

# *Tombstone Plutonic Suite*

## *Scheelite Dome*

- **Diversity of intrusive rocks**
  - Mafic (*lamprophyre*) to felsic
  - Emplaced between 92 and 90 Ma (U/Pb, Ar-Ar)
- **Complex petrogenesis**
  - Mantle and crustal component
  - Hybridized magma system
- **Sequence of emplacement**
  - Early felsic intrusions (*qtz-monzonite*)
  - Intermediate dykes (volatile rich)
  - Porphyritic granite dikes
  - Lamprophyres (*minettes and spessartites*)

## *Timing Constraints*

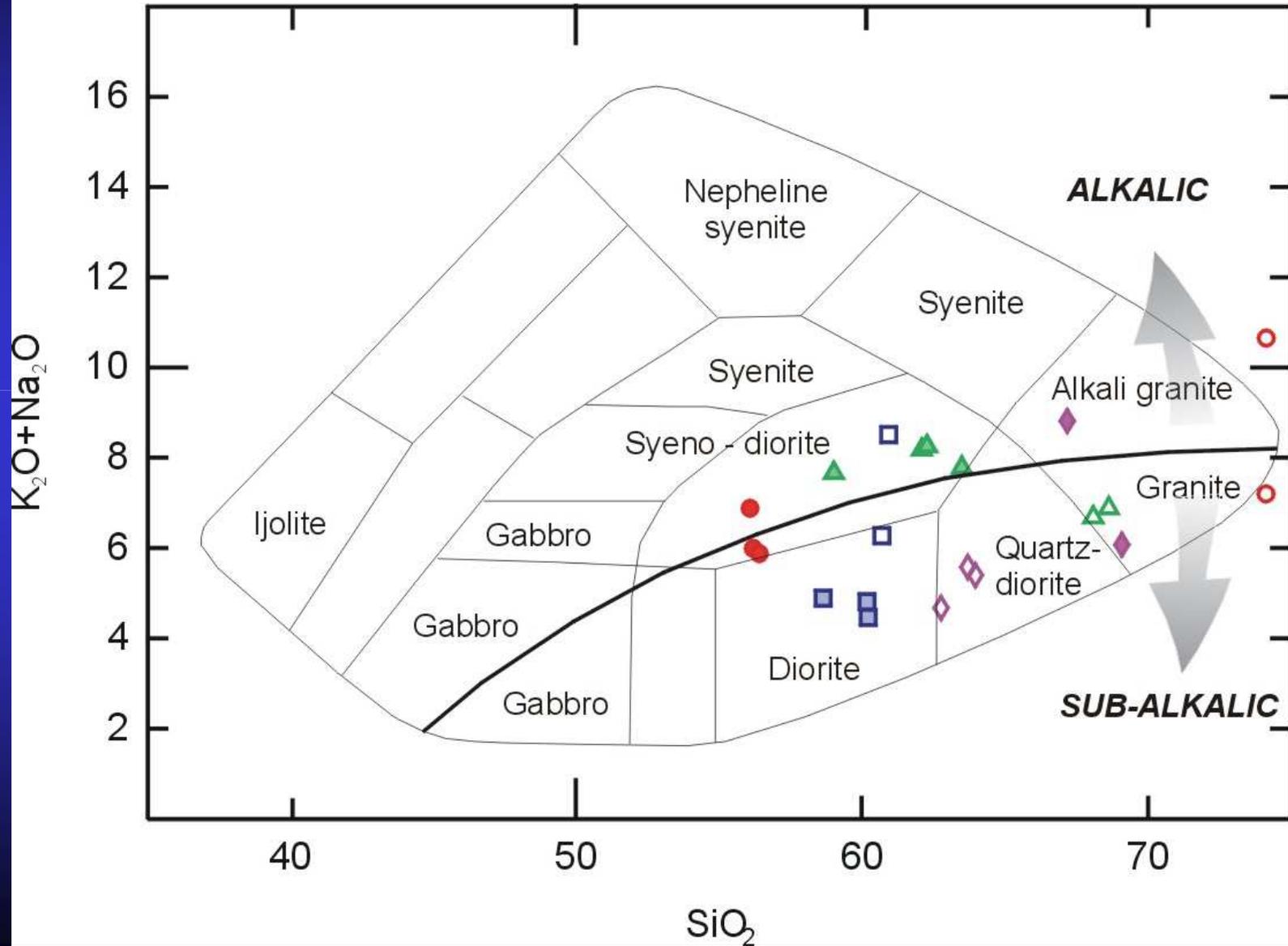
- **RELATIVE:**
- Qtz-monzonite cut by all other intrusive phases and hydrothermal assemblages
- Monzonite/latite and diorite/trachyandesite dykes emplaced next
- Lamprophyre and granite porphyry dykes feature mutually cross cutting relationships with mineralised hydrothermal assemblages
- **ABSOLUTE:**
- Qtz-monzonite – Emplaced @ ~ **92.5 Ma** (U/Pb & Ar/Ar)
  - Hydrothermal assemblages (Au & W) – **91.5 Ma** (Ar/Ar)
  - Late minette dyke (x cuts both mineralisation and intrusive rocks) – **91 Ma** (Ar/Ar)

