Microscale characteristics of REE bearing phases in the Dorowa ring complex- rocks - Zimbabwe: Implications for petrogenesis of the ring complex

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Study area


Kafue
National Park
Lusaka
Mongu
Lilongwe
Tete
Kafue
Choma
Coutada
pública
do Luiana
Katima Mulilo
Kasane
Livingstone
Chinhoyi
Harare
Dorowa Phosphate Mine
Chimoio
Zimbabwe
Hwange
National Park
Bulawayo
Beira
Botswana
Thohoyandou
Tzaneen
Polokwane
Kruger
National Park

Geology of the area

- The Dorowa carbonatite is
  - Part of the Mesozoic alkaline complexes intruding the Precambrian igneous and Karoo rocks in Zimbabwe
    - The other complexes include Mutandawe, Chishanya, Shawa,
  - Associated with plugs and dykes correlated to lavas of the basal Karoo volcanic succession
  - 3.5 km in diameter
  - Associated with magnetitite, pyroxenites, serpentinites, and syenites (mostly ijiolites but also foyaite, & pulaskite).
  - Major minerals include phlogopite, vermiculite, feldspars, pyroxenes, magnetite and calcite

- The complex consists of of coarse, medium and fine grained, leucocratic & mesocratic rocks exhibiting veining

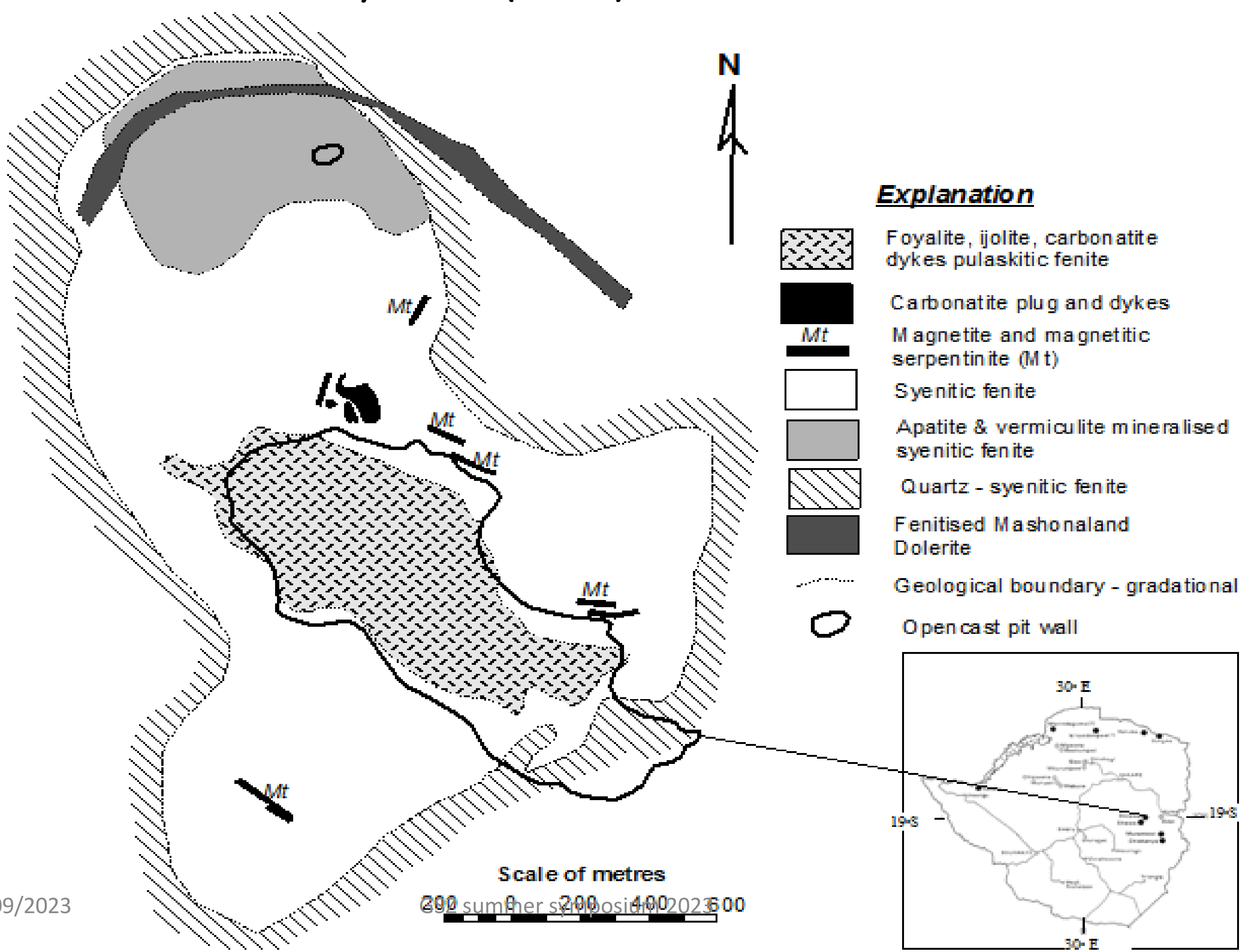
- Veining and xenoliths of mafic rocks in felsic rocks is prominent in the rocks

