



LEIBNIZ-SOZIETÄT DER WISSENSCHAFTEN ZU BERLIN e.V.  
*begründet 1700 als Brandenburgische Sozietät der Wissenschaften*

Vortrag zum EHRENKOLLOQUIUM am 11. April 2014 aus  
Anlass des 80. Geburtstages von Prof. Dr. Heinz Kautzleben

# “Ore deposit models as exploration tool: Thinking outside the box”

*by Reimar Seltmann, MLS*

*CERCAMS, Natural History Museum London*

If I start in the right place, everything I do works,  
If I start in the wrong place, nothing I do works,  
But I do the same things.

# Lagerstättenmodell / Ore Deposit Model

Modell zur Exploration von Lagerstätten basierend auf beschreibenden genetischen Faktoren und Indikatoren (geologische Charakteristika und Suchkriterien) welche spezifisch für einzelne Lagerstättentypen sind, zum Beispiel:

**Seltenmetall-Pegmatite**

**Greisen**

**Porphyry**

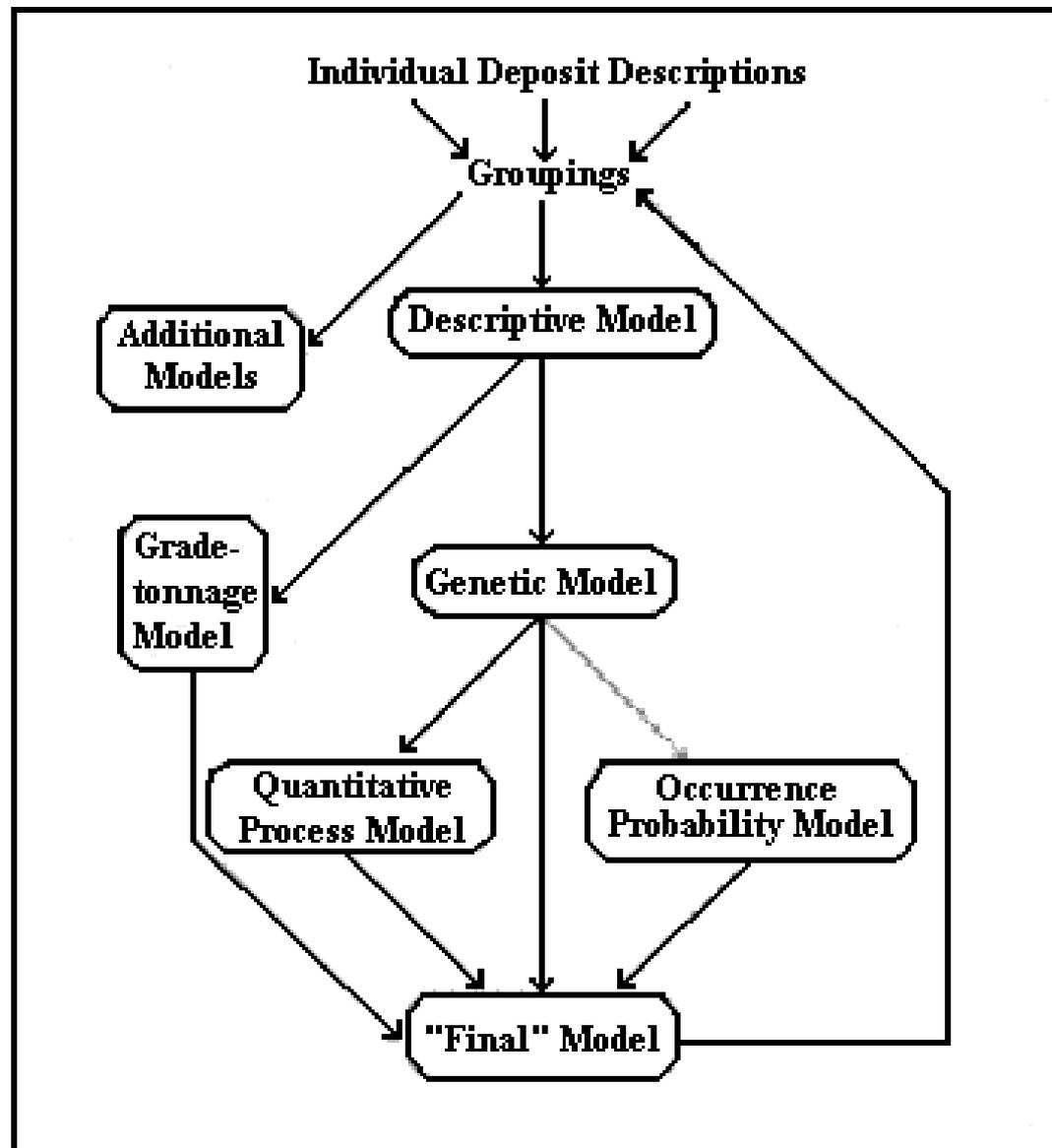
Skarn

Epithermal vein (hydrothermale Gang-LS)

VMS (Lahn-Dill-Typ)

Sed Cu (Kupferschiefer-Typ)

etc.

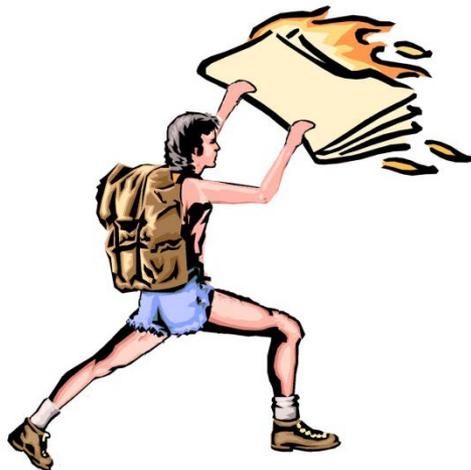


Flow sheet showing evolution of model types

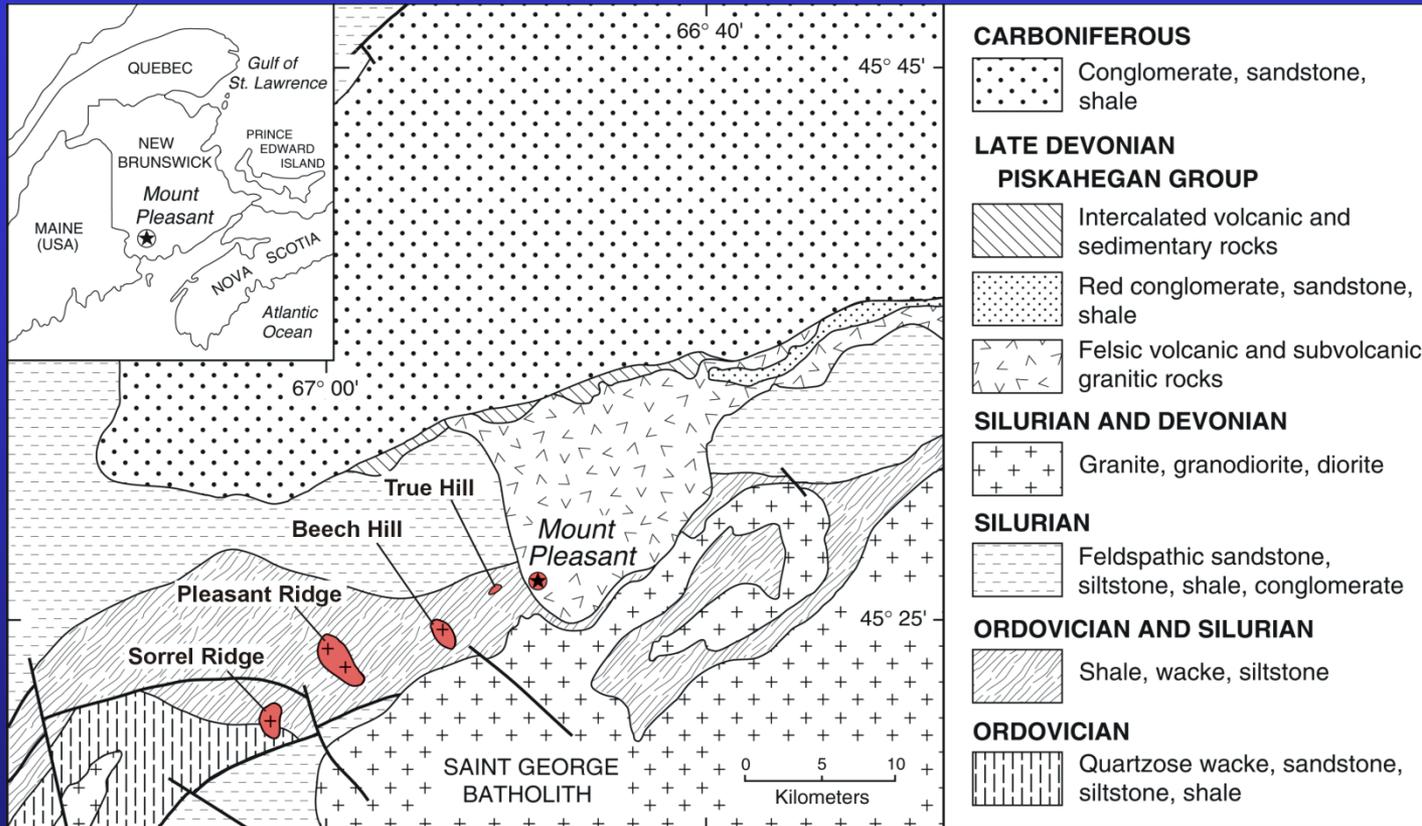
# OVERPRESSURED VOLATILES AND FLUIDS IN INTRUSION - HOSTED MINERAL DEPOSITS

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- Research Models
- Fluid – Volatiles Related Cupola Textures  
( UST's, mariolitic cavities, orbicles )
- Mineralised Examples
- Potential Economic Models