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### *Scheelite Dome*

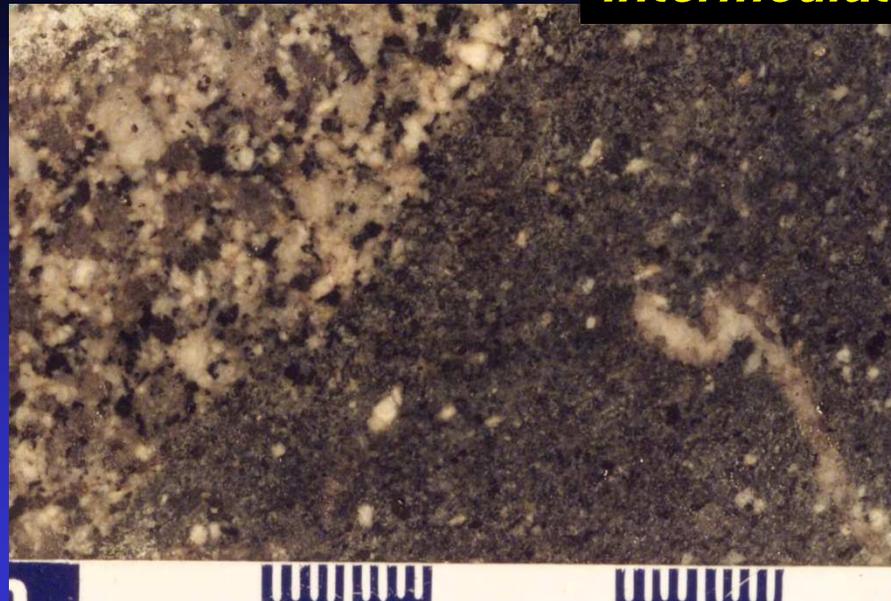
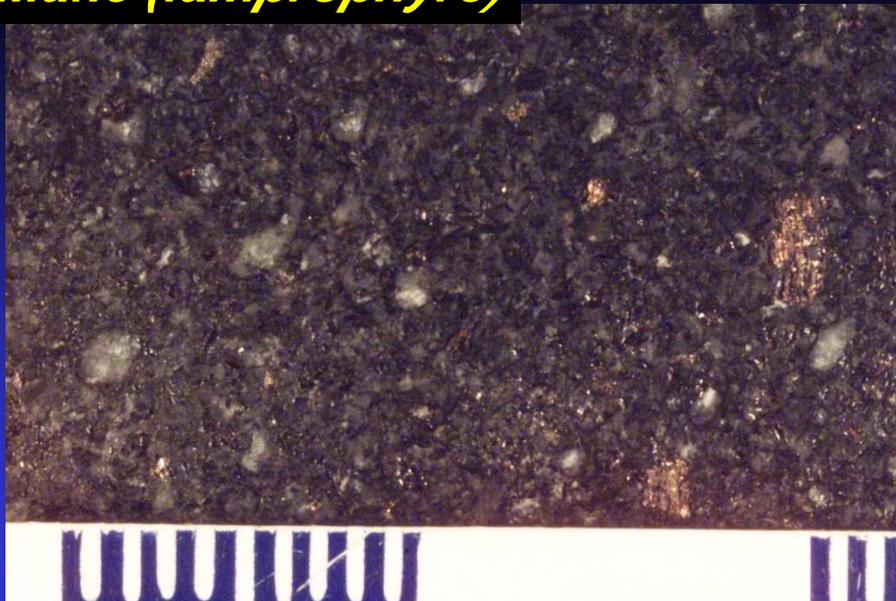
- Intrusions highly radiogenic (initial Sr >0.71)
- Typically heavy  $\delta^{18}\text{O}$  (*felsic intrusions >11 per mil, intermediate intrusions 9-11 per mil*)
  - (characteristics of crustal input)
- **However.....**
  - Unusual mineralogy and mineral chemistry
  - Strong evidence for magmatic disequilibria
- Uniform trace element signatures throughout **TPS** rocks

Scheelite Dome intrusive rocks  
SiO<sub>2</sub> vs total alkalis



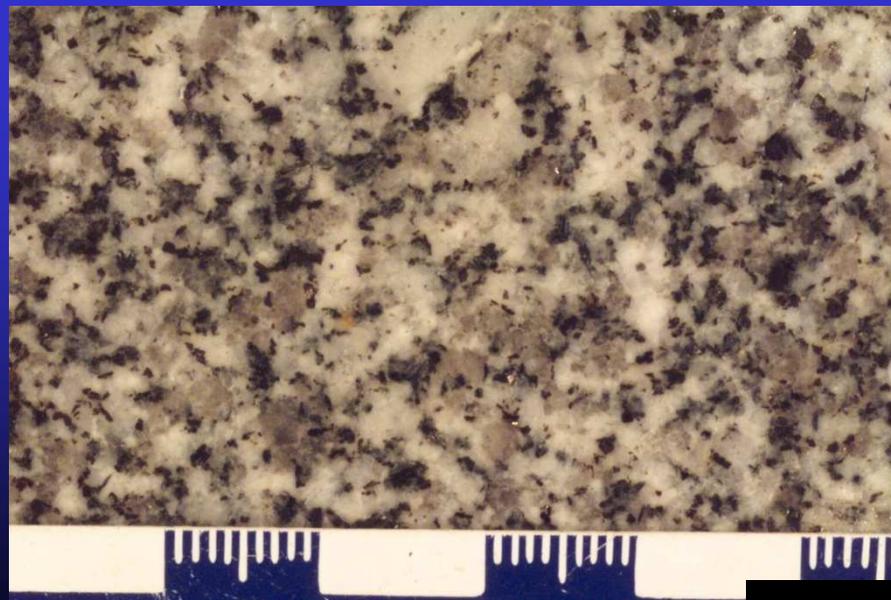
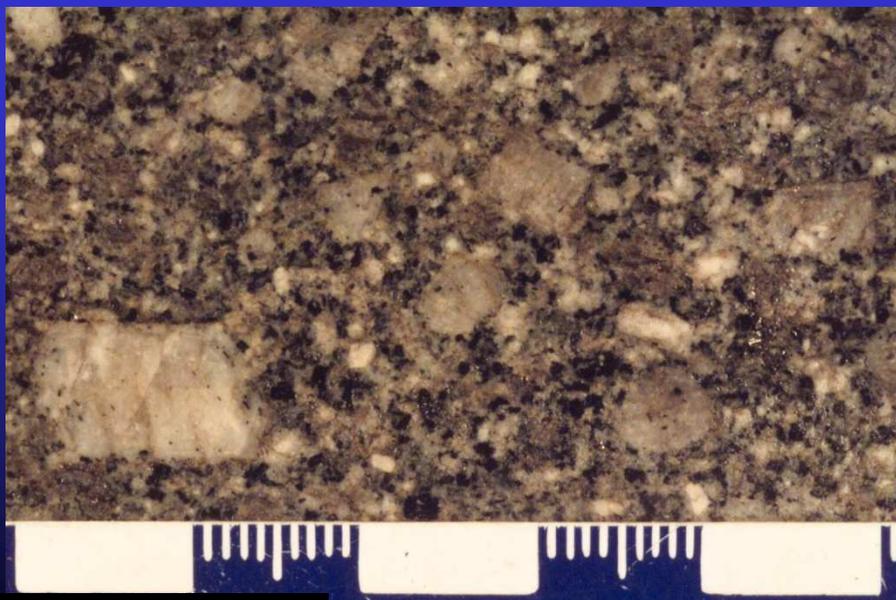
*Mafic (lamprophyre)*

