Pre-colonial mining in southern Africa

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Synopsis

This paper summarizes indigenous mining methods used to collect metal ores in pre-colonial southern Africa, south of 15°S. These methods, for the purposes of discussion, are divided into sections in order of increasing organizational complexity, from scavenging, which only required basic equipment and a relatively minimal division of labour, to underground mines, which necessitated complex planning to overcome obstacles such as the need for illumination and ventilation. Examples concerning the pre-colonial exploitation of iron, copper, tin, and gold have been taken from the archaeological literature. This review paper provides an introduction to the technology that was available to and used by miners in the past, illuminates some of the factors limiting their operations, and supports the claim to the indigenous nature of this activity.

Introduction

Mining, as defined by Stocks and Down is the 'removal of minerals from their natural geological environment and their transport to the point of processing or use[1]'. As so defined mining has, in one form or another, been providing essential raw materials for tens of thousands of years. Although metal ores were first mined in southern Africa (south of 15°S) approximately 2 000 years ago, minerals such as ochreous haematite, specularite, and pyrolusite were sought for use in cosmetics millennia earlier[2]. It is not uncommon for pigment minerals to be found in Middle Stone Age contexts[3], and dates as early as 40 000 BC have been suggested for the oldest of these mines[4].

Because metal working had far-reaching social, economic, and technological effects on human life in pre-colonial southern Africa, research on the mining and metallurgy of the period is interdisciplinary in nature. It has attracted a diverse range of researchers, from those focused on the socio-cultural and ethnographic aspects, to archaeometallurgists analysing ancient artifacts, to archaeologists documenting their finds of ancient mines, furnaces, and smelting sites. In spite of these efforts, achieving a holistic picture of past mining and metallurgy in southern Africa is like solving an old puzzle: one places various pieces together only to discover that many pieces are still missing. This is especially true with regard to mining. Although the field of archaeometallurgy is rapidly improving our knowledge of smelting and smithing technology, our understanding of early mining is still far from complete[5].

Smelting operations have often left behind tangible evidence in the form of a product that is perceived to have some cultural or historical value, for example an ingot or the remnants of a constructed furnace. The perceived value of many 'ancient' mines, however, has been predominantly that they indicate the location of deposits and thus they (and the evidence they contain) have often been destroyed by colonial prospecting and mining[6].

Compounding this problem of destroyed evidence is the fact that the southern African region lacks an indigenous written historical record and much of the knowledge conveyed through the oral tradition was truncated with the coming of colonialism[7]. Thus, we must rely on archaeological insights gained from the survey and excavation of surviving sites (see Figure 1) to help reconstruct the past, supplemented by descriptions from early missionaries, prospectors, and mining engineers.

One troubling aspect of this lack of evidence is that it opens the door to unfounded theorizing which can fail to acknowledge the innovations and achievements of indigenous metal workers. There is absolutely no evidence of the physical presence of foreign miners in southern Africa during the Iron Age[8].

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Figure 1—Map of southern Africa showing the principal archaelogical sites mentioned in the text

Nevertheless, there are both literature and media productions that attribute the 'ancient' mines to foreign influences, be they Sumerian, Phoenician, Indian, Arab, or Egyptian[9]. The weakest part of such arguments, Herbert asserts, is that 'mining techniques show so little difference throughout central and southern Africa and so little similarity to those in use outside sub-Saharan Africa from late antiquity onward[10]'. What similarities that do exist are those imposed by geological constraints on the exercise of a fairly rudimentary mining technology. One could also point to the uniform metal fabrication technology employed in southern Africa throughout the Iron Age, and its manifest difference from contemporaneous technologies from India, the Middle East and north Africa. Further, as argued by Phimister[11], there is nothing to indicate that foreign prospectors were necessary to 'get the ball rolling': simple curiosity would have undoubtedly led to the exploration of surface deposits by digging with sharpened sticks and washing. This report takes as given that ancient mining was practised by people who are ancestral to contemporary black Africans.

