Geological Society of Zimbabwe
A.M.Macgregor Memorial Lecture 2016

Field Excursion Guide

Nickel laterite deposits of the northern part of the Great Dyke, Zimbabwe

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Excursion Leader:

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Introduction

The field trip aims to show participants key aspects of the geomorphology of the northern part of the Great Dyke (Figure 1) and the nature and distribution of the distinctive erosion surfaces that are associated with nickel laterite mineralisation in one of Africa's largest expanses of exposed serpentinite.

Day 1 – (Figures 2 and 3)

Stop 1. Mvukwe Hill (WGS84 - S17.17986 E30.74828)

A road-side stop on the Mazowe – Mutorashanga road to view the topography of the Great Dyke from the east side in the vicinity of Mvukwe hill.

Note the following:

1. This stop is on the Miocene Post-African erosion surface, here a mature granitic plain and inselberg landscape on the east side of the Great Dyke.
2. To the west is Mvukwe hill (1752m) on the P5 and P6 Pyroxenites of the Pyroxenite Succession. This is the highest summit elevation of the entire Great Dyke and most probably formed a resistant massif overlooking the surrounding serpentinite and granite terrains during the formation of the Upper African erosion surface in the Early Cretaceous.
3. The Upper African Surface at a cliff-top elevation of ca. 1620m can be seen on serpentinites of the Dunite Succession to the north of Mvukwe hill. This erosion surface dies out to the south where the serpentinite outcrop narrows along the flanks as the central massif of gently, south-plunging pyroxenites broadens. From this point northwards to the central part of the Snake's Head section (Musengezi Subchamber), the Great Dyke contains one of Africa's largest expanses of exposed serpentinite (with potential for nickel laterite formation).

Stop 2. Mutorashanga viewpoint (WGS84 -S17.15017 E30.69899)

This stop in the axis of the Great Dyke provides panoramic views of the serpentinite terrain to the north and south and of the surrounding granite plain and inselberg landscape.

Note the following:

1. The viewpoint is situated on the Upper African Surface at a cliff-top elevation of ca. 1620m. Remnants of this heavily dissected plateau can be recognised to the north and south in the form of (1) a broad, *mesa*-like upland, (2) discontinuous, eroded, cliff-like features made up of horizontally-fractured serpentinite, and (3) remnants of the overlying sheeted silica vein zone.
2. To the south is the resistant massif of the Pyroxenite Succession including Mvukwe hill (almost 150m higher than the Upper African Surface).
3. Note particularly the significantly higher elevation (ca. 350m) of the surrounding granite terrain (of the Post-African Surface) to the east than to the west and the eccentric disposition of the Upper African Surface relics mainly on the east side of the Great Dyke with Post-African valleys on the west side.
4. Directly to the north is the old Mutorashanga chromite mining area where high-grade chromite was extensively mined in narrow chromitite seams for many decades up to the 1980s. Also to be seen are signs of eluvial chromite mining and associated slimes dams on the flat, Post-African valley floors on the west side; these serpentinite soils contain ca. 1% Ni.
5. Dunites in this part of the Great Dyke are completely serpentinised at surface (i.e., without relict olivine) and to depths of up to 300m below the Post-African Surface.

Stop 3. Mpinge section – Exposures of the Upper African Surface, Chikonyora hill
(Park - WGS84 - S16.84189 E30.85332, Chikonyora Trig Beacon WGS84 - S16.83906 E30.85581, Ganierite S16.84022 E30.85312°)

At this stop (in the axis of the Great Dyke towards the northern end of the Mpinge section) can be seen the principal regolith stratigraphy of the Upper African Surface exposed around and above old chromite workings on the southern slopes of Chikonyora hill (1729m).

On the way, after the turn-off from the Mvurwi - Guruve tarred road, and to the right of the dirt road, look out for soil-mining areas and the mill and slimes dam of the old Mpinge eluvial chromite operation (1970s); also a good example of a *butte* (isolated hill with steep sides and a flat top similar to but narrower than a *mesa*: north American geomorphological term) of the Upper African Surface.

At this stop, a short traverse up the southern flanks of Chikonyora hill to the north displays the regolith stratigraphy of a broad Upper African *mesa* (extending 3km to the north) from the concave lower slopes, via a cliff-like feature, to the wooded ferruginous silicified zone of a well developed silica cap.

Note the following:

1. This part of the Mpinge section features a long, wooded ridge on the west side marking the P7 Pyroxenite at the base of the Dunite Succession.
2. The cliffs of the Upper African Surface are visible to the east and south east, and to the west.
3. Samples of serpentinite saprolite from outside the collapsed chromite workings are enriched in nickel (probably mainly in nickeloan serpentine and goethite). It may be possible to locate discrete, fracture-related, green, 'garnierite-type' hydrated Ni-Mg silicate minerals.
4. The ferruginous silicified zone is best seen on the high wooded ground above the workings.

NB. Also of interest is the fact that it was from Mpinge section that bulk samples of nickel laterite and eluvial chromite concentrates were used to produce ferronickel and stainless steel alloy in successful electric arc smelting test-work at the Institute of Mining Research, UZ, in the 1970s. (See Slatter, D.L., 1979. Production of ferrochrome nickel alloys and stainless steel by direct smelting of oxide ores in Zimbabwe-Rhodesia. Transactions of The Institution of Mining and Metallurgy (Section C: Mineral Processing and Extractive Metallurgy), 88, C209-214. Slatter, D.L., 1981. The potential for the direct production of ferrochromium nickel alloys and stainless steel 'pig' in Zimbabwe. In: INFACON 80: Proceedings of the Second International Ferro-alloys Congress, Lausanne, October 1980 (Lausanne: IPFED, Institut des Producteurs de Ferro-Alliages d'Europe Occidentale), 233-243.)

Stop 4. Chikonyora ridge, Mpinge section (WGS84 - S16.79589, E30.82184)

A road-side stop between Mvurwi and Guruve to view the ridge of Chikonyora hill from the west side.

Note the following:

1. This stop shows, in the distance, the (several tens of metres) thick, wooded silica cap of the Upper African Surface on the ca. 3km-long Chikonyora ridge with intermittently exposed cliffs of horizontally-fractured serpentinite at a

lower elevation. The ridge is terminated at its northern end by the north northeast-trending, dextral Gurungwe fault.

Stop 5. Nyamaneche hill, Horseshoe section (WGS84 - S16.76740, E 30.85772)

A road-side stop between Mvurwi and Guruve to view Nyamaneche hill from the west side.