*Intermediate*



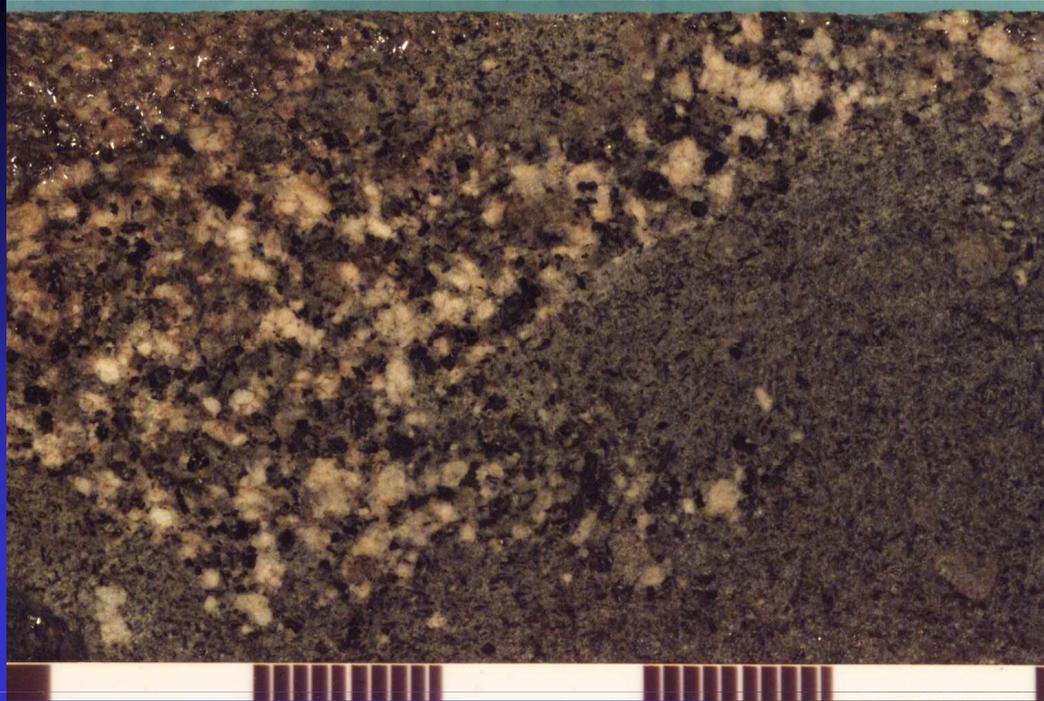
*TPS hand specimens*

*Scheelite Dome*



*Intermediate*

*Felsic*



**Syeno-diorite –  
Quartz-monzonite  
contact**

**Spessartite Dyke –  
Quartz-monzonite contact**

