FURTHER Re-Os ARSENOPYRITE GEOCHRONOLOGY FROM SELECTED MEGUMA AU DEPOSITS, MEGUMA TERRANE, NOVA SCOTIA: POSSIBLE EVIDENCE FOR A PROTRACTED GOLD-FORMING SYSTEM

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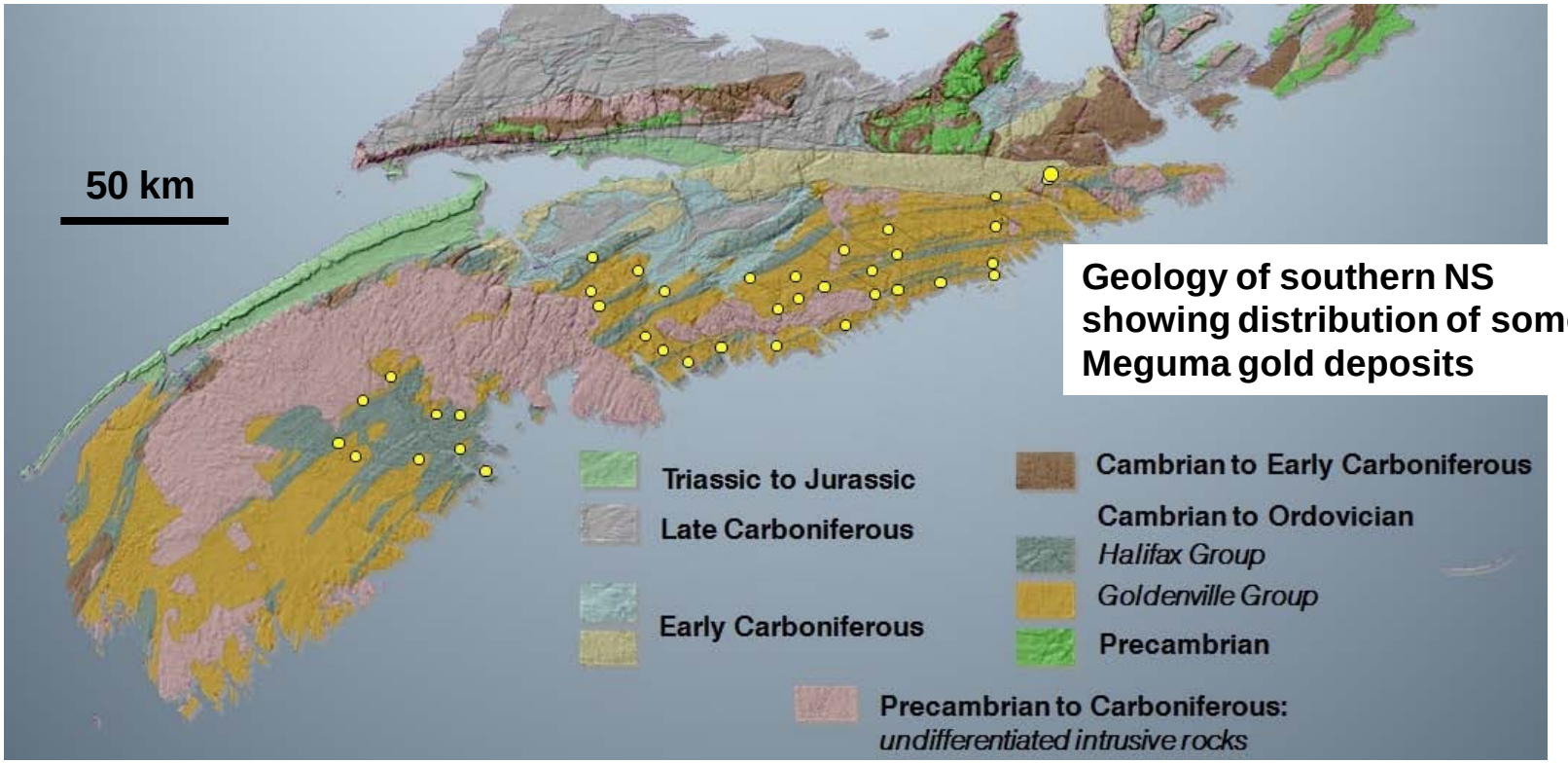
Background and Geological Setting

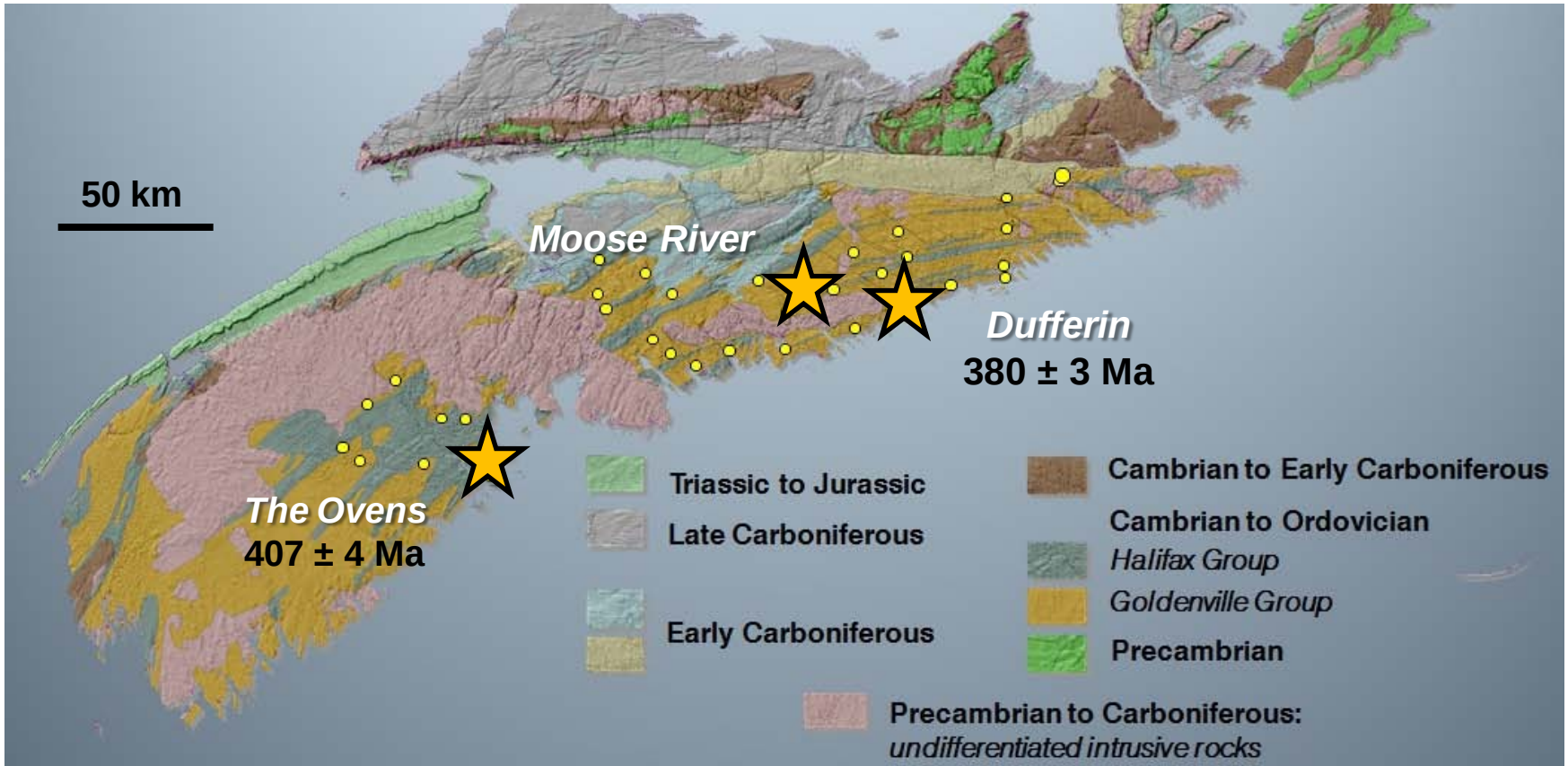
- Accreted to the Avalon Terrane along the Cobequid-Chedabucto Fault, Acadian
- Meta-sediment hosted orogenic gold deposits
- Cambro-Ordovician turbidites of the Goldenville Group and Halifax Group
- Acadian (ca. 410-400 Ma) greenschist to amphibolite facies metamorphism
- Late Devonian granitoid bodies and minor mafic plutons (ca. 380-370 Ma)
- Type: concordant, discordant, disseminated ; Model: pre-, syn-, late- folding
- Vein-hosted gold mineralization (Qtz-Carb-Sulfide assemblage)