Note the following:

1. This stop shows, in the distance, Nyamaneche hill at the southern end of the Horseshoe section which is offset from the Mpinge section by the Gurungwe fault.
2. Nyamaneche hill is a rounded serpentinite massif with intermittently exposed cliffs at elevations of ca. 1640m beneath a tree-less silica cap of the Upper African Surface.
3. About two kilometres to the north are two small remnants of the Upper African Surface with cliff-top elevations at ca. 1700m, indicating rapid steepening of the erosion surface to the north of Nyamaneche hill.
4. No remnants of any planar erosion surface are found further north within the Horseshoe section.

Stop 6. The Upper and Lower African Surfaces, Mvurwi section (WGS84 - S16.67823, E30.86751)

A road-side stop between Mvurwi and Guruve to view the topography of the Mvurwi section from the south side.

Note the following:

1. On the left is the markedly planar Lower African Surface dominated by a dissected *mesa* terrain at a cliff-top elevation of ca. 1525m.
2. In the near- and middle-distance, the low granite plain and inselberg landscape to the south of the Great Dyke is the Post-African Surface. On the left is the isolated granite inselberg of Nyambari with a summit elevation of ca. 1500m, only slightly less than the Lower African Surface on the Great Dyke serpentinites to the rear.
3. On the right is the Upper African Surface, here dominated by rounded summits including Mvurwi Peak (1738m).

Day 2 – Figures 4, 5, 6, 7, 8, 9, 10

This second part of the field trip is a full-day, circular traverse of part of the Mvurwi section, principally to examine the heavily-eroded Upper African Surface towards the east and the better-preserved *mesa* terrain of the Lower African Surface towards the west. The route is ca. 6-7km long with a moderate ascent of ca. 300m at the start.
After parking the vehicles, (Park - WGS84 - S 16.63883, E 30.86755) the traverse proceeds east northeastwards up to Hill 1724, (WGS84 - S 16.63005, E 30.88949) then north westwards to Shear Zone Hill (WGS84 - S 16.62727, E 30.87665) via a series of ridges and finally down to Hill B (WGS84 - S 16.62507, E 30.87079) and then back to the vehicles. Various features will be pointed out and examined on the way. It may be possible to locate discrete, fracture-related, green, 'garnierite-type' hydrated Ni-Mg silicate minerals.
From several high points during the traverse, the rugged terrain of the Snake's Head section (Musengezi Subchamber and Mvuradona Chamber) may be seen to the north and north east.

Geomorphology

The eastern part of the Mvurwi section comprises a 6 km long, rugged massif, including Mvurwi Peak (1738 m) (WGS84 - S 16.63461, E 30.89885), with a total relief of ca. 300 m. Westwards, the massif gives way quite sharply to relatively subdued topography at a lower level. This area, extending about 5 km further northwest, is characterised by a dissected table-land comprising discrete, flat-topped hills (or *mesas* and a few small *buttes*), the largest up to almost 100 000 m^2 in total area, with roughly accordant summits at a common elevation of ca. 1525m; these represent the Lower African Surface. The western *mesas* (e.g., Hills A & B and Shear Zone Hill) are characterised by a well-developed regolith with a distinctive layered stratigraphy. The regolith sequence typically displays (1) a cliff-like upper slope and a concave lower slope made up variously of massive serpentinite and horizontally-fractured serpentinite, and (2) an overlying silica cap of variably-silicified serpentinite in two parts: a lower zone of sheeted silica veins within horizontally-fractured serpentinite (sheeted silica vein zone), its base roughly coincident with the cliff-tops, and an upper (red-brown) ferruginous silicified zone.

The higher summits in the east (e.g., Hill 1724) are mostly rounded to pyramidal rather than flat-topped and their regolith sequence is heavily eroded and less systematic than that of the western *mesas*; these represent the Upper African Surface. The Upper and Lower African Surfaces are estimated to be ca. 200m apart vertically, with no evidence to explain their vertical separation by late faulting.

The granitic terrain either side of the Mvurwi section lies at ca. 100 m lower elevation to the north than to the south where a rolling Post-African plain at ca. 1350 m carries occasional inselbergs up to ca. 1500 m. Significantly, the summit elevation of the highest inselberg (Nyambari) is only slightly less than that of the western mesa terrain. Accompanying this elevation difference, the north-facing slopes (at least as far east as Mvurwi Peak) have steeper gradients and narrower, deeper valleys than the south-facing slopes. Because of the more recent rejuvenation evident on the north side, the *mesas* and many of the highest eastern peaks are eccentrically disposed towards the south or southwest.

Structural geology

The eastern massif is divided into two structurally distinct parts by the prominent, Camsasa fault, a curvilinear, sub-vertical, south- to southwest-trending structure of probable Proterozoic age located directly east of Mvurwi Peak. Further east, the contact zone with the north northeast-trending Horseshoe section is marked by two similar, related faults. Other important structural features of the Mvurwi section are (1) the marginal shear zones along the southern and northern contacts (indicated by a zone of variably sheared and altered serpentinites up to 200 m wide), and (2) silicified early fractures. Visible mainly on central hill-tops and their southern upper slopes, the ferruginous silicification associated with the early fractures is very common west of the Camsasa fault but quite rare on the rejuvenated northern slopes, even as detached blocks.