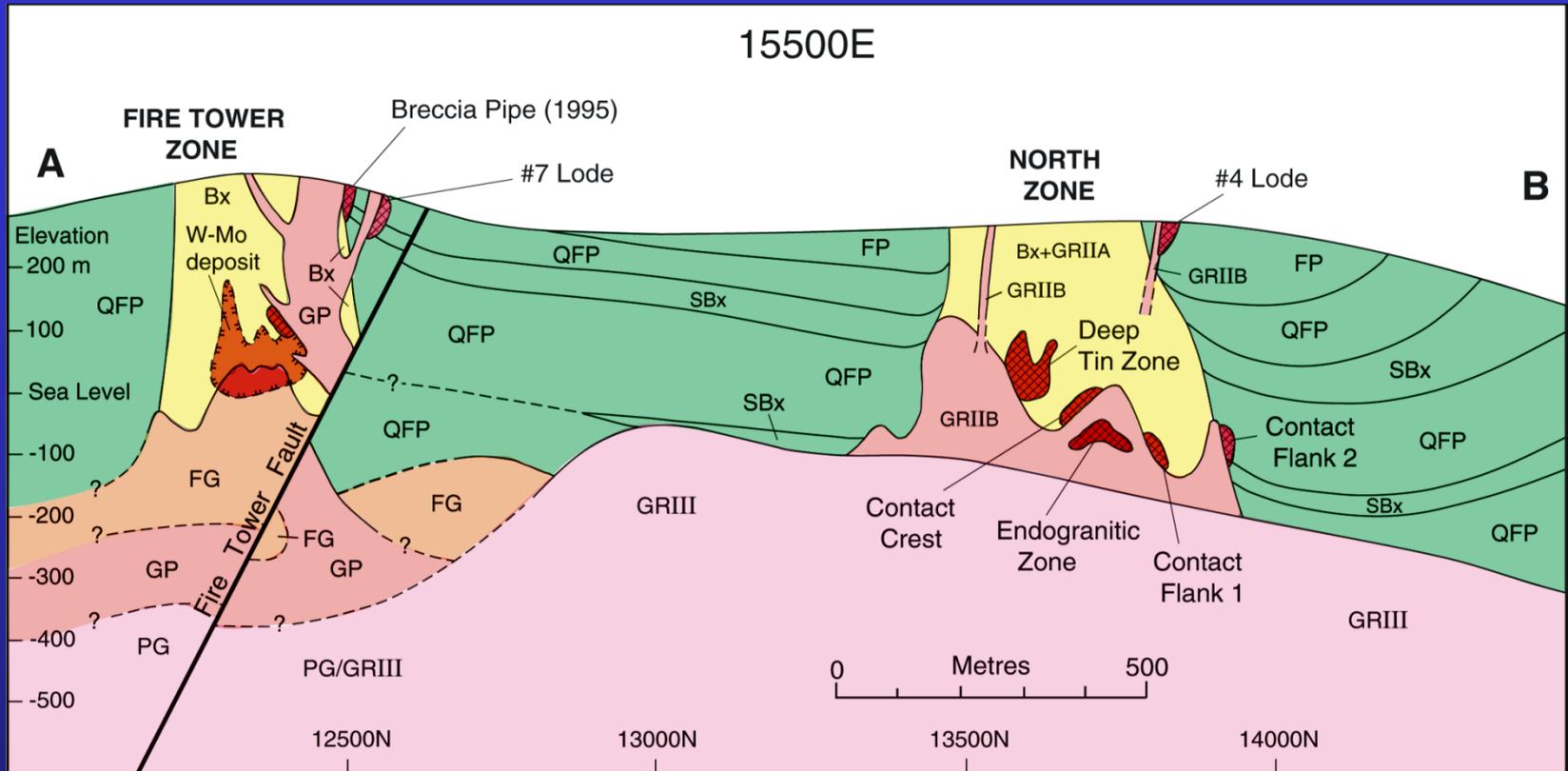
# Mount Pleasant deposits - tin



- Deposits located near the southwest margin of the Mount Pleasant caldera
- Associated with subvolcanic intrusions that are part of the Pomeroy Intrusive Suite (360 Ma)

*Presented results obtained from a joint collaborative study with WD Sinclair, GSC*

# Mount Pleasant deposits - tin



- Tin-base metal deposits are associated with subvolcanic granites emplaced in eruptive centres characterized by intensely-altered breccias
- Deposits associated with second phase GR II of three intrusive phases
- Reserves (North Zone): 4.8 Mt grading 0.82% Sn (after Sinclair 2005)

# Mount Pleasant deposits - tin

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- **Subvolcanic vein-replacement deposits, comparable to Bolivian and Japanese tin deposits**
- **Associated metals include Cu, Pb, Zn, In, W and Bi**
- **Typically sulphide-rich; arsenopyrite abundant at Mount Pleasant**
- **Tin occurs primarily as cassiterite; minor stannite and other Sn sulphosalts**
- **Mineralization styles range from breccias to stockworks to replacement**

# Mount Pleasant deposits - tin



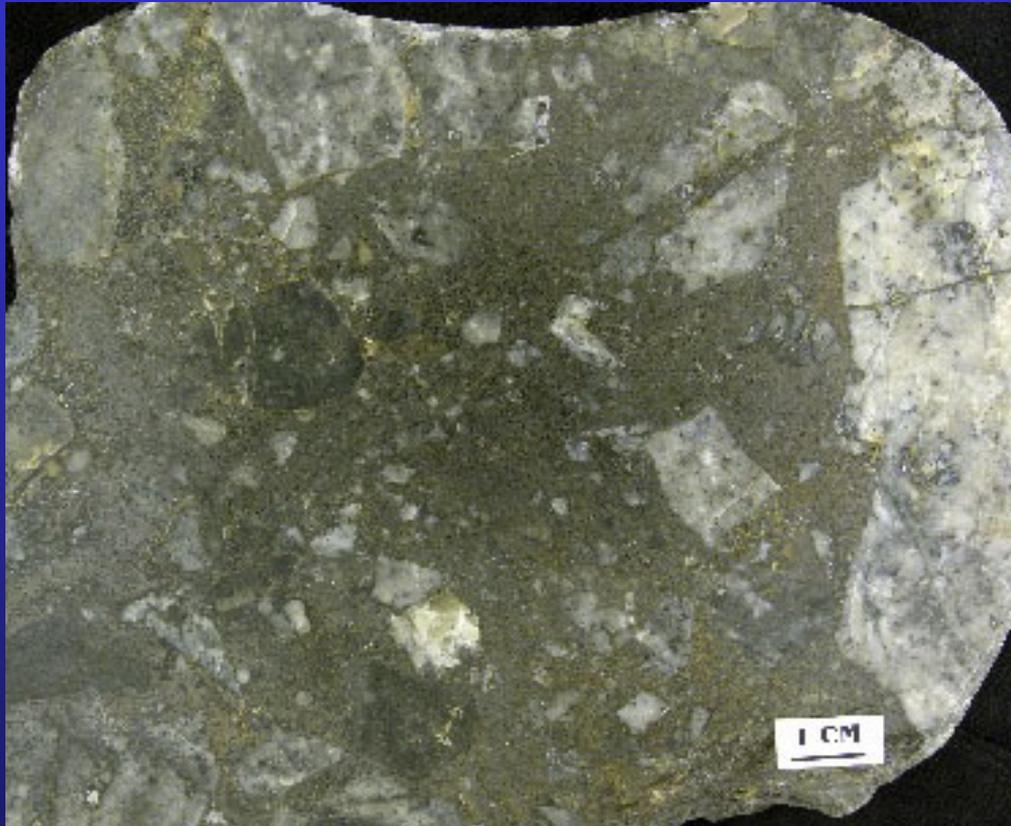
- Vein-stockwork in altered granite GR II
- Cassiterite occurs in fractures, along with fluorite and arsenopyrite
- Quartz-topaz alteration adjacent to veins

# Mount Pleasant deposits - tin



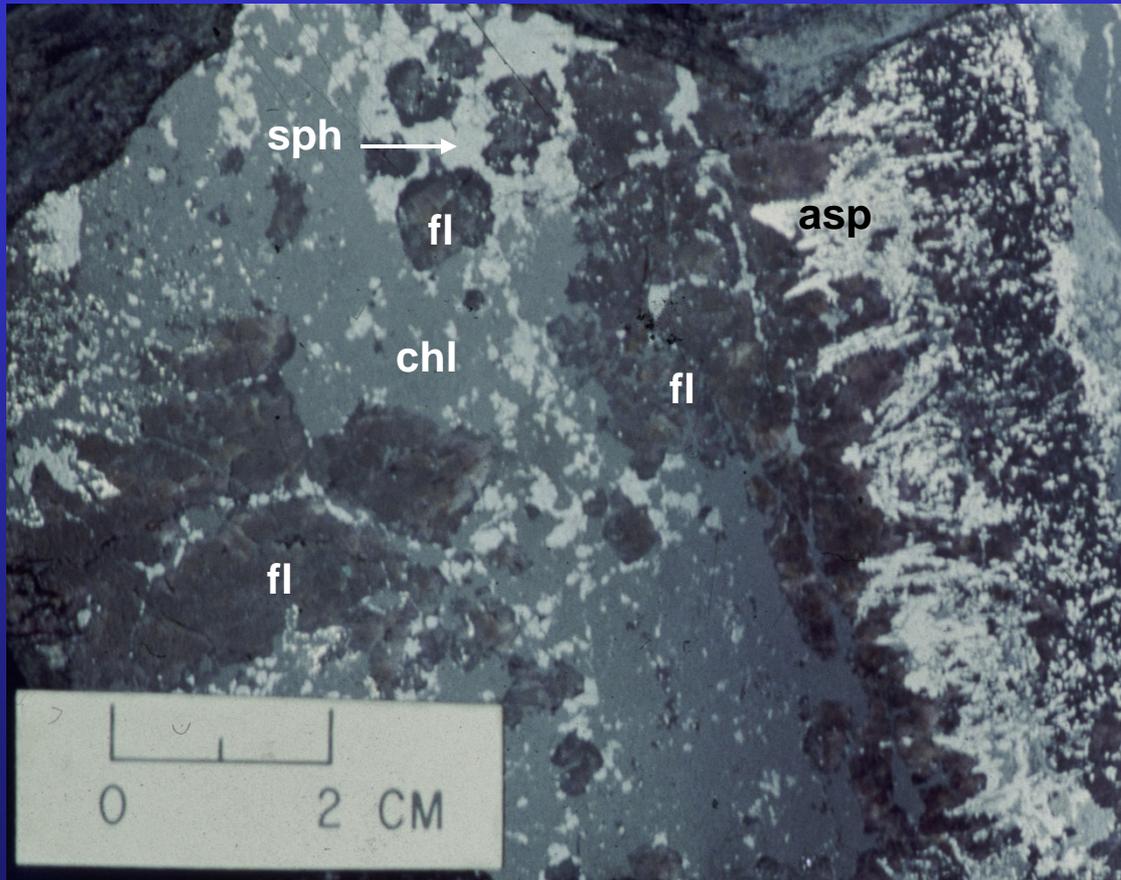
- Angular, clast-supported breccia
- Cassiterite disseminated in breccia matrix

