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Critical Minerals

Newfoundland and Labrador

N. Lachance

Report 26-3

St. John's, Newfoundland
2026

GEOLOGICAL SURVEY NEWFOUNDLAND AND LABRADOR 1864

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Author Address

N. Lachance
Mineral Deposits Section
Department of Energy and Mines
P.O. Box 8700
St. John's, NL
A1B 4J6
Email: NicolasLachance@gov.nl.ca

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CRITICAL MINERALS: NEWFOUNDLAND AND LABRADOR

INTRODUCTION

Critical minerals are considered essential to the economic well-being and security of countries. Canada, amongst other countries, has developed defined lists of critical minerals to guide investments and support supply chains (NRCan, 2022). The criticality of minerals is country-specific and ultimately is defined by the needs of commercial and industrial interests; it can change based on supply and demand, technological advancements, and shifting societal needs. Canada states that whilst there is no global definition of critical minerals, there is a shared perspective that critical minerals can be at risk of supply disruptions, and critical minerals can be defined variously as 1) minerals for which few or no substitutes exist, 2) are strategic and can have limited availability, and 3) are increasingly concentrated in terms of extraction and, even more, in terms of processing location (NRCan, 2022).

Newfoundland and Labrador's geology is diverse, encompassing parts of five Canadian Shield structural provinces in Labrador (southeastern Churchill, Makkovik, Nain, Superior, and Grenville; Wardle *et al.*, 1997), and four tectonostratigraphic zones of the Appalachian orogeny in Newfoundland (Humber, Dunnage, Gander and Avalon; Williams 1979) (Figures 1 and 2). Together, these represent almost 4 billion years of geological history from the Eoarchean to the present. The province's geology translates into potentially diverse mineralizing environments and styles, highlighted by the number of past-producing mines and advanced projects, including iron ore (green steel), nickel–copper–cobalt, copper–lead–zinc, fluorspar, antimony, gold, uranium, molybdenum–tungsten and rare-earth elements. Currently, 34 minerals occurring in the province are identified as being critical or of strategic value, and with a minimum of 60 advanced projects that contain at least one of the critical minerals and that have demonstrated resources, the province is well positioned to be a significant provider of critical minerals. The critical minerals of the province are presented in Table 1 along with Canada's critical mineral list for comparison.

This publication is a general reference guide to the critical minerals in Newfoundland and Labrador (DIET, 2023). It provides background information about each element including its definition, source minerals, uses, top producers, markets and world resources (unmined), metallurgy, and the mineral potential within the province. When available, global data for top producers is sourced from the United States Geological Survey (USGS, 2020–2025) and other recognized relevant publications (*e.g.*, BGS, 2025). These estimates are often inconsistent due to uncertain or unreported data, particularly related to metal by-product recovery of metals extracted at a level that may be considered insignificant during resource reserve reporting (McNulty and Jowitt, 2021). This can be compounded because these elements are produced at smelters or refineries downstream of a mine, which process mineral concentrates from multiple mines. The data about the province's mineral occurrences represents the current available information taken from the Mineral Occurrence Data System (MODS, 2025).

DEFINITIONS

Mineral Occurrence Data System

The Mineral Occurrence Data System (MODS) is the principal repository of geological information that encapsulates the mineral potential of the province. The database contains over 7600 records and is acknowledged as an important mineral exploration tool. Information sourced from the MODS is aggregated in this report; select representative mineral occurrences are listed in tables included for each mineral discussed and provide data arranged in four columns: Name/NMINO, Development, Deposit Type, and Resources/Assay; the types of data collected are explained in the following sections. The reader is referred to the MODS (https://gis.geosurv.gov.nl.ca/mods/mods.asp) for a complete list of occurrences. Mineral occurrence maps are also included for the province; they show the locations of occurrences from the showing status of development and above (*see* Development section below) including selected occurrences shown in the accompanying tables (Tables 3–34).