Bed-rock stratigraphy and lithologies

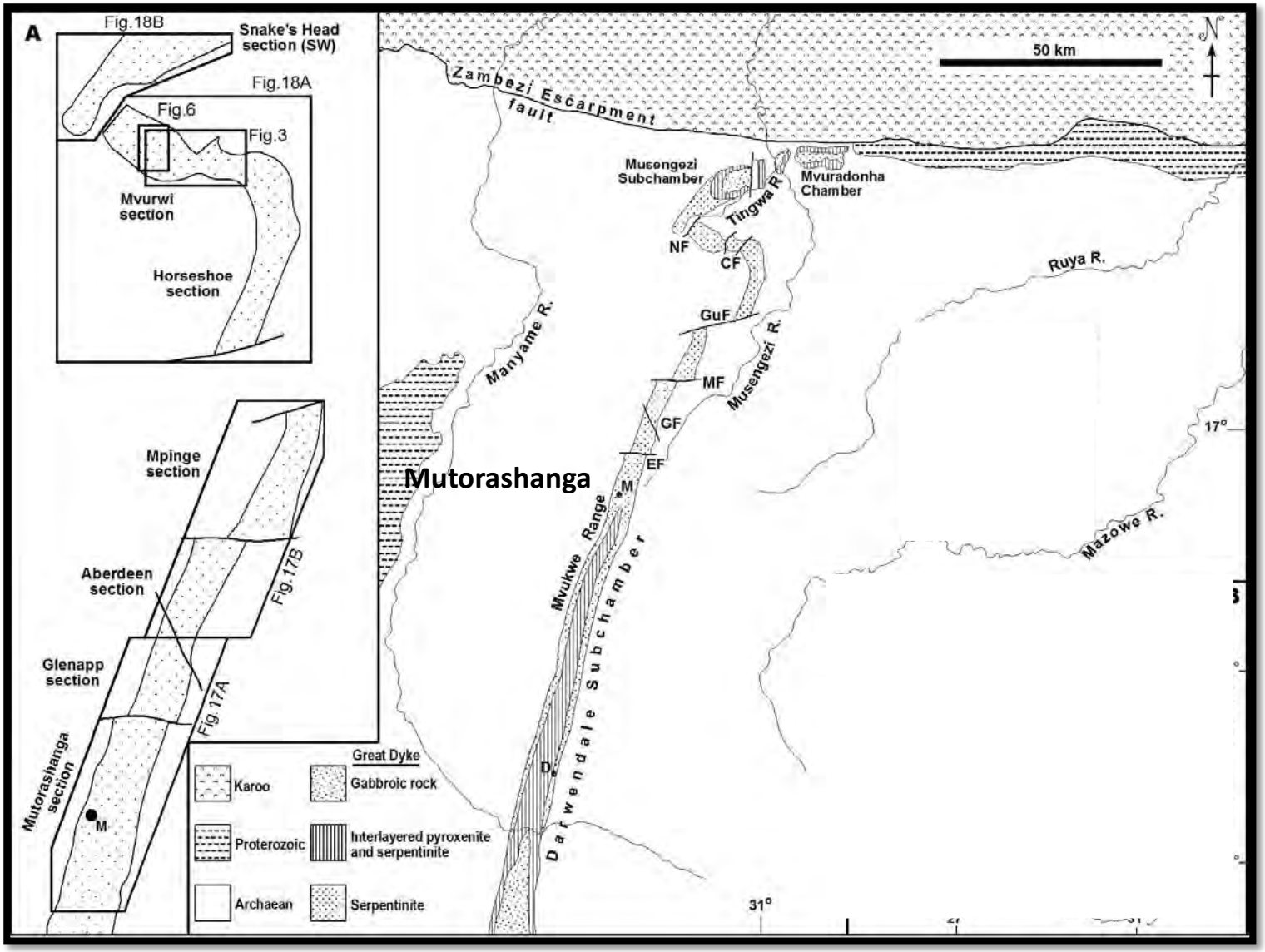
To the west of the Camsasa fault, on both the massif and in the *mesa* terrain further west, all the ultramafic rocks between the marginal shear zones consist of variably serpentinised dunite with occasional chromitites marked by surface rubble. The serpentinites are mostly massive, pale yellow-green and, particularly on elevated sites, are characteristically sculpted in outcrop; these serpentinites can contain ca. 50% fresh olivine. Elsewhere, they display closely-spaced fractures that, in general, lie parallel to the local slope and are interpreted as rebound or 'release of load' structures (e.g., the horizontally-fractured serpentinites of the *mesa* regolith).

Except for a large, 2 km-long, oval enclave of massive serpentinite (similar to that west of the Camsasa fault) on the upper part of Hill 1668, the ultramafic rocks east of the Camsasa fault are almost entirely represented by talc carbonate schists and variably-sheared, grey carbonated serpentinites. In the easternmost fault-block are two linear masses of distinctive megacrystic pyroxenite, and several chromitites have

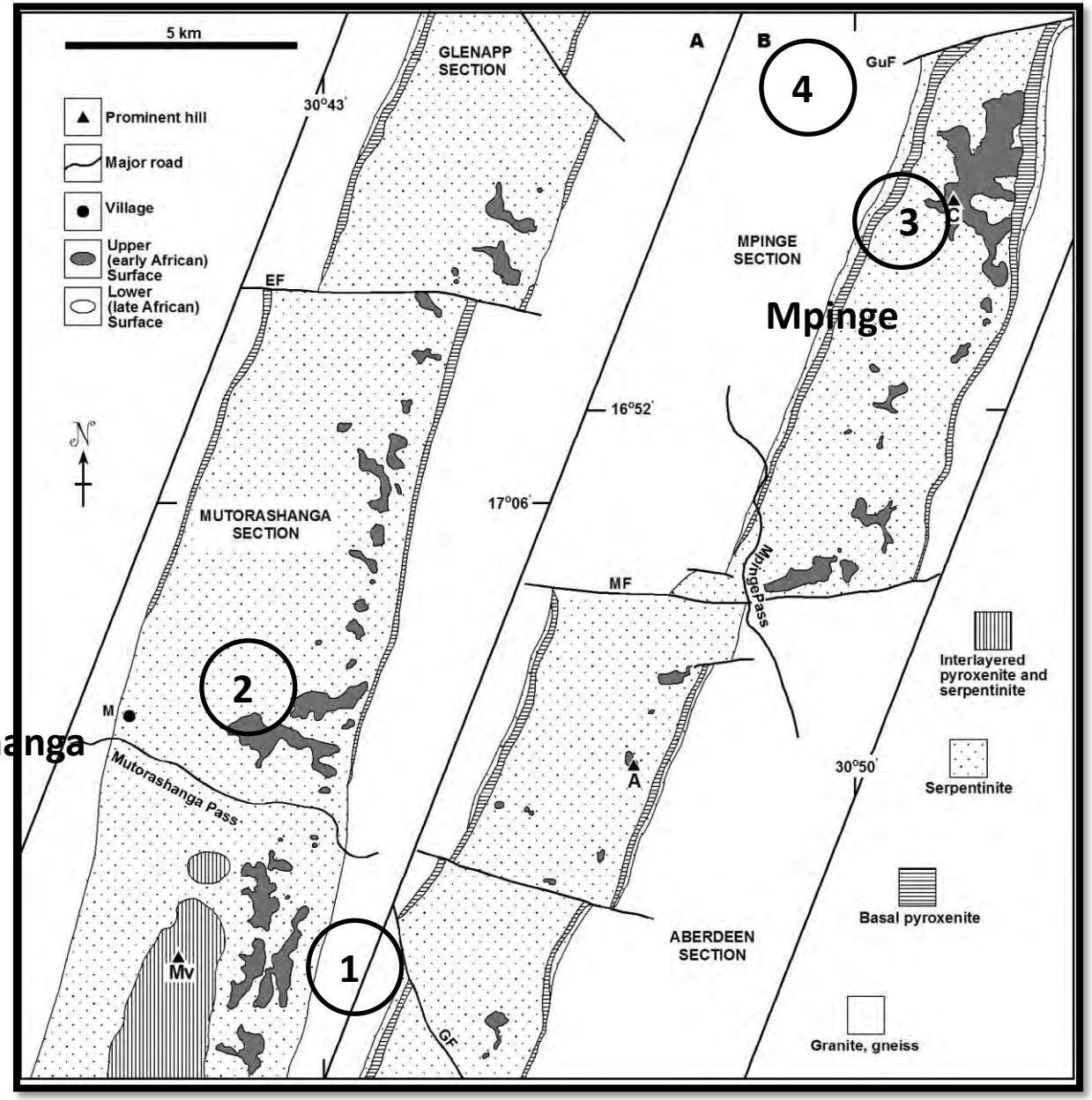
been exposed by limited mining. The pyroxenite (probably the P6 Pyroxenite at the base of the Pyroxenite Succession) is associated with a very coarse-grained chromitite (probably the C5 Chromitite overlying the P6 Pyroxenite). Other chromitites towards the southern granite contact are most likely the C6 to C9 Chromitites located stratigraphically beneath the P6 Pyroxenite. The serpentinites exposed in the Mvurwi section most probably represent the upper levels of the Dunite Succession and lowermost Pyroxenite Succession. Because of deformation, rare exposure of chromitite structural markers, and contradictory younging directions, the shape of the transverse synclinal layered structure here is uncertain.

