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Editorial

This issue of the newsletter, consists of a discussion of the idea that the Nyanga terraces are the product of gold mining endeavours by Mrs Ann Kritzinger. That this view is in complete opposition to current knowledge about the Nyanga culture is not in doubt. A variety of experts were invited to offer their comments on the piece and the author of the original article was given a chance to reply. I sincerely thank each contributor for taking the time to critique Mrs Kritzinger's ideas in a meaningful (and polite!) manner. Further sensible correspondence on this matter would be welcomed.

A Mining Perspective of the Archaeology of the Eastern Highlands of Zimbabwe

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Introduction - terraces and tanks

The agricultural theory explaining the archaeology of the Eastern Highlands of Zimbabwe is well documented (Soper 2002, Sutton 1983; Summers 1958). It is based on the assumption that small livestock was penned in thousands of stone-built pit structures to provide manure to raise the soil fertility of hillslopes for the purpose of intensive terrace farming between the 14th and 19th centuries. The hypothesis is published as fact in national textbooks and tourist literature, but there are anomalies inherent in the agricultural interpretation. The research presented here addresses this subject from a mining perspective.

The 'Nyanga' terraces extend over an estimated 7000 square kilometres from the Makaha Gold Belt in the north to the Biriwiri region of Chimanimani in the south, the Mozambique border in the east to the Nyangombe catchment on the west. They are labour-intensively built, often with rough stone walls over a metre high, and can rise for many flights up stony hillsides. The pit structures are equally labour-intensive in construction. They are not pits but, built up from bedrock within heavy-duty retaining platforms, they are tanks with paved or bedrock floors inclined to the slope of the hill. A tunnel enters each tank from uphill and a small drain exits downslope, both constructed on the incline through the platform (Fig 2).

On average, the tanks are 6m in diameter and 2-3m deep. Generally the largest dimensions of the tunnel are found at its entrance into the tank, a lintelled aperture 1m high x 50cm wide give or take a few centimetres. Contrary to the stockade-building rule that "The gate should not be at the highest point, otherwise it becomes a channel through which water runs into the kraal" (Turnbull 1950:30), the uphill position of the tunnel is inappropriate and frequently aggravated by radial walls directing runoff into the tank, something best observed during a rainstorm.

In the agricultural theory these radial walls are "interpreted as sheltering a homestead garden" (Soper 2002: 89; also see Soper 2005: 38-40). The exposure of the tunnels to downhill runoff is construed as "something like a sewage farm" (Soper 2002: 76-77, 127-128; Sutton 1988: 23), enabling liquid manure in the tank to be flushed through the drains. In this hypothesis small basin-like dams at the exit of drains from the platforms would serve to impound the effluent - a style of livestock management from the continent of Europe that is alien to the continent of Africa.

In order to confirm the precolonial practice of stall-fed livestock, production of slurry, and manuring of homestead gardens, 46 phosphate samples were taken in "potentially promising deposits" (Soper 2002: 7). Of those associated with pit structures, the highest values came from sites exposed to the grazing of modern livestock and wildlife. For instance 18 samples from "open grassy hollows" (Soper 2002: 89) of ruined pit structures gave an average 10 000ppm (Soper 2002: 77, 144, 167).

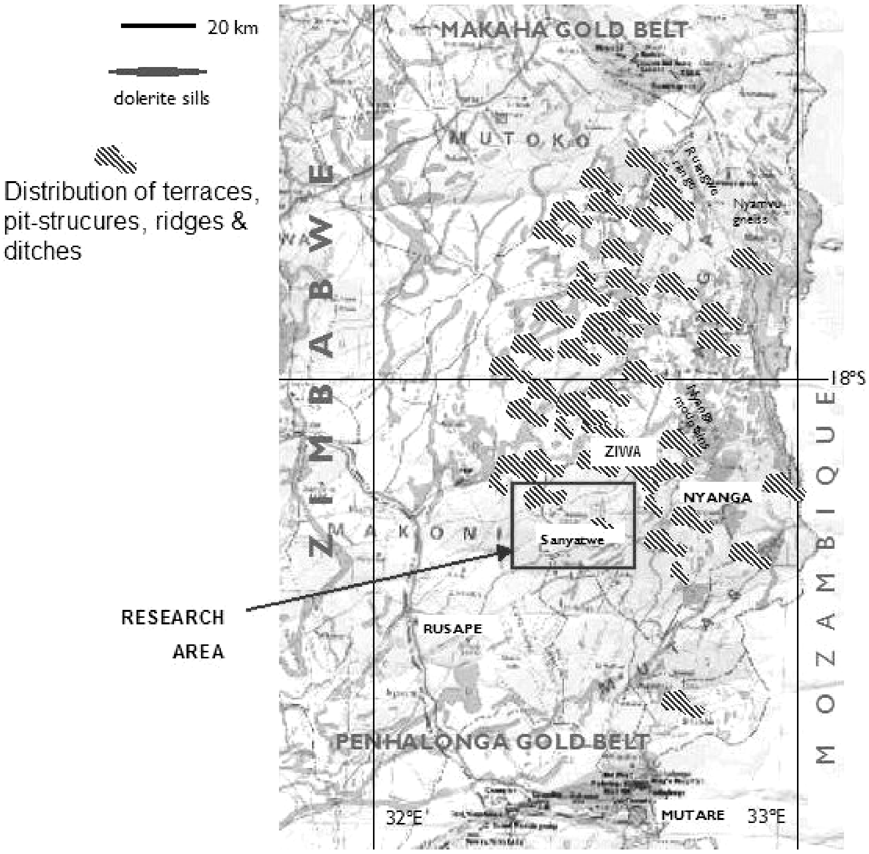

***Figure 1**: Location of Research Area*

Six samples tested from two well-preserved pit structures ranged from 220 to 770ppm. Only five samples showing the higher results of 8000-13 500 were "consistent with keeping livestock in a pit" (Soper 2002: 179). Five samples taken from "accumulation of slope wash" behind a radial wall gave "very low values" of 291-789ppm, showing "little here to confirm manuring of the garden" (Soper 2002: 179).

There were "no surviving traces of dung deposition on or between the paving stones" of structures called divided houses (see below), where "results of phosphate analysis were inconclusive" (Soper 2002: 109-110). This lack of direct evidence for manure in the pit structures is repeated in the absence of abrasion on paving and stone walls that one would expect from the presence of livestock (Soper 2002: 91, 178). It is also endorsed in the silence of the Portuguese on the subject, despite their need for supplies of fresh meat and grain in neighbouring regions in the 16th-18th centuries. Notwithstanding these shortcomings, data for the type of stock suited to a pit-structure environment are considered below.

Dung and dwarf cattle

It is not possible to flush the pellet-droppings of goats or sheep through narrow drains, and there is little evidence of pigs having been kept in the Eastern Highlands in precolonial times. In the late 1990s middens excavated on Mount Muozi, an atypical site 40 km north of Nyanga town where the only long-occupation sequence has been identified, focussed attention on 'dwarf cattle', with the excavation of a "relatively small" (Soper 2006: 61) assemblage of bone fragments of bos taurus.

