Copper in the Central Zone of the Limpopo Belt: the Messina and the Mutandahwe mines

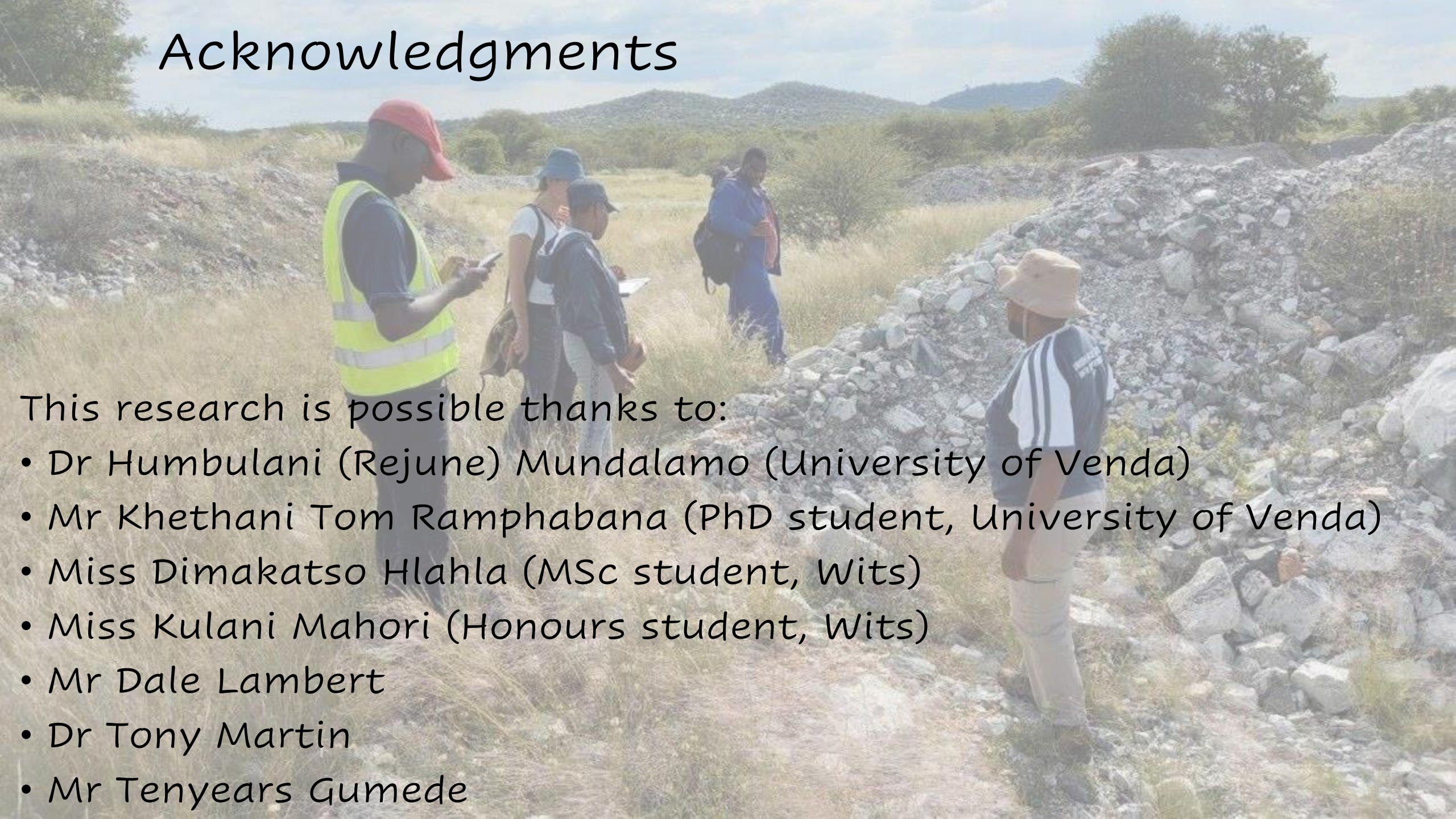
Linda Iaccheri
School of Geosciences

linda.Iaccheri@wits.ac.za

CIMERA – DST-NRF Centre of Excellence for Integrated Mineral and Energy Resource Analysis

WITS UNIVERSITY

Acknowledgments

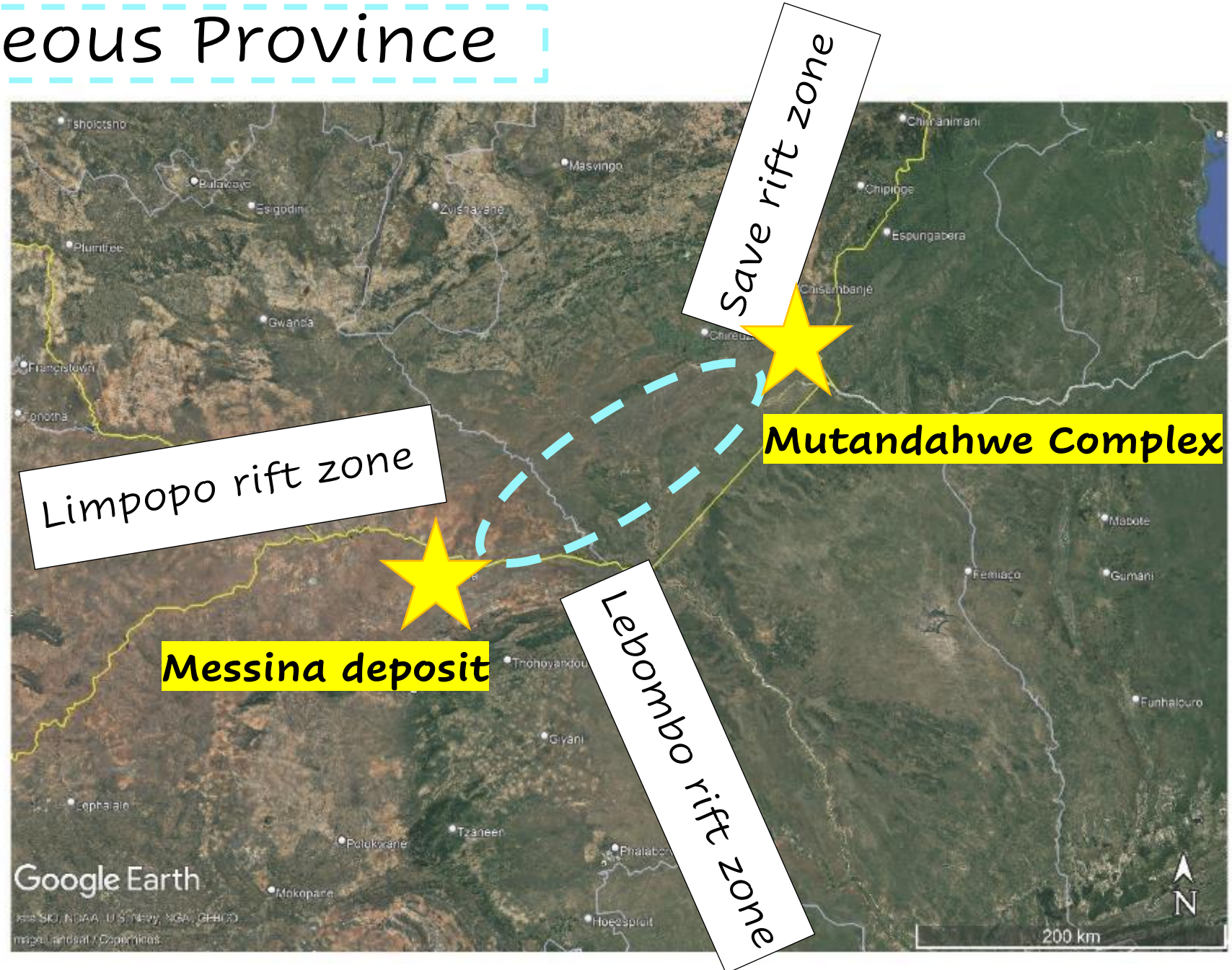


This research is possible thanks to:

- Dr Humbulani (Rejune) Mundalamo (University of Venda)
- Mr Khethani Tom Ramphabana (PhD student, University of Venda)
- Miss Dimakatso Hlahla (MSc student, Wits)
- Miss Kulani Mahori (Honours student, Wits)
- Mr Dale Lambert
- Dr Tony Martin
- Mr Tenyears Gumede

Nuanetsi Igneous Province

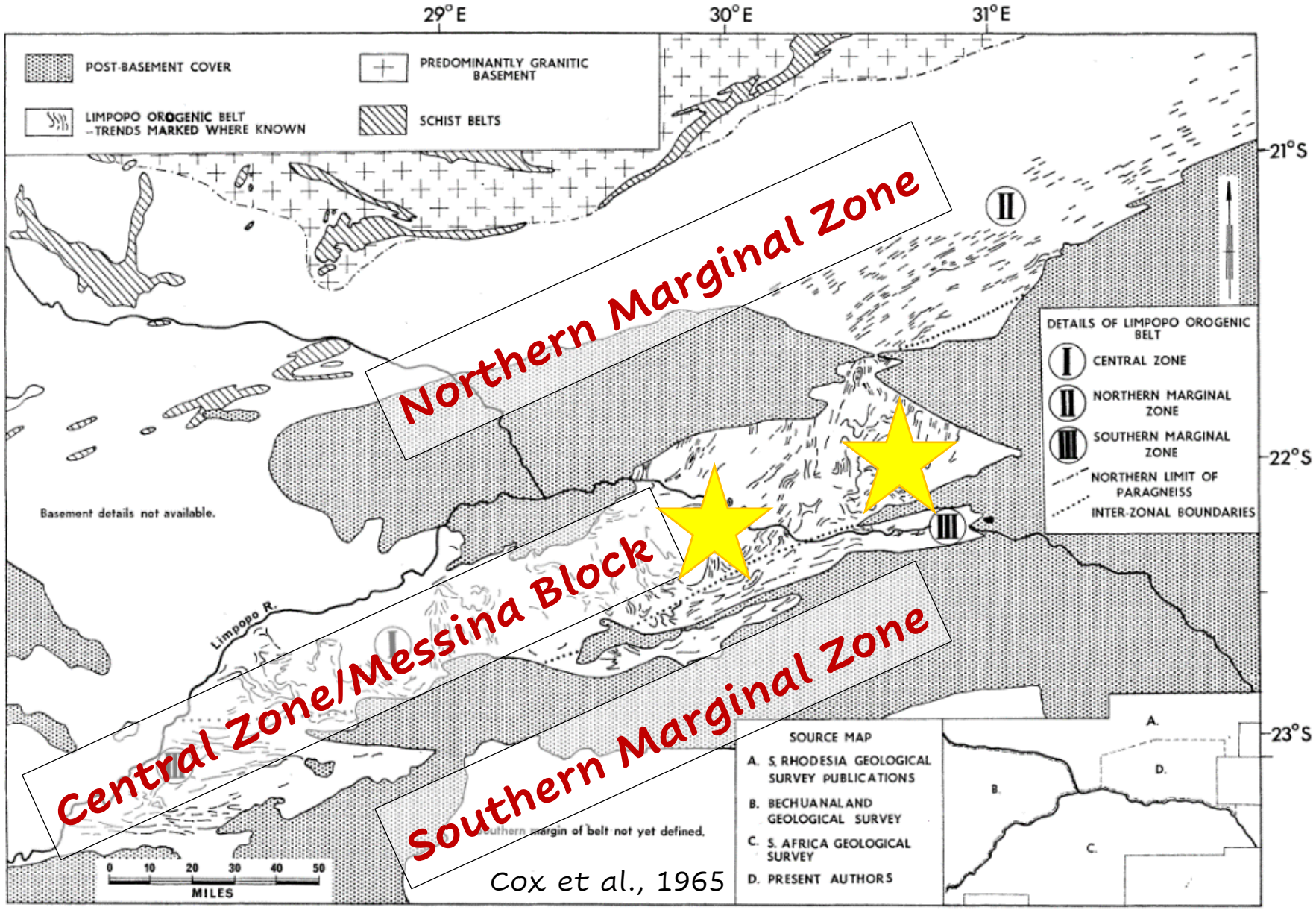
- situated in the south-eastern corner of Southern Zimbabwe
- marks the intersection of the Limpopo lineament with the volcanic monocline of the Lebombo