Note the following:

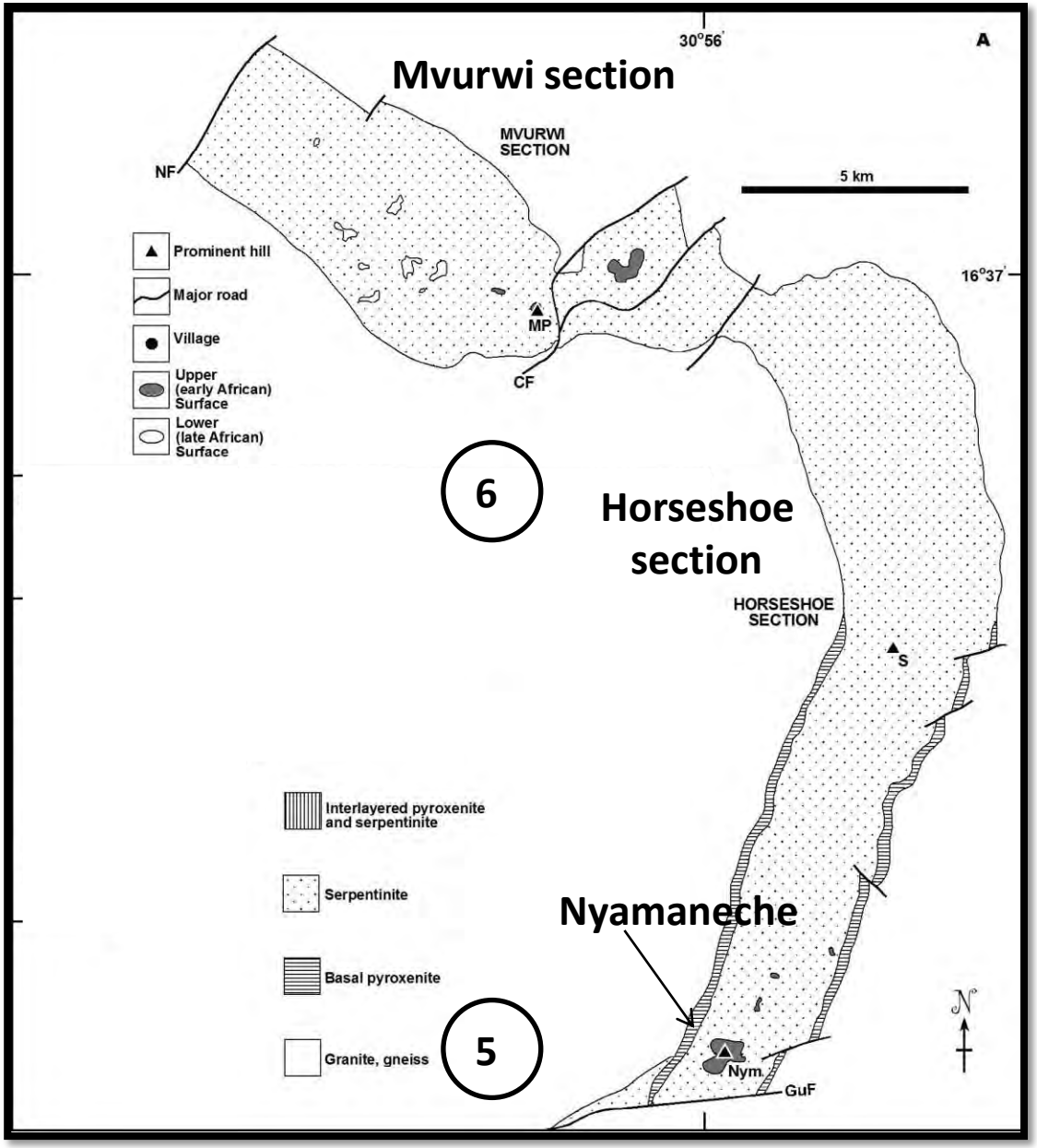
1. Hill 1724. This hill (part of the eroded Upper African Surface) is capped by rubble lag deposits of the ferruginous silicified zone (with possible contributions from silicified early shear fractures). Portions of the sheeted silica vein zone are visible at lower levels and serpentinites from pits excavated nearby are Ni-enriched.
2. To the south east is Mvurwi Peak (1738m) – also part of the eroded Upper African Surface – with similar lag deposits of silicified rubble. (Unfortunately, a visit there would add 2km to the traverse.)
3. In the distance to the east northeast is Hill 1668 located within the Camsasa fault zone. This hill, with cliff-top elevations of ca. 1650m and a relatively well preserved regolith profile, is interpreted to be an Upper African Surface remnant now at a lower elevation than Hill 1724 and Mvurwi Peak due to re-activation of the Camsasa faults.
4. Shear Zone Hill. This gently-sloping remnant of the Lower African Surface is located on the lower slopes of the eastern massif and overlooks the *mesa* terrain of the western part of Mvurwi section. Some 33 rotary air blast holes were drilled here; geochemical profiles of two holes (with shallow and deep regoliths) are provided; the Ni-enriched profile is composite and up to 13m thick.
5. Hill B. This is one of the largest and best-preserved *mesas* of the Lower African Surface and displays a complete regolith stratigraphy.