Name/National Mineral Inventory Number (NMINO)

Occurrences within the database are given a national mineral inventory number (NMINO) that consists of 3 segments (*e.g.*, 012B - 09 - Fe 002) where the first two segments identify the NTS grid and the map sheet, and the third identifies the

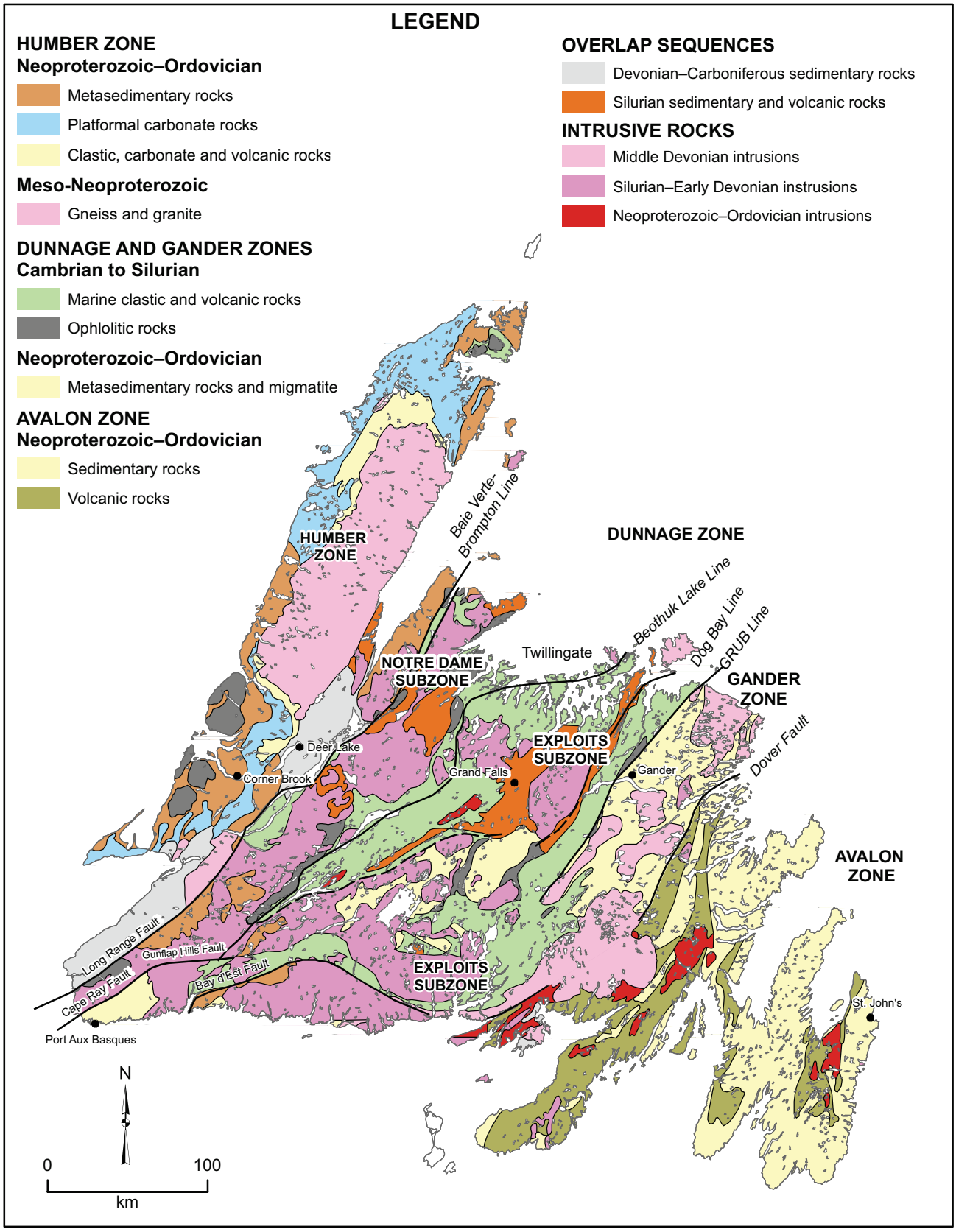

Figure 1. *Simplified geological map of Newfoundland (Colman-Sadd* et al.*, 1990).*