While none of the bones are considered "reliable predictors of height" (Soper 2002: 160), it is suggested that "cattle leg bones are of a dwarf variety with an average shoulder height around one metre" (Soper 2006: 27; also see Soper 2002: 242-248). Frontal fragments and horn cores indicate that adults had robust horns with a span of 49-52cm (Plug et al 1997) requiring the animals to be polled to fit through the tunnels (Soper 2002: 124).

Four decades prior to the discovery of the Muozi data, Summers (1958: 237) noted the existence of a small breed of Mashona cattle, while recording that "nobody is at all impressed by the theory that these tunnels would permit the passage of such animals". Beach however estimated that Mashona kasiri cattle small enough to "fit through the doorway of an ordinary Shona house" (in Soper 2002: 232), could, like the smallest naturally occurring British breed the Dexter, "fit into pit structure tunnels" (Beach 1996: 717).

To register for the International Herdbook as Miniature Dexters, animals "must be 42 inches [105cm] and under at maturity … All measurements are at the hip (hook bone)" (Gradwohl 2004). The Dexter - not much smaller than 90cm at the shoulder at maturity according to the American Dexter Cattle Association - is similar in stature to the small cattle standing "just 3ft. 4in. [100cm] at the withers" that caught the attention of Selous north of Lusaka (1881: 313).

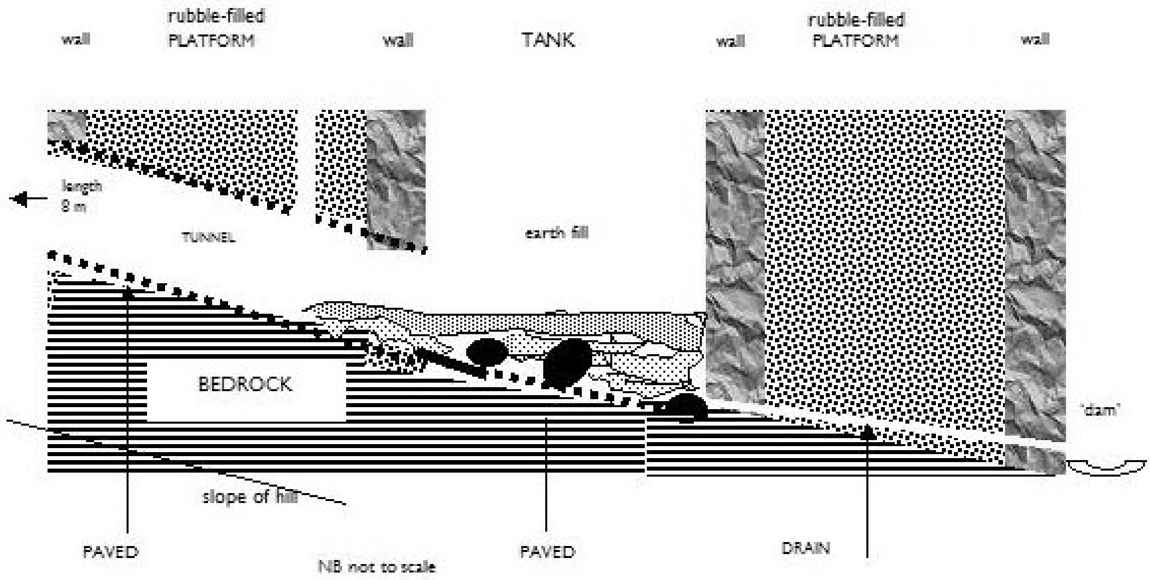

Figure 2: *Tank, hydraulically engineered and built up from bedrock using the slope of the hill*

In the course of his administrative duties for Manicaland Province, Stead (1949: 81) obtained measurements of pigmy cattle known as chunyarumbu ('tunyarumhu twengombe, dwarfed beasts'). He was disappointed to discover the animals were 51 inches (1.275m) high, had a horn span of 20 inches [50cm], shoulder span 26 inches [65cm] and hip span 27 inches [67.5cm]. This he said would present "a difficult problem in training cattle to enter a tunnel the maximum dimensions of which are 20 inches [50cm] wide and 41 inches [102.5cm] high".

Allowing for spine, neck and horns, none of the animals mentioned above could move freely through the lintelled openings into the tanks that seldom vary from the 1m x 50cm benchmark. Nor could they easily negotiate the majority of uphill entrances and interiors of tunnels with smaller dimensions and flat slab roofs. Cattle standing 1m at the shoulder are taller than those standing 1m at the withers, creating additional difficulties for the Muozi 'dwarf cattle'.

A fixed design feature of a bend inside most tunnels is frequently angled at 90 degrees within a width of 50cm. This bend is guaranteed to prohibit the passage of animals more than 1m in length - a conformation too squat for Muozi cattle standing 1m at the shoulder. The bend also makes the tunnel pitch dark at either end, even allowing for a little light from a narrow 'slot' invariably positioned in the roof.

Stead (1949: 81) noted that when the fathers of some of his interviewees had kept cattle in pit structures, "the tunnel-like entrance is removed" and the resulting gap in the wall "closed by means of poles". In terms of intact tunnels, he stressed the bovine phobia for dark holes upon which the cattle-grid principle is based - an aversion well known to ranchers loading animals into cattle trucks.

Stead (1949: 82) sees a further objection to the cattle-penning theory in the difficulty of removing manure from the bottom of tanks, many of which are 3m deep, adding significantly to the onerous task of building a complex structure for the penning of, in some calculated instances, as few as 3 beasts (Soper 2002: 125). "No evidence of roofing has ever been noticed" in regard to the tanks themselves (Soper 2002: 90), presumably leaving them open to the elements and predators such as leopard.

Huts and floors

Remains of open floors and stone-encircled areas frequently occur on the surface of the platforms surrounding the tanks. Commonly half of dhaka and half paved they seldom exceed 5m in diameter. Centrally divided by a low wall, it is thought the dhaka semicircle was a living area and the paved semicircle - both around 2.5m at their widest points - for stalling small stock such as goats. Although these floors, construed as the foundations of divided houses (Soper 2002: 108-110), and the so-called chief's hut over the slot in the tunnel ceiling, have no positive sign of having been roofed or not (Summers 1958: 83;

Soper 2002: 109), it is assumed that they were all domestic huts.

In association with these structures are frequent finds of grindstones, rubbing stones and very heavy hammerstones, implements of industry that are as common to mining as to farming in early sites worldwide. The platform floors, their structures and associated finds, are an area of on-going investigation in the present research, with results anticipated early next year.

Superstructures of burnt dhaka on semi-sunken circular stone foundations approximately 1-3m in diameter are common on the pit-structure platforms and among stone-walled enclosures at ground level. Called raised platforms, these structures are interpreted as grain bins, with the speculation that excavated "remains of charcoal must represent a thatched roof and destruction by fire" (Soper 2002: 110). Destruction by fire would be expected to char and carbonise seed, thus preserving it in a grain bin. That this is not the case points to a pyrotechnic function other than the burning of thatch.

Carbonised seed in direct evidence

Carbonised seed is important direct evidence for studies of early agriculture. Searches for these cultigens have largely proved negative. In addition to the two seeds of sorghum mentioned in Methodology below, Soper (2002: 249) found at Ziwa National Monument one carbonised seed of rapoko and a further 37 for which details have not been traced in the site reports to date (Chirawu 1999: 39-41). Summers (1958: 176) reported seeds of munga "common" at two sites at Ziwa where (unquantified) finds of rapoko and sorghum were also made in "a thin sprinkle of stones rather like gravel" below a superstructure of stone and dhaka. To confuse the issue, slag and large quantities of ash were also present (Summers 1958: 94).