Google earth view of Dorowa complex

- U shaped and not circular like the other 3 complexes

Dorowa carbonatite

Modified by Meck (2011) after Barber 1991



Production history

- Mined for its P content
- First production 1945
- Full production 1965
- Estimated reserve 75 million tonnes
- Average grade 6.5% P_2O_5
- Expected life span 78 years
- Phosphate ore consists of apatite with magnetite nodules and magnetite boulders with apatite veining

Phosphate rock with magnetite nodules

Apatite veins in magnetite Magnetite boulders stand out whilst the apatite veins are gullied due to difference in resistance to weathering

Current work

- Whilst phosphate is the major resource of interest, the complex contains an extensive natural anomaly of metals and critical elements related to the occurrence of igneous rock phosphate
- Both XRD and ICP–MS data from PhD showed presence of REE-Zr-Nb-Ta- Ce
  - Levels above crustal averages
    - ICP-MS data
  - Minerals containing REE
    - XRD picked phases greater than 2% in the samples and these were fluoro apatites, enstatite, augite
- Despite above REE-Zr-Nb-Ta-Ce enrichments noted, to date, these are not comparable to other igneous bodies

Element (ppm)	Observed in Dorowa (average of all rocks)	Average Crustal levels
Zr	183-227	162
Nb	40-83	22
Ta	3.64	2
Ce	198	48
Sr	4030	384

Petrogenesis???

- Yes they are higher than crustal levels but certainly not economic or comparable to other igneous bodies.
- Current economic levels from other carbonatite are tens, hundreds or thousands of times average crustal contents
  - wt% levels.
- Could petrogenesis have played a role ????
- Understanding of the petrogenesis of the alkaline complex and its relationship to the regional tectonics is vital in understanding the nature of these REE containing phases

Proposed petrogenesis models

- Based on various features previous authors have proposed the following models
- Mennell, 1938 and Macgregor, 1947) suggested a sedimentary origin for the carbonatite, involving the interaction of limestone with gneiss or the emplacement of marble blocks.
- Tyndale Biscoe, 1950; Swift, 1952; Lee, 1973; Harmer and Gittins, 1998) proposed a magmatic origin, either from primary carbonate magmas or from fenitization of granitic gneiss.