Although South Africa is the focus of subsequent sections of this report, this summary of pre-colonial mining methods has been extended to include archeological information gathered from sites elsewhere in southern Africa. As modern South Africa lacks a detailed account of early mining[12], this will allow insights to be gained from the more substantial body of research completed in Zimbabwe and eastern Botswana[13]. Examples from South Africa will be used where possible.

The mining techniques employed did not differ significantly throughout southern Africa[14]. The majority of pre-colonial mines for non-ferrous ores in Zimbabwe were for gold[15] while the majority of those in northern South Africa were for copper and tin[16]. The main sources of copper production in South Africa were in the Messina and Phalaborwa regions[17]. The centre of pre-colonial tin production was around contemporary Rooiberg in the central Transvaal[18]. Iron ores were widespread and readily available throughout the region[19]. Other metal ores, and minerals like diamonds were not mined until colonial times and have since become important to contemporary informal miners.

Although this paper focuses on the prospecting and mining of metal ores, this was only the first step in pre-colonial indigenous metal production. The reader is referred to other sources for information on the milling and recovery of the ore[20], the smelting and smithing of the ore[21], the metals trade[22], and the broader, historical context for these technological enterprises, including the spread of mining and metallurgy in Africa[23] and the socio-cultural context[24]. Summers' *Ancient Mining in Rhodesia and Adjacent Areas*[25], which details what he terms to be 'ancient' (here, pre-colonial) copper and gold mines and mining techniques, is perhaps the most comprehensive source yet written on the topic. Summers classifies, 'for convenience', ancient workings into four types[26]:

- Open stopes
- Open stopes with shafts
- Shafts with underground stopes
- Alluvial workings.

He clarifies that, although there are four types of ancient workings, there are basically only two *methods* of mining: 'open mines' (Class 1) and 'underground mines' (Class 2). He explains that Class 1A is a combination of these two, while Class 3 is a 'repetition of Class 1 which deals with a secondary occurrence instead of a primary mineralization[27]'. This paper will follow a similar scheme such that the different types of pre-colonial workings will be distinguished and discussed in order of increasing organizational complexity (the level of skill, technology, and decision-making entailed). For the purposes of this paper, mining techniques have been divided into three categories: scavenging, open mines, and underground mines.

Scavenging

It has been asserted that the excavation of minerals (for cosmetic purposes) and metals followed from more ancient hunting and gathering techniques[28]. The methods used in the collection of plants could have been applied easily to the collection of surface minerals, and bulb-digging techniques and tunneling methods (used for hunting underground game) could have led to the first surface scratchings. Although arguably not proper 'mining', scavenging for metal ores does involve the removal of minerals from their natural geological settings and is a precursor to more complex methods.

Scavenging leaves little tangible evidence, but there is no doubt of its occurrence. While copper, gold, and tin mining methods have tended to be more complex, there are numerous sites where iron ore could have simply been collected from the surface. Van der Merwe[29] describes two Iron Age smelting areas—Phalaborwa in the eastern Transvaal, South Africa, and Buhwa in southwest Zimbabwe—where 'pebbles of magnetite and hematite, respectively, with iron oxide contents in excess of 90%, occurred in quantity on the surface'. Mason[30] states that at places such as Broederstroom (South Africa), where the settlement dates from AD 350 to 600, people acquired iron and copper ore for smelting by collecting it from the surface where it was exposed by soil erosion.

While Summers[31] does not use the term 'scavenging', he does note that before open-pit mining for copper or gold, the rich surface outcrop was cleared and the surrounding downhill soil was searched for eluvial gold. Further, Summers' 'Alluvial Workings' category (Class 3) describes gold that occurs in alluvial deposits either in or beside rivers and he asserts that 'in such cases recovery is a simple matter[32]'. Placer deposits tend to be, by their very nature, easily and swiftly worked out[33], and Summers refers to such workings as mere 'surface scratchings[34]'. The methods used to work these shallow alluvial deposits are thus included as 'scavenging' as they involve gathering minerals without the planning and construction of a 'mine'. A special case of scavenging, albeit a more complex one, involves the working of alluvial deposits by underwater dredging. Summers provides the example of traditional gold washing in the Mazoe River in Zimbabwe[35]. From about May to September, when the summer floods have subsided, divers weighted down by a ten or twelve pound stone strapped to the small of their back are able to dredge for gold. Underwater, the divers shovel auriferous sand into a 'subrectangular wooden bowl' using a wooden, semicircular scoop. Once at the surface, the material is panned in another wooden dish and the concentrate is transferred to a special pottery dish where the sand is 'very carefully washed away' leaving the gold dust behind[36]. It is assumed that such methods are of substantial antiquity.

