

# **Gold in the Annidale Belt : mesothermal lode-type or extension of intrusion-related systems in southwestern New Brunswick?**

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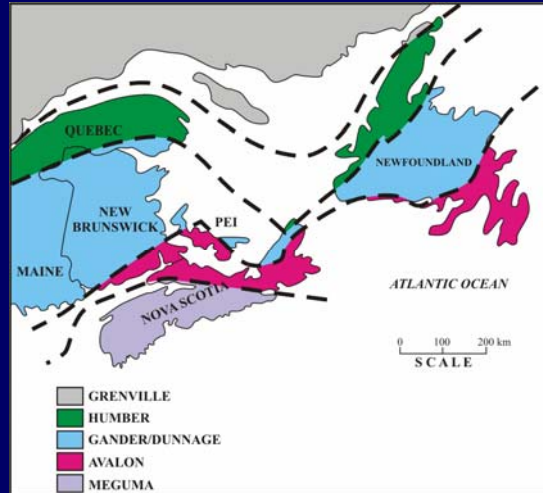


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Division des minéraux, des politiques et de la planification*



As the title suggests, the presentation focuses on the Annidale belt in south central New Brunswick and some of the ideas we have been working on with respect to the similarities between intrusion-related gold systems in southwestern N.B. and gold mineralization in the Annidale area, along strike to the northeast. This work has been a collaborative effort and utilizes information gathered from many sources. A brief overview of the tectonic history and types of gold occurrences in New Brunswick is also given.

## Tectonic Subdivisions of the Northeastern Appalachians



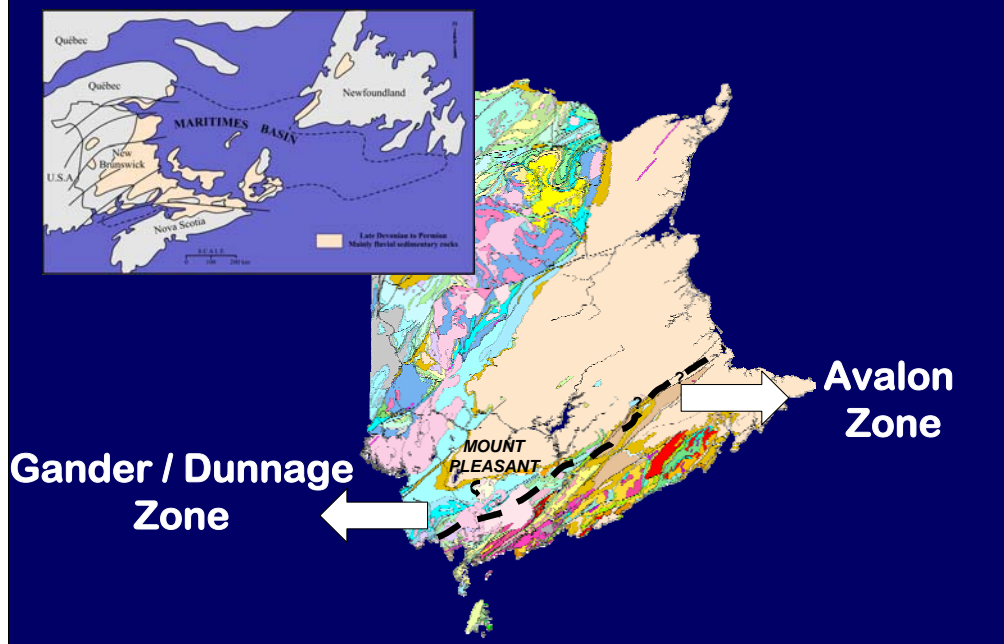
New Brunswick is located at the northeastern end of the Appalachian Orogen, which in Atlantic Canada is divided into several tectonic divisions or zones. These zones reflect various paleogeographic settings within and marginal to the Iapetus Ocean, which separated ancient North America from Gondwana in the early Paleozoic.