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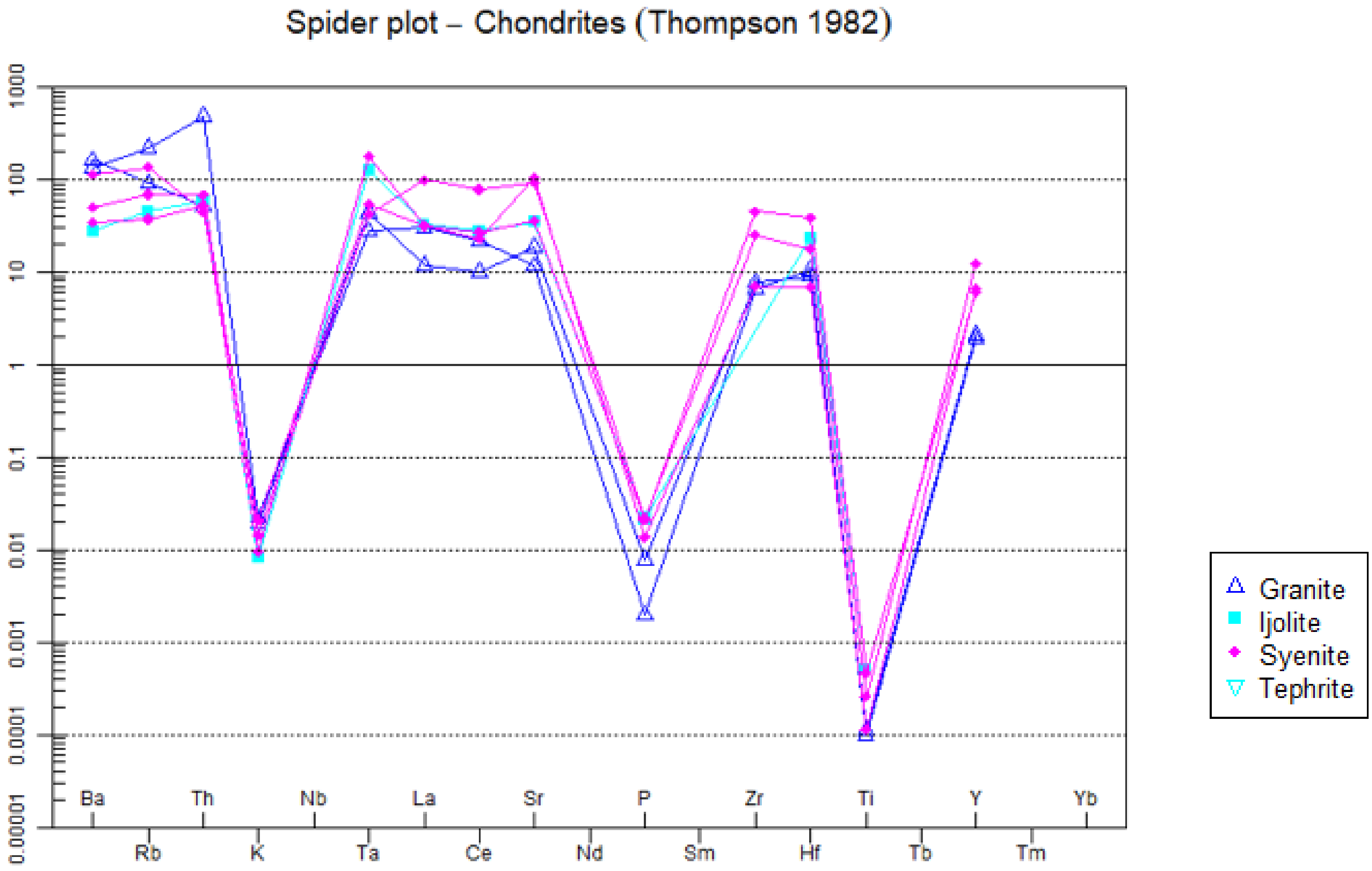
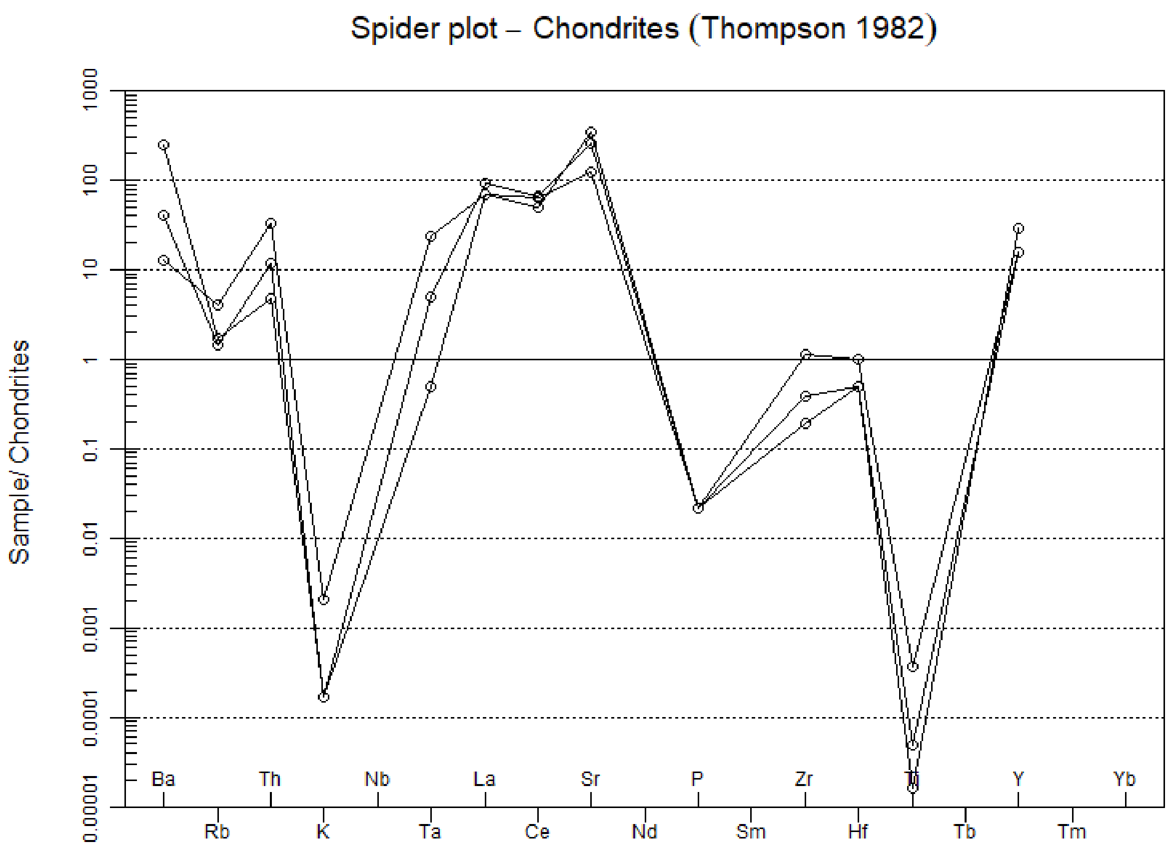
- Field evidence ??
- Micro-scale evidence ??
    - Geochemistry
    - Petrography
    - Cathodoluminesce
    - SEM