The Limpopo Belt

- Records collision of Kaapvaal and Zimbabwe cratons into the Kalahari Craton at ca. 2.6 Ga

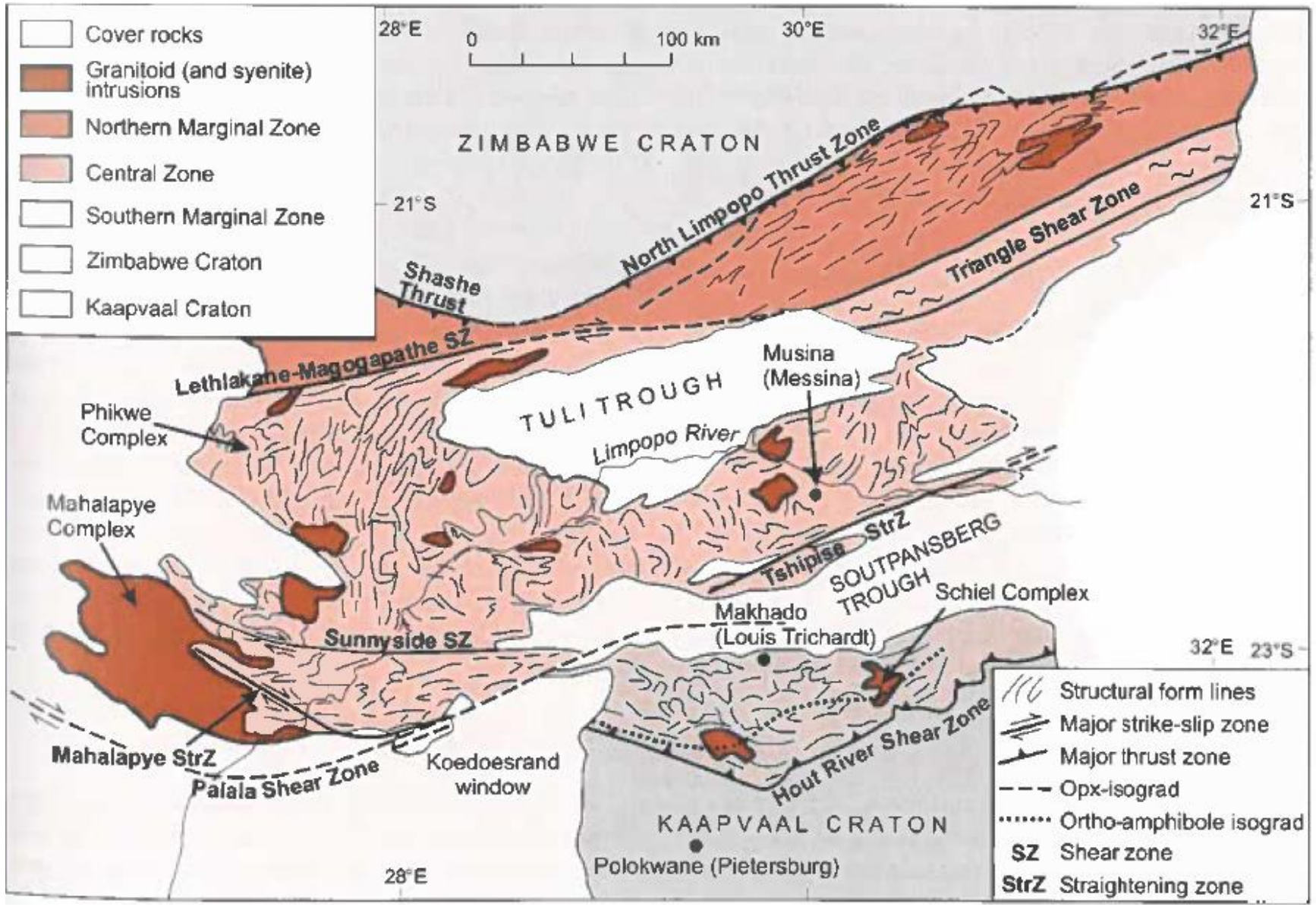
- Subdivided in 3 subparallel zones:
  - Northern
  - Central
  - Southern



The Limpopo Belt

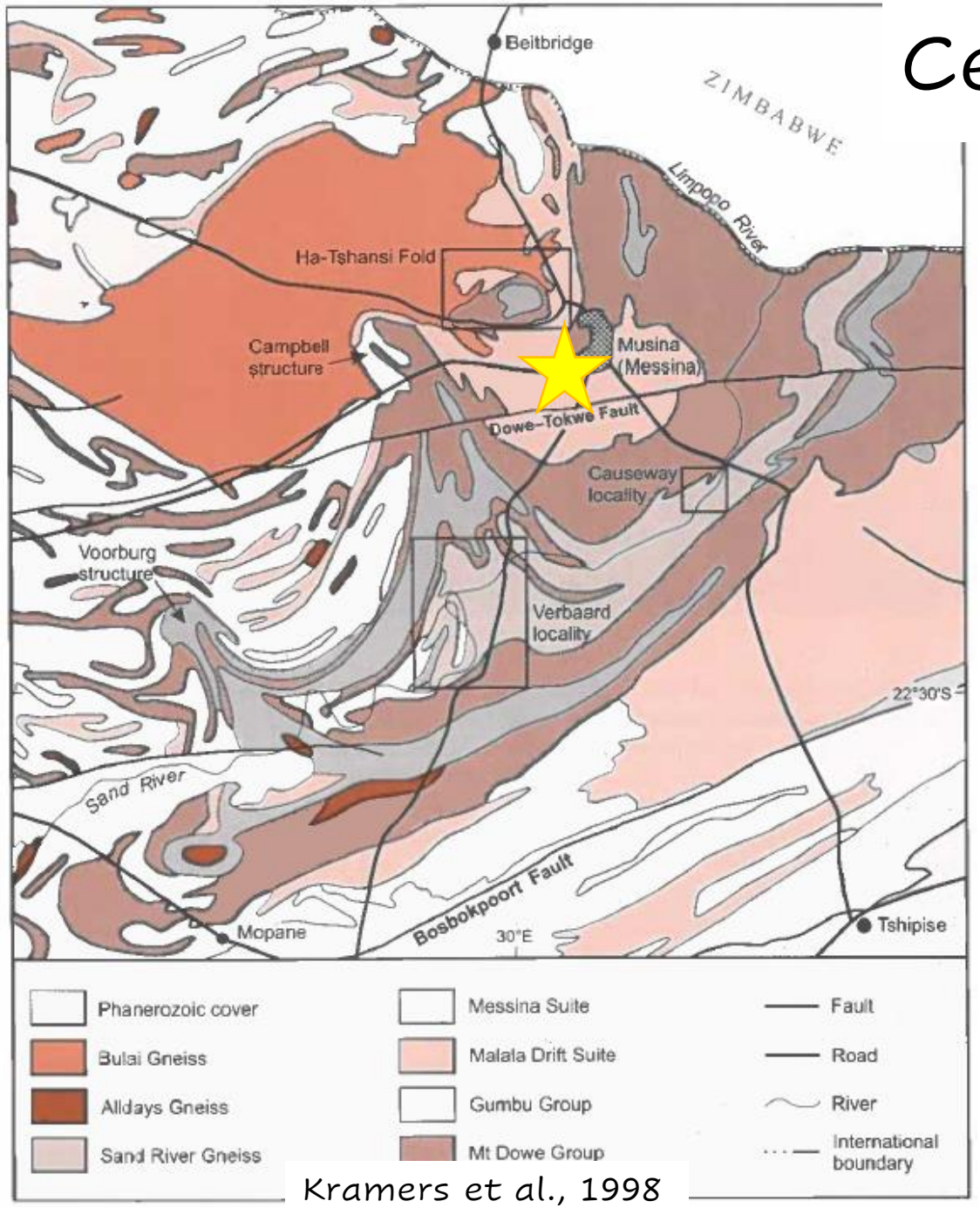
- Southern and Northern Marginal zones with cratonic evidence
- The Central Zone is the largest and shows structural complexity and high-grade metamorphic rocks

