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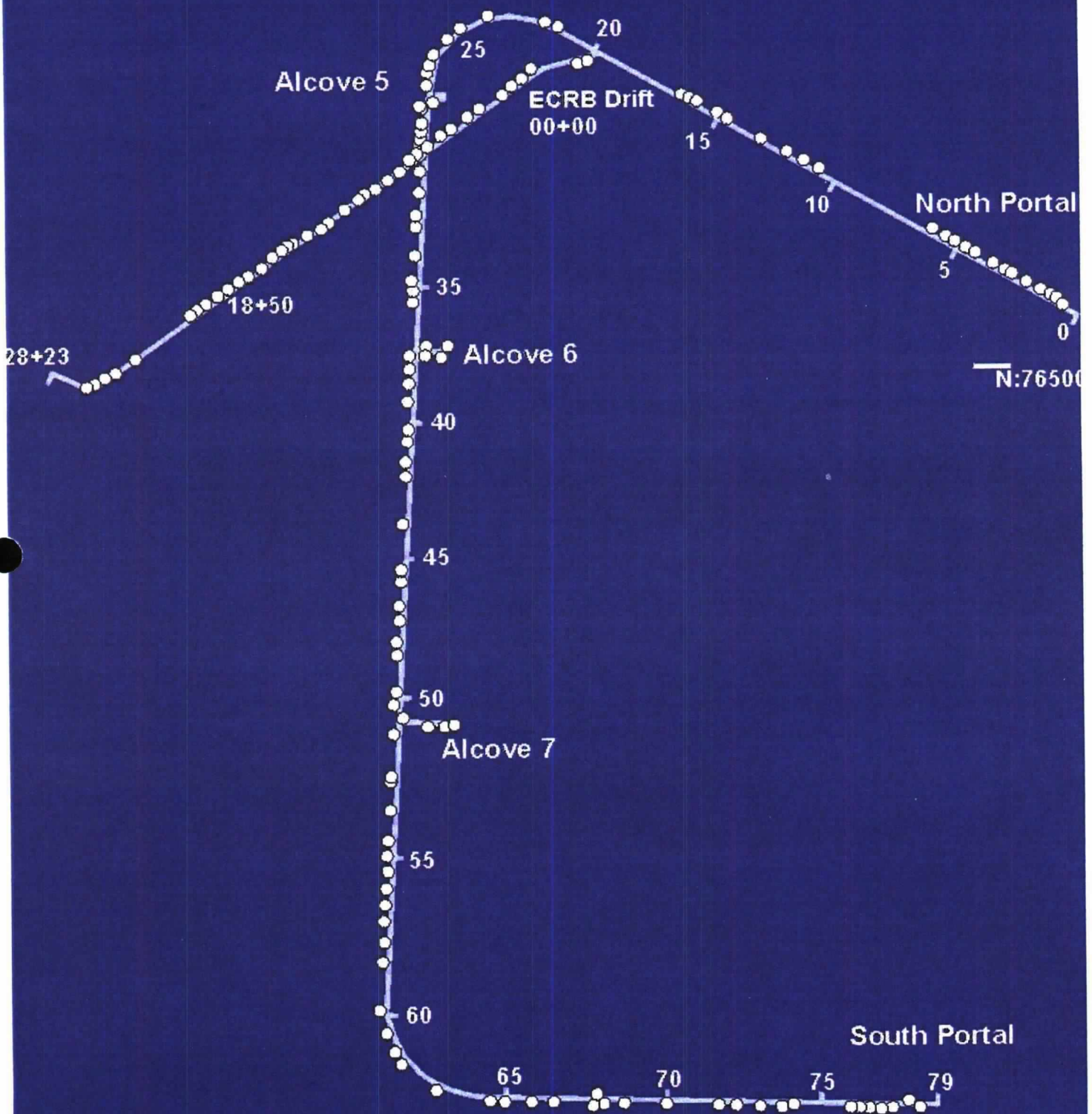
Thermochronological Evolution of Calcite Formation at Yucca Mountain, Nevada

Jean Cline and Nick Wilson
UNLV

Roadmap

- **Paragenesis**
- **Fluid inclusions**
- **Geochronology**
- **Conclusions**

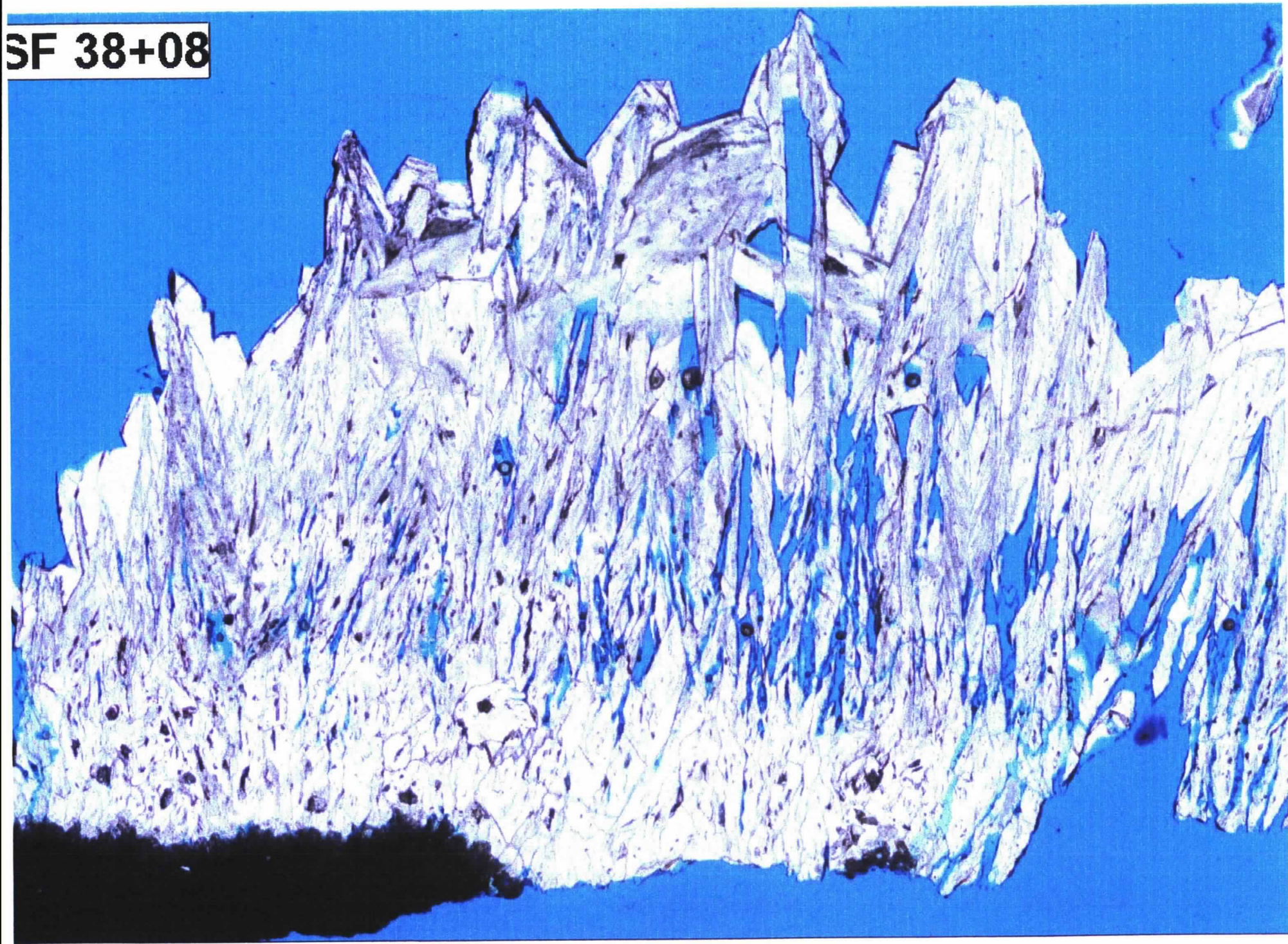
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- 1) Is there a *hot fluid* record at YM?
 - 2) *How hot* were the fluids?
 - 3) *How widespread* were the fluids?
 - 4) *When* did the fluids invade YM?