Many of the inconsistencies inherent in the agricultural theory are clues to another explanation for the hydraulic nature of the tank systems and the enormous land modifications of the Eastern Highlands of Zimbabwe. These are examined below in a mining context.

Methodology

In its initial two-year phase the study concentrated on an area of 20 km radius centred around Lat 18º22'S and Long 32º35'E at Sanyatwe. It was conducted chiefly through the process of landscape archaeology, a concept of multidisciplinary investigation which enabled the emphasis to shift from site-specific archaeological excavation to extensive field walking associated with practical geology and historical geography.

Soil study tests were a major focus from the beginning, with available funds directed at geochemical analysis with special emphasis on gold. Ongoing study incorporates mineralogical analysis of unexpectedly high coarse sand fraction in terrace horizons, and the inconsistency of soils transported and deposited from different parent origin, as recommended by the Dept of Soil Science and Agricultural Engineering, University of Zimbabwe (Soper 2002: 18). It will include sampling of the 'cultivation ridges' several hundred metres long and 7-10m wide that show as yet unclarified geomorphological issues comparable to those of the terraces.

A lithic study of the numerous instances of blocked tunnels sometimes completely filled with stones (Soper 2002: 98) and in some areas reported to be as high as 72 per cent, has been initiated. Previous research does not record type of stones nor does it analyse earth fill (Chirawu 1999; Summers: 1958: 89-90).

Crop trials were undertaken to test the soil fertility of terraces in three small experimental plots of rapoko (finger millet): one fenced and manured with cattle dung, the second manured but left unfenced, and the third neither fenced nor manured. A plot of munga (bulrush millet) was also tested. Tendai Mateta, the Sanyatwe farmer conducting the experiments (Kritzinger and Toga 2007; 'Drain Gold' 2006), found the tasks of carting manure to the terraces, digging it into the stony soil, weeding the crop and attempting to protect it from wildlife, to be arduous and impractical. Grazing of rapoko by kudu and munga by hare was particularly problematic at shooting stage, and it was seen that fencing against large wildlife could be effective only on the widest terraces of around 10m.

Some limited use is made of old wide terraces in the warmer regions of Nyamaropa and Honde Valley today, but the simple crop trials of this research are believed to be the first to put terraces under proof-of-principle test in a less hospitable environment in the Eastern Highlands. At an average 54cm, rapoko did not reach an expected height of 70cm-1m, and the trial plot of munga suffered from wind damage, with both millets producing more chaff than seed. Birds were an additional pest at harvest. Although Soper (2002: 249) found one carbonised seed of sorghum in each of two sites 60 km apart, this cereal was not trialled due to the well known fact that 'it does well under most conditions except those of high rainfall' (Wild in Summers 1958: 176).

A geophysical study is concentrated on a typical terraced hill in a zone of dolerite sills where alluvial

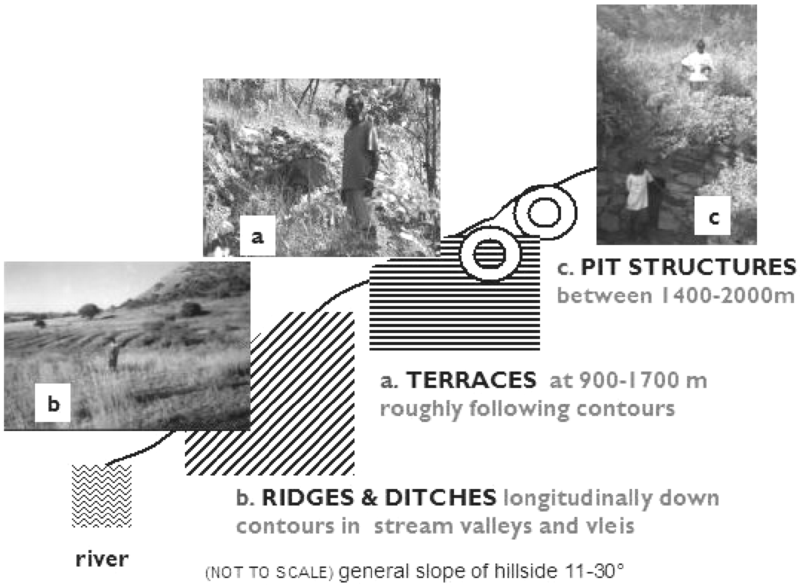

Figure 3: *Formation of secondary 'placer' and alluvial gold from a primary bedrock source. Extraction by pre-colonial miners would leave a benched (terraced) effect on hillslopes*

and bedrock gold were found in the field. These occurrences are in conflict with the absence of written records for auriferous deposits in the area.

Mining vs. farming

In his bulletin covering the portion of the Eastern Highlands east of Long 32º38 between Latitudes 17º30´ and 18º30´ Tyndale-Biscoe (1957: 10) noted that, "No mineral deposits of commercial value have so far been proved to exist in the area." Twenty years later this area was also pronounced a region of little economic importance by Stocklmayer (1978). Rather, Stocklmayer identified with the hypothesis of archaeologists and historians that, "ruins and terraces of an ancient civilisation are to be seen everywhere in the area … This terracing has given rise to the speculation that [it…] was the Granary of Central Africa" (Stocklmayer 1978: 4).

Since Stocklmayer's geological study, rural areas of the Eastern Highlands have been under-explored for gold. But recently the mineral potential of the Eastern Highlands had a dramatic re-evaluation when the well publicised artisan miners' gold rush to the lesser slopes of Chimanimani of 2003 developed into flourishing prospects.

'Supergene' gold

The re-evaluation of the Chimanimani geology by Zimbabwe Geological Survey (ZGS) detected the presence of auriferous 'supergene' deposits in a mantle of near-surface laterite always overlying dolerite. Supergene gold is chemically precipitated gold grains and nuggets deposited within laterite (Straight 2000). In the geology of the district of Nyanga, "[l] Laterite (ferricrete) commonly forms on the dolerites, especially in the higher rainfall areas" (Stocklmayer 1978: 146).

The terrace builders favoured dolerite above all other geological horizons (Soper 2002: 33-35). Dolerite is not considered a prospective rock for precious metals. In contradiction to this evaluation high grades for copper and nickel related to dolerite sills and dykes were reported in Exclusive Prospecting Orders for Nyanga District in the 1970s (ZGS Records, Harare). In the Muda river region of Mozambique the exploration company CAMEC announced the discovery of gold hosted in dolerite dykes in 2004 (St Brides 2004).

Alluvial and bedrock gold

Across the Eastern Highlands hundreds of informal gold panners active in the rivers (until the recent countrywide banning order) are living testimony to the existence of gold in dolerite zones. Alluvial gold cannot occur in isolation. It generally originates from an uphill source of primary bedrock gold. This primary gold weathers as secondary enrichment, commonly forming eluvial ('placer') deposits on hillslopes. In a continued process of weathering, the gold can migrate further to enrich gravel banks of rivers (Fig 3).

