BARBERTON / MAKHONJWA MOUNTAIN LAND

WORLD HERITAGE SITE

TENTATIVE LIST SUBMISSION

November 2007

Mpumalanga Province

SOUTH AFRICA

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WORLD HERITAGE SITE - TENTATIVE LIST SUBMISSION

State Party: Republic of South Africa, Mpumalanga Province **Date of Submission:** November 2007

Submission Prepared by: Barberton / Makhonjwa Mountain Land WHS Nomination Committee

This formalised structure consists of the following institutional role-players:

Mpumalanga Tourism and Parks Agency
Mpumalanga Dept of Culture, Sport & Recreation
Mpumalanga Office of the Premier
National Heritage Council
South African Heritage Resources Agency
Umjindi Local Municipality
Albert Luthuli Local Municipality
Barberton Community Tourism
Geological Society of South Africa
South African Institute of Mining & Metallurgy
Academic geologists from Research Institutions and Universities
Landowners of Nkomazi Wilderness and Mountainlands Nature Reserve
Mpumalanga Provincial Heritage Resources Authority

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1. NAME OF PROPERTIES

Barberton / Makhonjwa Mountain Land (BML)

Province and Region: Mpumalanga; covering part of at least two Municipalities: Umjindi Local Municipality (Barberton) and Albert Luthuli Local Municipality (Carolina/Badplaas).

Latitude and Longitude (approximate)[1]: S 25' 55" to 26' 10" - E 30' 30" to 31' 05"

Purpose of this document

To present a motivation for parts of the Barberton Mountain Land / Makhonjwa Mountains[2] to be placed on the SAWHCC Tentative List and thereby formally initiate the more detailed planning and negotiation processes necessary to complete World Heritage Site inscription.

[1] *This encompasses the entire BML. It will be reduced to fit the area as finally determined.*

[2] *The name **Barberton Mountain Land (BML)** is used in this document for simplicity because it is the geographical name used by Geologists all over the world for the mountainous region between Badplaas in the SW and Kaapmuiden in the NE. It is more-or-less underlain by extremely old Archaean rocks, collectively also known as the **Barberton Greenstone Belt** in the geological literature. Other names such as the Makhonjwa or Ngwenya Mountains will be considered in the more detailed planning process.*

2. DESCRIPTION

The area in question is located largely within the Barberton Mountain Land (BML). It is also known to geoscientists worldwide as the Barberton Greenstone Belt (BGB), composed of the rock sequences of the Barberton Supergroup. Its varied and complex, folded rock-types give rise to deeply incised mountainous terrain that stretches from the Lochiel Plateau in the south to the Nelspruit-Komatipoort area in the north and straddles the Swaziland border. It includes part of the Komati river catchment in the south west, the de Kaap catchment in the north and Mahlambanyathi and Crocodile Rivers in the northeast. The hills are steep and rocky, with moist grassy uplands and forested valleys. The altitude ranges from 600 to more than 1800 metres above mean sea level.

Historical summary

Oral history suggests that through the 1700s and 1800s the land was sparsely occupied by Swazi and other local pastoral people, together with their livestock. But the steep and rocky landscape did not provide well for human livelihoods and human occupation fluctuated both seasonally and according to the ebb and flow of local conflicts. Substantial settlements were rare, being limited mainly to the larger river valleys.

At the time of European settlement in the 1860s the region became a contested border zone. Land deals were struck between the Swazi king and Transvaal colonists, the echoes of which remain to this day. The BML lies mostly in South Africa with about 20% in NW Swaziland. The region is mainly used for timber growing, nature conservation, catchment protection and communal livestock grazing. Gold mining was *the* major economic activity and after 120 years some of the original mines are still producing. New mines and different minerals, mostly outside the BML, are likely to maintain the important role of mining in the district. Timber growing, having reached saturation levels, is unlikely to expand.

The significance of the BML first became known to the world when alluvial gold was found at Kaapsehoop in 1875. This was followed by the Moodies and Barber's reef discoveries and a subsequent 'gold rush' into the hills above the Suid Kaap river. Barberton's gold rush was quickly spent, soon to be dwarfed by the discoveries on the Witwatersrand in 1886. South Africa's mineral wealth, at that time mainly from diamonds and gold, grew enormously. A direct by-product of this affluence was the development of geological science to support mining. In the first half of the 20th century, technical expertise and geological exploration expanded rapidly, supported by equivalent growth in academic research and teaching.

From these backgrounds, the twin brothers Richard and Morris Viljoen, while student geologists in 1969, first described distinctive Archaean lavas from the Komati river valley, now known as

komatiites. This landmark discovery identified the oldest volcanic rocks of a hitherto unknown (ultramafic) composition. It suggested their formation at temperatures approximating 1650ºC – the hottest ever described for volcanic rocks on the Earth's surface. Their scientific publications triggered new enquiries into the nature of the early Earth that are continuing to this day. Many subsequent discoveries contributed to our present understanding of the significance of these extremely ancient but remarkably well preserved rocks. They include: the evolution of Earth's atmosphere; the origin of life; the growth mechanisms of continents; and the composition of the earliest oceans.

