The Thabazimbi Mine Cave, Limpopo Province, South Africa: Assessment of the Cave and its Speleothems

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Summary

This report presents the following documentation:

- Quantitative documentation of the Thabazimbi cave and its speleothems.
- Photographs of the cave and of the various speleothems within the cave. All photographs of the cave, its surrounds and speleothems were taken by the author.
- Discussion on the present status of the cave and its future status.
- Discussion the status of the NHRA with respect to rare geological specimens. Professional opinion will be provided as to the authority of the NHRA versus the Mineral and Petroleum Resources Development Act, an important point of departure in this particular case.

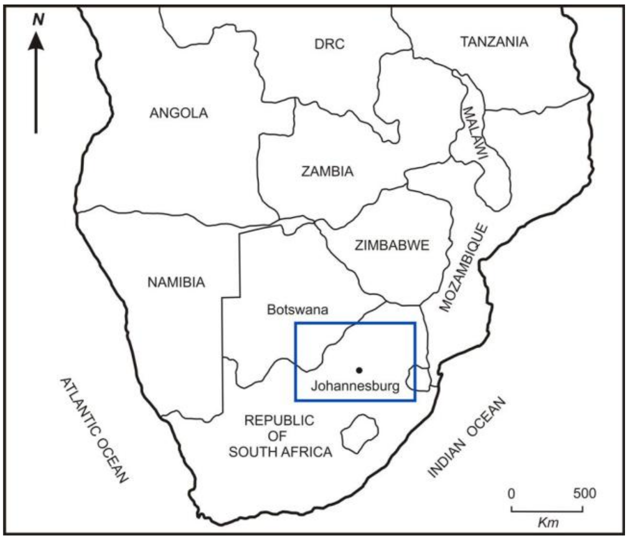
Background

In South Africa, the Transvaal Supergroup comprises a geological succession of mixed chemical and clastic sedimentary rocks with some interbedded volcanic units (Eriksson *et al*. 2006). One of the units in the succession, the Chuniespoort Group, consists predominantly of dolomite with lesser amounts of limestone and chert. This formation contains some spectacular caves, for example, Sterkfontein caves located northwest of Johannesburg which is now a declared World Heritage site, the Cradle of Humankind. This honour was bestowed on the region because of the extremely important Hominid fossils that have been discovered in the area and that have lead to a better understanding on human evolution. Wherever these dolomites are found, caves tend to be associated with the outcrops. There are often openings on surface where headward erosion in the underground chambers has led to surface collapse, sometimes as sinkholes. In these cases, the caves may have been inhabited for millennia by animals (and early Hominids) and any delicate cave formations that may have been present are often destroyed or discoloured by biological activity in the sensitive cave environment.

In rare instances, and this report documents one such instance, caves are never naturally open to the surface and they are therefore isolated from any human or animal or floral disturbances and their speleothems remain pristine. It was only during an iron ore mining operation nearby that the Thabazimbi cave was accidently encountered while driving a horizontal adit into the side of Thabazimbi Mountain.

Locality

Thabazimbi is located approximately three hours drive north of Johannesburg. There are large iron ore deposits in the area (van Deventer *et al.,* 1986) hosted in the Transvaal Supergroup rocks, and mining and farming provide the main source of revenue in the town. The cave is located in Thabazimbi Mountain to the east of the town and is on privately owned mine property and access is not permitted, either to the mountain or the cave.



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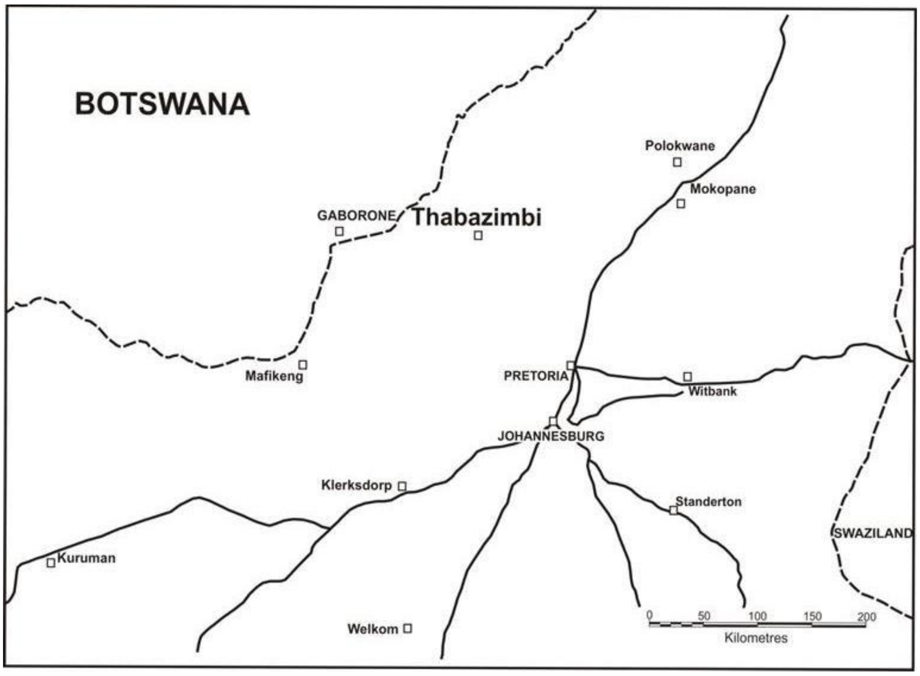

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(A). Southern Africa showing the region in which Thabazimbi is located. (B). The town of Thabazimbi is located north of Johannesburg close to the Botswana border.

