# Geological Inventory Of The Maremani Nature Reserve

Professor Jay Barton
Department of Geology, Rand Afrikaans University (RAU)
P.O. Box 524, Auckland Park 2006, South Africa
Telephone: 27-11-489-2304
FAX: 27-11-489-2309
E-mail: jmb@na.rau.ac.za

**Introduction**

The Maremani Nature Reserve is presently being established and this document is intended as a summary of aspects of the geology within the boundaries of the Reserve. I have taken the liberty also to express my opinions with regard to possible roles that the Reserve might fulfill with regard to promoting geological awareness, education and research.

The geology of the area covered by the Reserve was mapped in 1976 by Gunther Brandl and W. O. Willoughby of the Geological Survey of South Africa (presently the Council For Geoscience) at a scale of 1:50 000 for compilation at a scale of 1:250 000 (Brandl, 1981). The western portion to 30$^{o}$ 15' east was previously mapped at a scale of 1:10 000 for compilation at scales of 1:50 000 and 1:125 000 by P. G. Söhnge (1946; Söhnge et al., 1948). Also locally within the western portion of the Reserve, maps at the scale of 1:5 000 were compiled by Messina Transvaal Development Corporation on farms and prospects investigated by the staff of the Messina Copper Mine. These maps are presently archived with me at RAU.

Peter Horrocks wrote a PhD thesis on the geology of part of the western portion of what is now the Reserve (Horrocks, 1981). Charles Guerin in the late 1970's worked on an unfinished MSc thesis on the calc-silicate rocks exposed in an area south of that studied by Peter Horrocks, some of which occur within the Reserve. His map is archived with me at RAU. Presently, Stephan Bühlmann from the University of Würzburg in Germany is studying melting reactions in the rocks within the Messina Nature Reserve, adjacent to the Maremani Reserve, (Figure 1) for his Diploma Dissertation under the supervision of Professor Reiner Klemd and me.

The Messina area, of which the Reserve is part, contains several world famous geologic occurrences. For example, 1) the **copper mineralization** that was mined is unique, being mostly composed of a breccia filled with quartz and copper sulfide minerals. Blue quartz crystals from the upper levels of the mine is much valued by mineral collectors and fine clear quartz crystals occur in various places along the Dowe-Tokwe fault that crosses the Reserve. 2) The rocks exposed in the valley of the Sand River within the Messina Nature Reserve are some of the most spectacular in the world. These **Sand River Gneisses** are at least 3.2 Ga (billion ($10^9$) years) old and possibly as old as 3.8 Ga, making them among the oldest preserved on Earth. Perhaps more importantly, they have undergone several periods of deformation and metamorphism (tectonic events) between ~3.2 Ga and ~2.0 Ga, making them a fantastic laboratory to study that period of Earth history. 3) One of the oldest layered intrusions of earth, the **Messina Layered Intrusion**, is best preserved on the Farm Bokveld within the Reserve. 4) The **carbonate rocks** exposed in the eastern portion of the Reserve are among the oldest known on Earth. 5) The **sapphirine bearing rocks** in the western portion of the Reserve are very rare on Earth. Therefore, I suggest that one of the prime functions of the Maremani Nature Reserve should be to foster geological awareness, education and research.

**Rock Formations Present In The Reserve**

A stratigraphic column of the rock formations exposed within the Maremani Nature Reserve is presented in Table 1. Figure 1 is a geological sketch map of the Reserve. The oldest of these rocks (>3.0 Ga) belong to the Central Zone of the Limpopo Belt (e.g. Van Biljon and Legg, 1983), an east northeast trending band of highly deformed and metamorphosed rocks with a history extending from at least 3.2 Ga to ~2.0 Ga.