Scavenging, then, consisted of relatively simple methods and flexible organization, and involved no more decision-making than did food gathering. Tools were relatively unspecialized and probably restricted to carriers (i.e. woven baskets or leather bags), iron hoes (for shallow digging), and the clay or wooden implements used for gold washing. The only real constraint on such operations was a seasonal one: gold washing tended to be done in the winter months when the water levels were lower and miners could take advantage of any gold deposited by floods at the beginning of the previous summer[37].

Open mines

This type of ancient working, creating a narrow but deep trench, appears to be the most common[38], and is especially suited to rocks which dip very steeply or are vertical[39]. As Evers and Van den Berg explain, 'individual stopes are open trenches, sometimes very narrow and as long as 610 m. Stopes end-to-end can stretch for several miles[40]'.

These operations were much more complex than simple scavenging in terms of both the equipment needed and the necessary planning. The confined spaces in which miners had to work led to the development of specialized tools (Table I provides a summary of some of those associated with pre-colonial open mining methods), and there were several different techniques used to create open stopes[41].

After clearing the surface outcrop, Summers[43] asserts, the miners would 'attack' the reef (or 'ore body')—which was usually up to 1 metre wide—from both sides. This resulted in a trench approximately 3 metres wide, which could increase to 5 or 6 metres as the edges became trampled or eroded. Where the walls were of relatively soft rock, two reefs in close proximity were occasionally taken out as one in a technique referred to as 'side-stoping'. Where the walls were of hard rock, the reef was removed from beneath the miner, a method called 'underhand stoping'[44]. Summers cites the example of the Phoenix gold mine in Zimbabwe, where there were two parallel reefs bounded by magnesite-marbles: 'the only part the miners needed was the reef itself and if it could be extracted completely the resulting gap, which in this case

Table I

Tools associated with pre-colonial mining

Technique/Tool	Description	Purpose
Rock-breaking		
Stone hammers and pounders	Dolerite, diorite, or—more rarely—quartz-porphyry, 'greenstone' or granite	Rock-breaker. Also used to drive gads
Iron gads/chisels	Smaller ones were pointed at both ends, one end being held in a wooden handle. Larger ones were driven with stone hammers	Used to split ore
Stone wedges	Very few examples from ancient mines. Wooden wedges, although unknown in the archaeological record due to their impermanence, would seem a more likely tool	Used to enlarge or deepen a crack in rock
Firesetting	The process of heating rock and then cooling it rapidly (with water)	Used to crack rock
Digging Tools		
Hoe	A heavy diamond-shaped iron tool hafted in a wooden handle. Hoes worn down in the fields could be adapted for mine use	Used to break, dig, or draw soil. Gathered together broken rock to draw into a basket or other carrier
Shovel	Iron, with cranked shanks Smaller iron scoops known from Zambian copper mines	To gather ore
Haulage and Hoisting		
Small wooden bowls	Not many examples. It seems that in shallow diggings mined ore was passed in bowls from hand to hand until it reached the surface	Haulage in shallow mines
Buckets (wood/hide/bark/clay)	Not many examples. A small bucket (approx. 3 litre capacity) with three holes for suspension has been found	Haulage and hoisting in deeper mines
Baskets	At Messina, some traditional evidence has been obtained that baskets made of tightly woven palm ribs and reinforced with a leather cover were used	Carrying ore

Compiled from Summers and Phimister[42]

was comparatively wide, would lead down to more reef[45]'. The ancient excavations followed the main reef down to 30 metres where, Summers suggests, it was abandoned due to increasing depth. The adjacent Globe mine was abandoned at 24 metres due to the presence of water[46].