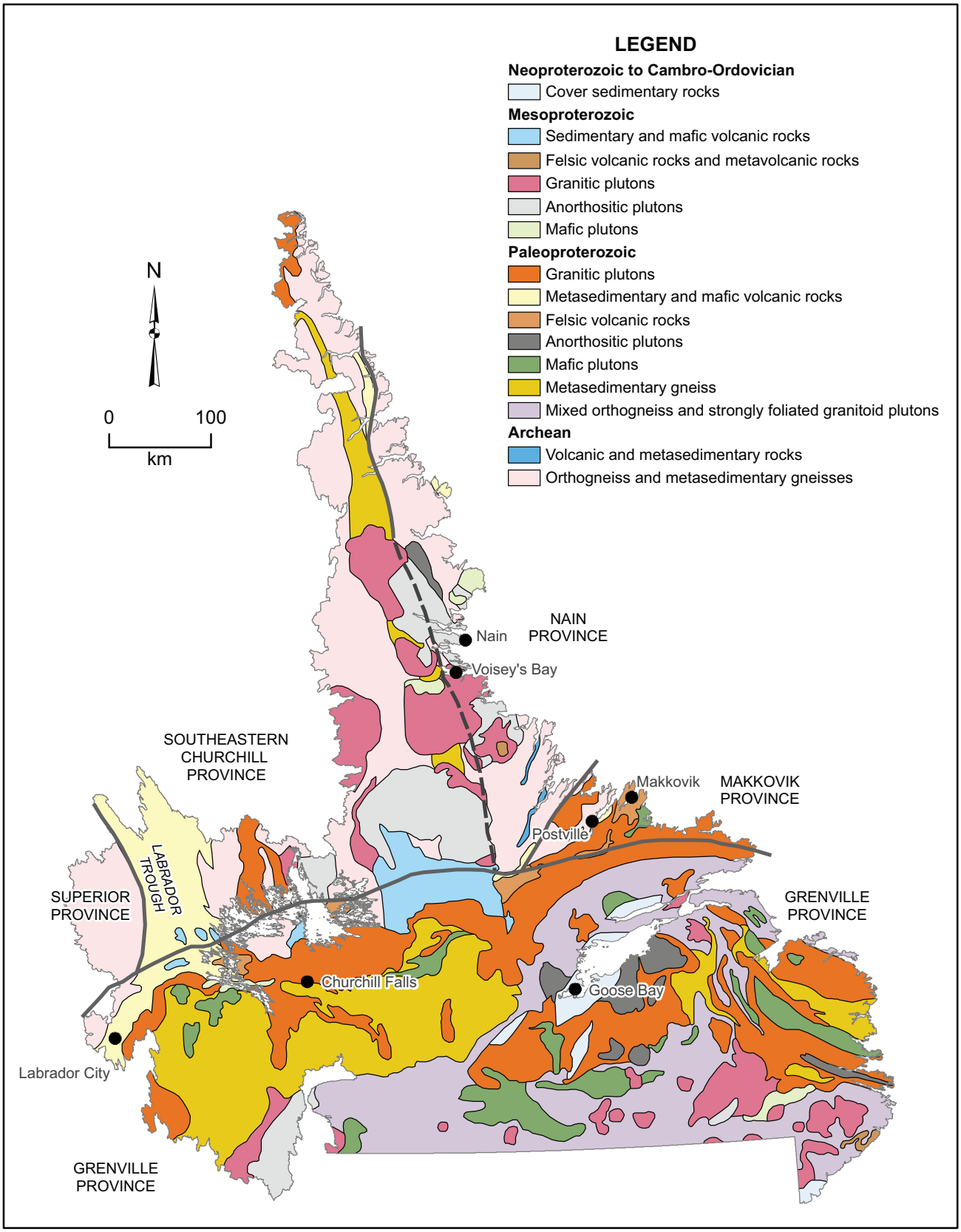

Figure 2. *Simplified geological map of Labrador (Wardle* et al.*, 1997).*

Table 1. Comparison of minerals included in Newfoundland and Labrador's critical mineral list (DIET, 2023) with minerals from the government of Canada's critical mineral list (NRCan, 2022)

Critical Minerals	Newfoundland and Labrador	Canada	Critical Minerals	Newfoundland and Labrador	Canada
Aluminum		*	Magnesium	*	*
Antimony	*	*	Manganese	*	*
Arsenic	*		Molybdenum	*	*
Barium	*		Nickel	*	*
Beryllium	*		Niobium	*	*
Bismuth	*	*	Platinum-Group Elements	*	*
Cesium	*	*	Phosphorus		*
Chromium	*	*	Potassium (Potash)	*	*
Cobalt	*	*	Rare-Earth Elements	*	*
Copper	*	*	Scandium	*	*
Feldspar	*		Silicon	*	*
Fluorine	*	*	Tantalum	*	*
Gallium		*	Tellurium		*
Germanium		*	Tin	*	*
Graphite	*	*	Titanium	*	*
Hafnium	*		Tungsten	*	*
Helium		*	Uranium	*	*
Indium		*	Vanadium	*	*
Iron (Green Steel)	*	*	Zinc	*	*
Lead	*		Zirconium	*	
Lithium	*	*			

primary commodity of the deposit. The term primary commodity is defined as either the most prevalent commodity within the occurrence, or the commodity that is most likely to be developed. The coding requirements of the MODS demands that only one commodity be designated as the primary commodity in the system, even if it relates to multiple commodity polymetallic deposits.