Geology of southern NS showing distribution of some Meguma gold deposits

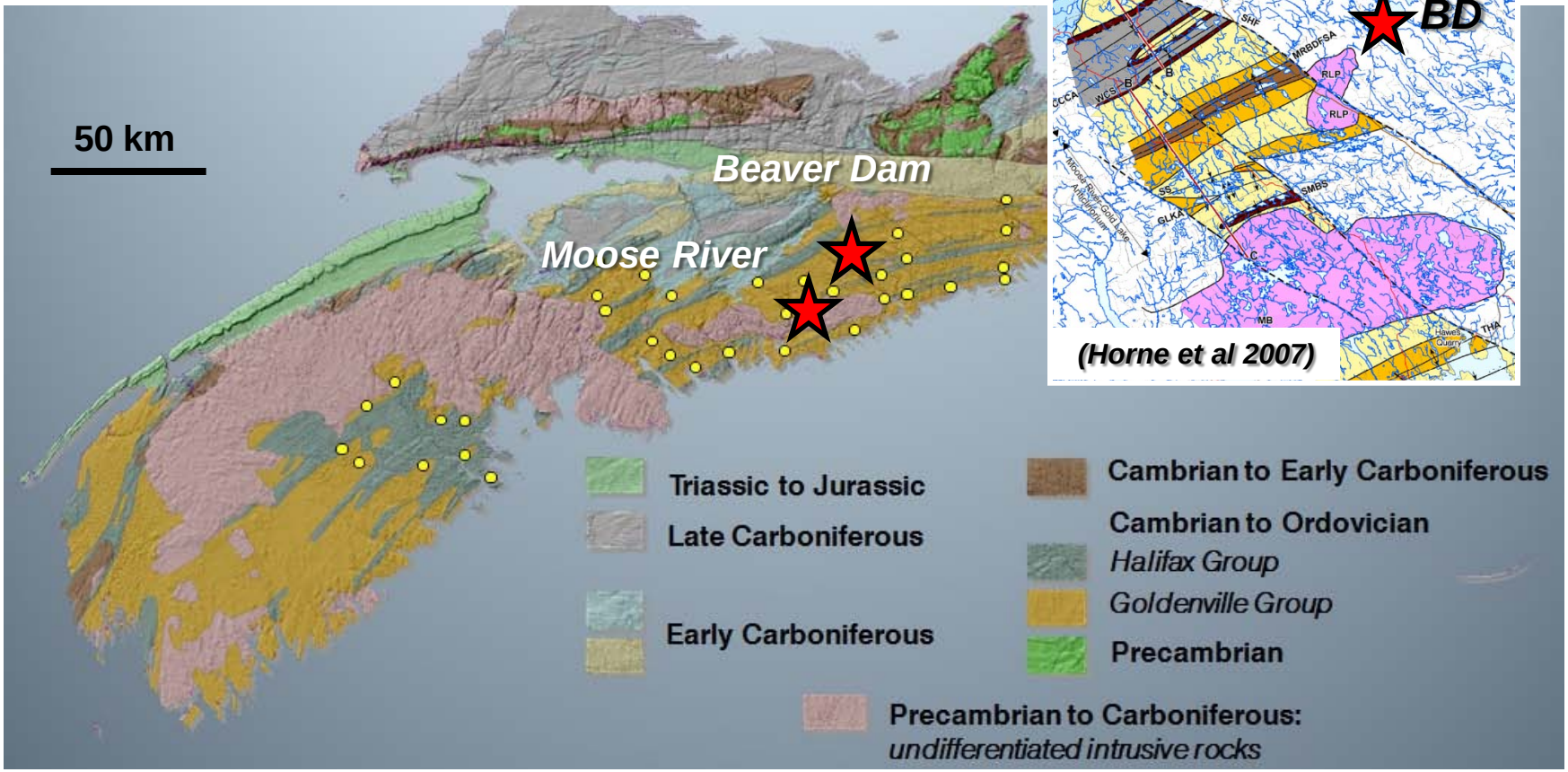
Previous Geochronology

- ^{39}Ar-^{40}Ar slate / siltstone whole rock age of 400 - 410 Ma constrains the regional metamorphic age, prior to granitoid intrusions between 370 -380 Ma (Ar-Ar, U-Pb, Rb-Sr), Ar-Ar vein minerals 370-380 Ma (Kontak 1990, 1993)
- Re-Os date the paragenetic associated sulfide minerals to obtain the age of the gold mineralization. Two Re-Os arsenopyrite ages from two gold deposits are 380 ± 3 Ma (Dufferin) and 407 ± 4 Ma (The Ovens) indicate multi-stage gold district, but Touquoy zone, Moose River: 457 ± 110 Ma, MSWD =27, disseminated Aspy from wall rock (Morelli et al. 2005)



This Study – Beaver Dam and Moose River

- The Re-Os age of auriferous arsenopyrite at deposits
- Beaver Dam deposit and Moose River deposit
- Ar-Ar whole rock age 380-385 Ma, Mica age 370-380 Ma (Kontak 1990, 1993)
- The U-Pb age of local granite at Beaver Dam deposit (River Lake intrusion) (371 Ma (ms) and 378 Ma (bt); Kontak et al. 1990)

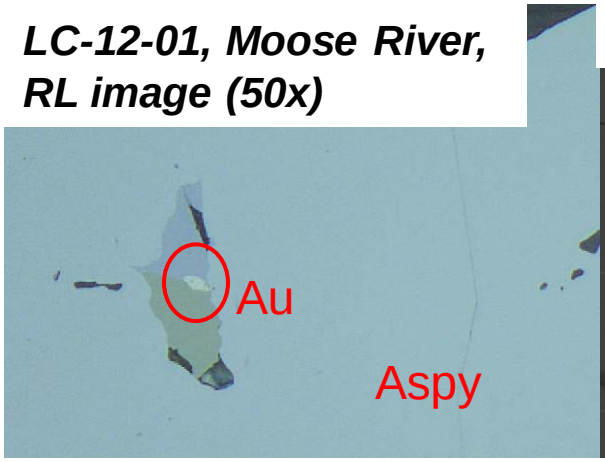


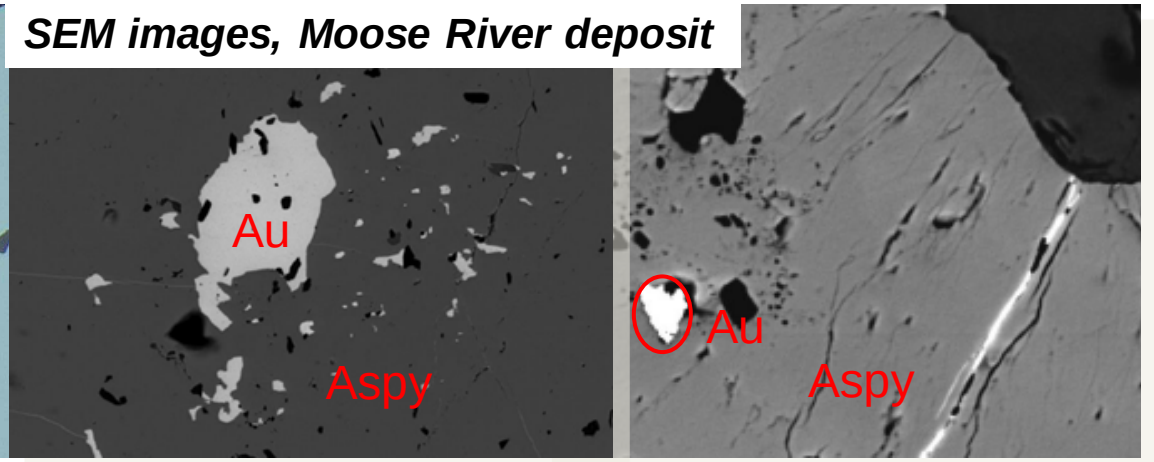
Sample Collection & Preparation

Aspy sampled from drill core (Halifax) and granite from River Lake intrusion

1) Thin Section & Re Tests; 5 Aspy samples, 3 from BD, 2 from MR
2) Aspy crystal is subdivided to separates, analyze independently (need variation in Re-Os values), hand picked/mineral separation

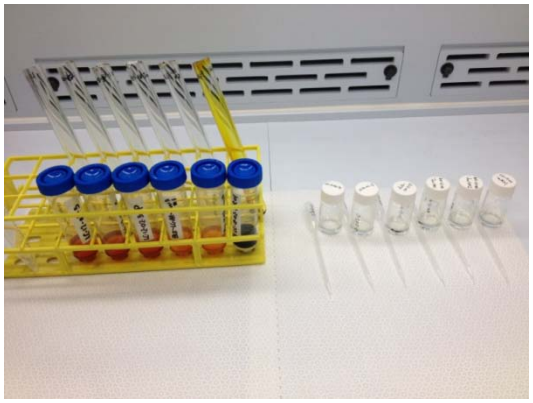
3) Gold in the Aspy crystals



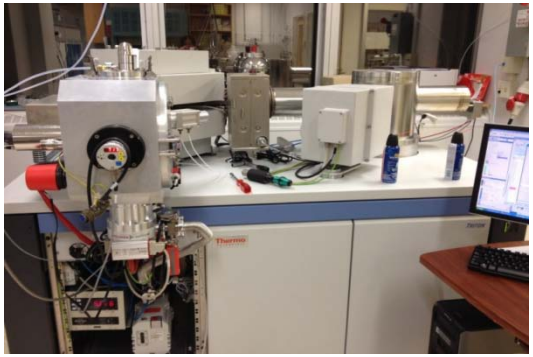


Methods – Re-Os and U-Pb

Re-Os Chemical processing:
Arsenopyrite analyzed by Carius tube dissolution methods



Re-Os Mass spectrometry:
Negative thermal ionization mass spectrometry (NTIMS)