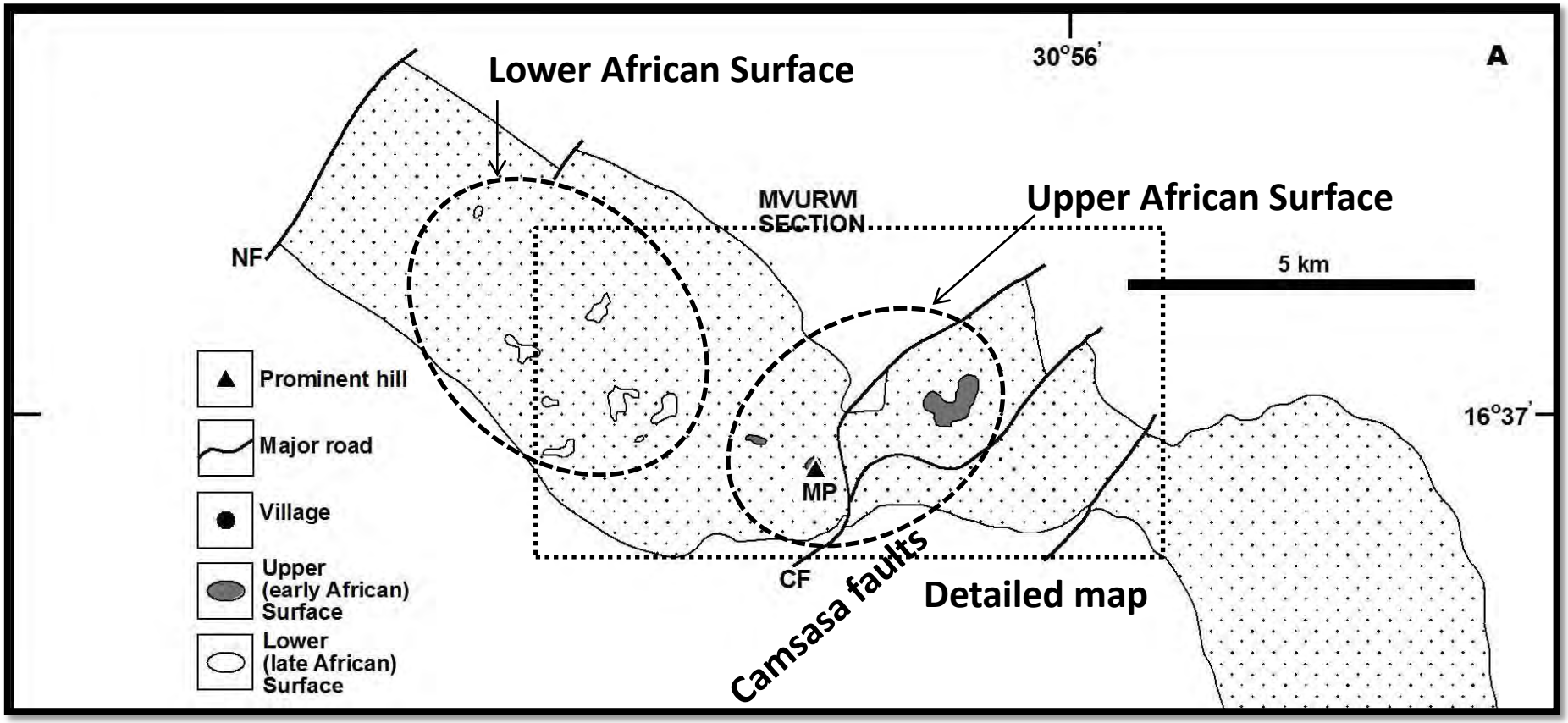
Field trip location



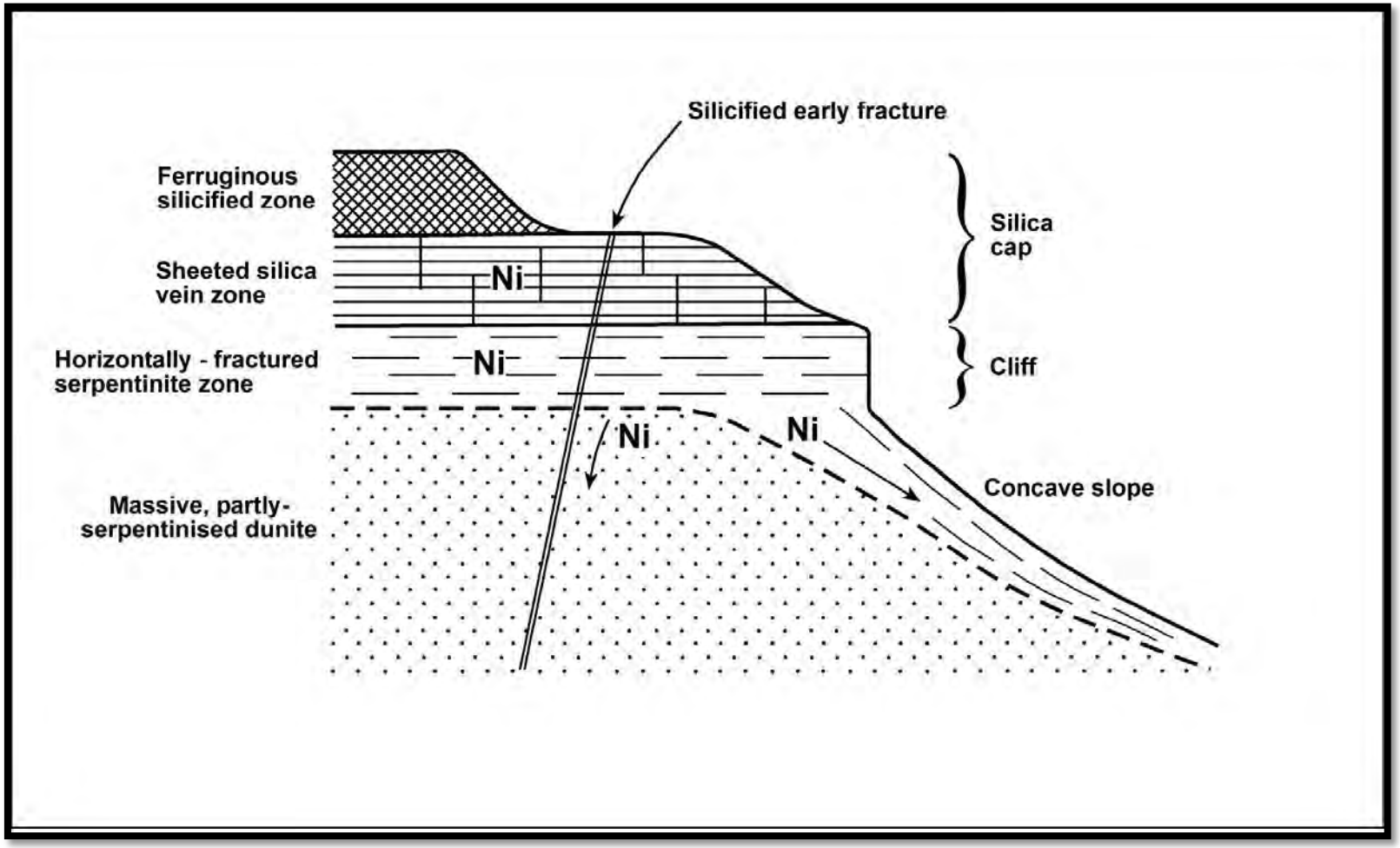
Field trip - Day 1: Stops 1 - 4