In a typical terraced hillslope in the research area, primary gold in the form of an underground stockwork of parallel quartz veins was discovered in mid-2005 by two Zimbabweans Samuel and Tendai Gungutsva, prospecting a hill to seek the source for alluvial gold being panned in the nearby river. The primary-source quartz reefs are narrow (approximately 25-35 cm wide), yielding gold values of 14-19 grams a tonne (g/t) at depths of 8m. The footwalls of the shafts are weathered dolerite, with laterite visible in hillwash downslope.

A block of four gold claims was registered with the relevant authorities in August 2005, and applications for four Exclusive Prospecting Orders covering 220 000 hectares of similar terrain from Sanyatwe in the south to Ruangwe Range in the north were approved by the Mines Affaires Board in October 2006.

'Placer' gold

The existence of bedrock gold within terraces puts a new perspective on the purpose for their construction. Based on the evidence of gold in the Sanyatwe terraces, it seems probable that the early miners of the Eastern Highlands stripped off lucrative eluvial (placer) deposits in a widespread activity of bench-mining. The longitudinal slope of the terraces rules out irrigation but is compatible with the technique of ground sluicing, a method of working placer deposits well known in past ages. Georgius Agricola (1556: viii, 346-347) recounts "the season when a torrent rises from storms of great violence or long duration, and rushes down the mountain" and this torrent "collects and carries together with earth and sand … particles of gold loosened from veins and stringers".

Stripping-ratios of waste removed against the amount of 'pay dirt' to be washed or sluiced is very high for placer deposits. Depending upon grade, more than 90 per cent of the material mined can be waste - in visual terms, a tonne of ore exploited to recover gold the size of a sugar lump, say 3g/t. Extraction of ore and the dumping of waste is in keeping with the disturbed landscape of the Eastern Highlands.

It is normal practice in mining for deposits to be worked out and then abandoned. This routine is in harmony with the evidence for single-phase occupation that presents an anomaly in terms of terrace farming (Soper 2002: 133). The justification that the terraces were built by a "small locally shifting population" and sited not from choice but from land pressure (Beach in Soper 2002: 233; Summers 1958: 257) conflicts with the fact that the fertility of the soil improves as the terrain flattens out into upper stream valleys, generally only a few minutes' descent away.

It is debatable that this comparative ease of access weakens a second argument that the terrace builders fled to the hills from Ngoni and Gaza raids - an event that would limit the period of terrace farming to the mid-1800s. On a wider scale this 'Refuge' theory is challenged on historical issues (Mazarire 2005, Beach 1988).

Hydraulic tanks

The hydraulic design of the tanks incorporates principles for the recovery of a heavy metal such as gold by gravity concentration, a method requiring a controlled stream of water and a sloping surface in the manner of a sluice. The curve incorporated in the tunnels is similar to the inside bend in alluvial rivers - the 'point bar' where heavy minerals fall out of suspension and collect as alluvium. A point-bar function for this laboriously engineered feature is more logical than an obstruction to the passage of livestock. The paved floor, inappropriate as a corridor for hoofed animals, ensures the provision of the clean water necessary in mineral processing.

In a mining model small catchment points termed dammed basins present at drain exits and also around 6-10m downhill exhibit the features of tailings ponds for the collection of concentrates. The slope of the drains fulfils the essential requirement noted by Idriess (1936: 37) that "There must be fall to take away the tailings". Furrows bringing water from sources often 250m away, and frequently shown to be feeding groups of tanks (Soper 2006: 54-60, 2005: 38-40; Summers 1958: 236), are further evidence of a dedicated management of water essential to gold recovery plants.

Direct evidence - gold

In contrast to the unsatisfactory record of evidence for farming and livestock, 28 samples out of 31 assayed for gold have given positive results, with an average grade of 7.10 g/t. Results of ten rock samples from terraces ranged from 4-19 g/t. Five samples of infill taken at a tunnel entrance into a tank registered 0.14-0.21 g/t. Two samples of soil from drain exits yielded trace values, a third 0.72, and a fourth the high grade of 12 g/t. Three samples of laterite showed 0.03, 0.13 and 0.88g/t. From slag scatter two samples gave results of 0.88 and 46 g/t. Four samples from two slag heaps of 50cm radius and 0.25-0.5m deep gave grades of 0, 3.5, 26 and 28 g/t. Two samples of flux (?) recorded 0 and 4 g/t. The third zero result came from an associated artefact of dhaka.

Historical landscape

It is well known that mention of the export of gold from the hinterland of Sofala dates back to the 10th century (Summers 1969: 169). A hitherto-neglected list of mines between the Zambezi and Limpopo rivers including 21 gold and ten iron mines for Manyika (Pereira 1857) has been studied in an effort to determine whether the archaeology is linked to the history of the dynastic ruler. Dated as 'discovered 1500' the results are revealing.

Six of the mines carry names of Manyika dynastic houses or old family lines. More names are retained in landscape features of the Eastern Highlands of Zimbabwe - from Mukosa in the Makaha Gold Belt to Mkondwe in the Penhalonga Gold Belt - than in the Upper Revue valley in Mozambique, long thought to be the geological host for the renowned Manyika goldfields.

Conclusion

Practical tests revealed that the terraces are unsuitable for cereal production. The tanks are skilfully engineered to a hydraulic plan, excessively labour-intensive for the building of cattle kraals, but ideally suited to the recovery of gold by gravity concentration. Gold was discovered in the terraces and pit-structure soils. Massive slag heaps, crushing stones, and some crucibles discovered in the area of study support the mining theory.

Comments

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I have read through Kritzinger's article and find it quite interesting. Although her arguments are a little undeveloped the evidence of the gold samples is very significant, due to the grades of gold she quotes in the samples around the structures and in slag found. If these gold values are correct and can be confirmed then is no doubt that these structures were once a centre of a gold mining community.

Gold sampling and assay is however very prone to error and bias. If you recall the Bre-X saga that erupted in 1997 which involved gold ore samples which were salted with gold resulting in a massive fraud. Contamination of samples for gold assay can be deliberate or accidental. From my experience, laboratories are notorious for contaminating gold samples - simply done by processing low grade or barren samples through the same laboratory crusher or mill after high grade samples had been processed. This is a very common error in laboratories in Zimbabwe.

Sampling practice (especially size and preparation) is also very critical in obtaining representative and accurate gold assays. Samples need to be selected carefully to avoid any bias such as rock type, size or visual appearance. Often a mine sampler (unskilled) will selectively collect samples know to contain gold (i.e. grey quartz chips) from ore as he knows these will give the result the 'manager' wants…. The sample is however not representative of the bulk of the ore and the manager will be no doubt be unhappy with production…

The article needs significant clarification on how the samples were collected including a diagram showing the sample sites (grid / GPS reference), the size of the bulk samples (kg), sample preparation and assay details. There are several different ways to assay for gold, all of them have a certain error, and all can have large errors if not carried out correctly. It would also be normal to reference the method used and the accreditation of laboratory where the samples were assayed.

Therefore, clarification on the above would help professionals to assess the results more confidently.

That said, some of the assays quoted are generally considered high, i.e. over 10 gpt. These are rare to find by an inexperienced sampler in an area not known for its gold. Thus these results are very interesting indeed but need to be confirmed.

