

MINERAL COMMODITIES OF NEWFOUNDLAND AND LABRADOR

BARITE



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Foreword

This is the ninth in a series of summary publications covering the principal mineral commodities of the Province. Their purpose is to act as a source of initial information for explorationists and to provide a bridge to the detailed repository of information that is contained in the maps and reports of the provincial and federal geological surveys, as well as in numerous exploration-assessment reports. The information contained in this series is accessible via the internet at the Geological Survey of Newfoundland and Labrador website: <http://www.nr.gov.nl.ca/nr/mines/geoscience/>

Publications in the Series

Zinc and Lead (Number 1, 2000, revised 2008)
Nickel (Number 2, 2000, revised 2005, 2008)
Copper (Number 3, 2000, revised 2005, 2007)
Gold (Number 4, 2005, reprinted 2008)
Uranium (Number 5, 2009)

Rare-earth Elements (Number 6, 2011)
Iron Ore (Number 7, 2012)
Fluorite (Number 8, 2013)
Barite (Number 9, 2014)

Additional Sources of Information

Further information is available in the publications of the geological surveys of Newfoundland and Labrador and Canada. The Geological Survey of Newfoundland and Labrador also holds a considerable inventory of exploration-assessment files available for onsite inspection at its St. John's headquarters and for download via the Geological Survey of Newfoundland and Labrador website: <http://www.nr.gov.nl.ca/nr/mines/geoscience/>. Descriptions of individual mineral occurrences are available through the provincial Mineral Occurrence Database System (MODS), which is accessible from the Survey's website. Up-to-date overviews of mining developments and exploration activity targeting a range of commodities are available on-line at <http://www.nr.gov.nl.ca/nr/mines/>

Contact Address

Geological Survey of Newfoundland and Labrador
Department of Natural Resources
P.O. Box 8700
St. John's, NL, Canada
A1B 4J6
Tel. 709.729.3159
Fax 709.729.4491
<http://www.nr.gov.nl.ca/nr/mines/geoscience/>

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Compiled by T. Adams and A. Kerr, 2014

Front Cover: Pink barite veinlets in Cambrian mudstones, St. Bride's area, southern Newfoundland

Introduction

History

Barite (BaSO_4) occurs in several areas of Newfoundland as a primary commodity, and as a secondary commodity in some base-metal sulphide deposits and fluorite-bearing veins. The first barite occurrence in Newfoundland was recognized in 1874, near St. Bride's on the southwest Avalon Peninsula. A larger barite vein was subsequently discovered at Collier Point, Trinity Bay, and was mined, on a small scale, from 1902 to 1904, and again in the 1980s.

The largest resource of barite in the Province is in the Buchans Cu–Zn–Pb sulphide deposits, where barite is a major gangue mineral. Much of the barite is now concentrated in mine tailings, which were exploited in the early 1980s, and again from 2006 to 2009. Barite also occurs in Carboniferous sedimentary rocks in western Newfoundland. The Ronan deposit, located on the Port aux Port Peninsula, was explored during 1942–43, and exploited briefly in 1999. The sulphate minerals here also include the Sr-rich mineral celestite (SrSO_4). There is a local demand for barite, notably in offshore drilling applications, and potential remains for future primary or secondary production. Resources remain in the tailings from Buchans, and probably also at Collier Point. Lesser known barite veins and occurrences have, so far, seen only limited evaluation.

Uses of Barite

The petroleum industry is, by far, the largest consumer of barite (roughly 85% of global consumption) and uses it primarily as a weighting agent in drilling fluids or 'muds' utilized in drilling for oil and gas. In addition to its intrinsically high measured specific gravity (4.5 for pure BaSO_4), barite has low abrasivity, is non-corrosive, and non-toxic; in these respects, it is preferable to synthetic alternatives, and is also readily available and relatively cheap.

The unique properties of barite make it useful in several other applications. It is added as filler in paint and plastics, and is also used in the production of *lithopone*, a high-quality white pigment that is added to paints and some enamels. Barite is the main source for elemental barium, which is used by the chemical and pharmaceutical industries. Barium is opaque to ionizing radiation and is employed in diagnostic imaging of the gastrointestinal

tract. Also, finely ground barite is added to synthetic rubber to incorporate the rubber into hot asphalt, typically used in high-traffic areas such as parking lots.