**Table 1: Geological Column for the Maremani Nature Reserve**

| Time span | Unit | Lithology |
|---|---|---|
| Present (<0.002 Ga) | | Undifferentiated sand, gravel and conglomerate |
| Tertiary (0.065 Ga to 0.002 Ga) | | Undifferentiated sand, gravel and conglomerate, some associated with the Kalahari beds in Botswana |
| Jurassic (~0.18 Ga) | Letaba and Clarens Formations, Karoo Supergroup | Interbedded sandstones and mafic lavas |
| Proterozoic (~1.85 to ~1.9 Ga) | Mafic dykes | Gabbro, possibly associated with the lavas of the Soutpansberg Group |
| Archean (~ 3.0 Ga) | Mafic dykes | Deformed and metamorphosed gabbro |
| Archean (>~3.0 Ga) | Singelele Gneiss | Deformed and metamorphosed granite |
| Archean (>=3.1 Ga) | Messina Layered Intrusion | Deformed and metamorphosed anorthosite and leuconorite with layers of chromitite and magnetitite |
| Archean (>3.2 Ga) | Beit Bridge Group | Deformed and metamorphosed sediments and felsic volcanoclastic rocks |

**1. Archean (>2.5 Ga)**

High-grade, metasedimentary rocks classified as the **Beit Bridge Group** underlie most of the Reserve. The precursors to the rocks apparently were marls, limestones, sandstones, dolostones, shales, banded iron formation (BIF) and felsic volcanic rocks. Quartzite (meta-sandstone), often interbedded with para-amphibolite (meta-marl) form distinct ridges but the other lithologies crop out less distinctly. These rocks were deposited sometime before ~3.2 Ga ago on what may have been a passive continental margin to the Kaapvaal Craton although alternatively they may have been deposited on an exotic terrane of uncertain origin. Subsequently, these rocks were metamorphosed and deformed at least twice under granulite facies conditions (T >850$^{o}$C, P >8 kbar, i.e. >25 km depth). These metamorphisms and deformations (tectonic events) were associated with mountain building. The first of these tectonic events occurred before ~3.0 Ga ago and the second at ~2.04 Ga ago. During the last event, extensive melting occurred of all of the lithologies exposed within the Reserve. Intrusive igneous rocks occur on the farm Singelele (the granitic **Singelele Gneiss**) and over wide areas to the east, in particular on the farm Bokveld (the >3.2 Ga, mafic **Messina Layered Intrusion**). ~3.0 Ga deformed mafic dykes also occur throughout the area. These dykes were intruded at high crustal levels during a period of extension between to two high-grade tectonic events outlined above.

## 2. Proterozoic (2.5 Ga to 0.53 Ga)

Evidence from outside the Reserve suggest that the area was once covered by ~1.85 to 1.9 Ga volcanic and sedimentary rocks belonging to the Soutpansberg Group, remnants of which are exposed in the southern Soutpansberg to the south. These rocks were eroded away by some yet undetermined time. Undeformed, ~1.9 Ga mafic dykes occur throughout the area, however, that may have been the feeders for the lavas of the Soutpansberg Group.

## 3. Phanerozoic (0.53 Ga to present)

Rocks of the upper portion (Jurassic) of the Karoo Supergroup (Permian through Jurassic) occur in the southeastern portion of the Reserve on the farms Dawn, Frampton and Skirbeek. These consist of the aeolian sandstones of the Clarens Formation and the overlying, 0.18 Ga Letaba lavas. The sandstones crops out as distinctly rugged, brown weathering ridges but the lavas are poorly exposed and underlie flat low lying ground between the Bosbokpoort Fault and the sandstones. These rocks are preserved in a series of down dropped grabens. However, evidence from outside the Reserve indicates that these rocks and possibly older Karoo rocks once covered the entire area. The lavas and sediments were laid down during the breakup of Gondwana. These were eroded during the Tertiary (<0.065 Ga). No known coal formations are preserved on the Reserve. It is possible that fossils are preserved in the Clarens sandstones.

Tertiary sands, gravels and conglomerates in the form of perched terraces occur throughout the area, particularly along the Sand River. These terraces are remnants of more extensive sediments derived from a short distance to the south, perhaps the Soutpansberg. Along the Sand River on the farm Vryheid, these terraces have yielded alluvial diamonds. Sand has been migrating into the area from the west over the past 0.002 Ga. Some researches equate this sand with the Kalahari Beds in Botswana.