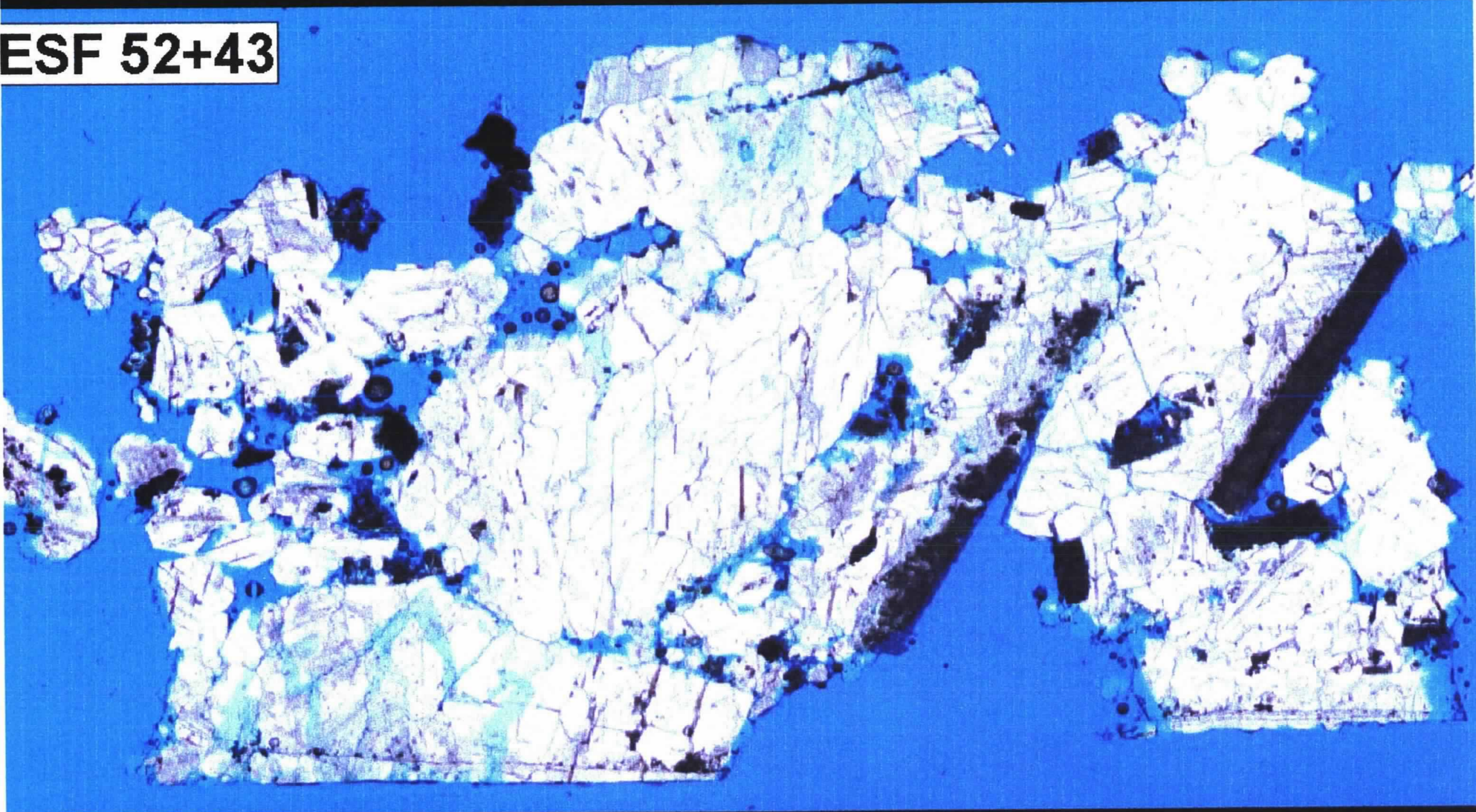
Paragenesis Study

- **Petrography**
- **Chemistry**
- **Cathodoluminescence**
- **C & O isotopes**

SF 38+08



ESF 52+43



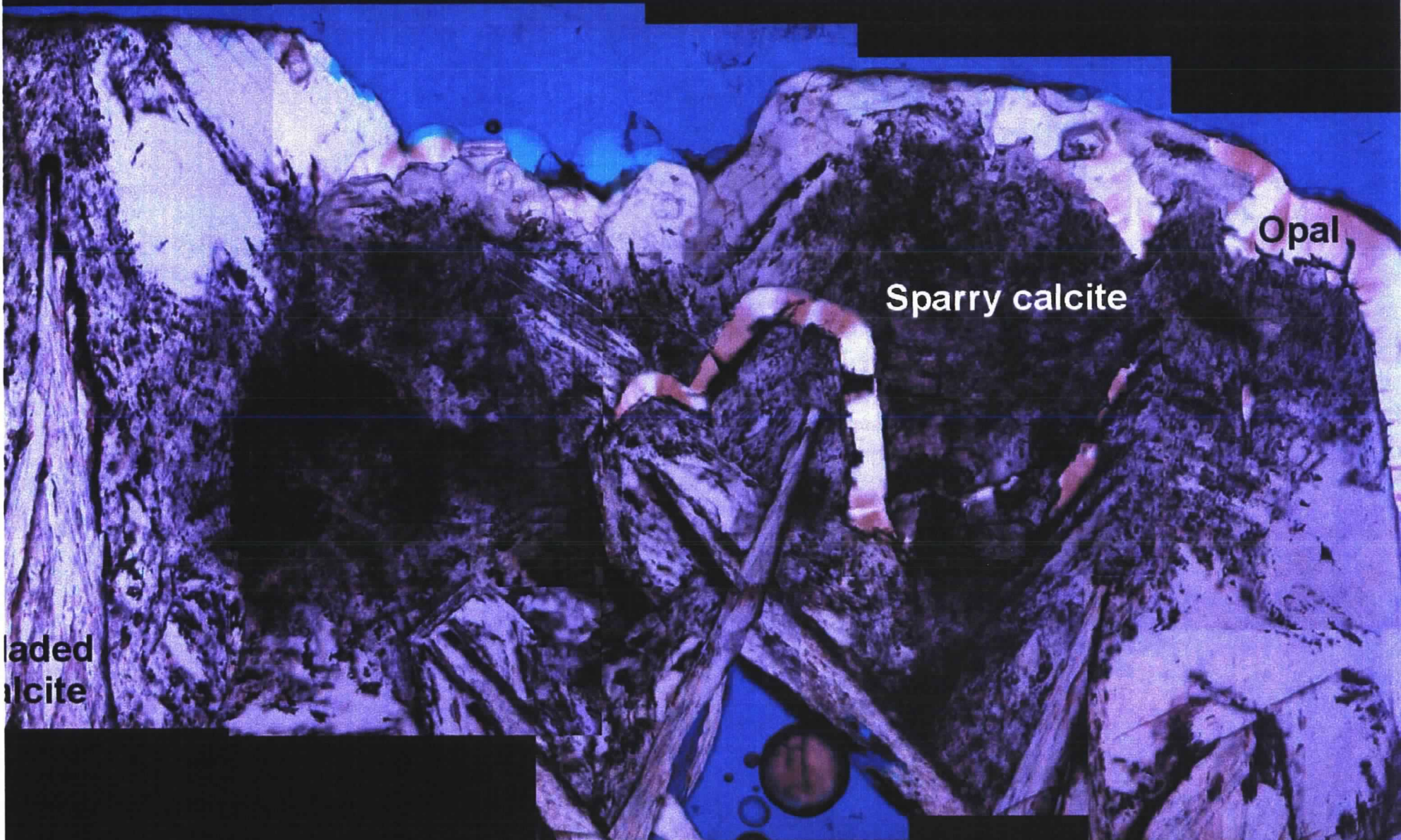
ESF 29+