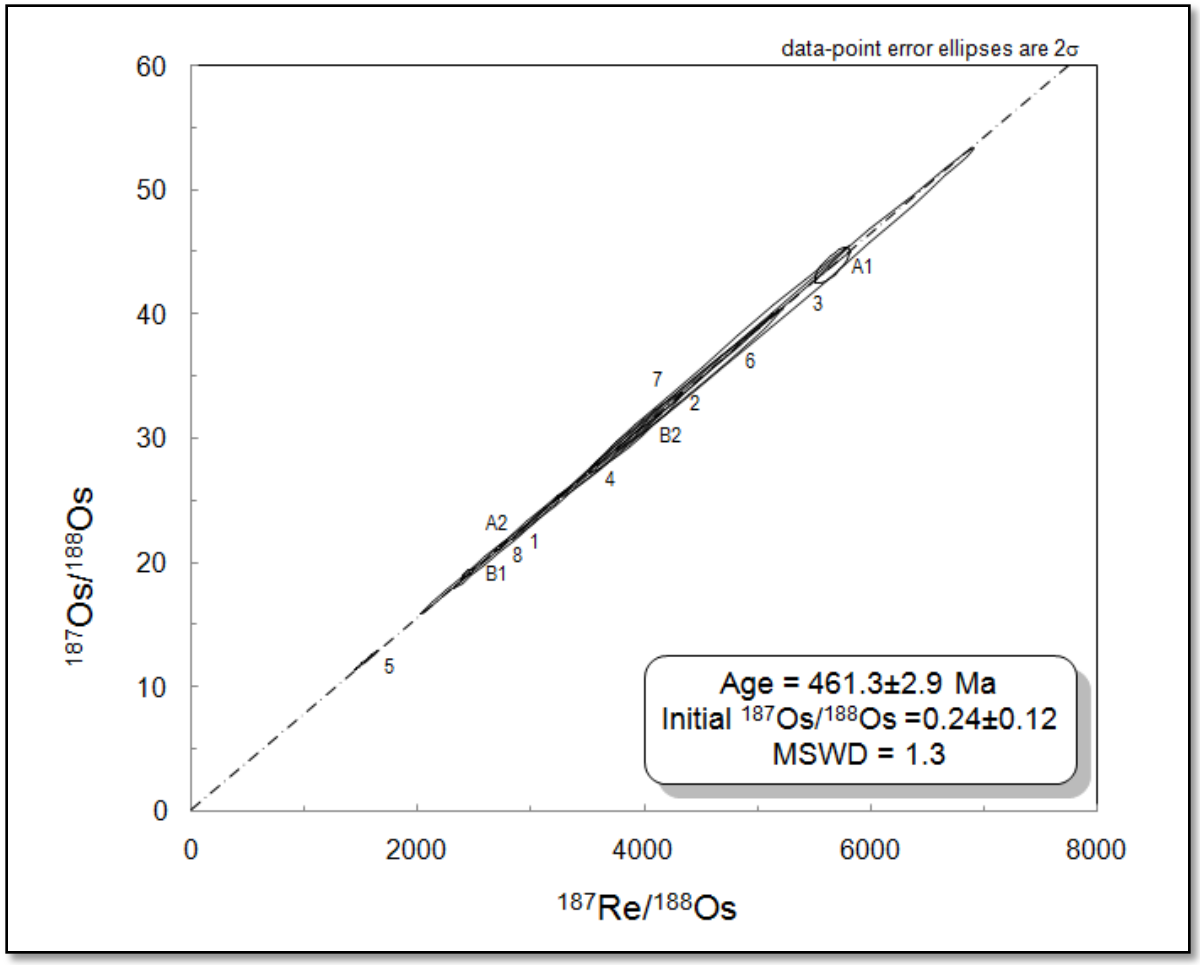


U-Pb *in situ* analysis:

For granites, zircons were handpicked and analyzed by LA-MC-ICP-MS.

Re-Os Results – Beaver Dam Deposit

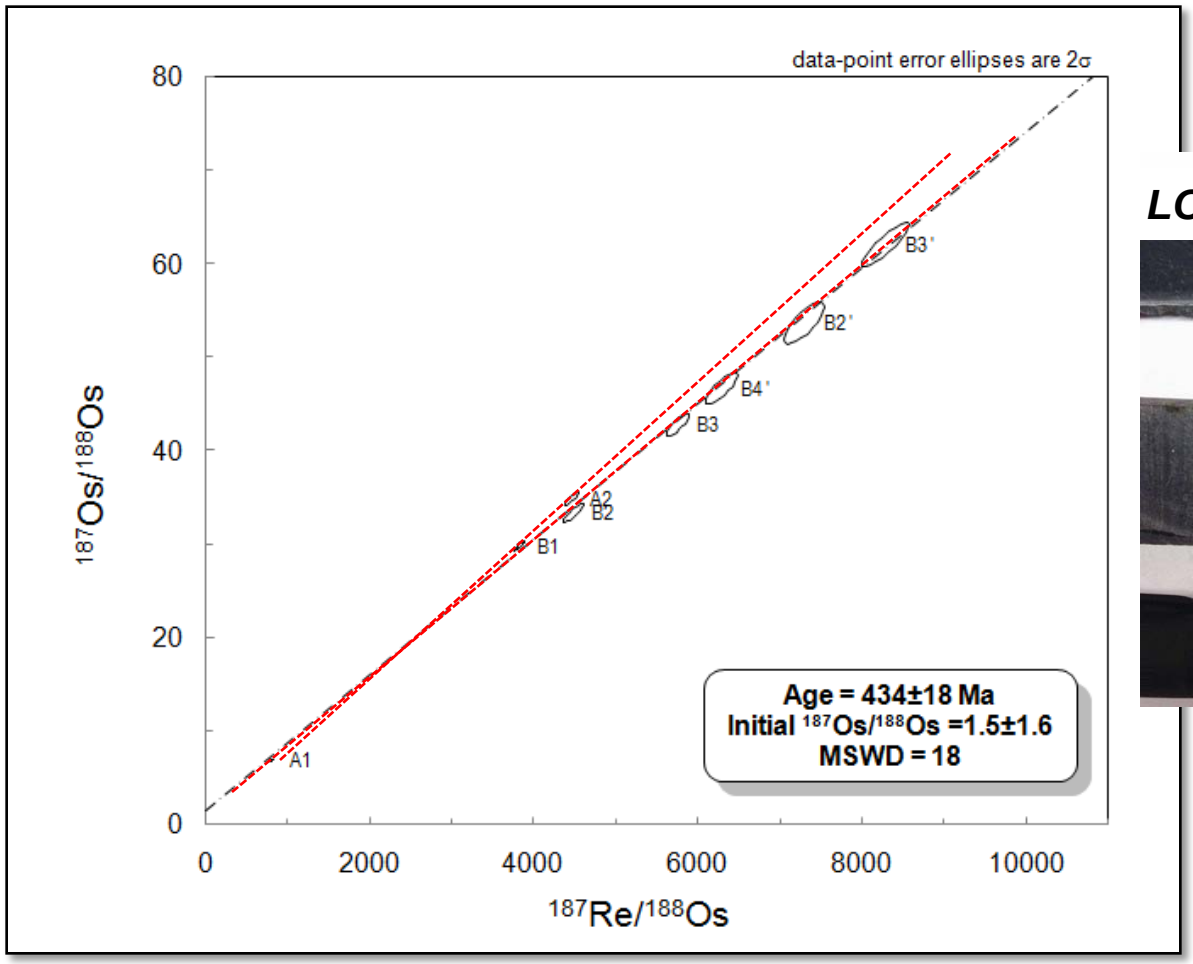
- Vein sample LC-12-16 provided an isochron age of **461.3 ± 2.9 Ma, (n=12), MSWD=1.3**



