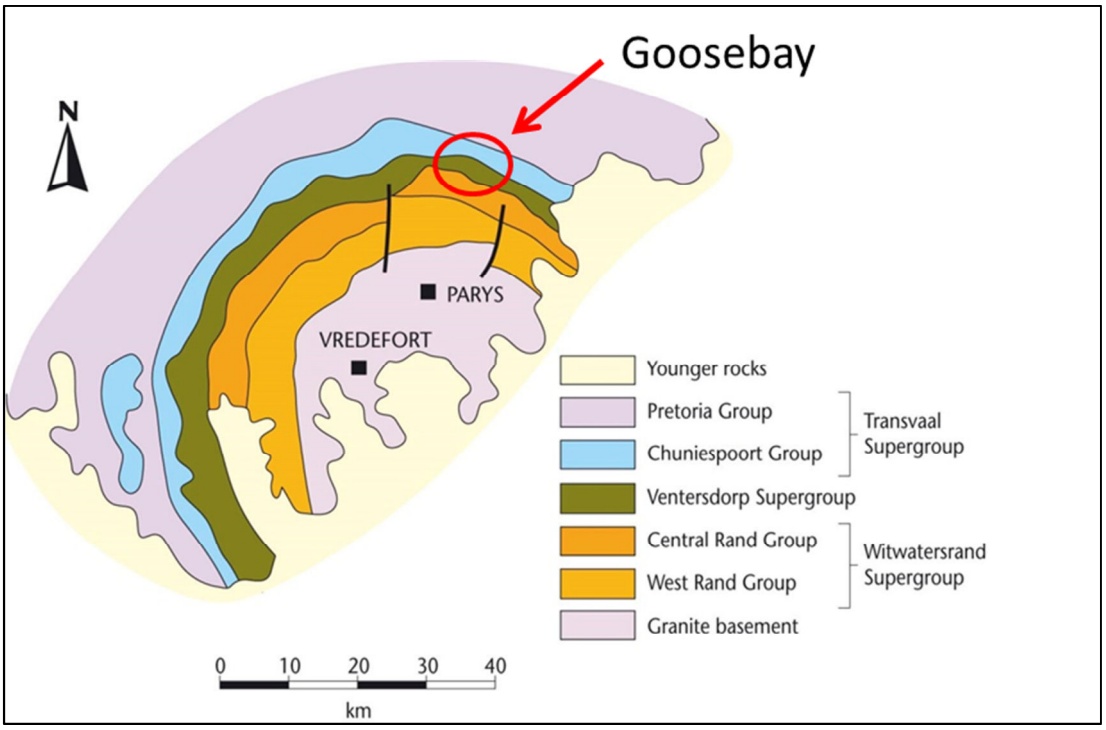

Figure 3: Simplified geological map of the Vredefort Dome (McCarthy and Rubidge, 2005).

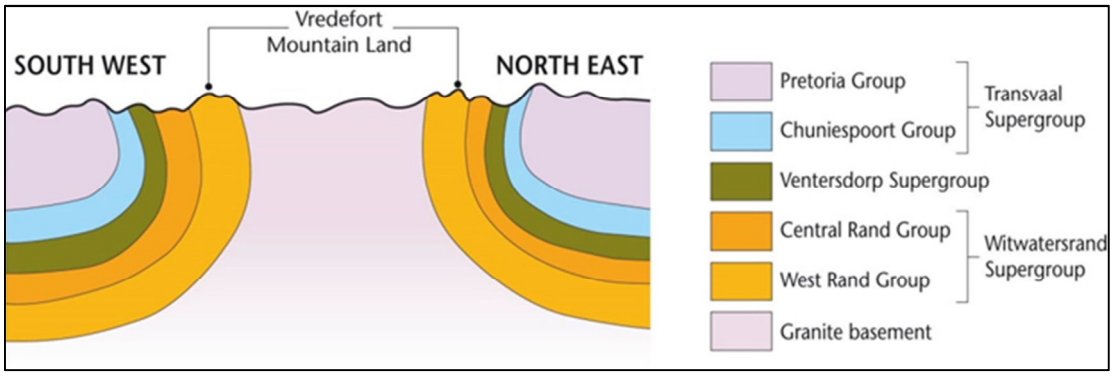

Figure 4: Geological cross section through the Vredefort Dome (McCarthy and Rubidge, 2005).