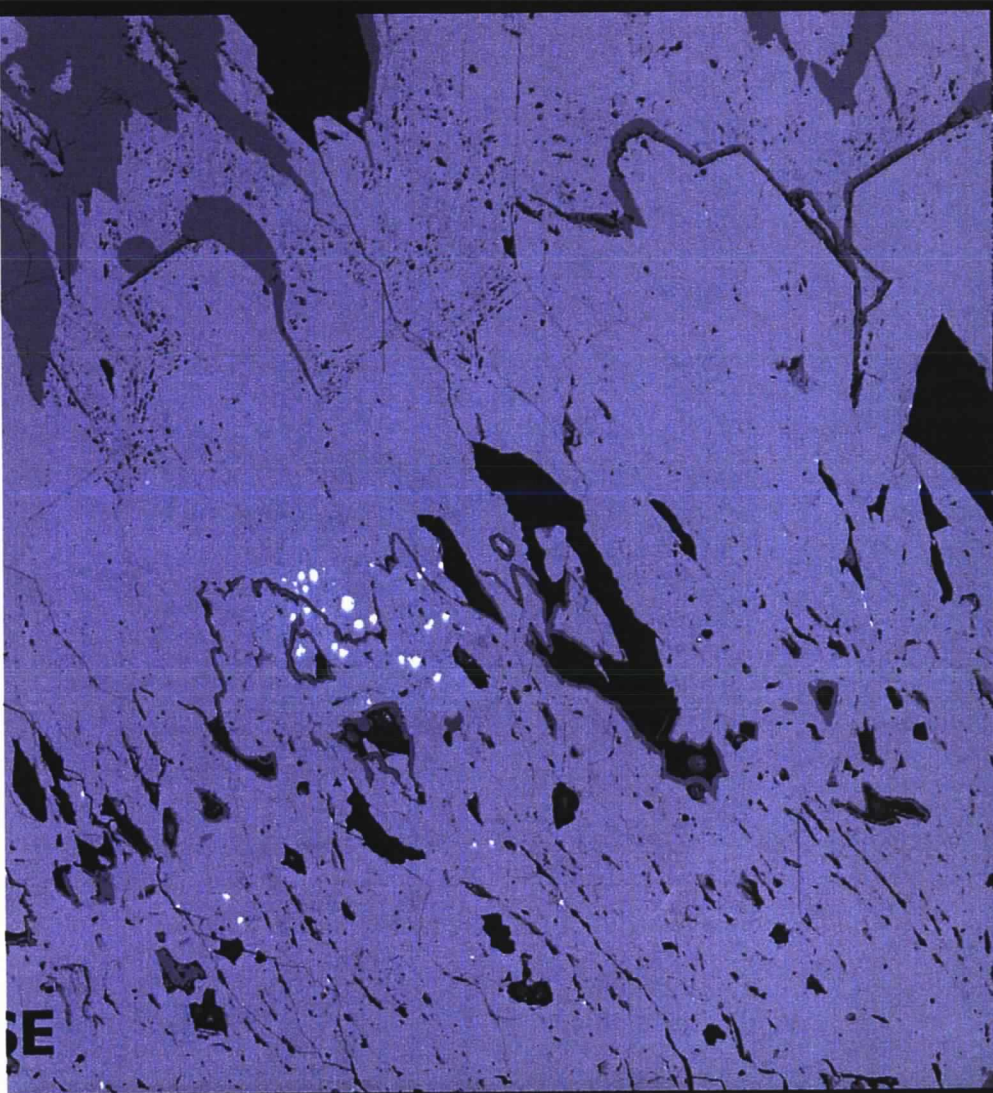
Opal

Sparry calcite

bladed
calcite

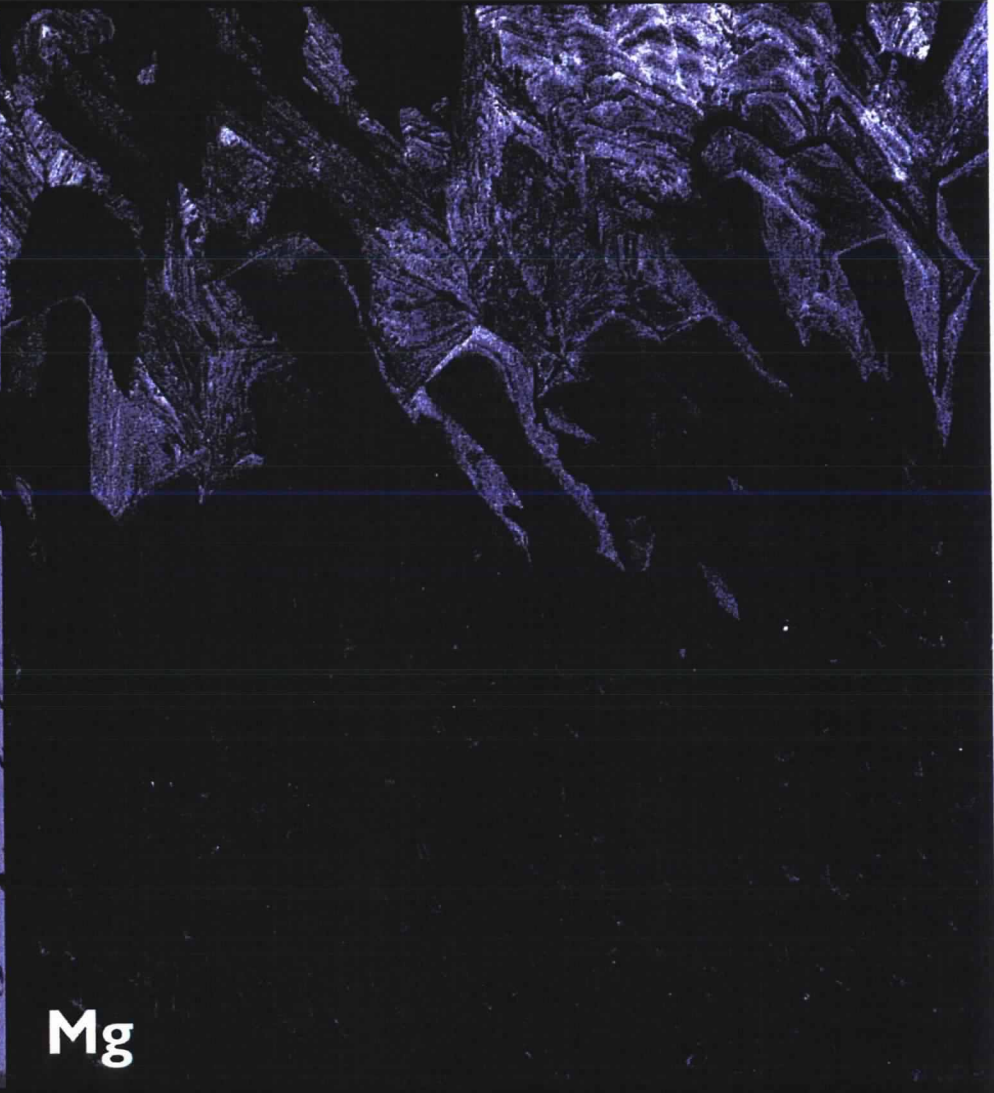
5 mm





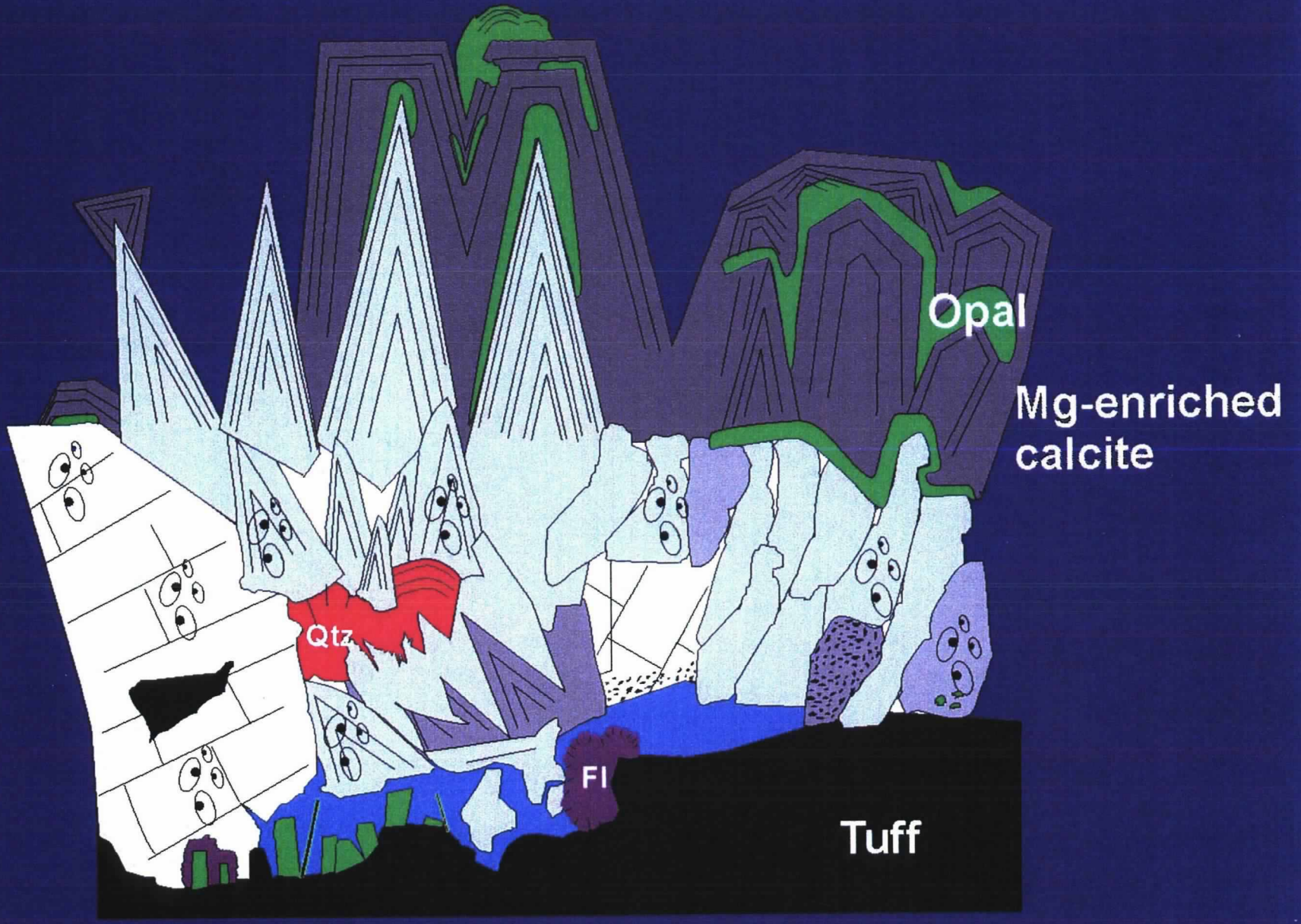
SE

SF 78+41



Mg

~ 3 cm



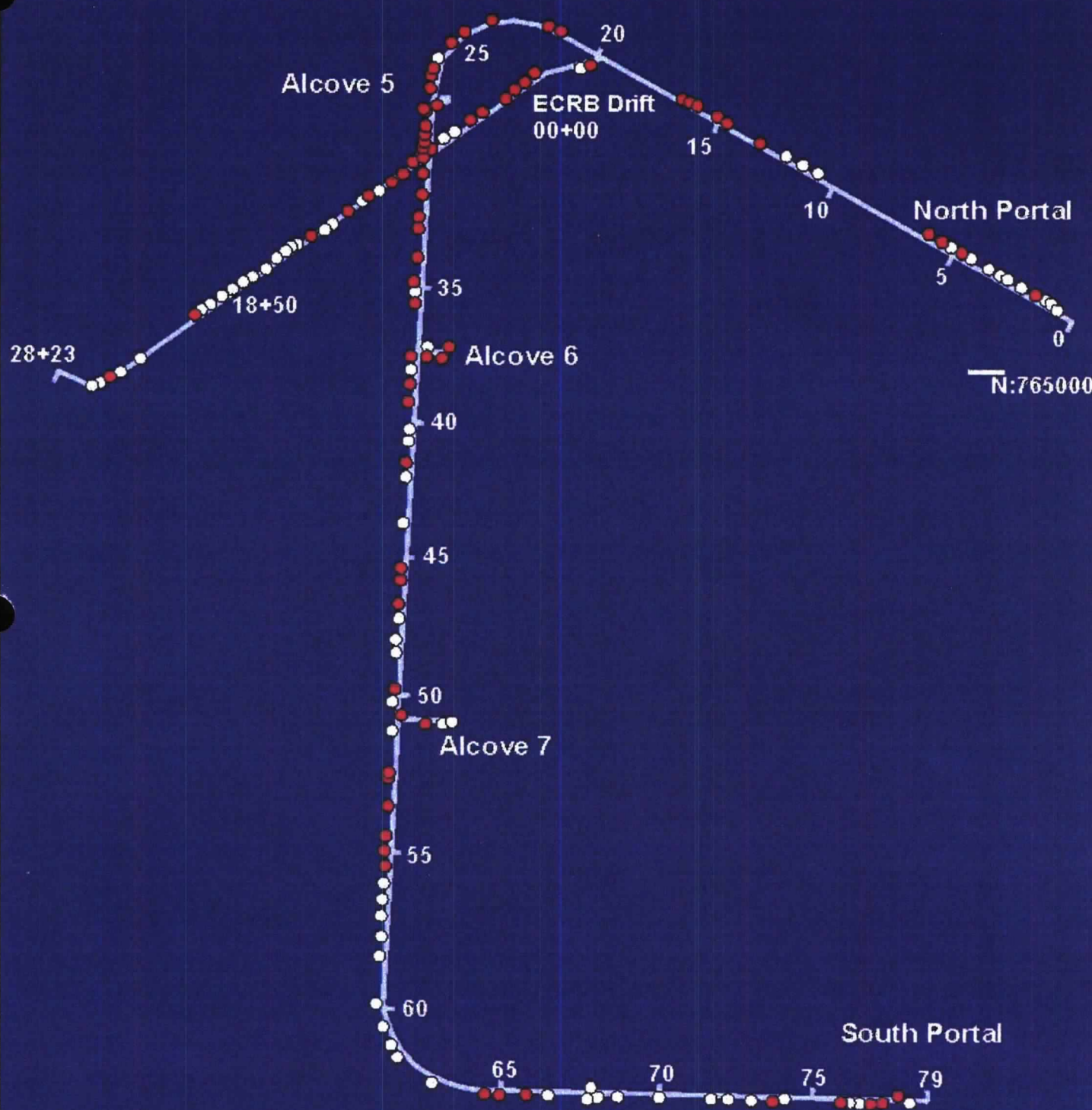