Thus, while the area continues to yield gold to this day, the past half century has seen the BML's geology achieve a different type of fame, more significant and longer-lasting than its colourful gold-rush past. Its importance is now derived from the extreme age of its rocks (ca. 3650 – 3100 million years), their excellent state of preservation, their low degree of geological disruption, and ease of access for scientists and laypeople alike. Rocks of similar age and even older, are known from a few other parts of the world (see Sect. 6). But not one combines the outstanding and diverse values of the BGB. This region offers a virtual library of information at the limits of terrestrial time and allows us to study and learn about the origins and earliest history of our planet (C. Heubeck, in lit.).

> *". . the rocks in the Barberton belt provide a unique view of the early Earth that is quite literally unavailable anywhere else."*
>
> Prof Don Lowe, Stanford University

Demarcation and land use

The precise extent of the potential World Heritage Site is not yet defined. Its outer limits lie within the South African portion of the BML (see Map 1). The ultimately delineated site can only be determined through a more detailed planning and negotiation process that will follow tentative listing. Map 2 gives a perspective of the biodiversity attributes of the area, highlighted by the Barberton Centre of Plant Endemism (BCPE) relative to conserved and transformed landscapes. The two dominant land uses in the area are nature conservation and timber production. This land use pattern, together with currently active mining, provides a guide as to which areas should be included for inscription. A sensible minimum area comprises the currently formalized nature reserves, on both state-owned and private land.

It is acknowledged that several important geological "type localities" fall outside the protected area boundaries proposed. The oldest and most studied elements of the Archaean sequence are located in the Komati river valley to the south of the BML. Including all key elements within the protection status of the whole World Heritage Site is likely to be complex as it will be dependent on negotiation with landowners and communities. Their inclusion will be one of the objectives of the next phase of more participatory and detailed planning.

For the purpose of registering the BML site on the SAWHCC Tentative List, the properties will include[3]:

Name	Ownership	Size	
Songimvelo Nature Reserve	State owned	35 800	ha
Songimvelo Nature Reserve 'Panhandle' section	State owned	13 250	ha
Mountainlands Nature Reserve	Community, Public, Private Sector Partnership	16 700	ha
Barberton Municipal Nature Reserve	Municipal land	350	ha
Barberton Nature Reserve	State owned	2 450	ha
Nkomazi Wilderness	Private	30 000	ha
	Total area	**98 550**	**ha**

Scientists from all across the globe annually visit BML to gain a better understanding of how our planet and life on earth evolved. Here a group is pictured against the backdrop of a well exposed sedimentary layering structure during a specialist tour, undertaken in preparation of this World Heritage Site, Tentative List submission.

[3] *The half dozen 'Botanical Reserves', including some Natural Heritage Sites as well as other Protected Areas and specifically identified sites of significance, may or may not be included, dependent on the future WHS planning process.*

3. JUSTIFICATION OF UNIVERSAL VALUE

The features of BML that have Outstanding Universal Value (OUV) are primarily geological. Specific sites illustrating key scientific findings and events are listed at the end of this section.

SUMMARY OF THE OUTSTANDING UNIVERSAL VALUES

Barberton Mountain Land contains the oldest well preserved sequence of volcanic and sedimentary rocks on Earth. These highly accessible Archaean exposures present a continuous 350 million year sequence of rocks, from 3600 million years in age. Their physical and chemical characteristics provide an unparalleled repository of scientific information about the early Earth. The outstanding value of these rocks lies in the large number of sites and features that, when combined, provide a unique and as yet only partially explored scientific resource.

Specifically the BML Archaean sequence includes:

- records of Earth's earliest life forms, including microfossils, stromatolites, biomats and other organically derived material;
- records of:
  - the formation of the earliest continental crust;
  - several of the earliest and largest meteorite impact events;
  - the chemical and physical nature of the Archaean ocean, including precise tidal intervals;
  - the composition of the early atmosphere; and
  - the nature of the environments within which the earliest life forms originated and developed;
- the 'type-locality' of the distinctive komatiite volcanic rocks.

The outstanding value of these rocks is also due to their remarkable state of preservation. They are not entirely unaltered, but enclaves exist where original components are intact for most rock types in this long Archaean sequence. From these sites geologists and paleobiologists have learned more about the Earth's early history than from any other comparable geological site.