Discovery and History of the Thabazimbi Cave

The accidental discovery of the cave by the Thabazimbi iron mine has been described by Martini (1986a). In November 1985, Martini and members of the South African Spelaeological Association (SASA) were contacted by the mine's chief geologist, H.J. Snyman, to enquire whether they would be interested in investigating the cave which had, in fact, been discovered about 30 years earlier during the nineteen fifties. At that time, a horizontal adit had been driven into the side of a mountain on the mine property and the cave was discovered close to the adit roof, necessitating structural reinforcement to prevent the adit collapsing from above. Mine management then put a security and conservation programme into place whereby only one access point allowed a small group of visitors under strict supervision to enter the cave via the adit. (All visitors were required by law to undergo safety training induction before accessing the mine property and entering the cave). The cave access point is locked by a steel door and there is no other point of entry. The entrance to the adit on the slope of the mountain is also secured with a locked security gate. The existence of the cave was also not widely publicised and known only to mine personnel.

Google earth image of the Thabazimbi Mountain. Mining operations and mine access roads can clearly be seen in the area that contains the cave.

View of Thabazimbi Mountain located east of the town.

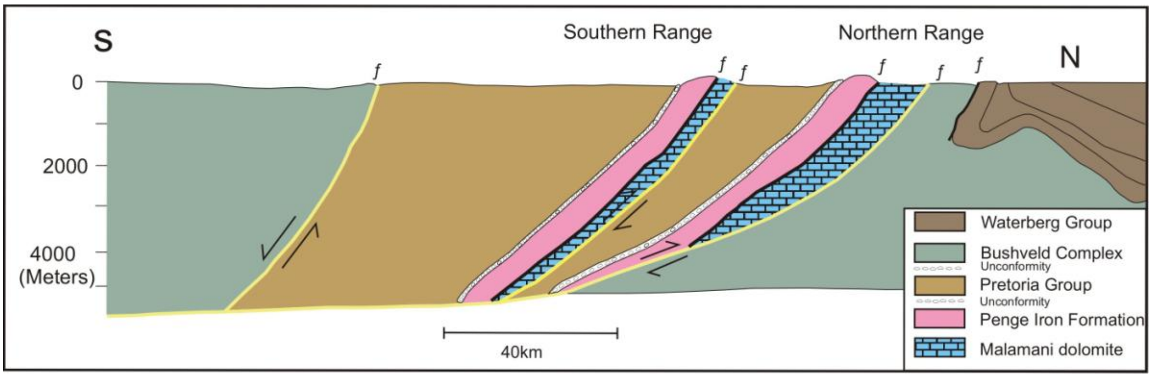
In recent years, mine management have permitted a local tour guide to take small groups of visitors through the cave. (*Note: Since January 2010, access is no longer permitted by tour groups).* There is a fixed tourist path that is defined by steel ropes beyond which visitors were not allowed to venture. Electric lights were once installed in the cave but no longer function. (Sometime in January 2011, cable thieves gained access to the cave and stole the cables used to power the lights and incurring damage to some speleothems). This is probably advantageous as excess light in caves can promote unwanted growth of plants which can in turn change the microclimate in the cave to the detriment of the speleothems.

The entrance to the Mostert adit on the western flank of Thabazimbi Mountain.

A detailed cave management and conservation plan was proposed to the mine management by Martini (1986a) and this was implemented and strictly adhered to so as to prevent destruction of the cave and its contents.

Regional Geology

The Thabazimbi iron ore deposit is hosted by the Penge Iron Formation (ca. 2460 Ga, Pickard, 2003), and is a lateral equivalent of the Asbestos Hills Iron Formation, of the Transvaal Supergroup. This Transvaal Supergroup succession was deposited in a Neoarchean - Palaeoproterozoic basin that outcrops in the Transvaal structural basin (east) and in the laterally equivalent Griqualand West basin (west) (Beukes, 1986). The Penge Iron Formation conformably overlies chert-poor dolomites of the Malmani Subgroup, and is in turn disconformably overlain by siliciclastic sedimentary rocks of the Pretoria Group (Beukes, 1986). The Thabazimbi cave occurs in the dolomites / chert of the Eccles Formation in the Malmani Subgroup. Stratabound high-grade hematite ores (~65 % Fe) occur primarily in the basal part of the Penge Iron Formation, however subordinate ores also occur higher up in the stratigraphy (Gutzmer *et al*., 2005).