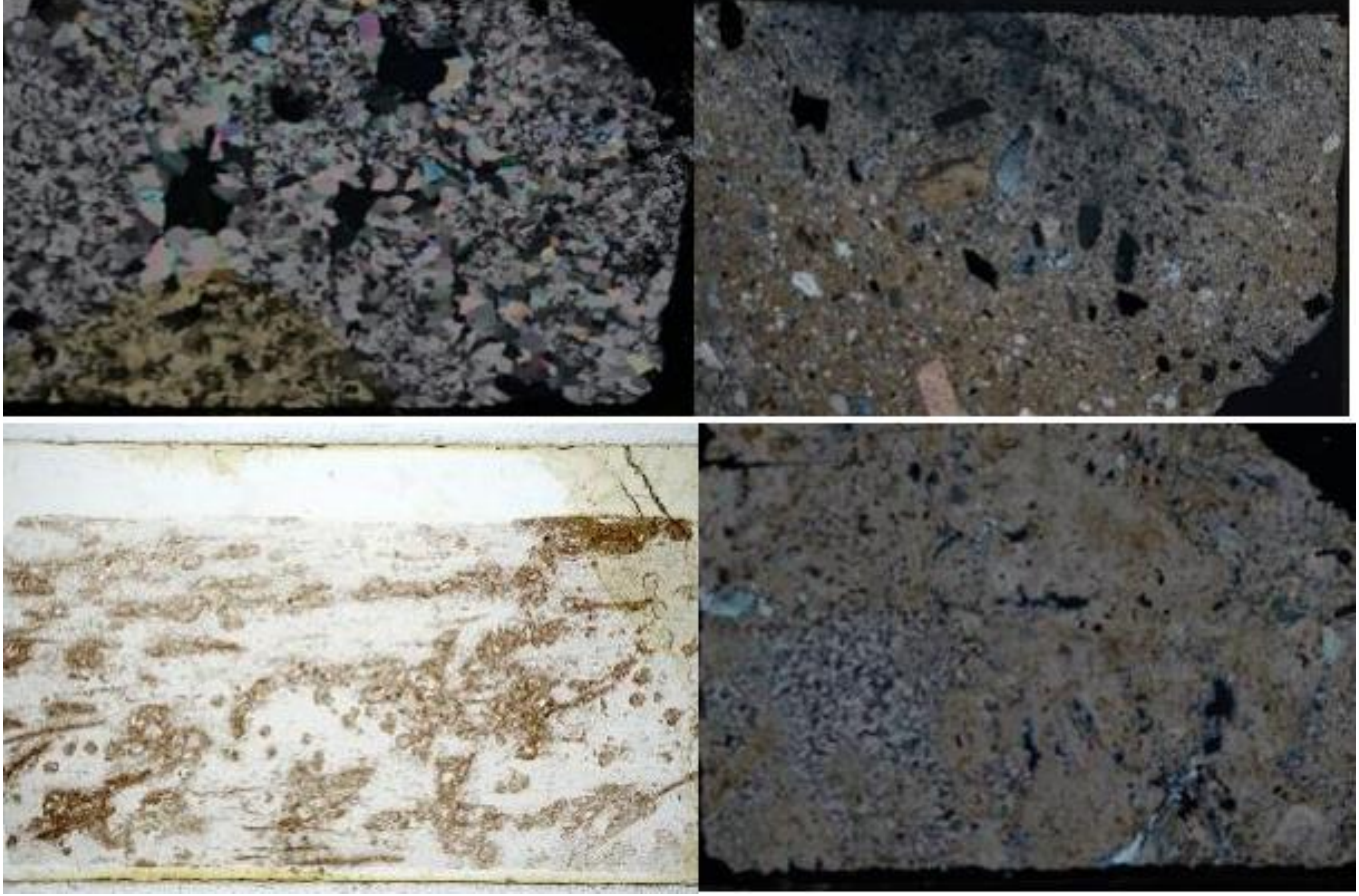


- The geotecto plots sho that the carbonat rocks hav similar trend to the fenite and ijiolites.