LC-12-16

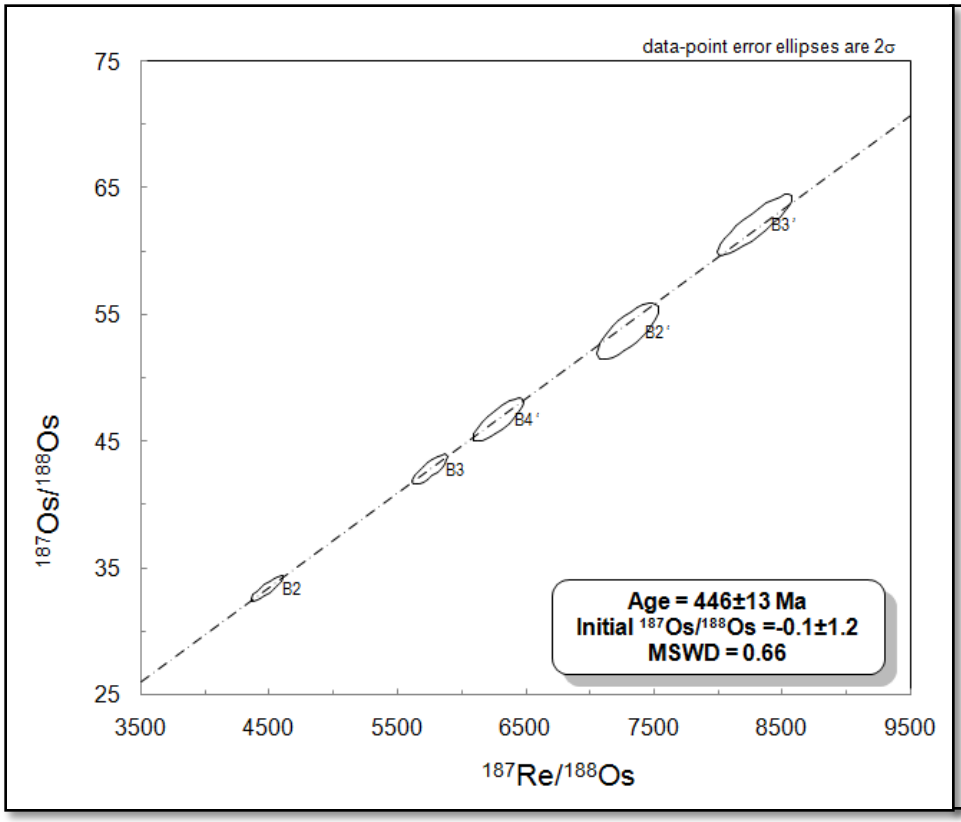
Re-Os Results – Beaver Dam Deposit

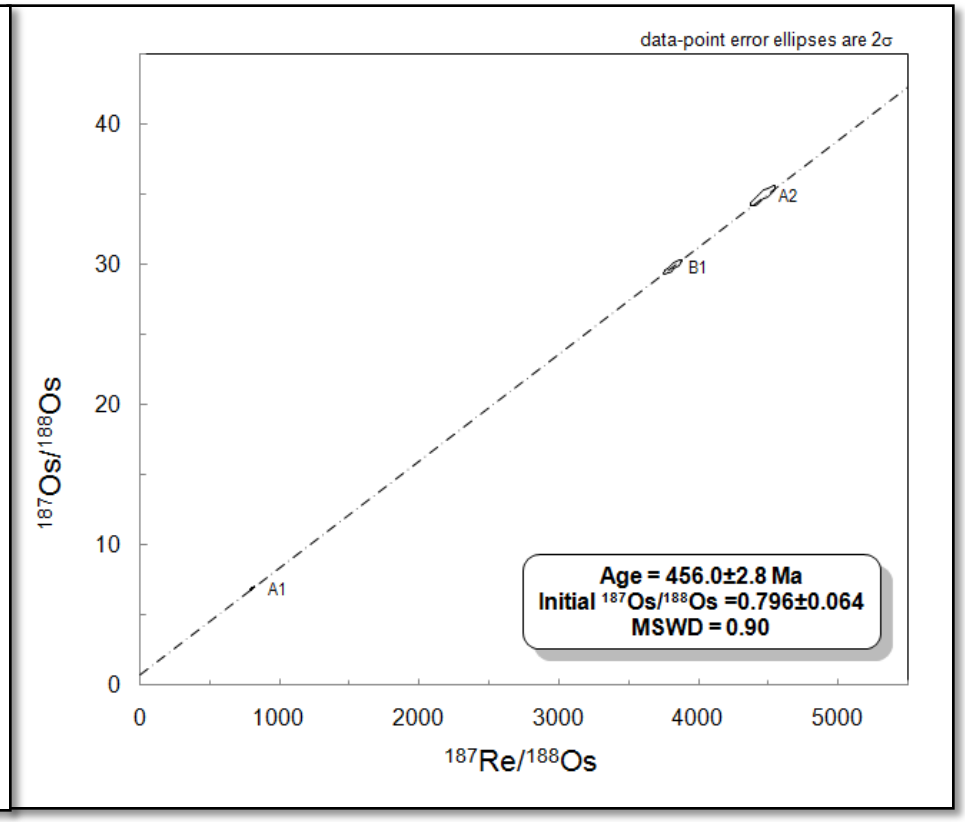
- Vein sample LC-12-15
- **High MSWD=18 (n=8), possible complex ages?**



Re-Os Results – Beaver Dam Deposit

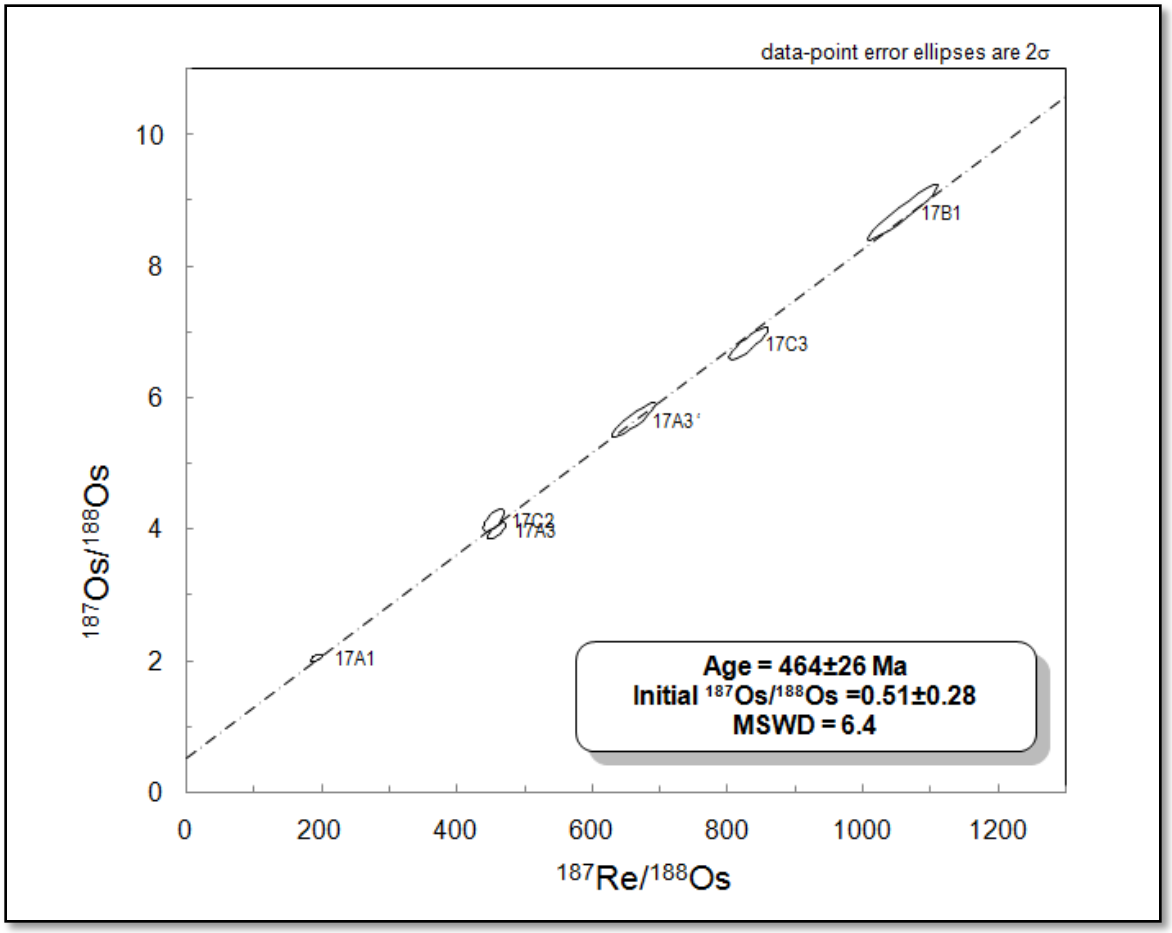
- Vein sample LC-12-15 : two data groups in Re-Os plot: isochron ages **446±13 Ma, MSWD=0.66 (n=5)** and **456.0±2.8 Ma, MSWD=0.90 (n=3)**
- Multiple growth stages





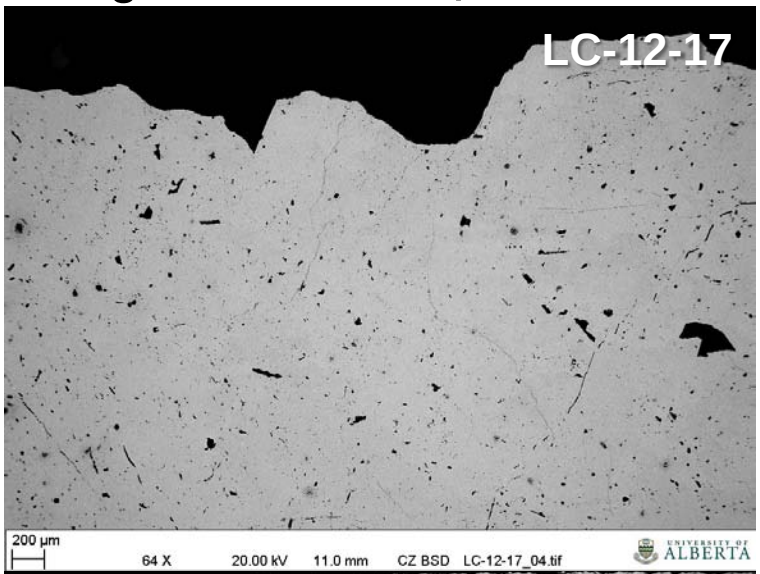
Re-Os Results – Beaver Dam Deposit

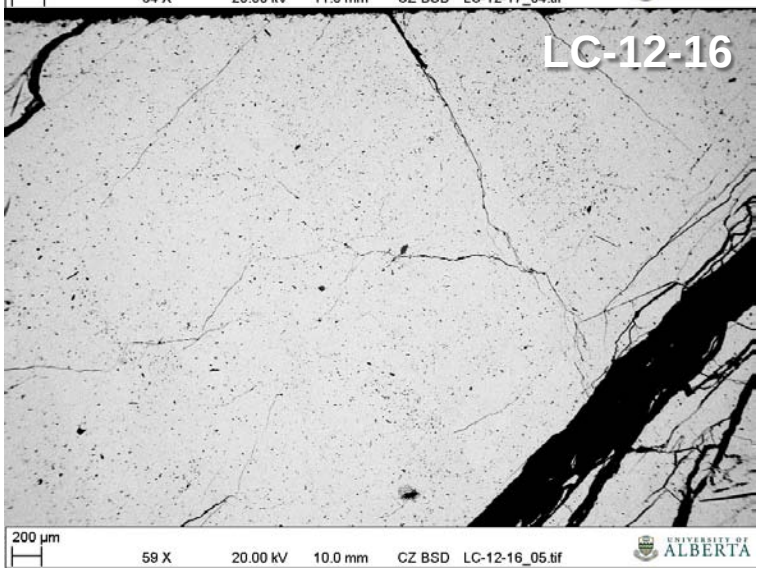
- Vein sample LC-12-17 provided an isochron age of **464 ± 26 Ma.(n=6)**
- Uncertainty due to the low concentration of Re and Os

