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Field Excursion Guide-

Magondi Belt and other outcrops near Chinhoyi, NW Zimbabwe

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Introduction

The aim of this excursion is to examine rocks of the Palaeoproterozoic Magondi Belt (Deweras and Lomagundi Groups) exposed in the Chinhoyi area, as well as some older and younger rocks in the region, such as the Neoarchaean Eldorado Conglomerate of the Chinhpyi Greenstone Belt, and the Portelet Estate Outlier of Sijarira-type redbeds, of possible Neoproterozoic age.

The Magondi Supergroup is a mainly metasedimentary succession, with minor mafic and intermediate to felsic metavolcanics, which is found in the Palaeoroterozoic Magondi Mobile Belt of western Zimbabwe. It is subdivided into the Deweras, Lomagundi and Piriwiri groups, which were deposited between c.2.16 and 2.0 Ga (Master et al., 2010; Glynn et al., 2012). In addition, lithologies of the Dete-Kamativi Inlier of NW Zimbabwe are also part of the Magondi Supergroup. The Magondi Supergroup is underlain by a Basement Complex consisting of Archaean granite-greenstone terrain and gneisses of the Zimbabwe craton, including the Great Dyke and related intrusive complexes.

The Deweras Group, which unconformably overlies the granite-greenstone terrain of the Archaean Zimbabwe craton, comprises a redbed sequence, up to 1.3 km thick, of meta-arenites, rudites, pelites and minor carbonates and evaporites, together with enriched sub-alkaline mafic lavas and pyroclastic rocks.

The Lomagundi Group, which overlies the Deweras Group unconformably, is subdivided into three formations. The Mcheka Formation consists of basal conglomerates, grits and quartzites, followed by stromatolitic dolomites, phyllites, pockmarked quartzites, argillites and banded iron-formations. The Nyagari Formation consists of striped slates, sandstones and intermediate volcanics, while the Sakurgwe Formation consists predominantly of greywackes.

The Piriwiri Group (which is considered by some to be the contemporaneous distal facies equivalent of the Lomagundi Group) consists of basal graphitic and pyritiferous slates with narrow bands of cherty manganiferous quartzite, followed by argillites and phyllites with minor interbedded greywackes, chert, felsites, tuffs, agglomerates and andesites. These rocks will not be seen on this excursion.

The Magondi belt was unconformably overlain by Neoproterozoic rocks of the Sijarira Group, and structurally overthrust by the Makuti Group, which was deformed and metamorphosed in the late Neoproterozoic to early Palaeozoic Pan-African Zambezi Orogeny. Dating by Master et al. (2020) indicates that the Sijarira Group is younger than 632 Ma, and is derived from arc terrains in the southern Mozambique and Maud Belts to the east of the Zimbabwe Craton. The Portelet Eastate Outlier may be a remnant of a much more extensive sheet of Sijarira-type redbeds which may have once covered the Archaean Zimbabwe Craton.

Stop 1: Manyame River, Chinhoyi. (30.21455 E -17.35365 S WGS84)

Exposures of the ELDORADO CONGLOMERATE which occurs in the late Archaean (c. 2.7 Ga) Chinhoyi Greenstone Belt. The Eldorado Conglomerate is a deformed polymictic diamictite, up to about 50m thick, containing cobbles and boulders (up to 2m in length) of granitoids, greenstones, porphyries, chert and BIF, which occurs within a pyroclastic sequence of ash-fall, lapilli and lithic tuffs and agglomerates, which in turn overlies pillowed mafic greenstones and banded iron-formation. The Eldorado diamictite is regarded as a possible lahar, with rounded clasts of different lithologies ripped up from the wallrocks in a violent volcanic eruption, mixed with huge volcanic bombs that are flattened. It was the host rock for the Eldorado Gold Mine which in the first decade of this century was the largest gold mine in the then Southern Rhodesia (now Zimbabwe). The Eldorado Mine declared a total production of 492 211 ounces of gold between 1906-1944, at an average grade of 10.44 dwt/ton. The mineralized zone was about 400' wide, and 2500' deep, and there were two parallel "reefs" or ore shoots, between 70" and 140" thick. The gold was free milling, with very little sulphide. Considerable interest and geological debate was sparked off after its discovery in 1894, when it was initially thought to be a Witwatersrand-type reef or "banket" (Mennell, 1905; Gregory, 1906). Stagman (1961) gives the following account of the debate:

"The conglomerate was the subject of much controversy. When the ore body was found it was at first believed to be a fossil placer analogous to those on the

Witwatersrand. It was named "the banket", which led to great excitement as it was concluded that the mineralization would extend for miles on strike and down to thousands of feet in depth. The rock was traced for many miles to the south-west and north-east, and some 20 000 claims were pegged, which represent 2000 average blocks, banked five to ten deep, covering 50 miles of strike. This is, indeed, the picture presented by the old claims plans, when all the country was pegged from south of the Angwa river, near the Maggiemac mine, round in a curve to the Great Dyke, beyond the Muriel Mine."

The Eldorado conglomerate, in the Manyame River, Chinhoyi Greenstone Belt

"It soon became apparent that, away from the Eldorado mine, very little of the conglomerate was auriferous. The suggestion was then advanced that the rock at the mine was not a sediment, but a rolled breccia of some sort."