INDIVIDUAL CARBONATE ROCKS

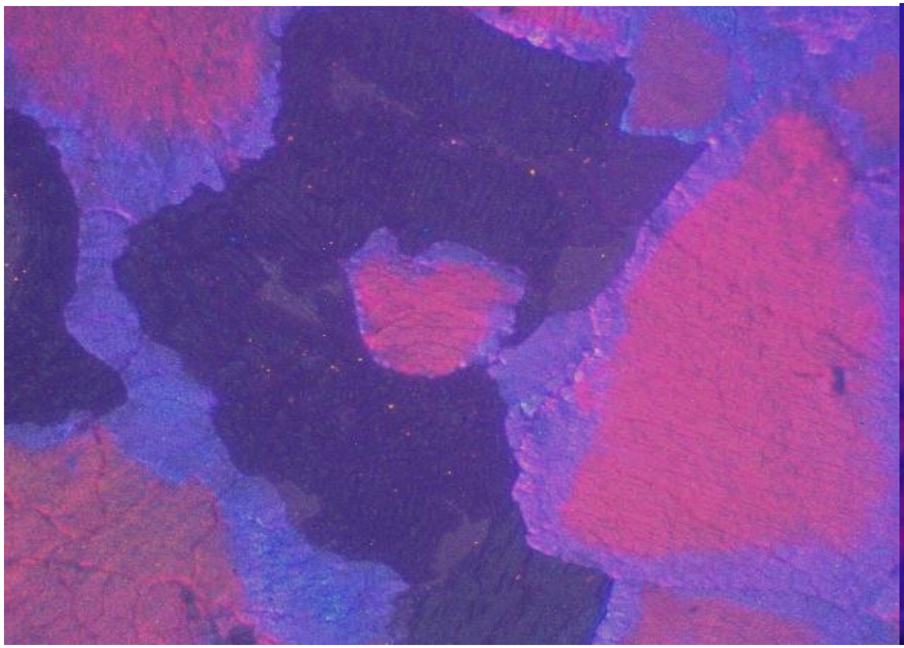
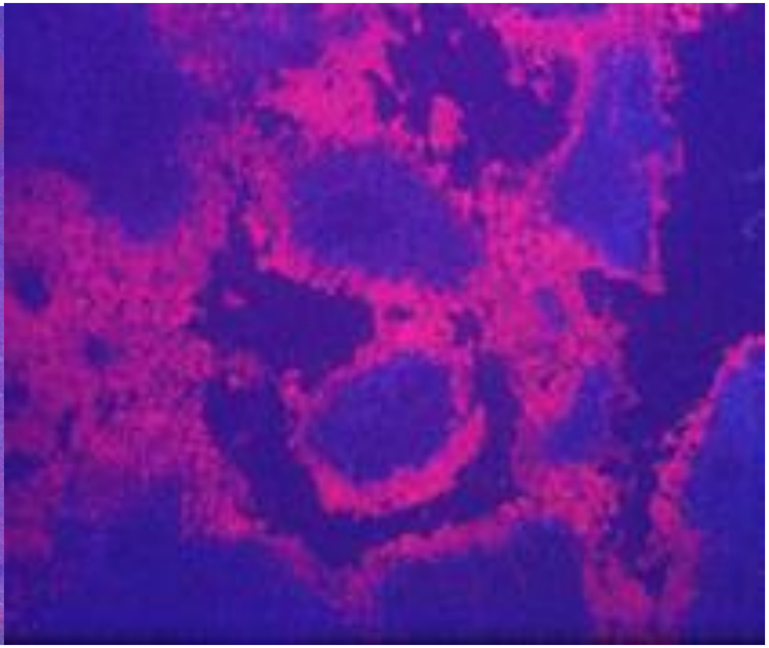


- Beforsite
- Calcites
- Dolomites
- Similar trends



- crystalline textures, porphyritic texture, carbonate spherules that cannot be explained by replacement textures, euhedral phenocrysts

Reverse zoning (calcic plagioclase surrounding the lower melting sodic plagioclase) indicate either ascent of magma from a deeper to a shallower chamber iso-entropically or convection of a magma in a large chamber polybaricaly

Summary of Petrogenesis

- The rocks have textural features that appear to arise from co-existence with magma.
- Textural diversity suggesting several generations of formation.
- Reverse zoning is an indicator of either ascent of magma from a deeper to a shallower chamber iso-entropically or convection of a magma in a large chamber polybaricaly
- The similar trends displayed by the geotenic plots of the rock suite suggest that thecarbonate rock may have same origin as the fenites:
- Sodic alteration supports fenitization of the rocks
- Evidence for fenitization is abundant however primary carbonate magma evidence also present