The New Brunswick segment of the orogen is comprised mainly of the Gander/Dunnage zone shown in blue and the Avalon Zone shown in pink. The Gander/Dunnage zone represents Cambro-Ordovician tracts of Iapetus ocean floor, island-arcs and back-arc basins along with continental margin strata deposited on the Gondwanan side of Iapetus. The Avalon Zone existed as a micro continent either along or proximal to the Gondwanan margin in the Early Paleozoic.

It is comprised mainly of Precambrian and Cambrian arc- & extension-related volcanic and sedimentary rocks overlain by a thick sequence of shallow marine sedimentary & minor subaerial volcanic rocks. These terranes were deformed and sequentially accreted to the Laurentian continental margin during the closure of Iapetus in the Ordovician and Silurian.

The boundary between the Gander/Dunnage and Avalon zones in New Brunswick is now represented by a cryptic suture, the approximate location of which is depicted by the black dashed line shown on the diagram. The boundaries between these amalgamated terranes are important as they are the location of deep-seated structures along which gold is commonly associated.

## Geological Map of New Brunswick



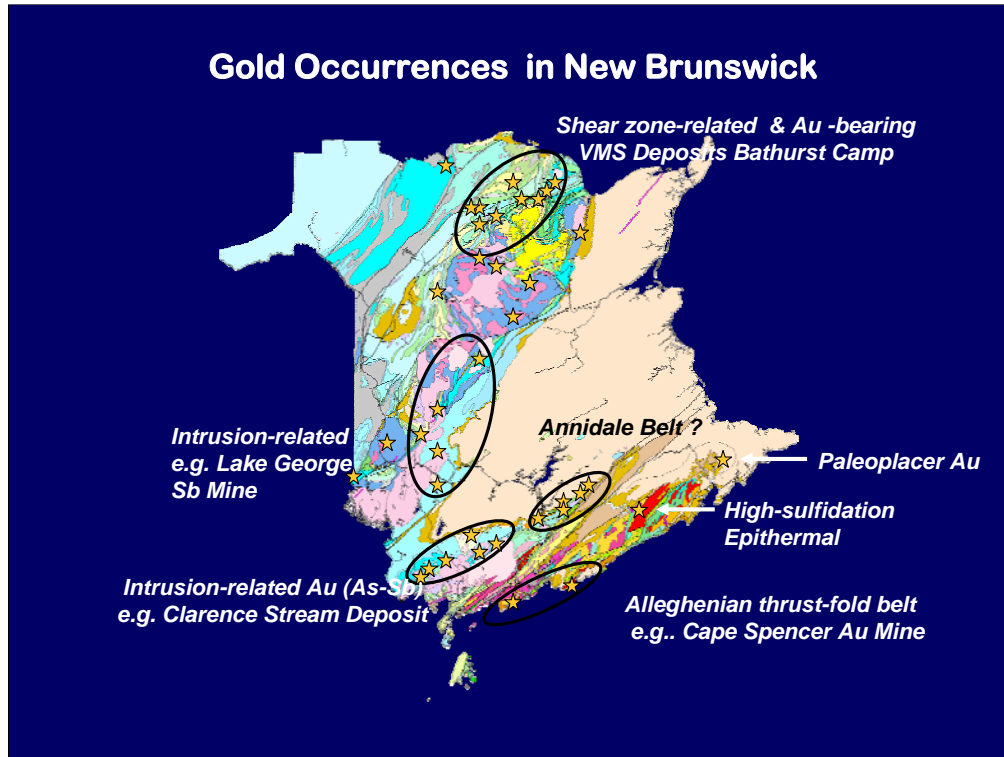
The geological map of New Brunswick shows the Cambro-Ordovician volcanic and sedimentary rocks of the Gander/Dunnage zone exposed in northern, central & southwestern NB and the Precambrian-Cambrian rocks of the Avalon zone in southeastern NB.

The Gander/Avalon boundary is now concealed by Middle Paleozoic & younger rocks, most of which were deposited in remnant basins remaining after destruction of much of the Iapetus Ocean. Rocks of Silurian age shown here in blue colours were the first strata to overstep the Avalon-Gander boundary.