# Mount Pleasant deposits - tin



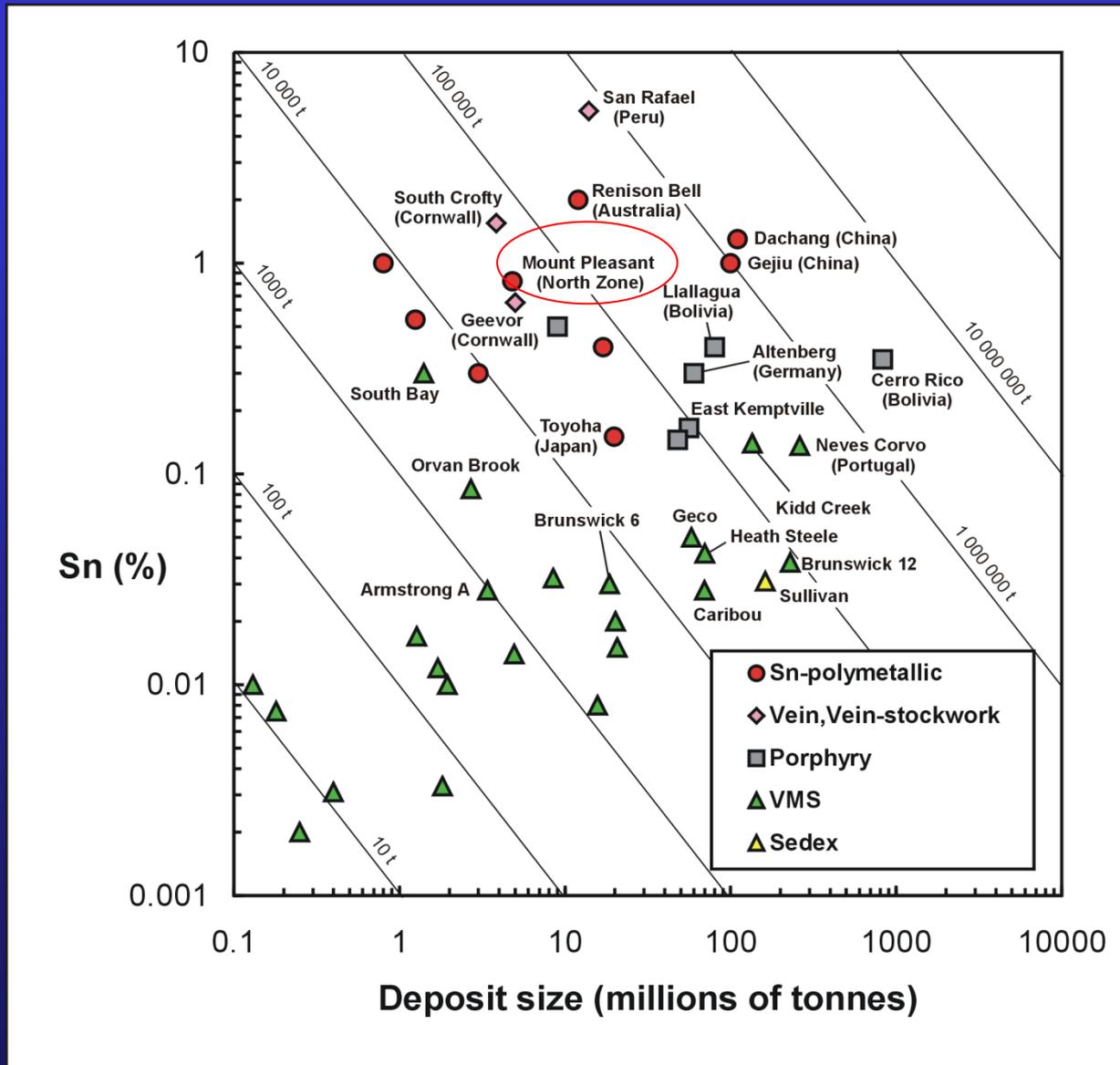
- Angular, matrix-supported breccia
- Sulphide-rich matrix consists of sphalerite and chalcopyrite, with lesser amounts of cassiterite and other sulphides, sulphosalts

# Mount Pleasant deposits - tin

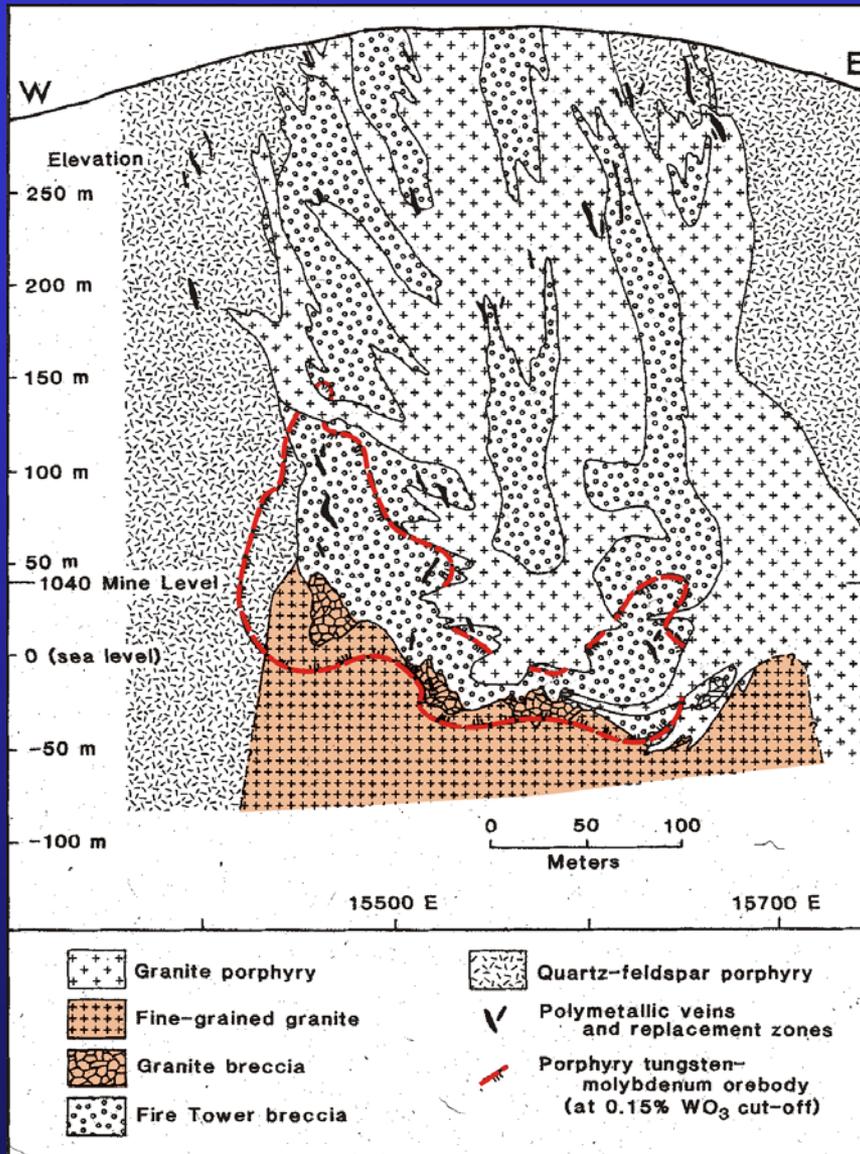


- Massive chlorite-sulphide replacement
- Cassiterite disseminated in massive chlorite; fluorite, arsenopyrite, sphalerite and other sulphides associated

# Tin deposits of the world



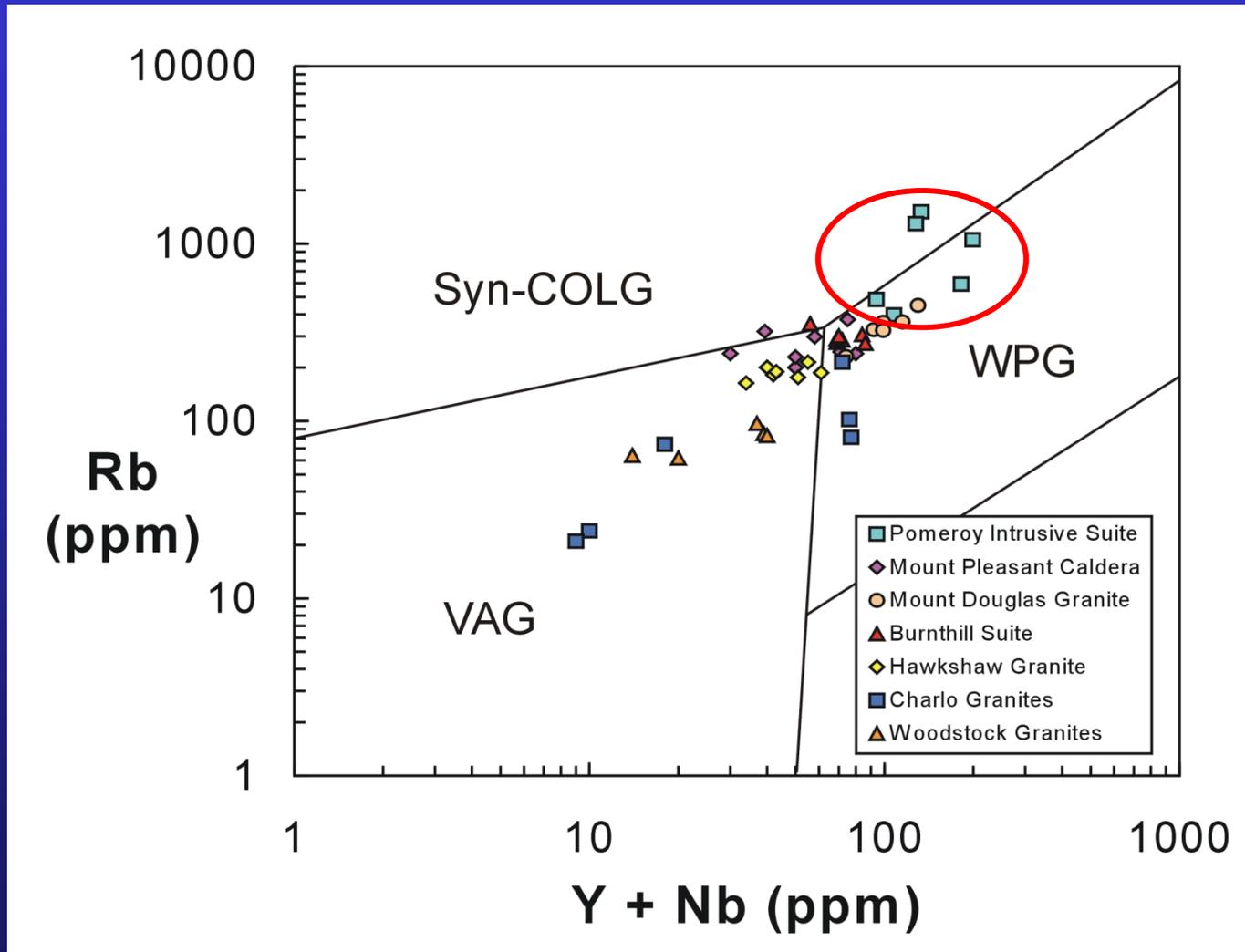
# Mount Pleasant - tungsten



From Kooiman et al. (1986)