Mineralogy

Barite (BaSO_4) contains 65.7% BaO and 34.3% SO_4 in its pure form. However, natural barite typically contains some strontium (Sr), and there is a complete solid solution between barite and the analogous (isomorphic) mineral known as celestite (SrSO_4). The most important property of barite and celestite is their high measured densities, but barite is significantly denser than celestite (about 4.5 g/cm^3 versus $< 4.0 \text{ g/cm}^3$ measured density, respectively). Other useful properties include three well-developed cleavages, low reactivity, low solubility and low abrasivity. Barite is soft and exceptionally easy to grind into powder. Barite has a vitreous to pearly luster, is transparent to translucent depending on the type and amount of impurities, and varies from white to different shades of blue, yellow, red and pink. It commonly forms as coarse-bladed (tabular) crystal aggregates but can also occur as compact, fine-grained, earthy forms mostly seen in stratiform deposits. Although it has a perfect cleavage, it is brittle and fractures unevenly.

Product Specifications

To have potential commercial value, barite must meet certain criteria. For example, barite used in drilling muds must have a minimum specific gravity of 4.2, which limits the amount of contaminants permissible in the concentrate, or the proportion of celestite in solid solution or physical mixtures. There are also government regulatory restrictions imposed on the concentrations of deleterious or toxic elements such as lead (Pb), cadmium (Cd) or mercury (Hg), and these limits vary according to jurisdiction. Pharmaceutical and medical applications commonly demand exceptional purity ($> 97.5\% \text{ BaSO}_4$) and low levels of heavy metals and other impurities. As a rule, barite products need to be as pure as is feasibly possible, and physical separation processes are required for lower grade stratiform deposits, or those associated with metal sulphides, such as galena or sphalerite.

Deposit Types

Three types of barite deposits provide virtually all of global barite production. Canada's contribution is trivial ($< 0.3\%$ in 2010). 'Stratiform' deposits are the largest contributors, and account for most current production;

'vein-type' deposits are the most widely distributed and highest in grade or purity, but these tend to be small. 'Residual' deposits are low-grade mixtures of insoluble barite and clays, and are no longer exploited.

'Stratiform' barite deposits are mostly hosted by marine sedimentary sequences, and were deposited on, or just below, the seafloor; they are part of a wider family of deposits known as sedimentary-exhalative (SEDEX) that are considered to result from interaction of hydrothermal or basin fluids with seawater. These deposits occur in host sequences of Proterozoic to Cenozoic age and, in the absence of sulphides, may be difficult to recognize. Many such deposits are important for contained metals (largely Zn, Pb and Ag), and in many cases (e.g., Red Dog in Alaska) recovery of the associated barite is uneconomic, although resources are significant. Other examples are barite-rich and metal-poor, and range from numerous small Ba-rich lenses dispersed in siliciclastic sedimentary rocks, to enormous deposits such as those of India, where some individual stratiform barite lenses contain up to 70 million tonnes. The barite in such deposits is typically grey or black, and associated with organic material; some amount of physical separation and concentration is generally required in its processing. Stratiform barite accumulations are also associated with some volcanogenic massive sulphide (VMS) deposits, but these are generally smaller than those known from the SEDEX environment. Barite typically occurs as a gangue mineral in the sulphide ores, and may, in some cases, form discrete horizons interpreted to be of exhalative origin, as in the SEDEX environment.

'Vein-type' barite deposits form by precipitation from hot barium-enriched hydrothermal fluids focused within faults and fractures, typically in response to fluid mixing, changing salinities, or reduced pressures and/or temperatures. Barite veins are typically narrow, irregular, and steeply dipping, but they commonly contain material of high quality that requires minimal processing, or which can be crushed and sold directly. However, associated minerals such as quartz, calcite, fluorite, and sulphides may be present, and these impact upon processing requirements and viability. Barite in such veins ranges from large bladed, well-formed crystals to fine-grained and/or amorphous microcrystalline material. Fluorite veins are a common companion to barite veins in many producing districts.

'Residual' deposits occur in tropical or formerly tropical areas through dissolution of Ba-rich rock types, in many cases low-grade material of stratiform or vein origin; barite remains with clays as a consequence of its insolubil-

ity under surface conditions. These were once important sources in parts of the USA (Missouri and Georgia) but production from these deposits has long since ceased.