Ancient structures around Zimbabwe often shows signs of iron, copper or gold smelting (Summers 1969) and sometimes ore was transported some distance to the fortified living areas for smelting. This may explain the slag and remnants of gold ore at the sites.

I am by no means an authority on this but I could suggest a simple technique to test her hypothesis. Firstly, if the surrounds contained sufficient high-grade gold bearing ore to warrant ancient Artisanal mining on the scale hypothesised, then the area would still today contain significant and widespread gold ore. Artisanal or commercial mining always leaves a residue of gold both in un-mined or poorly processed ore and in the processed 'tailings'.

If, as hypothesised, this was a large scale Artisanal mining community extracting gold from the hill sides, then much gold would still remain there today for it is impossible even with today's technology and earth moving that all the gold could be recovered / extracted.

If the mining was more mining of reef than the processing of alluvial ore, then there definitely would be tonnes of rock that are mineralised - but not of high enough grade to warrant the ancient processing and thus left on the surface. One just has to look at an area currently mined by Panners (Makorakosa) in Zimbabwe. Many tonnes of low-grade gold ore or barren rock is discarded at the mine site for every tonne of gold ore taken for milling.

If either hypothesis (reef mining or alluvial sluicing) were to have occurred on the hill sides then there would be low grade ore and residues left behind which could be easily sampled and assayed. These residues or low grade ores left on the hills at Nyanga would run at least 1 gpt Au and there would be many hundreds if not thousands of tonnes of such rock on the surface of the area around the hypothesised mining sites.

To see if this is true, one could collect bulk rock and alluvial samples from the area (not just in and around the pit structures), crushing such and assaying. This would be very similar to a conventional and currently practised method of geo-chem soil sampling - as used by geologists to identify potential mineral deposits. This method is unintrusive and simply involves augured samples on a 25 x 25m grid over the area in question and assay via method's designed specifically for low-grade samples. Secondly, a simple geological assessment by a geologist would show any mineralised or potentially mineralised rocks in the area in question.

I feel that Kritzinger's work has generated enough interest that I would now like to see the structures myself and then I will be able to form a better opinion.

PAUL MUPIRA

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After the demise of the "slave pits" theory and the emergence of a new body of knowledge on the Nyanga archaeological complex since the 1980s (see Sutton 1983, 1984, 1985, 1988; Soper 1996, 2002; Chirawu 1999), one would have expected a new and refreshing perspective on this cultural landscape from Kritzinger. Instead, Kritzinger's mining perspective on the Nyanga terrace complex takes us back to the 'slave pits' era type of conjectural interpretation with little or no supporting evidence. The few comments below explain why this is so.

Pits or tanks?

As Soper (2002: 92) shows the speculation associating the pit structures as mineshafts and gold-washing tanks is not new and dates to the early 20th century. However, until the latest attempt by Kritzinger, the idea has not been popularised or followed up due to lack of credible supporting evidence. We must get the basics right in order to proffer a credible challenge to the agricultural theory. Firstly, I think that Kritzinger has not assessed the design features of pit structures correctly. For example, the assertion that tunnels are frequently angled at 900 is incorrect, and the entry is rarely oriented in the uphill position (i.e. facing upslope).

Terraces and bench-mining

The crop trials conducted by Kritzinger provide an interesting line inquiry. However instead of focusing on the key issues like results (productivity of the soils, yield rates etc) Kritzinger focuses on processes (difficulties of carting manure, digging into the stony soil, weeding etc). The contemporary use of terracing though comparatively limited compared to the past should have been useful in shedding light on how people deal with the processual issues that have not hindered the use of some of the existing terraces and the construction of new ones in the case of Biriwiri in Chimanimani. It would have been useful to provide more details on the characteristics of the "less hospitable environment" where the "simple trials" were conducted. For example detailed agricultural potential studies (see Chirawu 1999 and Soper 2002) show that terracing is found in granite and dolerite areas with the latter known to be more fertile than the former. The trials therefore need to be rigorous to be useful in the interpretation of past practices.

Kritzinger then associates 'placer' gold with the dolerite zones and that terraces developed as a result of bench-mining. This is the most problematic part of her contribution. If gold is found in all the terraced areas of Nyanga and surrounding districts this would be the biggest gold deposit in southern Africa and probably the world's largest prehistoric mining zone. As Soper says in this volume such large scale gold workings would have attracted the Portuguese who travelled extensively throughout Zimbabwe from the 16th century AD ostensibly to get to the source of the gold in the African interior.

Secondly, this 'new perspective' does not account for the existence of extensive terracing in granite areas. Soper (2002: 35) estimates that 56.8% of the terracing is in granite areas. Neither does the mining theory explain the existence of the so-called hydraulic tanks on the Nyanga plateau in areas of sedimentary rocks such as sandstones, argillites, schists and siltstones (see Soper 2002: 34).

Recent studies have shown that pit structures are found as far as Vumba (Katsamudanga 2007). They are found in abundance in Penhalonga, an area with a long history of gold working documented in the written records. However, there is no record at all of the processing methods suggested by Kritzinger. The famous gold deposits and the processing methods would surely have been captured in some oral memories. In any case why would so many 'processing plants'/hydraulic tanks be necessary for such small quantities of gold? Why would it be necessary to lintel the 'tank' tunnels? If getting the cattle through the tunnels would be cumbersome, then the extraction of alluvial gold from the rough paved surfaces of the pit tunnels, bottoms and the drain holes must have been equally outlandish.

Having said this, the discovery of some gold deposits in the Nyanga area is of special interest to researchers. Not that it aids in explaining the existence of terraces and pit structures. Rather it brings in another important branch of production that may have complimented agriculture. It will help in supporting a new line of thinking that I have been developing that contrary to some writings (e.g. Summers 1958; Beach 1980); the Nyanga communities may not have been extremely poor. I am convinced that the evidence for 'placer' gold working cannot be the pit structures or terraces. Possibly some of the grinding grooves and stones generally seen as being for food processing could also have been used in such gold processing.

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I do not propose to respond to the criticisms of the “agricultural interpretation”. The evidence and reasoning are set out in full in Soper (2002) but cannot apparently convince in the face of a fixed preconception. Most of the supposed anomalies are in fact based on misconceptions which I do not have space to enumerate here.

The existence of gold outside the limited area examined is a moot point which remains to be proved. In the meantime I will look at the evidence on the ground and see whether it could be consistent with Kritzinger’s gold interpretation. This interpretation is very difficult to criticise directly as her ideas on how any gold could have been extracted in practice are very vague, in this paper at least.