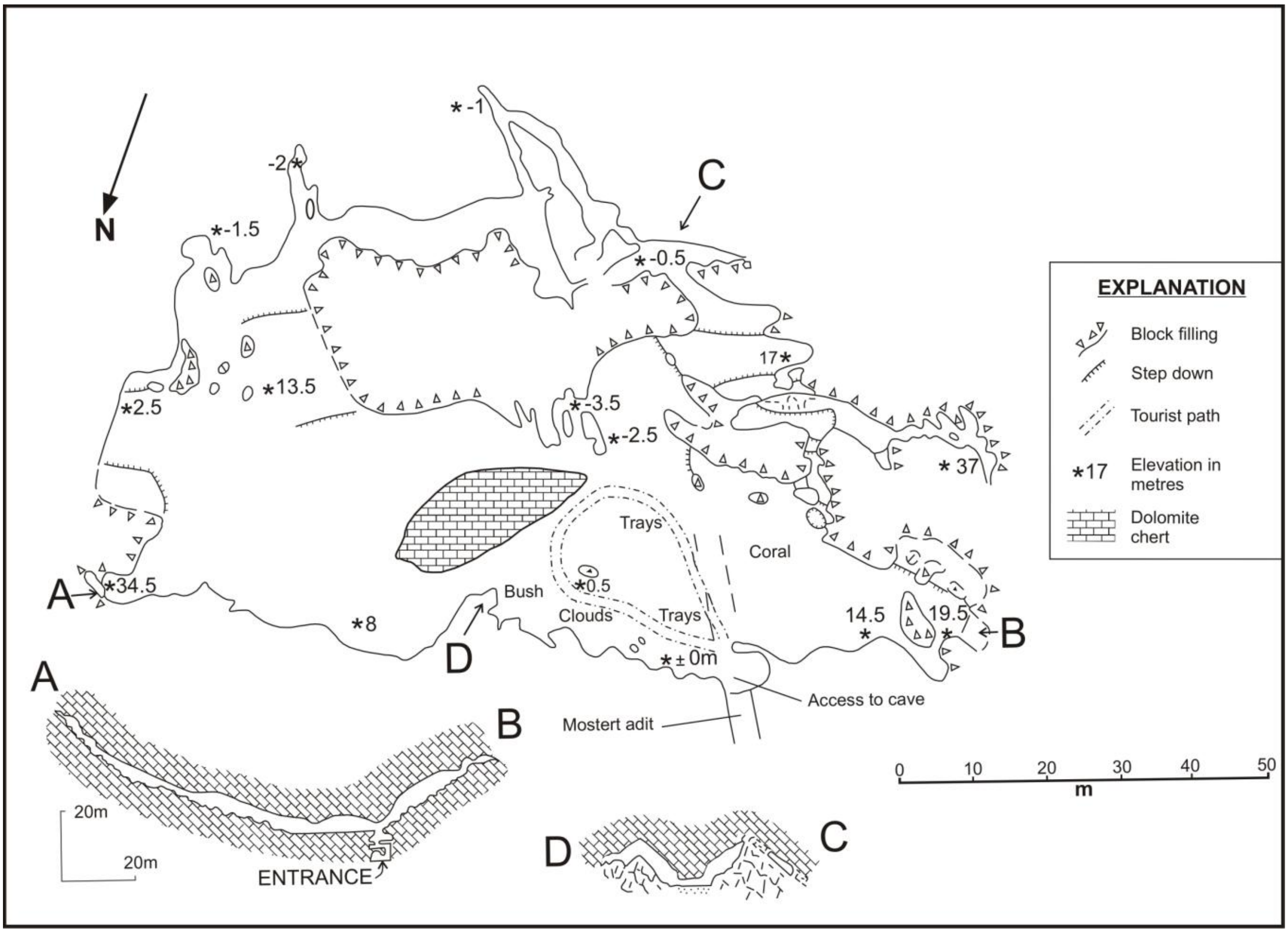
Simplified geological cross section through the Thabazimbi region. The cave is located in the dolomite on the northern slope of the Northern Range of hills.

In the Thabazimbi area, the Transvaal Supergroup strata has been affected by the emplacement of the 2060 Ga Bushveld Complex causing the strata to dip steeply (45 - 55°) to the south below the Bushveld Complex. The sedimentary beds have been duplicated by south-dipping thrust faults, resulting in two major mountain ranges, locally referred to as the Southern and the Northern range, and a minor Middle range (Gutzmer *et al*, 2005). Within the Penge Iron Formation dolerite sills occur and these have been duplicated together with the strata during thrusting.

The thrust fault system generally postdates the emplacement of the Bushveld Complex and has caused the Transvaal strata to override Bushveld-age granite and also Late Palaeoproterozoic Waterberg sedimentary rocks to the north of Thabazimbi (Gutzmer *et al*, 2005). Additionally, a series of NE-SW and NW-SE trending normal faults occur at Thabazimbi, and are presumed to postdate the Bushveld intrusion, thrusting and Waterberg sedimentation (Gutzmer *et al*, 2005). These normal faults are generally only associated with minor displacement, but may be intruded by dolerite dykes. (Chisonga, 2010).