Barite Deposits

Barite deposits in Newfoundland (Figures 1 and 2) include vein-type deposits (mostly on the Avalon Peninsula) and stratiform deposits (mostly in central Newfoundland); the latter are all associated with VMS-type base-metal mineralization, in which barite is a secondary commodity. Minor vein-type occurrences are widely scattered elsewhere. Barite deposits are also known on the west coast, but their origins are less clear. To date, no barite deposits have been recognized in Labrador.

Collier Point Barite Veins

The Collier Point barite veins (Figures 2 and 3) are hosted within green arkose of the Neoproterozoic (Ediacaran) Hearts Desire Formation, and represent the most important primary barite producer in the Province.

The veins are located on the Isthmus of the Avalon Peninsula (Figure 2). The main vein has a maximum thickness of 3.6 m near the shore and was

exposed for more than 600 m along its strike, with a typical thickness of about 1 m (Figure 3). It was mined on a small scale in the early 1900s by the Collier Point Barite Company, and had a total extraction of about 5000 tonnes. The material is high purity (> 93% BaSO₄). The vein was mined again in the early 1980s and approximately 8100 tonnes of ore was extracted during this stage. The Collier Point barite veins are estimated to have provided a total of 12 600 tonnes, but there is little information on remaining resources or its depth extent. Drilling work in the mid-1990s intersected apparent vein widths exceeding 8 m, and it was suggested that the remaining resources could total some 25 000 tonnes. Production resumed briefly in 1998, and it is unclear how much was mined after this estimate was made. The mine site has been rehabilitated, but loose material remains abundant on the surface. Barite is typically massive, and ranges in colour from translucent to white, grey or pink (Plates 1 and 2). Colour variation is not linked to any obvious compositional variations.

Other Vein-type Deposits in Eastern Newfoundland

Other vein-type barite occurrences in Newfoundland are scattered (Figure 1), but the largest cluster of such deposits is on the Avalon Peninsula, notably around Placentia Bay (Figure 2) and also in the St. Lawrence area

The Collier Point barite vein was the most important primary producer in the Province.