## Major Faults

Two major faults occur within the Reserve. The Bosbokpoort Fault marks the northern edge of Karoo rocks and cuts through the farms Dawn, Frampton and Skirbeek. It forms a distinct ridge including Maremani due to its highly resistant composition. It is composted of silicfied mylonite and cataclasite. Its age is uncertain and it has a significant dip slip component and an undetermined strike slip component. It may be a major source of water and certainly hydothermal graphite deposits occur along its length. The Dowe-Tokwe Fault extends from the Limpopo River on the farm Twilight past Messina almost to Alldays and is exposed on the farms Twilight, Palm Grove, Steenbokrandjes, Magdala, Vryheid and Singelele. In contrast to the Bosbokpoort Fault, it is not a positively weathering feature but is obvious from air photographs and satellite images. Besides being a possible source of water, this fault and northeast trending faults splaying off it, such as the Messina Fault west of the Reserve, are the locus of copper mineralization and possibly diamond mineralization. The Dowe-Tokwe Fault has a long history of movement from at least 1.9 Ga until after 0.18 Ga.

**Mineralization**

No operating mines exist within the Maremani Nature Reserve although some inoperative ones exist. While mineralization occurs throughout, it is particularly abundant in the western portions near Messina. The recorded mineralization and the farms on which it occurs are presented in Table 2.

**Table 2: Known mineralization within the Maremani Nature Reserve**

| Mineralization | Farms in the Maremani Nature Reserve where it occurs |
|---|---|
| | |
| Alluvial diamond | Vryheid |
| Chromite | Bokveld, Boschrand, Steenbokrandjes |
| Copper | Singelele, Steenbokrandjes, Ter Blanche Hoek, Vryheid |
| Corundum | Bokveld, Chirundu, Magdala, Palm Grove, Randjesfontein, Steenbokrandjes, Vryheid |
| Crisotile (asbestos) | Palm Grove |
| Graphite | Dawn, Woodhall |
| Iron | Bokveld, Leuwdraai, Magdala, Steenbokrandjes, Twilight, Woodhall |
| Magnesite | Dawn, Solitude, Twilight |
| Sillimanite | Randjesfontein |
| Vermiculite | Malala Hoek, Palm Grove, Randjesfontein, Udini |

Although not reported from within the Reserve, deposits of lead and chromite occur within a few tens of kilometers. The Pande Magnesite Mine is situated in Zimbabwe about 3 km north of the farm Twilight on which magnesite also occurs.

In view of the fact that the mineral rights now rest with the government and not with private individuals, there is a real risk that legal prospectors may be allowed onto the Reserve and if they wish, they will be entitled to undertake excavations. These may not be environmentally friendly. It is critical, therefore, to know as much about the mineralization present as possible. I suggest, therefore, that before any old workings are filled in that they are documented.

**Drainage**

Three major drainage systems exist within the Reserve, the Limpopo, Sand and Nzhelelel systems. The latter two are tributaries to the first. The Limpopo and Sand Rivers are old with complex histories as reflected by the size of their valleys that are far larger than the present rivers warrant. In the case of the Limpopo, this is because the Zambezi River used to flow into it through the Shashi. The Sand River rises near Pietersburg and is incised into the Soutpansberg. It obviously carried far more water than at present but why this was so is uncertain. The Nzhelele River rises in the Soutpansberg and is younger than this feature.

Until February, 2000, the many dams on the Sand River meant that the Sand River only flowed during floods. Yet old habitation sites along the River suggest that it was perennial. The floods of February, 2000, destroyed all of the dams and the River has flowed ever since as it was reported to do before the Second World War. The Nzhelele Dam in the Soutpansberg restricts the flow the Nzhelele River. Plans to build dams on the Shashi River in Botswana will restrict the flow of water from the Shashi into the Limpopo.