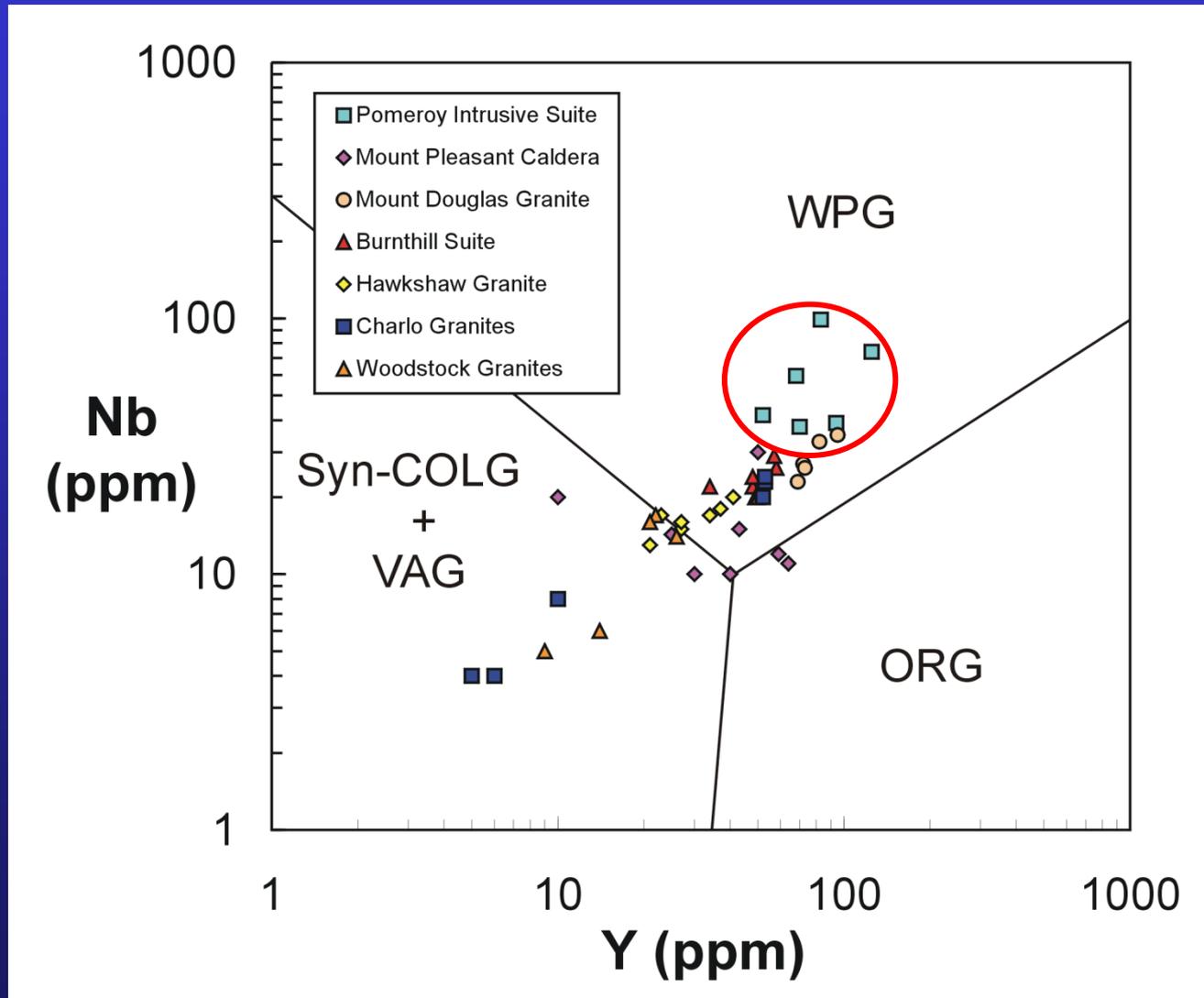
- Porphyry-type deposit at the top of a small intrusion of fine-grained granite (equivalent to granite I in the North Zone)
- Tungsten occurs primarily as wolframite in fractures and quartz veinlets; associated ore minerals include molybdenite, bismuth, bismuthinite
- From 1983 to 1985, produced about 1 Mt grading 0.11% W (Sinclair 2005)

# Rb versus Y + Nb



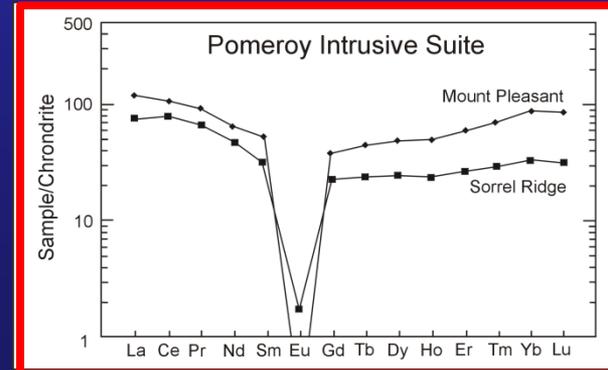
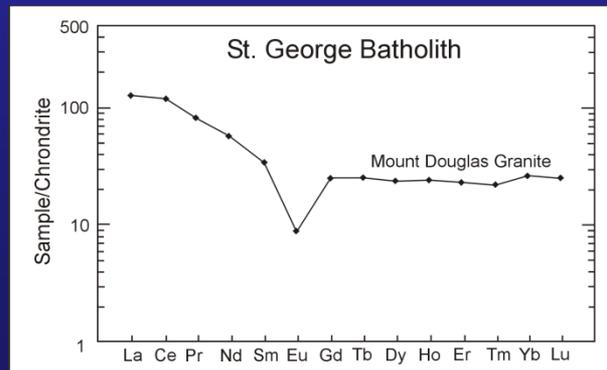
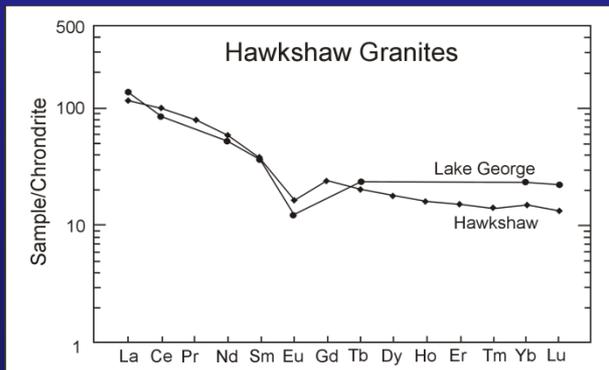
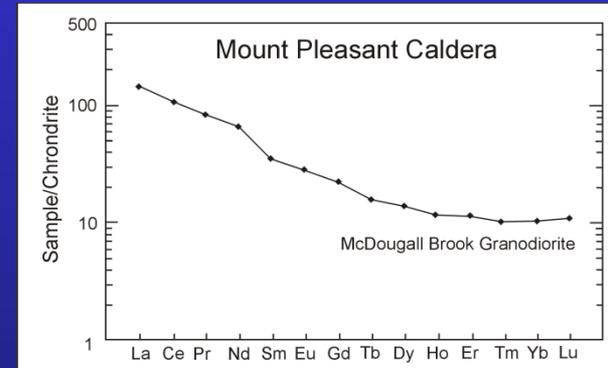
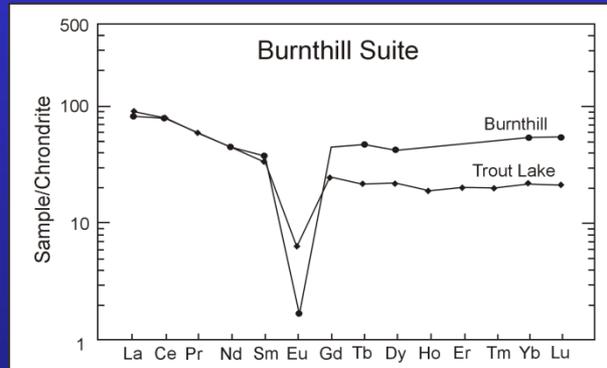
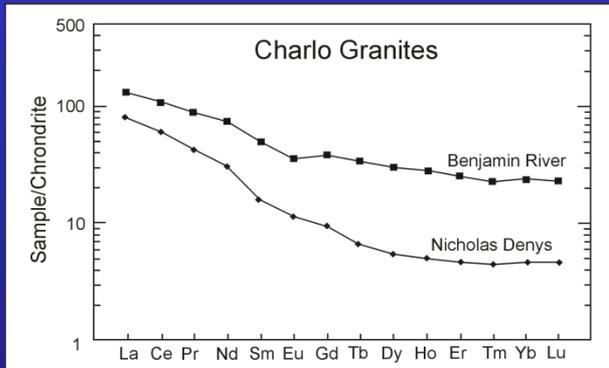
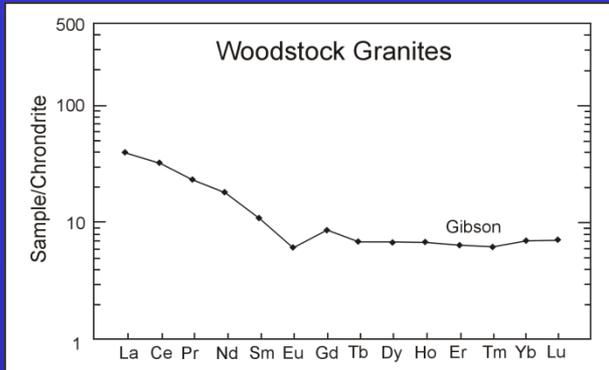
Data from Whalen (1993)

# Nb versus Y = postcoll A-type tendency

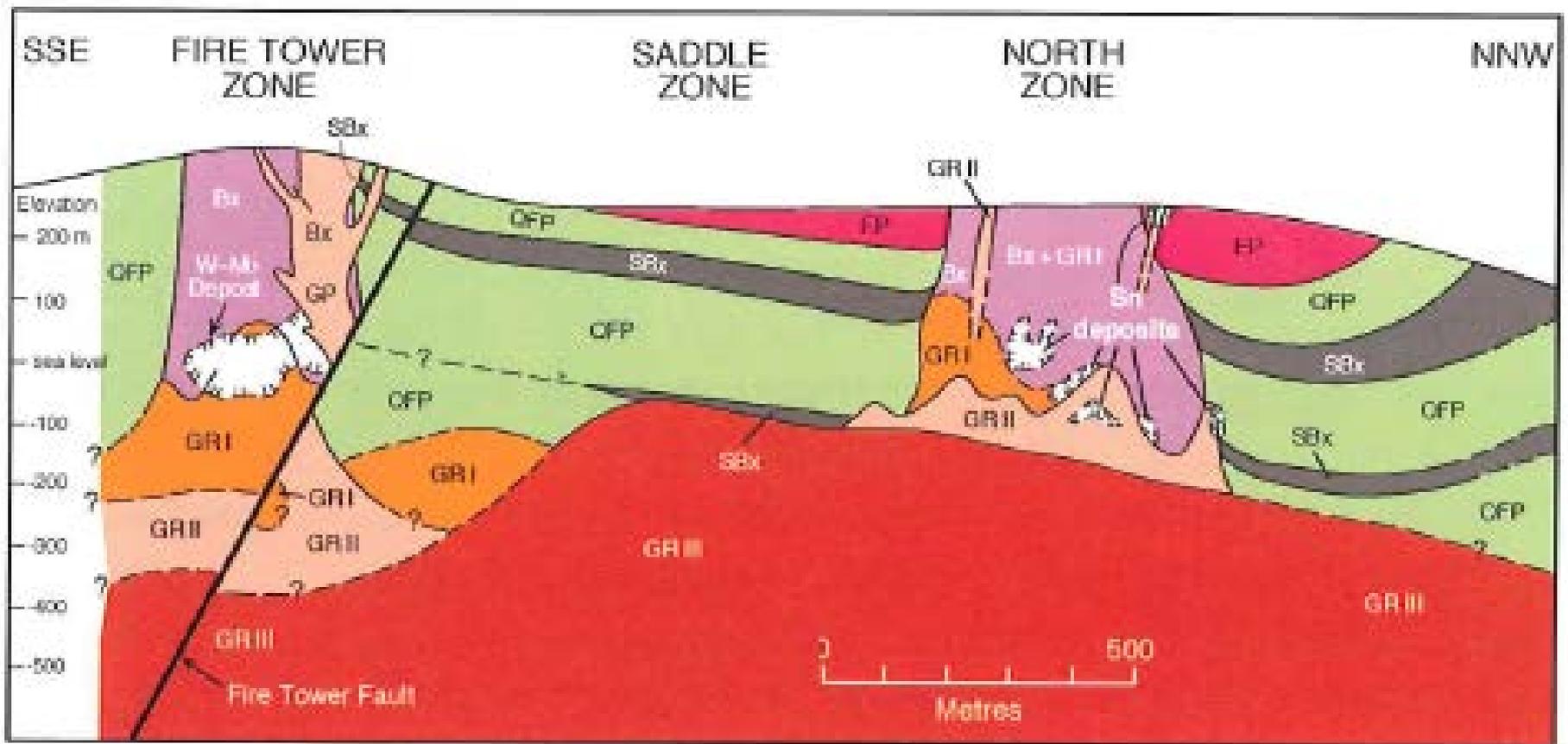


Data from Whalen (1993)