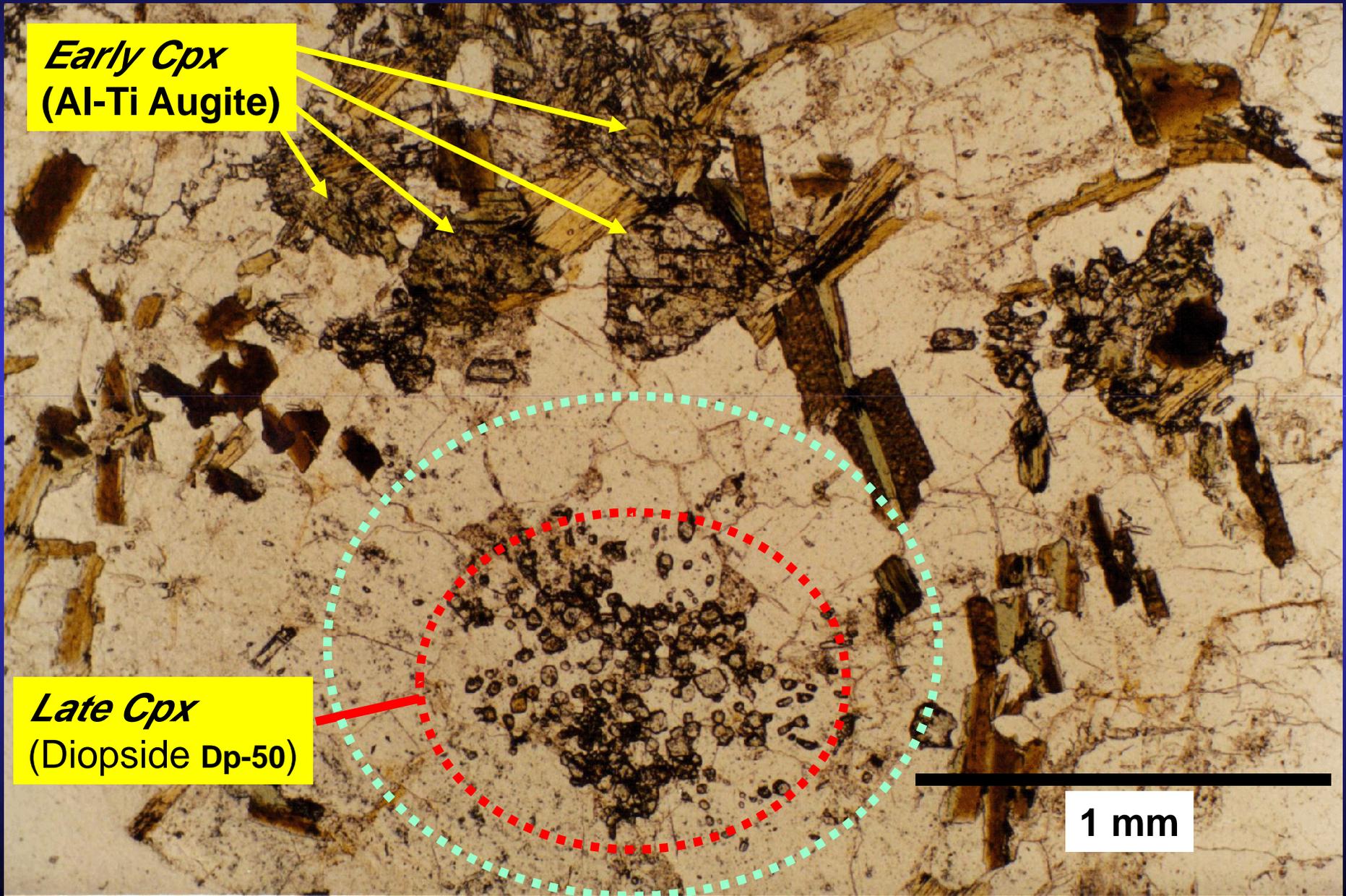


*Photomicrograph: Intermediate dyke*

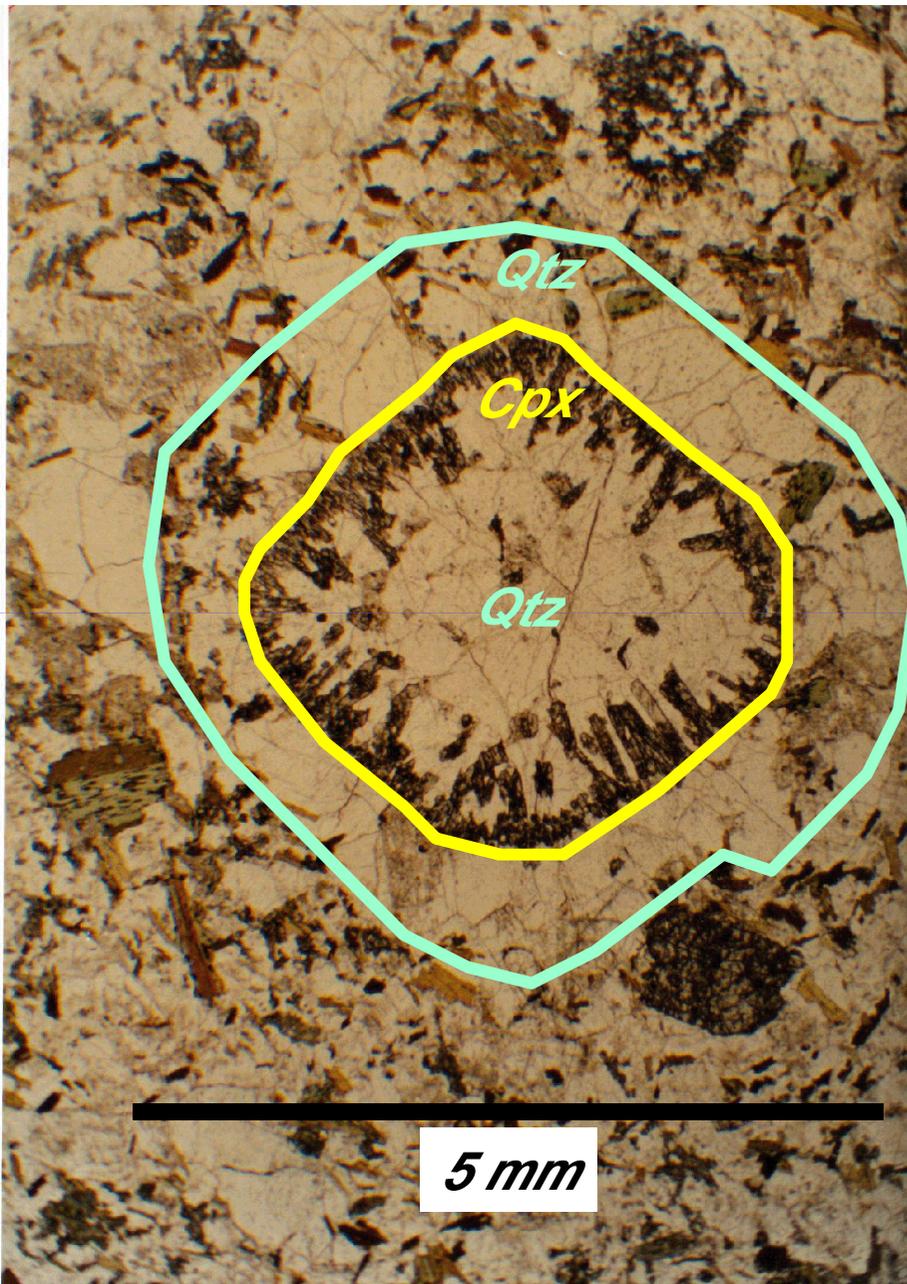
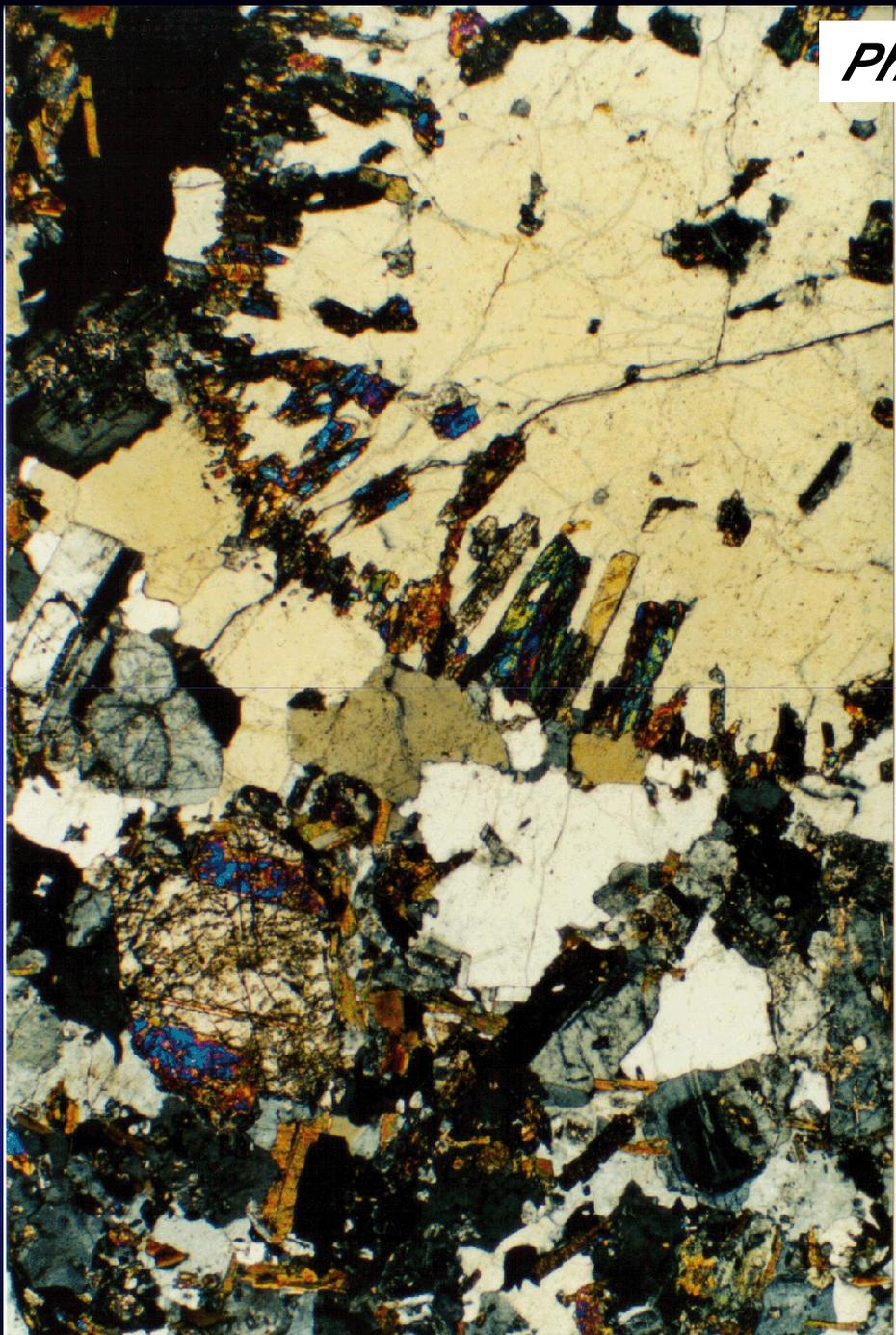
*Early Cpx*  
(Al-Ti Augite)