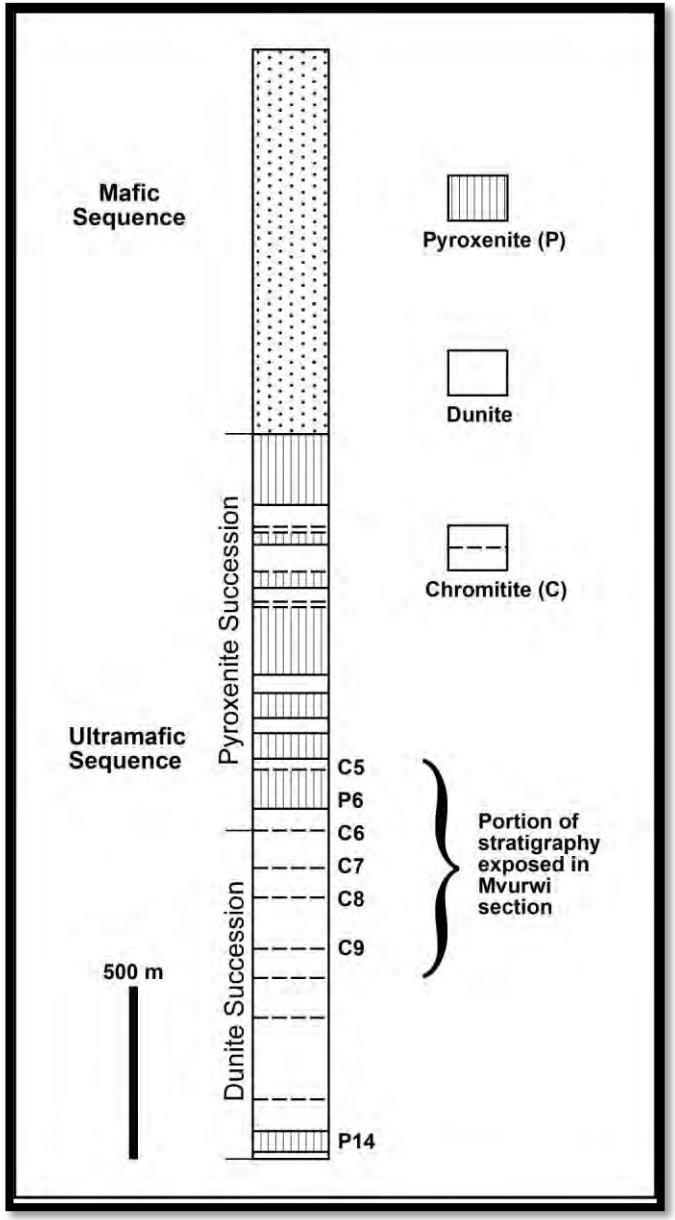
Field trip - Day 1: Stops 5 - 6



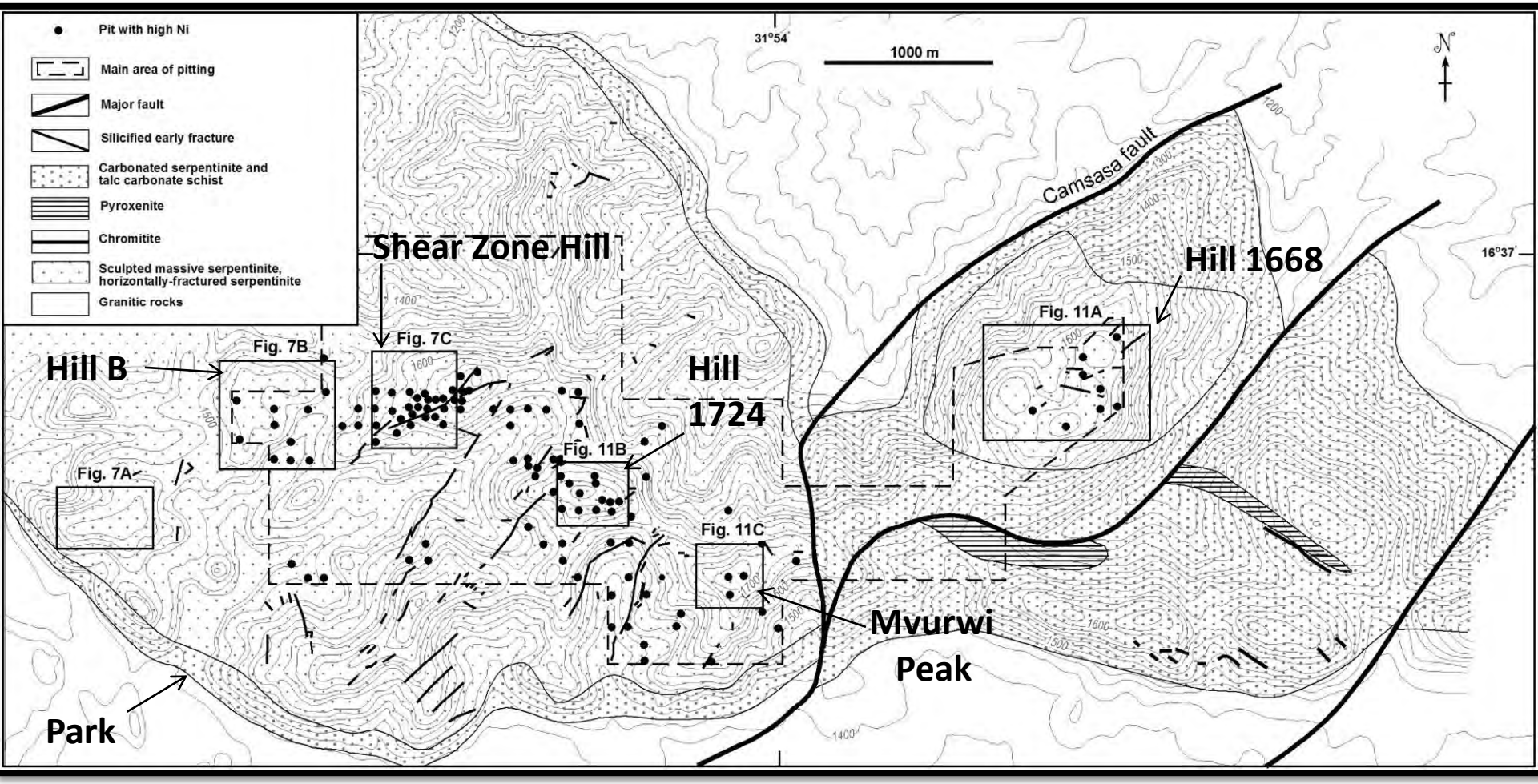