Road traverse from Chinhoyi across Lomagundi Group

Take the road to Lomagundi College from the town of Chinhoyi. The road goes from the Archaean Chinhoyi greenstone belt (good exposures of the Eldorado conglomerate in the Manyame River outside Chinhoyi), across farmlands, and you approach the thrust front of the Magondi Belt, expressed as a low range of hills (Manyame Range) to the west of Chinhoyi. Just after you climb up onto this hill, you will see the first exposures on your right hand side. There is a good roadcut exposure of the Lower Dolomite of the Lomagundi Group, which was sampled for C & O isotopes (Master and Verhagen, 1998). If you look carefully you will find calcite nodules in this fine grained dolomite, some also containing quartz. This Lower Dolomite is overlain by ripple-marked siltstones, which can also be seen in this roadcut. The siltstones are overlain by the Pockmarked Quartzite, which forms the crest of the hill, as the road swings to the left and cuts through it. Once you get to the other side of the hill, look out for a tobacco curing shed on the left hand side of the road. Turn left here- there is a dirt road that leads off to a low hill on the left, where there is a little quarry, in dolomite.

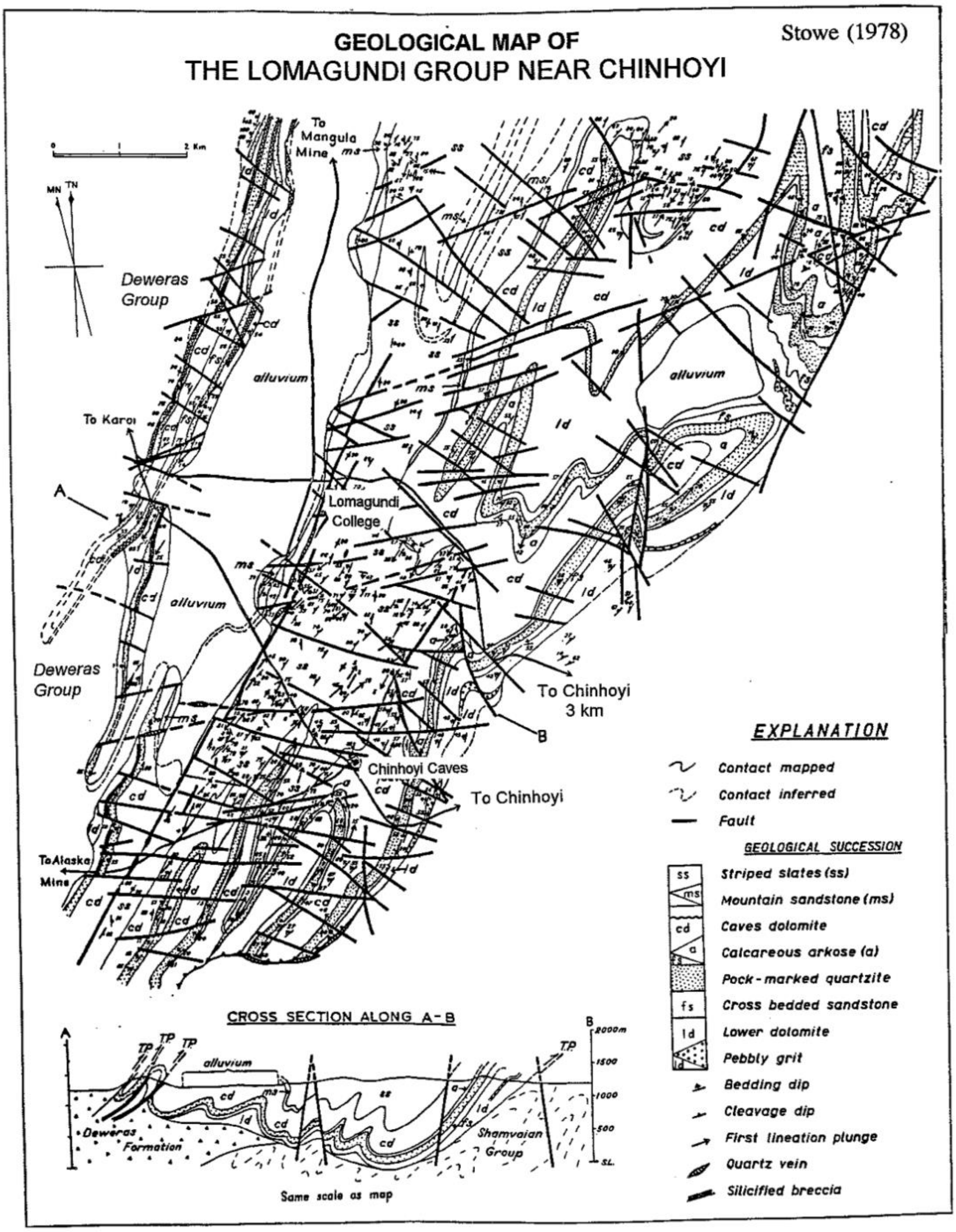
Stop 2. Dolomite Quarry. Stromatolites in Upper Dolomite, Lomagundi Group.