Description of the Cave

Since January 2010, access is permanently prohibited. Access was gained via the Mostert adit that was opened approximately half way up the hill that overlooks Thabazimbi town. The cave is located several meters above the roof of the adit, so access is gained via two separate flights of near-vertical steel stairways, which are locked-off from the adit by a steel door. One climbs up these and then effectively enters the cave head-first, immerging from the stairs below (see map below: “access to cave” is point of entry from below, and Section A-B). This entrance to the cave is approximately 8 m above the top of the mine adit below.



Plan view of the Thabazimbi cave and two cross-sections A-B and C-D. Redrawn from Martini (1986a).

During January and February 1986, Martini and members of SASA mapped the cave in detail using a measuring tape, compass and clinometer. Some of the contents of the cave were documented and published in the local Bulletin of the South African Spelaeological Association (Martini, 1986a and 1986b). These publications are difficult to obtain, even in

South Africa, but copies are in the possession of the author of this report. Therefore, extensive reference is made here to these two articles for the fundamental description and data dealing with the cave's dimensions and speleothems, and also for the proposed genesis of the cave.

The cave measures 110 meters long by 40 meters wide, at its widest point. If a 0 m elevation datum level is taken as the top of the access ladder at the cave entrance then the two highest sections of the cave above this datum are in the west (34.5 m higher) and south-eastern point (37 m above datum) as mapped by Martini (1986a). Some sections of the cave are below the 0 m datum, for example, the south-central sections. Some portions of the cave walls and fallen blocks are barren surfaces. Other portions of the cave's hanging wall consist of sequential layers of chert that form a ribbed effect; white rhombohedral calcite crystals have nucleated on the edges of the chert bands. A predetermined path is controlled by ropes and poles ("tourist path" on map) delineating a circular route of about 100 m. While traversing this path, examples of speleothems, namely clouds, aragonite bush, frostwork, popcorn, trays (Martini, 1986b) and corals can be seen. During a visit to the cave, access was allowed to explore further afield beyond the confines of the tourist path. In the extreme north-western portion, there is aragonite frostwork accumulations on a section of the cave floor and crystallized on fallen dolomite blocks. In places these formations rise up to half a meter above the floor. The aragonite is extremely delicate and snow white.

Speleothems in Cave: Descriptions and Photographs

Speleothems are defined as secondary mineral deposits that have formed in caves (Moore, 1952; Self and Hill, 2003) and they are not individual mineral crystals *per se*, but, with few exceptions, are formed by aggregates of minerals. Speleothems are thereby differentiated from the surrounding and enclosing cave bedrock and from sediments deposited in caves. Hill and Forti (1997), in their *opus magnum* of caves minerals of the world, describe thirty eight different varieties of speleothems, some of which are found in Thabazimbi cave. A notable feature of Thabazimbi cave is the virtual absence of typical smooth botryoidal stalactites, stalagmites and draperies. The speleothems consist almost exclusively of aragonite and / or rhombohedral and botryoidal calcite.

Photomozaic of the western section of the cave (the portion between "C" and "B" on the plan) showing chert blocks with rhombohedral calcite crystals preferentially coating the edges. Note the rubble on the floor that is collapsed roof material. Part of the tourist path rope is on the left. Field of view is approximately 20 m.

The aragonite is present as very delicate crystals up to several centimetres long that either protrudes vertically out from the cave walls, or as masses (bushes) of aragonite on the floor of the cave. These are similar to formations that have been called frostwork by Hill and Forti (1997) as they look very much like masses of frozen ice crystals scattered in the cave. Self and Hill (2003) refer to the frostwork as crystallictites, an ontogeny term for aragonite formations that branch and that are composed of crystals. Some aragonite stellate clusters in the cave have nucleated on botryoidal, mammillary calcite, called coralloids (Hill and Forti, 1997) and corallites which are:

"..... *aggregates composed of spheroidalite individuals and so have a rounded form and a branching pattern due to the uneven growth* ...."

(Self and Hill, 2003, page 138).

Examples of coralloids are popcorn and cave coral, and both varieties occur in Thabazimbi cave. Aragonite bush resembles three-dimensional dendrites as the delicate acicular aragonite crystals bifurcate and crystallize outwards as arborescen*t* structures. Because the cave has never had a surface opening, almost all of the speleothems are still in a pristine state. There are some parts of the cave's interior where the surfaces are coated or partially coated by dust and cave residue. This was most likely caused by the nearby mining operations where blasting caused local seismic disturbances in the cave's environment producing dust inside the cave. Similarly, there are large slabs of dolomite that have detached from the roof of the cave and that lie on the floor. When and how these fell down is not known, and could be via natural weathering phenomenon over the millennia or due to the disturbances caused by mining in the region (see "Genesis of the Cave" below).

Close-up of part of the formation shown in the previous photomozaic. Thick layers of calcite coat the protruding edges of the hard chert layers. Note the head for scale.