→ ENE/SWS LIMPOPO TREND



Kramers et al., 1998

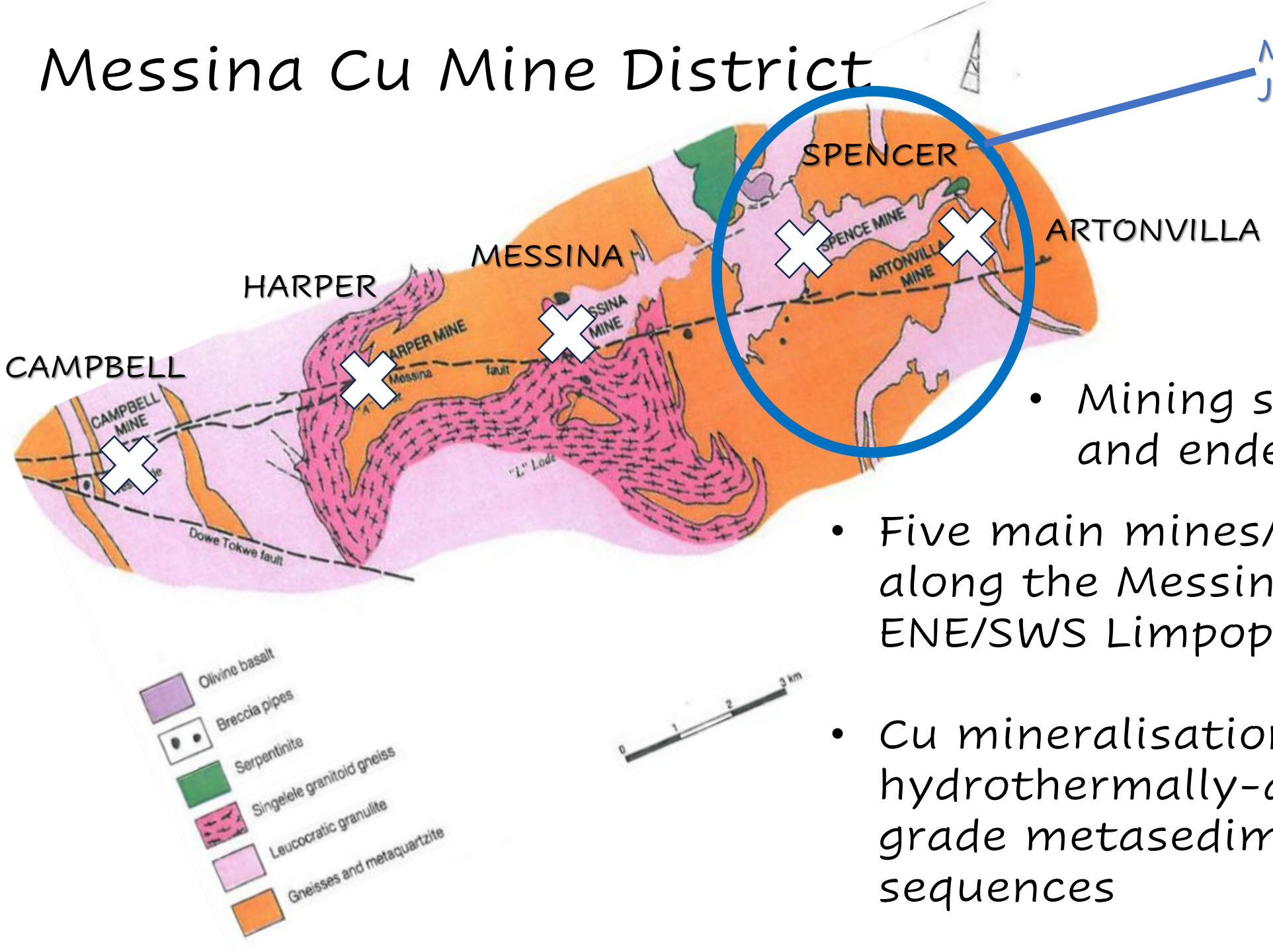
Central Zone – Limpopo Belt



Kramers et al., 1998

- High-grade metasedimentary sequence (Mt DOWE GROUP and GUMBU GROUP)
- with interlayered quartzo-feldspathic gneiss (MALALA DRIFTS Suite)
- and mafic rocks (MESSINA Suite)
- Famous exposures of the Sand River Gneiss at Causeway and Verbaard localities

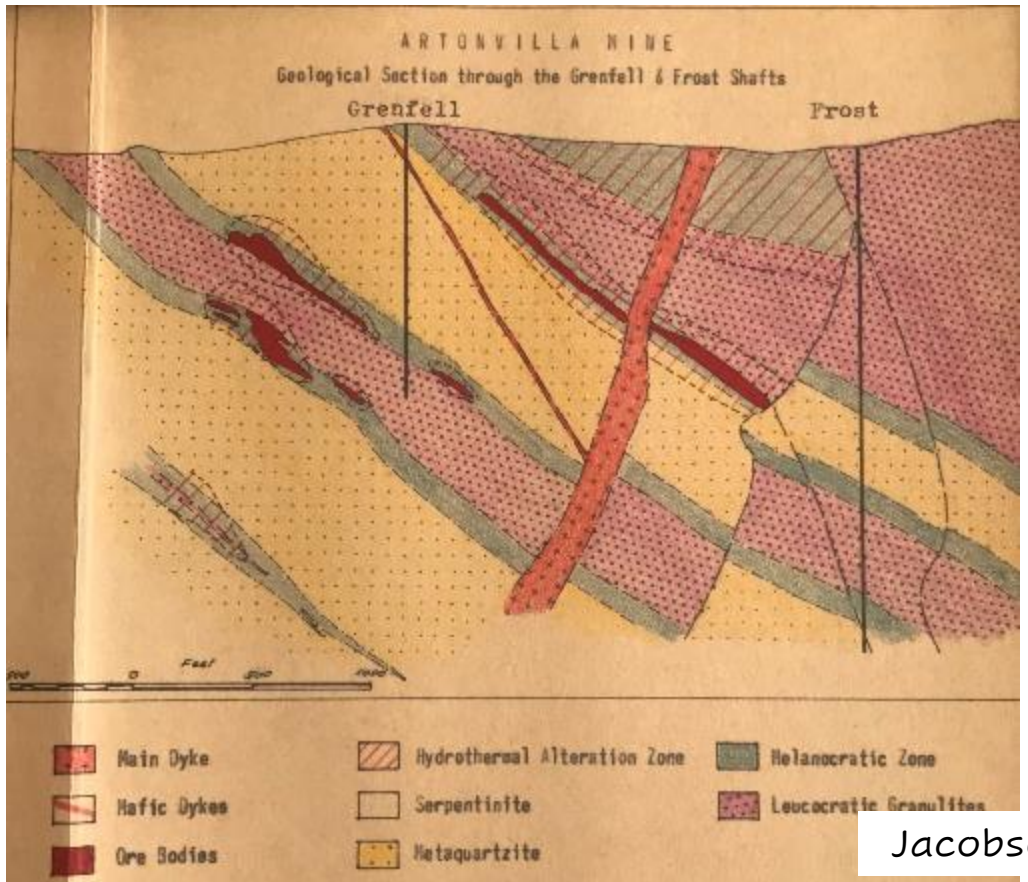
Messina Cu Mine District



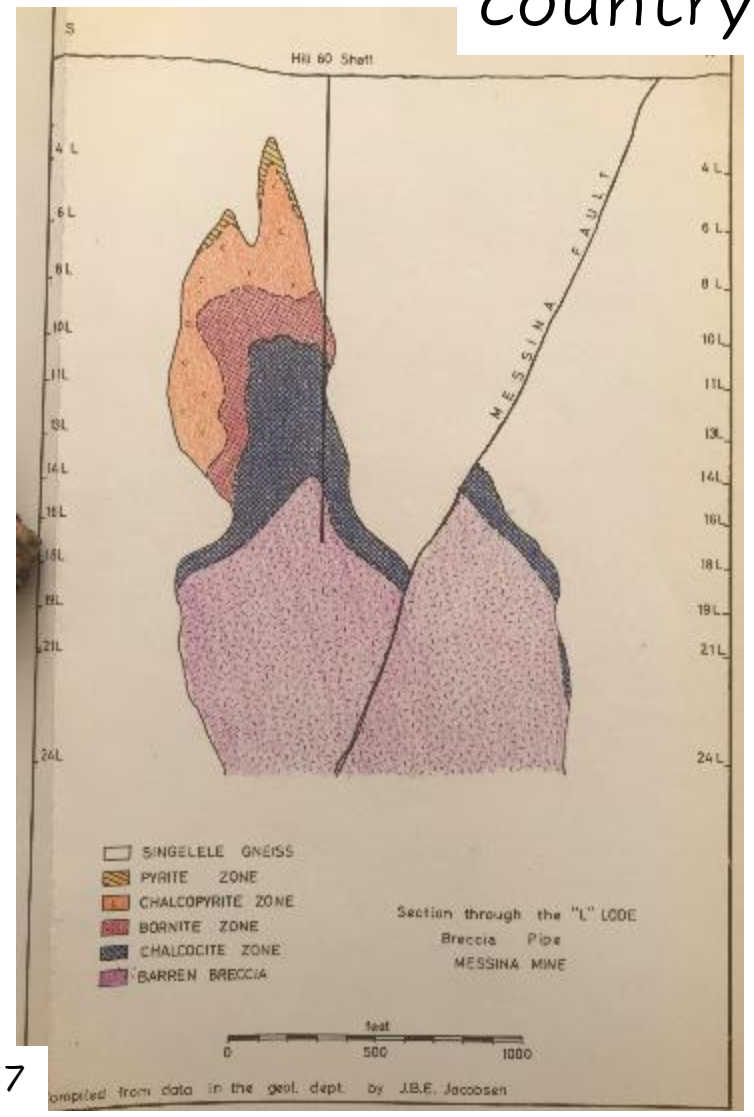
- Mining started in 1903 and ended in early 1990s
- Five main mines/shafts located along the Messina Fault with an ENE/SWS Limpopo trend
- Cu mineralisation within a hydrothermally-altered, high-grade metasedimentary sequences