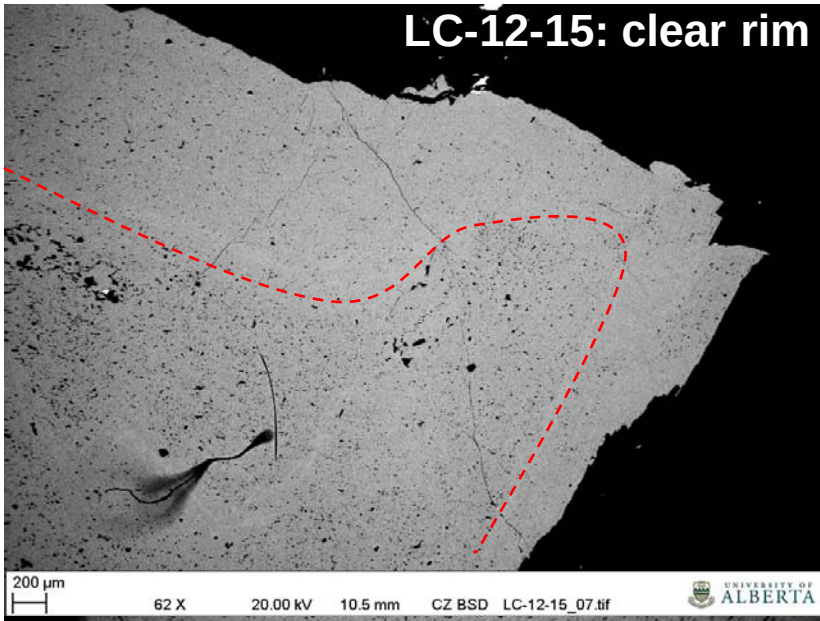


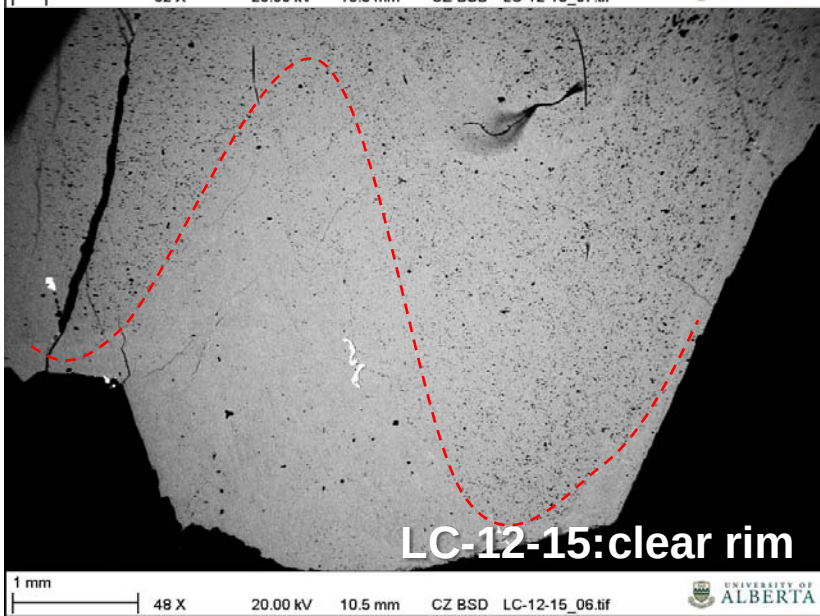
SEM Results for Arsenopyrite- Beaver Dam Deposit

- **LC-12-15**
- Overgrowth rim
- Age **446±13 Ma; 456.0±2.8 Ma**





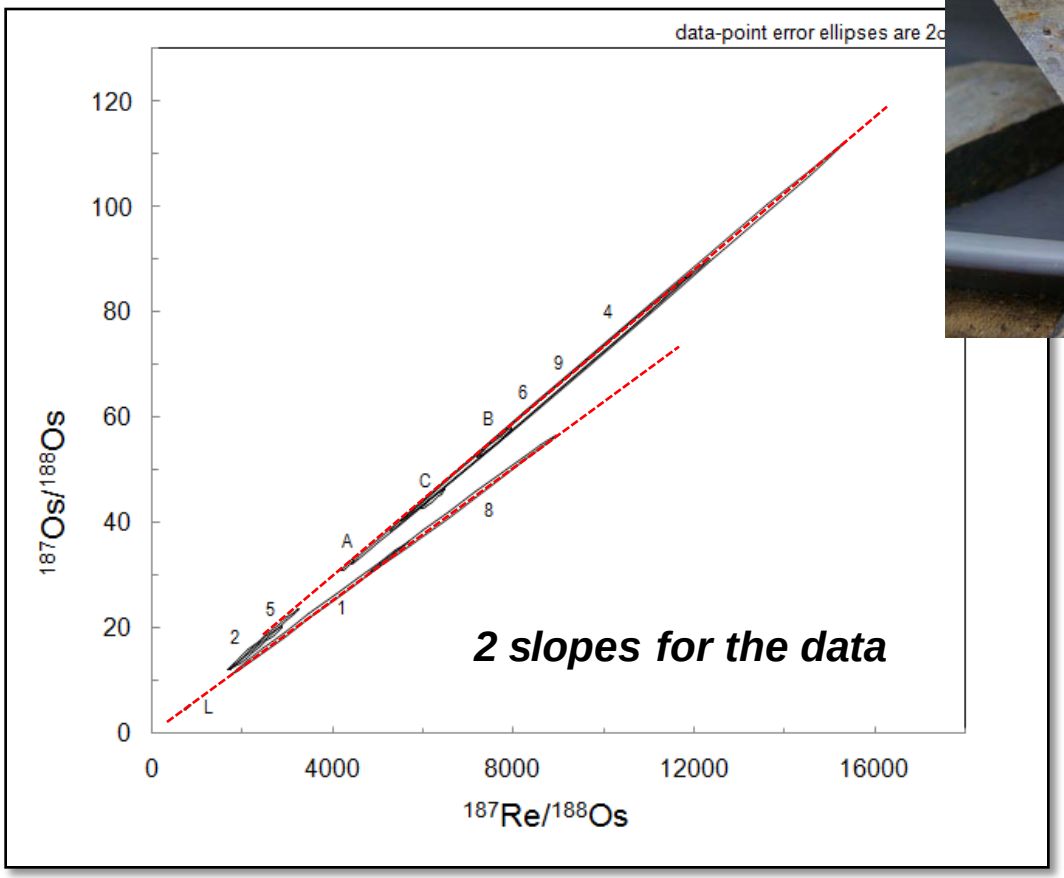




Re-Os Results – Moose River/Touquoy Deposit

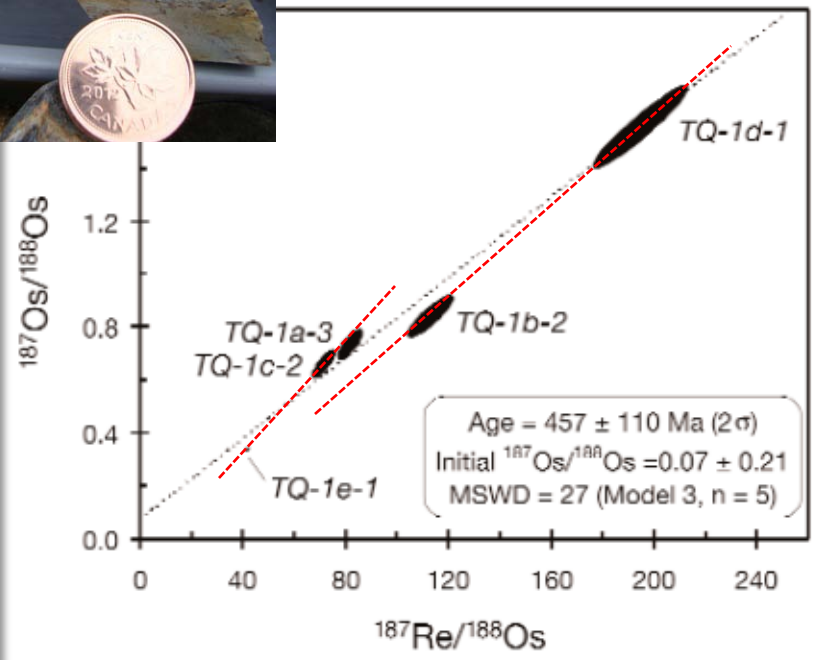
- Vein Aspy sample **LC-12-02** provides a complex isochron.
- Diagrams compare LC-12-02 vein Aspy and Morelli et al. disseminated Aspy from the Touquoy Deposit.