As the main continental collision event ended, Silurian and older rocks were intruded by voluminous syn-to post orogenic Late Silurian to Late Devonian I- and A-type plutonic rocks (in pink colours), which in southern N.B. are represented by the Saint George & Pokiok Batholiths.

Emplacement of the youngest phase of the Saint George Batholith was coincident with the development of an epicontinental caldera complex which generated the Mount Pleasant Sn-W-Mo-Bi-In deposit.

Immediately following batholith emplacement a large intermontane basin, referred to as the Maritimes Basin, developed under an extensional tectonic regime. The erosional remnants of the Maritimes Basin, shown in the tan color, comprise Latest Devonian and Carboniferous, generally flat-lying, terrestrial sediments that were eroded from the uplifted Appalachian orogen. The Maritimes Basin contains our potash, natural gas and oil reserves along with sedimentary copper and uranium occurrences.



By virtue of New Brunswick's diverse geology there are several types of gold occurrences in NB.

Epigenetic gold occurrences associated with major faults and shear zones & gold extracted from gossans over VMS deposits are found in northern New Brunswick.

Another major type of gold occurrence, represented by the past producing Cape Spencer Mine and Armstrong Brook property, is associated with Permian folding & faulting related to the final docking of the Meguma terrane of Nova Scotia.

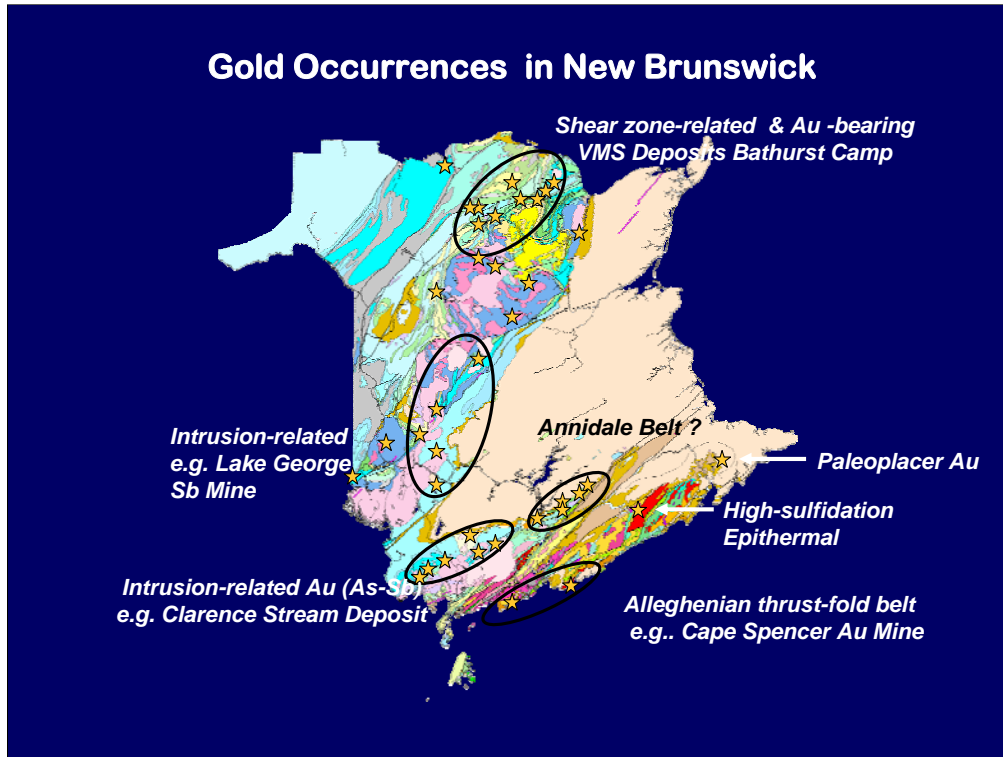
High sulfidation epithermal gold has also recently been identified in southeastern New Brunswick and may be analogous to mineralization of this type in the Avalon Zone of Newfoundland; however, our work on this is in a very preliminary stage.

We also have paleoplacer gold occurrences in Carboniferous fluvial sediments in the southeastern part of the province.