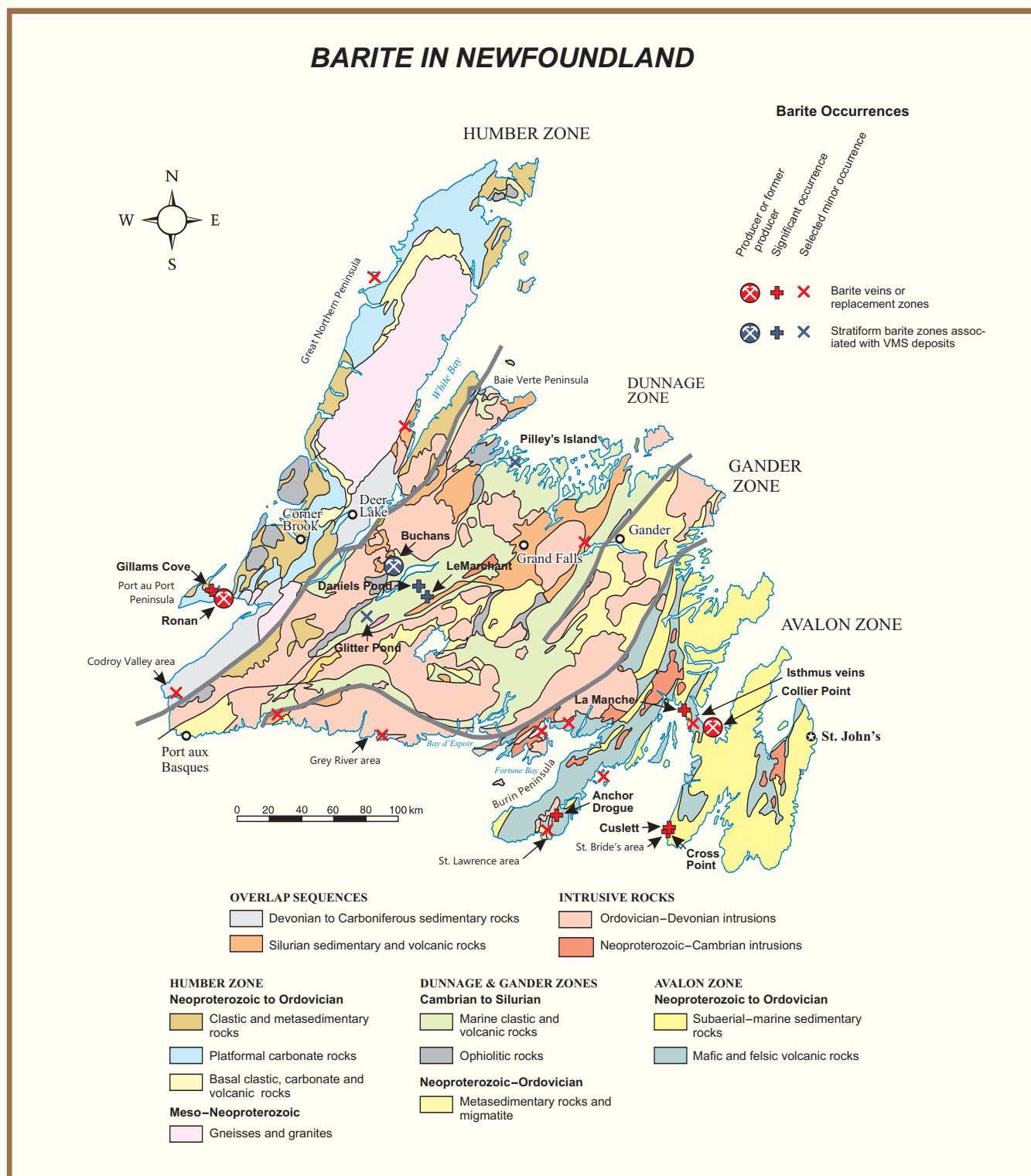


Figure 1. Simplified geological map of Newfoundland showing the locations of barite occurrences or groups of occurrences.

of the Burin Peninsula (Figure 1). The veins around Placentia Bay are essentially monomineralic barite, but in most other vein occurrences, barite is associated with fluorite, tungsten or base metals.

The best known barite veins on the Avalon Peninsula are the Cross Point and the Cuslett (also known as Otterub) veins located near St. Bride's (Figure 2). Numerous other smaller barite veins also occur, and they are hosted by late