# Rare-earth element patterns = Mount Pleasant G1-G3 represent the most evolved granitic intrusions



Data from Whalen(1993) and others

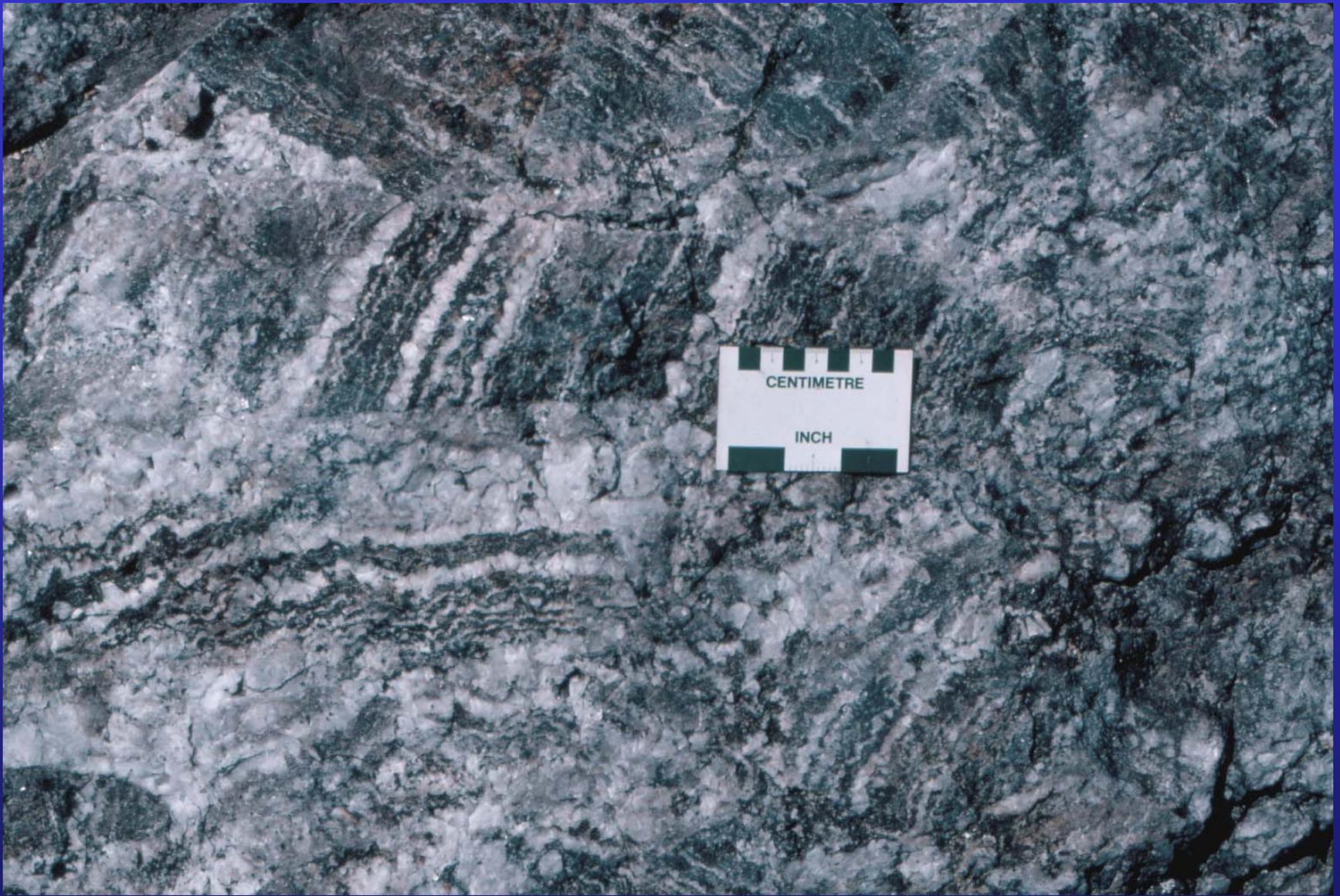


*Abb. 4.23: Schnitt durch die Lagerstätte Mount Pleasant (modifiziert nach W.D. Sinclair)*

*Profile of the Mount Pleasant ore deposit*



Example of unidirectional solidification texture (UST) forming brain rock at Mount Pleasant W-Mo deposit

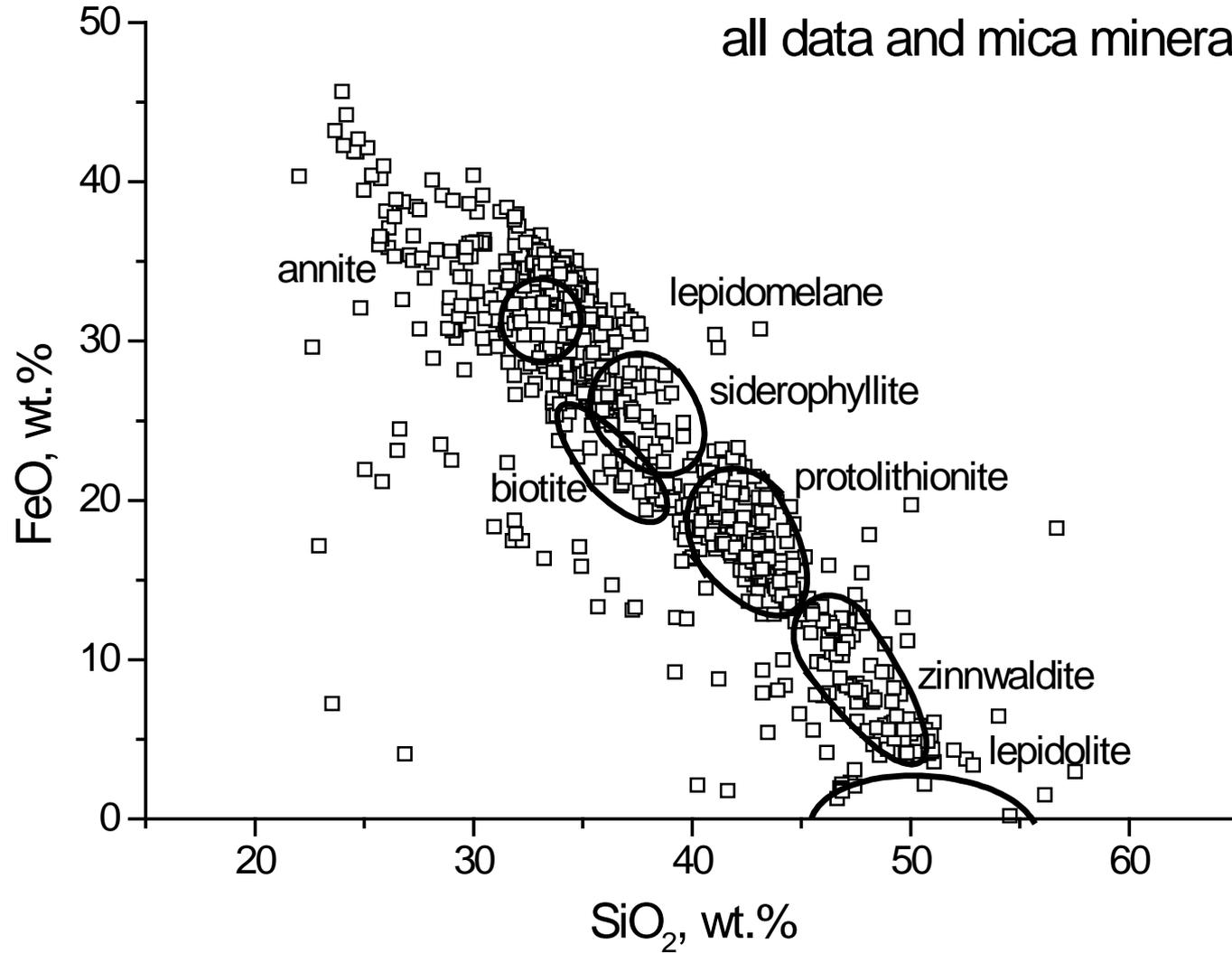


Brecciated UST brain rock (fragmentation of chilled carapace after overpressured fluids cause hydraulic fracturing & brittle failure), True Hill, near Mount Pleasant