Frostwork formations of aragonite bush are not exclusively found on the cave floor. Delicate acicular aragonite formations also attached to the sides of the cave and on portions of the fallen blocks. In these settings, the aragonite is usually a later, secondary overgrowth on top of earlier formed botryoidal calcite.

General view of a section of the cave showing the dolomite breccias rubble strewn floor. Some aragonite overgrowths occur on the rubble, suggesting that the fall may be ancient and not mine related.

In situ botryoidal calcite coralloid calcite and delicate acicular aragonite frostwork projecting from the cave roof. Note hanging droplets of water. Field of view is approximately 1m.

In situ calcite and aragonite coating the cave wall, partially stained by dust and iron oxides. Field of view is approximately 2m.

Delicate in situ aragonite frostwork rising from the cave floor. The main crystal cluster is 25 cm.

Delicate in situ aragonite frostwork rising from the cave floor. The main crystal cluster is 25 cm.

Aragonite frost crystallized on the edge of a dolomite matrix coated in reniform and botryoidal calcite / aragonite. The field of view is approximately 2-3 m.

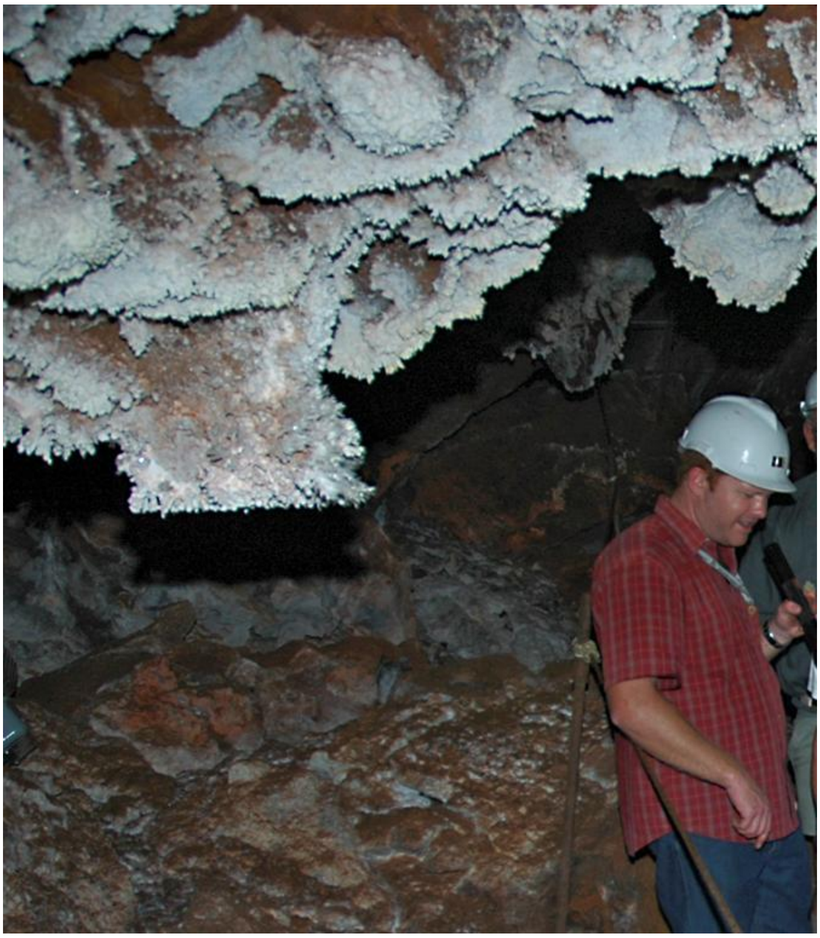
Calcite is present as white to off-white, well-formed euhedral rhombohedra up to 8 mm that partially coat the edges of chert layers hanging down from the roof in the western part of the cave. These formations produce an attractive white coating of calcite on the dark chocolate-brown chert. Calcite also occurs as coralloid speleothems (Hill and Forti, 1997). These deposits consist of elongated stems of fine grained calcite that have round, bulbous terminations producing club-shaped structures. It appears that the coral formations were originally aragonite that has been pseudomorphically replaced by calcite. Many of the coral stems are hollow, forming soda straws, caused by the dissolution of aragonite coinciding with the calcite precipitation (Martini, 1986a). Aragonite is less stable than calcite and crystallizes by rapid evaporation when magnesium is present thereby delaying the crystallization of calcite. If there is moisture present, then aragonite can convert into calcite which is the more stable form of calcium carbonate. Spectacular sprays of aragonite frost often radiate out from the calcite coral. Delicate aragonite crystals also nucleate onto the ends of stalactites composed of calcite popcorn forming polymineral multiaggregates (Self and Hill, 2003).