As far as I can gather she envisages that the main source of gold was eluvial slope deposits worked by “bench mining”, the gold being at very low concentrations - 3 gm/tonne is suggested but might be generous (“more than 90% of the material mined can be waste” is misleading - I am not too confident of my maths but 3g/t looks to me like 0.0003% give or take a zero or two!). The extent of the terracing, if all is due to gold mining as claimed, gives an idea of the order of magnitude of the supposed undertaking. A minimum of some 22000 hectares of terracing has been identified from aerial photos, or 220 million sq. metres (on dolerite, granite and sedimentary rocks). If say an average of 20cm of soil was removed (surely a conservative estimate) and the weight of soil was say half a tonne per cubic metre, this indicates the processing of around 22 million tonnes of deposits. The only practical way of doing this would be by large scale sluicing which requires a constant well-directed fast-flowing stream of water with riffles or some other means of trapping the heavy minerals. I have seen this in practice for the extraction of cassiterite in the Plateau tinfields of Nigeria where it involves powerful gravel pumps. In earlier times the method was ground sluicing in the streams, the drastic erosional effects of which are still very evident. In the Nyanga case where could this water have come from and how was it directed? This volume of material could not have been carried to streams and the vast majority of terraces have no artificial water supply (and could not have been irrigated as she seems to think I have proposed).The suggestion that the “longitudinal slope of the terraces” and run-off from rainfall would be adequate is unconvincing. If she means lateral slope along the terraces, measured gradients are of the order of only 1 or 2 degrees and storms of the requisite force are sporadic at the best of times. Consistent ground sluicing in situ is thus out of the question.

It is also implied that the pit-structures were “tanks” associated with gold washing but it is not explained how the features of such structures could have been used. The features she discusses are the gradient, the stone paving, the entry tunnel, the pit or “tank”, the drain and the small dam below (not a constant feature). If the function of all the pit structures (and pit enclosures) is the same, they should all show the requisite features, including the small dam below and, more significantly, a consistent water supply. This is not the case; many of the pit structures and most if not all the pit enclosures of Ziwa could not have been accessible by artificial water furrows. Nor are the radial walls she mentions a consistent feature and do not in any case direct run-off water into the pit. She suggests that sluicing of gold took place in the tunnel - what then was the “tank” for? Sluicing could hardly have been below the pit in the drain which is only about 20cm square in section. The small dams below are seen as “tailings ponds for the collection of concentrates” - firstly tailings are the remaining spoil after removal of concentrates and secondly such dams would not hold more than a couple of cubic metres at the most. If any sluicing took place in the tunnel or pit, any heavy concentrates such as gold would be deposited in the cracks between the paving stones and would be very difficult to recover.

To make a convincing case for her gold mining hypothesis, Kritzinger needs to think through the process of recovery in detail and provide explanations consistent with all the evidence. Some questions which spring to mind:

Terraces
Why did they bother to carefully construct the riser walls? Why is there any soil remaining on the terraces if they stripped it all off? Propose a viable method of regular sluicing - and the physical evidence for it - for processing millions of tons of deposit which could hardly have been transported elsewhere for processing.

“Hydraulic tanks”
Why was such a labour intensive structure necessary at all for purely functional purposes? Why did they need the tunnel? An open passage or channel would seem simpler and more efficient for whatever the purpose may have been. Sharp bends in tunnels are in fact very rare and usually the result of bedrock constraints.

What does she think was stored in the “tank”, how did it get there, how was it processed and how extracted? Why is there no access except through the tunnel? If this is seen as water storage for sluicing events, below the pit rather than in the tunnel, one would expect the consistent presence of some kind of paved sluice box below, not the small basin which would be quite inappropriate.

Why is the drain so small? It could hardly accommodate a significant amount of tailings. Explain the small basin below and why it is not a constant feature.

On a wider scale explain why the average diameter of the pits increases with altitude to a maximum above 1700 metres, when the occurrence of hypothetical eluvial gold might be expected to decrease with altitude.

Finally the “silence of the Portuguese” is invoked against the stock/agriculture interpretation. How much more incredible it would be if the area were producing gold, the main stimulus for their presence?

Other questions could be raised, but unless these here can be plausibly answered it would appear that the physical details of terracing and pit-structures are quite incompatible with the gold interpretation.

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Kritzinger observes that the agricultural interpretation of the Nyanga terraces and other archaeological remains - following the work of Roger Summers fifty years ago and more recently that of Robert Soper - is 'published as fact in national textbooks and tourist literature'. While it is heartening to know that the results of research on Zimbabwe's archaeology and their relevance to the country's history are filtering through - and gradually supplanting fantastic notions previously prevalent - it is important that no particular line should be promoted as unquestioned dogma or the final word. The existing state of knowledge is there to be built on and, where necessary, revised by asking new questions and testing them through further field research and the best techniques available. It should certainly not be assumed that we now understand every aspect of the working of the intensive and highly specialised agricultural system which persisted at Nyanga till two centuries ago (as Soper has outlined it, with myself in broad agreement). Much remains to be learned about the millets, sorghum and other crops which were cultivated (both on the hillside terraces and on the valley beds), on their agronomy and the overall planting regime, with doubtless variations relating to the different soils of Nyanga and changes in altitude. The same applies to the management of the small cattle, which - according to our reconstruction, indirectly argued though that may be - were stalled and fed inside the homesteads (sometimes in a stone-lined device resembling a pit) to produce modest milk yields and, equally important, manure for the fields. For these reasons Kritzinger's paper is a useful reminder of the limitations of current understanding of Nyanga.

Identifying difficulties in comprehending the agricultural interpretation, whether particular details or even the whole, is one thing. But proposing a diametrically opposed theory, as Kritzinger does, for the main archaeological features of Nyanga - one that envisages both the vast extents of hillside terracing, and the numerous homestead complexes containing 'pits' with tunnel adits, as the relics of a gold-mining industry - is something else. The latter requires convincing evidence of its own; it cannot stand simply because of 'anomalies', whether real or imagined, in the agricultural argument. One should note, moreover, that several of the specific objections which Kritzinger raises, especially about dwarf cattle and the feasibility of stalling them in the 'pits', derive from observations candidly acknowledged and discussed in Soper's published research report - some of them being misconstrued in Kritzinger's article. (See Soper's comments, above.)

Like Soper, I am in no way persuaded by Kritzinger's case for mining being responsible for the Nyanga terraces, or by her image of the 'pit'-structures as installations for winning gold through sorting and washing soil in bulk. Firstly, had gold been extracted on a massive scale so close to the coast, relatively speaking, as the Nyanga hills, one would have expected external interest (with information on named places and districts) to have registered itself more prominently in Portuguese records from the sixteenth century onward, if not earlier in Arabic ones relating to the Swahili trade through Sofala. That need not disprove Kritzinger's case; but it should warn against precipitate advocacy of a gold hypothesis without corroborative evidence of substantial mining, processing and transporting of the metal. (I say this, however, in ignorance of the map and/or topographical list of mines supposedly known in Manyika country about 1500 AD, to which Kritzinger alludes with the reference 'Pereira 1857'. Is this 'hitherto neglected' source of information really relevant to Nyanga?)

I cannot comment on the mineralogical tests which Kritzinger cites - at least, not as set out in her paper. Any sensible discussion will need clearer information on the locations sampled (confidential?), and on the methods, comparisons and controls applied. And are we to infer that gold was the sole mineral identified in all the analyses attempted? Whatever significance may be read from them, it does not necessarily follow that a mineral content or trace element revealed in a laboratory would have been recognised and exploited in previous centuries.