LC-12-02



Touquoy/Moose River

Morelli et al. (2005)
Aspy in wall rock

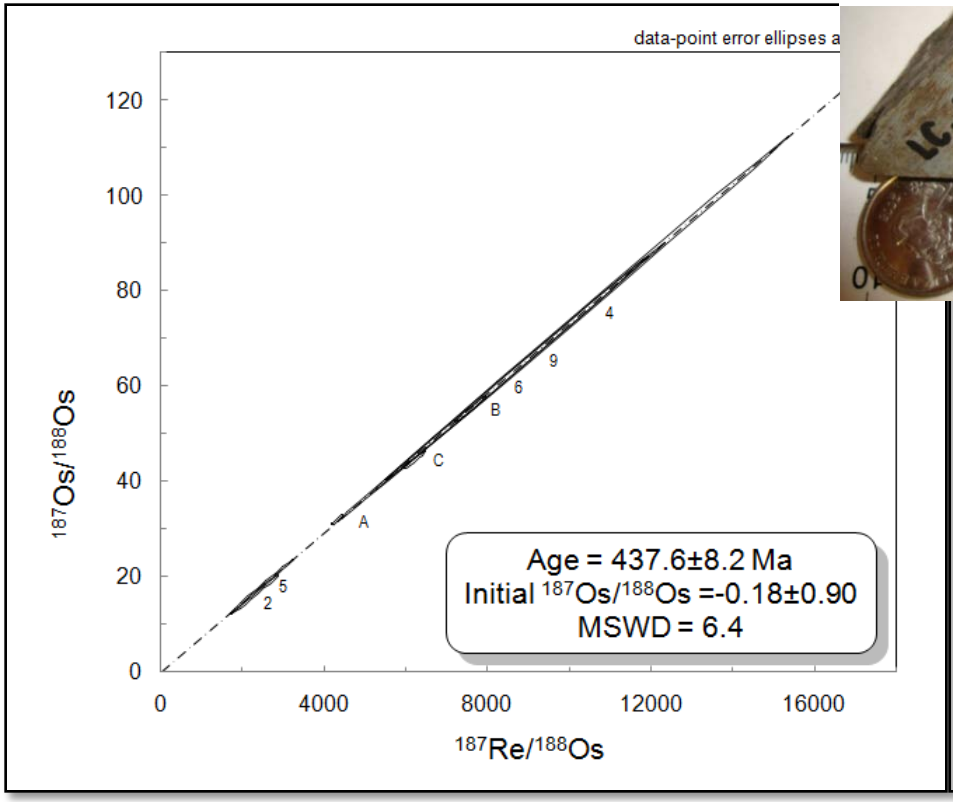


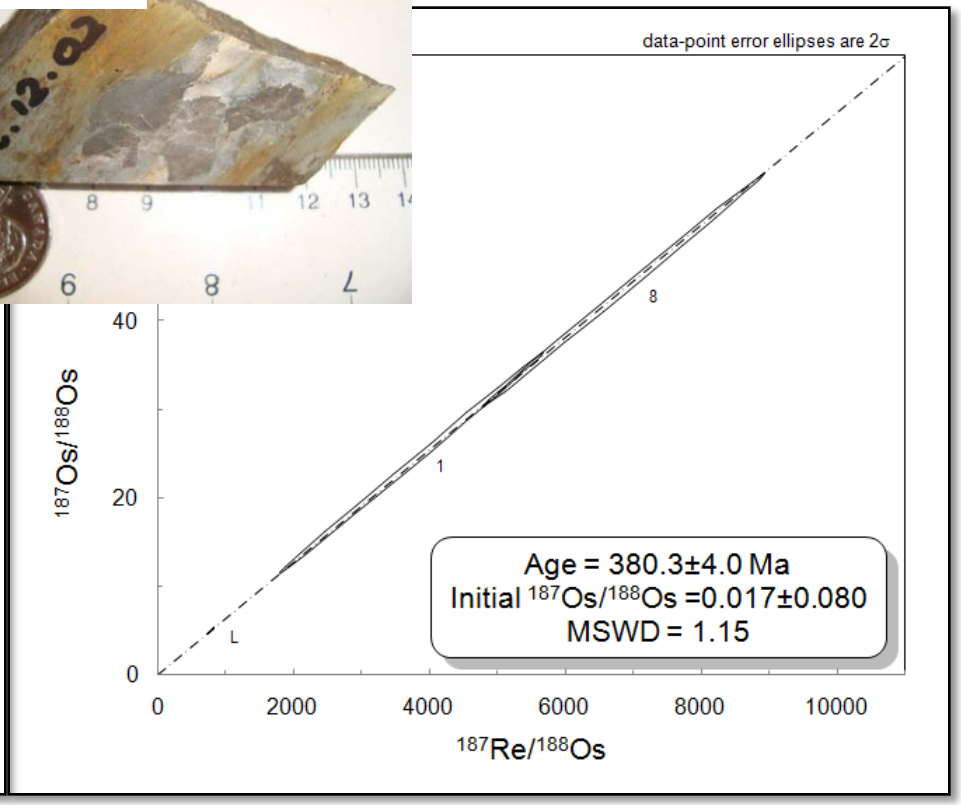
Re-Os Results – Moose River/Touquoy Deposit

- Data of the vein sample **LC-12-02** appear to define two groups in Re-Os plot: isochron ages of **437.6 ± 8.2 Ma** and **380.3 ± 4.0 Ma**.

- Thus, Aspy in the Moose River deposit appears to have more than one age

LC-12-02

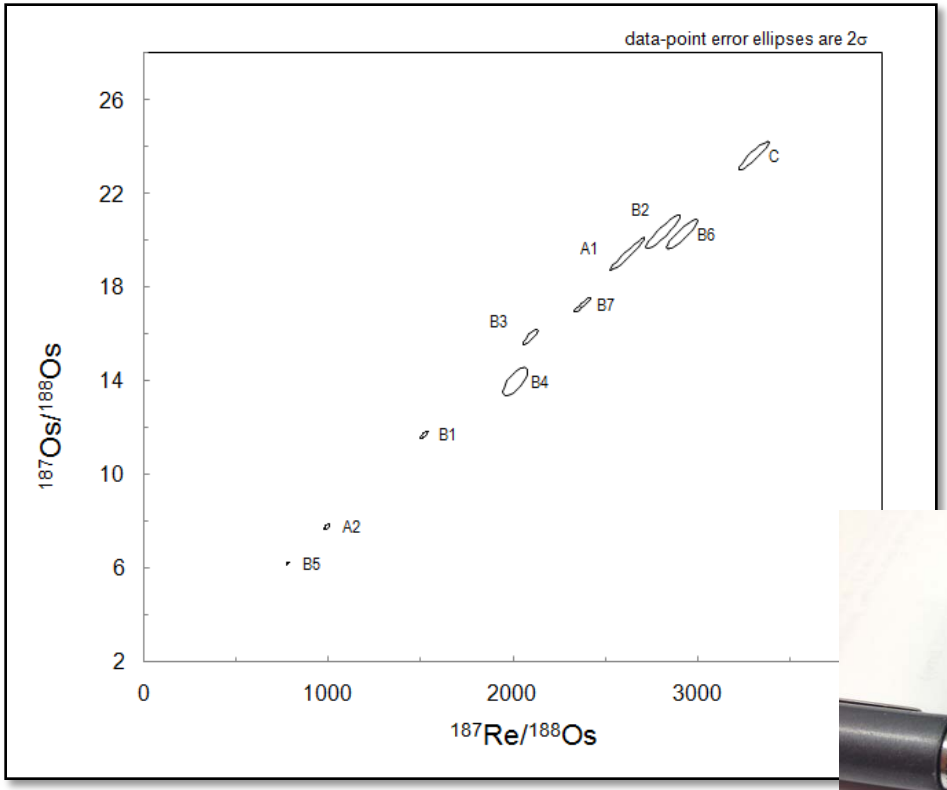


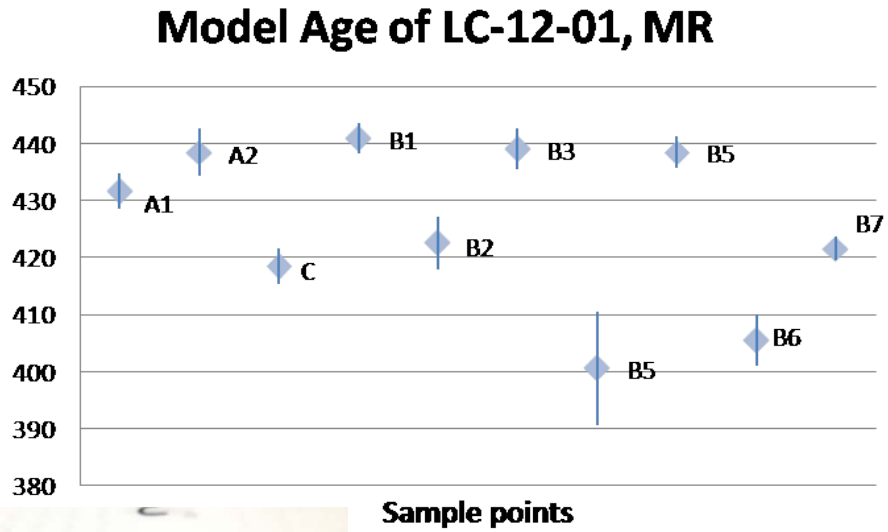


Re-Os Results – Moose River/Touquoy Deposit

• Vein sample **LC-12-01** from the Moose River deposit: Aspy indicates Re-Os model ages from **400 to 440 Ma**;

• The Aspy from the Moose River/Touquoy deposit are not homogeneous .