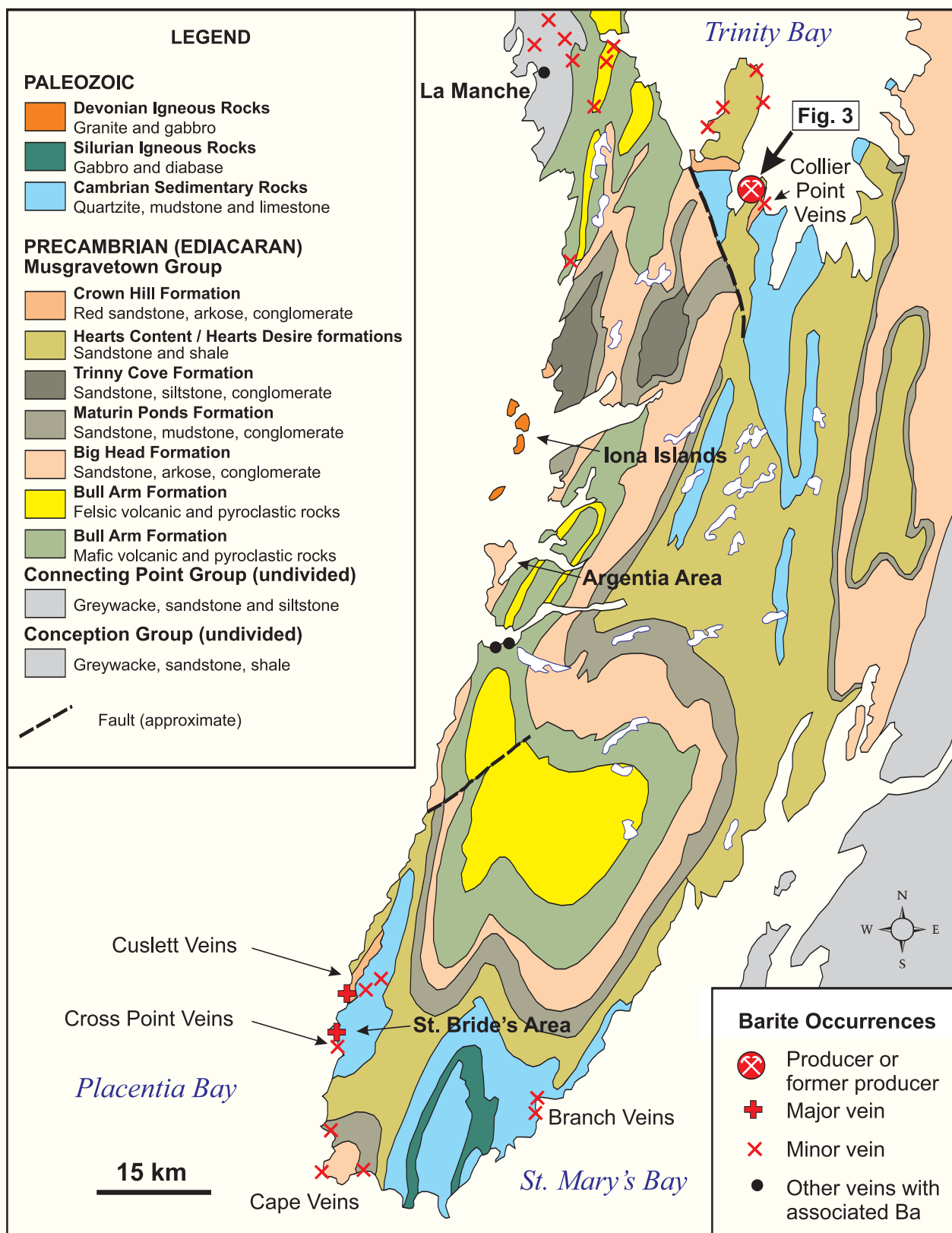


Figure 2. Geological map of the southwestern Avalon Peninsula and the Isthmus of Avalon area, showing the locations of vein-type barite occurrences. The Devonian intrusive rocks indicated on offshore islands are part of what is interpreted as a large batholithic body located beneath the waters of Placentia Bay.