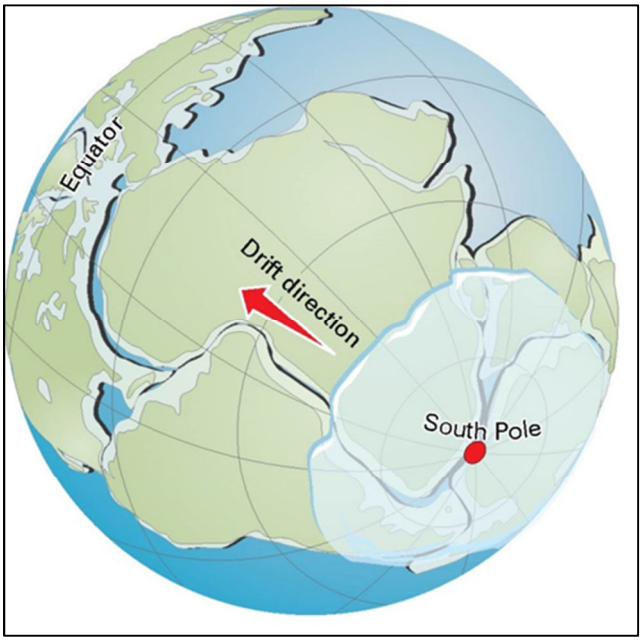

Figure 5: Between 500 and 120 million years ago, Africa formed part of the supercontinent Gondwana. This landmass slowly drifted across the surface of the Earth and the African continent moved over the South Pole between 480 million and 300 million years ago (McCarthy, 2009).

Following its emergence from beneath the ice cap, what is now southern Africa was partly submerged beneath a shallow sea. River systems emerging from the melting ice deposited sandstone and mudstone (shale) in large deltas which gradually buried the glacially eroded Vredefort landscape, initially filling the valleys, followed by the ridges. Peat collected in densely vegetated swamps amongst the deltas, which was ultimately converted into coal by heat and pressure from the overlying sediment. These sedimentary rocks form part of the Karoo Supergroup.

The modern river systems of southern Africa began to form about 150 million years ago as Gondwana began to break up. By about 50 million years ago, the interior of southern Africa had been eroded down to a low-lying plain, much like present day Australia, which has an average elevation of only 330 m above sea level. Uplift of southern Africa occurred between 20 and 5 million years ago, resulting in a central plateau which lies at an elevation largely above 1 000 m above sea level. Only two primary rivers drain the vast interior plateau – the Vaal and Orange rivers, both of which arise near the eastern escarpment and flow across the entire country to the Atlantic Ocean. The Vaal River has been steadily eroding the Karoo Supergroup sedimentary rocks. In the Vredefort area, the Karoo cover rocks have been completely removed from the northwestern section of the dome, but still cover the southeastern section (Figure 3). Essentially only the soft Karoo sedimentary rocks have been eroded away, thus resurrecting the ring-shaped pattern of ridges and valleys formed by the

glaciers that preceded the Karoo sedimentation. The manner in which the Karoo strata were removed occasionally resulted in fairly sudden changes in the course of the Vaal River, leaving Vaal River sediment (gravel overlain by sand) preserved in valley bottoms. In addition, during dry periods in pre-historic times, sand banks would have been exposed in the bed of the Vaal River. Some of this sand would have been blown out into adjacent valleys by the wind.

2.2 Palaeontological implications

The Goosebay project area is situated on the northern portion of the Vredefort collar (Figure 2). A more detailed geological map of the area is shown in Figure 6. The rocks underlying the entire area were deposited between 3 000 million and 2 400 million years ago, well before the appearance of animals and plants. As a consequence, no fossils as such can be expected to occur on the property. The dominant life form that prevailed at the time these rocks were deposited was various species of bacteria, and in fact bacterial growth was largely responsible for the precipitation of the dolomite of the Transvaal Supergroup (Vmd in Figure 6).

