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Field Excursion Guidebook

An Introduction to the geology and geochronology of the Dete-Kamativi Inlier

Dr Sharad Master

Economic Geology Research Institute,
School of Geosciences,
University of the Witwatersrand,
Johannesburg, South Africa,
sharad.master@wits.ac.za

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Introduction

Dete-Kamativi Inlier

The Dete-Kamativi Inlier is a sequence of Precambrian metamorphic rocks which are exposed through Phanerozoic cover in western Zimbabwe (Figure 1). The rocks consist of granodioritic orthogneisses, granites, and highly deformed and metamorphosed supracrustal sequences which have been subdivided into the Malaputese, Inyantue, Kamativi and Tshontanda formations (Lockett, 1979) (Table 1, Figure 2).

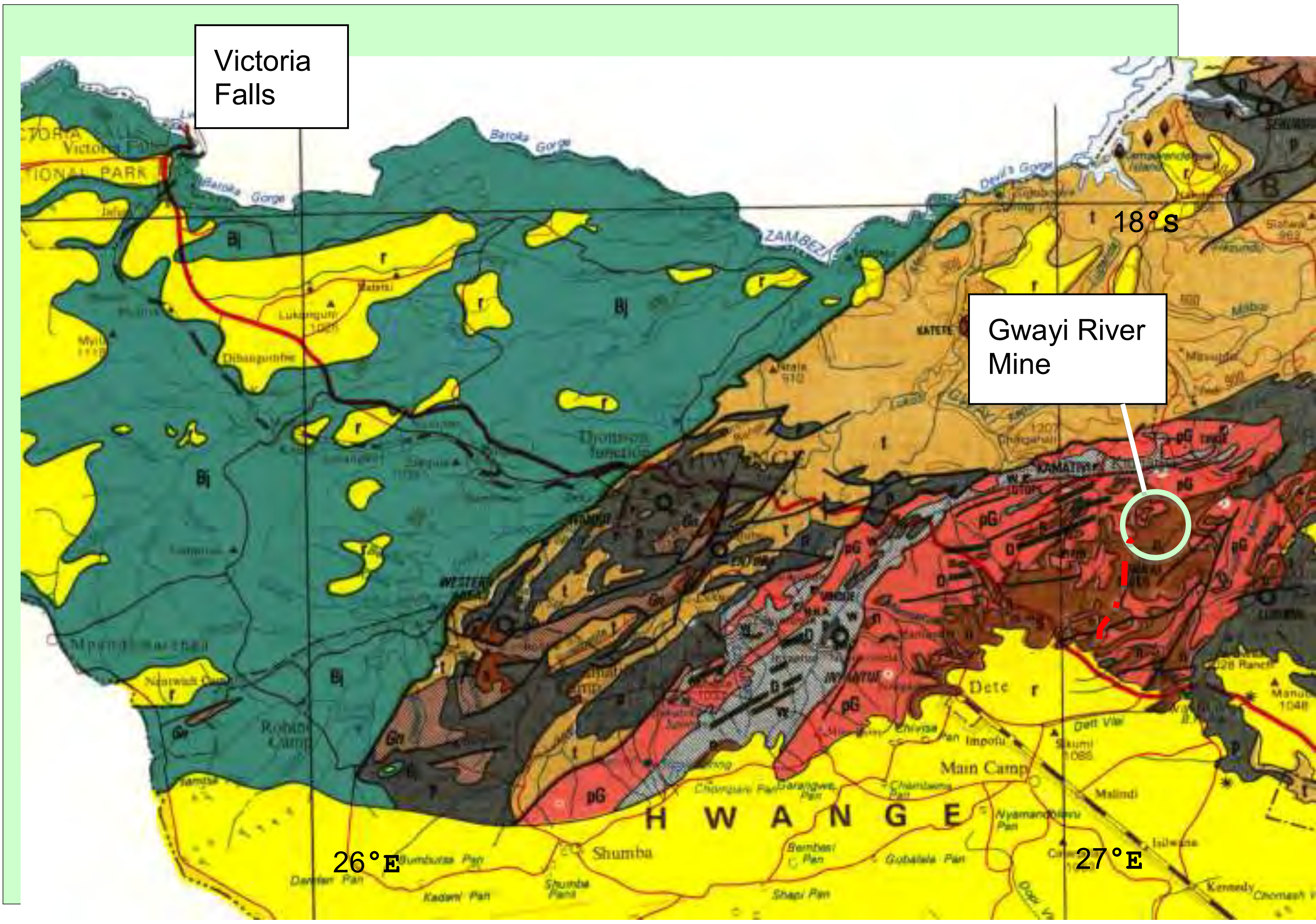


Figure 1: The Dete-Kamativi Inlier and surrounding region.
Extracted from the 1:1,000,000 Geological Map of Zimbabwe (1977).

Table 1: Stratigraphy and correlation of the Dete-Kamativi Inlier, NW Zimbabwe, after Lockett (1979a, and Master et al., 2010). Geochronological data are from Master et al. (2013a,b).

Formation	Lithology	Correlation
	Intrusive granites (2.07-2.03 Ga)	
Kamativi	Muscovite and biotite schists, minor psammites	Piriwiri Group
Tshontanda	Garnet-mica schists, sillimanite gneisses, impure quartzites	Piriwiri Group
Inyantue	Garnetiferous gneisses, arenites, calcareous and graphitic rocks	Lomagundi and Deweras groups
Malaputese	Pink arkosic psammites, calc-silicates, metapelites, mafic metavolcanics, quartzites	Lomagundi and Deweras groups
	Migmatitic Granitic Orthogneiss (2.71 Ga)	