Of the three systems, the Limpopo and Nzhelele are the most important for the Reserve. If water is to be pumped from the Limpopo as historically has been done on the farms bordering it, the amount of water available may drop. This is already a factor being negotiated among interested role players with regard to well fields upstream. The Nzhelele catchment includes much of the eastern portion of the Reserve. It is perennially flowing. However, if demands for water from the Nzhelele Dam continue to increase, the amount of water coming into the Reserve from upstream may decrease significantly.

**Important Geological Sites**

At least three unique geological sites occur adjacent to and within the Reserve that are worth preserving and exploiting. There probably are many more. I feel that these sites should be combined with other important ecological and geological sites for awareness, educational and research purposes. The world famous Sand River pavements, for which National Heritage Site status is being sought, occur with the Messina Nature Reserve bounding the Maremani Reserve on the west. It is possible that similar exposures also occur downstream in the Maremani Reserve. I have not examined the river north of the bridge on the Messina-Tshipise road since the 2000 floods.

Sapphirine is a rare mineral that is known to occur in perhaps a dozen localities in the world, most famous of which is in Greenland. Two of these localities are in the Central Zone of the Limpopo Belt, one on the farm Randjesfontein and the other north of Lilliput Siding to the west. Its wide compositional range makes this mineral very useful for determining pressure and temperature conditions during metamorphism (Horrocks, 1981; Van Biljon and Legg, 1983).

The Messina Layered Intrusion is one of the oldest layered intrusions known on Earth. Where exposed on the farm Bokveld, large fragments of the original cumulate plagioclase crystals are preserved despite the intense deformation and metamorphism that they have been subjected to.

**A Geological Policy For The Reserve**

I feel that the almost unique geological setting of the Maremani Nature Reserve outlined above makes it imperative that the Management of the Reserve formulates a geological policy toward utilizing these resources as soon as possible. People such as myself would like to use the Reserve as a focus of geological awareness, education and research within a greater ecological context. Requests for access and support will no doubt be forthcoming. Important geological exposures, particularly scarce mineral occurrences, could be destroyed if not closely monitored. Mineral collectors have a very bad reputation in this regard but improperly supervised students can also inflict great damage. I suggest that two practices might be implemented. 1) Visitors wishing to examine and, in particular, sample geological exposures should outline their intentions in writing either before or when visiting the Reserve. If they deviate from these intentions in practice, they should be held responsible. 2) A self-guided, geological tour should be established within the Reserve to highlight important geological aspects. This should be combined with highlights of the botany, zoology and archaeology. It is with amazement that I find that there is no formal venue around Messina where students from the primary and secondary schools can come and learn about nature and ecology. I have advocated this function for years for the Messina Nature Reserve but funding and enthusiasm has never come forward from Government. I see no reason why the Maremani Nature Reserve, perhaps in collaboration with the Messina Nature Reserve, should not provide this very essential venue. I suspect that a well-formulated plan would also receive the backing of De Beers Consolidated Mines (Venetia Mine), which underwrites a great deal of the extra education expenses in Messina.

I certainly would like to be involved in these ventures.

**References**


Brandl, G., 1981, The geology of the Messina area, Explanation of Sheet 2230, Geological Survey of South Africa, 35 p. (accompanied by 1, 1:250 000 geological map).

Horrocks, P. C. B., 1981, The Precambrian geology of an area between Messina and Tshipise Limpopo Mobile Belt, PhD thesis, University of the Witwatersrand, 205 p (plus appendices and maps).

Söhnge, P. G., 1946, The geology of the Messina copper mines and surrounding country. Geological Survey of South Africa Memoir, 40:280 p. (accompanied by 2, 1:50 000 geological maps).

Söhnge, P. G., Le Roux, H. D. and Nel, H. J., 1948, The geology of the country around Messina, Explanation of Sheet Number 46 (Messina), Geological Survey of South Africa, 82 p. (accompanied by 1, 1:125 000 geological map).

Van Biljon, W. J. and Legg, J. H. (Editors), 1983, The Limpopo Belt, Special Publication of the Geological Society of South Africa, 8:203 p. (accompanied by three maps).