*Late Cpx*  
(Diopside Dp-50)

1 mm

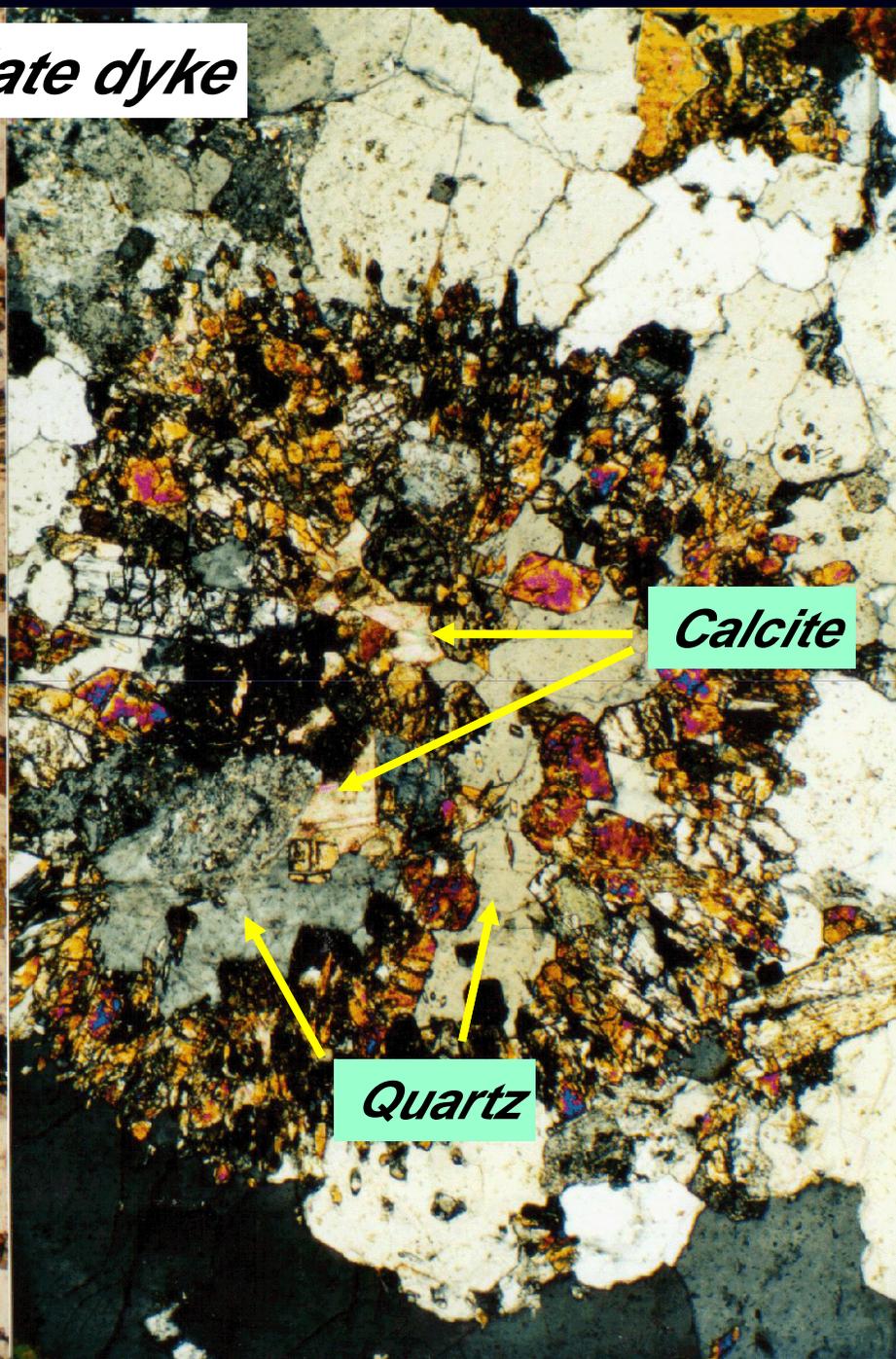
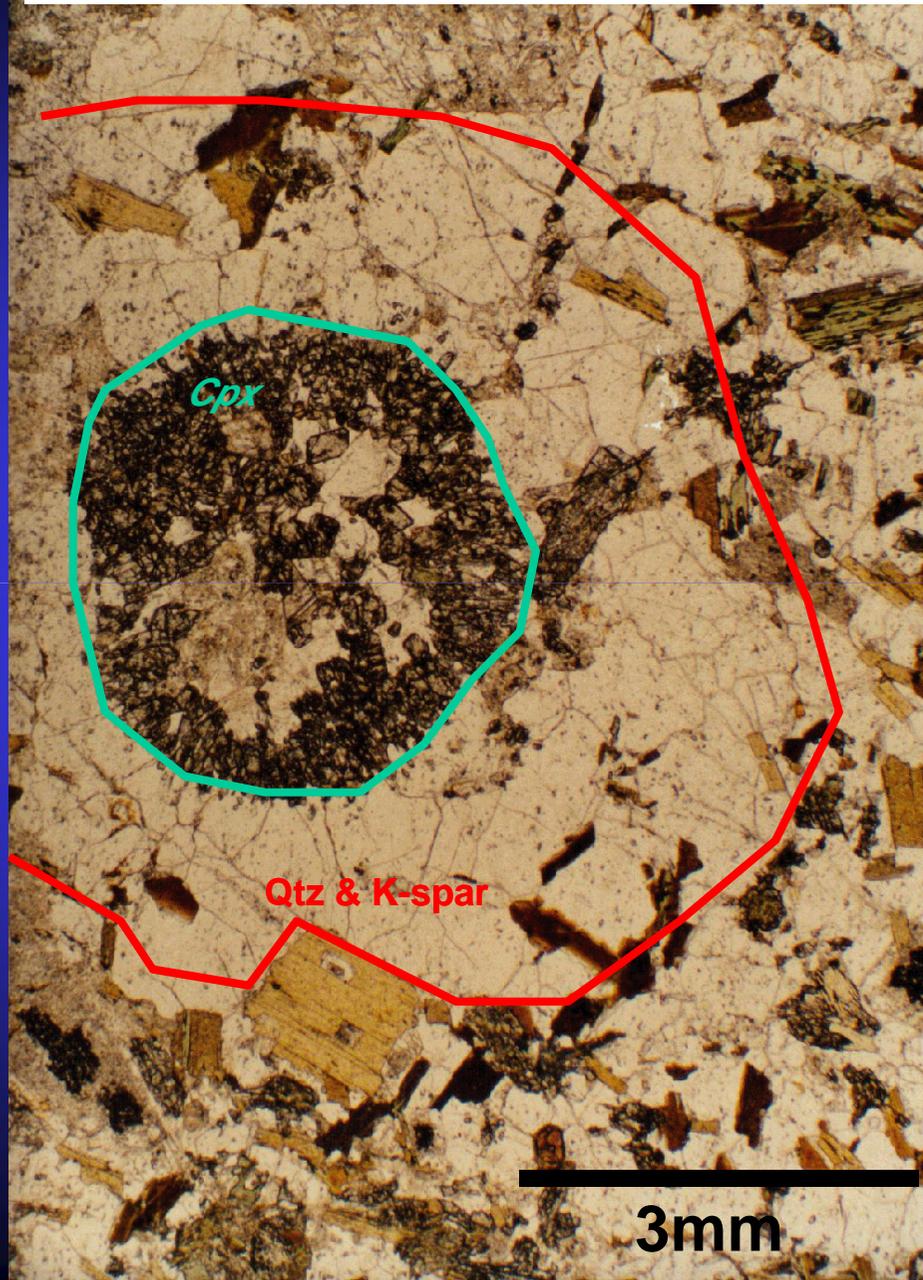