Malaputese Formation

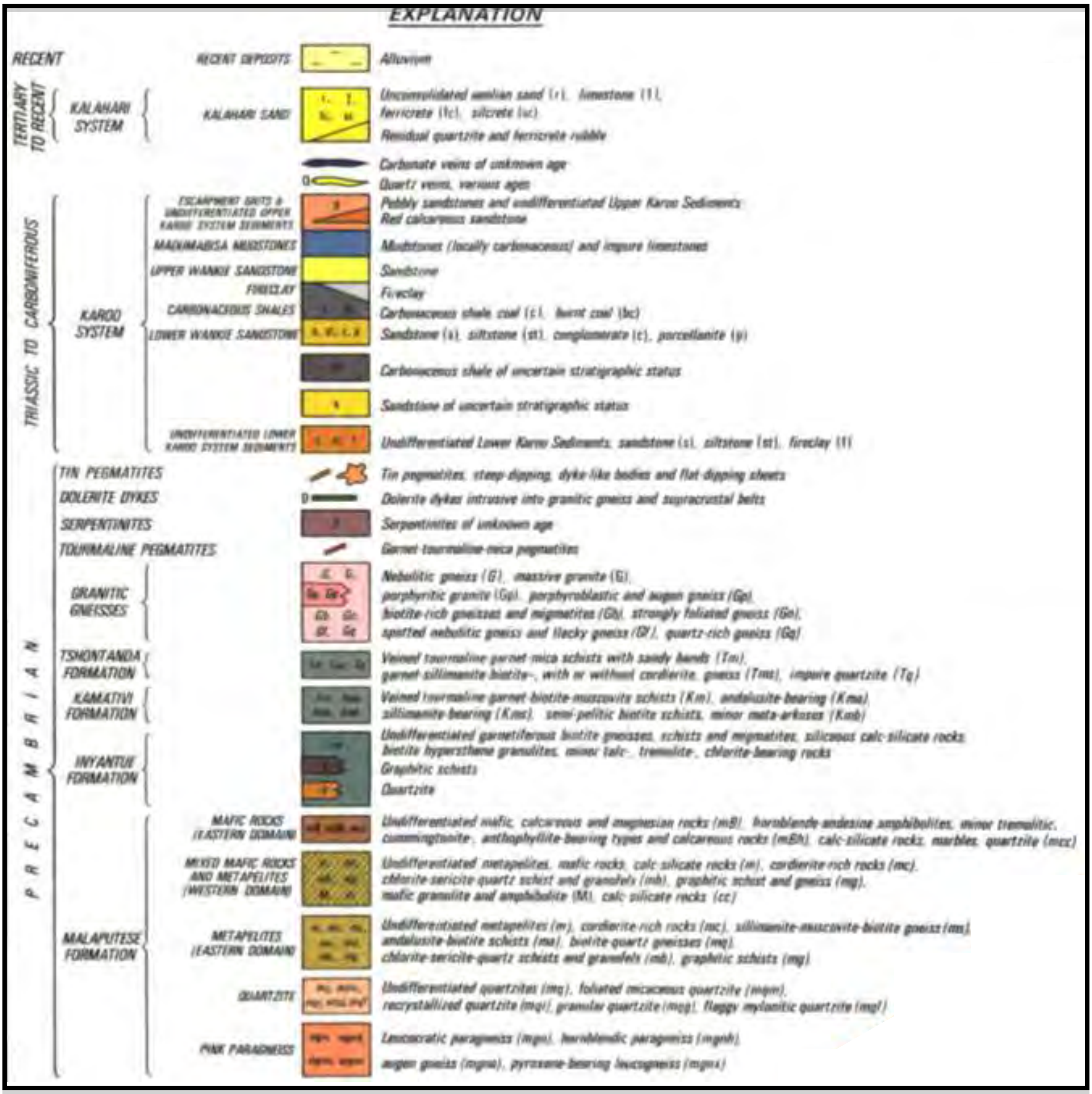
The Malaputese Formation, consisting of metasedimentary and mafic rocks, is exposed over much of the south-east portion of the Dete-Kamativi Inlier, and is divided into two stratigraphic domains (Lockett, 1979). The Western Domain consists of pink paragneiss at the base with minor intercalated calc-silicate and pyroxene leucogneisses, followed by a sequence of metapelites with minor graphitic, calcareous and mafic rocks, with quartzites forming the top of the succession. The Eastern Domain consists of quartzite at the base, followed by a succession of metapelites with graphitic schist interbeds, and by a sequence of mafic rocks with intercalated metasedimentary schists and quartzites.

The rocks were metamorphosed to upper amphibolite and granulite facies, and the metapelites contain cordierite, sillimanite and andalusite. Retrograded schists consist of chlorite, sericite and quartz. The pink paragneisses are interpreted as metamorphosed continental arkosic red-beds (Lockett, 1979). The quartzites are interpreted to have formed on a shallow marine shelf by a marine transgression over a stable cratonic platform. The metapelitic schists are interpreted to have been deposited in a shallow marine or lagoonal depository, while the intercalated graphitic schists are regarded as metamorphosed black shales indicating strongly reducing, anoxygenic conditions of deposition (Lockett, 1979). The mafic rocks are hornblende-andesine amphibolites, and are chemically classified as subalkaline basalts, which Lockett (1979) compares with continental olivine-tholeiite plateau-basalts. The schists intercalated with the metabasalts consist of calcareous marbles and calc-silicate-rich rocks, anthophyllite-cordierite rocks, and thin-bedded fine grained quartzites, and are interpreted to be metamorphosed interflow sediments. They are hosts to stratabound copper mineralization at the Gwayi River Mine and other prospects in the area (Lockett, 1979; Bahnemann and Lockett, 1979).

Inyantue Formation

The Inyantue Formation is composed of garnetiferous gneisses and schists with intercalations of calcareous, graphitic, magnesian and arenitic rocks (Lockett, 1979). The garnetiferous gneisses and schists, making up 95% of the sequence, have been divided into four varieties: (i) sillimanite-cordierite-garnet-biotite gneiss; (ii) garnetiferous gneiss with a leucosome phase; (iii) speckled, augen and banded gneisses; (iv) veined biotite schist. Narrow bands of tremolite, epidote and diopside-bearing siliceous calc-silicate rocks are ubiquitous in the gneisses and schists. Graphitic horizons, 1-20m wide, may occur singly or in groups of three or more bands, and may have associated coarse-grained diopsidic rocks. An impersistent quartzite horizon is found interbedded with the schists. Thin bands of magnesian chlorite-tremolite, tremolite-talc and chlorite-talc rocks occur in biotite schists. Scattered outcrops of medium-grained grey biotite-hypersthene granulites are also found.

Figure 2a: Explanation of the Geological Map of the Country around Dett (Dete), from Lockett (1979a)