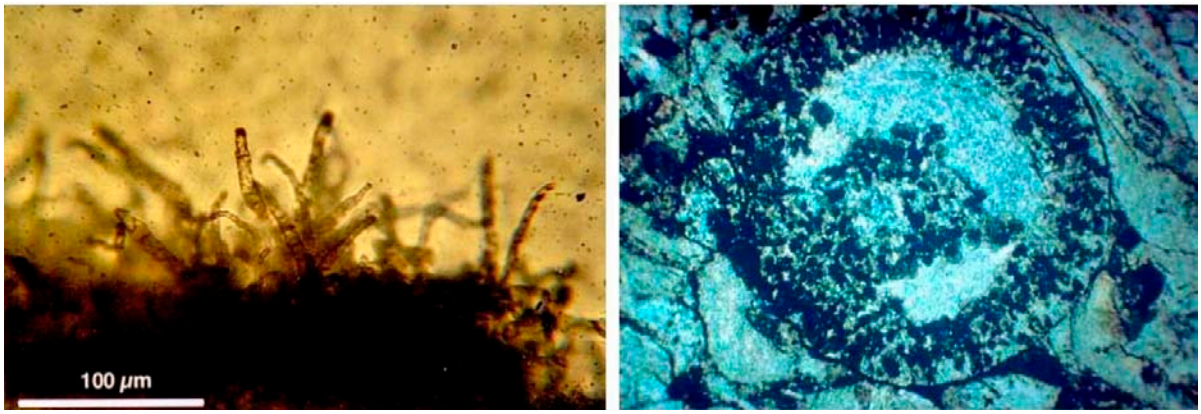
From a non-geological perspective the site has additional values that supplement and boost its outstanding values. These include scientific and aesthetic features that readily attract a range of visitors, general tourists and special-interest groups. There are high levels of biodiversity, especially plant endemism; unspoiled scenic, wilderness and watershed values; important cultural and historic features, including the site of South Africa's first real gold rush. The site is also readily accessible and has comfortable year-round climate.

These varied and attractive features, located close together, create strong potential for sustainable tourism, which in turn, leads to economic growth and poverty alleviation. Tourism developments provide for easier and wider visitor access and the generation of revenue. In turn, this improves access for scientific study, investment in protection, management and interpretative services and finally, a much broader reach for visitors to learn about and understand the world they live in, in an exciting natural environment.

STATEMENT OF SIGNIFICANCE

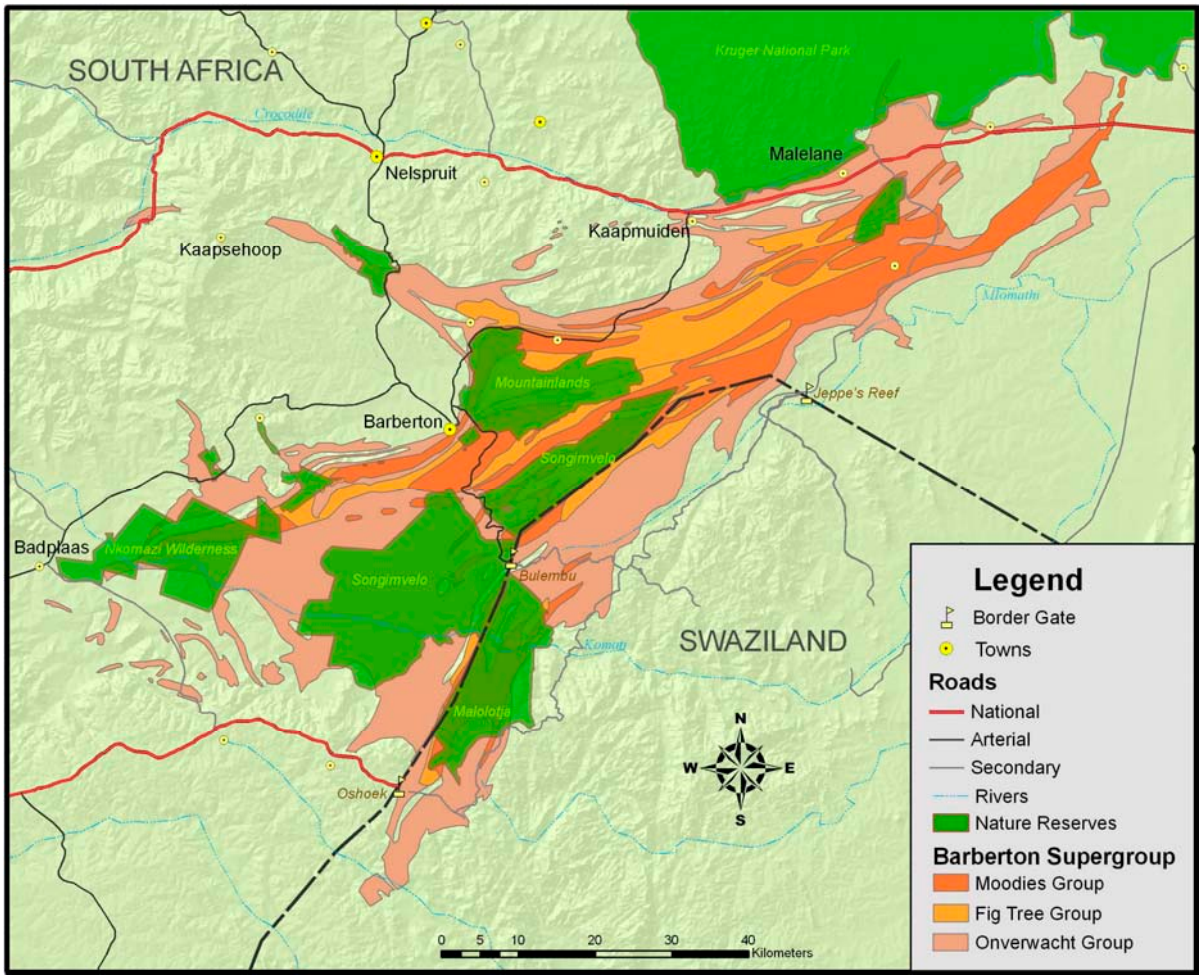
The Barberton Mountain Land contains the oldest well-preserved sequence of volcanic and sedimentary rocks on Earth. Its rocks provide a globally unique source of information about the earliest measurable conditions of the Earth's oceanic crust. From them we have learned about the surface processes at work as the Earth cooled from a molten body, to the creation of the primitive biosphere. The outstanding value of this geology lies not so much in any one site, but in the large number of sites of interest which, when their information is combined, allows the BML to tell a consistent, rich and as yet only partially explored story, of how life on earth began.