Development

A classification scheme is used to define the amount of information known about each occurrence and the level of development an occurrence has received (status), which is a function of how much exploration work has been performed (*i.e.*, drilling, channel sampling):

- *Producer* – Commodity is extracted for sale
- *Past Producer (Dormant)* – The commodity is no longer produced; there are known reserves or demonstrated resources
- *Past Producer (Exhausted)* – The commodity is no longer produced and there are no reserves or demonstrated resources
- *Developed Prospect* – Enough information exists to reasonably estimate the grade and amount of the commodity, and the commodity has not been produced (grade of mineralization available at and below surface)
- *Prospect* – Grade of mineralization available but not enough data exists to reasonably estimate the amount the commodity
- *Showing* – Mineralization exists in outcrop and shown by assay, with little information about its spatial extent
- *Indication* – An indication of the existence of a commodity, *i.e.*, field observation

Deposit Types

When sufficient information is known about an occurrence, deposit types are used to define and categorize occurrences in the MODS. At the base level, mineral deposits are classified as: a) **magmatic** – formed during the cooling and crystal-

lization of magma, b) **hydrothermal** – formed by the interaction of hot water and rock/magma, c) **sedimentary** – formed by the precipitation or settling of minerals directly from water in oceans or lakes, d) **residual** – formed by the intense weathering of rocks under hot, humid conditions, and e) **placer** – formed by the physical concentration of heavy particles of rocks or minerals by the action of moving water. Beyond these classifications, a multitude of additional terms and characteristics can be applied to further define a deposit such as host rock, environment, shape, alteration etc.; the terminology is defined in the glossary included with this publication.

Resources/Assays

This includes relevant information about the mineral resources and reserves of an occurrence, including grade and/or quantity from the assays of drilling, channel, or grab sampling, and when available, a National Instrument (NI) 43-101 defined resource calculation of mineral deposits. Mineral resource deposits defined under the NI 43-101 are classified as a) *inferred resource* (abbreviated to Inf. Res.) where grades are estimated with a low level of confidence, b) *indicated resource* (Ind. Res.) where grades are estimated using sampling in drilling and trenches at a reasonable level of confidence, or c) *measured resource* (Meas. Res.) where grades are confidently estimated by a competent person (defined by the NI 43-101 code). Historical calculated reserves predate compliant NI 43-101 reporting standards and should be regarded as estimations, all deposits are cited in metric tonnes (t). Mining terms and abbreviations, units of measure, and symbols for the periodic table used in this report are defined in Table 2, and a glossary of geological terms can be found at the end of this document.

Table 2. Abbreviations, units of measure and symbols used in this report

Term	Abbreviation	Term	Abbreviation
diamond-drill hole	DDH	graphite	C
total rare-earth elements	TREE	iron	Fe
total rare-earth oxide	TREO	lead	Pb
parts per million	ppm	lithium	Li
tonnes	t	magnesium	Mg
grams per tonne	g/t	manganese	Mn
weight percent	wt%	molybdenum	Mo
million	M	nickel	Ni
million tonne	Mt	niobium	Nb
antimony	Sb	platinum-group elements	PGE
arsenic	As	potassium	K
barium	Ba	tantalum	Ta
beryllium	Be	tin	Sn
bismuth	Bi	titanium	Ti
cesium	Cs	tungsten	W
chromium	Cr	rare-earth elements	REE
cobalt	Co	uranium	U
copper	Cu	vanadium	V
fluorine	F	zinc	Zn
feldspar	Fsp	zirconium	Zr

DATA SHEETS

ADVISORY

Representative data, synthesized within the foregoing tables of this report, date as far back as 1890. Quality control of the methods and techniques used in the field and laboratory to obtain this data were current for the time period in question. Users should consult the Geological Survey database to ensure the originality and correctness of the data.

ANTIMONY (Sb)

Description

Antimony is a brittle, lustrous, silver-white, soft metalloid that is stable at room temperature, but reacts with oxygen when heated. It occurs in over 100 minerals, but the most commonly mined is stibnite, which may contain trace amounts of copper, gold, lead, silver, arsenic and mercury. Global antimony production comes from either primary antimony ores (dominantly stibnite) or those that produce antimony as a by-product of mining for precious metals, copper, lead and/or zinc (Seal II *et al.*, 2017). Although antimony and many of its compounds are toxic, it is used in a wide variety of applications from common household goods to military and industrial uses.