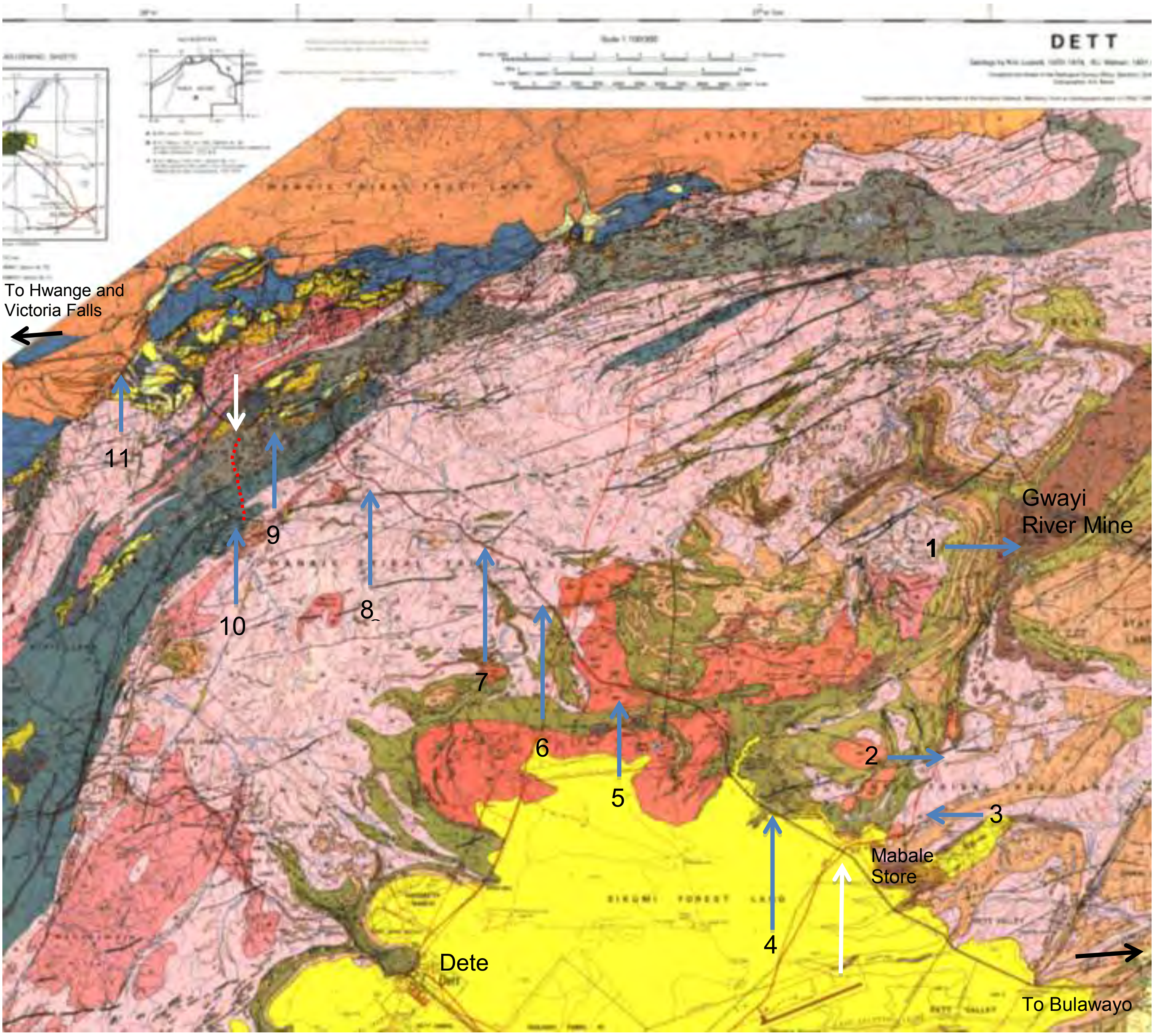


Figure 2b: Extract from the geological map of the country around Dett (Dete), from Lockett (1979a). The location of the field excursion stops is shown with arrows.

The garnetiferous gneisses and schists are interpreted, on the basis of their modal composition, to be metamorphosed argillaceous sediments (Lockett, 1979). The graphitic horizons, with diopsidic rocks, are interpreted to have been carbonaceous shale with lenticular beds of impure limestone. The siliceous calc-silicate bands were probably calcareous sandstone or siltstone intercalations, and the talc-tremolite-chlorite rocks were probably dolomitic marls. The biotite-hypersthene granulites, which contain accessory graphite, are interpreted as metamorphosed greywackes. The recrystallized quartzite is interpreted to have been a lenticular quartz-arenite horizon (Lockett, 1979).

Kamativi and Tshontanda Formations

The Kamativi and Tshontanda Formations are found in two elongated belts that were formerly thought to be continuous (Lockett, 1979). The Kamativi Formation consists of tightly folded muscovite schists, subordinate fine-grained biotite schists, and minor arkosic psammites. The muscovite schists are medium-grained, strongly foliated rocks which contain garnets, schorl, and in some varieties, retrograde andalusite porphyroblasts with sillimanite inclusions. There are rare remnants of sillimanite-bearing schists. The biotite schists form intercalations in the muscovite schists, ranging in width from a few centimetres to over 100 m. The fine-grained biotite schists range from sheared, flaggy types to more massive, poorly cleaved varieties, and they commonly display a fine compositional banding parallel to the schistosity. The schists consist mainly of quartz, plagioclase and biotite. Minor meta-arkose, which is a grey, medium-grained granoblastic garnetiferous quartz-andesine rock with a biotite-rich fabric, forms psammitic intercalations in the schists (Lockett, 1979).

The Tshontanda Formation is composed of garnetiferous mica schists and subordinate sillimanite gneisses, with local intercalations of impure quartzite. The garnet-mica schists are medium to coarse-grained and consist of muscovite, biotite, quartz, garnet, chlorite and tourmaline (Lockett, 1979). Fine-grained semipelitic biotite schists with interlaminated more psammitic layers form banded intercalations in the muscovite schists. The sillimanite gneisses range from garnetiferous metapelites to more psammitic sillimanite-biotite-quartz gneisses. Alternations of biotite-rich and psammitic layers impart a banding to these rocks. The impure quartzites are grey, fine-grained, massive to finely banded quartz-oligoclase-mica rocks which form lenticular horizons, 1-30m wide, in the semipelitic biotite schists and the more psammitic sillimanite gneisses (Lockett, 1979).

The modal compositions and layering of the rocks of the Kamativi and Tshontanda Formations suggest that their protoliths consisted of micaceous shales interlaminated with subordinate silty shales and siltstones, and incorporating narrow sandy horizons of arkose and feldspathic quartzite. According to Lockett (1979), the lack of associated clean quartzites and calcareous rocks suggests a deeper water origin than for the Inyantue Formation. Lockett (1979) did not recognise any turbidite sequences, however, and considered that a deep-water geosynclinal environment was unlikely.

Correlations

Lockett (1979a,b; 1981) correlated the metapelitic rocks of the Dete-Kamativi inlier with the Piriwiri Group, but Watson (1962) suggested that they could also be correlated with the older Hurungwe paragneisses in the Kariba area. Watson (1962) correlated the Malaputese Formation with the Lomagundi Group, but Lockett (1979) pointed out that in order satisfy lithological requirements, the Deweras Group would have to be included in the correlation, and would account for the pink paragneisses (meta-arkoses) and the metavolcanics.

Lockett (1979a) rejected the suggested correlation between the Malaputese Group and the Deweras and Lomagundi Groups, on the sole basis that there was an unconformity between the latter two groups, whereas he did not recognise one within the Malaputese Group. He also cited the presence of Lomagundi Group lithologies in the Sawmills borehole 130 km to the southeast of the Dete-Kamativi inlier as evidence that the Lomagundi basin passed well southeast of the Malaputese Group outcrops, and could not therefore be a correlative. Master (1991) felt that Lockett's (1979a) objections to the correlation of the Dete-Kamativi inlier lithologies with those of the Magondi Supergroup were weak, and disregard their very close lithological similarities. Master (1991) argued that the Deweras-Lomagundi-Piriwiri Group sequence of copper-bearing arkoses, sub-alkaline basalts, orthoquartzites, dolomites, slates, graphite-bearing schists and wackes is matched closely by the copper-bearing pink paragneisses, sub-alkaline amphibolites, metaquartzites, marbles, aluminosilicate-bearing and graphite-bearing schists and gneisses of the Malaputese-Inyantue-Kamativi-Tshontanda Formations of the Dete-Kamativi inlier. This close lithological correspondence, together with the similarities in terms of age, suggested that the metasedimentary and metavolcanic rocks of the Dete-Kamativi inlier are the high-grade metamorphosed equivalents of the Deweras, Lomagundi and Piriwiri Groups which outcrop in the northern part of the Magondi basin. As regards the lack of lateral strike continuity between the two areas, it was postulated by Master (1991) that the Dete-Kamativi inlier rocks were deposited on the western side of the Magondi rift basin. During the Magondi Orogeny, this western flank of the basin was overthrust by the basement/magmatic arc terrain to the west, resulting in granulite grade metamorphism of the Malaputese Group. In contrast, farther north along strike, the western edge of the basin, together with the flanking Hurungwe gneisses/magmatic arc, was itself uplifted and involved in thrusting over the central part of the basin (filled with Piriwiri Group rocks). This led to granulite facies metamorphism of the Piriwiri Group, and the complete erosion of the Deweras and Lomagundi Group/ Malaputese Group equivalent rocks of the northwestern flank.

Mineralization

Although copper staining is widespread in the Malaputese Group, significant copper sulphide mineralization is restricted to rocks of the Eastern Domain, mainly in association with the mafic amphibolites. There was one operating mine in the area, the Gwaai River Mine, and many small claims and workings (Lockett, 1979a; Master, 1991).