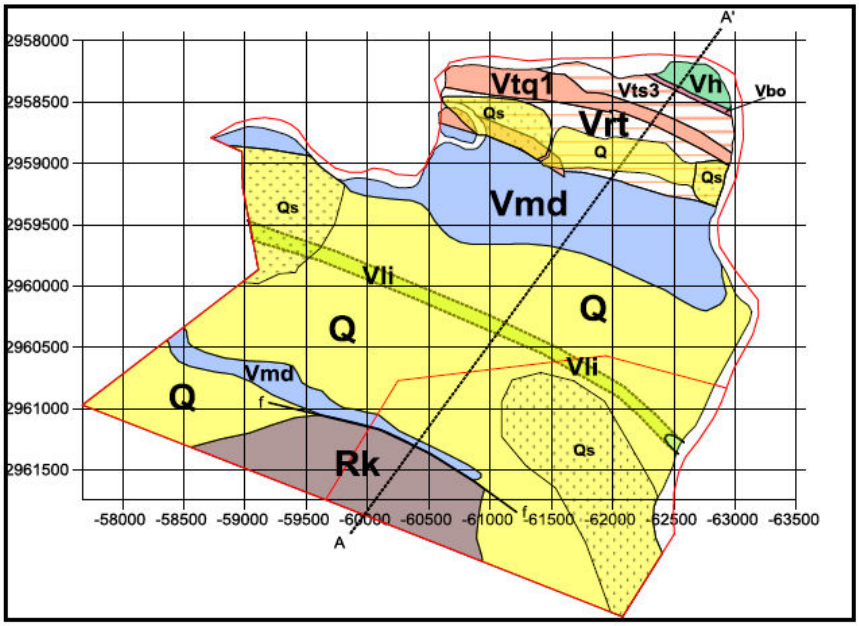

Figure 6: Geological map. Rock formations (from oldest to youngest) are: Rk = Ventersdorp Superpergroup (lava); Vmd = Malmani Subgroup of the Transvaal Supergroup (dolomite); Vrt, Vtq1 and Vts3 = Timeball Hill Formation of the Transvaal Supergroup (shale and quartzite); Vh = Hekpoort Formation of the Transvaal Supergroup (lava), Vli = igneous intrusion, Qs = recent gravel overlying Vmd and Vrt; Q = recent sand deposits overlying Rk, Vmd and Vrt.

Under very special conditions bacterial cells were sometimes fossilized, but the fossils are so small they can only be seen using an electron microscope. The structures formed by bacterial colonies are often found preserved, much like abandoned coral reefs, and are known as stromatolites. The shapes of these colonies vary, and depend on the conditions which prevailed at the time of deposition. They are therefore useful to sedimentologists, but have very limited palaeontological value. The dolomite of the Transvaal Supergroup is very widespread across South Africa, so it is very unlikely that the small outcrops of dolomite that occur at Goosebay have any special value. I am therefor mystified as to why the dolomite on the Goosebay property has been classified having a high palaeontological sensitivity (Figure 7).