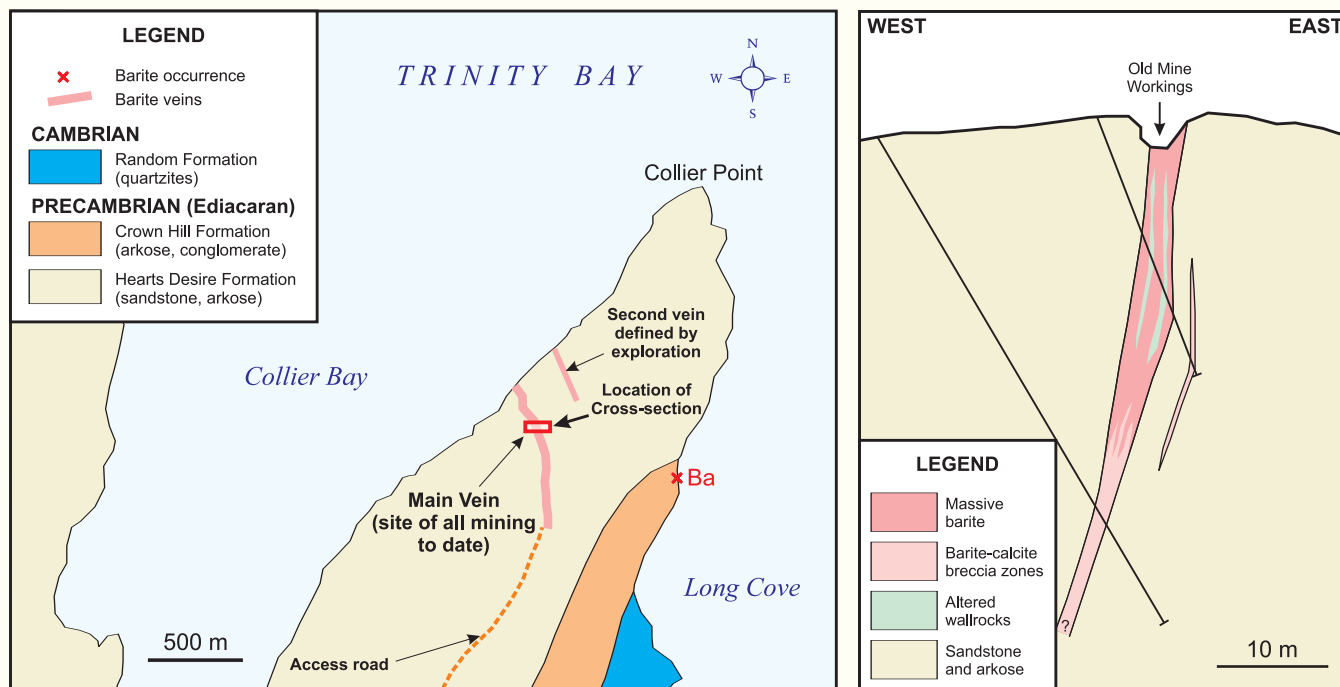


Figure 3. Simplified geological map of the area around the Collier Point barite veins, Trinity Bay, with a partly schematic east–west cross-section through the vein and its wallrocks.



Plate 1. Massive white and grey barite from the Collier Point vein, Trinity Bay.

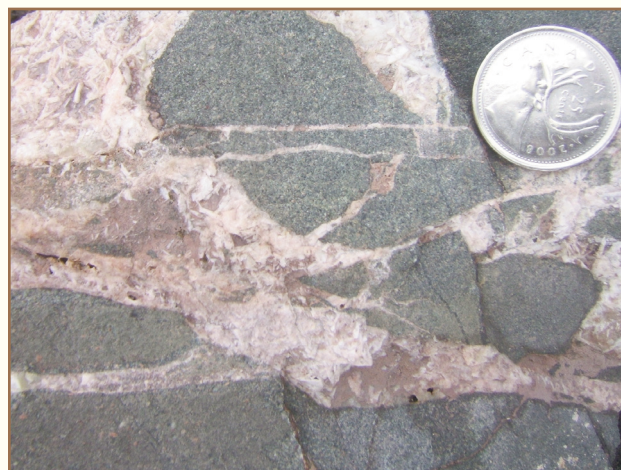


Plate 2. Minor barite veins cutting arkosic wallrocks at the Collier Point deposit, Trinity Bay.

Precambrian (Ediacaran) and Early Cambrian sedimentary rocks, most commonly associated with normal faults. The Cross Point veins occur in such a fault (Plate 3). Banding is present locally, and most of the material is salmon-pink. The Cuslett vein is similar to the Cross Point vein, and shows evidence of multiple stage growth patterns (Plate 4); bladed white barite occurs in veinlets within the surrounding arkose. In both cases, the widths of veins vary vertically, and likely also vary longitudinally. Analyses suggest high purity ($> 96\%$ BaSO_4). Similar barite veins occur in many locations along the north side of Placentia

Bay (Figure 2), and barite is also associated with Pb–Ag-rich hydrothermal veins near Argentia, and at the La Manche deposit (Figure 2). The origins of barite veins on the Avalon Peninsula are not well established, but field relations indicate a post-Cambrian and likely post-Silurian age. Barite and other veins may be linked to the hydrothermal aureole of a granitic body largely hidden beneath Placentia Bay, where granites outcrop on islands (Figure 2) and, in part, correspond with a prominent aeromagnetic anomaly.



Plate 3. *Cross Point barite vein, St. Bride's, Placentia Bay (portrait mode). Note the location of the vein within a normal fault zone juxtaposing Cambrian siltstones with red mudstone and limestone.*



Plate 4. *Barite vein in outcrop, Cuslett, Placentia Bay. Note growth zone structure.*

The fluorspar-mining district around St. Lawrence also contains barite-rich veins, and barite is present as a significant gangue mineral in many veins, including those that produced fluorspar. The Anchor Drogue vein, located northeast of the St. Lawrence area (Figure 1) is the most barite-rich. Hydrothermal veins around St. Lawrence also

contain local base-metal sulphides, and are considered to be related to the Late Devonian St. Lawrence Granite.

Buchans Stratiform Barite Deposits

The Buchans deposits of central Newfoundland (Figure 1) were one of the most important base-metal producers in the history of the Province. Large quantities of barite were associated with the sulphide orebodies, but this accumulated in the mine tailings. These represent the largest barite resource currently identified.