Qtz

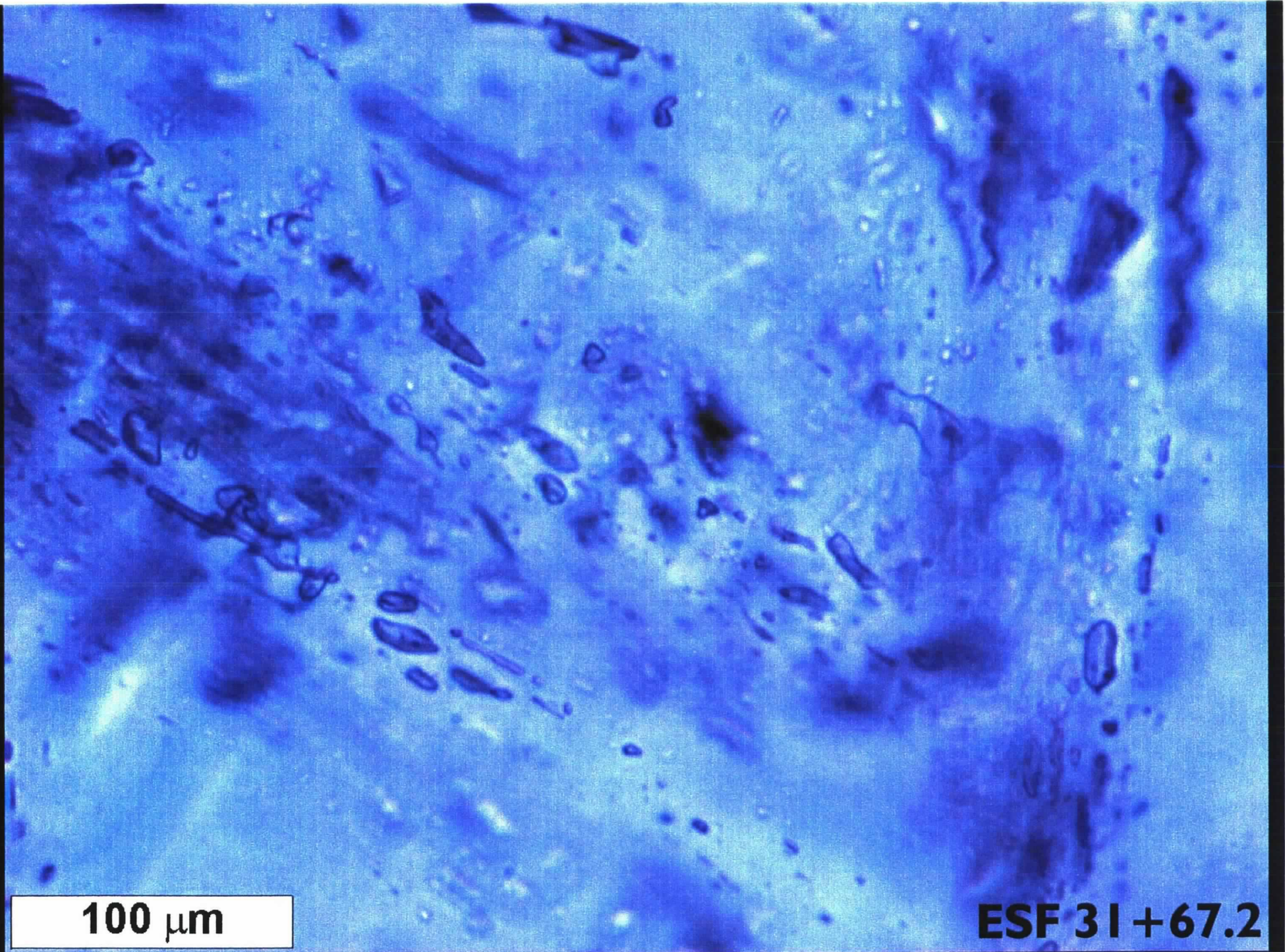
Opal

Mg-enriched calcite

FI

Tuff



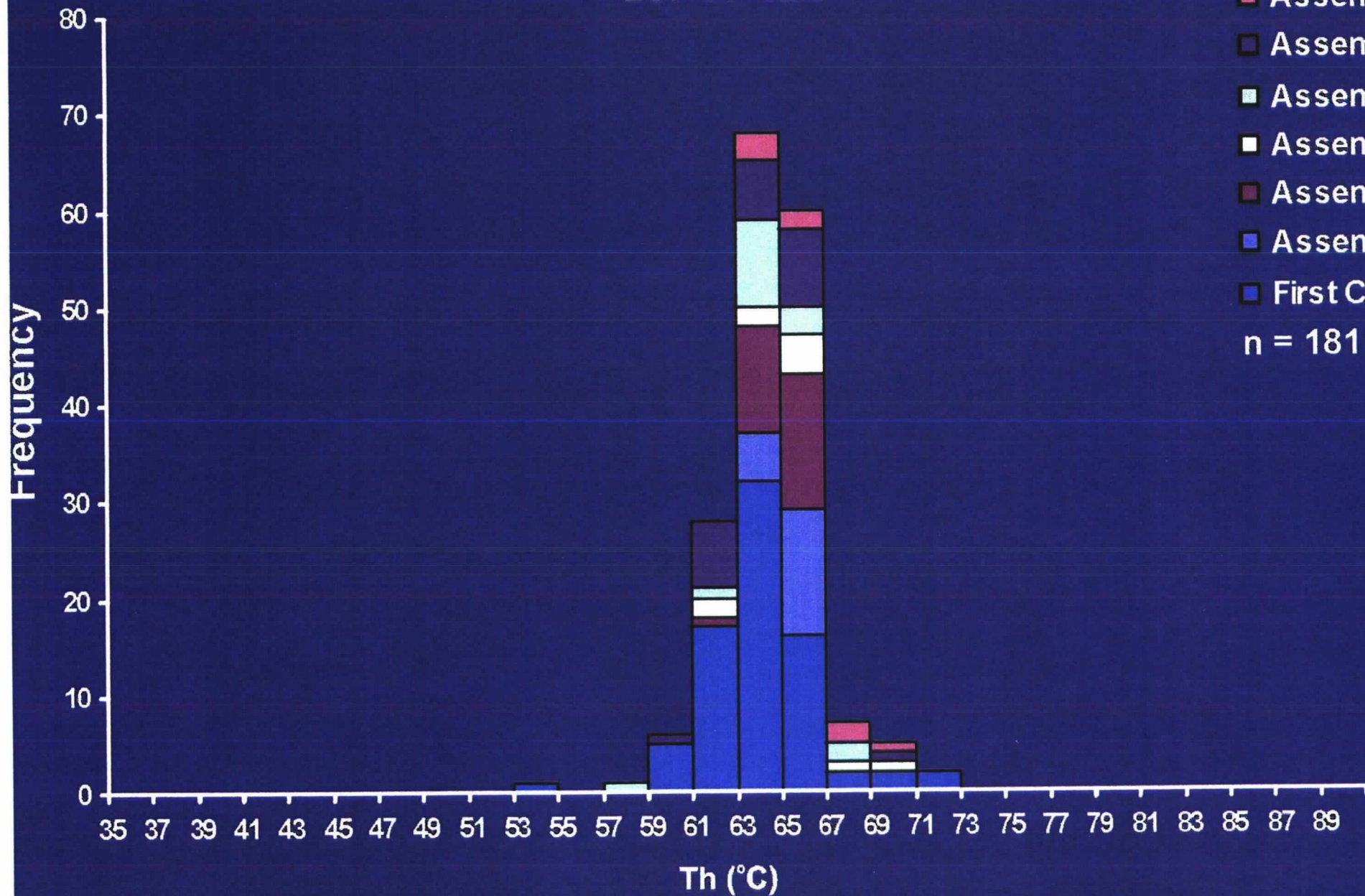


100 μm

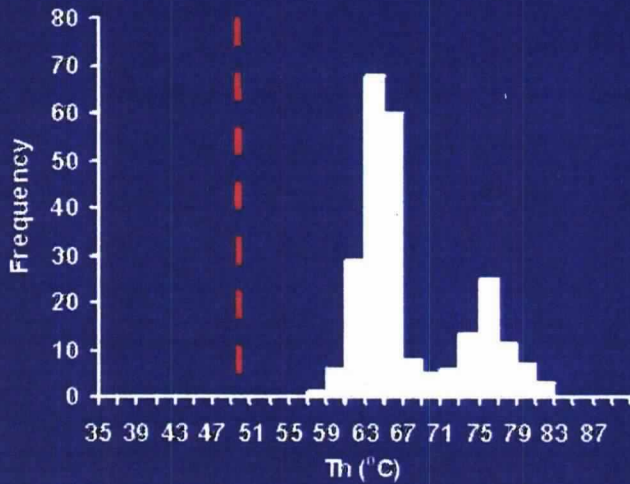
ESF 31+67.2

ESF 01+62.3