Source Mineral

Stibnite

Uses

Alloys, flame retardants, batteries, munitions, solder in semi-conductors, circuit boards and electric switches, fluorescent lighting, high-quality clear glass, cellular devices, solar panels, pharmaceuticals.

Global Mine Production

Annual production of antimony in 2024 was estimated at 100 000 t (USGS, 2025). The top three producers were China (60 000 t, 60%), Tajikistan (17 000 t, 17%), and Russia (13 000 t 13%).

Mineral Resource Supply and Demand Outlook

Some sources (*e.g.*, Core Market Research, 2025; Future Market Insights, 2025a) predict a rise in demand in antimony metal of about 3.5–4% over the next 10 years from 2025 to 2035. There is a scarcity of large, commercially viable deposits outside China and Russia (USGS, 2025). China announced export restrictions on antimony and other minerals in 2024 which led antimony prices to skyrocket (The Oregon Group, 2025b).

Recovery

Antimony mines are divided into two broad categories: primary and by-product antimony producers, where the latter is recovered as a by-product of gold, silver, copper, lead, and zinc mining operations (Seal II *et al.*, 2017).

Recycling

The bulk of antimony recycled is recovered at secondary lead smelters (battery re-cyclers) as antimonial lead from the lead-acid battery industry. Recycling supplied about 18% of estimated USA domestic consumption in 2023 (USGS, 2024).

Geological Setting

Antimony is a significant pathfinder mineral indicative of a range of mineral deposits. It is widely diffused in many types of polymetallic deposits (*e.g.*, Au, Ag, Cu, Ba, U, Sn, As, Bi, Mo, W, Ni), occurring in hydrothermal environments, orogenic and Carlin-type gold deposits, and in intrusions as accessory minerals associated with porphyry copper and molybdenum deposits. Broadly, antimony mines are divided into primary antimony producers and by-product antimony producers (Schwarz-Schampera, 2014). It is likely to be recovered as a secondary component of precious- and base-metal deposits, however it also occurs in quartz–stibnite deposits hosted dominantly in shale, marl and carbonate rocks (± quartzite and granite), and the most significant current and recently mined antimony is sourced from quartz–stibnite deposits (Seal II *et al.*, 2017). Important representatives of these deposits located in Canada include the Beaver Brook and Lake George deposits in Newfoundland and New Brunswick respectively, and the Bridge River district in British Columbia.

MODS Occurrences

There are 89 antimony occurrences (14 primary) in the Mineral Occurrence Database System (MODS), including two past producers, and one developed prospect. Most occurrences, including the only one in Labrador, are hosted in orogenic vein systems and are regionally associated with gold mineralization. Antimony is predominantly recorded as a secondary mineral associated with primary gold occurrences in the MODS. A recently mined antimony deposit (Beaver Brook East Zone) located in central Newfoundland occurs as quartz–stibnite–carbonate breccia-vein-system. Representative antimony occurrences are listed in Table 3 and illustrated in Figures 3 and 4.

Table 3. Representative antimony occurrences for Newfoundland listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
Beaver Brook East Zone – 002D/11/Sb 003	Past Producer (Dormant)	Structurally controlled vein system (significant wallrock alterations	First delineation of resource before mining: 2.2 Mt grading 3.99% Sb (Morrissy and House, 1998). Internal resource calculation at the Beaver Brook Mine in 2013 estimated 533 370 t of remaining resource grading 4.17% Sb (Beaver Brook Mine internal report, 2013)
Cross Cove (Frost Cove) – 002E/10/Sb 001	Past Producer (Dormant)	Structurally controlled mesothermal veins	Historical past production at the mine was estimated at no more than 1000 t mined between years 1890 to 1916. Mineralization is restricted to the contacts of an approx. 2-m wide felsic dyke intruded in altered andesite (Heyl, 1936)
Beaver Brook Central Zone – 002D/11/Sb 001	Developed Prospect	Structurally controlled hydrothermal veins	Resources at the Central Zone were determined to include 154 570 t of ore grading 5.62% Sb (Reeves, 2009)
Kim Lake #2 – 002D//03/Sb 001	Prospect	Structurally controlled hydrothermal veins	175 m zone opened laterally and at depth: 2 trench samples grading 1.94% and 1.25% Sb (Dean, 1978)
Little River Antimony – 001M/13/Sb 003	Prospect	Structurally controlled veins (no or minimal wallrock alteration)	Trench samples grading up to 3.1% Sb in gold bearing quartz veins (Woods, 2010)
Pond Island – 002E/06/Sb 001	Showing	Structurally controlled mesothermal vein system	Three mineralized veins close together and approx. parallel to each other are mineralized. 2 grab samples assayed 3.67% and 13.92% Sb (Evans, 1992)
Moretons Harbour Antimony – 002E/10/Sb 002	Showing	Structurally controlled mesothermal vein system	The occurrence is the southern extension of the vein/rhyolite dyke hosting the Cross Cove historical mine (Fogwill and Wahl, 1965)