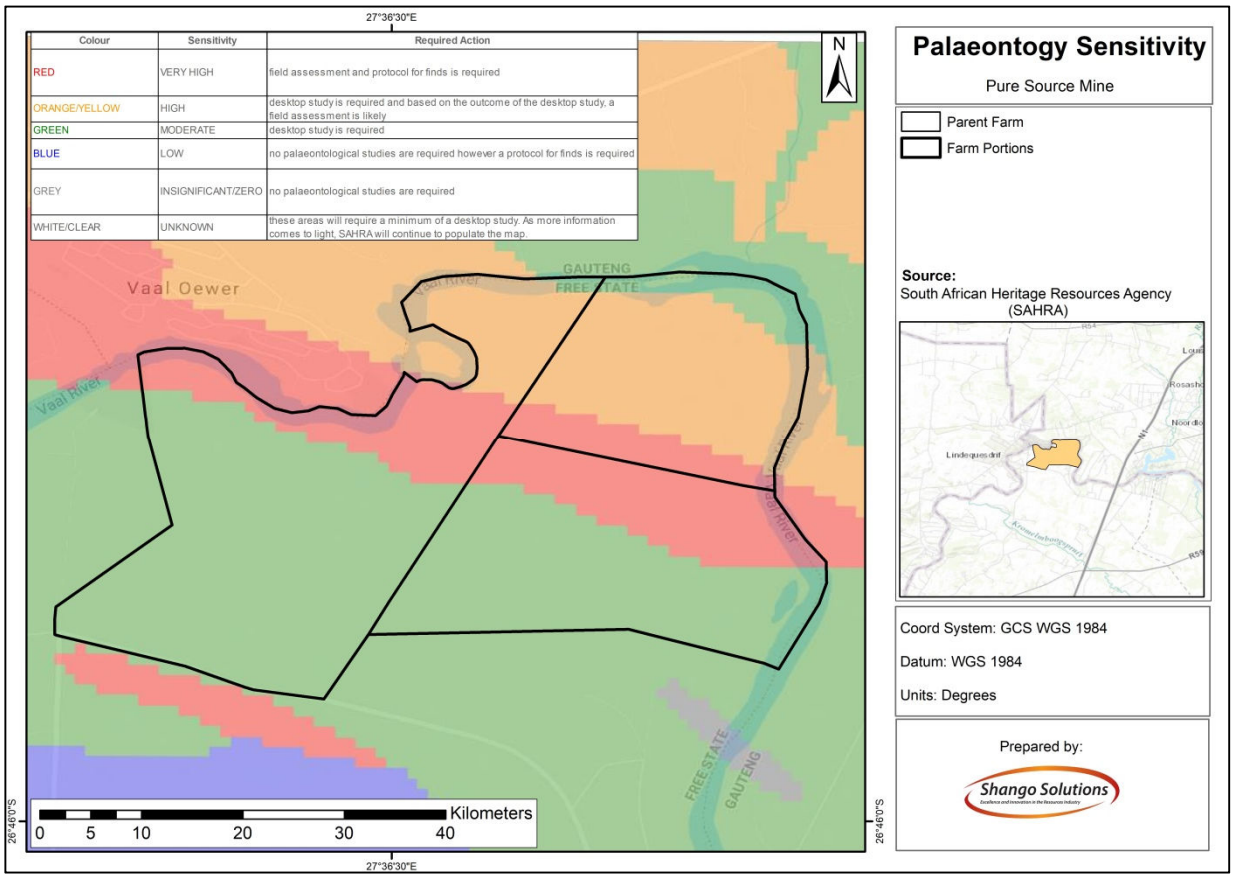

Figure 7: Palaeontology Sensitivity Map of the Goosebay area (SAHRA website).

The age of the river gravel and sand that overlie the ancient rocks described above is unknown, but could date back more than a million years. As such, they could contain artifacts of archaeological interest, which could become exposed during the proposed mining activity, as well as animal remains from the period. In view of this possibility, I consulted with Prof Roger Gibson, a Vredefort expert, Prof Bruce Rubidge, a leading vertebrate palaeontologist (both from the University of the Witwatersrand), and Dr. James Brink (via Bruce Rubidge), an

authority on animal and plant remains that occur in young river gravels (from the National Museum, Bloemfontein). None of these specialists were aware of the discovery of any plant or animal remains in recent gravels in the Vredefort area. However, should such material come to light during the proposed systematic mining of sand and gravel at Goosebay, it is recommended that a qualified archaeologist be called in immediately to document the material and examine its context to assess whether the site should be preserved.

The Vredefort Dome is of especial geological significance because it is the largest known asteroid impact site on Earth. Moreover, the depth of erosion of the core rocks of the structure provides unique access to the deep root zone of such an impact site (see Figure 2). The collar rocks provide evidence of the response of rocks to the declining pressure wave during the impact event. It is likely that the Goosebay property contains rock exposures of this outer, less shocked, zone. However, it is noteworthy that the list of sites of geological interest in the Vredefort area compiled by Reimold and Gibson (2009) does not contain any from the Goosebay area. This suggests that area has few, if any, geosites sites of special interest.