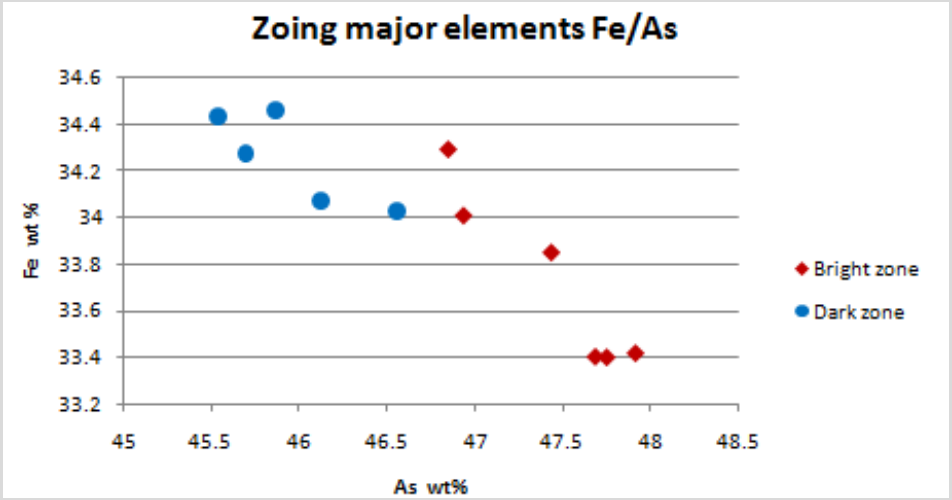


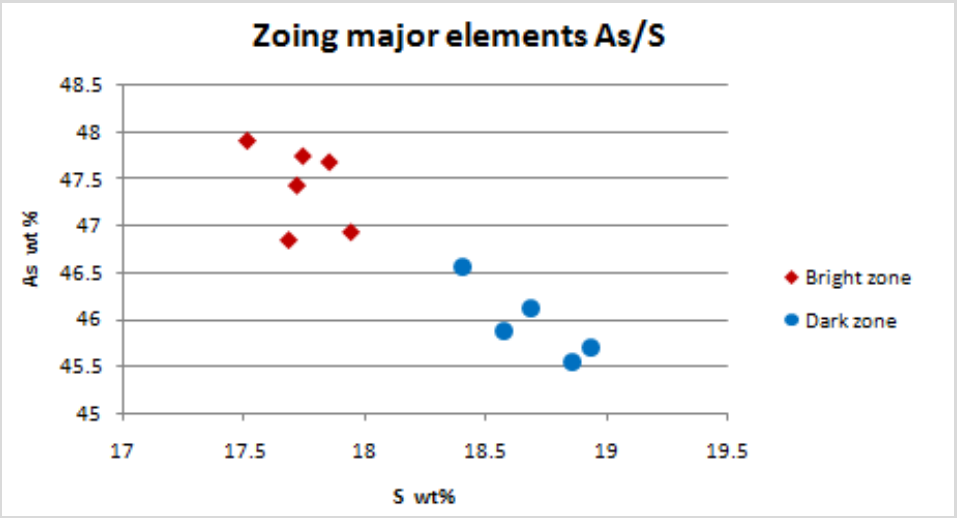


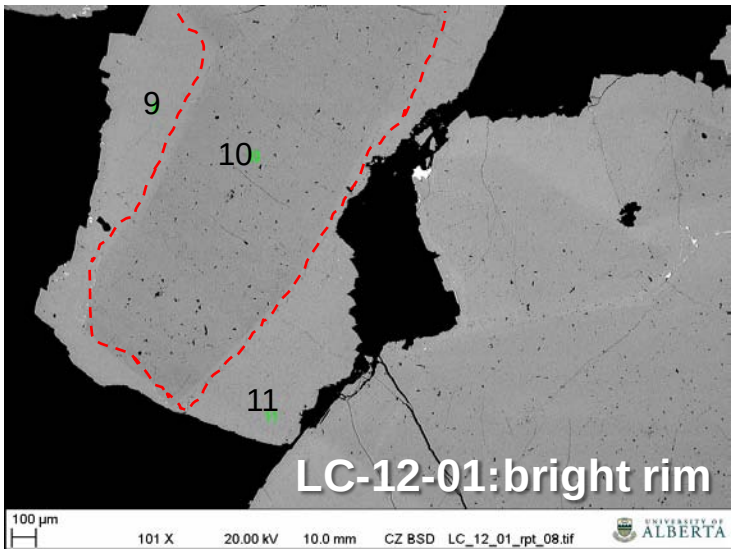
LC-12-01

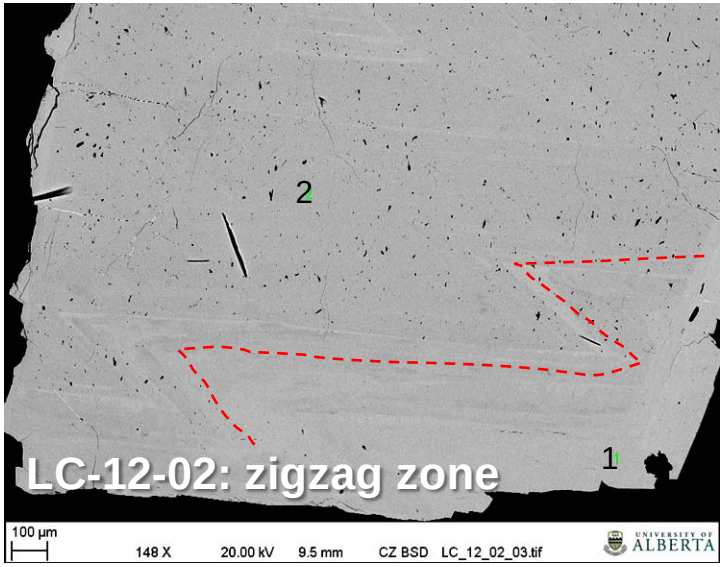
SEM Results of Arsenopyrite- Moose River

- The major element concentration are variable, zoning under low contrast





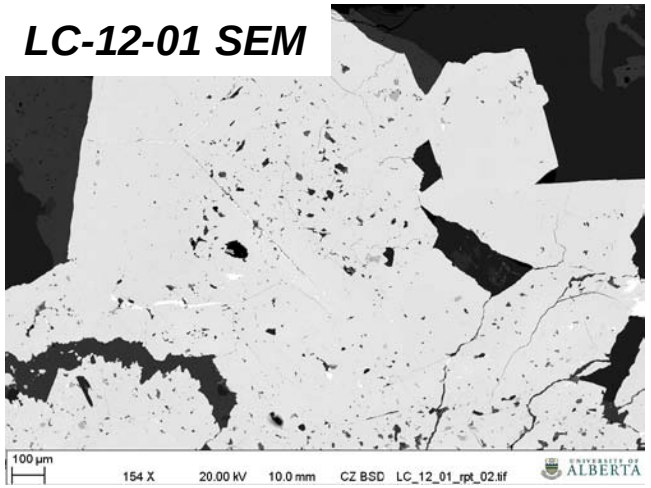


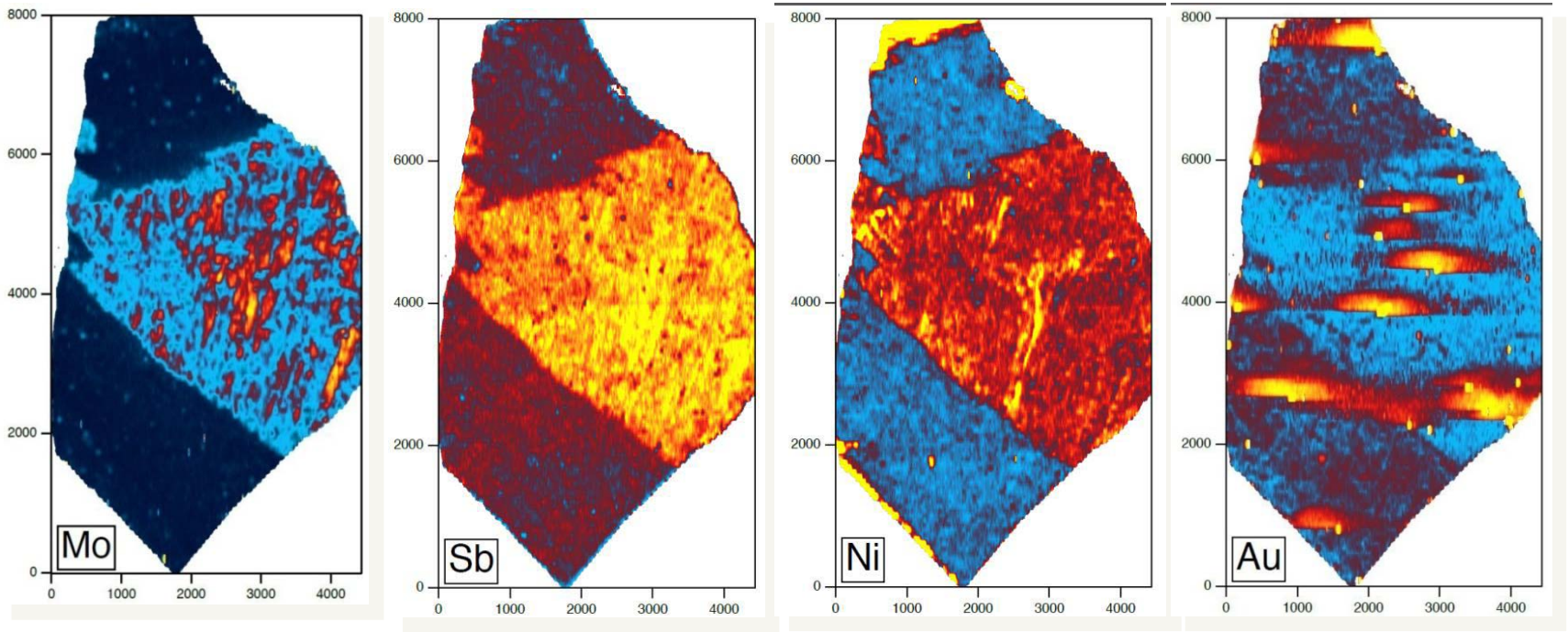


SEM - LA-ICP-MS Results
Moose River Deposit

- **SEM -** small inclusions in the core with clear overgrowth;
- **Trace element** mapping shows Mo, Sb, Ni, Au with different stages for elements (e.g., Au two stages);
- **Multiple growth of Aspy.**