(30.147 E, 17.33309 S, WGS84)

This has good exposures of the Upper Dolomite or Caves Dolomite of the Lomagundi Group, which have also been sampled for C and O isotopes (Bekker et al., 2001). If you climb the side of the quarry and get towards the top, you will see good exposures of columnar stromatolites (Master, 2003). Near the top of the dolomite section, above the quarry face, there is some malachite staining in the dolomite.

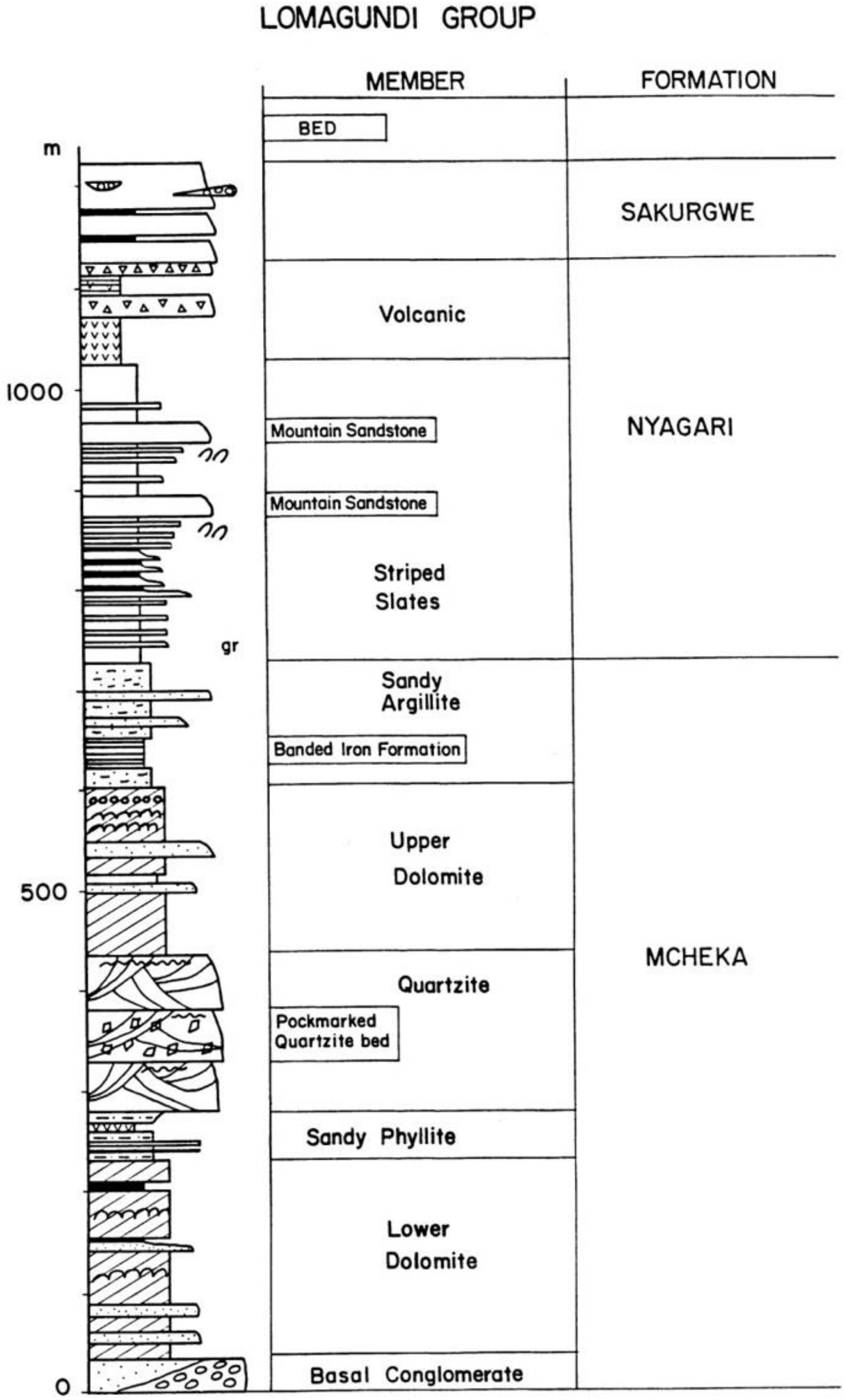
When you carry on along this road beyond the Upper Dolomite, you will see some quarries on your right in the Striped Slates. These are fine-grained micaceous pyritiferous slaty shales and siltstones, with a stripy appearance due to alternation of shale and siltstone. Not much in way of sedimentary structures to be seen- but possibly deposited on storm-dominated shelf. Look for more evidence on sedimentary environment.

The Lomagundi College Road, it leads to Lomagundi College, then curves west to rejoin the National Road. Turn left (going SE) onto the National Road, heading back towards Chinhoyi. You will encounter hills of Striped Slates with some road cut exposures, not very good. You will eventually see Chinhoyi Caves, which are well worth a visit. These are located in the Upper or Caves Dolomite. Just past Chinhoyi Caves is the turn-off to Alaska. At the turnoff there is a dolomite quarry mining the dolomite. Along the road to Alaska Mine, go over the railway line, past the smelter, until you get to the Angwa River where there are good exposures of the Deweras Group aeolianites.