Intrusion-related gold mineralization associated with Devonian granitic rocks throughout the province is one of the most significant types of gold occurrences found to date. This type is represented by the Clarence Stream deposit in southwestern N.B., which is currently under evaluation by Freewest Resources, and continues to yield promising results.

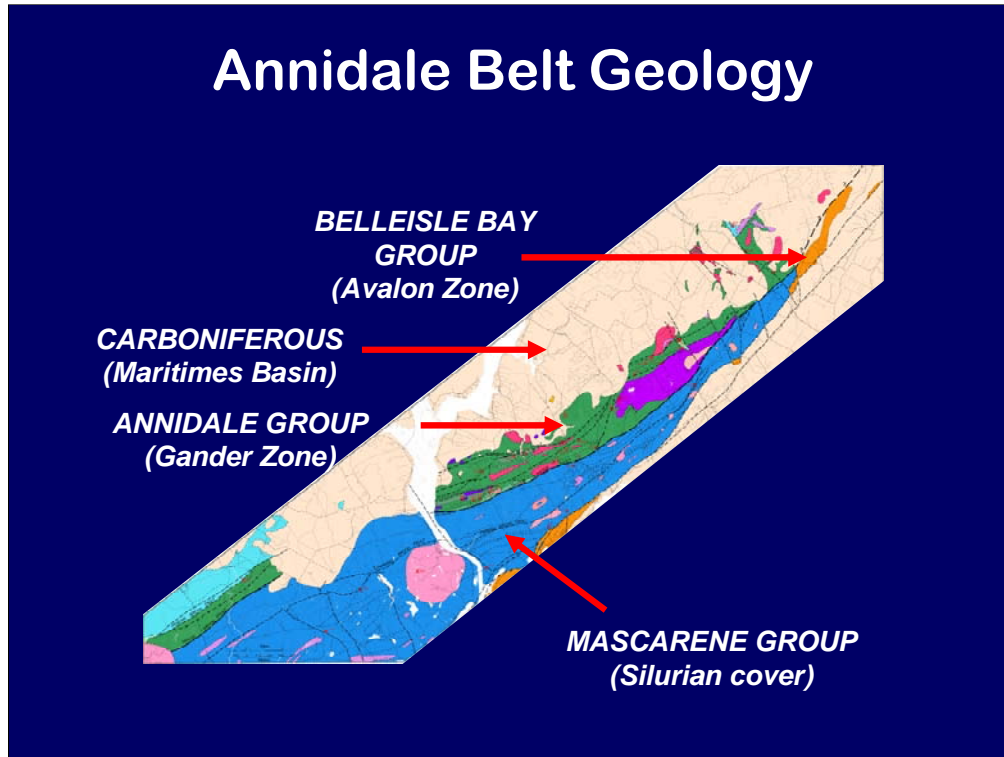
Mineral deposit studies in the Clarence Stream belt, which were part of a federal TGI project, have demonstrated that the gold in this belt is magmatic in origin and that the timing of the mineralization coincides with the emplacement of the Early Devonian Magaguadavic intrusive phase of the Saint George Batholith.

Another important feature of these deposits is that they are located in close proximity to the Avalon - Gander boundary and straddle the Sawyer Brook Fault, which separates the Silurian Mascarene cover sequence from Cambro-Ordovician rocks of the Gander Zone.



The Annidale Belt to the northeast of Clarence Stream occupies a similar position with respect to the Mascarene cover sequence and rocks of Ganderian affinity. The Annidale Belt also contains numerous gold occurrences, most of which are associated with quartz/carbonate veins along northeast-trending shear zones or northwest-trending brittle faults. Although the exact nature of these occurrences is still poorly understood, some preliminary ideas have started to emerge which may shed some light on the genesis of these deposits.