LC-12-01 SEM

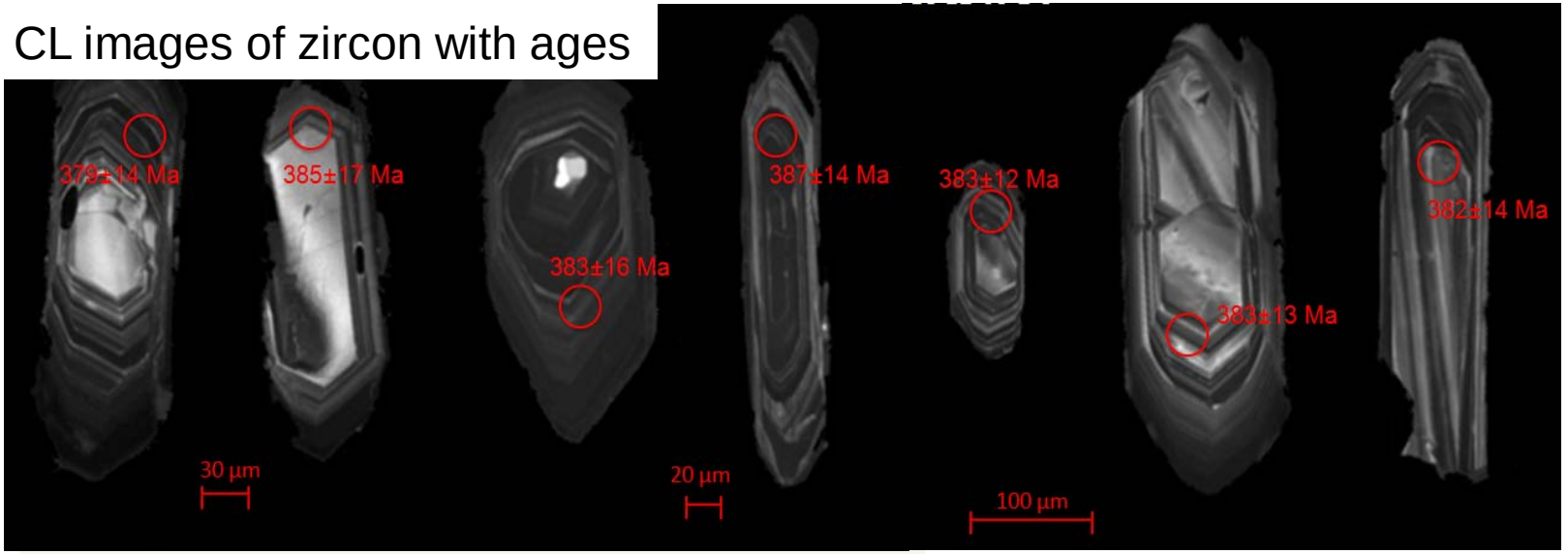




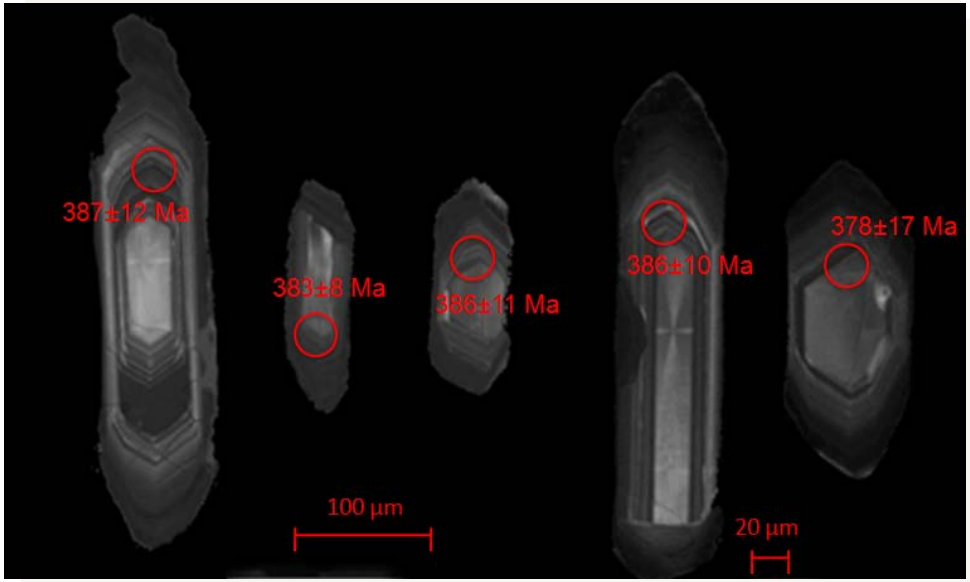
Trace element mapping of the Aspy from the Touquoy, Moose River deposit

River Lake Intrusion: U-Pb Zircon Dating

CL images of zircon with ages



Granite LC-12-05

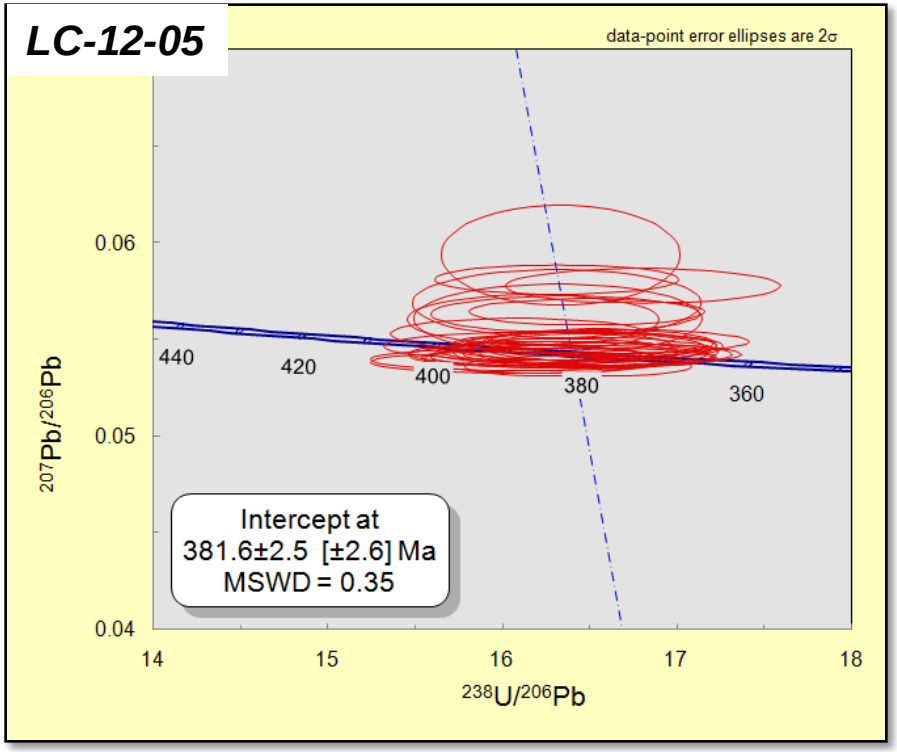


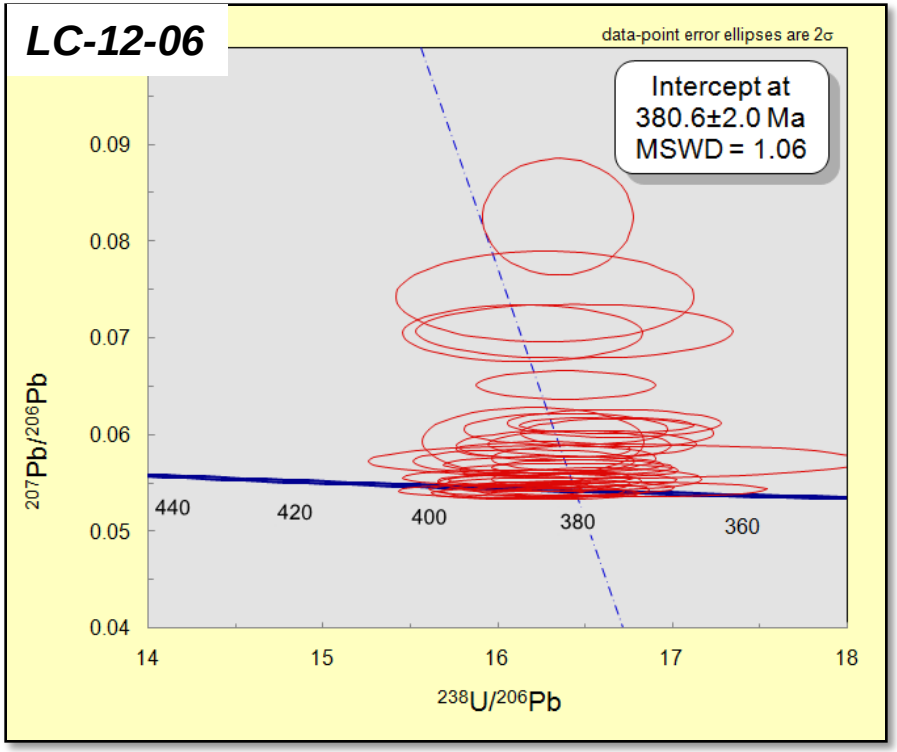
Granite LC-12-06

River Lake Intrusion: U-Pb Zircon Dating

- Granite zircon U-Pb ages:
  Sample LC-12-05: **381.6 ± 2.5 Ma**
  Sample LC-12-06: **380.6 ± 2.0 Ma**

- Data compare to U-Pb TIMS zircon ages of 378 ± 1 Ma for the Musquodoboit (Kontak et all. 2004) and 380 ± 1 for the South Mountain (Kontak et al. 2003) batholiths in the Meguma terrane.





Conclusions I

- **The Beaver Dam deposit:**
- Re-Os arsenopyrite ages of
- **LC-12-16: 461.3 ± 2.9 Ma**
- **LC-12-15: 456.0±2.8 Ma / 446±13 Ma**
- **LC-12-17: 464 ± 26 Ma**
- **Much** older than for Dufferin (380 Ma) and The Ovens (407 Ma) deposits

- Possible multiple growth: 456.0±2.8 Ma / 446±13 Ma, SEM
- No similar ages known in the Meguma terrane - what happened in the Meguma terrane before 410 Ma?
- U-Pb zircon ages of rhyolite from the Avalon Terrane - 460 Ma, 454Ma (Murphy, Hamilton, 2003, 2011)

- The new Re-Os results indicates tectonothermal events **prior to Acadian deformation;**

- The **onset of some gold mineralization** in Meguma is **pre-Acadian.**

Conclusions II

- **The Moose River deposit:**
- Complex Re-Os ages, **ca. 380 Ma and ca. 437 Ma; 400-440 Ma,** Model age

- **Multi-stage sulfide growth:**
- SEM, major and trace element evidence;
- Multiple ages - formed in Early Silurian, influenced by later metamorphism and hydrothermal events.

- **437.6 ± 8.2 Ma** : pre-Acadian arsenopyrite formation, might also be related to the Beaver Dam deposit: LC-12-15 double ages, regional event
- U-Pb zircon age of a felsic tuff of 438 +3/-2 Ma in the Meguma terrane (White Rock Fm) (MacDonald et al., 2002).
- **ca. 400 Ma-410 Ma**: regional metamorphism
- **ca. 380.3 ± 4.0 Ma**: granite intrusion

- **Granite U-Pb zircon age: 381.6 ± 2.5 Ma; 380.6 ± 2.0 Ma**
- ~Conforms to the 380 Ma magmatic activity in the Meguma terrane

Thanks!
Questions?

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Laser-ablation ICP-MS laboratory at Laurentian University
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Scanning Electron Microscope Lab at the University of Alberta
Canadian Centre for Isotopic Microanalysis at the University of Alberta
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