Martini (1986b) describes aragonite trays from the Thabazimbi cave and although these structures may not be very aesthetic, their very unusual shape and mode of formation are virtually unique in South African caves; they are known from only one other cave, the famous Cango Caves in the Western Cape Province and here they are composed entirely of calcite and have a somewhat different form:

> *"However, the most extraordinary speleothems in the* (Thabazimbi) *cave, although not the most outstanding aesthetically, are what are designated here as "trays". They are developed at the extremity of roof pendants and consist of inverted tables made of aragonite needles and cave coral. ……. These "trays" seem quite rare ……..*

Their peculiar character is due to the fact that they develop only horizontally and vertically but cannot grow downward, as if in this direction they are limited by some invisible barrier. Observations show that this limit does not correspond to a former surface of a pool as the "trays" develop at any level and that their positions are controlled by the elevation of the roof pendant extremity. It was also observed that water is actively dripping from the "trays" and is saturated or slightly undersaturated in calcium carbonate as no deposition occurs on the floor below the "trays": on the contrary, corrosion holes have been observed in the carbonate crust".

(Martini, 1986b).



Flat-bottomed in situ speleothem tray. The flat, horizontal lower surface typifies all of these tray formations, although the flat bases are at varying elevations in the cave.

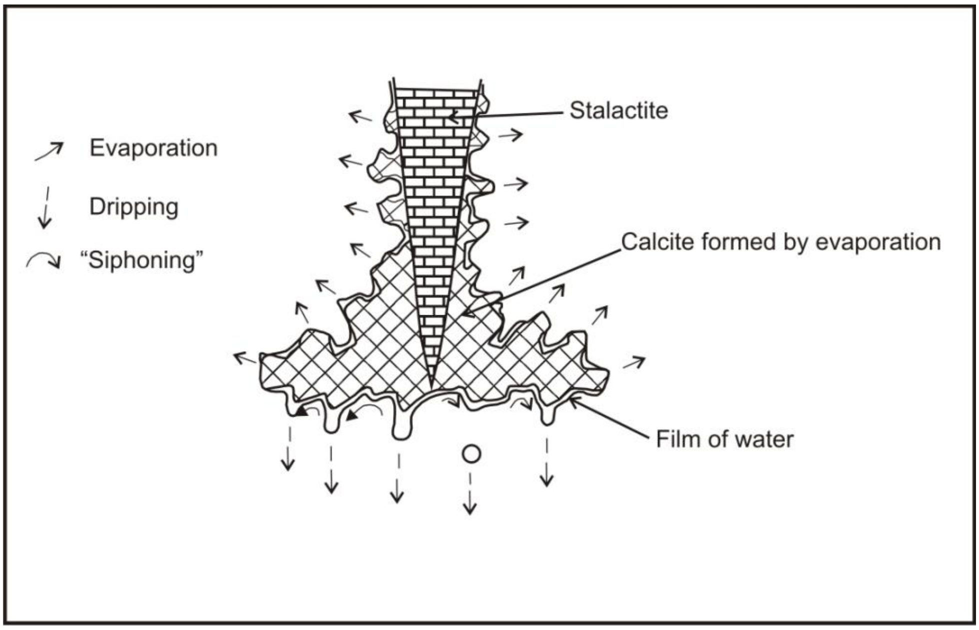
The formation of these interesting aragonite trays in the Thabazimbi mine cave is related to four mechanisms:

1. "*The elevation of a tray is controlled by the tip of stalactites and roof pendants. This elevation varies from one tray to another and eliminates the hypothesis of control by the surface of an ancient pool, where one would expect the trays to be located at common levels*
2. *Observations in the Thabazimbi Mine Cave showed that water dripping from the trays is undersaturated in calcium carbonate. This eliminates the possibility of*

deposition by CO_2 release only. The alternative mechanism is then by the concentration of the solution by evaporation.

3. *In the case of calcium carbonate deposition by evaporation, the maximum rate of deposition is achieved only a certain time after undersaturated seepage water enters the cave.*
4. *Where evaporation occurs, water can continuously rise up the walls by capillary action, which is impossible when the atmosphere is saturated in humidity".*

Keeping these four remarks in mind, the following model may be proposed. A slightly undersaturated solution flows along a rock pendant or along a stalactite. If the flow is sufficiently fast, most of the solution will leave the pendant or the stalactite without having reached saturation by evaporation. The only places where it can stay long enough to achieve this saturation are "off the main currents", where stagnation occurs: any positive reliefs like asperities, ledges, etc. Here aragonite or calcite is deposited. The more the crystals grow, the more solution is attracted toward these "precipitation centres" as the surface available for evaporation increases. For instance the surface of a cluster of thin aragonite needles is considerable and should act as a powerful "capillary pump". On a pendant no crystal growth is possible below the tip: as soon as a crystal grows downward, it attracts water and abundant dripping stops deposition of $CaCO_3$. Growth is only possible upward and laterally explaining the remarkable flat surface of the trays". (Martini 1986b)



Cross-section of a tray speleothem. Evaporation promotes calcite precipitation caused by oversaturation of calcium carbonate. The excessive flow (dripping) from the lower surface prevents evaporation and calcite crystallization, hence the flat, tray-like surface. (Redrawn from Martini, 1986b).