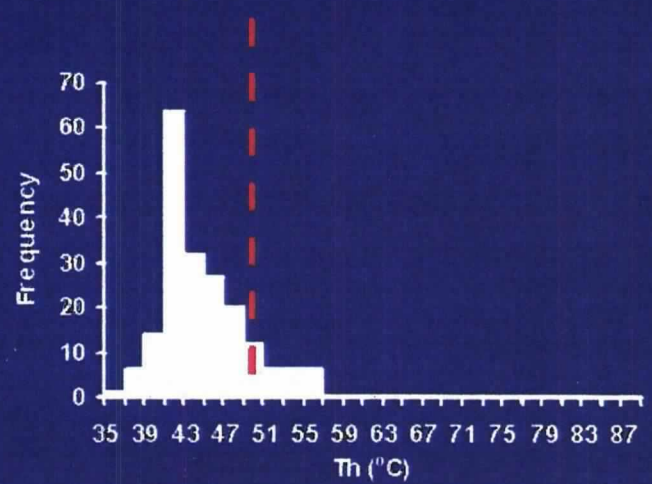
- Assem 6
 - Assem 5
 - Assem 4
 - Assem 3
 - Assem 2
 - Assem 1
 - First Chip
- n = 181



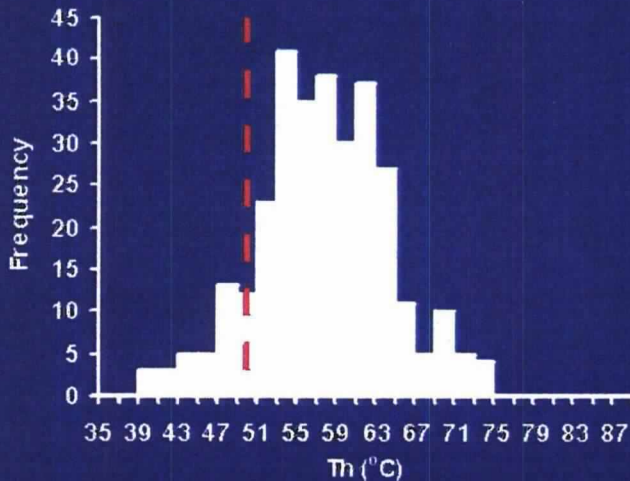
Zone 1 (n=242)
Samples ESF 00+00 - 06+11.5



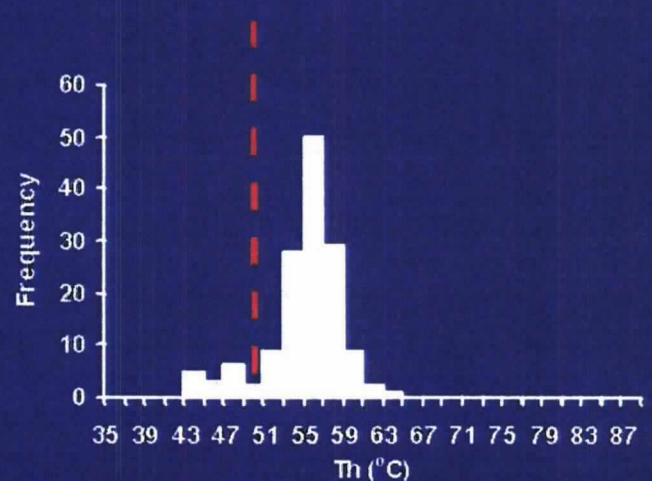