Field trip – Day 2: Mvurwi section



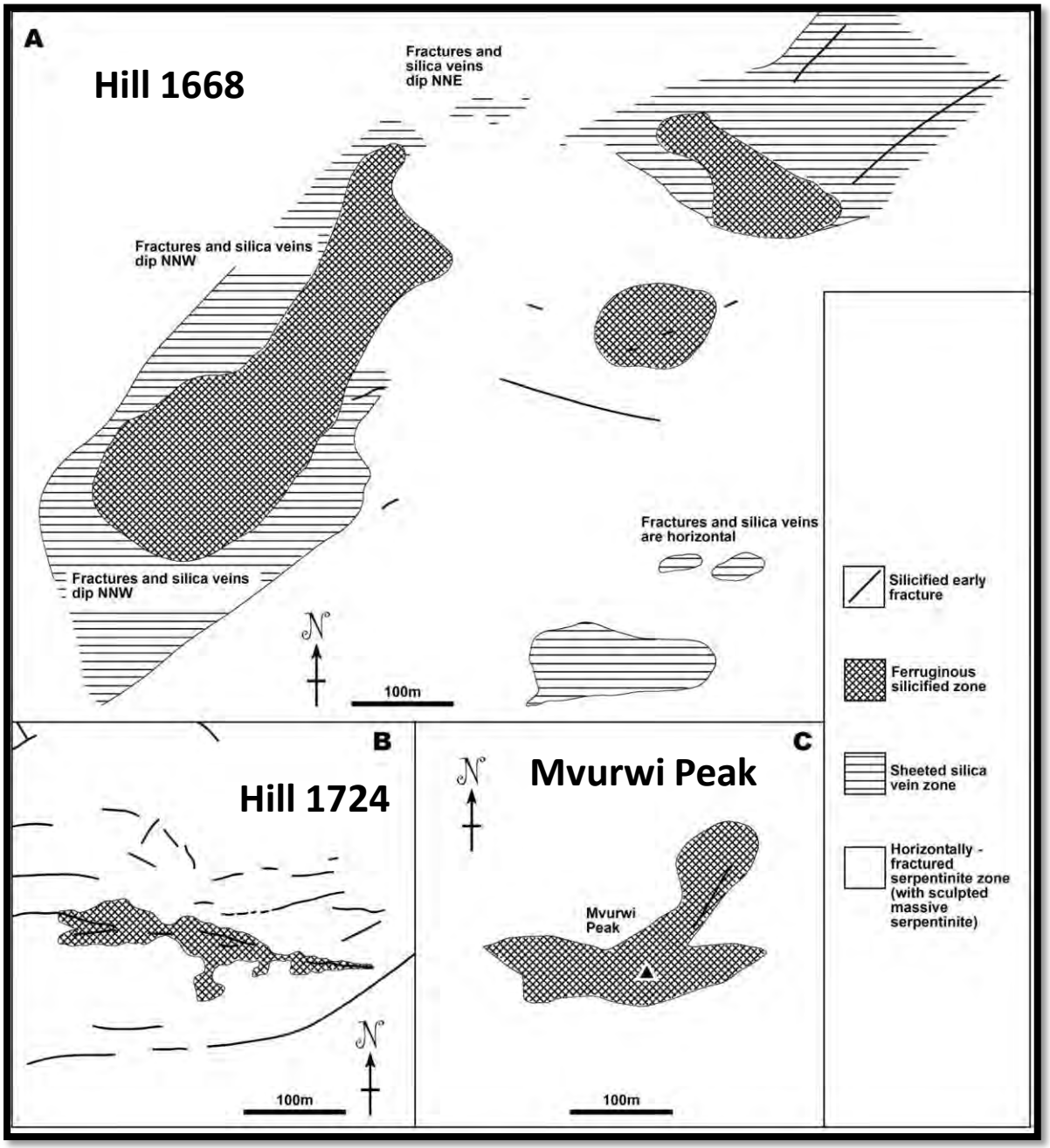
Upper and Lower African Surfaces - Regolith statigraphy