That apart, the suggestion that the so-called 'pits' with their tunnels and drains were designed as gold-washing stations looks to me ingenious but quite untenable (for the reasons explained in Robert Soper's response). Equally unconvincing is the notion that the vast extent of terracing - predominantly to the north of the scene of Kritzinger's investigations, it seems - is the result of stripping of the surface for mineral extraction. The flights of terraces, as I recall them on both sides of the Nyanga range, lack signs of disturbance, in the forms of quarries, pits and heaps of waste typical of exploitative mining, whether for gold or other minerals. (One does encounter iron-working debris in places, which is hardly surprising. Would that be the explanation of the modest slag-heaps which Kritzinger records?) In particular, one would not expect strip-miners to have put so much effort into constructing coursed walling, terrace by parallel terrace, with drain devices in places, or neatly lined tracks running transversely through them. In the agricultural interpretation, these would have provided access to the homesteads, for the inhabitants as well as livestock being led to and from water. Frequently the walling of the domestic structures, with the stock-pens and access arrangements, was integrated with that of the surrounding terraces.

The assumption of an agricultural purpose for the Nyanga terracing is, in the first place, a 'common-sense' one inspired by broad parallels in many other parts of the world - sub-Saharan Africa included - of existing cultivation on built terraces (as well as archaeological examples similarly interpreted). In certain instances terraces may be precisely levelled for methodical irrigation from artificial furrows; but more commonly, as at Nyanga, they are more roughly levelled to conserve soil and ease the work of hoeing, weeding and reaping. The closest parallel to Nyanga is perhaps Konso in Ethiopia where, moreover, stall-feeding of small cattle in the homesteads with treatment of their dung for manure is to this day an essential concomitant of the cultivation of grains on stone-terraced fields. Other examples of similarly intensive and integrated farming systems utilising small breeds of cattle and their manure are recorded from the Nuba hills and places further west across the Middle African belt, or again on Ukara island in Lake Victoria. Although no historical connection is assumed between these living systems in scattered parts of Africa and the abandoned one of Nyanga, they illustrate how individual agricultural communities, especially densely settled ones in restricted zones, may react to their environment and its exigencies. There is nothing 'un-African' about the construction and constant maintenance of terraces, the manuring of fields or other special or complementary practices. Rather, over the last century the effect of colonial rule (and in certain countries settler farming), followed by increasing 'globalising' pressures, reduced the viability of local economies so that many indigenous practices, especially the more intricate and labour-dependent sorts, have declined.

In her criticism of the agricultural interpretation of the Nyanga terraces, Kritzinger mentions some experiments with planting pearl- and finger-millet, on fenced and unfenced plots, manured and not manured, with unflattering results. Without more details, it is difficult to comment - except that in testing a defunct agricultural system, or, rather, an aspect of it in isolation, one would not predict a bountiful yield at first attempt. Knowledge and experience have been lost, and one should certainly not underestimate the sheer labour as well as inherited skills essential for subsisting off grain-crops. Persistent weeding and a constant alert to fend off wild animals (pigs, baboons or indeed elephants, as well as various antelopes and hares), and scaring flocks of seed-eating birds, have always been essential for ensuring a harvest in good and bad years alike. There is obviously room for more experimentation, with suitable controls and modifications as one goes along. Such a programme could prove instructive, provided one is not looking simply for 'success' or 'failure' or for quick 'solutions' to archaeological problems.

While therefore I am not impressed by a mining explanation for the archaeology of Nyanga, there is no disputing - as Kritzinger reminds us - that gold has been exported from the Zimbabwean plateau into the Old World economy for over a thousand years. That means that trade routes, for not only gold but all sorts of merchandise carried both to and from the coast, were passing the Nyanga hills, to either their north or south side, if not both, doubtless with variations over time. (Most of the commerce between Great Zimbabwe and Sofala would presumably have run well south of Nyanga; while that nearer the Zambezi would have kept north - if the normal supposition is correct that trading caravans would have preferred not to pass directly through the eastern highlands, with their rugged terrain and 'strange' populations.) Now, the sequence of occupation which Soper has established at Nyanga begins about 1300 AD (when Great Zimbabwe, only some 300 km away, was enjoying its greatest wealth, splendour and power). Are we to imagine that the farmers of Nyanga, both then and through the following centuries, were so busy developing their intensive subsistence system in their remote mountain fastnesses that they remained ignorant of what was happening all around? Or, alternatively, that they were only too conscious of the predatory habits of the kingdoms to their west that based at Great Zimbabwe as well as its tributaries, competitors and successors that they strove to insulate themselves from their tentacles? Or did they, contrarily, aim to profit from the regional economy by producing surplus crops for supplying the itinerant traders and porters, and thus contribute in a positive way to the broader story of this quarter of Africa between the fourteenth and eighteenth centuries? Whatever the answer, the descendants of those Nyanga farmers must comprise a substantial part of the present population of the easterly edge of Zimbabwe and adjacent Mozambique - even though the terraces were eventually abandoned and the dwarf cattle breed became essentially extinct, along with the system to which they belonged.

Reply:

Each author is answered in turn:

John:

Twenty of the 31 grab samples were selected by a senior geologist (ZGS), a qualified prospector, a metallurgical engineer (UZ); eleven were collected by me. Laboratories used (quantity in parenthesis): ZimLab (19), Ministry of Mines Dept of Metallurgy (2), UZ Dept of Metallurgical Engineering (9) and Institute of Mining Research (1). Summary of method: FA50-50g fire assay with AAS finish. Samples were a maximum of 2kg to reduce laboratory preparation cost. Iron oxide (*FeO*) and Copper (*Cu*) were detected.

Former exploitation was placer working rather than reef mining. There is little evidence of waste rock other than numerous heaps of sorted quartz, a feature of terraced landscapes from south of Sanyatwe to Ruangwe range north. Sampling such quartz heaps led to the Gungutsva lode. The veins seldom outcrop and I believe they were missed by the former miners. Contra-contour ridges and ditches (mihomba) are under examination in respect of dumping and other issues.

Following a recent field trip to the research area the Geological Society of Zimbabwe (GSZ) proposes to sponsor a university undergraduate to initiate a geophysical and geochemical exploration programme in 2008. Funding is required to evaluate the mining theory further afield. Regarding payable residues in the research area, a GSZ member believes the dumps of laterite assayed at 0.03-0.88g/t may potentially form a resource for a smallworker.

Mupira:

Tunnel entrances are always sited upslope of the tanks, and passages always run downslope. From published plans (Soper 2002: 176, 181; Summers 1958: 65) and interiors explored, it is known that tunnel entrances are frequently positioned at right-angles to their exits into the tanks. There are no sharp corners. A curve butts the two directions in the manner of a plumber’s elbow. Tunnel roofs are flat not arched, therefore lintels are structural features.

The original purpose of the tanks is not captured in oral memory throughout Manicaland (impressions that intact structures were cattle pens appear to come second-hand from academic hypothesis). The Shona name *ninga* is given to the hidey-hole nature of the tunnel not the function of the tank.

Dolerite versus granite percentages given by Soper are puzzling. His two sentences following these calculations confirm a clear “preference for dolerites” (Soper 2002: 35). A comparison of 1:50 000 topographic maps with geological surveys identifies a secondary choice of granodiorites, adamellites, gneisses and tonalites. All these granitoids in Zimbabwe are prospective (Kalbskopf and Nutt 2003). Sedimentary rocks of the Umkondo Group are of particular interest to the ZGS in studying gold anomalies in this research. There is no reason to believe that only “small quantities of gold” were processed. On the contrary the indications are that vast areas were subjected to exploitation by bench-mining.