The most outstanding feature of these exposures so far discovered is that they have revealed by far the oldest microfossils ever described at ca.3500 million years old (Walsh and Lowe, 1985). Since the late 1960s, many eminent palaeontological researchers from the USA, UK and Germany conducted collecting expeditions in the Barberton Mountain Land. NASA funded some of these investigations, to learn more about the likely environments and appearances of the earliest life on Earth which would assist in developing guidelines for its missions to Mars and other searches for extraterrestrial life. Several international scientists return annually to pursue long-term projects in various geoscientific fields of cutting-edge research. (C. Anhaeusser in lit.).



Left: *Volcanic rocks in Barberton Mountain Land contain minute traces of the world's earliest life forms, seen here as hair like tubes created by bacteria, found in the glassy rims of pillow lava, photographed through an electron microscope and dated to about 3 480 million years ago. (Prof. Maarten de Wit as cited in Delius, Mpumalanga History and Heritage, 2007)*
Right: *Spherule beds resulting from meteorite impact events that occurred elsewhere on earth over 3.4 billion years ago are revealed in the Dycedale Syncline as spherules of less than 1mm in diameter, seen here under a microscope.*

Additional value lies in the ancient granitic rocks that intrude into and envelop the Barberton greenstone belt. These range in age from over 3500 to 3200 million years and present an extended evolutionary history that is also outstanding in terms of exposure and preservation. The oldest granitic and gneissic rocks consist of sodium-rich tonalites, trondhjemites and granodiotites, evolving into more potassium-rich 'normal' granites. These granitic rocks played an important role in the structural and metamorphic history of the region and their relationships with the volcano-sedimentary Barberton greenstone successions can rarely be matched elsewhere in the world (Robb et al., 2006).