Zone 4 (n=194)
Samples ESF 40+68 - 57+00



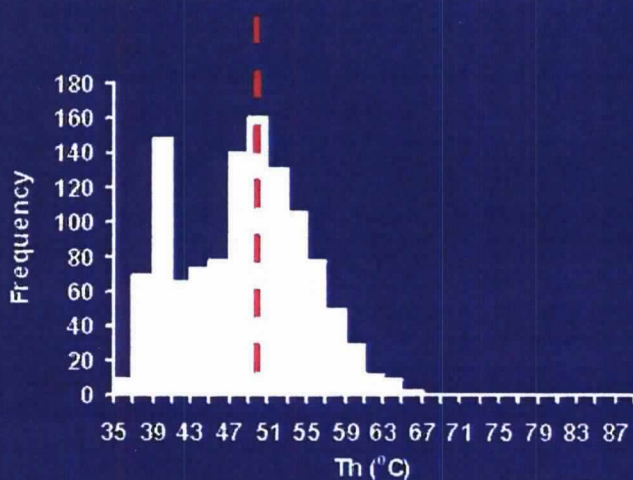
Zone 2 (n=307)
Samples ESF 10+75 - 16+46



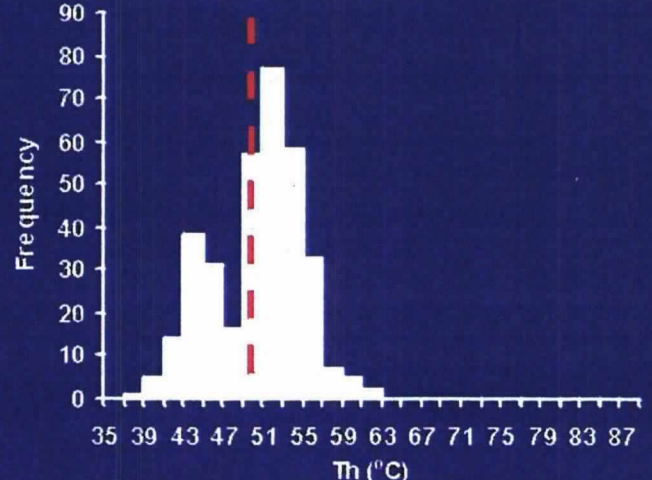
Zone 5 (n=144)
Samples ESF 57+70 - 78+41