Similar constraints are noted by Fagan[47] in his description of the Leopard Kopje copper mines of the Messina region in the Northern Transvaal (before AD 900 to after AD 1500): a trench was dug and widened according to the dip of the strata, and the work was carried as far down as the water table and ventilation would permit (some workings going as deep as 40 metres below the surface). As the indigenous miners had no means of pumping water from their mines[48], the water table was a limiting factor in pre-colonial workings. Phimister[49] suggests that the seasonal fall in the water table made reef mining viable at greater depths, and thus mining activity was often confined to the winter months.

Another physical factor limiting these miners relates to the geology of the deposit: as stated by Miller, 'indigenous copper mining was restricted to the oxidized surface zone of ore bodies to recover azurite and malachite[50]'. Fripp[51] makes a similar observation pertaining to gold mines, stating that the transition from oxidized surface ore to sulphide ore posed problems for ancient miners as the sulphide ore contains a much smaller percentage of free gold, is of a harder consistency, and was difficult for them to smelt. Further, the distribution of the desired mineral in the lode was often problematic as there are numerous instances where workings ceased 'through a slight dislocation in the pay shoot, in some cases this being only two or three feet[52]'.

Mechanical factors limiting these operations included the need for ventilation at increasing depths and the use of firesetting techniques[53], the difficulty of transporting the ore to the surface in deeper mines[54], and the caving of mines due to rock instability. An example of this last problem occurred at the Gaika gold mine in Zimbabwe:

➤ 'The complexity of the ore bodies was not fully appreciated by the ancients who, at a depth of 40 or 50 ft, found that the reef split so they followed down the separate sections leaving a comparatively thin section or 'horse' standing between the two stopes. After a while the mass of barren material, no doubt far thinner than the ancient miners realised, collapsed and trapped one of the miners whose skeleton was discovered in the 1940s during development work[55]'.

Many mine trenches may have been back-filled to prevent such disasters as well as to clear waste material from the working area[56].

Open mines thus involved much more organization, technological innovation, and decision-making than did scavenging. Miners had to have a conceptual understanding of the reef in order to decide how to extract it, as well as the tools and practical skills necessary to do so. Further, the numerous physical and mechanical obstacles necessitated more social cooperation and a series of technological decisions ranging from how to 'attack' the reef to when to abandon it.

Underground mines

When there are horizontal reefs, Summers[57] claims that it is necessary to approach the reef 'by a shaft at the foot of which the ore is taken out by an underground stope'. When the reef dips between 15° and 45°, a combination of open workings and shafts was often used. Both variations are included in this section along with what Evers and Van den Berg[58] consider a separate class of workings; adits (sub-horizontal underground tunnels). Shaft diameters in pre-colonial workings vary significantly, and were usually 6 to 15 metres deep[59].

The earliest South African example of a shaft, gallery, or adit was found at Lolwe Hill, Phalaborwa, where ancient miners sought malachite and azurite (the site is now the location of a large open pit mine). A shaft 6 metres in depth with a 10 metres horizontal gallery was dated at AD 770 by Van der Merwe and Scully[60]. This marks the beginning of an Iron Age sequence at Phalaborwa: adjacent workings have been dated at AD 1000 and AD 1750. Van der Merwe and Scully[61] assert that the diggings follow the veins with great accuracy, and 'were small enough in diameter to indicate the use of child labour...in many instances'. Although the picture is not complete, vertical shafts, some as deep as 20 metres with diameters as small as 0,45 metres were found; in some cases the shaft is said to end abruptly in a round chamber, while in others it branches off into horizontal galleries. A semi-circular trench, roughly 30 metres long at the top and 20 metres deep at the middle, was also revealed, as well as a partially filled adit. Among the tools associated with this mine were iron gads, chisels, and dolerite hammerstones. A heavy deposit of charcoal on the floor of a gallery was presumably the result of firesetting to break rock from the gallery walls.