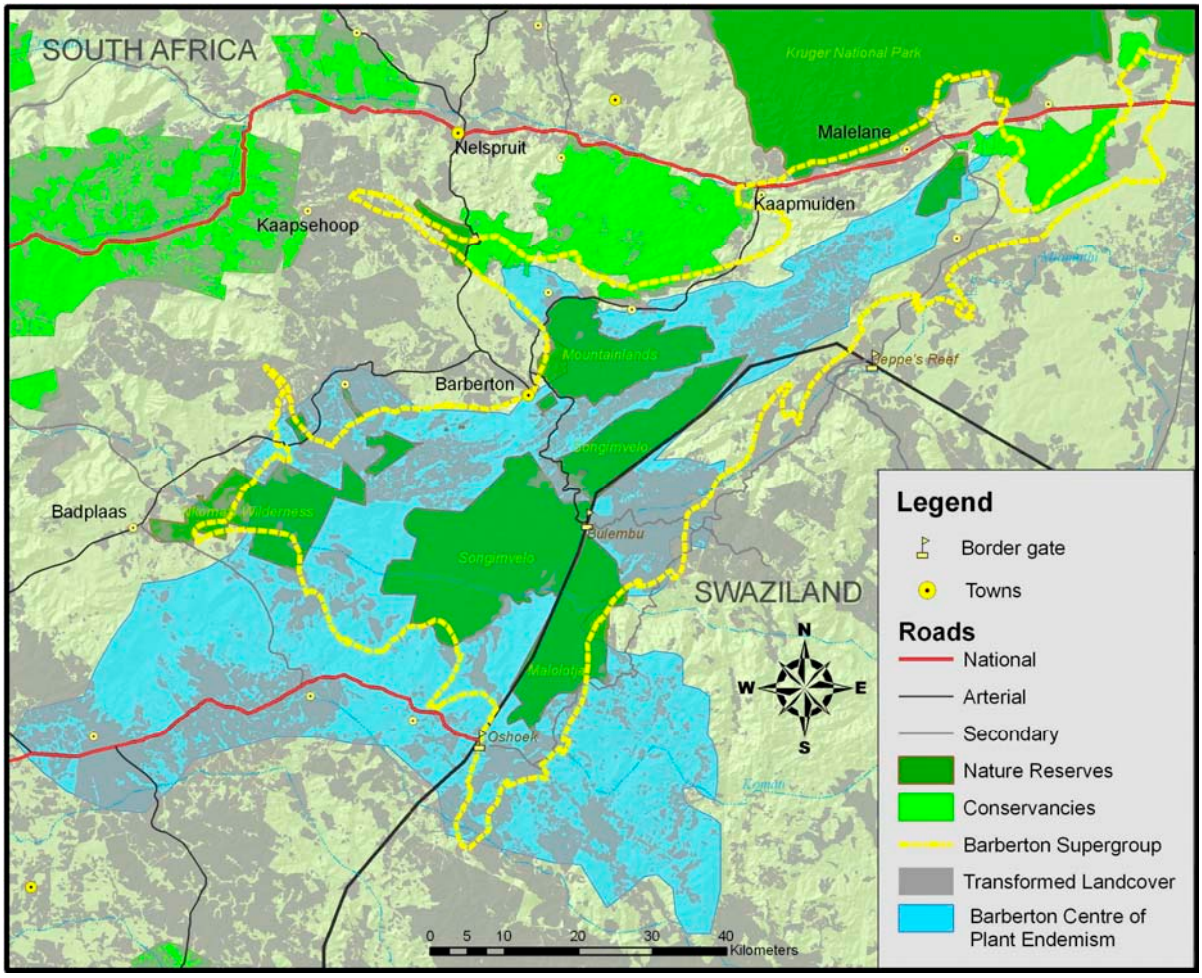
MAP 1: *The Barberton Mountain Land as defined by its underlying Archaean geology, also referred to as the Barberton Supergroup or Barberton Greenstone Belt (Geological Map of South Africa, 1984).*

In keeping with the area's exceptional geology there is a correspondingly rich biodiversity. The steeply broken terrain, unusually mineralised soils (e.g. Mg- and Cr-rich serpentine and talcose soils) high rainfall and extremes of temperature have given rise to a local Centre of Plant Endemism (Van Wyk and Smith, 2002), one of twenty such biodiversity hotspots in South Africa (Map 2). Although this feature, on its own, does not rate OUV, when added to the geological values and outstanding wilderness and aesthetic qualities, it makes for a tourism attraction that geology, on its own, cannot provide. These supplementary values, along with the accessibility of the site, will attract researchers and tourists that will enhance the spread of knowledge and understanding of the early Earth.

Incidental to, and adding value to these main scientific features, are aspects of cultural significance that enrich overall visitor interest. These include:

- The oldest record of ancient mining located in NW Swaziland. Lion Cavern at the Ngwenya Iron Ore Mine (Bomvu Ridge) was initially dated at 41 250 BC – some seven times older than the oldest known flint mines of Western Europe (Boshier and Beaumont, 1972). Later C^{14} dating of the Bomvu ridge material, suggests a more likely age to be 70 000-80 000 BC (Dart and Beaumont, 1971).

- A rich contemporary history of dynamic local African cultures, colonisation and early gold mining (Bornman, 1995).
- An extremely high frequency of stone-age tools and related artifacts as well as San cave paintings (Boshier and Beaumont, 1972).



MAP 2: *The biodiversity value of the BML is indicated by the Barberton Centre of Plant Endemism relative to areas of conserved and transformed land (adapted from Lotter and Ferrar, 2006).*

Qualitative statements by eminent scientists

"The oldest well preserved sedimentary and volcanic rocks on Earth. … These rock layers are like the pages of a book that we can read and translate in terms of early Earth's history. Here in Barberton is the Rosetta Stone for this period of time."

Prof Don Lowe, Stanford University

"The Barberton Mountain Land offers the geologist a unique opportunity to study the early stages in the evolution of the Earth. There, remnants of the oldest upper mantle, oceanic crust, and an overlying island-arc-like rock complex are fossilised in a sea of granite and granitic gneiss …Studies of these rocks offer deep insight into many aspects

of terrestrial differentiation, especially the early evolution of oceanic and continental crusts, the seas and the atmosphere."

Prof Al. Engel, 1970, as cited in McCarthy & Rubidge (2005)

"Rocks from these areas provide the only direct information from which the earliest history of our planet can be reconstructed with confidence ... Because the world's oldest fossils have been found here, the area is a Mecca for scientists interested in how the young Earth worked 3 500 000 millennia BC, and in searching for new clues to the origin of life."