Messina Cu mineralisation

1. Within hydrothermal altered amphibolites

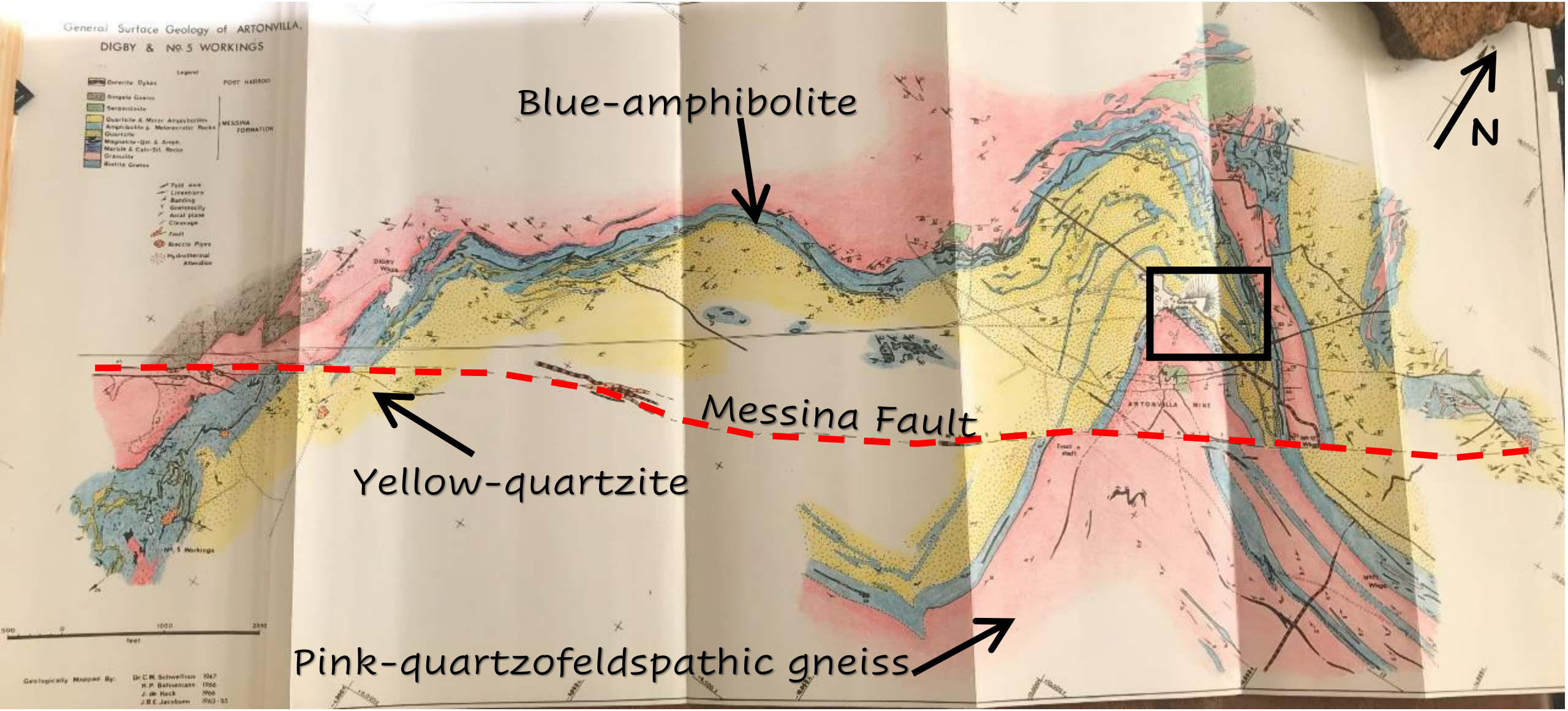


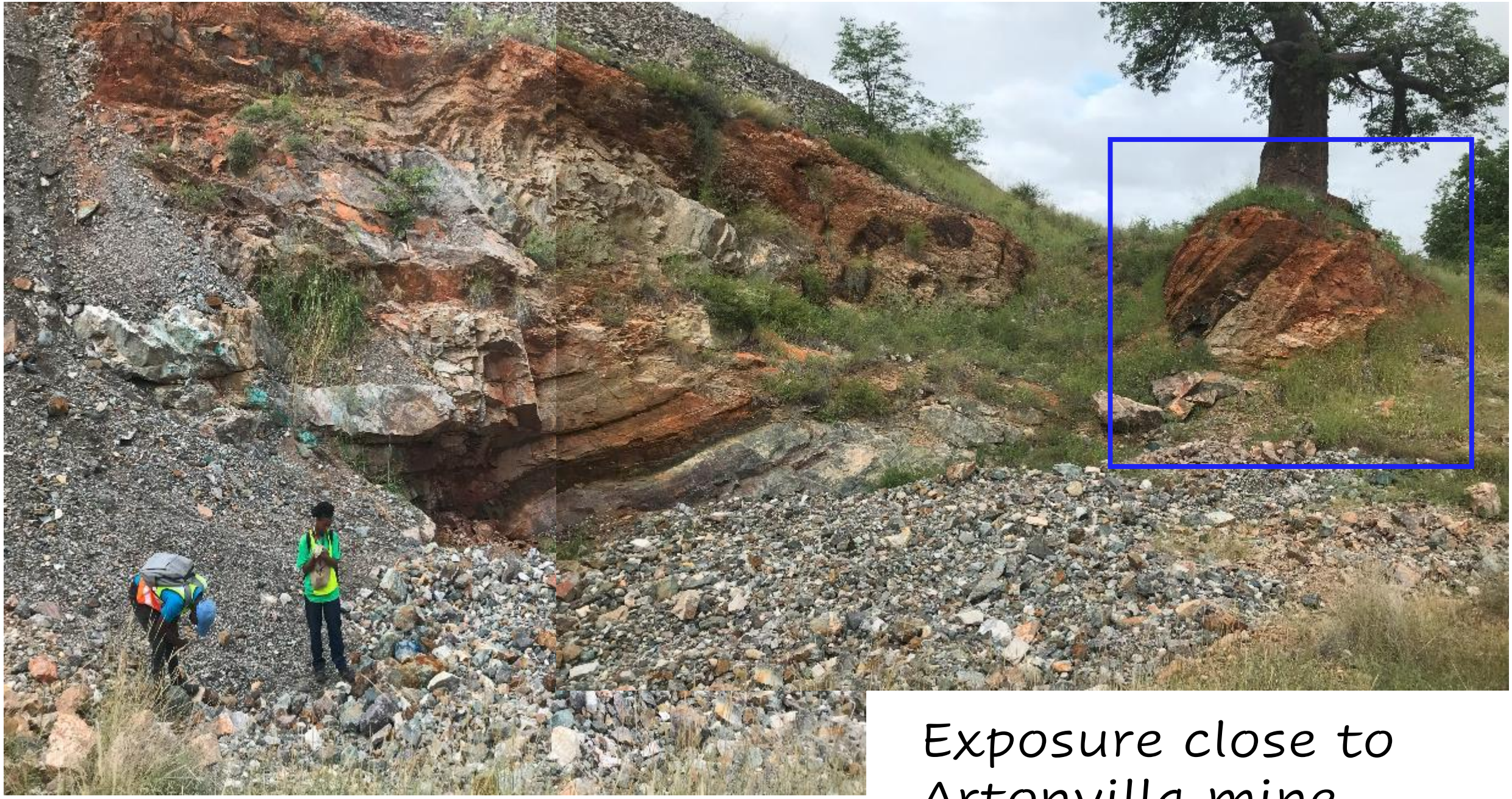
2. Quartz-breccia pipes cutting through hydrothermally altered country rocks



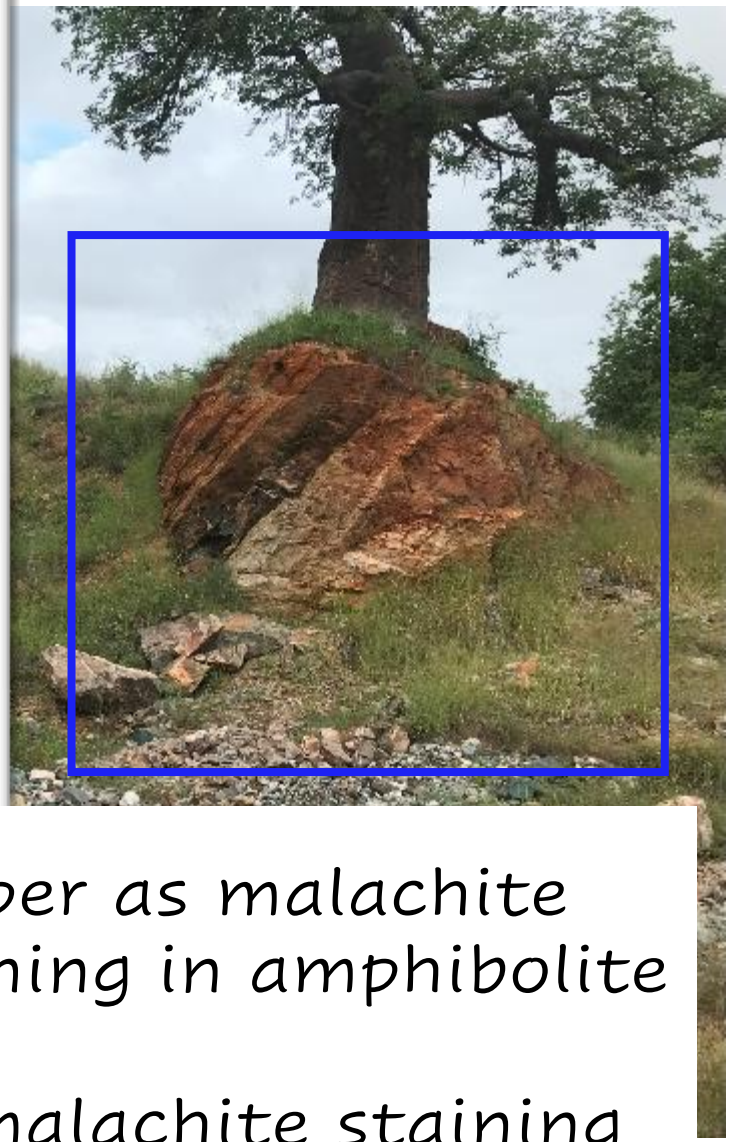
Jacobsen 1967

Geological mapping of the Artonvilla Mine area by Jens Jacobsen (1967)