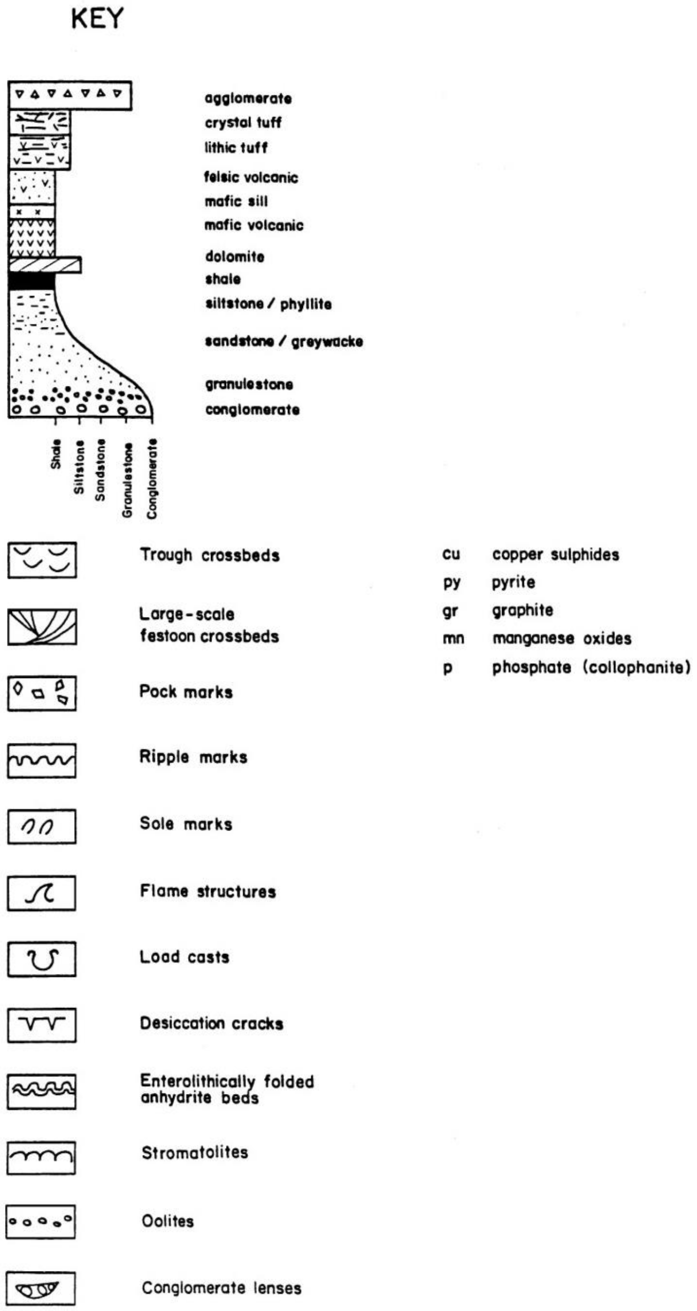


Geological Map of the Lomagundi Group near Chinhoyi (after Stowe, 1978)

Deformed columnar stromatolites, Upper Dolomite Member,
Mcheka Formation, Lomagundi Group.



Lomagundi Group stratigraphic column (Master et al., 2010)



Stop 3: Deweras Group- aeolianites exposed in the Angwa River-world’s oldest desert? (30.04888 E, 17.38896 S, WGS84)

The Deweras Group, the basal part of the Paleoproterozoic Magondi Supergroup, unconformably overlies the Neoarchean granite-greenstone terrain of the Zimbabwe Craton. It comprises a red bed sequence, up to 1.3 km thick, of meta-arenites, rudites, pelites and minor dolostones and sulfate evaporites, together with subalkaline basaltic lavas, pyroclastic rocks, and sills (Master et al., 2010). Detrital zircon U-Pb dating gives a maximum age of 2171 ± 11 Ma for the basal Deweras sedimentary rocks, which are overlain by ca. 2070 Ma Lomagundi Group rocks (Glynn et al., 2012). The

Deweras Group was deposited in rift-related continental alluvial fan, braided stream, playa flat, and playa lake environments.

Master and Eriksson (2014) identified aeolian facies in the Deweras Group arkosic arenites, in three localities: (1) underground exposures at the Shackleton/Avondale Cu mines, situated at 30°02.0'E, 17°18.5'S; (2) outcrops along the Angwa River between Alaska Siding and Alaska Mine on Belltrees Farm at 30°03.0'E, 17°23.2'S; and (3) in a vertical borehole MJZM/5 on Inyati Farm at 30°11.103'E, 19°04.360'S.

The aeolianites (having respective thicknesses of ~5, ~30 and 49 m) overlie fluvial facies, and are overlain by, or interbedded with, playa flat/lacustrine facies (with desiccated shales deposited in ephemeral playa lakes in interdunal pan environments, and rippled clastic anhydrite beds reworked on the shoreline) in the first two localities, and by a mafic volcanic succession in the borehole. The three localities are found over a region 33 km long and 5 km wide. These occurrences may be part of a continuous wedge-shaped body of sandstone, containing about 3.3 km^3 of aeolianite, representing a small sand sea.

