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

- $^{39}\text{Ar} - ^{40}\text{Ar}$ 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 $380 \pm 3$ Ma (Dufferin) and $407 \pm 4$ Ma (The Ovens) indicate multi-stage gold district, but Touquoy zone, Moose River: $457 \pm 110$ 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

LC-12-01, Moose River, RL image (50x)

SEM images, Moose River deposit
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 $461.3 \pm 2.9$ Ma, $(n=12)$, MSWD=1.3
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 \( 464 \pm 26 \) Ma. (n=6)
- Uncertainty due to the low concentration of Re and Os

![Diagram showing Re-Os isochron plot with data-point error ellipses and age and initial Os/Os values]
SEM Results for Arsenopyrite- Beaver Dam Deposit

- LC-12-15
- Overgrowth rim
- Age 446±13 Ma; 456.0±2.8 Ma
• 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.
Data of the vein sample LC-12-02 appear to define two groups in Re-Os plot: isochron ages of $437.6 \pm 8.2$ Ma and $380.3 \pm 4.0$ Ma.

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

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: $381.6 \pm 2.5$ Ma
  - Sample LC-12-06: $380.6 \pm 2.0$ Ma

- Data compare to U-Pb TIMS zircon ages of $378 \pm 1$ Ma for the Musquodoboit (Kontak et al. 2004) and $380 \pm 1$ 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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