3 ASSUMPTIONS, GAPS, RESTRICTIONS AND LIMITATIONS

I am familiar with the Vredefort area in general and have visited it many times. I have also published several papers on the geological significance of the Vredfort Dome. However, I have never visited the Goosebay property. This report was therefore prepared as a desktop study, drawing on my knowledge of the geological history and more importantly the extensive body of literature which exists on the area, notably that identified by Reimold and Gibson (2009).

Whilst I am certain that there are no fossils in the collar rocks at Vredefort, it is possible that there may be sites of particular geological interest at Goosebay which ought to be preserved. The identification of such sites can only be done by a field investigation, and it is therefore recommended that a field inspection be carried out. It is also possible that sites of geological interest may be exposed during mining activities, so on-going monitoring should be undertaken during mining.

4 CONCLUSIONS AND RECOMMENDED STUDIES

This desktop study has revealed that the palaeontological sensitivity of the Goosebay property is very low. The rock formations that underlie the area are older than 2 400 million

years and formed long before the evolution of plants and animals. Dolomite rocks in the area were deposited by bacterial colonies, and reef-like features constructed by these colonies may be preserved in the rocks. While interesting to sedimentologists, such features have little palaeontological significance. The Vredefort structure is of especial geological interest, and there may be rock exposures on the property that are worthy of conservation. It is therefore recommended that a field investigation be carried out prior to mining to determine if any such sites exist.

During mining of the sand and gravel, it is possible that items of archaeological significance may be encountered. It is important that any such objects should be assessed by an archaeologist and their context documented to assess whether the discovery site should be conserved.

5 REFERENCES

Bisschoff, A. A. 1999. *The Geology of the Vredefort Dome. Explanation to Sheets 2627CA, CB, CC, CD, DA, DC, 2727AA, AB, BA. Scale 1:50 000*. Council for Geoscience, Pretoria, 49 pp.

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Nel, L. T. 1927. *The Geology of the Country around Vredefort, An Explanation of the Geological Map*. Geological Survey, Department of Mines and Industries, Union of South Africa, 130 pp.

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Appendix A: CV

CURRICULUM VITAE

TERRENCE SINCLAIR McCARTHY

PERSONAL DATA

Telephone:	(27 11) 717 6558 (27 83) 456 4273
E-mail:	spike@shango.co.za
Date of birth:	11 September 1947
Place of birth:	Johannesburg
Marital Status:	Married, three children

EDUCATION

1953 – 1959:	Observatory East Primary School, Johannesburg
1960 – 1964:	Athlone Boys High School, Johannesburg University entrance matriculation, awarded first class
1965 – 1967:	University of the Witwatersrand, Johannesburg B.Sc. Geology and Chemistry
1968:	Johannesburg College of Education Transvaal Teachers' Higher Diploma, awarded with distinction
1969:	University of Cape Town B.Sc. Hons. Geochemistry, awarded with distinction

1970 – 1971:	University of Cape Town M.Sc. Thesis title: Aspects of the chemistry of stony meteorites. Awarded with distinction
1972 – 1977:	University of the Witwatersrand, Johannesburg Ph.D. Thesis title: Geochemical studies of selected granitic terranes in South Africa

EMPLOYMENT HISTORY

July 2013 – present:	Professor of Geochemistry, University of the Witwatersrand
January 1978 – June 1982:	Senior Lecturer, University of the Witwatersrand
July 1971 – December 1977:	Lecturer, University of the Witwatersrand
January 1971 – June 1971:	Graduate assistant, University of Cape Town

UNIVERSITY ADMINISTRATION

January 1985 – January 2001:	Head, Geology Department
January 1999 - January 2001:	Acting Head, Geophysics Department
January 2001 – December 2001:	Acting Head, School of Geosciences

COMMITTEES (CURRENT)