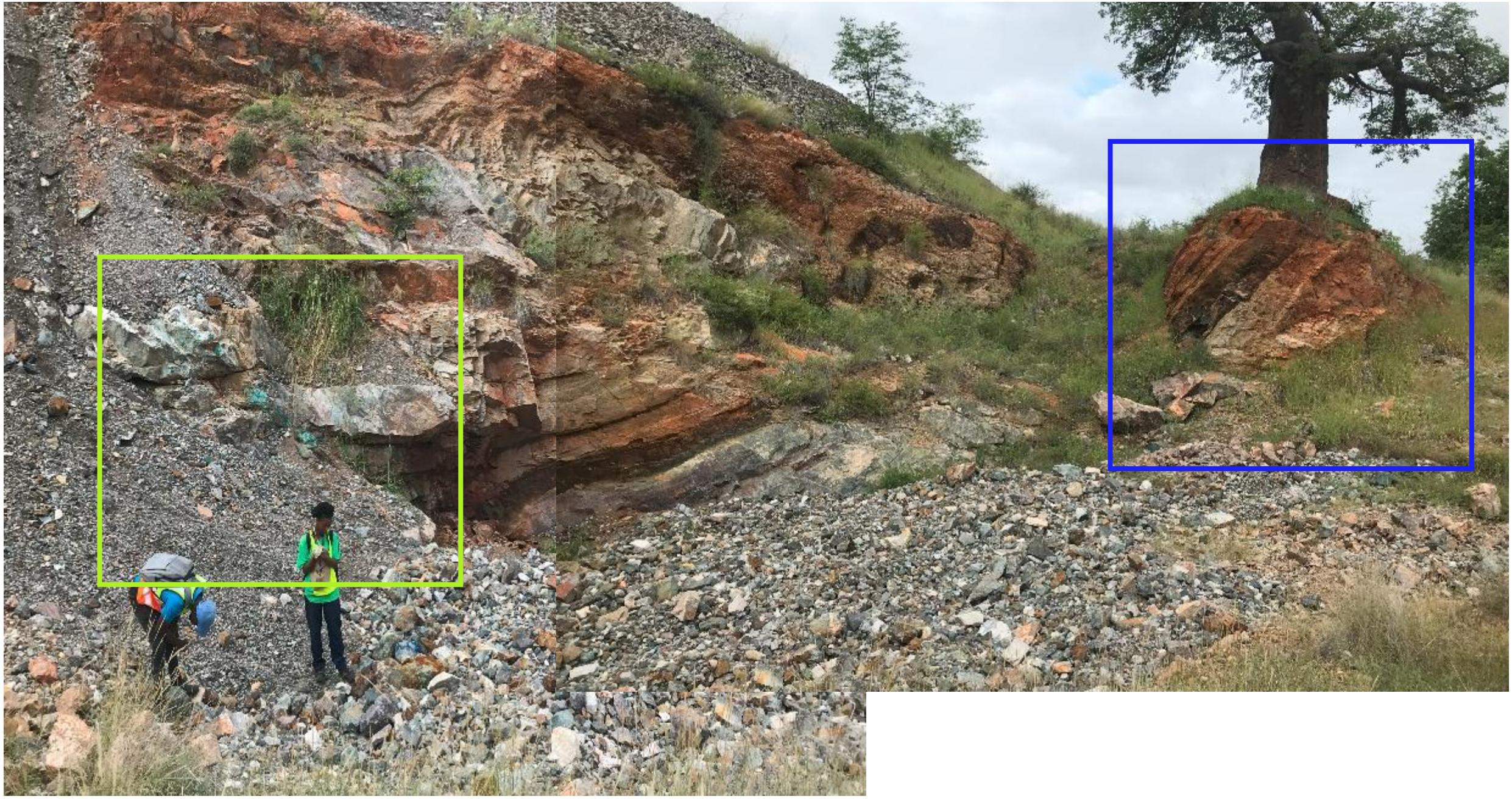


Exposure close to Artonvilla mine



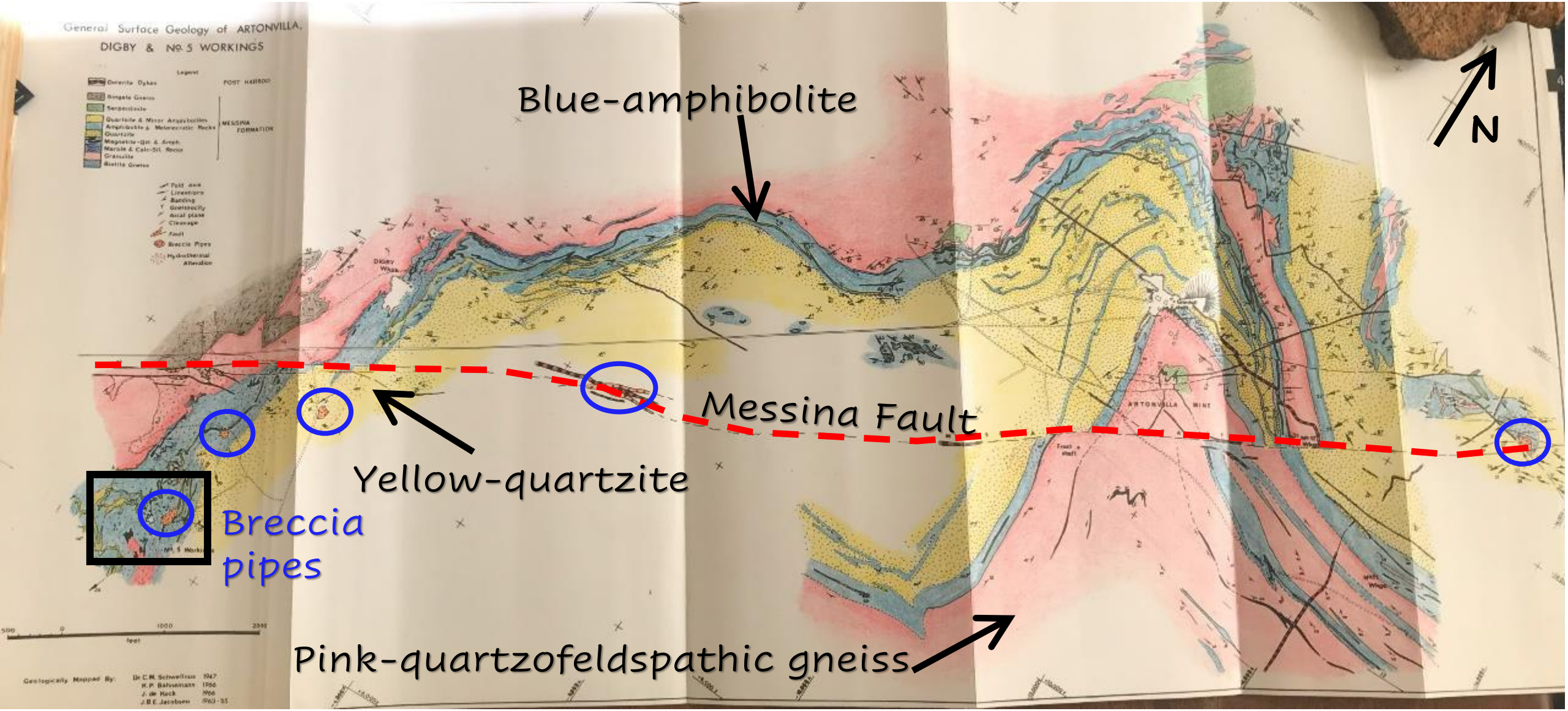
Copper as malachite staining in amphibolite

no malachite staining in interbedded quartzites



malachite staining as alteration of bornite-quarzt veins crosscutting the country rocks

The rich-Cu mineralisation is related to breccia pipes: we want to have a closer look to them



Hunting for breccia pipes within the amphibolite unit

Colloform white quartz cementing amphibolitic breccia

Entrance workings #5

Surface expression of mineralisation in brecciated amphibolite

And in places pervasive chloritic/epidote alteration with malachite staining

Surface mapping shows the presence of another type of alteration: hematitisation of the more felsic units within country rock

Pervasive hematitisation leads to formation of what I call “hematitic caps” with ± epidote and quartz breccia pipes

Weak to no malachite staining

“hematitic caps” with formation of new specularite and epidotisation, with secondary quartz veining and weak malachite staining

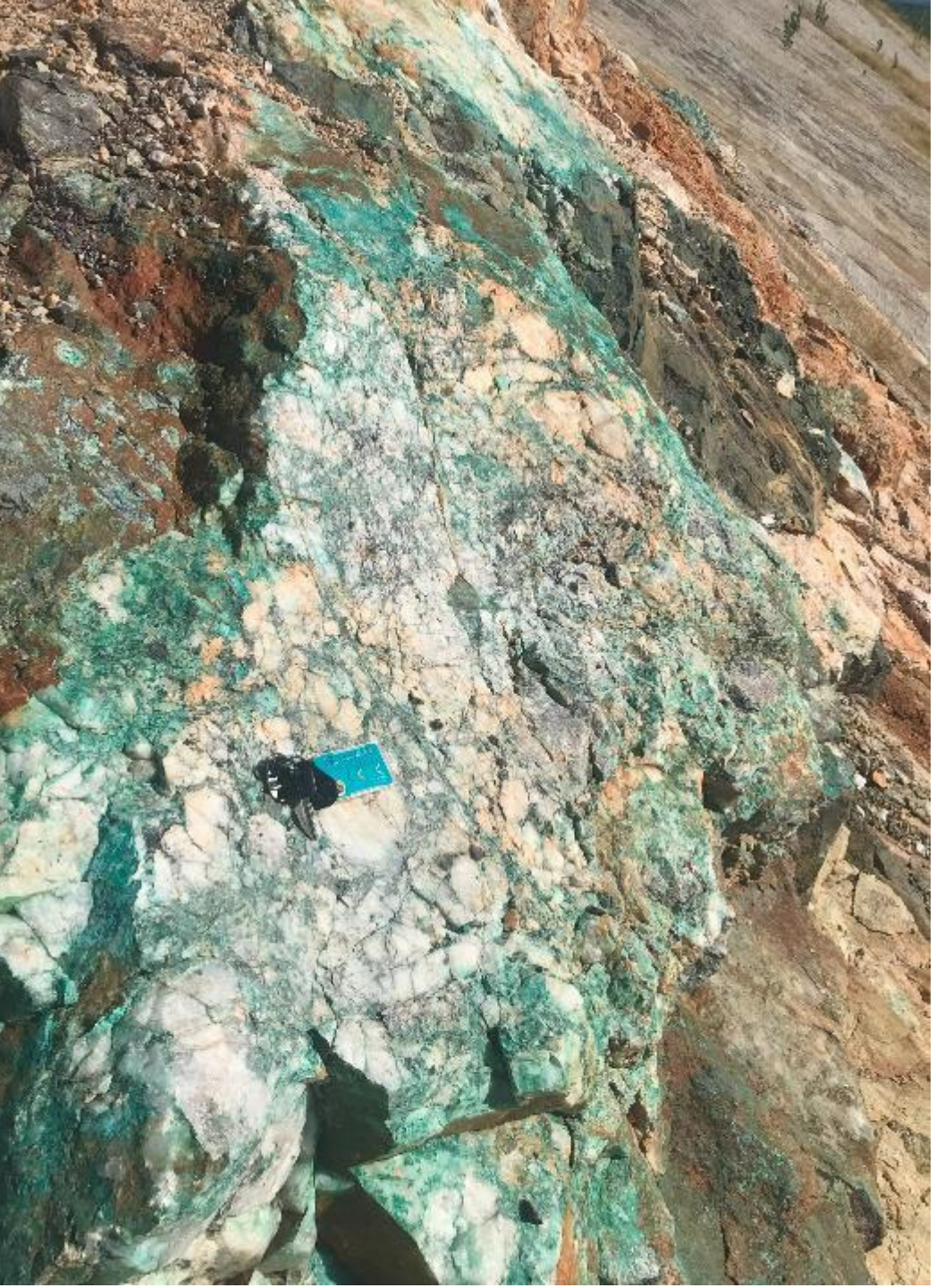
Complete mineralogical replacement and metasomatism of the country-rocks

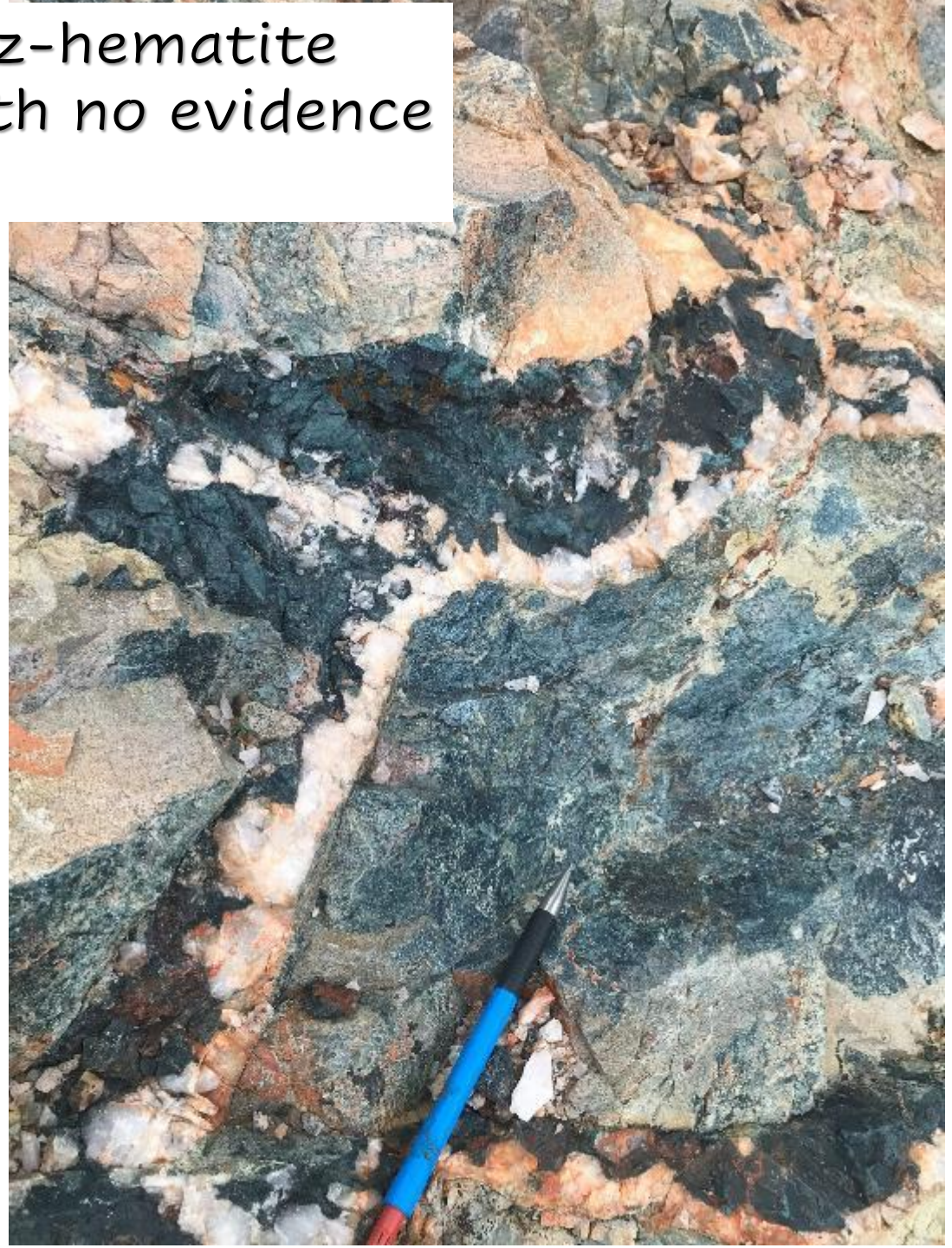
Messina Cu breccia pipe mineralisation recently exposed along the N1