*Photomicrograph: Intermediate dyke*

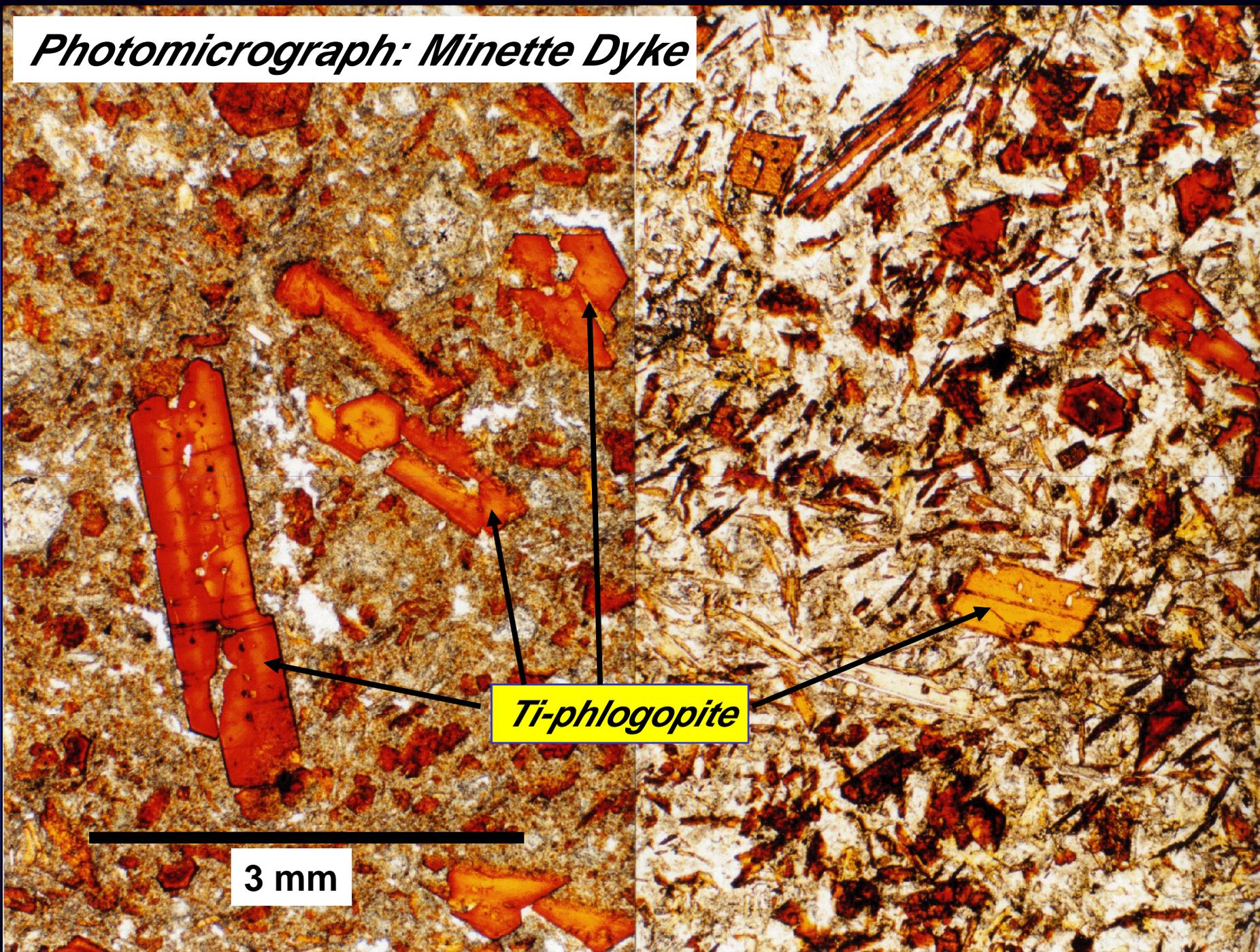


*5 mm*

*Photomicrograph: Intermediate dyke*



*Photomicrograph: Minette Dyke*



3 mm

*Ti-phlogopite*

*Photomicrograph: Spessartite lamprophyre*

*Relict Cr-diopside*

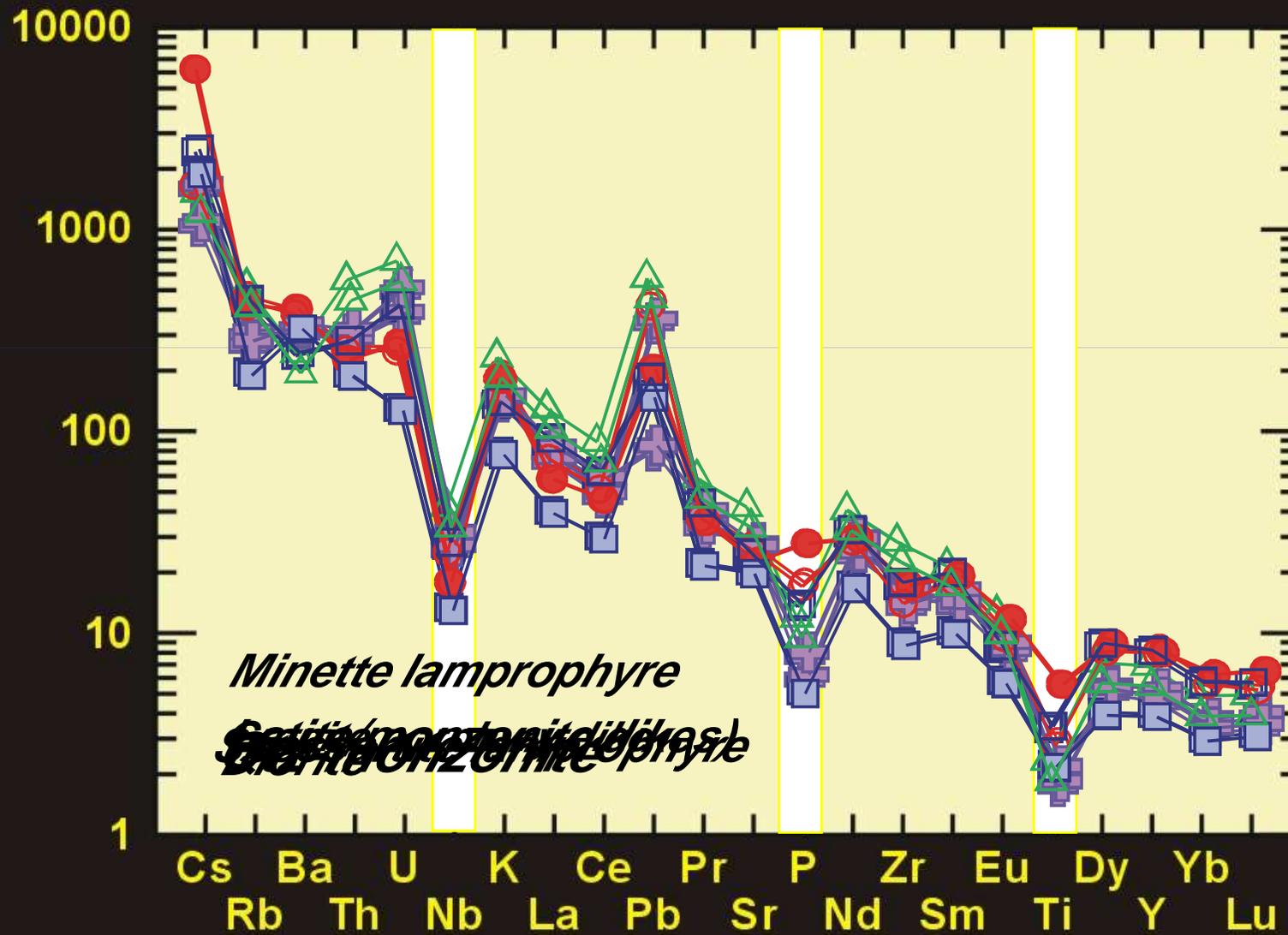
1.5 mm

- amphibole rich*
- xenocrystic Cpx + Cr-spinel*