The schists of the Kamativi and Tshontanda formations are extensively invaded by tin-, tungsten- and lithium-bearing quartz-feldspar-muscovite pegmatites (Lockett, 1979a). The pegmatites, which contain cassiterite and wolframite, as well as minor tantalite-columbite, amblygonite, lepidolite, spodumene and petalite, have been mined at the Lutope and Kamativi mines (Lockett, 1979a, Master, 1991). There are also scheelite- and wolframite-bearing zones within the schists which are associated with stratiform tourmalinites, and isoclinally folded (at RHA and Tung Mines) (Cunningham et al., 1973); and vein deposits of argentiferous galena at Elbas Mine (Lockett, 1979a; Master, 1991). Other mineral prospects present in the area include graphite and fluorite deposits (Lockett, 1979a).

Structure and Metamorphism

Rocks of the Dete-Kamativi Inlier have been strongly deformed and metamorphosed to amphibolite facies. Rocks of the Malaputese Formation were affected by three folding events, recognised from small-scale and regional structures, while the rocks of the Kamativi and Tshontanda formations have been intensely deformed and attenuated into thin, linear or slightly arcuate belts (Lockett, 1979).

Rocks of the Malaputese Formation were affected by three fold phases, F1, F2 and F3, recognised from small-scale and regional structures (Lockett, 1979). The first deformation produced NE-trending F1 isoclinal folds and some recumbent structures in the quartzites. The second deformation produced SE-trending F2 folds, which were overprinted by NNE-trending F3 folds, producing regional dome and basin, arcuate and lobate interference structures outlined by the Malaputese quartzites (Lockett, 1979).

The rocks of the Kamativi and Tshontanda Formations have been intensely deformed and attenuated into long thin linear or slightly arcuate belts.The schists are isoclinally folded with a steeply dipping fabric, and are cut by numerous shear zones. Lockett (1979) proposed that the deformation took place under sinistral simple shear, based on the "drag direction to swept back schist protrusions into granitic rocks along the northern margins of the Kamativi and Tshontanda belts". However, examination of the geological map (Lockett, 1979) indicates that the sigmoidal shape of the schist belts is due to regional NE-SW dextral transpressional shear, which would also explain the NNE orientation of F3 folds in the Malaputese Formation.

Geochronology

The only previous geochronological work in the Dete-Kamativi inlier was done by Priem et al. (1972). They obtained Rb-Sr whole-rock ages on granodioritic gneisses and unfoliated intrusive granites of 2159 ± 100 Ma and 2000 ± 80 Ma, respectively (recalculated using ^{87}Rb decay constant from Steiger and Jäger, 1977). These poorly constrained ages reflect magmatic episodes on the western side of the Magondi basin pre- or syn-kinematic (granodioritic gneisses), as well as postkinematic (unfoliated granites), with respect to the Magondi Orogeny. The granodioritic gneisses probably represent a calc-alkaline magmatic arc, while the granites represent post-collisional crustal melts following granulite-facies metamorphism and migmatite formation.

The new geochronology of the Dete-Kamativi area reported by Master et al. (2013a,b) shows that the area is underlain by Archaean continental crust of the Zimbabwe Craton, which extends much further west under the Magondi Belt than was previously suspected. Superimposed on granitic Archaean migmatites (2.71 Ga) are the schist belts that comprise the Magondi Supergroup supracrustal sequences of the Malaputese, Kamativi, Tshontonda and Inyantue Formations. These are in turn intruded by biotite granites and biotite granodiorites dated at between 2.07 and 2.03 Ga- representing an Andean-type magmatic arc on the western edge of the Archaean Zimbabwe Craton.

It appears that the Choma-Kalomo Block of southern Zambia was already in place at 1.2 Ga, since it contains deformed supracrustal rocks with detrital zircons clearly derived from the Archaean Zimbabwe Craton and the Magondi Mobile Belt (Master et al., 2013b). The Choma-Kalomo Block contains two granitoid plutons, of 1.37-1.345 Ga and 1.20-1.18 Ga age (Hanson et al., 1988; Bulambo et al., 2004, 2008).

Itinerary

Depart Victoria Falls at 7:30 AM. Arrive and meet at turnoff to Gwayi River Mine (Mabale Store) at crossroads between Victoria Falls-Bulawayo road and Hwange National Park Main Camp/Gwayi River Mine road (c. 170 km from Victoria Falls).

Stop 1: Malaputese Group at Gwayi River Mine (dumps around the Adder adit). GPS Coordinates: 18° 26' 44"S; 27° 06'37"E

The Gwayi River Mine (formerly Gwaai River Mine) was operated by Messina (Transvaal) Development Corporation from 1970 until 1975, when the mine was closed for economic reasons. The mines have been dormant ever since, but since 2010, a Chinese company, Sino-Mining, has been doing exploration in the area.

At 9:30, we move in a convoy to Gwayi River mine, to examine dumps around the Adder adit. We will examine amphibolites, and calc-silicate-bearing marbles, which are the country rocks surrounding the mineralized host rocks (metapsammites with stratabound chalcopyrite and pyrite mineralization, oxidized to malachite and azurite). The mineralized horizons are interpreted as interflow sedimentary rocks intercalated with mafic metavolcanic rocks (now represented by amphibolites).

Although copper staining is widespread in the Malaputese Group, significant copper mineralization is restricted to rocks of the Eastern Domain, mainly in association with the mafic amphibolites (Lockett, 1979a). There was one operating copper mine in the area, the Gwayi River Mine (also spelt Gwai or Gwaai), and many small claims and workings. At the Gwayi River Mine, there are three ore shoots in the form of flattened elongate cigar-shaped pods which are restricted to the noses of fold closures, and which plunge parallel to co-linear F1 and F3 deformation structures (Lockett, 1979a,b; Bahnemann and Lockett, 1979). There are two types of copper occurrences: in shears and fractures within tremolite and cummingtonite-anthophyllite amphibolites which are enclosed in hornblende amphibolites; and in siliceous and calc-silicate-rich interflow metasedimentary intercalations in the mafic sequence. The sulfides consist of chalcopyrite, pyrite and pyrrhotite. At the Adder shoot at Gwayi River Mine, coarse sulfides occur together with vein quartz filling breccias in calc-silicate rocks in the nose of a fold. At the Puff Adder shaft, finely disseminated sulfide mineralization is localized within bands of vitreous grey quartzite grading outwards into cross-cutting veins and blows of quartz (Lockett, 1979a). The orebody varies from 3 to 15m in width, and has a strike length of 400m, and a down-dip extent of at least 470m (Lockett, 1979a).

The ores appear to have been metamorphosed at high grades, and then retrograded. Ore minerals are intergrown with metamorphic minerals like almandine garnet, cordierite, tremolite, cummingtonite, anthophyllite and epidote. The ores predate regional granitic events, as they are cut by undeformed granitic intrusions. Bahnemann and Lockett (1979) attributed the origin of the Gwayi River Mine mineralization to "syngenetic volcanic exhalations next to fumarolic vents" or to a "final degassing of the lava pile". These volcanogenic deposits were then metamorphosed, stretched and deformed into the shape seen today.