# Annidale Belt Geology



A simplified geology map of the Annidale Belt shown above, taken from Johnson and McLeod (2000), Johnson (2001, 2003, 2005) and McLeod (2000, 2005), is coloured primarily to emphasize the three major pre-Carboniferous volcano-sedimentary sequences which transect the belt. These are:

Precambrian and Early Cambrian Avalonian rocks of the Belleisle Bay Group (in orange)

Late Cambrian-Early Ordovician Ganderian rocks of the Annidale Group (in green)

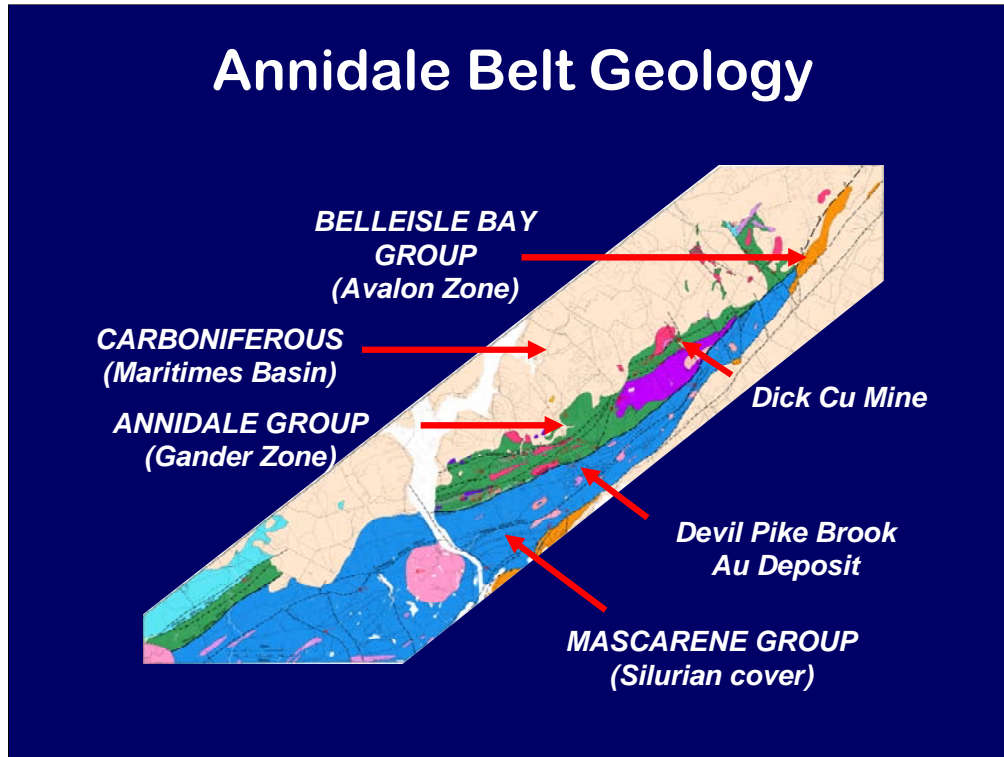
Silurian cover rocks of the Mascarene Group (in blue)

Carboniferous fluvial sedimentary rocks of the Maritimes Basin (in tan) overstep all of these units

The Annidale Group, which is host to the majority of gold occurrences in the belt, comprises a sequence of mafic volcanic rocks, black shales, ultramafic rocks, qtz-mica schist, and felsic intrusions and rhyolitic domes (shown in dark pink). The sequence is polydeformed and dismembered into a number of different thrust panels. The felsic rocks have been dated at two localities (U-Pb), both of which yielded ages ranges 495-500 Ma (McLeod et al., 1992).

Gold occurrences in the belt, depicted by the small red X's, generally occur in quartz +/- carbonate veins in highly sheared and altered zones parallel to the regional fabric, although there are gold occurrences associated with northwest-trending faults as well.

# Annidale Belt Geology

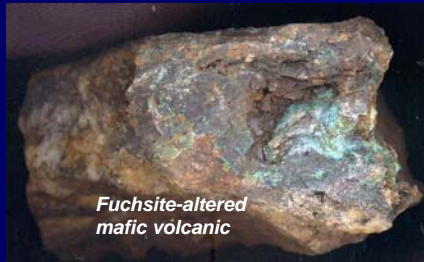
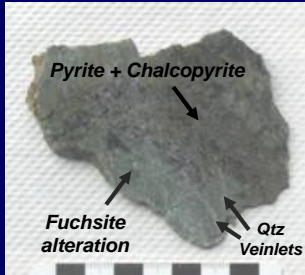


One of the most thoroughly studied gold occurrences is the Devil Pike Brook deposit hosted by the Silurian Mascarene Group about ½ km south of the faulted boundary with the Annidale Group. Gold is accompanied by abundant pyrite, lesser chalcopyrite, minor sphalerite and trace arsenopyrite (Lafontaine et al., 2005). Preliminary conclusions suggest that the characteristics of the deposit are most comparable to mesothermal lode-type gold deposits.