The details of these pre-colonial workings are not just evidence of the mining techniques used by the indigenous miners, but of their technologically-based decisions. Underground mining utilized the same tools as open mining (Table I), and involved all of the physical and mechanical constraints previously mentioned. Because these mines were significantly more complex, however, the problems relating to mine stability, ventilation, illumination, and transportation of the ore to the surface were significantly more severe and required the miners to make complex development strategies.

In the Harmony Block of the north-eastern Transvaal, Evers and Van den Berg[62] investigated a copper mine consisting of twenty-five units containing thirty-one shafts and one open stope; one unit has been dated to the thirteenth century. 'Unit 22', consisting of a vertical shaft 5,5 metres deep and opening into a two-section stope, was unique in the quantity of preserved timbering discovered there. Twenty-one posts or pieces of wood were removed or exposed in the clearing operations. Of these, seven were in positions suggesting that, prior to collapsing, they may have formed a platform to facilitate access to the working and removal of ore. In the stope, three props were found still *in situ* supporting the hangingwall[63].

Safety measures such as these did not, however, always have the desired effect. Summers[64] reports that in spite of pillars of ore left for support in the Aboyne gold mine (a twelfth century mine located in Zimbabwe and consisting of both open stopes and underground workings), a series of collapses occurred at the edge of the stope. Several skeletons were found in positions that suggested the miners had been killed by a roof fall. In at least one case, pillars are not evidence of the miners' concern for safety but of their selectivity. Baumann[65] reports that a number of pillars were left in a stope at the Weynek tin mine not to support the hanging, 'but simply because the value had gone out of the ore'.

Although back-filling (packing rubble into already-mined stopes) for support was used as a safety measure in some mines[66], it also served the purpose of aiding in ventilation[67]. By allowing only two means of access to the upper surface at any time, 'one shaft could be used as an up-draught chimney drawing air down the second[68]'. This was necessary to remove noxious gases from firesetting.

The Rooiberg tin mines of the central Transvaal, South Africa, were the centre of pre-colonial tin production in southern Africa and have been dated to the fifteenth to seventeenth century AD on the basis of charcoal embedded in a tin artifact from the area[69]. Friede[70] states that the mines were 'opened by the sinking of vertical or inclined shafts, and the tin lodes were followed by drives to pockets and pipes'. Baumann[71] reports that some of the pockets were so low and narrow that 'the ancient miners had evidently to lie quite prone with back and sides touching the wall'. Some old workings contain shafts only 0,3 to 0,4 metres wide and 10 metres deep and it is assumed that these were ventilation shafts[72].

In addition to providing insight into how the pre-colonial miners dealt with ventilation, the Rooiberg mines also provide insight into the methods used to transport the ore to the surface. At the bottom of one working a tree was found '6 in. in diameter at the base and about 14 ft. long with branches hacked off about a foot from the stem[73]'. This tree had evidently been used as a primitive ladder. In another old Rooiberg working, a number of steps or footholds have been cut out from top to bottom of the soft footwall, dipping at 75 degrees. Baumann[74] also suggests that broken ore was probably carried to the surface in baskets or grass bags, although no remains have been found due to their impermanence. The possibilities of leather bags[75] and earthenware pots and baskets[76] being used as carriers have also been discussed.

Evers and Van den Berg[77] suggest that the Harmony copper miners may have used a ladder similar to that found at Rooiberg, and that steps similar to those reported by Baumann were cut into the wall of a shaft at Messina. Summers[78] suggests that at the Umkondo gold mine in Zimbabwe, ropes may have been used to hoist men and material to the surface.

It is more difficult to reconstruct how pre-colonial miners dealt with the need for illumination. Evidence of artificial lighting has not survived in the archaeological record. Most mining was probably done in daylight, but it has been suggested that natural light sometimes had to be supplemented by torches made of long-burning leaves or pods[79].

As these examples demonstrate, the level of skill, technology, and decision-making involved in an underground working far exceeds that required in either of the other two categories, making these operations the most complex—and the most dangerous. In spite of the technological innovations developed by these miners (including the use of timbering, pillars, and back-filling for support), safety was always an issue as the skeletons in the Aboyne and Umkondo mines attest[80].