Prof Maarten De Wit, University of Cape Town

"The Barberton Mountain Land ... has come to be recognized in the world of earth science as one of the truly remarkable localities for understanding the history and evolution of the Earth **….** *These rocks provide scientists with a unique opportunity to study events that took place very far back in Earth's history. There are only a few places in the world where rocks of this great age are preserved, but few can match the diversity and spectacular exposures that occur in the Barberton Mountain Land".*

Prof Carl Anhaeusser, University of the Witwatersrand

"On another continent, in another region where men have toiled and died for gold, the Barberton Mountain Land of the eastern Transvaal and Swaziland has become a mini-classic and a mecca for students of granite-greenstone terrains"

Prof Preston Cloud (1988), Univ. California at Santa Barbara

The most important specific geological sites could include[4]:

- The type locality for komatiite volcanic rocks which contain "spinifex" textures indicating the supercooling of very high temperature volcanic eruptions. (several)
- Pillow-structured komatiitic basaltic lava, indicating widespread, under water volcanic eruptions
- The Middle Marker sedimentary layer, separating predominantly komatiitic volcanic rocks from predominantly basaltic and felsic volcanic rocks, illustrating the gradual growth of a small continental nucleus
- Banded chert containing abundant organic matter and rare microfossils, providing a potentially diverse record of earliest life (several)
- Spherule beds recording at least four of the earliest recorded meteorite impact events (each being far larger than the famous K-T impact event which led to the extinction of the dinosaurs)

[4] *Note: all the categories listed can be found at more than one locality.*

- Ancient hot springs in the Fig Tree Group that provided an environment for bacteria and early life forms (significance contested)
- Colorful sedimentary Banded-Iron-Formations (BIF) composed of hematite and jasper, precipitating from anoxic sea water
- Sedimentary structures such as cross-bedding, laminations, and mudcracks allowing the detailed reconstruction of ancient shorelines, deltas and tidal zones and allowing precise tidal and lunar measurements
- The oldest well-preserved layered ultramafic complexes, containing chrysotile asbestos and magnesite deposits
- Plutonic rocks (granites) of various mineralogical composition, belonging to several time periods during major crust-forming events
- Gold mineralization, including historic mining sites.

4. WORLD HERITAGE CRITERIA MET

C(i)	C(ii)	(iii)	(iv)	(v)	(vi)	N(vii)	N(viii) ✓	N(viii)	N(ix)	N(x)

Criterion (viii):

Section 49 of the WHC Guidelines defines "Outstanding Universal Value" as:

> *"… cultural and/or natural significance which is so exceptional as to transcend national boundaries and to be of common importance for present and future generations of all humanity. As such, the permanent protection of this heritage is of the highest importance to the international community as a whole."*

Section 77 (viii) of the WHC Guidelines:

> *"... be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features;"*

The BML site meets both these criteria as a Natural Heritage Site deserving WHS status, in particular its representation of, *"major stages of earth's history, including the record of life"*.

In elaborating on the values of geological sites, the IUCN has produced further guidelines that suggest 13 Themes within which geo-sites should be considered (Dingwall et al., 2005): Theme, 4. (**Stratigraphic sites**), and Theme 5. (**Fossil sites**), are most relevant to BML with Theme 13. (**Meteorite impact**) also adding value in support.

5. ASSURANCE OF AUTHENTICITY AND/OR INTEGRITY

Authenticity in terms of the WHC is not a major issue in respect of Natural Heritage sites (WHC Operational Guidelines, Sect II E, 2005) as it is validated by the exhaustive and detailed peer-review system of technical geoscience publications. The published record of scientific research in the BML is very extensive, numbering more than 2330 geological publications alone since 1875 (C. R. Anhaeusser, five bibliographies from 1976-2002). These include peer-reviewed publications, survey reports, research theses, maps and text books. The experience and seniority of the geologists quoted above, most of who are active researchers in the region, also provides credible assurance.

The integrity of the site requires consideration of a sufficient and manageable area with practical and effective boundaries. In addition, paragraph 93 of the Guidelines states:

> *"…(a site) should contain all or most of the key interrelated and interdependent elements in their natural relationships."*

The issues involved in deciding on the size of the site, concern: ownership; access; controlling development; and providing for and managing resources and visitors. At this site in Mpumalanga, it extends further, and involves Integrated Development Planning, part of a mandatory state responsibility at the Local Government level. The larger the area and, in particular, the larger the number of land owners and land uses involved, the greater the complexity and cost of management. Management planning will also have to deal with the concept of geo-site conservation and geo-tourism which are relatively new in South Africa.

The 'sufficient area' referred to above must allow not only for currently known sites but should include localities where future research opportunities lie. This requires the existing geological 'type-localities' and known sites to be included **plus**, a sufficient sample of the rest of the 'Archaean time-slice' to protect the resource base for future research. Who knows which sedimentary layer in that Archaean sequence will reveal the next "gee whizz" discovery. Improving technology will undoubtedly test our current interpretations and theories in such an extreme area of research.