In addition to the carbonate speleothems, there are some secondary, weathered layers of brown, soft spongy-form material coating fallen blocks of rock in the central sections of the cave. This material is very soft, friable and has the texture of powdery talc – any form of contact causes it to instantly crumble into powdery clouds of dust-like particulate material. Samples of this were taken for X-ray diffraction analysis. XRD results identified the presence of quartz, dolomite and goethite. Trace amounts of mica, represented by phlogopite, and rancieite were also tentatively indentified however these need to be confirmed by other methods. Quartz may have formed from the dissolution of chert bands interlayered in the dolomites and redeposited by very slow evaporation (Cairncross and Dixon, 1995).

Precipitation of Calcite and Aragonite

In nature, carbon dioxide in the atmosphere is dissolved in rain water forming weak carbonic acid according to the following reaction:

$H_2O + CO_2 \rightarrow H_2CO_3$

Carbonic acid dissolves limestone and dolomite forming calcium bicarbonate and magnesium bicarbonate respectively:

$H_2CO_3 + CaCO_3 \rightarrow Ca(HCO_3)_2$
$2H_2CO_3 + CaMg(CO_3)_2 \rightarrow Ca(HCO_3)_2 + Mg(HCO_3)_2$

As rain water percolates through soil it takes into solution trapped carbon dioxide eventually reaching a point where is becomes saturated in carbon dioxide (McCarthy, 2009). This solution percolates into caves and once in contact with the air in the cave, a degassing of carbon dioxide occurs in order to establish equilibrium between water and air (McCarthy, 2009). Degassing or sublimation of the carbon dioxide causes the precipitation of calcium carbonate as the mineral, calcite, the release of liquid water and gaseous carbon dioxide according to the reaction:

$Ca(HCO_3)_2 \rightleftharpoons CaCO_{3(s)} + H_2O_{(l)} + CO_{2(g)}$
(s = solid; l = liquid; g = gas)

Magnesium bicarbonate is more soluble than calcium carbonate and tends not to precipitate and may contribute to the preferential formation of aragonite over calcite in caves. Calcite and aragonite are polymorphs. Although calcite and aragonite are composed of the same chemical elements, namely, calcium, carbon and oxygen and have the same chemical formula, they differ in crystal structure. Calcite forms trigonal crystals, whereas aragonite forms orthorhombic crystals (Curl, 1962). Calcite should be the dominant species of calcium carbonate formed by the loss of carbon dioxide and evaporation of natural calcium bicarbonate solutions if temperature is the controlling factor (Curl, 1962). Since appreciable amounts of aragonite are found in many cave deposits, as in the Thabazimbi cave, factors other than temperature must influence the polymorphs formed. Aragonite crystallizes by rapid evaporation in the presence of magnesium which delays the precipitation of calcite (Curl, 1962).

It appears that rapid evaporation in the cave environment suggests that the air in the cave is dry and that slow diffusion of solutions could represent a drier climatic period in which less water was filtering into the cave. During these periods, the rate of introduction of solution and rate of evaporation would change markedly resulting in the preferential formation of aragonite. Furthermore, the thickness of calcite layers in caves may correlate with rainfall, suggesting that calcite precipitation was largely dependent on the quantity of water supplied to the speleothem.

Genesis of the Cave

The cave is interpreted to have formed in two stages (Martini, 1986a). The first involved the formation of solution passages along joint planes in the dolomite-chert layers. These are indicated by the dotted line on the map in the southern and central areas. The second stage of formation involved the collapse of rock from the roof following continued dissolution of the dolomite and the progressive enlargement of the cavity. The passages and chambers formed in this period have a characteristic jagged roof accompanied by accumulations of heaps of irregular shaped rubble blocks of rock on the floor below. These two processes have produced a cave system that has "V" shaped profile (sections A-B, C-D on the map).

Discussion: The National Heritage Resource Act (1999), Caves and Rare Geological Specimens

The current NHRA (1999) Act no longer specifies that caves or cave deposits are afforded protection by the Act. The previous version of the Act did include caves and cave deposits together with fossils and meteorites. The latter two are still included in the Act together with a new category deemed, quote, "*rare geological specimens*". The question therefore arises whether the Thabazimbi cave contains rare geological specimens and whether these should be afforded heritage status via the "*rare geological specimen*" clause. This particular section of the Act is fraught with problems and these have been discussed (and published) by Cairncross (2011). Defining rarity with respect to geological specimens is extremely difficult and the NHRA does not provide any definition of such "*rare geological specimens*". A copy of Cairncross (2011) is attached with this report and reference should be made to it in this regard. Suffice to say that the rarity status of the Thabazimbi cave speleothems is open to debate. For example, their mineralogical composition – calcite and aragonite – is common, not rare. However, their morphological features, particularly the aragonite frost and trays, would be acknowledged, within the South African context, to qualify as rare, based on their abundance in other known South African caves. A complicating legal aspect in this particular case exists, *inter alia* from Cairncross (2011)*:*

"The NHRA is at odds with South Africa's current Mineral and Petroleum Resources Development Act (MPRDA) of 2002. This Act, under one of its definition clauses states:

> *"Mineral": means any substance, whether in solid, liquid or gaseous form, occurring naturally in or on the earth or in or under water and which was formed by or subjected to a geological process, and includes sand, stone, rock, gravel, clay, soil and any mineral occurring in residue stockpiles or in residue deposits….."*

Therefore, "rare geological specimens" fall under the definition of the Mineral and Petroleum Resources Development Act as they are all minerals. Any operating mine or activity that is extracting "minerals" is therefore contravening the NHRA because undoubtedly, some of the operations will periodically mine, process and destroy rare geological specimens. The corollary is that the MPRDA takes precedence over the NHRA and rare geological specimens have no protection if they are exploited by activities related to legal exploitation of South Africa's mineral resources. This dilemma needs to be addressed. One way to do so, would be to have an amendment to the NHRA wherein is stated that mines operating under the jurisdiction of the MPRDA are exempt from the "rare geological specimens" clause as exploitation of ore bodies cannot but mine and destroy rare specimens from time to time."

The fact that this particular cave and its speleothems (minerals) are the property of an operating mine implies that the mine is legally operating under the ambit of the MPRDA and therefore can proceed with mining in or near the Thabazimbi cave. A similar situation exists (existed) with the Rand London dolomite quarry located on the outskirts of Krugersdorp in Gauteng. During the 1970's and 1980's, this quarry extracted dolomite from an open-pit / quarry located in the same geological formation that contains the Thabazimbi cave, notably the Transvaal Supergroup dolomites. This quarry operated during the time when the previous Heritage Act was in force and caves and cave deposits were still then afforded protection by the older version of the Act. Even so, the Rand London Company (and later Anglo Alpha who took over the quarry) mined within their legal right and consistently destroyed caves and magnificent cave speleothems within the quarry during normal day-to-day blasting and extraction of the dolomite hosting the caves.

Conclusion and Recommendations

The Thabazimbi mine cave contains speleothems, notably aragonite frostwork, popcorn coralloids, polymineral multiaggregates and trays. In the opinion of this author, the aragonite frost and trays would qualify as rare geological specimens under the current NHRA (1999). Future mining operations make the continued existence of the cave uncertain and local disturbances caused by surrounding mining activity may already be having an impact on the cave's contents.

Regarding the legal status of the cave via the NHRA (1999), the following factors need to be taken into consideration:

1. The cave has never had a natural opening to the surface and would have lain undiscovered without the accidental discovery during mining operations over 50 years ago. As such, there is no public access to the cave, either by humans, animals or even flora.

2. The cave has, in the past, been accessed by small, controlled groups, and this has already had some impact on the cave and its contents. For example, a walkway with confining ropes was installed to restrict access during visits. Therefore, some artificial disturbance has already taken place, although minimal.

3. It appears that future mining in the area, according to learned opinion at the mine, will have an impact on the cave and its speleothems. The extent of the impact is unknown and could vary from minor dust disturbance in the cave to total catastrophic collapse of the cave. Whatever the effect of surrounding mining, future access will be prohibited due to safety reasons. This implies that after mining proceeds, the cave will never be accessed again and will be sealed forever.

4. Based on (3) above, this report proposes that a salvaging operation be put in place prior to mining. This would involve the following procedure:

- A selection of as many different types, varieties and sizes of the speleothems must be carefully and professionally collected. This requires specialist collecting techniques that minimize damage or, preferably, omits damage completely to the speleothems. They will need to be collected and properly handled and packed while in the cave and then transported out of the area. <u>**NOTE:**</u> It is important to state here that due to (a) the hardness of the dolomite substrate and (b) the delicateness and fragility of the speleothems, most speleothems may be unsalvageable and best efforts will probably only yield a small percentage of the cave's content. But this would be preferable to nothing. Furthermore, the relatively narrow opening at the entrance to the cave precludes any salvaging of very large speleothems. Those collected, would have to be packed / laid in small open boxes lined with very soft material such as dry cleaning plastic. These small boxes would then be placed in large cardboard boxes also lined with soft material to buffer any potential damage. Boxes will have to remain open to avoid damage to the specimens. These boxes will then have to be lowered carefully down the metal stairs and loaded in vehicular transport parked at the steel door in the Mostert Adit. An inventory of specimens will be made and the samples then transported to a place of safekeeping until they can be dispersed to the relevant organisations.
- It is proposed that these specimens get donated to local museums, notably the Transvaal Museum in Pretoria and the Johannesburg Geology Museum in the Museum Africa complex, Johannesburg and any other museum with proper geological collection and curation protocols where the specimens can be properly housed and preserved. If sufficient speleothem specimens are collected then these could also be donated to local university geology departments for curation and preservation purposes, or similar institutions.
- A scientific article will be written and published on the cave and its speleothems thereby documenting it for posterity as it will no longer be accessible or may even be destroyed.

Point number 4 above may well be contentious because collecting or disturbing cave speleothems is discouraged globally (Cabrol, 1997) and caves and cave deposits are universally considered as sacrosanct. However, this particular cave and its future survival is unique and its existence and contents will be lost forever unless a proactive campaign such as that proposed in (4) above is implemented.

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