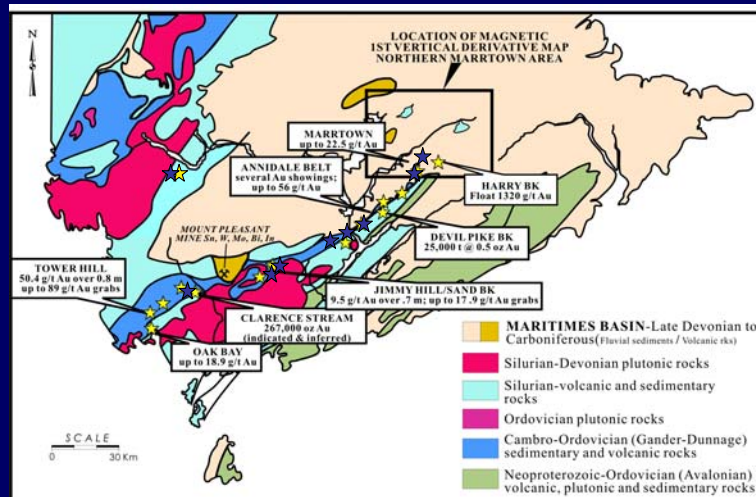
A similar association between gold, copper, pyrite and other base metals characterizes the Old Copper Mine at Annidale. The Annidale copper zone occurs adjacent to extensive fuchsite alteration zones which contain low-grade gold.

# Annidale South Fuchsite Zone

Au, Cu, Ag, Zn, As, Pb



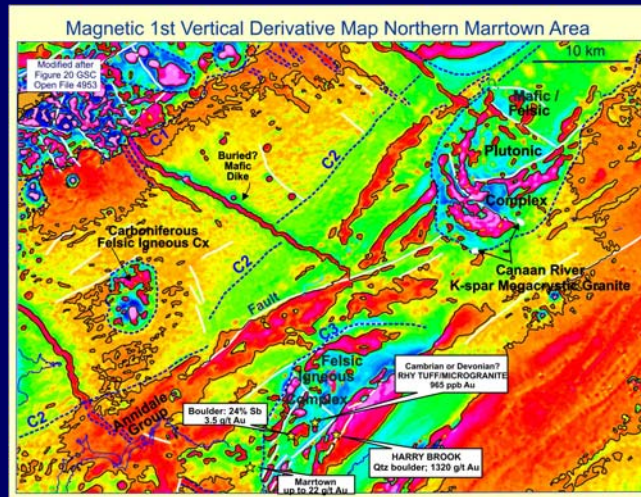
## Distribution of gold occurrences in Annidale and Clarence Stream areas



This diagram shows the distribution of some of the more significant gold occurrences in the Clarence Stream, Lake George and Annidale areas (gold stars). Mineral deposit studies by (Thorne et al. 2005 & references therein) have demonstrated that the gold mineralization at Clarence Stream is spatially and temporally associated with an Early Devonian K-feldspar megacrystic granite (Magaguadavic Granite of McLeod, 1990). The presence of late antimony veins characterizes the intrusion-related gold mineralization at Clarence Stream and Lake George and this association appears to continue into the Annidale area. Antimony occurrences and massive antimony float (shown as blue stars) occur throughout the Annidale belt (e.g. Gardiner, 2003). In the western part of the belt near Bald Hill, work by Thorne (2005) resulted in the discovery of massive antimony veins (2.3 % Sb) in brecciated microgranite with elevated levels of gold (600 ppb Au) and arsenopyrite (1.2% As).