Political and Planning Support

Local support for WHS listing is premised on a rising consensus that development is urgently needed in the region and that tourism-related development is the most sustainable option. The Premier of Mpumalanga is personally aware of and supportive of the project and has had it presented to the Provincial Cabinet in July 2007. It forms part of the Premier's "Heritage, Greening Mpumalanga and Tourism Flagship Project". At Local Government level the Mayor of Umjindi Local Municipality (Barberton) has been proactive in aligning civil society support for Barberton as an "Eco-Heritage Town". This pre-determines a future development scenario based on growing outdoor tourism which, in turn, is based on the unique natural attributes of the area. The Municipal Council contributes to a Public-Private-Partnership in tourism promotion, in the form of Barberton

Community Tourism (BCT), a non-profit (Section 21) Company, dedicated to promoting sustainable tourism in the region. BCT is an active supporter and contributor to the WHS listing process, at present facilitating a grant from the National Heritage Council to help compile this proposal. The Mayor and Councillors of the Albert Luthuli Municipality have also registered unqualified support for the WHS initiative.

Much regional planning has taken place over the last eight years. Most of it advances regional development through growing a tourism based economy dependent on conserved and accessible natural resources. Among the many studies conducted, the following planning reports demonstrate both the integrated approach and the consensus and support that exists (also see reference list):

- Maputo Development Corridor, Multi-agency Tourism Impact Study, 1998.
- Tourism and Biodiversity Corridor Study and Development Plan. DEAT/MPB report, 2001.
- Badplaas/Barberton/Malelane focus-area study on Tourism Development, JICA/DEAT Report, 2002.
- Barberton-Complex Strategic Eco-Tourism Development Plan, MPB/ICS Report 2002.
- Songimvelo/Malolotja Trans Frontier Conservation Area, Tri-National MOU. October 1999, and its implementation agreement signed in 2006.

Future Planning Tasks

Following registration on the Tentative List full-scale planning of the site will take place. This will produce a comprehensive Management and Development Plan involving the participation of all stakeholders, including full consultation with local communities. It will also deal with an infrastructure development schedule and institutional provisions for ongoing management of the site. Various aspects of training and other capacity building will be a prominent feature and appropriate financial commitments and an operational budget will have to be provided. These plans will also have to be factored in to the Integrated Development Plans (IDPs) of both Local Municipalities.

Issues concerning trans-frontier aspects of the site will also have to be addressed. A Trans-Frontier Conservation Area (TFCA) agreement has already been signed by South Africa, Swaziland and Mozambique. At present it is in an early conceptual phase but Songimvelo Nature Reserve and Malolotja Nature Reserve in Swaziland are key components of the TFCA and both occur within the BML (Map 2). The designation of core zones and surrounding buffer zones will also need to be addressed, particularly in considering how development, land use and management issues will be handled. WHS planning will also deal with all the legal and access-control issues, especially contractual arrangements on private land to ensure conservation in perpetuity. These arrangements will all contribute to assuring the integrity of the site.

At present the site is formally recognized for its biodiversity and aesthetic values by proclamation as a group of formal Protected Areas in terms of provincial and national conservation statutes. It is not similarly recognised for its geological or other heritage values. This is due in part,

a) to the lack of any legal provision to conserve geological heritage *per se*, and
b) to South Africa's new heritage institutions having primarily a cultural mandate.

Efforts by local geological interest groups are underway to establish a system of Geosites throughout the country, in line with international trends. The process of applying for global recognition for the country's prime sites will materially assist in this endeavour. (We are aware that the 'prior recognition' issue drew criticism of the process used to register the Vredefort Impact Structure.) A parallel process to attain National Heritage Site recognition for the BML will be promoted and tested as part of the ongoing planning process. If conferred, this will be completed prior to any formal submission for WHS inscription.

6. COMPARISON WITH OTHER PROPERTIES

One of the first attempts to systematically organize geo-heritage sites for conservation purposes was commissioned by IUCN in 1996. Wells (1996) proposed a classification system based on geological age and emphasising the value of the fossil record, and tabulated the allocation of sites per category. His age-classes follow the established geological/palaeontological time scale of 'epochs' and 'periods' but they stop at the Cambrian (542 million years bp). This time period, however, represents only the last 13% of the measurable age of rocks on Earth, the oldest being ca. 4100 million years old. Wells (1996) collapses the remaining 3.5 billion years into a single 'Precambrian' period. It appears that conventional wisdom, or the limits of technology at the time, did not anticipate Precambrian fossils or sites of broader geological significance in the distant 87% of Earth's history. Whatever the reason, there are no inscripted World Heritage Sites in this final category.