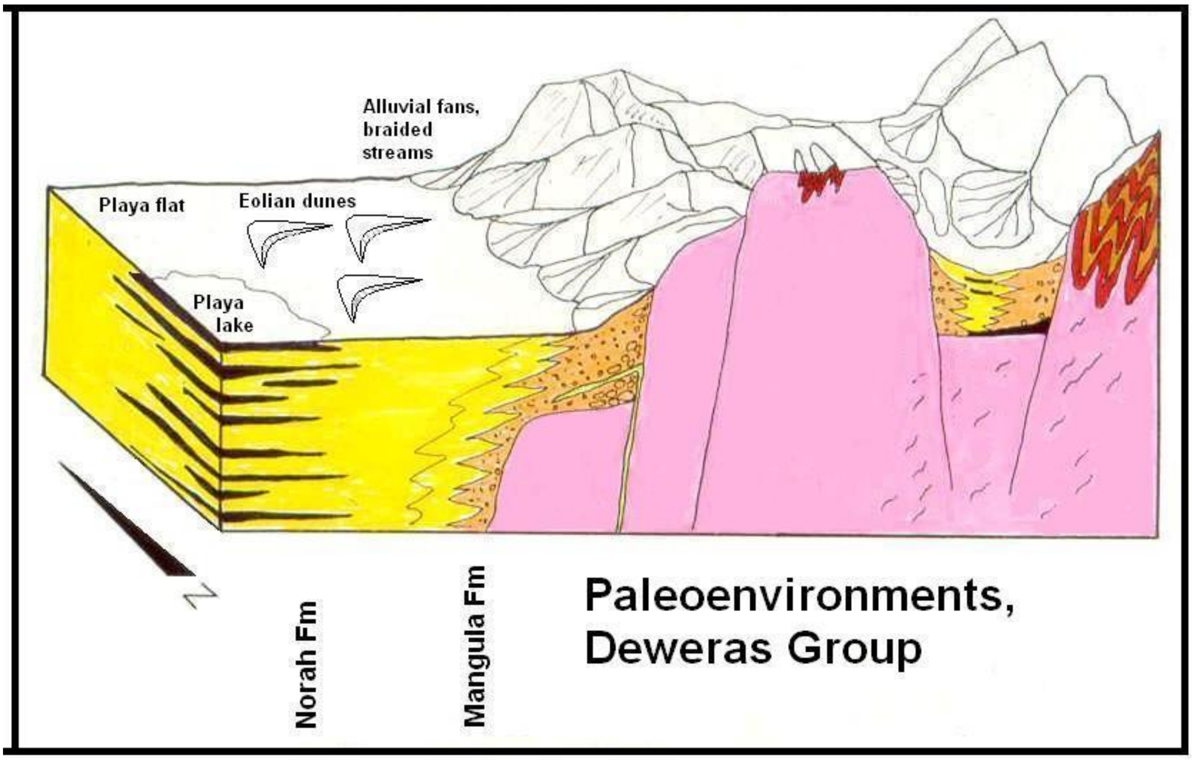
The aeolianites are recognised based on the presence of: (1) medium-grained arkosic sandstones, with well sorted, well rounded grains; (2) large-scale planar crossbeds, locally with tangential bottomsets; (3) inversely graded cm-scale wind ripple deposits (subcritically climbing translatent strata) with local cross laminations; (4) wedge-shaped grainflows; (5) pinstripe laminations, and (6) Stokes surfaces. The Deweras Group aeolianites and associated evaporitic playa facies possibly represent the oldest recognised desert environment in the sedimentary rock record (Master & Eriksson, 2014).

Inversely graded wind ripples, Deweras Group exposures in Angwa River.

Comparison

Inversely-graded ripple lamination in Jurassic Navajo Sandstone eolianites, Glen Canyon, Arizona

Inversely-graded ripple lamination in Paleoproterozoic Deweras Group eolianites, Angwa River bridge, Zimbabwe



The **Deweras Group** was deposited in rift-related continental alluvial fan, braided stream, playa flat, playa lake and aeolian environments (Master, 1991; Master & Erikssen, 2014).

Whereas the oldest aeolian facies are 3.2 Ga dunes overlying braided stream deposits of the Moodies Group (Simpson, Eriksson & Mueller, 2012), there is no evidence of an arid environment. The c. 2.1 Ga Deweras Group aeolianites and associated evaporitic playa facies show clear evidence of deposition in arid conditions, and they possibly represent the oldest recognised desert environment in the sedimentary rock record (being about 300 Ma older than the Makgabeng Formation aeolianites of the Waterberg Basin, South Africa).

Stop 4: Visit to the ALASKA MINE quarry. (30.01668 E, 17.39984 S, WGS84)

Oxidised copper ore, mainly malachite, was mined for centuries at the Alaska Mine. The orebodies are hosted in sheared dolomites of the Lomagundi Group which are part of a thrust duplex. In the deeper levels, the hypogene mineralization consists of djurleite pseudomorphs after pyrite.