Due to the complexity of these operations, Mason[81] asserts that 'mining as an exercise involving sinking shafts and galleries into solid rock probably did not develop until populations had increased to a point where specialist mining activity became both possible and profitable'. Although there is not much information available regarding the level of social stratification in the Iron Age communities, there is reason to believe that such specialist mining activity had to be supported by others in the community, indicating a distinct division of labour.

Discussion

The three main mining activities—scavenging, open mining, and underground mining—are not necessarily discrete. All three techniques were often used by the same group of people at the same time and place. Further, although it is likely that scavenging was used before open mining and open mining before underground mining, and should not be seen as evolutionary steps. The more complex techniques did not *replace* the less complex. As Evers and Van den Berg[82] make clear, these different types of workings 'probably reflected differences in geological structure and mineralization'. Materials lying on the surface (i.e. magnetite pebbles) were simply gathered. Lodes that dipped very steeply (or were vertical) tended to be open mined. Lodes located some distance beneath the surface were mined using shafts and underground stopes. Thus, although iron ore was often scooped from the surface or from shallow pits[83] and mining for copper, gold, and tin tended to be more complex, mining for each of these metals was not limited to any one technique.

Factors limiting these pre-colonial operations were both physical and mechanical. Physical factors that led to the abandonment of many workings included the presence of water, the distribution of the desired mineral in the lode (i.e. a dislocation in the pay shoot), and the transition from oxidized surface ore to sulphide ore. Mechanical factors, which were overcome in many workings but limited the extent of others, included the need for ventilation and illumination, the transportation of ore to the surface from greater depths, and mine instability.

These indigenous technological achievements took place within a social setting which we aim , to some extent, to reconstruct. More complex operations required more time, effort, and skill, and thus more support from other members of the community. Mining, as Phimister[84] asserts 'was tied to and grew out of agricultural activities'. Mining was predominantly a dry season activity[85] as this coincided with both a fall in the water table and the time between harvesting and planting: this meant that the 'search for and working of reef outcrops could be combined with land clearance for next season's crops[86]'. Collett[87] provides a warning regarding the dangers of divorcing technology from culture:

- 'In recent centuries European culture, in its scientific manifestation, has treated technology as a series of physical or chemical processes...while this approach is useful in the understanding of technology in scientific terms, it is less useful when it is employed as a method for understanding productive processes in societies that do not employ European scientific concepts. The problem with the scientific approach in the latter context is that it leads the analyst to divide the activities that occur during the production of an item into 'technological' acts and 'magical' or 'symbolic' acts. However, activities are rarely, if ever, divided into these two categories by the participants. Rather, they perceive all the acts that occur during the productive process as essential for a successful outcome'.

Thus, the ritual and symbolic aspects of technologies such as mining and smelting are, to the people involved, as crucial to success as we might term the more 'technologically meaningful' practices. The interested reader is referred to sources such as Childs and Killick[88], Collett[89], and Herbert[90] for information regarding the social and cultural significance of mining and metallurgy.

European colonization was the ultimate constraint on these indigenous operations as 'imported goods rapidly undermined the value of traditionally produced goods[91]' and local mining declined drastically. Although much of the evidence of pre-colonial mining has since been destroyed by modern mining operations, recent research has started to balance the colonial-oriented version of history with information regarding the achievements of indigenous miners and smelters—from whom, it seems, there is a lot to learn. Pre-colonial prospectors had to search for ore without the aid of satellite photography, magnetometers, seismic studies, and chemical analysis. By necessity, however, the ultimate goals of both ancient explorationists and modern ones had to be the same: to locate promising ore deposits and decide whether developing the site (mining) is justified. The skills that these ancient prospectors developed are reflected in the fact that by the time the European settler community arrived in the region almost every gold-bearing quartz outcrop had already been worked[92], nearly every viable outcrop of copper-bearing rock had been exploited[93], and hardly a tin lode of any importance was left untouched[94].

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