Dingwall et al (2005) present the following definitions to assist the value judgements required by comparative analysis (edited for brevity):

- ***"Outstanding:*** *the World Heritage Convention sets out to define the geography of the superlative – the most outstanding natural and cultural places on Earth;*
- ***"Universal:*** *The scope and significance are global ... importance is to all people of the world ... WH properties cannot be valued from a national or regional perspective;*
- ***"Value****: What makes a property outstanding and universal is its "value". Value is established by clearly defining its worth; assessing its quality; and ranking its importance based on clear and consistent standards."*

This means that World Heritage selection has to be:

The *very best* sites, accessible and important to *all people*, possessing the *highest existing and potential scientific value.*

The BML contains by far the oldest geology ever proposed for WHS inscription, but that is not its main value. The reason for its high value lies in the state of preservation of the rocks that allows scientists, with increasingly sophisticated technology to interpret the earliest history of the earth. This is because the chemical and physical structure of these rocks, have miraculously remained largely unaltered by the passage of vast periods of time. That is why the rocks still preserve microfossils and other clearly interpretable, detailed evidence of their origins (such as chemical composition, isotopes etc.). That is why, in the unmatched 350 million year sequence of the Archaean eon that is represented by the rocks of the BGB, the future discoveries from these geological exposures are likely to be even more enlightening and valuable.

All the inscripted World Heritage sites that have "earth science features of outstanding universal value" (184 of them) may be provisionally sorted into 13 Themes (Dingwall et al, 2005). If BML is distinguished primarily by features that fit Themes 4 and 5, with support values from Theme 13, then comparisons should be made mainly with sites claiming these attributes. In addition there are a further 60+ sites, inscripted for <u>other</u> Natural Heritage values, such as biodiversity. Most of these sites have "earth science values" supporting the primary features for which they earned inscription. Comments summarising these comparisons are set out below.

Themes	Comparative comments
Stratigraphy (Theme **4**): (from the 184 sites with "earth science features")	Two sites have features of OUV. Neither present other features of significant value: **1. Grand Canyon** (USA, Permian period); **2. Dorset & East Devon Coast** (UK, Mezozoic era) which is mainly an exemplary fossil site.
Fossils (Theme **5**): (from the 184 sites with "earth science features")	Eleven sites have OUV (+ one [**Ngorongoro**, (TZ, Pleistocene)] with a "possible" OUV feature). None presents other features of significant value. Of the 11 sites, only three are from the Devonian era or older, and all are from Canada (in increasing age): **Miquasha**, Devonian (fishes and forests); **Gros Morne**, Ordovician (fishes and corals) and **Burgess Shale** from the Cambrian (first trilobites and other enigmatic fossils).
Meteorite Impacts (Theme **13**)	Only the **Vredefort Impact Structure** is inscripted, presenting no other features of significant value.
There are **no sites** that have Stratigraphic, Fossil or Meteorite Impact features, from any of the other World Heritage sites inscripted for other natural heritage values.	

Extracted from Dingwall et al (2005)

In summary, there are no inscripted geo-heritage sites from the Precambrian on the World Heritage list. Fossil sites of this age are presumably not expected or extremely rare, until the discoveries in the Barberton Greenstone Belt pushed the time-frontier of life back an incredible one billion years (Walsh and Lowe, 1985; Westall, 1998). The two existing stratigraphic sites are both relatively young in geological terms.

A thorough comparison should include a sample of known sites that have *not* been brought to the notice of the WHC, examples:

Pilbara, in northern West Australia, is the most comparable site but is not registered as any form of heritage asset. It is more extensive than the BML site, more remote and much more difficult to

access. Material is very poorly exposed, deeply weathered and includes a much lower diversity and smaller age-range of available rocks (D. R. Lowe, in lit.).

There are Canadian sites in the **Slave Province** (NW Territories) where 4 000 – 2 800 myr old rocks are reported, and along the **Labrador Coastal Strip** (opposite West Greenland). There are also sites in West Greenland in the Fiskenaesset and Nuuk regions, where the **Amitsoq gneisses** are located as part of the **North Atlantic Craton.** These exposures have an age range of 3870-3380 myrs. The **Isua greenstone belt** is the oldest known greenstone belt in the world, but is strongly metamorphosed, fragmented and poorly exposed, being partly covered by the Greenland ice sheet. (C.R. Anhaeusser, in lit.). As such these sites have far less potential to yield important new information about the Earth's early surface and life than the BML. They are also difficult to access for a wider interested public.

These sites are all older than, or have a similar age to, the BML but are highly fragmented and metamorphosed and do not provide a clear record of events in the early stages of Earth's history (McCarthy and Rubidge, 2005). There are snippets of rocks of this age in many other areas, but the continuity of the BML record is unrivalled. Also, in many of these areas, such rocks are covered by deep soils, forests, or younger materials (D. R. Lowe, in lit.).

It is also necessary to look at the range of WHS inscriptions within South Africa to consider the balance provided by other candidate sites, and those that have already been inscripted. Only two of the SA sites have any geological features of value. These are the Vredefort Impact Structure and the Cradle of Humankind. The first is truly ancient (~2023 Myr), but is otherwise one-dimensional as the stand-alone oldest and largest known meteorite impact site. The second is very recent, comprising karst breccia deposits around 3 million years old, one of the richest hominid/pre-hominid sites known. No meaningful comparison can otherwise be made with the extremely old, multidimensional, well-preserved and accessible Archaean features of the Barberton Mountain Land.

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