Barite is also widespread as a gangue mineral in massive sulphide ores, and also forms massive clasts in debris-flow ore deposits (Plate 5). The various modes of occurrence suggest that massive barite accumulations were associated with the sulphide deposits, or as separate accumulations, which were later transported to form debris-flow deposits.

A discontinuous 0.1- to 3.9-m-thick barite-rich unit overlies the rhyodacite polymictic breccia unit that forms the immediate footwall to sulphide deposits.

It is estimated that about 4 million tonnes of mine tailings from mining operations at Buchans were discarded into tailings ponds, and into Red Indian Lake. The tailings ponds accumulations (up to 2 million tonnes containing up to 30% barite) are of most economic interest, and were exploited in the early 1980s, and from 2006 to 2010. Operations are currently suspended, but resources remain for future production should demand appear.

Other Stratiform Barite Deposits

Barite is a minor gangue mineral in many other sulphide deposits in central Newfoundland that were mined, or could be mined, for base metals (Figure 1). Like the Buchans deposit, these are all of volcanogenic massive sulphide (VMS) type. Prominent examples include Daniels Pond, Pilley's Island, and the LeMarchant prospect south of Red Indian Lake (Figure 1). There is little information on barite resources or composition in these deposits, but they are not presently considered to be of economic importance.

Barite Deposits in Carboniferous Sedimentary Rocks

Several barite deposits are known in western Newfoundland, and most are hosted by Carboniferous carbonate and clastic rocks of the Bay St. George subbasin (Figure 1). The most significant is the barite-celestite mineralization at the Ronan deposit on the Port au Port Peninsula (Figures 1 and 4).

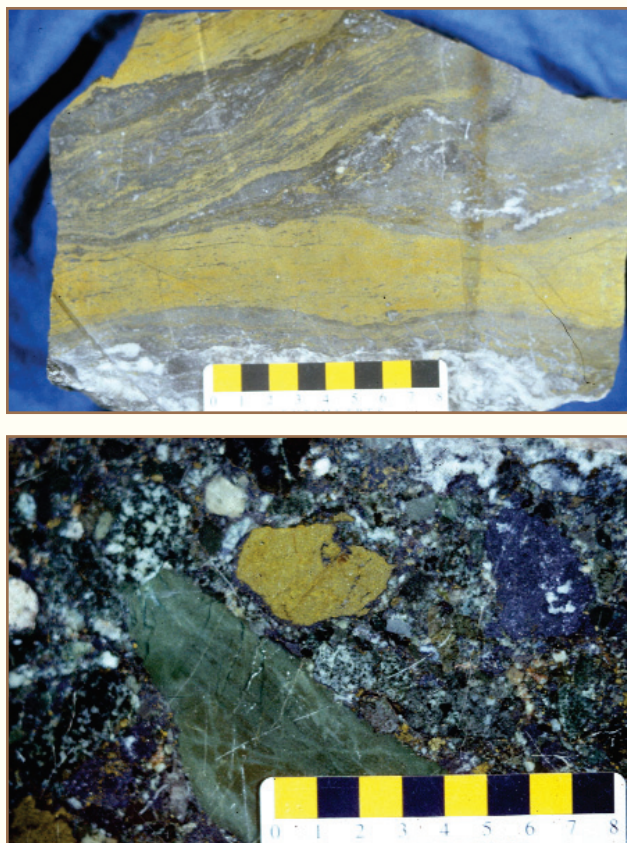


Plate 5. Slabs of massive and transported ores from the Buchans Zn–Pb–Cu deposits, showing white barite layers in the former (top), and discrete grey and white barite fragments in the latter.

The Ronan deposit is a wedge-shaped body of Ba–Sr sulphates, which appears conformable with bedding of the Carboniferous Codroy Group strata, and is confined to a paleodepression, interpreted as an ancient buried valley or paleokarst channel (Figure 4). The host rocks are described as sandy and shaly limestones, and are variably replaced by celestite and barite. The deposit is essentially at surface, with minimal overburden, and has attracted past attention largely for its strontium resource. The deposit was mined briefly in 1999 and about 60 000 tonnes of barite–celestite ore extracted, but the strontium and barium sulphates could not readily be separated by physical means. Drilling work suggests that the deposit has a celestite-rich central zone surrounded by a barite-rich zone. Historical work estimated 130 000 tonnes of barite–celestite mineralization composed of 40% BaSO_4 and 25% SrSO_4 . Metallurgical and processing tests using heavy liquid separation test demonstrated that gangue minerals could be removed, to yield a high-grade barite concentrate and a lower grade barite–celestite concentrate.