The Alaska Mine, which is very old, was worked for copper by the indigenous population (Brackenbury, 1906; Summers, 1969). The mineralization occurs in highly sheared dolomites and intercalated sandstones and siltstones of the Lomagundi Group, and consists mainly of oxidised malachite ore, with some hypogene ‘chalcocite’ which occurs as pseudomorphs after pyrite, and minor chalcopyrite (Stagman, 1961; Newham, 1986). Sulphur isotopes of the sulphides range in δ^{34}S from +8.1 to -2.0 permil (von Rahden and de Wet, 1984). The malachite occurs as paint-like films along cleavage planes and fractures. Other oxide minerals recorded are chrysocolla, cornetite, planchéite, shattuckite dioptase, cuprite and tenorite. Native copper occurs as dendritic crystals, and as sheets along fractures and faults. J.B.E. Jacobsen (1964) described the geology of the deposit, and interpreted the host rocks to be part of an allochthonous nappe that was bounded at the base by a major breccia zone. The nappe consisted of several imbricately stacked thrust sheets, in what would today be termed a duplex structure. Newham (1986) reinterpreted the structure to be a simple syncline, as shown in his idealized cross-section of the deposit. This is at total variance with the detailed mapping of Jacobsen (1964), as well as with maps produced by the mine in 1970.

Examination of a sample from the sandstone orebody, which contains ‘chalcocite' pseudomorphs after pyrite, revealed convincing evidence for the timing of the mineralization. The ‘chalcocite' was shown by XRD to be the first occurrence in Zimbabwe of the closely related mineral djurleite ($Cu_{31}S_{16}$) (Master, 1991a,b). The djurleites, pseudomorphous after cubic pyrite, are deformed into parallelepipeds, and appear diamond-shaped in cross section. The host rock is a highly sheared metasiltsone, which has shear planes with talcose partings, and which have a strong slickensided striation lineation, with steps at right angles to this. Fibrous minerals growing in the lee of the slickenside steps are oriented parallel to the lineation. The long axes of the deformed djurleite pseudomorphs are also aligned parallel to the lineation, and they appear to have stretched during simple shear.

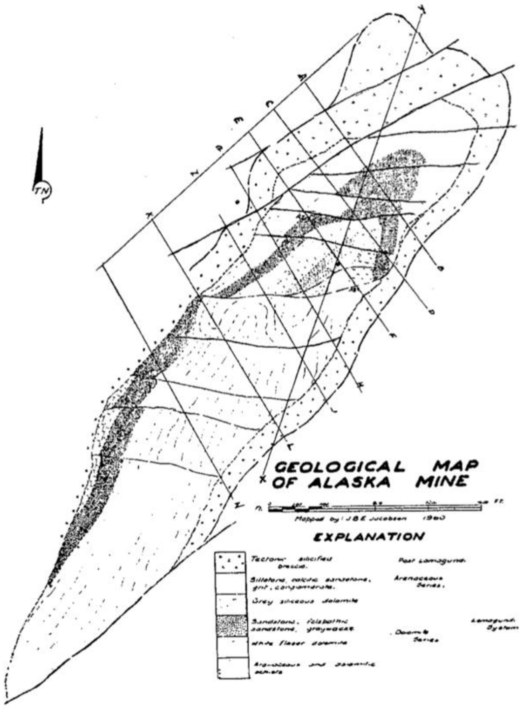


Figure 31: Geological map of Alaska Mine (after Jacobsen, 1964).