An alternative explanation of the origin of these deposits is that they were generated by metamorphic fluids which leached copper from the volcanic pile during the first deformation and high-grade metamorphic event (Master, 1991). The alteration of mafic volcanics is a good potential source of copper, and may have provided the metal in many copper districts. The metamorphic fluids were channeled along permeable pathways, such as interflow sediments intercalated with the volcanics, as well as along faults, shears, and brecciated fracture zones in the noses of folds. The copper-bearing fluids would have replaced early-formed pyrite to produce chalcopyrite in these permeable zones, giving rise to the elongate shapes of the orebodies. Pyrrhotite may have formed during the metamorphism by desulfidation of pyrite. The same metamorphic fluids would have given rise to the very widespread, but uneconomic, veins and hydrothermal fracture fillings that cut all the Precambrian rocks of the area (Lockett, 1979a). The copper deposits in the Malaputese Group should thus be regarded as metamorphogenic or “metamorphic” rather than “metamorphosed”. The mineralization at Gwayi River Mine shows similarities with mineralization in the Matchless Belt of the Damara Orogenic Belt in Namibia, especially of the Matchless and Otjihase Mines, and Gorob and Hope prospects. It also shows similarities with some zones of stratiform chalcopyrite replacements in interflow pyritic sedimentary intercalations within the Silverside mafic volcanics, in the basal Deweras Group of the Magondi Supergroup in NW Zimbabwe (Master, 1991).

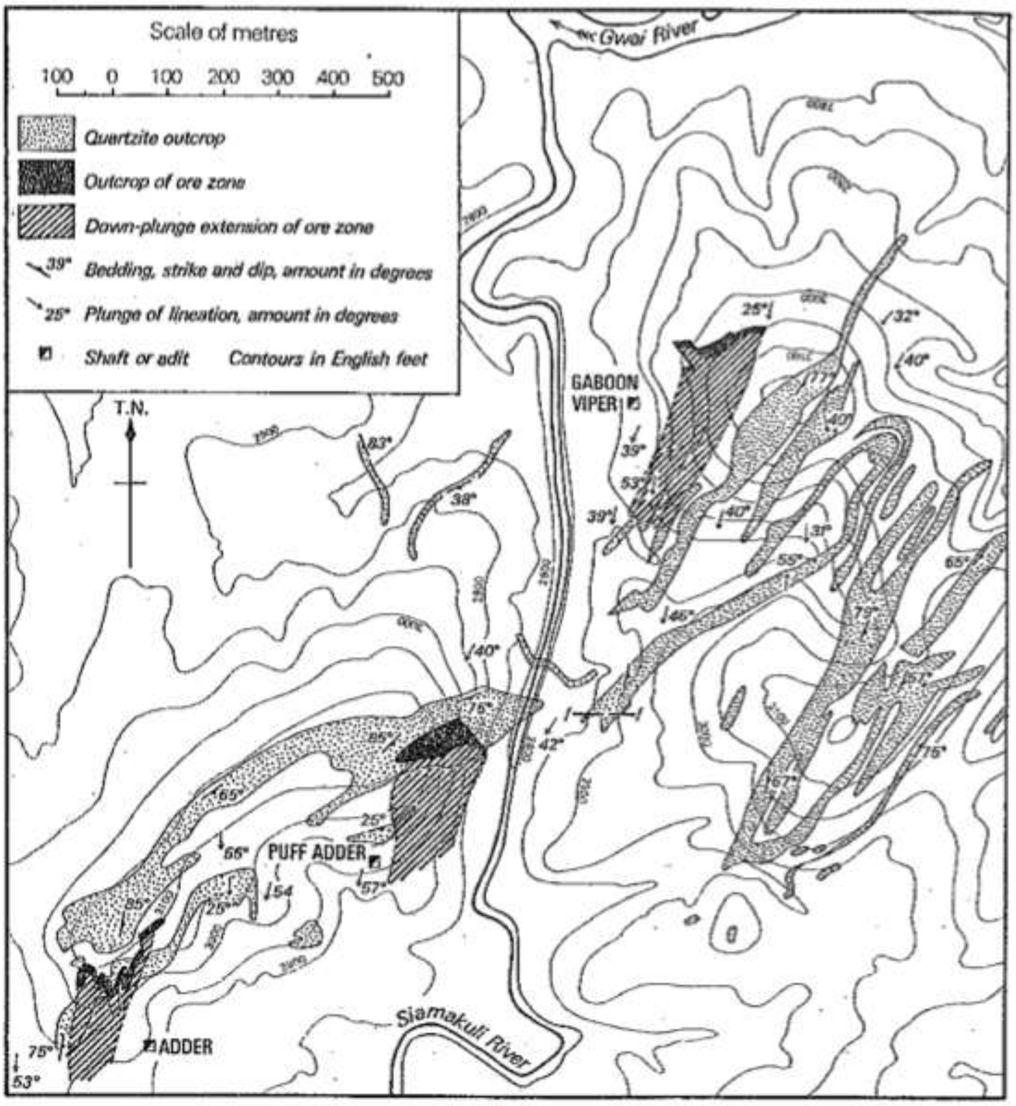


Figure 3: Plan projection of the orebodies at the Gwayi River Mine (After Lockett, 1979a).

Figure 4: Stop 1. Malaputese Formation amphibolites at Adder adit, Gwayi River Mine.

Stop 2: Palaeoproterozoic (ca. 2.03 Ga) granitoid (ZDK2) intrusive into the Malaputese Group. GPS Coordinates: 18° 31’54”S; 27° 04’28”E

This is a K-feldsparphyric porphyritic granite, cut by aplitic dykes. It has a weak fabric. It has yielded a simple population of zircons which give an age of 2.03 Ga (Master et al., 2013a,b).

Figure 5: Stop 2. Palaeoproterozoic K-feldsparphyric porphyritic granite, 2.03 Ga, cut by an aplite dyke.

Stop 3: Palaeoproterozoic (ca 2.07 Ga) granitoid (ZDK1), with complex (inherited) 3.4 and 2.7 Ga zircons. GPS Coordinates: 18° 33’ 54” S; 27° 03’ 18”E

In this outcrop, there is a deformed granite with anastomosing subhorizontal fractures, which is weathered with brownish iron oxide staining. It has yielded a very complex set of zircons, with inherited cores as old as 3.4 Ga, with 2.7 Ga overgrowths, and a final overgrowth at 2.07 Ga, which is possibly the age of intrusion of the granite, which was subsequently deformed (Master et al., 2013a,b).

Figure 6: Stop 3. Deformed Palaeoproterozoic granite with complex zircons: Inherited cores as old as 3.4 Ga, with 2.7 Ga overgrowths, and latest overgrowths of ca. 2.07 Ga (possible intrusion age?).

Stop 4: Tourmalinised amphibolite schists of the Malaputese Group. GPS Coordinates: 18° 33’ 18.8”S; 27° 00’ 11.7” E

This is an outcrop on the main Bulawayo to Victoria Falls road, about 3 km NW from the turnoff to Gwaai River Mine (i.e., Mabale Store). Here there are schistose amphibolites which are strongly impregnated with tourmaline which occurs in the form of black acicular or prismatic crystals. This is one of many examples of tourmalinization in the schist belts of the Dete-Kamativi Inlier, often associated with quartz-muscovite and tin-bearing pegmatites that are of late Mesoproterozoic ca. 1.03 Ga age (Master et al., 2013b).