Zone 3 (n=1161)
Samples ESF 21+61 - 40+21



Zone 6 (n=342)
All ECRB samples

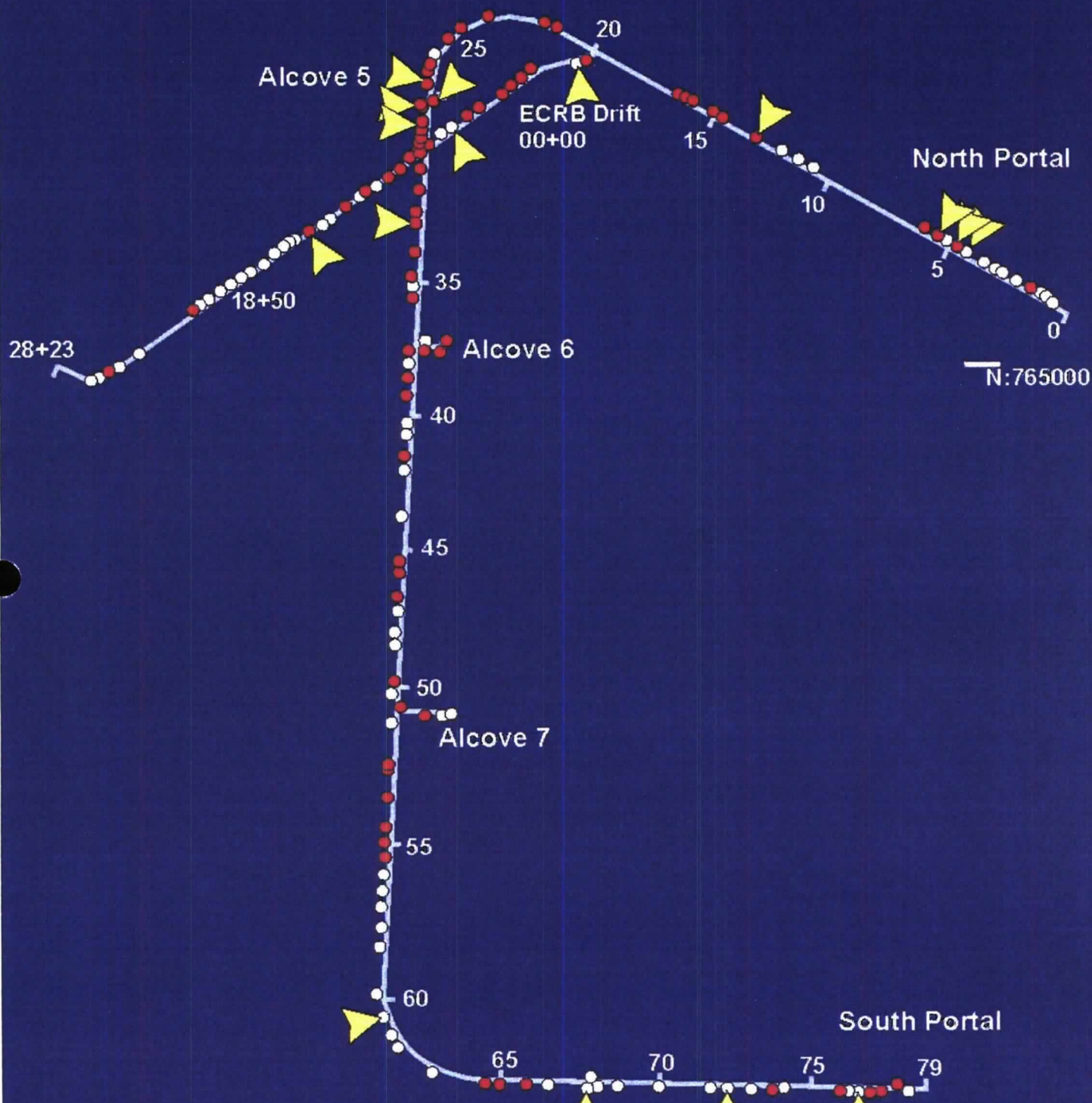


Fluid Inclusion Data

- Most inclusions homogenized at 45 to 60°C
- Inclusions in the IFZ homogenized at <40 to 50°C
- Homogenized T's in the North ramp reached 81°C

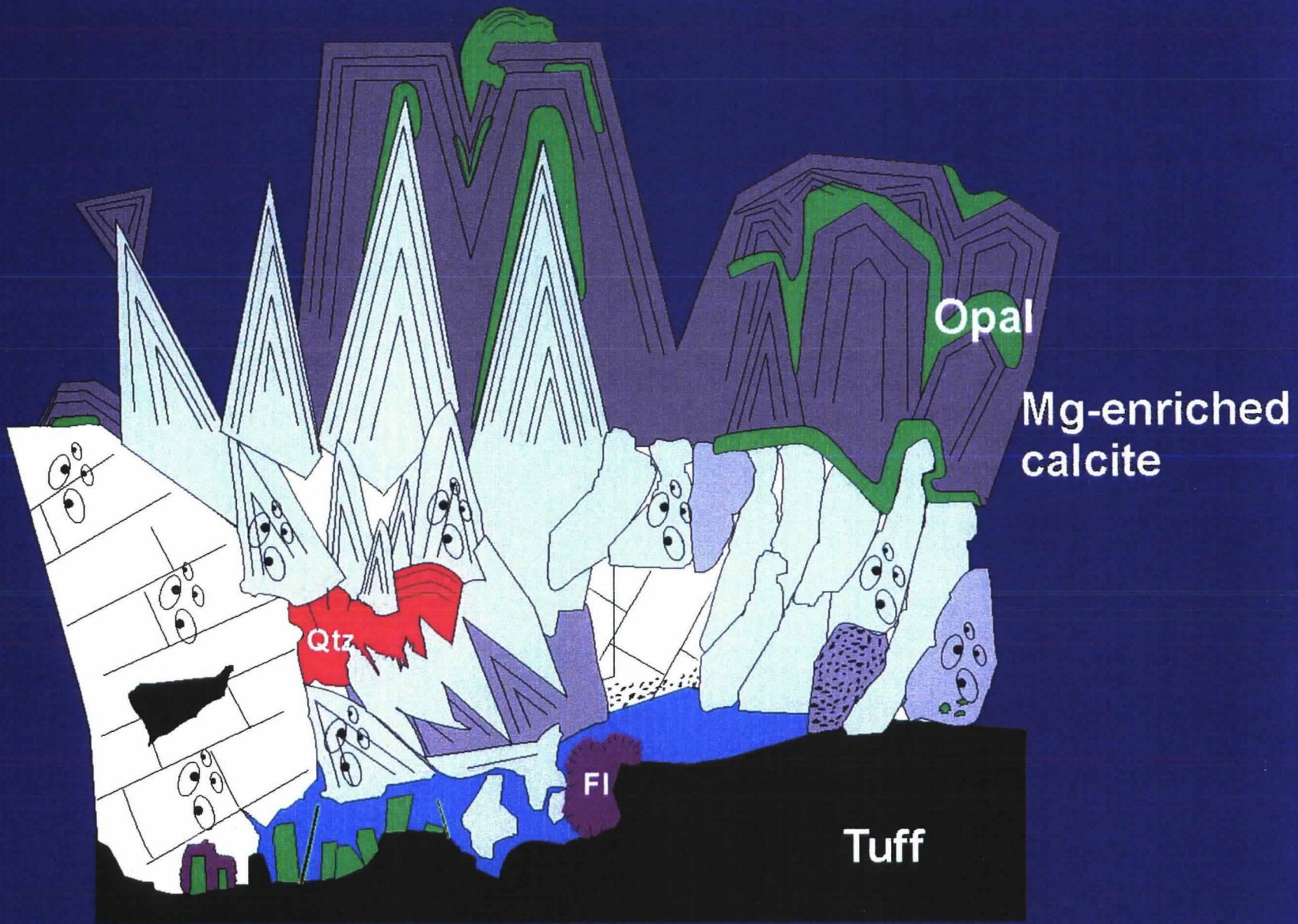
Fluid Inclusion Data

- 2-phase fluid inclusions are in *relatively* old and intermediate calcite
- 2-phase fluid inclusions were not found in younger MGSC or coarse bladed calcite



- Sample location
- Sample containing FIAs
- ▲ Sample used for dating

~ 3 cm



- Opal intergrown with MGSC was dated using U-Pb ($n = X$)
- The MGSC and opal began to precipitate between ~ 1.9 and 2.8 mya
- Fluids with elevated temperatures invaded YM $> 1.9 - 2.8$ mya