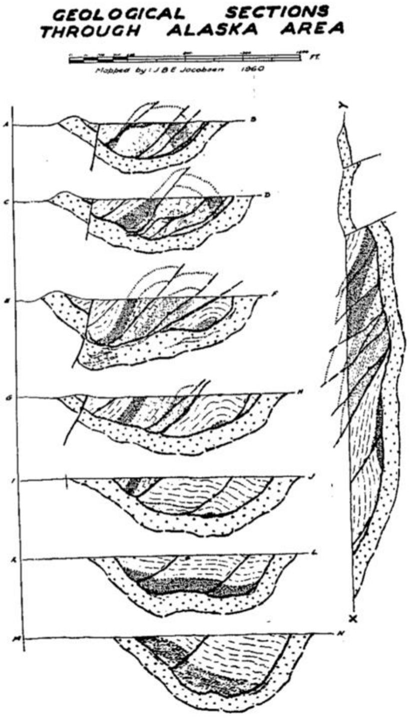


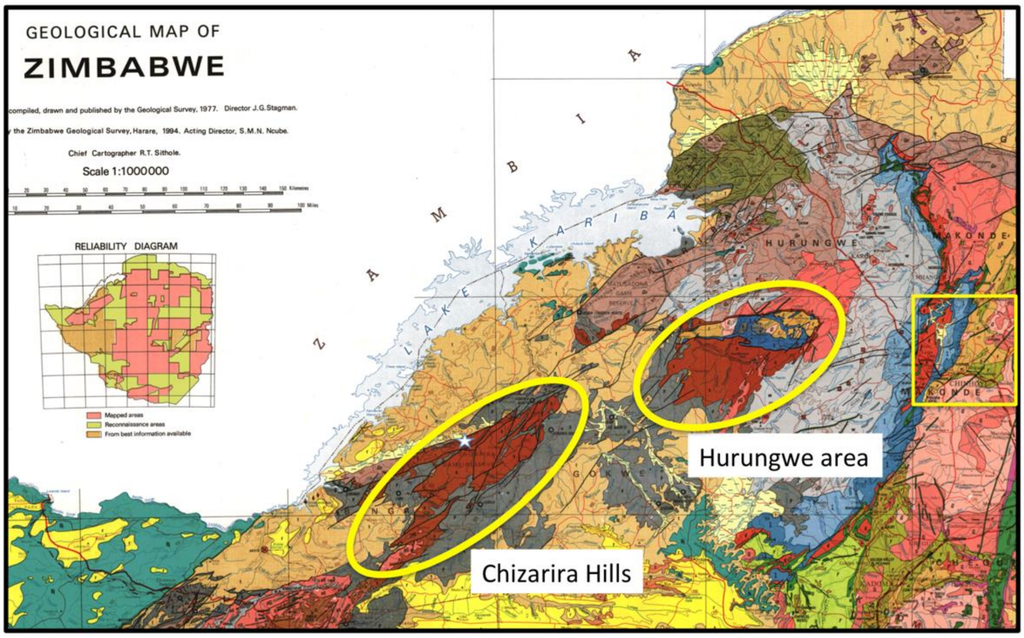
Fig. 32: Geological sections through Alaska Mine (after Jacobsen, 1964). The section lines are shown in Fig. 31.

The djurleite pseudomorphs have quartz-rich pressure shadow fringes, indicating that the replacement took place after these fringes had formed around the earlier euhedral pyrites. If the djurleite replacement had taken place before any deformation, there would be no pressure shadows around the djurleites, but instead, because of the low grain boundary energy and strength of chalcocites, they would have been totally flattened into parallelism with the cleavage. The deformed pseudomorphs with pressure shadows indicate that the replacement must have happened syntectonically. A first increment of deformation produced a schistosity in the rock, and formed quartz pressure shadows around rigid pre-existing pyrite crystals. The rock was then infiltrated syntectonically by copper-bearing solutions moving along permeable cleavage and fracture planes, which replaced the pyrite by djurleite. The djurleites, with their inherited quartz pressure shadow fringes, then underwent further deformation, in which they behaved plastically, and suffered rotation and flattening by simple shear. A similar example of chalcocite pseudomorphs after euhedral pyrite occurs at the Klein Aub Mine in Namibia, but in this case the replacement was post-tectonic, since the chalcocites, with their quartz pressure shadows, are undeformed.

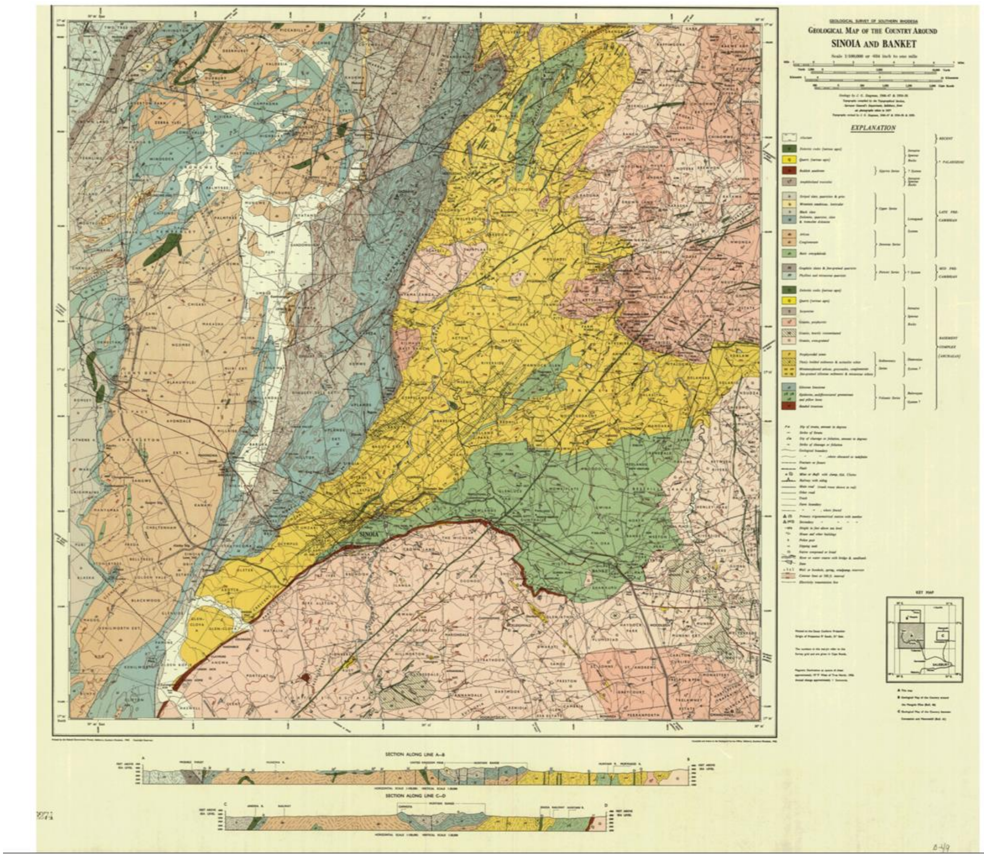
Stop 5. Sijarira Group outlier, Portelet Estate (30.15966 E, 17.47189 S, WGS84)

Stagman (1961) mapped a small outcrop of red indurated sandstone which formed an outlier sitting on the Archaean basement granite of the Biri dome south of Chinhoyi.