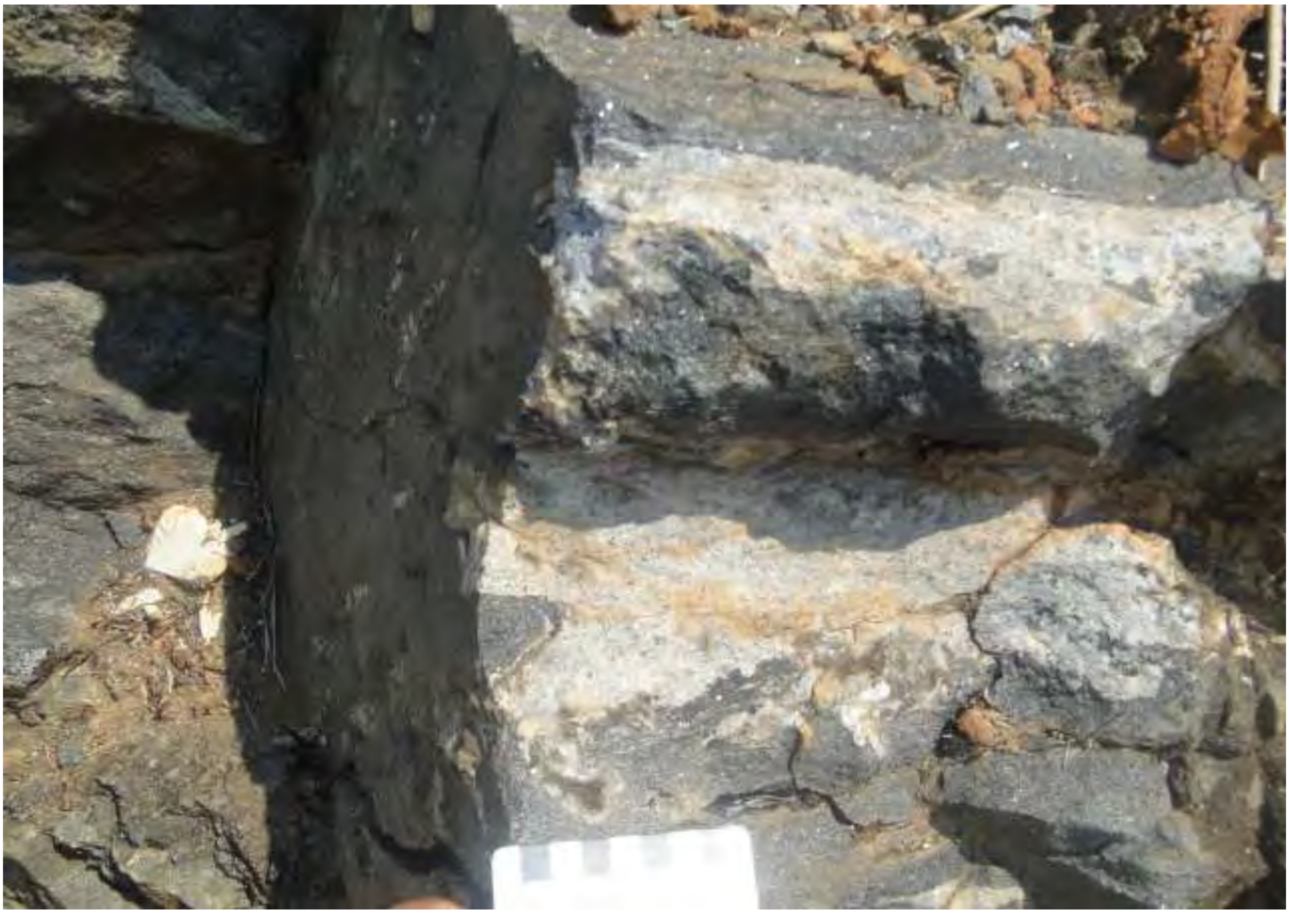


Figure 7: Stop 4. Tourmalinised amphibolite schist, Malaputese Formation

Stop 5: Pink paragneiss (meta-arkose) (ZDK9C) of the Malaputese Group. GPS Coordinates: S18 30 42.0 E26 57 34.3

At this outcrop locality, about 10 km further NW from the previous stop, there are numerous roadside outcrops of strongly recrystallized pink paragneiss of the Malaputese Group. The gneisses are interpreted as meta-arkoses, and some show relict cross bedding. They have yielded a detrital zircon population that ranges in age from 2254 ± 18 to 2796 ± 17 Ma, with a strong age peak at ca. 2.7 Ga (Master et al., 2013a,b). In terms of age and lithology, the correlation of the Malaputese Group with the Deweras Group (which has a maximum age of 2235 ± 32 Ma; Glynn et al., 2012), as suggested by Master et al. (2010), is confirmed. The detrital zircon population indicates that at the time of deposition of the Malaputese Group, the basement rocks that were exposed in the provenance areas for the sediments were mainly 2.7 Ga Archaean rocks of the Zimbabwe Craton.

Figure 8: Stop 5. Pink paragneiss of the Malaputese Group, with a maximum age of 2254 ± 18, and a provenance from mainly 2.7 Ga basement rocks of the Archaean Zimbabwe Craton.

Stop 6: Archaean (2.71 Ga) migmatitic granitoid gneisses (ZDK11). GPS Coordinates: 18° 28' 0" S; 26° 54' 26" E

These are variegated inhomogeneous, polydeformed migmatitic gneisses, with leucocratic quartzo-feldspathic leucosomes and biotitic melanosomes. These migmatitic gneisses are the westernmost dated Archaean rocks of the Zimbabwe Craton. They have zircons which an age of ca. 2.71 Ga (Master et al., 2013a,b)- and they appear to be the source of the 2.7 Ga detrital zircons in the Malaputese Formation meta-arkoses (pink paragneisses), as well as the source of inherited zircons in the Palaeoproterozoic granites intruding the western Magondi Belt. These gneisses would appear to have formed the basement during Magondi Supergroup deposition in the Dete-Kamativi area, and they were intruded by syn-tectonic or orogenic granitoids during the Magondi Orogeny, in what would have been a continental Andean-type magmatic arc.

Figure 9: Stop 6. Archaean biotitic migmatitic granitoid gneiss, 2.71 Ga- the westernmost dated gneisses of the reworked Archaean Zimbabwe Craton basement of the Magondi Belt in the Dete-Kamativi Inlier.

Stop 7: Isoclinally infolded remnant of amphibolite schists, intruded by unmetamorphosed Kamativi Dyke Swarm dolerite dyke. GPS Coordinates: 18° 27' 09.6"S; 26° 53' 04.7"E

At the sign that marks 40 km to Gwayi River, there is a roadcut exposure of isoclinally folded amphibolite and biotite schists which was mapped by Lockett (1979a), who regarded it as a tightly infolded remnant of the Malaputese supracrustal sequence, surrounded by basement granitoid gneisses. It may possibly be a large raft or xenolith, or even a roof pendant, of the Palaeoproterozoic post-Magondi biotite granodiorites that are found close by (Stop 8), containing numerous biotite-rich schlieren. At the SE end of the roadcut, there is a prominent exposure, with large rounded boulders, of one of the dolerite dykes that make up the Kamativi Dyke Swarm (Wilson et al., 1987). This dyke swarm has not yet been dated, and no palaeomagnetic work has yet been done on its dykes.

Figure 10: Stop 6. Rounded boulder outcrops of a dolerite dyke that belongs to the undated Kamativi Dyke Swarm.

Stop 8: Palaeoproterozoic ca. 2.03 Ga biotite granodiorite (ZDK12). GPS Coordinates: 18° 25' 59" S; 26° 50' 54"E

Palaeoproterozoic (ca. 2.03 Ga) granitoids (biotite granodiorite), with numerous biotite-rich schlieren, representing an Andean-type continental magmatic arc on the western edge of the Zimbabwe Craton (Master et al., 2013a,b).