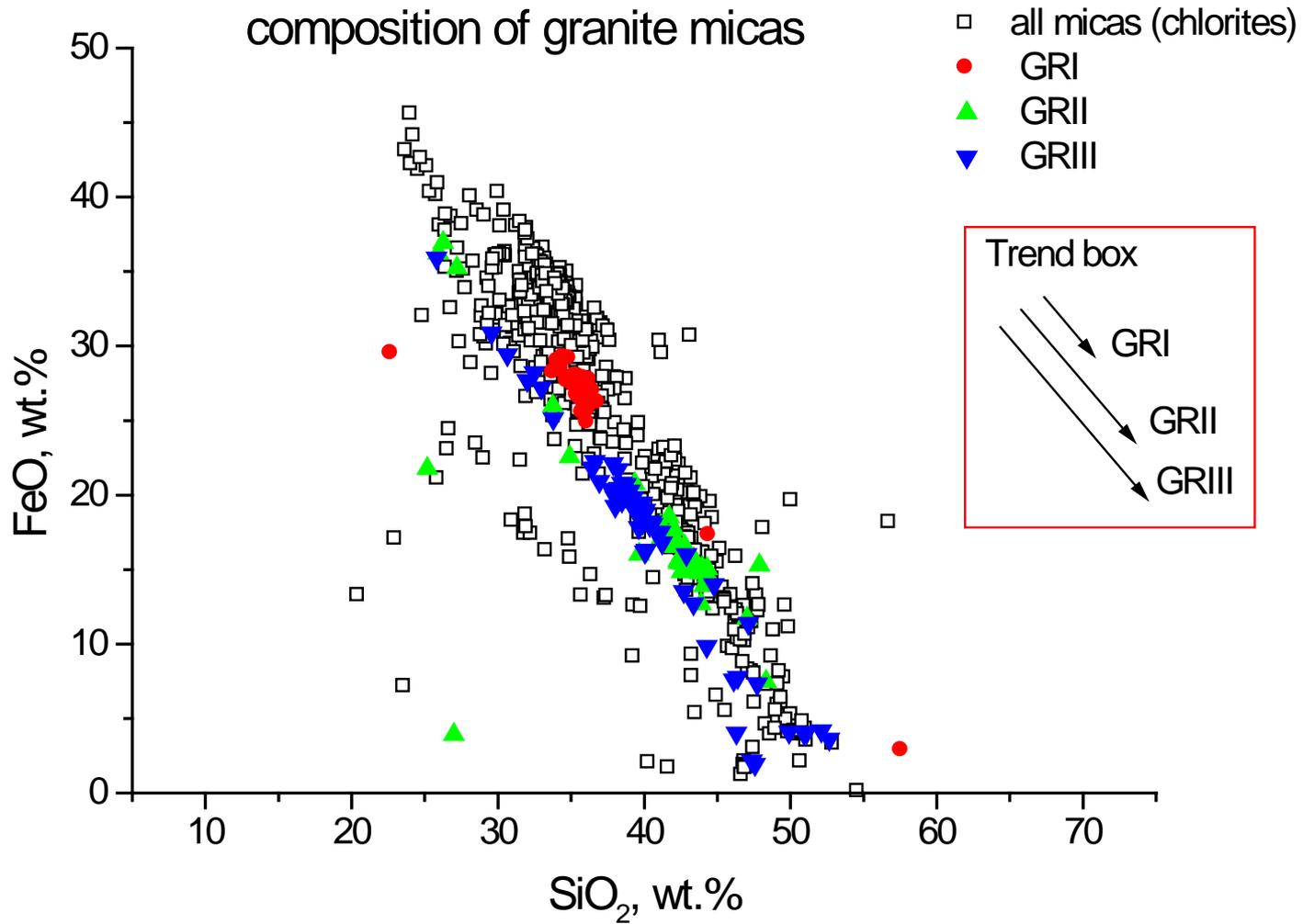


Quartz veined greisen stockwork in granite GR II

MOUNT PLEASANT  
all data and mica mineralogy

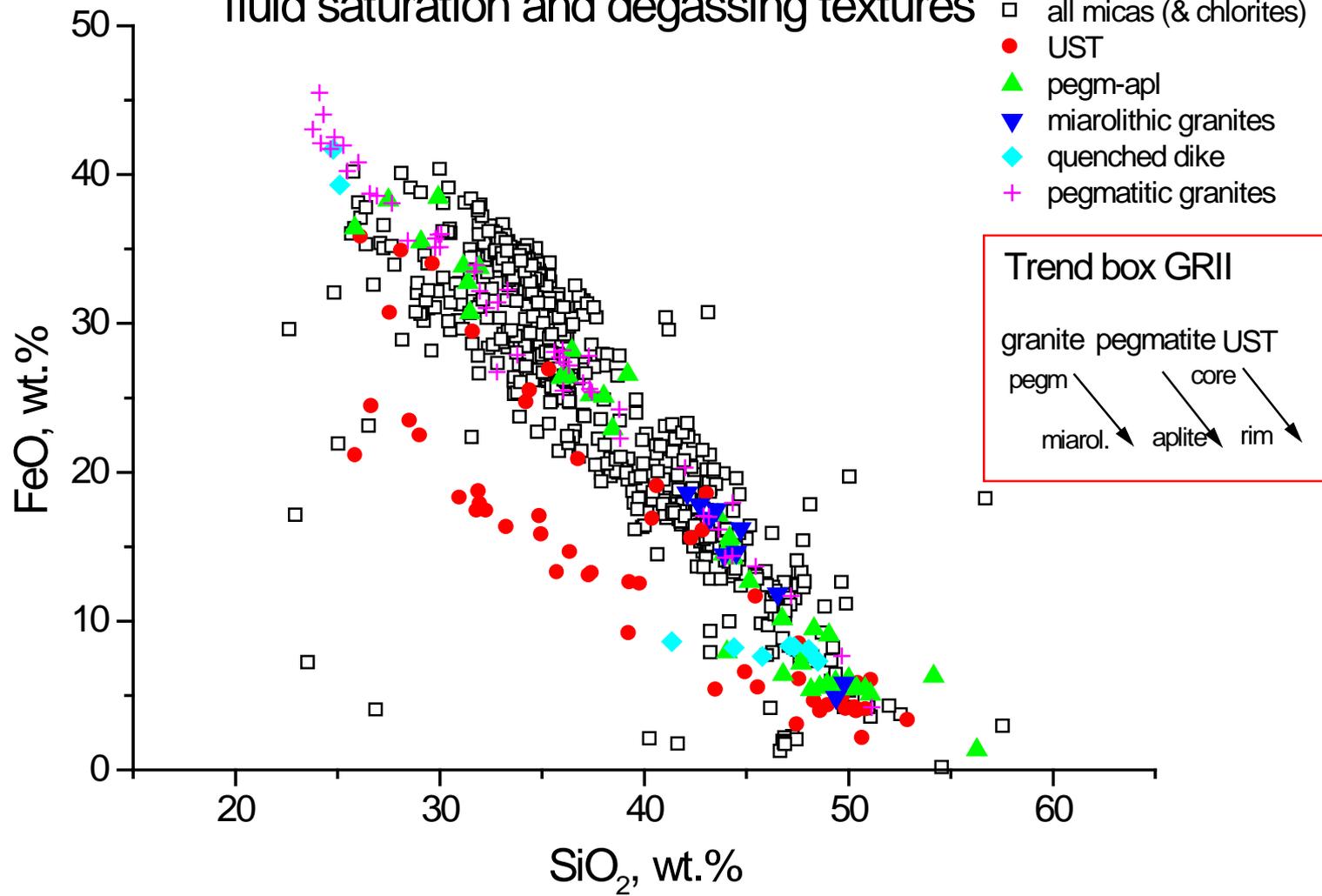


# MOUNT PLEASANT composition of granite micas



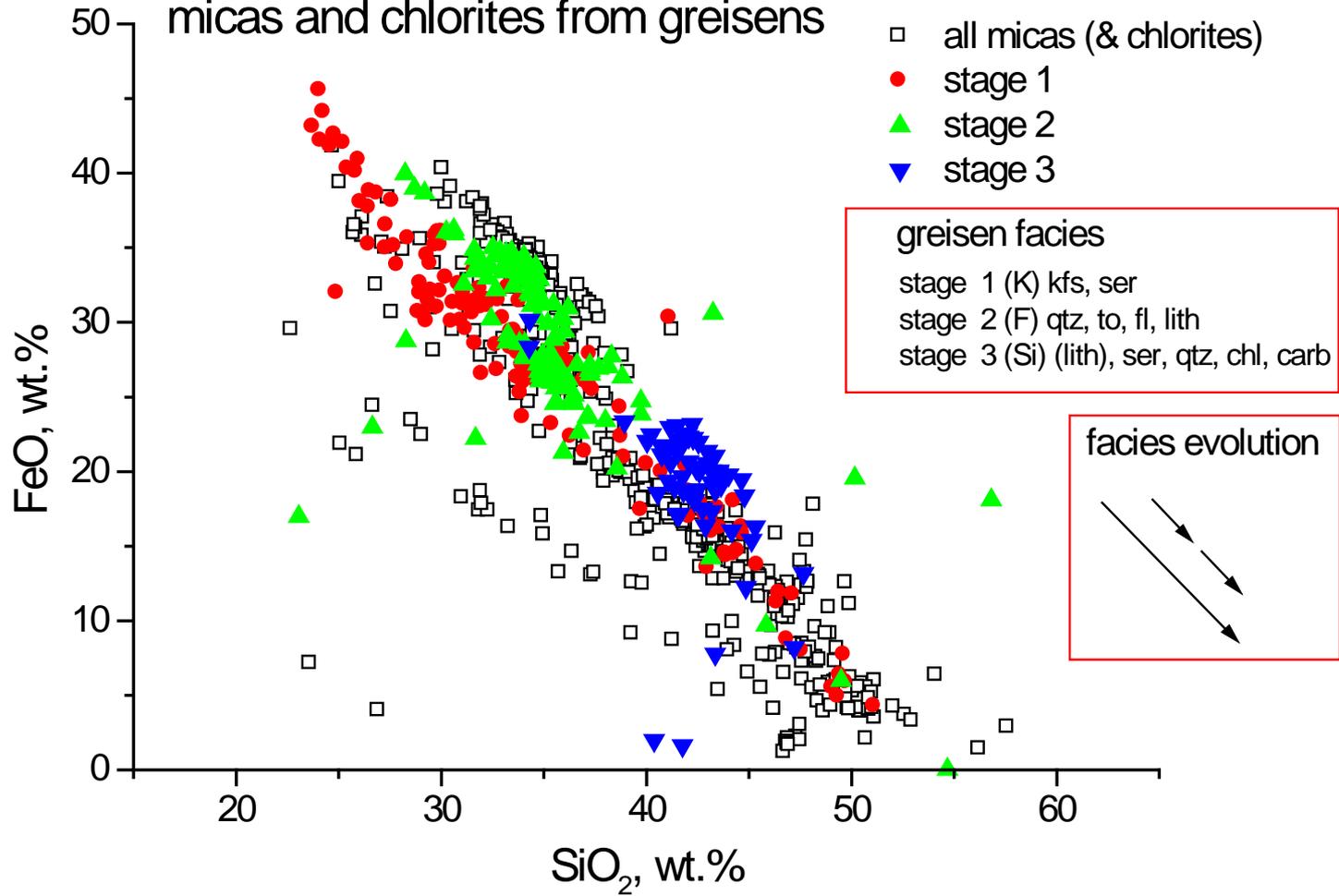