- accessory magnetite, barite, allanite, titanite*

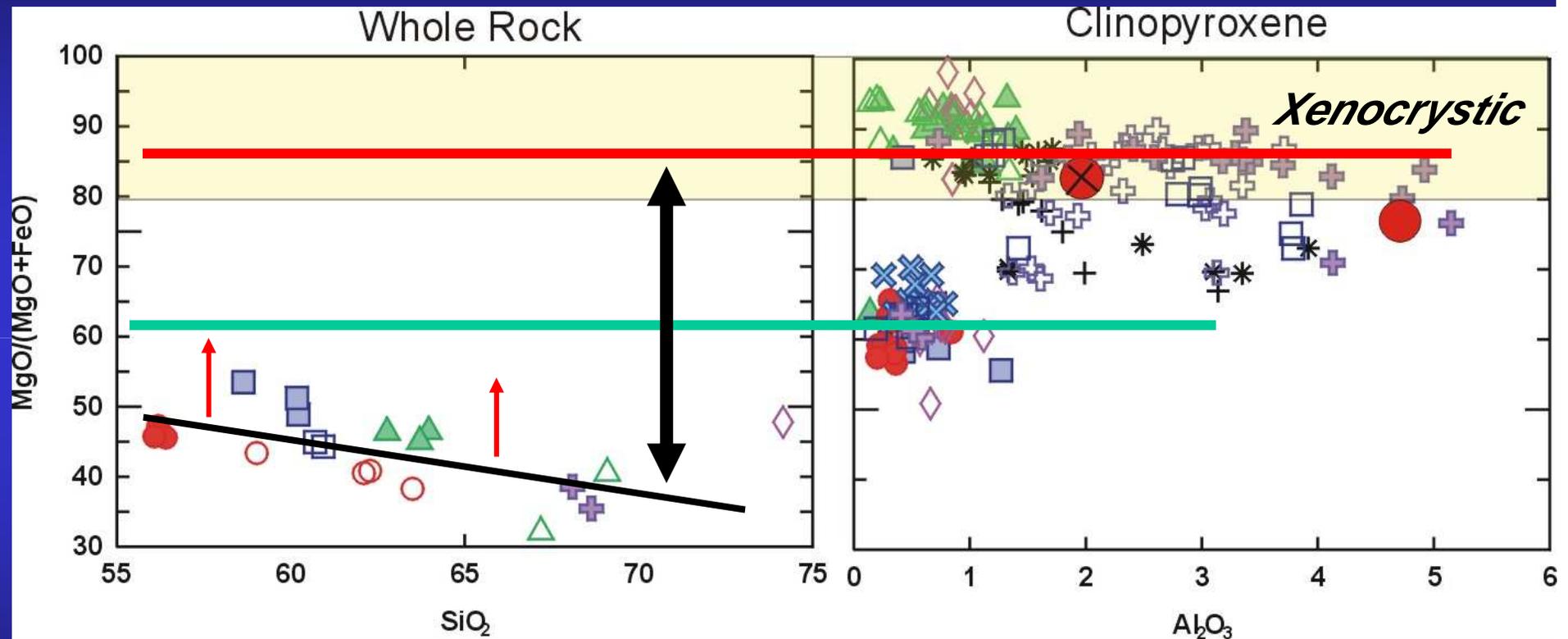
# Trace Elements

Primitive Mantle Normalised

Sun and McDonough - 89



## *Whole rock Mg no. vs Cpx Mg no.*



*Clinopyroxenes are compositionally equivalent with those described in mantle xenolith studies: that is they equilibrated with mantle rocks in a high P-T setting*