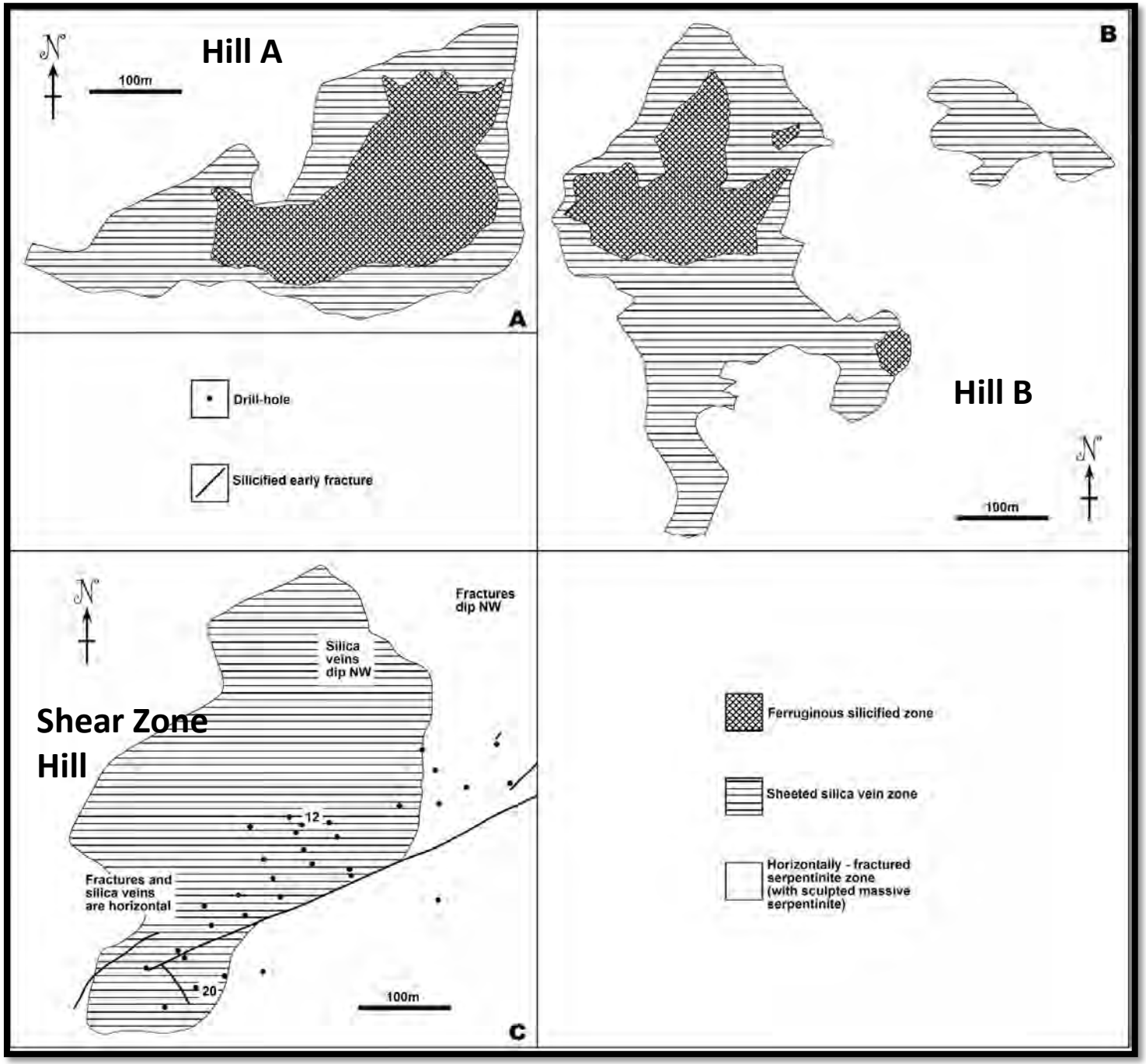
Day 2: Stratigraphic location of the Mvurwi section



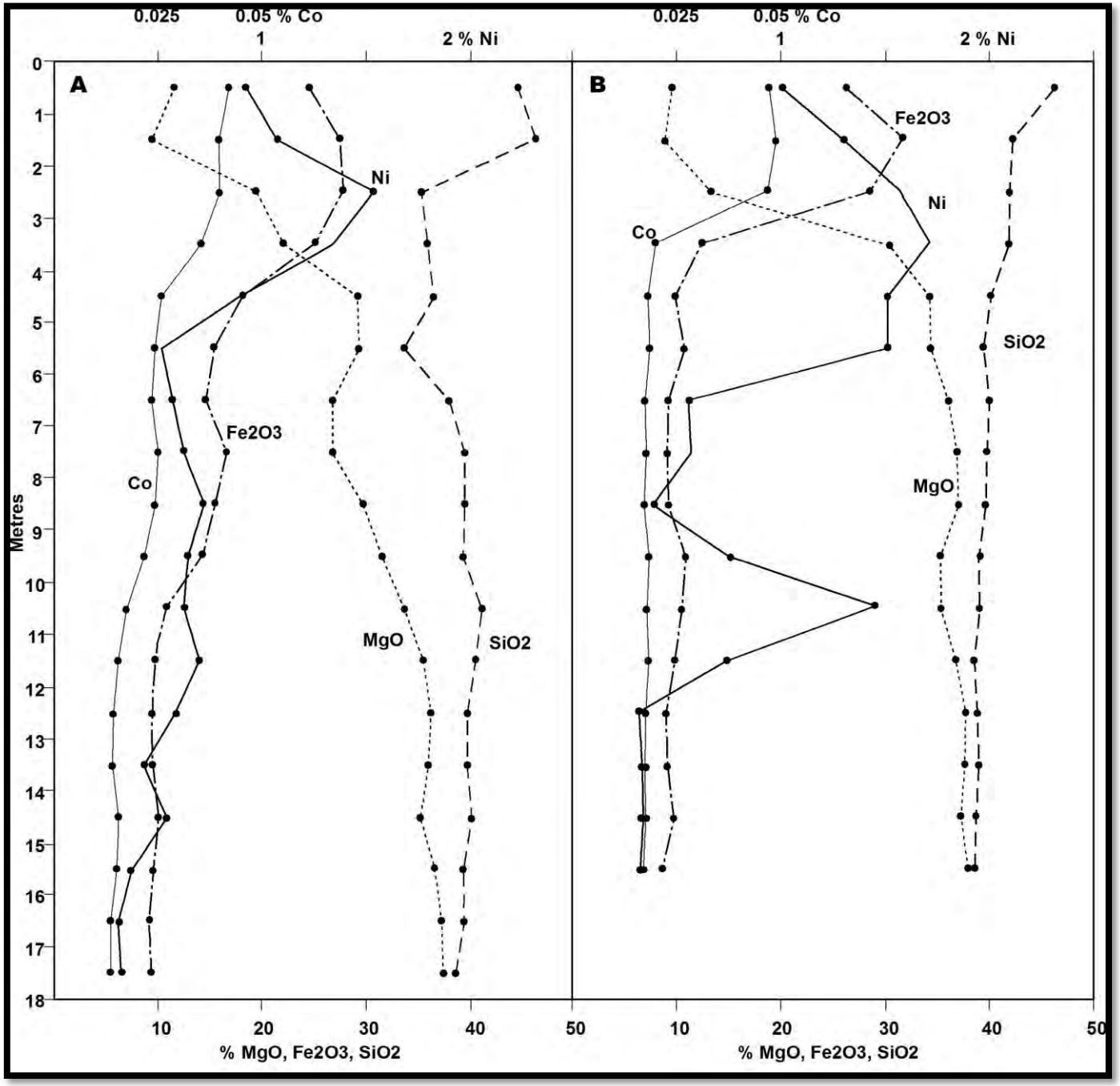
Field trip - Day 2: The Mvurwi traverse
(Park - Hill 1724 – Shear Zone Hill – Hill B – Park)



Mvurwi section. Upper African Surface - Distribution of regolith lithologies



Mvurwi section. Lower African Surface – Distribution of regolith lithologies



Mvurwi section. Shear Zone Hill – Geochemical profiles for two rotary air blast drill-holes