F 27+84

Opal 3
U-Pb 0.7-0.9

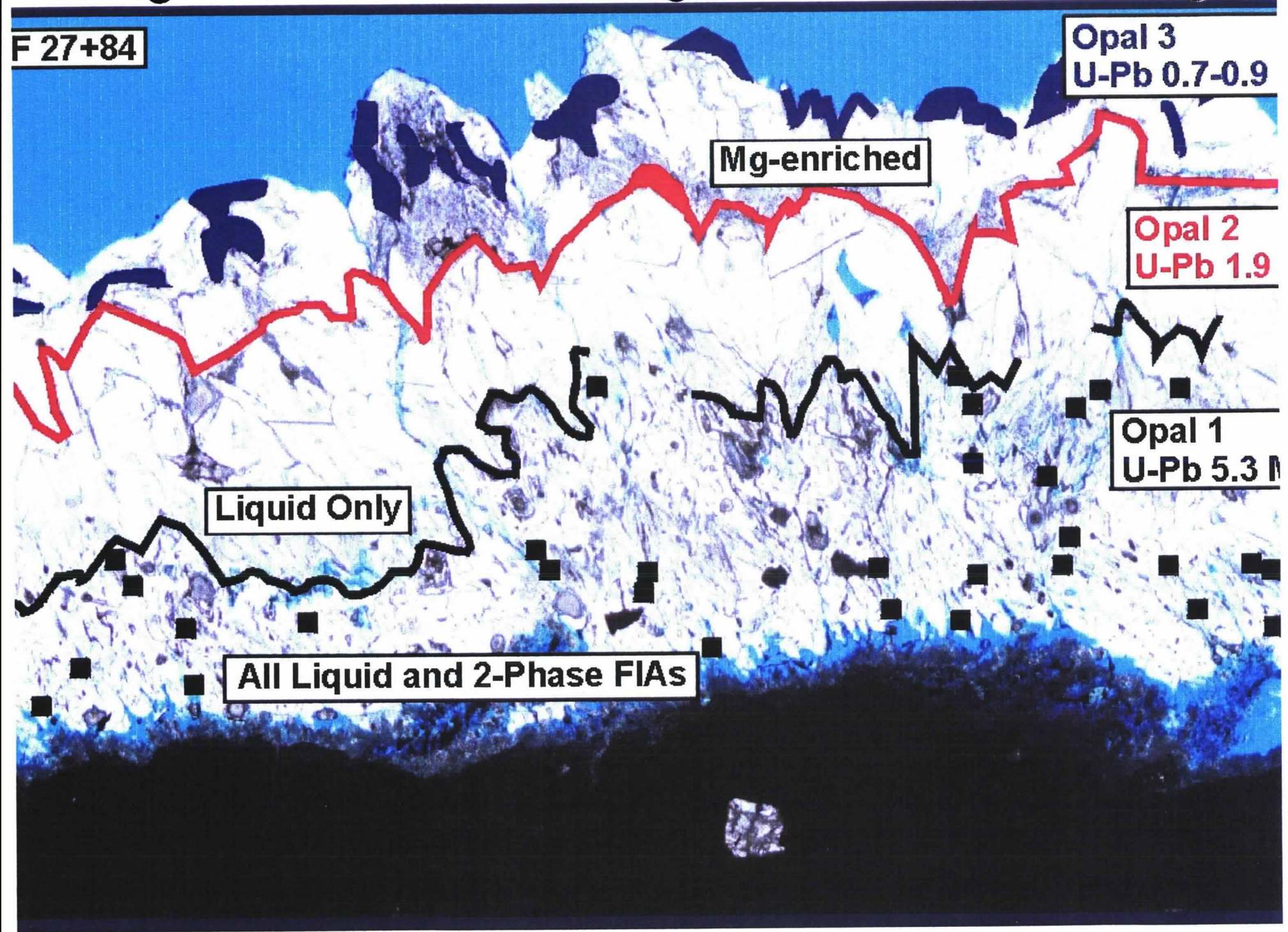
Mg-enriched

Opal 2
U-Pb 1.9

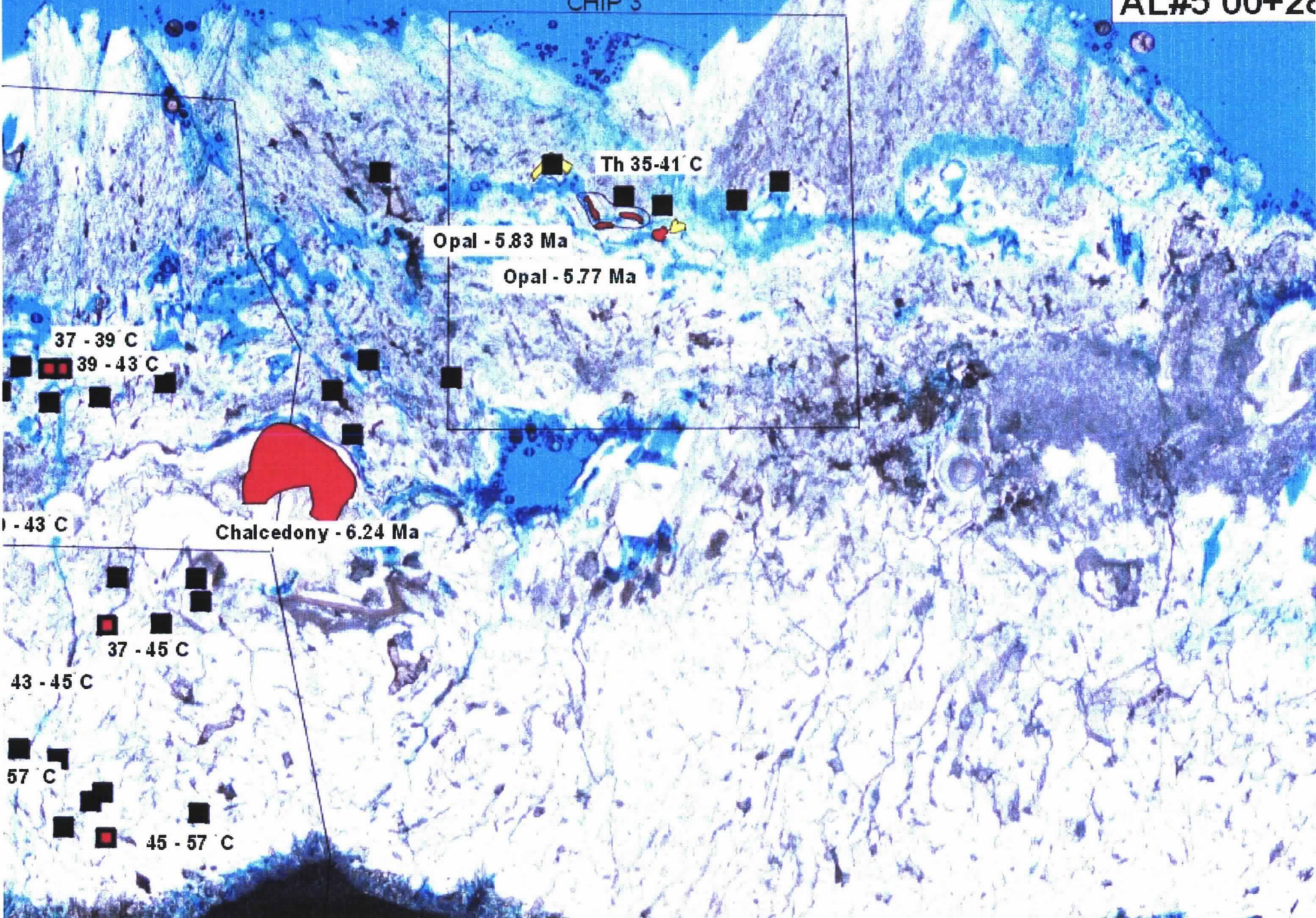
Opal 1
U-Pb 5.3 M

Liquid Only

All Liquid and 2-Phase FIAs



CHIP 3



Conclusions

- There is a record of hot waters at YM
- Temperatures average about 45 to 60°C
- This record is found across the repository site

Conclusions

- 2-phase fluid inclusions across YM were trapped > 1.9 mya
- Some fluid inclusions were trapped > 5.3 mya
- Some fluid inclusions ($35-41^{\circ}\text{C}$) were trapped < 5.7 mya

Conclusions

Secondary minerals at YM do not exhibit characteristics that are typical of hydrothermal mineralization (sparse, low T, no HT brecciation, vein style and complexity,