Quartz breccia pipe shows pervasive malachite staining due to presence of bornite; and iron staining for alteration of hematite

Brecciated chloritized and epidotised amphibolite cemented by white quartz in a quartzitic country rock

Late quartz-hematite veining with no evidence of Cu



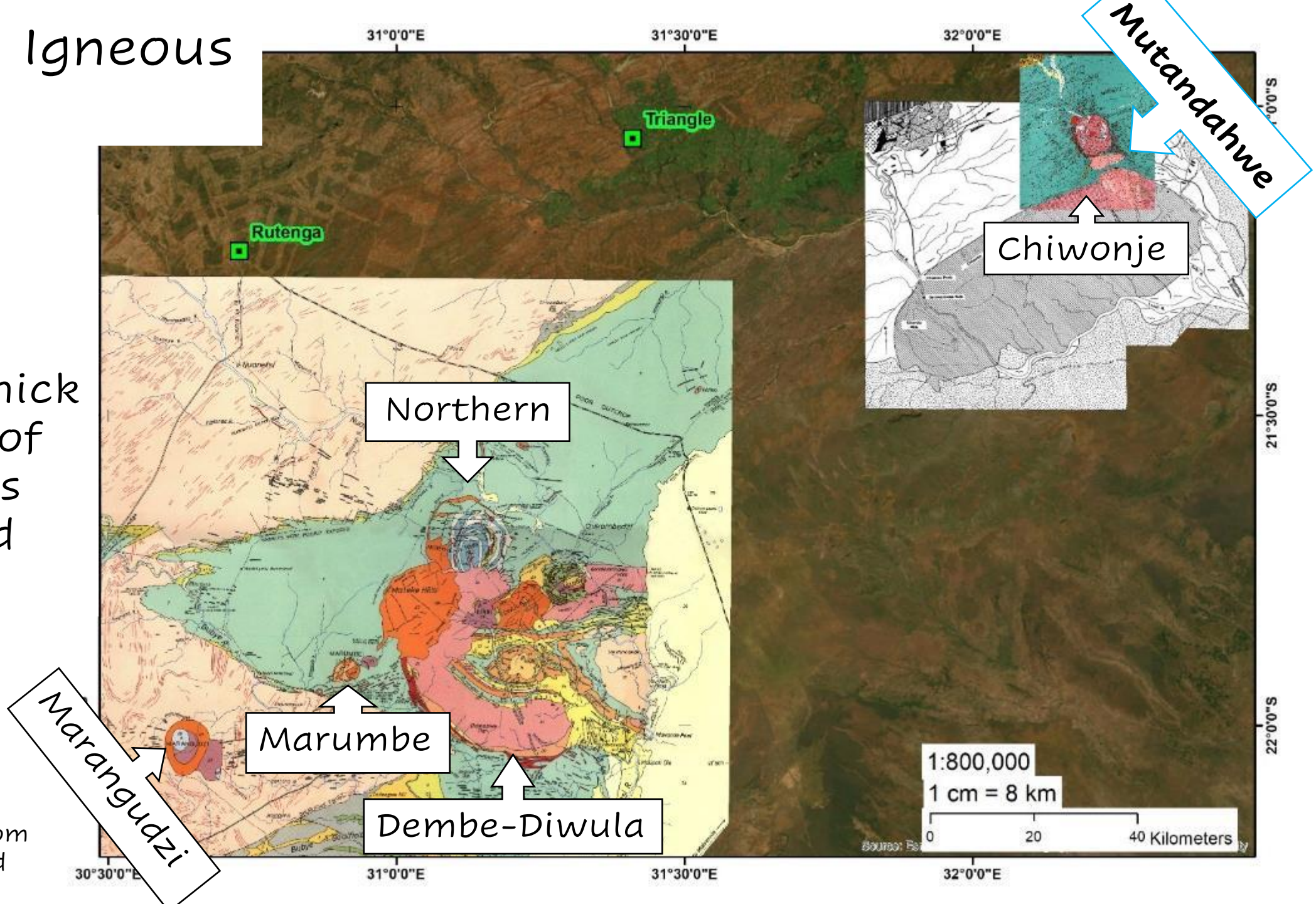


- The Messina Cu deposit interpreted as a magmatic hydrothermal ore deposit
- The composition and age of the hydrothermal fluids are debated
- The proposed source of the magmatic hydrothermal fluids is the Nuanetsi Igneous Province

Bornite within secondary quartz

Nuanetsi Igneous Province

Seven late-Karroo ring complexes cutting a thick succession of Karroo lavas (basalts and rhyolites)



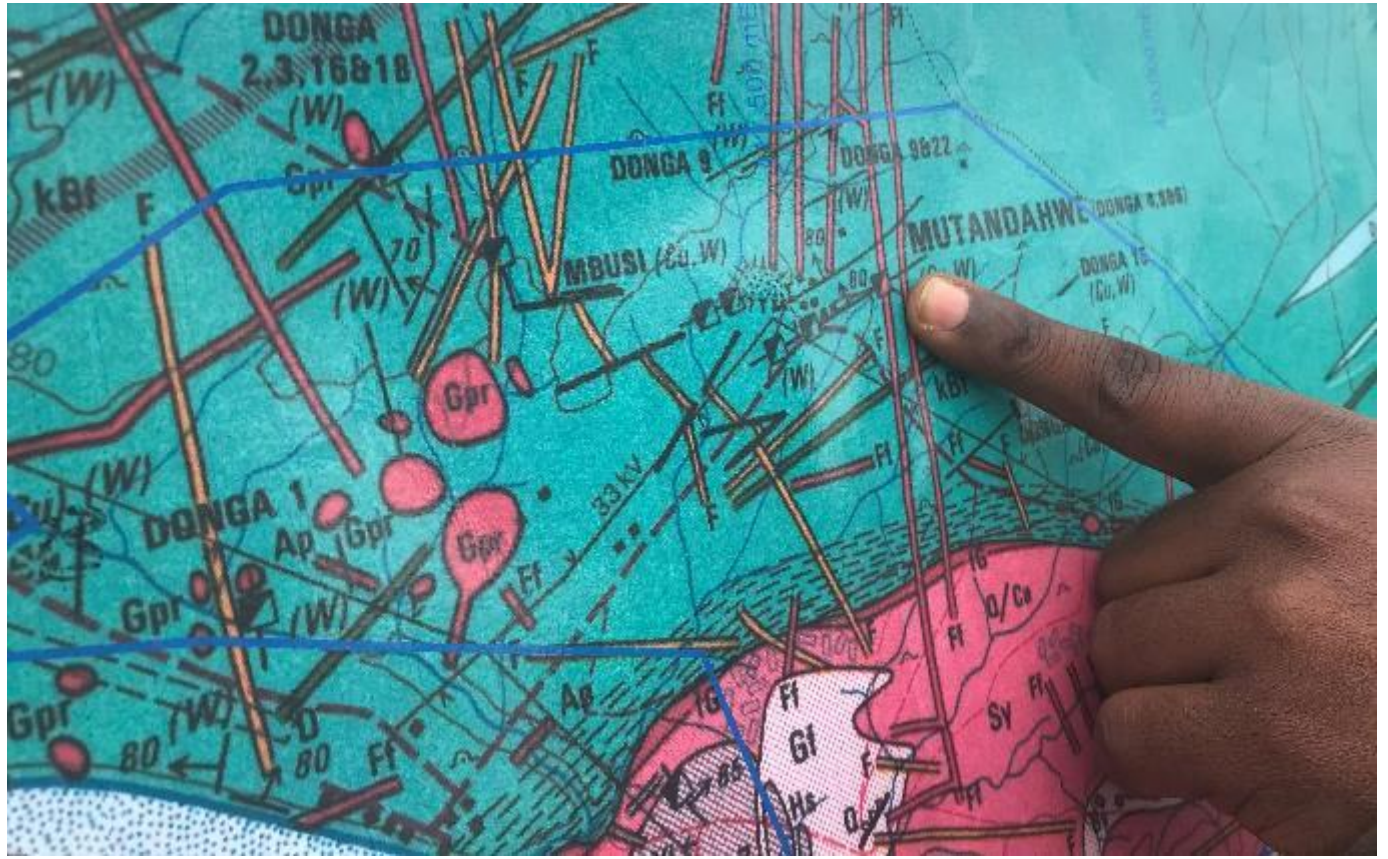
Collated images from Cox et al., 1965 and Wilson et al., 1998

Mutandahwe Complex

- near circular complex about 6-7 km in diameter
- comprises granophyres, quartz-syenites and granites
- shows evidence of a felsic volcanic phase associated with the granitic stage

Mutandahwe Complex and its Mineralisations

- Last phases of magmatism associated with hydrothermal activity and emplacement of mineralisations
- **Cu** and **W** showings rim the granitic intrusion (Example, MUTANDAHWE Cu MINE; BUONA FORTUNA W Prospect)



- **Mo** mineralisations present within the pluton (Example, LAZENO Project)

Mutandahwe Cu Mine

- During 1968-1977 two main shafts and three ventilation shafts were sunk and the mine was exploited to 5 level (128 m)
- Produced mainly Cu and minor W