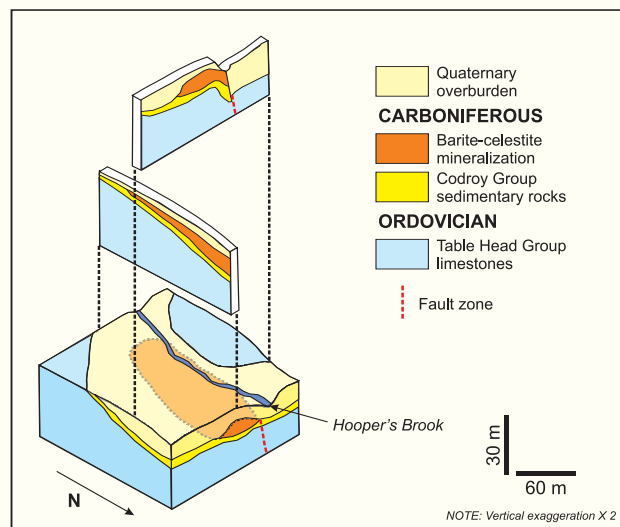


Figure 4. Block diagram showing the geometry of the Ronan Ba–Sr deposit of the Port au Port Peninsula, and its possible relationship to stratigraphic units and a small fault zone. From an original sketch by G. McArthur in 1973.

The Gillams Cove occurrence is a similar small barite–celestite deposit, also hosted by the Carboniferous Codroy Group. The deposit measures roughly 45 x 75 x 2 m in size with a non-compliant resource of about 16 000 tonnes of mixed barite and celestite. There is no record of any mining attempts.

Most of the other barite occurrences in the Bay St. George subbasin, in the vicinity of the Codroy Valley (Figure 1), seem to be of vein-type affinity. These narrow veins of barite containing lesser calcite and quartz occur mostly in the Anguille Group sandstones and the Ship Cove limestone of the Codroy Group.

Other Barite Occurrences

Barite is locally associated with some epithermal-style gold mineralization in central Newfoundland, near Gander (Figure 1). At this site, bladed barite is associated with subvertical veins also containing galena and minor sphalerite. The veins are also anomalous in Hg, Au and Ag. The barite appears to have formed at a fairly late stage, as it replaces earlier silicification in the immediate wall rocks. Mineralization is post-Silurian, based on the age of the host calcareous sandstones. Minor barite is common in a range of epithermal environments, and it may be present in other such occurrences, where it could easily be confused with carbonate minerals.

Exploration Potential

Past barite production in Newfoundland involved direct extraction of high-quality material from hydrothermal veins, and the reprocessing of tailings from Cu–Zn–Pb deposits that contained barite as a secondary commodity. There is future production potential for both types of deposits, and substantial barite resources remain in the Buchans tailings. Of the numerous barite veins that are known on the Avalon Peninsula, only the Collier Point deposit has received significant industry attention. Other veins, such as those around St. Bride's, appear to be small, but our knowledge is in many cases limited to small surface exposures, and longitudinal and lateral thickness variations are typical of most hydrothermal veins. Deposits of this type are generally not large, but may have potential for small-scale production of high-purity barite for the chemical and pharmaceutical industries, as well as for drilling applications, especially if there is a viable local market.

Stratiform barite mineralization that is not associated with metal sulphides may be difficult to recognize during prospecting, and environments in which sedimentary sulphide accumulations exist may merit further evaluation for this commodity. Shales and deep-water sedimentary rocks in central Newfoundland represent an environment of this type that has received limited attention, due to the generally low base-metal contents of known sulphide zones.

Barite does not occur as a primary commodity anywhere in Labrador, although the mineral is reported as gangue in a small lead–zinc-rich vein near Makkovik. There are also reports of barite from heavy mineral surveys in western Labrador that were aimed largely at evaluating diamond potential. The sources of such material are not presently known, but sedimentary rocks in the eastern Labrador Trough have previously been identified as having potential for SEDEX-type deposits.

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