# MOUNT PLEASANT

## fluid saturation and degassing textures

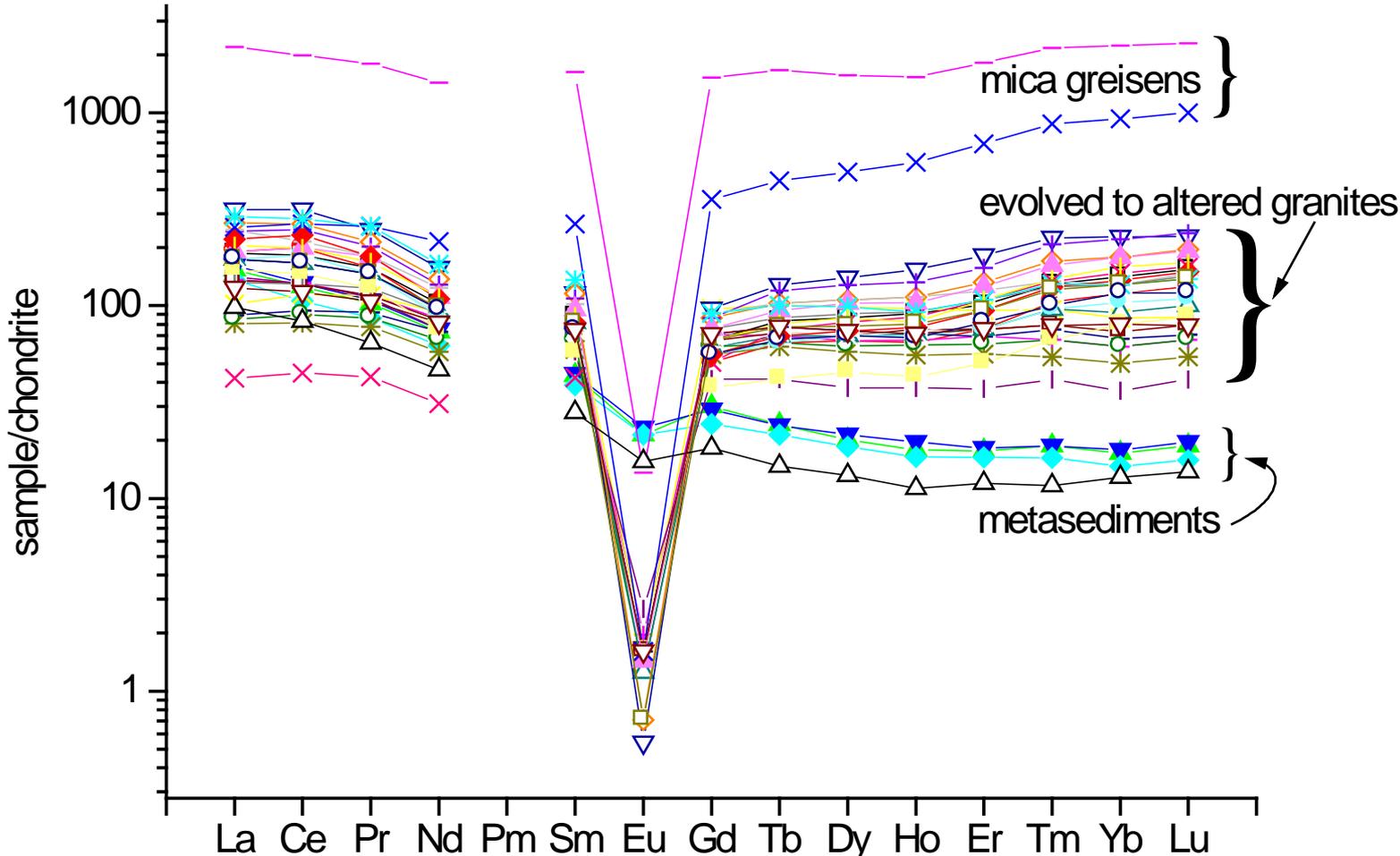


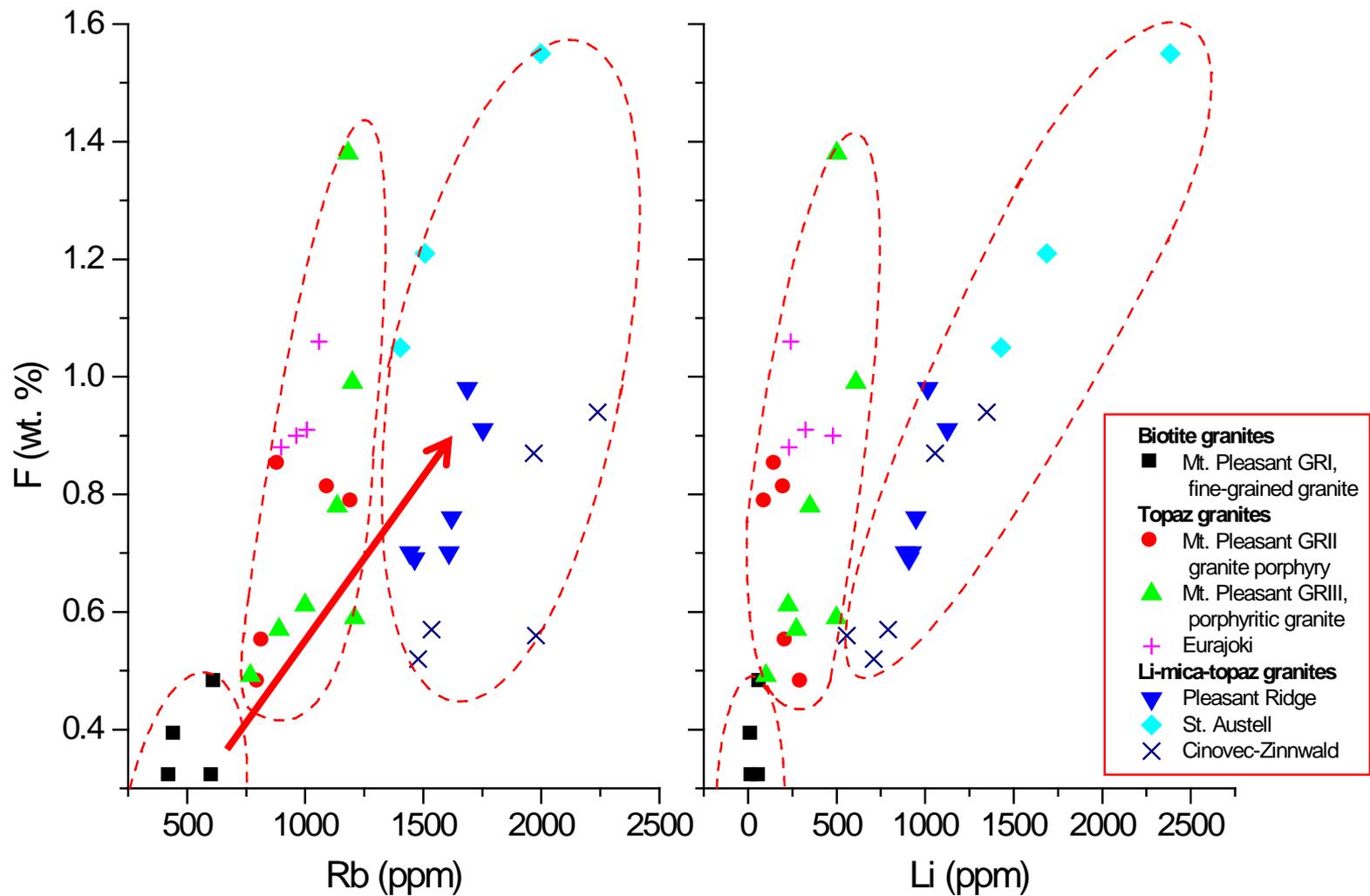
# MOUNT PLEASANT

## micas and chlorites from greisens



# Mount Pleasant





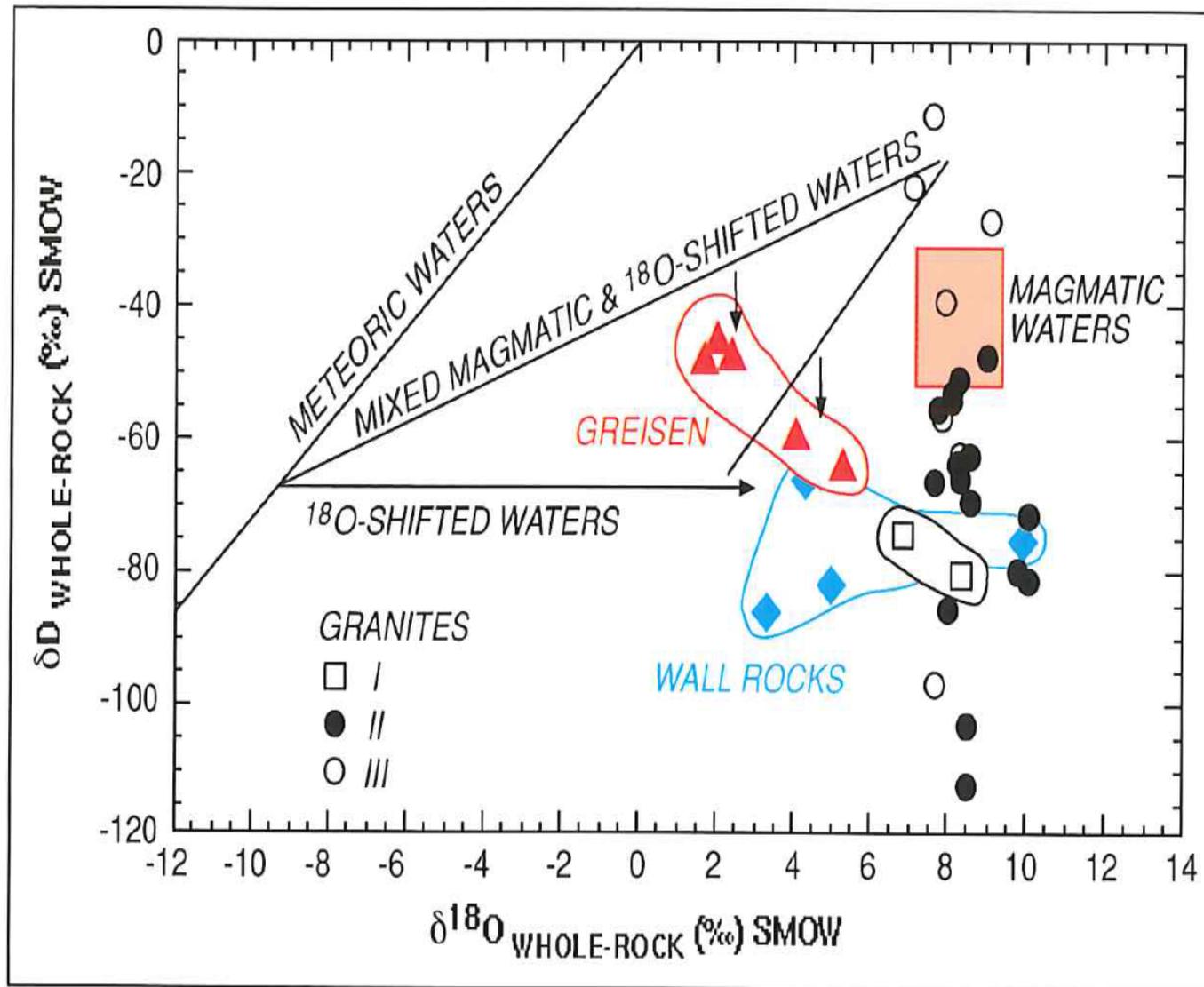
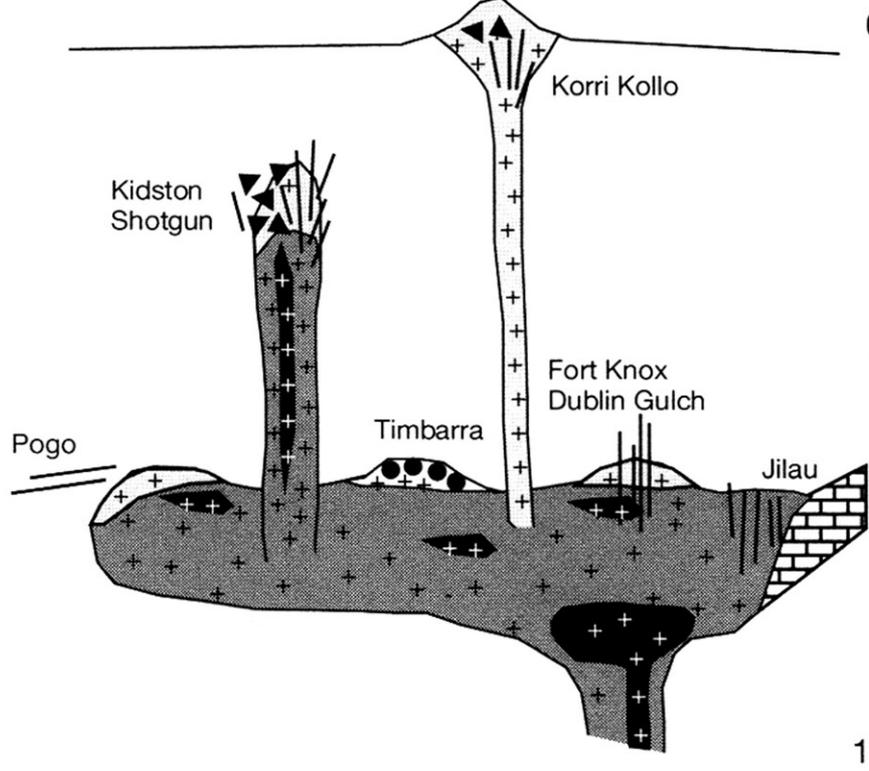