It is unlikely that Zimbabwe’s early miners would have neglected to place trapping mechanisms over their paved floors. The use of biodegradable turf, shrubs or skins predating canvas, corduroy, and blankets in gold recovery is extensively documented. The slope at a tunnel’s exit into a tank, sometimes overlain by an inclined slab, is similar in principle to the head of a ‘buddle’ where material of high specific gravity was manually agitated before a stream of water carried away the tailings (Agricola 1556: 300-350; Willies 1975: 53). Pereira’s list would seem to uphold a theory about former wealth in Nyanga communities.

Soper

I regret I am unable to comment on unidentified “misconceptions”. With regard to an attempt to calculate tonnage in surface extraction, representative figures for yield are essential. Nuggets from Chimanimani range “from a few millimetres to 2cm across, and larger particles up to the size of an average man’s fist are being recovered” (Mupaya and Mangezi 2004). In similar geology, visible gold and small nuggets have been found in the research area. The 3-g/t sugar lump example was given to make a visual statement: yield against extraction. As an indication of grade 3g/t would be low not “generous”. Values from primary vein-gold in the research area indicate that secondary deposits were likely to have carried free gold, thus reducing mass in the calculation.

The fact that terracing does not have a blanket coverage over the extent of 22 000 hectares compounds the difficulty in arriving at an accurate figure for extraction. Additionally we do not yet know the time span of exploitation. A De Beers mining engineer estimated that “many hundred million tons” must have been removed in hard-rock mining (Williams 1948: 15) over a span of ten centuries in Zimbabwe’s central plateau (Summers 1969). In the light of this evaluation extraction of 22 million tonnes’ eluvial material appears reasonable over the four hundred years radiocarbon dated for Nyanga archaeology (Soper 2002).

The inclining of terraces one into another would enable seasonal hilltop runoff to separate mineralised material from overburden and debris, with the additional advantage of being able to sluice on the spot (Agricola 1556: 300-350). Goodwin (1953: 40) witnessed in South Africa “an hour’s heavy rainfall remove soil… [totalling] a mass of 1,500 cubic yards or metres.” This is not to infer that Goodwin’s “immense carrying power of water” was the only aid employed in pre-recovery classification.

The “little depth of soil” on stony dolerite terracing (Summers 1958: 178) is indicative of strip-mining and an indictment of farming, even allowing for the known greater fertility of weathered dolerite soils. The stone risers of terraces would protect against landslip in the course of exploitation. That terraces appear to have been “cut back into the slope to some extent”, that there are “lines of stones across terraces”, that small drains through riser walls are not infrequent (Soper 2002: 33, 37, 39, 43-4), and indications that “soil layers, except for the lowest ones in most terraces, have been transported and deposited” (Soper 2002: 18), all figure in the developing picture of the bench-mining model.

Exterior features of tanks appear to be adapted to site-specific conditions. Furrows feeding groups of tanks can be seen to work in tandem with radial walls (e.g. Soper 2005: 38-40; Soper 2002: 170), or radial walls appear to channel hilltop runoff into tunnel entrances without the aid of furrows. Employment of runoff minus radial walls is also evident. These variations have yet to be surveyed and categorised.

Thank you for pointing out my incomplete sentence. The italicised words complete the phrase “tailings ponds for the collection of waste from concentrates”. These are unlikely to be a “constant feature”. More interception reservoirs would be required in processing rich deposits with tailings profiting from retreatment, than in low-grade recovery. The occurrence of eluvial gold is unlikely to “decrease with altitude”. On the contrary its greatest concentration is around the primary bedrock source at the highest elevation in the profile, where larger tanks to accommodate a greater mass for beneficiation would be logical.

Whether tanks built to larger dimensions was due to the greater importance of cattle above “around 1700m” (Soper 2002: 93), or whether this reflected more profitable extraction at the superior position of the lode (where modern mines are invariably sited), is a matter for scientific determination. A practical advantage in a gentle slope at lower altitudes having the optimum fall required for a tail-race in comparison to steeper gradients, awaits survey assessment. In the latter case a lesser gradient could be achieved artificially by increasing the diameter of the tank and probably the width of the platform to project the drain at an angle less acute than the natural slope of the hill.

The standardised dimension of the drains built through the platforms is not small in tailings’ removal technology. About three times the size of the 60mm-bore tailings’ removal pipes of traditional smallworkers’ gold-recovery shaking tables, they conform to the fluid dynamics principle that the larger the flume the less the pressure to transport the tailings. Remnants of dhaka on many inside walls, and large blocking stones found at drain openings, suggest a dual purpose for the tanks. One as a recovery processing plant for mineralised material (possibly fed through the slot incorporated in the roofs of tunnels). Another as a waterproofed cistern, in the construction of which the heavy-duty platform provides necessary reinforcement.

Closed tunnels ensure the provision of clean water required in gravity concentration, and provide security for a valuable commodity. I cannot fathom “bedrock constraints”. The platforms house the tunnels above bedrock level. Sutton’s phrase “tunnel adits” similarly implies the misconception that the structures are subterranean, built into hillsides. It is not possible to sluice in a drain, or inside a closed tunnel.

Sutton

Before our age of shareholder insistence on transparency, it was not common for the location of precious metal deposits to be divulged. Penetrating centuries of silence, a recent interpretation of "stone structures, place names, topographic features and historical records" has found that gold was the "prime causative factor" in the initial siting and subsequent growth of Aksum (Phillipson 2006: 27).

Regarding Zimbabwe the Portuguese made several references to the concealment of mines (Summers 1969: 165, 182). Mupira's statement that the Portuguese "travelled extensively throughout Zimbabwe" from the sixteenth century is based on slender evidence. At that time the goldfields of Manyika were known only by hearsay, reputed to be in a region "full of mountain ranges, and therefore very strong and difficult of conquest, even by the forces of the Monomotapa. They say that it contains much gold" (Theal 1899: 216). Pereira's list (1857) discloses the names of Manyika's mining localities three hundred years after their "discovery 1500".

Comparing Summers' distribution of early terracing in sub-Saharan Africa (1958: 248) with the continent's collision belts and highly prospective Precambrian shields reveals a close connection. From Gauteng in the south to Tigre in the north, and including "places further west across the Middle Africa belt", the relationship between terracing and auriferous zones is a subject requiring thorough on-site examination.

Of the examples given, the Konso gneiss lies in the southern extremity of Ethiopia's auriferous Adola belt that hosts among others Lega Dembi with a projected annual output of 3 ton Au. The Nuba hills and neighbouring Tagale country in Sudan are known from antiquity for the recovery of gold; a belt between Terter and Gebeiha having reserves of commercial interest today. Ukara island in Lake Victoria Nyanza is an outlier of the auriferous Nyanzian craton-related greenstones, its scattered gold mines including Geita, the largest in East Africa. Geita's north-eastern extension strikes directly toward Ukara island.

Placer working does not leave quarries or open pits. After a passage of time little trace remains of this type of extraction. The heaps of sorted quartz found throughout the terraced regions are however an enduring sign of gold mining.

I fully agree that more experimentation in crop trials should be initiated under correct procedures and controls. Professionals from several disciplines need to be involved and adequate funding is essential.

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