Figure 11: Stop 7. Biotite granodiorite (2.03 Ga) with biotite-rich xenolithic schlieren.

Stop 9: Pegmatites in Kamativi Schist Belt

Quartz-feldspar-muscovite-tourmaline pegmatites intruding schists of the Kamativi Schist Belt. These pegmatites were dated at 1025 ± 15 Ma (Rb-Sr isochron) (Priem et al., 1972; Cahen et al., 1984), and now a tin pegmatite been recently dated using the Pb-Pb method on columbite and feldspar, at 1030 ± 9 Ma, indistinguishable, within error, from the 1080 ± 31 Ma (Rb/Sr, Ri = 0.705), and 1060 ± 40 Ma (K/Ar) age of the Phoenix tin pegmatite in the Choma-Kalomo Block of Zambia (Cahen et al., 1984; Master et al., 2013b).

Stop 10: Inyantue Formation paragneisses, and Pb claims near Elbas Mine. GPS Coordinates: 18° 26′ 32.7″S, 26° 46′ 53.8″E.

Exposures of isoclinally folded Inyantue Formation paragneisses in the Inyantue River, near Elbas Pb Mine. The gneisses were interpreted as metamorphosed argillaceous sediments and greywackes Lockett, 1979a,b). These gneisses are also invaded by tourmaline-bearing muscovite pegmatites. Alongside the dirt track on the far side of the Inyantue River, there are prospecting pits dug for argentiferous galena, which was mined at the Elbas Mine some 2 km away. Samples collected from these pits show a black oxidized mineral, which may be minium or massicot, both black Pb oxides formed from the oxidation of galena. Galena from the Elbas Mine was shown by Master (1991) to have a concordant $^{207}Pb/^{206}Pb$ age of ca. 1.18 Ga, which is the same age as the younger granites within the Choma-Kalomo Batholith in Zambia (Hanson et al, 1988; Master et al., 2013b).

Stop 11: Escarpment Grit of the Karoo Supergroup at Dinde School.

Coarse gritty, planar crossbedded sandstones of the Triassic Escarpment Grit Formation, (uppermost sedimentary rocks of the Karoo Supergroup), which overlies the Dete-Kamativi Inlier (Watson, 1962; Lockett, 1979a). (Optional stop, depending on time available).

Geophysical evidence for the nature of the crust of NW Zimbabwe, in the Victoria Falls region

Sedimentary rocks (sandstones and carbonaceous shales) of the lower Karoo Supergroup outcrop in the Hwange area, where the largest coal mines in Zimbabwe are found within the Carbonaceous Shale Formation (Figure 1, 2a). Once we cross the Deka Fault, the rest of the traverse to Victoria Falls is in the Jurassic-age uppermost Karoo Victoria Falls basalts (ca 180 Ma), overlain by Kalahari Group sands.

Geophysical evidence shows that the crust and lithosphere beneath the Karoo Supergroup in NE Botswana, adjacent to the northwesternmost corner of Zimbabwe (NW of the Deka Fault) has a different magnetotelluric signal from the rest of the Magondi Belt and Archaean Craton (Miensopust et al., 2012). There is a N-dipping mid-crustal conductive layer that separates the Magondi Belt from the Choma-Kalomo Block (which is referred to by Miensopust et al. 2012 as the Ghanzi-Chobe Belt), while there little difference between the Magondi Belt and Zimbabwe Archaean Craton. The Zimbabwe Craton and Magondi belt have a lithospheric thickness of 220 km, while the region referred to as the Ghanzi-Chobe Belt (i.e., Choma-Kalomo Block) has a lithospheric thickness of 180 km (Miensopust et al., 2012). The Ghanzi-Chobe Belt of Botswana appears to die out towards the Choma-Kalomo Block, or it may be represented by the folded schist belts on that block. A comparison of the processed aeromagnetic map of Zimbabwe with the geologic map of the Choma-Kalomo Block (Figure 13) clearly shows that the Victoria Falls region is underlain by a SW continuation of one of the schist belts of the Choma-Kalomo Block.