## *So ???*

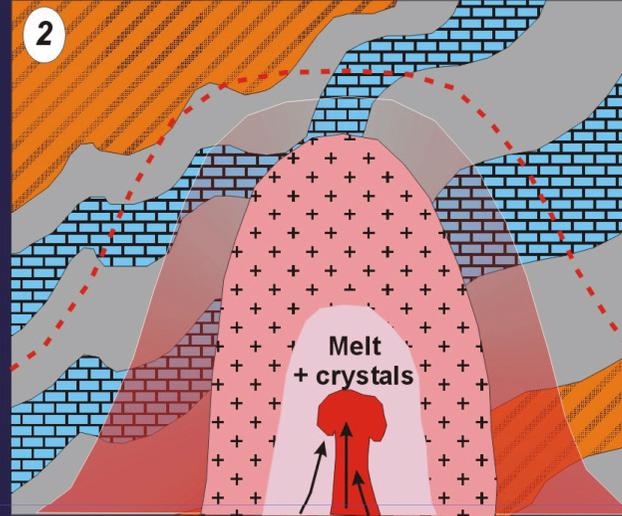
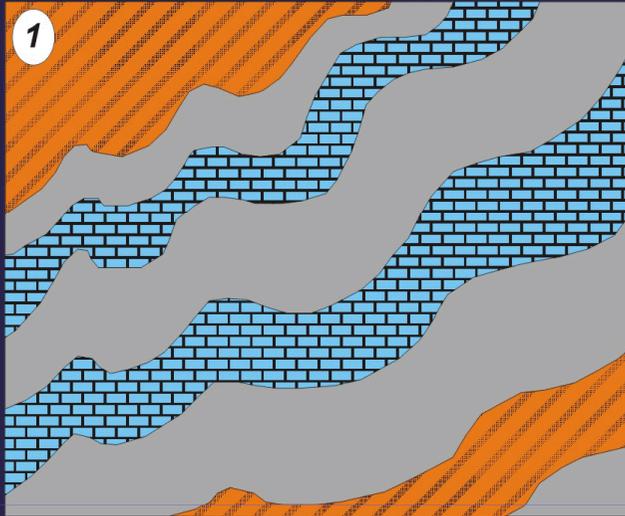
- Weird minerals
- Strange textures
- What does it all mean??

*Complex magma system with evidence for mantle and crustal input*

*Mafic component is alkalic, volatile-rich sourced from enriched mantle source (lamprophyric)*

*Evidence for mixing, quenching, and volatile exsolution (deuteric calcite alteration, and calcite in miarolitic cavities infers CO<sub>2</sub> is a fundamental volatile component of TPS magmas)*

*Deformed & weakly metamorphosed  
basinal sedimentary rocks*



**1.** Deformed basinal strata at ambient geotherm of 250°C

**2.** Felsic magma intrudes strata and raises geotherm, hornfelsing surrounding rocks

**3.** Continued influx of more primitive magma leads to mixing, quenching and intermediate dike series. Subordinate aplite and granitic dikes fractionated off main felsic body

**4.** Geotherm retracting, Continued influx of primitive magma (lamprophyre dikes)

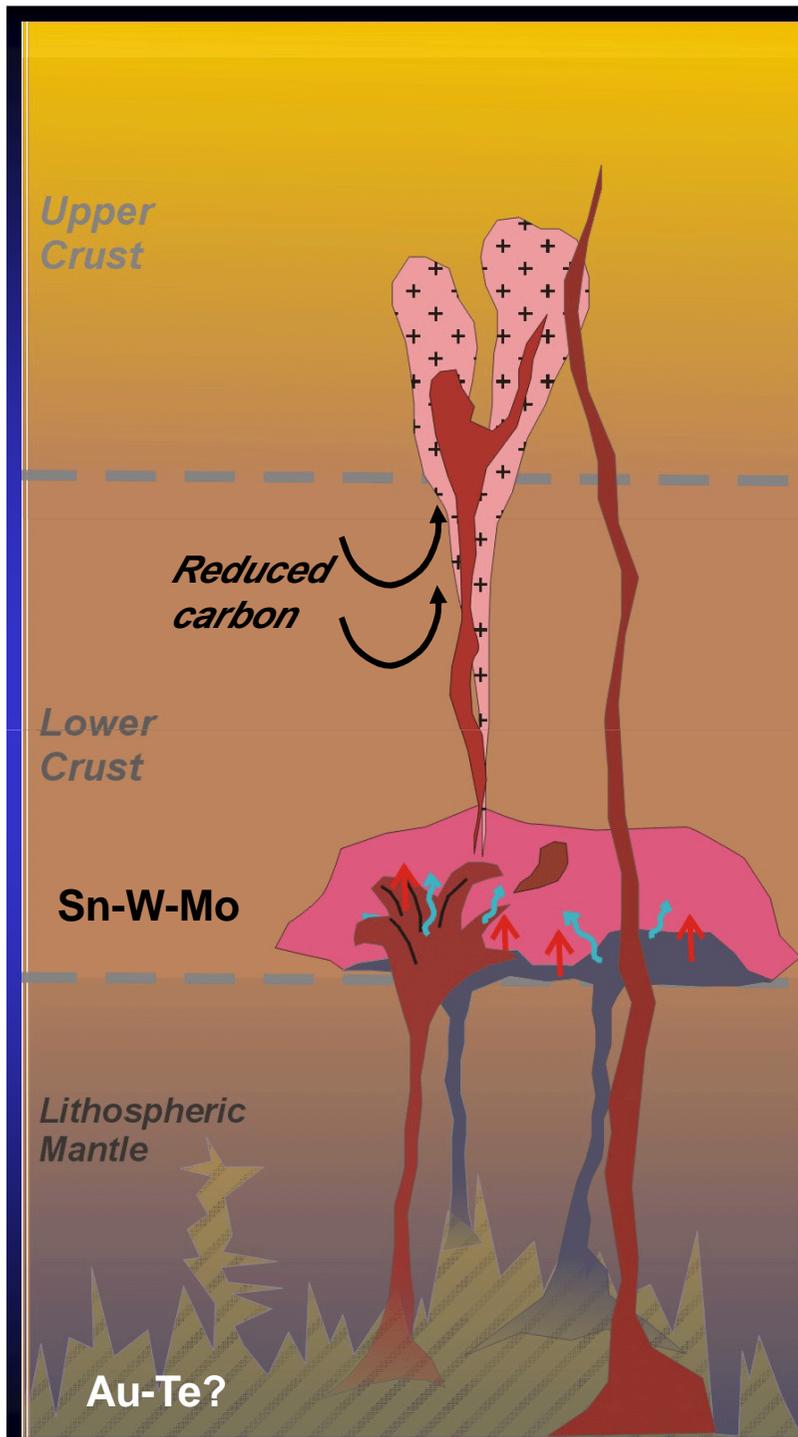
## *Schematic Lithospheric Section*

- Post-collision and subduction processes

Volatile-rich mafic, alkalic melts from metasomatised upper mantle contribute heat and volatiles to the lower crust, to promote melting.

Felsic crustal melts of lower density than mafic melt

Influx of mafic magma continues, with progressively less crustal contamination



# *Summary of Reduced Intrusion-Related Gold Systems*

- *Setting:* continental margin – inboard of magmatic arc
- *Timing:* post collisional, transitional regime, commonly follows a cessation of subduction
- *Magmatism:* subalkalic – alkalic, substantial crustal component with mafic input
- *Hydrothermal activity:* focused around cooling magmatic centres (convective flow)
- *Diversity* of mineralisation styles within individual systems
- *Aqueous-carbonic*, low salinity fluids (*high level systems have less CO<sub>2</sub>, higher salinity*), variable oxidation state within systems