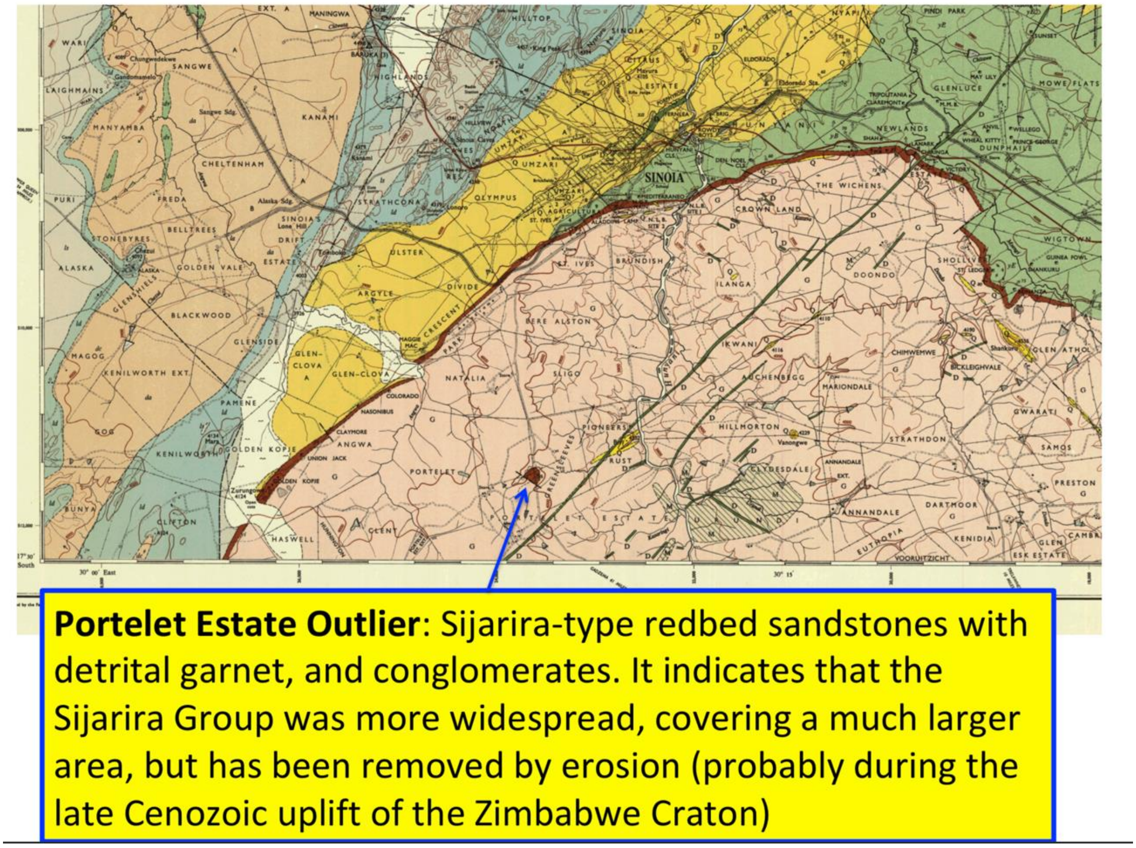
He stated: “The presence of a small downfaulted outlier of Sijarira sandstone resting on the granite astride the main road through Portelet Estate testifies to the former wide lateral extent of this rather thin, shallow-water series, the nearest large development of which is 50 miles (80 km) away to the north-west in the Urungwe Reserve. The rock is indistinguishable from some of the Sijarira sandstone near Wankie. The exposure is composed of a small ridge of reddish sandstone trending north-west, plus a few acres of reddish brown soil surrounded by pale granite sand.”



Sijarira Group- unfossiliferous undeformed unmetamorphosed redbeds of continental fluvial and shallow marine origin, 660m to 1170m thick. Unconformably overlying 1.21 Ga granites, and overthrust by Neoproterozoic Hurungwe Klippe at 550 Ma.



Geological Map of the area around Sinoia and Banket (Stagman, 1961)



Portelet Estate Outlier: Sijarira-type redbed sandstones with detrital garnet, and conglomerates. It indicates that the Sijarira Group was more widespread, covering a much larger area, but has been removed by erosion (probably during the late Cenozoic uplift of the Zimbabwe Craton)

The rock (specimen 16091) is very hard, fine-grained and has a chonchoidal fracture.

The Portelet Estate Outlier has never been studied since its discovery and mapping by Stagman (1961). No sedimentary structures have been described, and the nature and accessibility of the outcrops at present is not known (it is on private property).

Acknowledgments

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