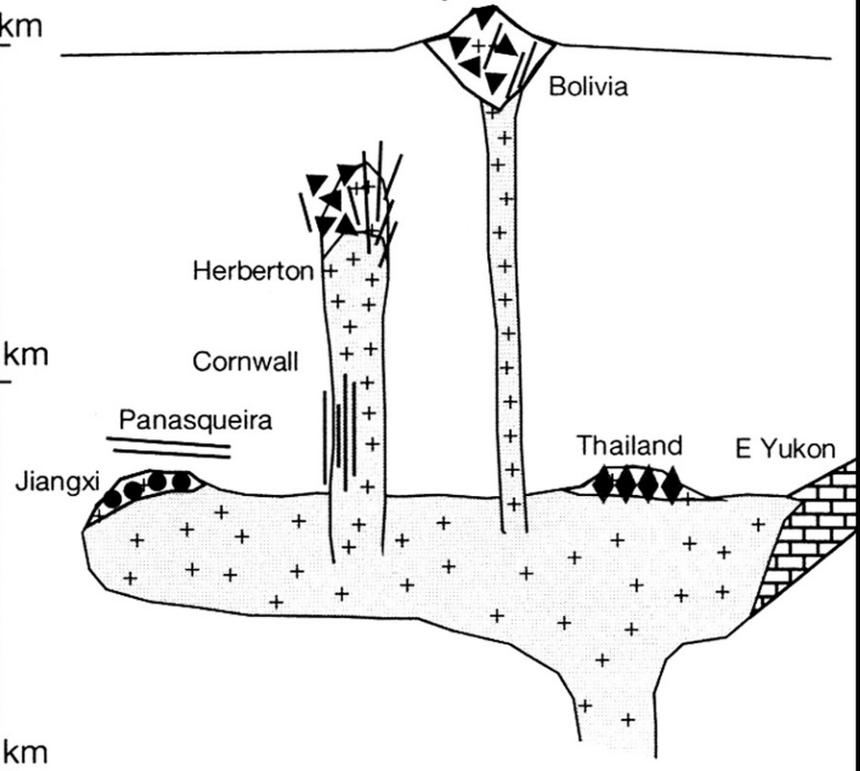
Abb. 4.22: Greisenmineralisation aus magmatisch-meteorischen Mischwässern im  $\delta D - \delta^{18}O$  Diagramm für alterierte und mineralisierte Gesteine der Lagerstätte Mount Pleasant, Kanada.

# Au-Bi+/-W Deposits



Granites associated with Au-Bi+/-W  
 Rb/Sr 0.1 to 1.0  
 $Fe_2O_3/FeO$  0.1 to 0.6  
 Metaluminous to peraluminous  
 I-type

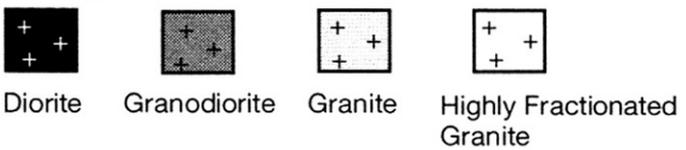
# Sn-W Deposits



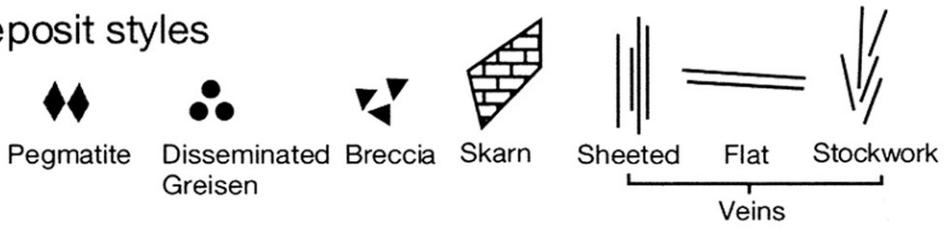
Granites associated with W+/-Sn  
 Rb/Sr 0.1 to 10  
 $Fe_2O_3/FeO$  0.1 to 2.0  
 Peraluminous to locally metaluminous  
 I-type and S-type

Granites associated with Sn+/-W  
 Rb/Sr 1 to 100  
 $Fe_2O_3/FeO$  0.01 to 0.5  
 Peraluminous  
 I-type and S-type

## Granite types

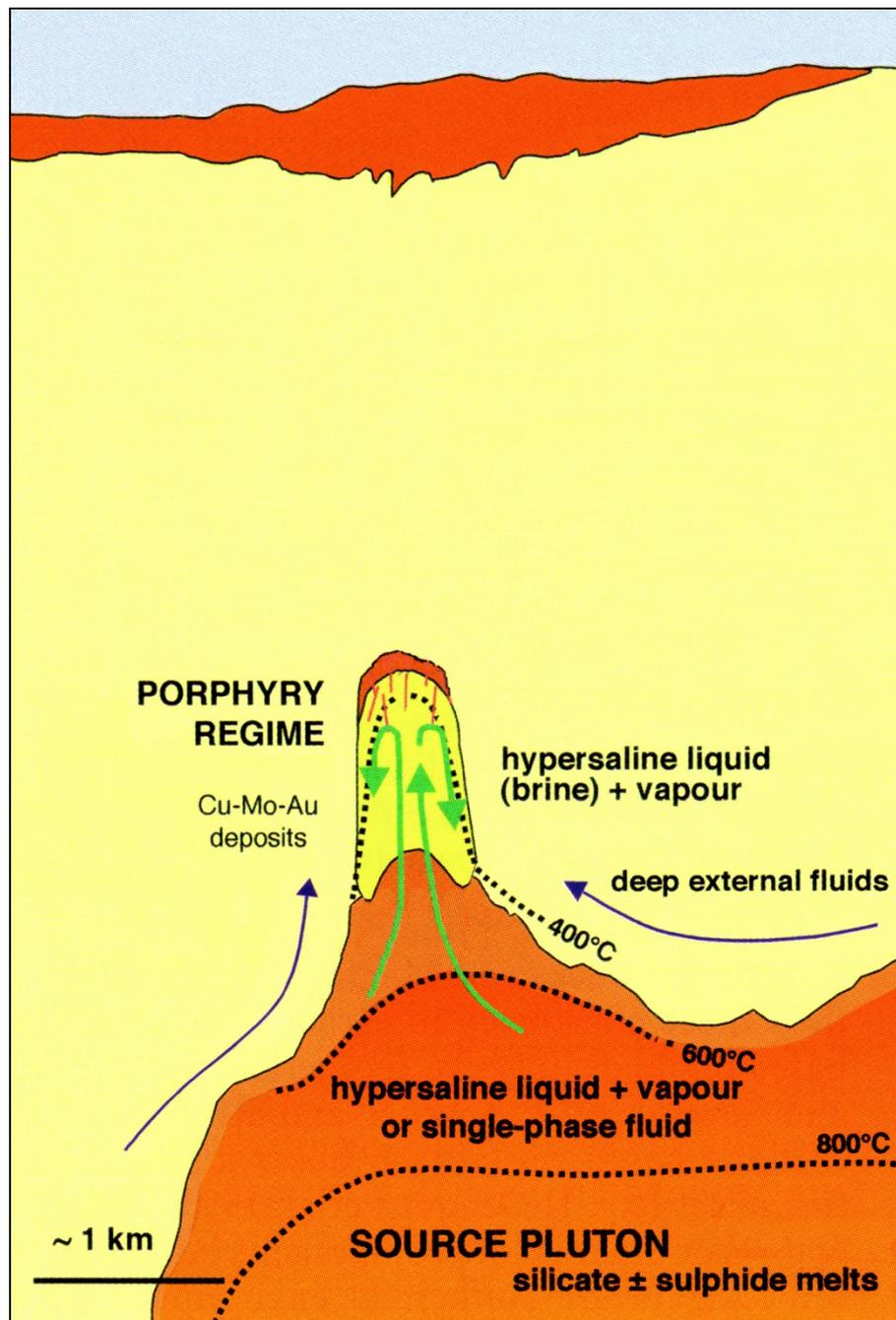
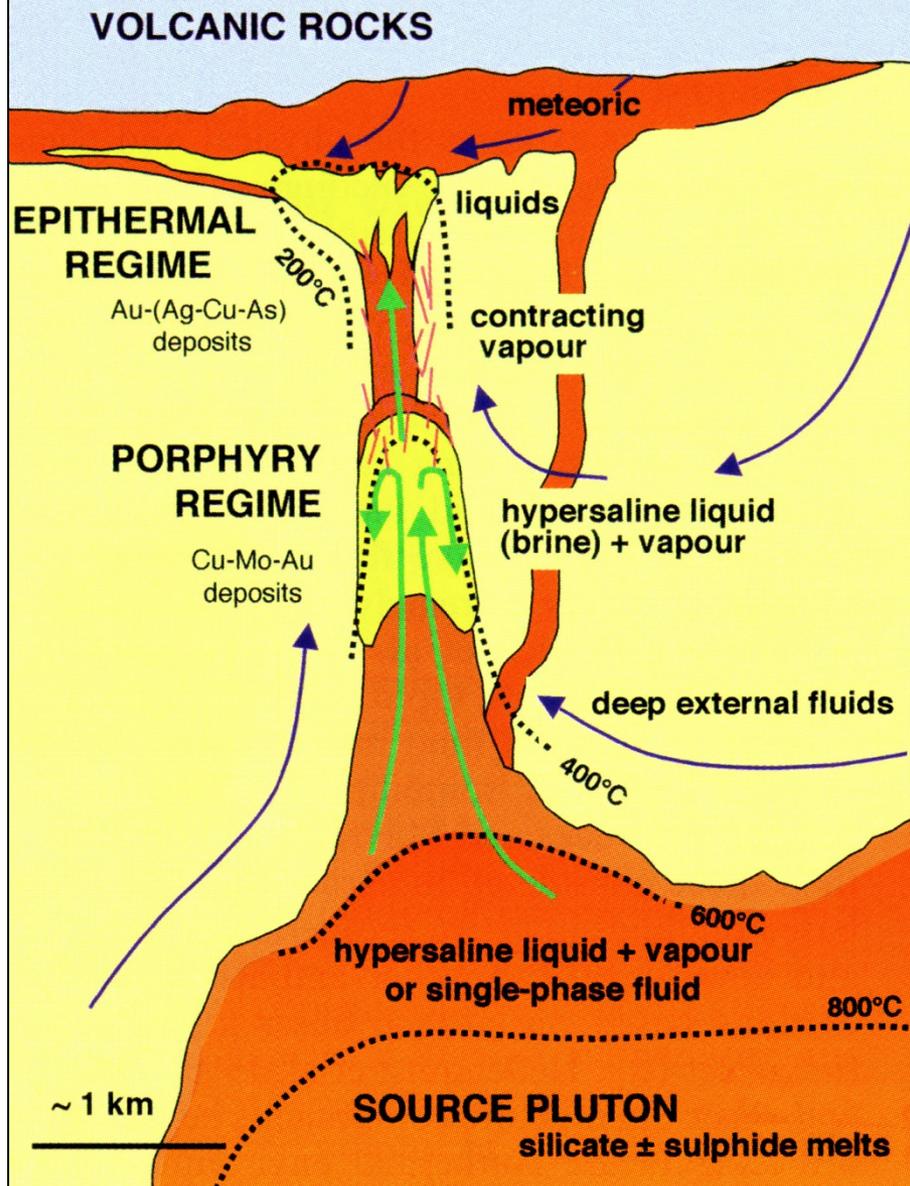


## Deposit styles



(Baker et al., SEG Newsletter, April 2005)

(from Heinrich, 2005)



# An integrated deposit model for Mount Pleasant

W-Mo porphyry breccia pipe

defragmenting UST brain rock of chilled carapace G1

Sn & base metal (Pb-Zn-Cu-In) greisen vein stockwork  
produced within main granite G2

Nb-Ta rare metal granite (G3, inner granite)

The deposit formation at MP reflects in space and time a continuum of fractionation processes and fluid-rock interaction during pulses of late subduction to post-collisional magma intrusions along a vertical profile.