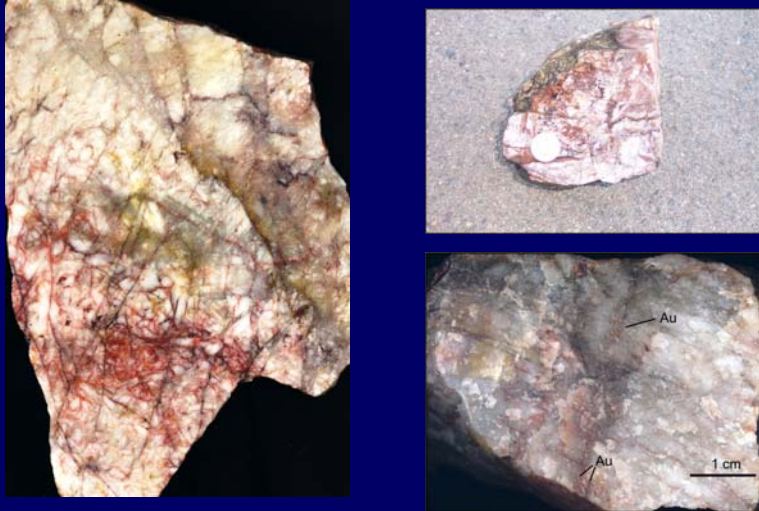
Massive antimony boulders have also been reported from the Marrtown - Harry Brook area in the extreme northeastern end of the Annidale Belt. Although the pre-Carboniferous basement rocks of the Annidale Group are mainly concealed by a thin cover of Carboniferous rocks in this area, a recent high resolution aeromagnetic survey by the GSC (located on above diagram) indicates the presence of shallowly-buried felsic igneous rocks.

## Northeastern Annidale Belt



This diagram, taken from Thomas and Kiss (2005), is the first vertical derivative magnetic map for the northeastern end of the Annidale belt, an area where basement rocks are mostly concealed beneath a thin cover of Carboniferous sandstone. The magnetic map exhibits several interesting features, one of which occurs in the vicinity of the Marrtown gold occurrence and Harry Brook high-grade gold-bearing quartz float. Using gravity data in conjunction with the magnetic maps, Thomas and Kiss (2005) interpreted the arcuate magnetic high in this area to be a shallow-buried felsic igneous complex and the discovery of microgranite and rhyolite tuff in the Harry Brook inlier confirms this. Several small basement inliers in the Canaan River area consist of K-feldspar megacrystic granite (similar to the Magaguadavic Granite) over a similar arcuate magnetic high in the northeastern corner of the map.

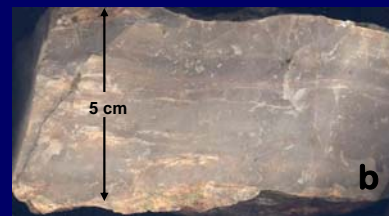
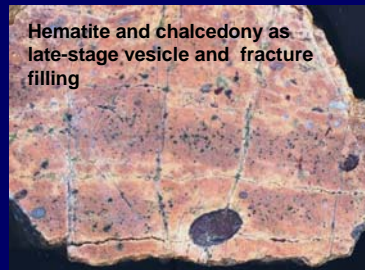
## Harry Brook - 1320 g/t Au



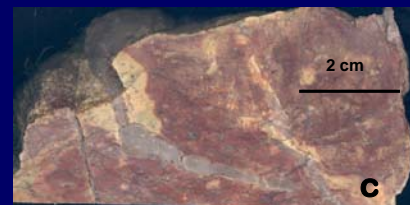
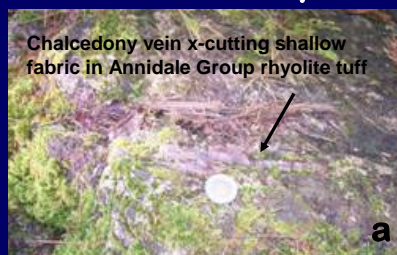
*Visible gold along hematite microfractures in quartz boulder*

These are photographs of recently discovered high-grade gold-bearing boulder in the Harry Brook area. The boulder was found approximately 500 metres downstream from one of the highest stream sediment gold anomalies in the area (Geological Survey of Canada, Open File Report 1638, 1988). The quartz vein material is in part brecciated and contains abundant hematitic microfractures and a crude quartz/chalcedony banding. The sample, assaying 1320 g/t Au, also contained elevated Hg (2.83 ppm) and > 10 ppm Ag (above the detection limit).