Mutandahwe Cu Mine

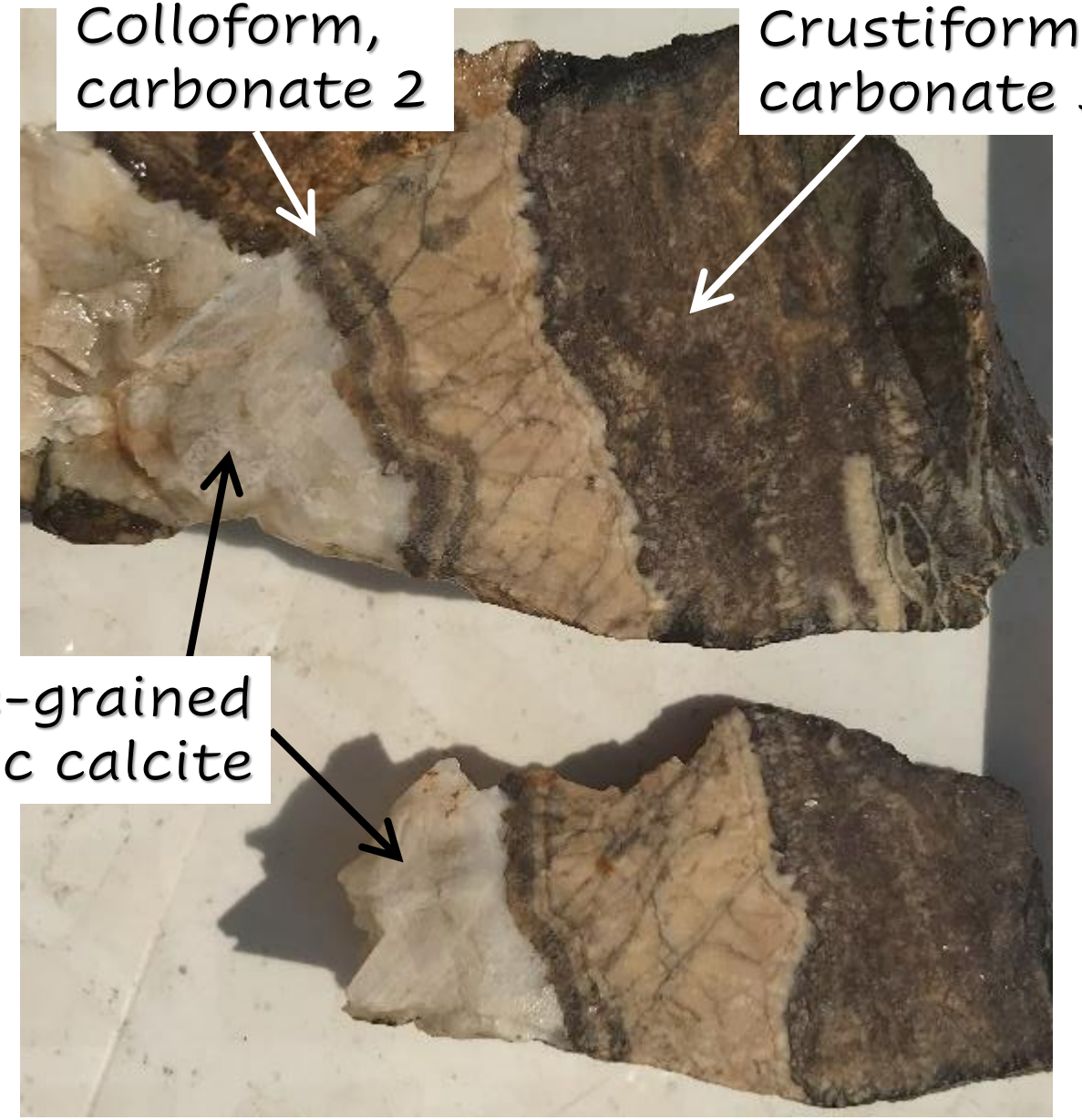
Sampling in May 2023 in the dump next to adit #183 FT

Mutandahwe Cu mineralisation

Samples collected from mine dump record a mineralization mainly related to veining into a hydrothermally altered (chloritization and biotitisation) basaltic country rock:

1. Carbonatic veins without macroscopic evidence of sulphides
2. Quartz-carbonate veins with sulphides
3. Quartz-vein with sulphides
4. Veins and alteration of hosting basaltic rock

Mutandahwe Mine
Carbonatic veins



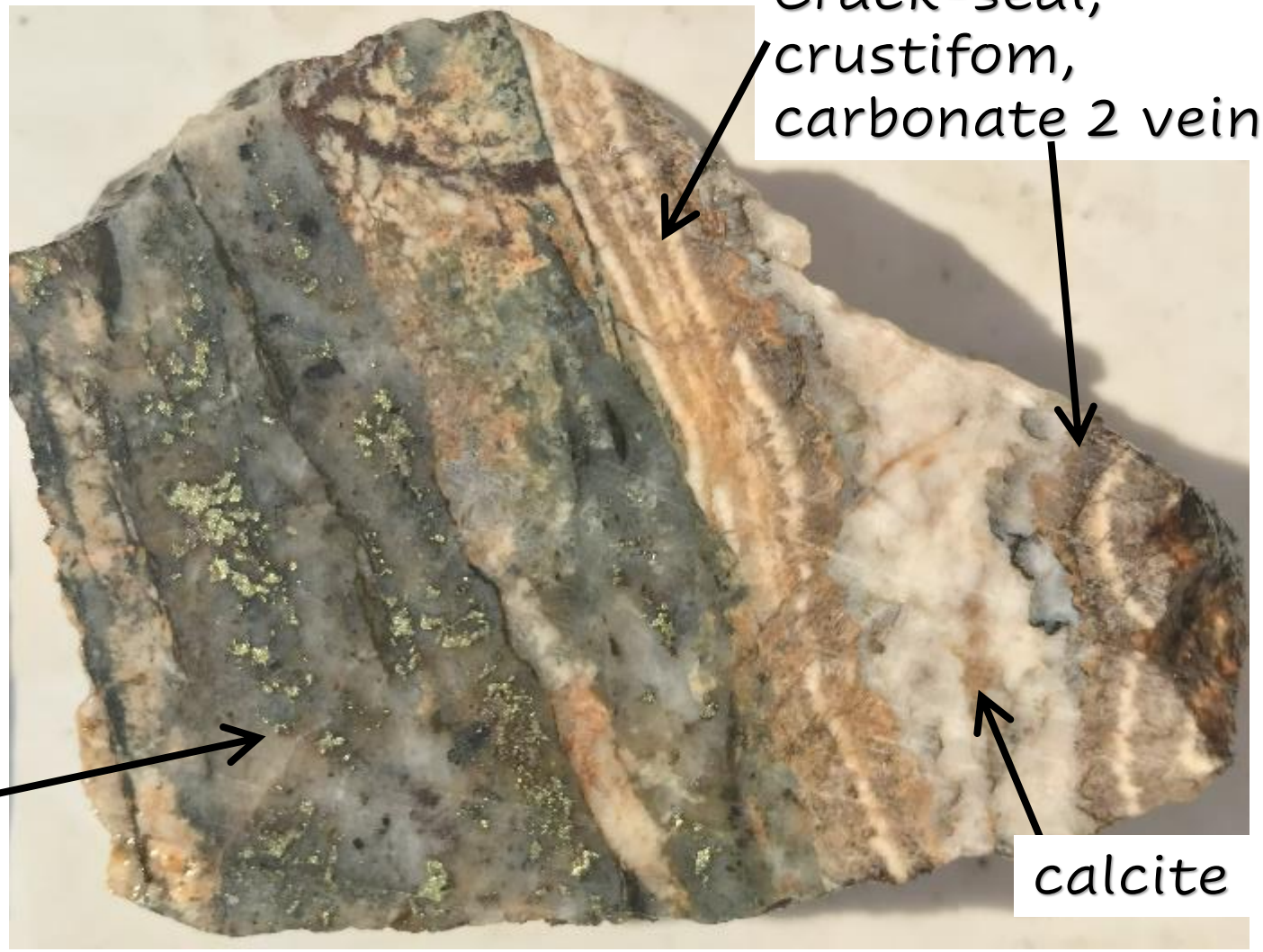
Mutandahwe Mine
Carbonatic veins

Coarse-grained mosaic calcite

Colloform, carbonate 2

Fine-grained brecciated and chloritized basaltic host rock

Mutandahwe Mine
quartz-carbonate veins with sulphides

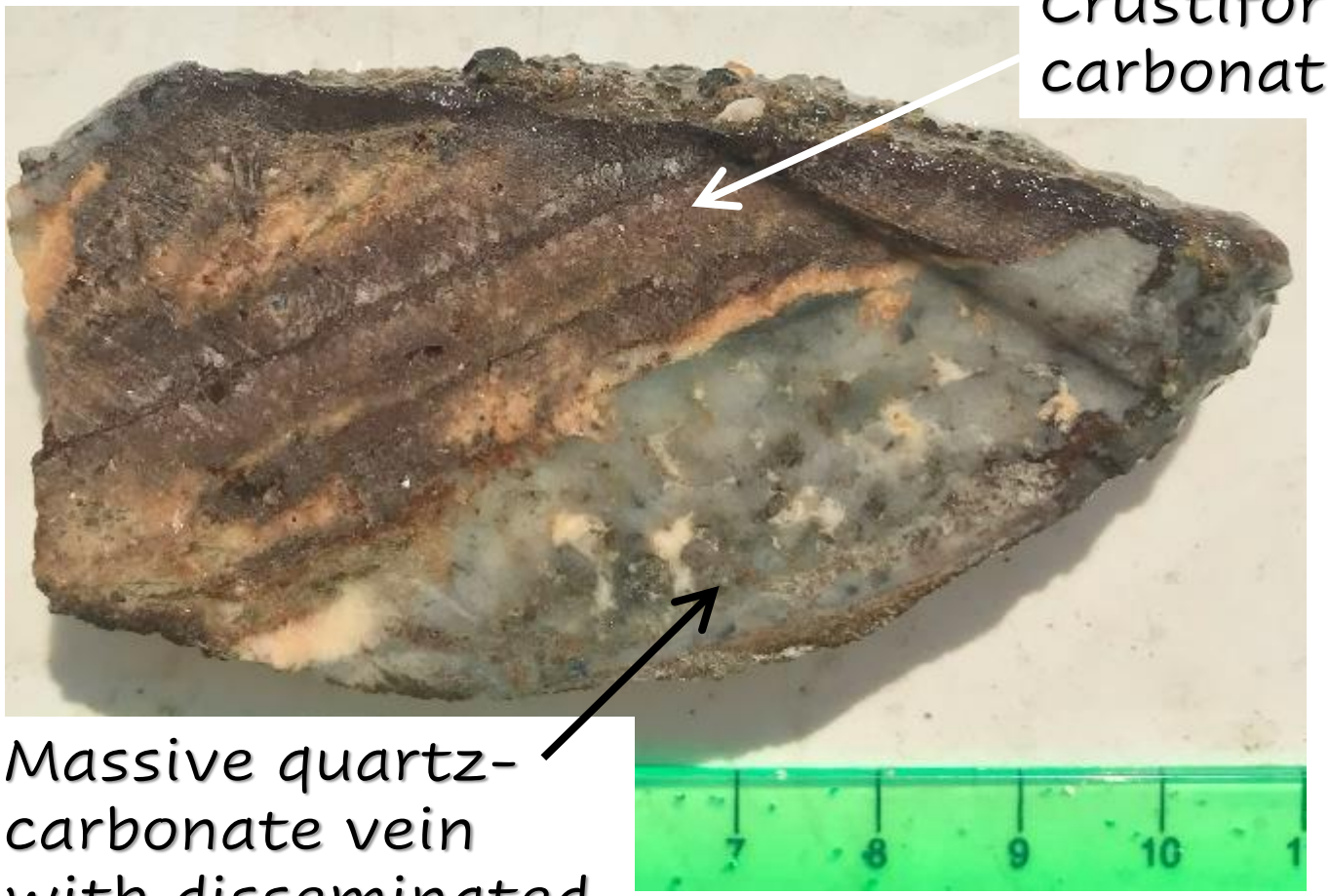


Crack-seal, crustifom, carbonate 2 veining

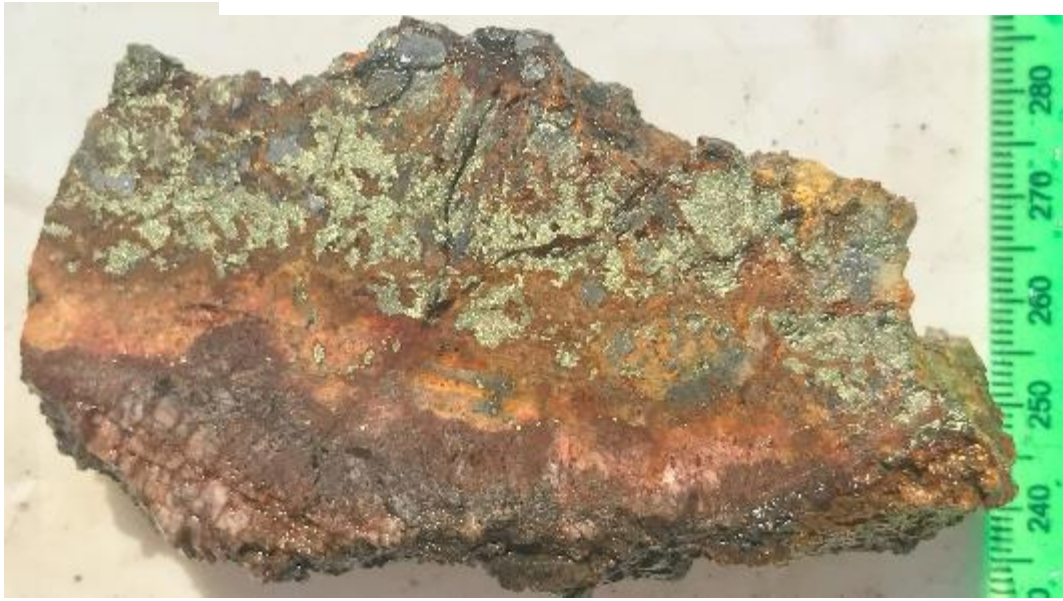
Massive quartz with disseminated chalcopyrite, minor pyrrhotite