- Senate
- Science Faculty Research Committee
- Board Member, Witwatersrand University Press

- Board Member, Institute of Human Evolution

COMMITTEES (PAST)

- Makapansgat Research Committee
- Science Faculty Board
- Science Faculty Executive
- Staffing and Promotions Committee, Science Faculty
- Nominations and Screening Committee, Science Faculty
- Executive Committee of the Faculty of Science
- Faculty of Science/Science Student Council Liaison Committee
- Higher Degrees Committee (Chairman on several occasions)
- Committee of Research Directors
- University Management Review Committee
- Science Faculty Research Committee
- Equipment Committee
- Steering Committee for Reflection Seismology
- University Research Committee
- University Research Committee Executive
- University Research Committee - Financial Resources Sub-Committee
- Senate Library Committee
- Senate Committee on Salaries and Conditions of Service
- Senate Library Committee
- Consultative Committee for the School of Earth Science
- Council Committee on Exclusions

- Board of Control of Economic Geology Research Unit
- Board of Control of Bernard Price Institute for Geophysical Research
- Board of Control of Bernard Price Institute for Palaeontological Research
- Board of Control of Schonland Research Centre
- Board of Control of the Climatology Research Unit
- Served on numerous ad hoc and standing committees in respect of:

i) Selection Committees for Chairs

ii) Departmental Review Boards (Civil Engineering, Mechanical Engineering, Metalurgy, Mining Engineering, BPI Palaeontology and Geophysics).

iii) Ad hoc Committee meetings to deal with Higher Degree matters

iv) Staff appointments in the Faculty of Engineering

v) Fellowships Committee

vi) University rationalization

vii) Committees related to Science Faculty research activities too numerous to list

viii) Negotiations related to the University Car Scheme

xi) Organizing Committee of the Wits Millennium Celebration of the Origins of Humankind in Africa (Chairman), 2000; Organizing Committee of The 4 billion year story of earth and life (Chairman), 2001; Organizing Committee for The Story of Life, 2005.

NON-UNIVERSITY ADMINISTRATION

CURRENT

1987 – Present:	South African Committee on Stratigraphy (National Committee)
1991 – Present:	South African Committee on Stratigraphy Witwatersrand Working Group (Chairman)
1989 – Present:	Jim & Gladys Taylor Trust Board of Trustees

PAST

- Chairman of the Northern Branch of the Royal Society of South Africa
- Higher Degree Examiner for Universities of Cape Town, Orange Free State, Rand Afrikaans University, Pretoria University and University of Port Elizabeth

1997: Technical Committee, Council for Geosciences (formerly the Geological Survey)

1995 – 1998: Adjudicator, Technology Top 100 (National competition for technical innovation)

1981 – 1983: Council of the Geological Society of South Africa

1992 – 1994: Member of Earth Sciences Advisory Board at the University of Cape Town

1992 – 1994: External Examiner, Rhodes University

1993 – 1995: Geocongress '95 Consultative Committee

- National Drilling Committee (Sole University representative)

1992 – 1995: FRD Sabbatical Grants Committee

1992 – 1995: Water Research Commission - steering committee for palaeo-flood project

1998 – 2000:	Reed Bed Research project – steering committee
1991 – 1994:	South African National Committee of the IUGS
1995 – 1998:	External Examiner, University of Pretoria
1996 – 1998:	External Examiner, University of Cape Town
1996 – 1998:	Convenor, Evaluation Panel for Earth Scientists for the FRD
2002 – 2004:	Chairman, Organizing Committee for Geoscience Africa Conference

AWARDS

1982:	Jubilee Medal, Geological Society of South Africa for best paper in South African Journal of Geology
1992:	PICS Award (Third Prize) from SPOT Image (France) for paper on the application of SPOT satellite imagery
1995:	Elected Fellow of the Royal Society of South Africa
2007:	Rated B1 category scientist by the NRF
1999:	Draper Medal of Geological Society of South Africa, for distinguished contributions to Earth Science in South Africa Finalist, Category A (an individual over a lifetime), National Science and Technology Award.