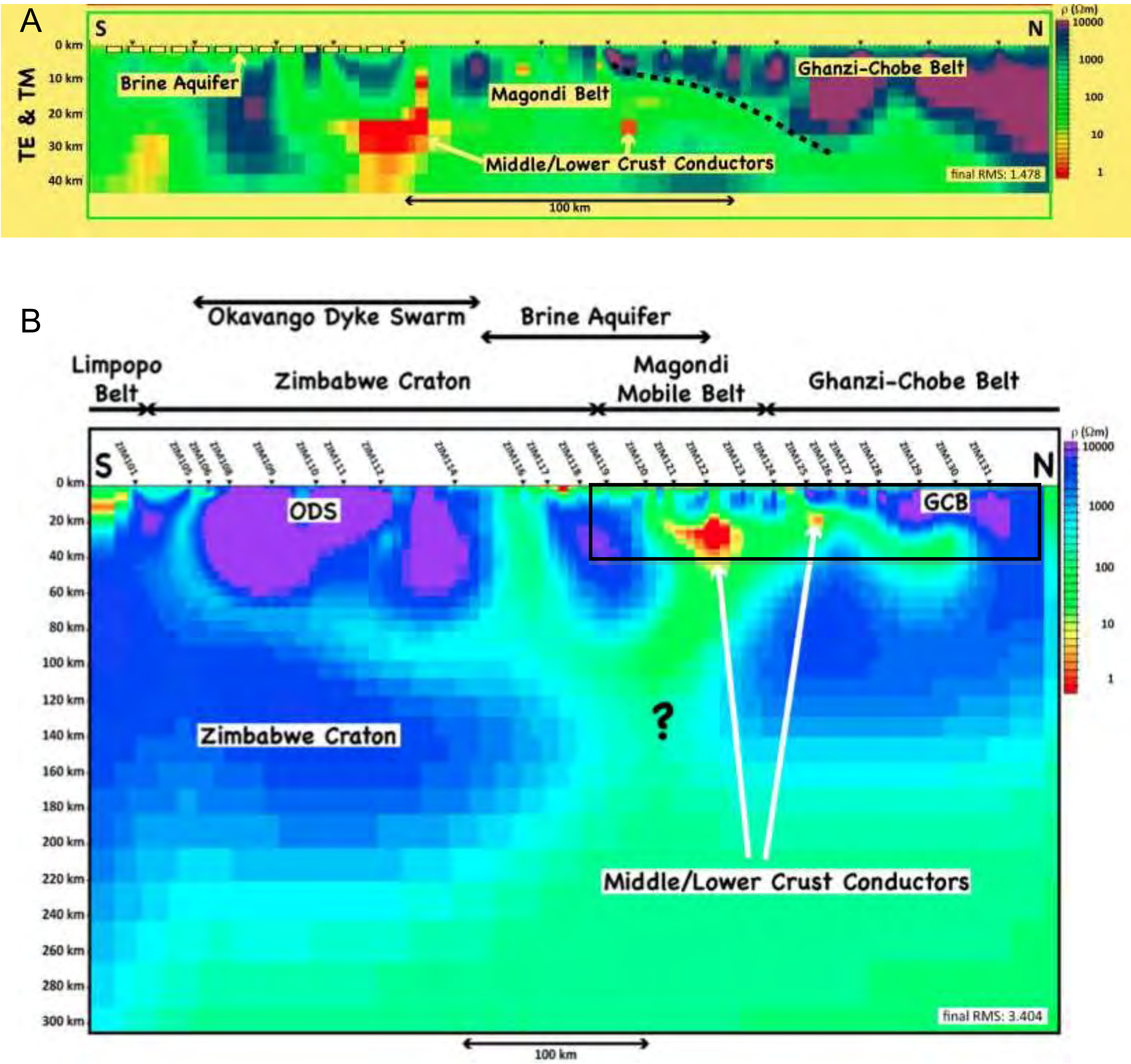
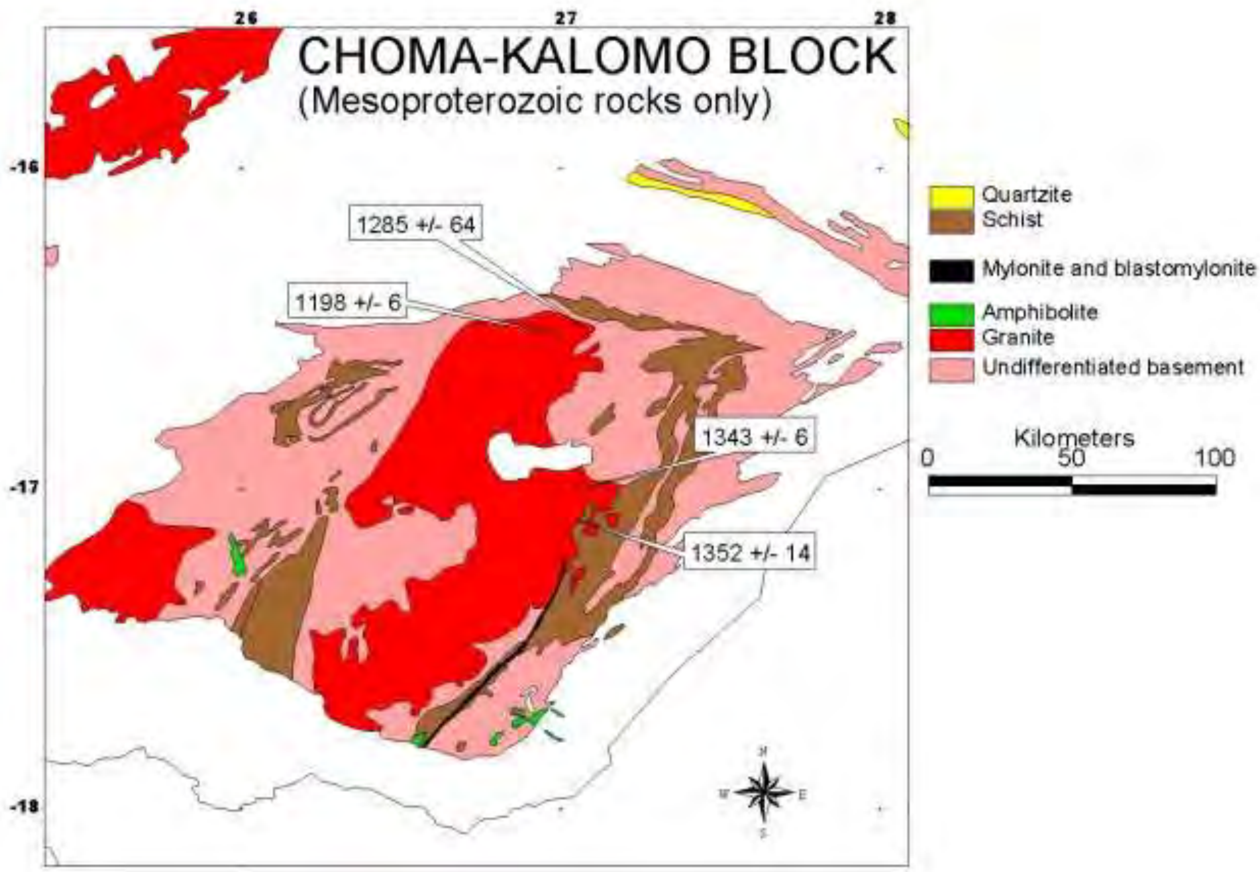
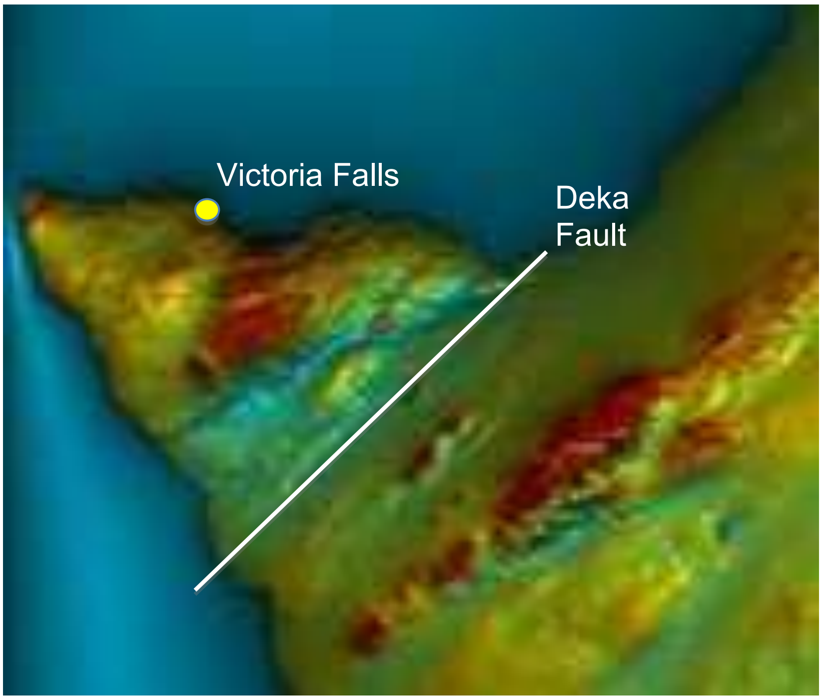


Figure 12: Magnetotelluric profiles (taken on a road traverse in NE Botswana, parallel to the border with Zimbabwe, from Kazangula in the N to Francistown to Palapye in the S), showing the relative conductivity or resistivity of different layers, and the lithospheric structure, from Miensopust et al., (2012). A. Detail of box shown in B, of the MT profile of the contact between the Magondi Belt and the Choma-Kalomo Block. B. MT profile of lithospheric section from Limpopo Belt, the Zimbabwe Archaean Craton, the Magondi Belt, to the Ghanzi-Chobe Belt on the Choma-Kalomo Block.





Processed aeromagnetic map of NW Zimbabwe. Processed by Gordon Cooper, School of Geosciences, University of the Witwatersrand. Taken from website of the School of Geosciences, www.wits.ac.za.

Figure 13: A geological map of the Mesoproterozoic rocks of the Choma-Kalomo Block, Zambia (after Bulambo et al., (2004, 2008) (top) compared with processed aeromagnetic map of NW Zimbabwe at a similar scale (bottom). In the aeromagnetic image, red areas correspond to higher magnetic susceptibilities, and the larger area SE of the Deka Fault coincides with the Dete-Kamativi inlier, while the smaller area SE of Victoria Falls appears to coincide with the SW continuation of a schist belt from the Choma-Kalomo Block, although it is entirely covered by Jurassic (uppermost Karoo) Victoria Falls basalts.

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