### Rhyolite tuff Harry Brook inlier



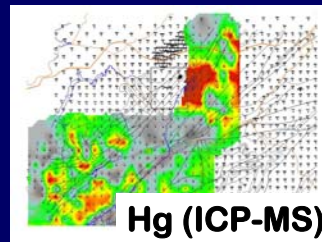
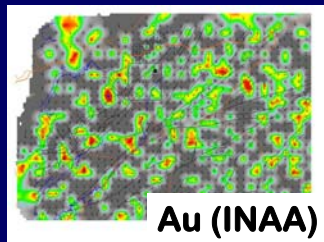
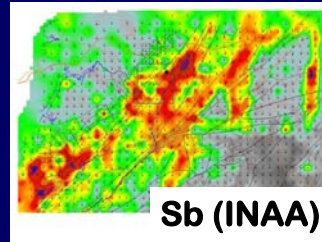
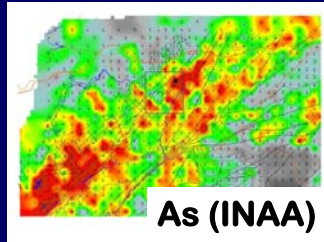
### Rhyolite tuff Annidale Gp



During the 2005 field season, an outcrop of felsic tuff was discovered on a logging road northwest of the gold-bearing boulder on Harry Brook (Harry Brook inlier). As shown on a previous slide, the outcrop overlies the magnetic feature interpreted to be a large felsic igneous complex. The tuff contained elevated gold (965 ppb), chalcedony/quartz & hematite veins, fractures and vug fillings along with autobrecciated zones which suggest that the veining/fracturing was syn-volcanic (upper left photo in diagram above). Based on the presence of black matrix felsic breccia in the Harry Brook inlier, these rocks were tentatively correlated with black rhyolite domes of Cambrian age that occur along strike in the Annidale Group. This correlation however, is now questioned for a couple of reasons: Thin sections of the felsic tuff in the Harry Brook inlier revealed that it exhibits perfectly preserved glass shards and is classified as an unwelded, vitric-crystal tuff, which is uncharacteristic of the tuffs in the Annidale Group (photos a, b, & c).

In addition, recently discovered chalcedony veins in the Annidale Group tuffs in the Stewarton area clearly cross-cut the shallow foliation indicating these rocks were deformed prior to veining and are therefore likely older than those in the Harry Brook inlier.

## Till Geochemistry Annidale Belt - Harry Brook areas (Allard, Pronk and Bolton, 2005)



Till geochemical maps of the Annidale belt. The black star indicates the location of the high-grade gold-bearing boulder on Harry Brook. Antimony and arsenic anomalies in the southwestern corner of the maps are in the general vicinity of Bald Hill, where massive Sb-As veins occur in outcrop. The Sb-As-Hg anomalies east of the Harry Brook area have yet to be explained, however, the area has received very limited exploration to date.

## Conclusions

The Annidale Belt has excellent potential to host intrusion-related and/or high-level epithermal gold, in addition to the mesothermal lode-type gold already documented

- situated on the same tectono-stratigraphic boundary as the intrusion-related gold system at Clarence Stream
- presence of favorable structures and shallow-buried intrusions, in particular K-feldspar megacrystic granite, characteristic of many intrusion-related gold systems
- numerous (>25) gold +/- antimony occurrences, locally with bonanza-grades (> 80 g/t Au @ Devil Pike Bk and 1320 g/t Au @ Harry Bk)
- geochemical anomalies for indicator metals (Sb-As-Hg)
- abundant chalcedony/quartz occurrences with low (but anomalous) Au content
- virtually unexplored to date

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