calcite

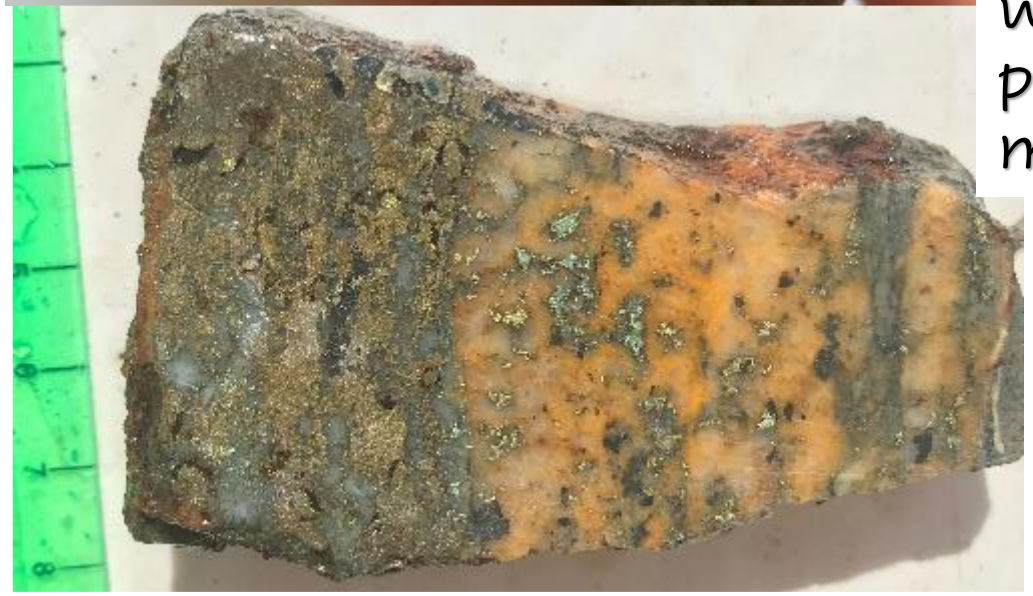
Mutandahwe Mine
quartz-carbonate veins with sulphides



Massive chalcopyrite-pyrrothite adjacent to crustiform carbonates

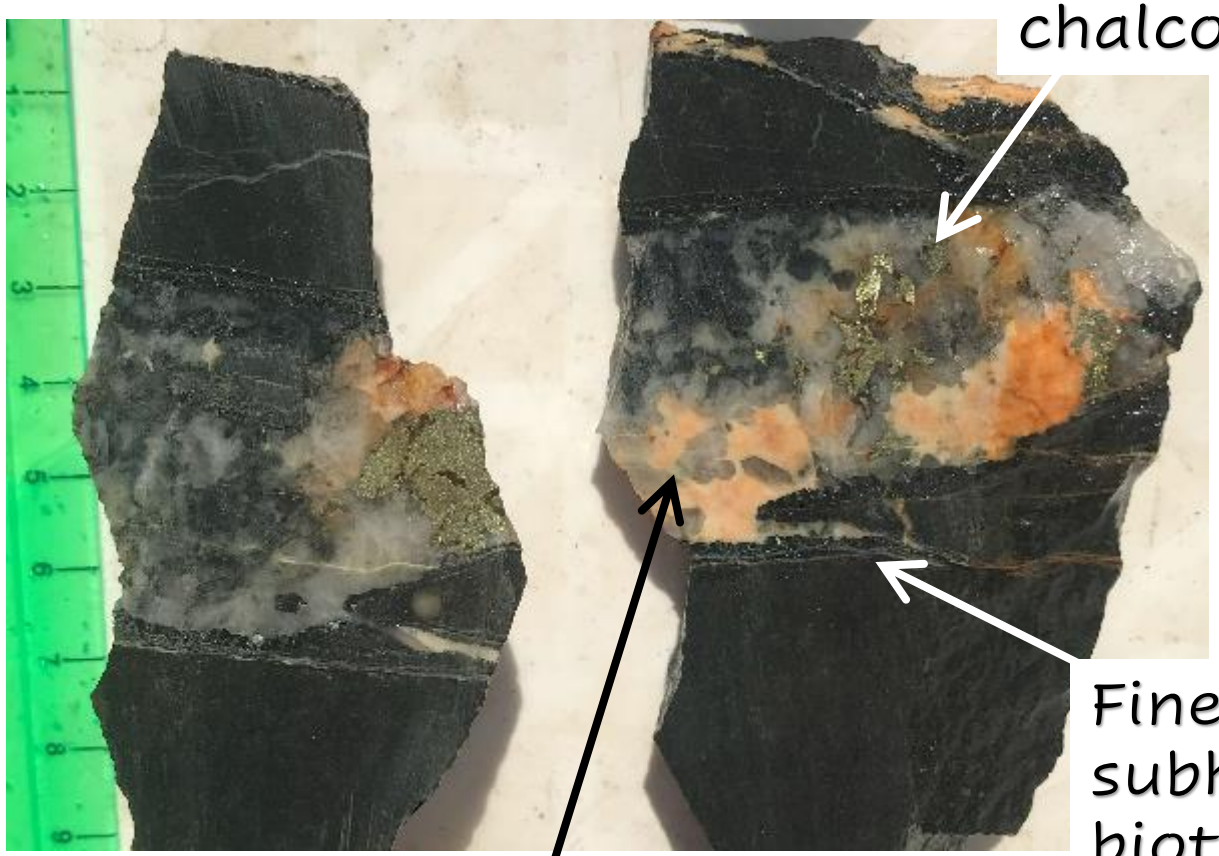


Massive quartz-carbonate veins with chalcopyrite, pyrrhotite and minor pyrite



Mutandahwe Mine veining in basaltic host-rock

Subparallel quartz-carbonatic veins in a biotitised basaltic host-rock

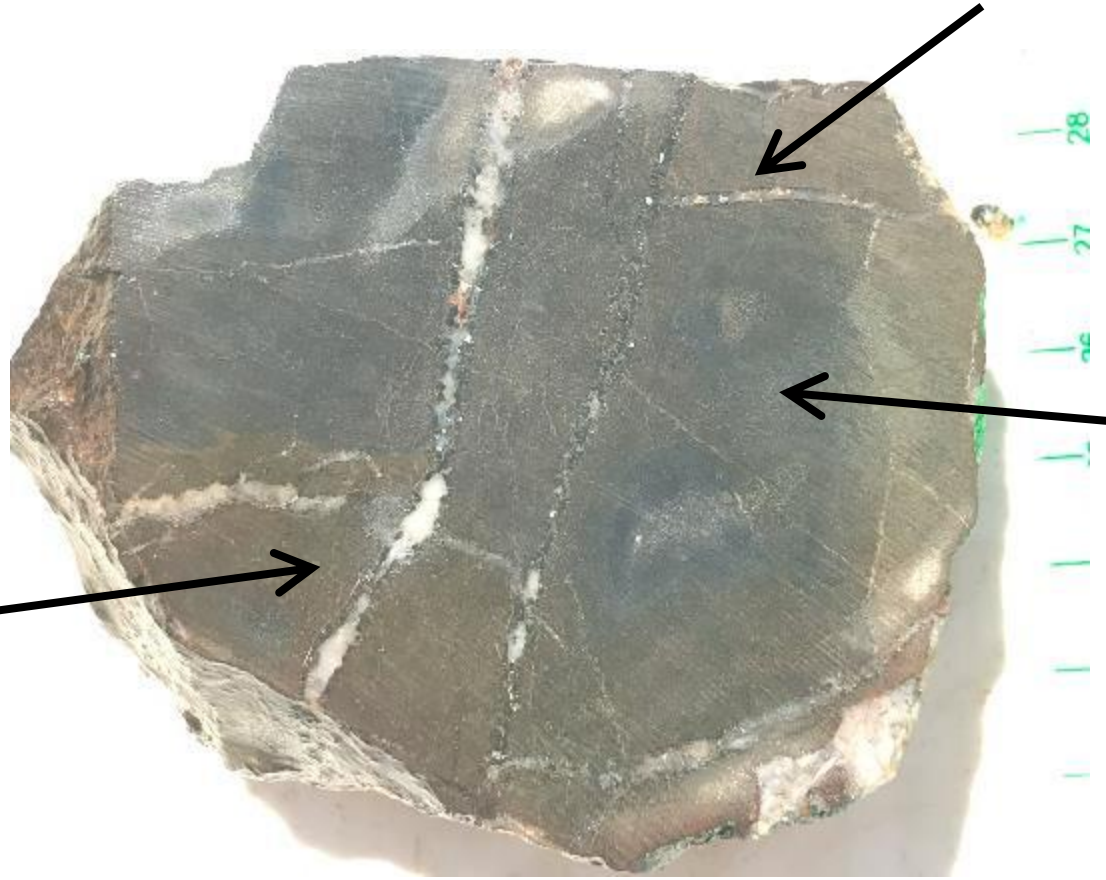


Interstitial coarse-grained chalcopyrite

Fine-grained subhedral biotite reaction rim

Subhedral/Euhedral quartz within pinkish and anhedral carbonates

Stockwork of fine-grained white quartz veining in fine-grained, altered biotite-rich basalt



Alteration halos within the basaltic rock

Each vein shows a reaction rims of subhedral biotite at the contact vein/basaltic host rock

Future directions

- Dating:

1. mineralisation (Re-Os dating of sulphides)
2. alteration minerals
3. Host-rocks

- Fluids inclusions in quartz for characterising the composition of the mineralising fluids

- Detailed petrographic observations coupled with SEM elemental maps of mineralisation (perhaps presence of minor rare metals within sulphides/oxides/carbonates)

Mutandahwe Mo mineralisation –LAZENO Project

References

- Cox et al., 1965
- Kramers et al., 1998
- Jacobsen, 1967
- Wilson et al., 1998