TEACHING

Undergraduate

Geology I:	Earth Materials (Science and Engineering students)
Advanced Earth Science III:	Exploration and Environmental Geochemistry
MSc in Environmental Science:	Topic on wetlands

Post-graduate

Current post-graduate students:

- Andreas Friese Ph.D. (co-supervised with E G Charlesworth)
- Navitha Dukkan M.Sc. (co-supervised with J Ward)
- Rebekah Grow M.Sc. (co-supervised with G Botha)
- Mary Evans Ph.D.
- Jaco Venter M.Sc.
- Kate Lishman M.Sc.

Previous post-graduate students:

- H Tutu Ph.D. (co-supervised)
- I Haddon Ph.D.
- A Rompel Ph.D.
- D Brandt Ph.D.
- S Master Ph.D.
- F Walraven Ph.D.
- Dana Roberts Ph.D. (co-supervised)
- Henk Coetzee Ph.D. (co-supervised)
- J Palmer M.Sc. (co-supervised)
- J M Myers M.Sc.
- P Linton M.Sc.
- R Preston M.Sc. (co-supervised)
- T Clarke M.Sc. (co-supervised)
- J Russell M.Sc. (co-supervised; University of Johannesburg)
- V Vermaak M.Sc.

CURRENT RESEARCH ACTIVITIES

- I am founder and leader of the Sedimentology Research Group, which consists of a loosely-knit, multi-disciplinary team of academics which is engaged in sedimentological and ecological research in wetlands in southern Africa. This group has been active for the past 20 years, and its primary objective has been to unravel the functioning of the Okavango ecosystem. To date, members of the group have published more than 70 refereed papers on the Okavango. Research has covered the geology, tectonics, sedimentology, hydrology, geohydrology, hydrochemistry, climatology, geomorphology and plant and animal ecology of the Okavango. The research has involved international collaborators from the USA, Israel, Switzerland, Germany, Sweden, Australia, UK and Botswana, as well as local collaborators from the Universities of Natal and Cape Town, and from several Departments within Wits University. Four Post-doctoral Fellows (from the UK and Sweden) have worked in the group. The group has expanded its activities to include other wetlands, including Zeekoevlei at Memel, Nylsvley and Marievale. We are currently also involved in studying pollution problems on the Witwatersrand and around coal mines, and the role of natural wetlands in passively treating polluted water.

- Witwatersrand Basin Research: together with several colleagues and postgraduates I have been involved in research on the tectonic evolution of the Witwatersrand Basin since the early 1980s, which resulted in the development of a new conceptual model of the Witwatersrand Basin.

- In addition to the above major research endeavours, I am also involved in a variety of other collaborative and student research projects in petrology and sedimentology.

CONSULTING ACTIVITIES

- I am occasionally active in consulting work, some of which is done for commercial gain while some is done for scientific reasons only. This work has included: membership the South African Lunar Sample Investigation Team (1970 - 1971) reporting to NASA; geomorphological survey of the national low level radioactive waste disposal site, reporting to the Atomic Energy Commission of South Africa; three requests to provide independent evaluations of the potential of companies prior to raising capital on the Johannesburg Stock Exchange; environmental impact of dredging of the lower Boro river, Okavango Delta (for Debswana); possible environmental impact of water abstraction from the Okavango river at Rundu (for the CSIR, contractor to the Namibian Government); an environmental impact assessment of a proposed hydro-electric plant on the Kavango River in Namidia (for Nampower); evaluation of the alluvial diamond potential of the Vaalbos National Park, and numerous ad hoc consultancies related to amongst other things, alluvial diamonds and Witwatersrand gold deposits.

REFEREEING

I have refereed articles for Geochimca et Cosmochima Acta, J.Geology, Israel J.Earth Science, S.Afr.J.Geol, Sedimentology, S.Afr.J.Science and S.Afr. Geogr. Journal, Water SA, Geology, and proposals to the National Science Foundation (USA).

PUBLICATIONS

I have authored or co-authored three books, two in the field of popular science, as well as about 180 research articles in scientific journals.