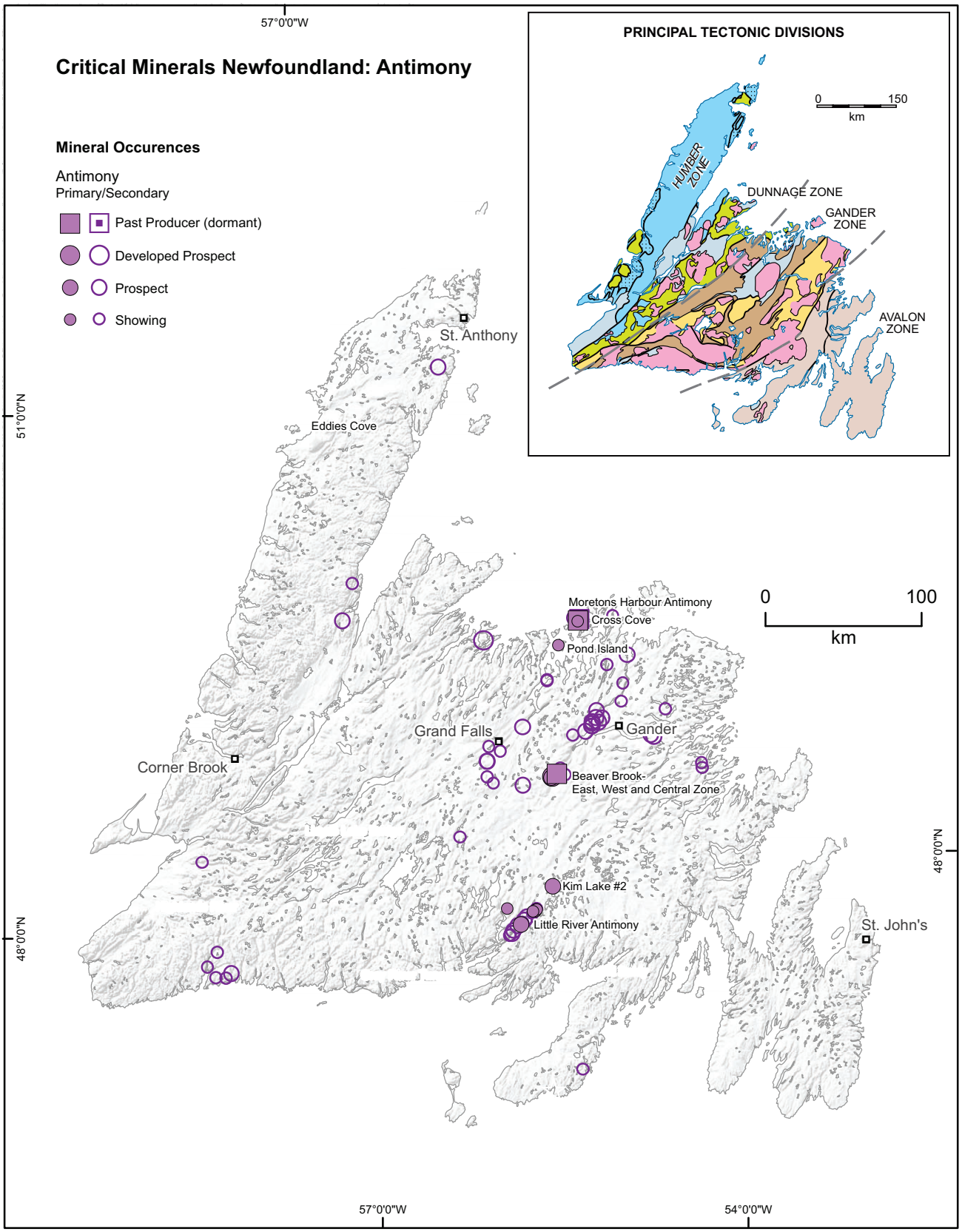

Figure 3. *Map showing the distribution of antimony occurrences in Newfoundland as well as illustrating all levels of development above indication.*

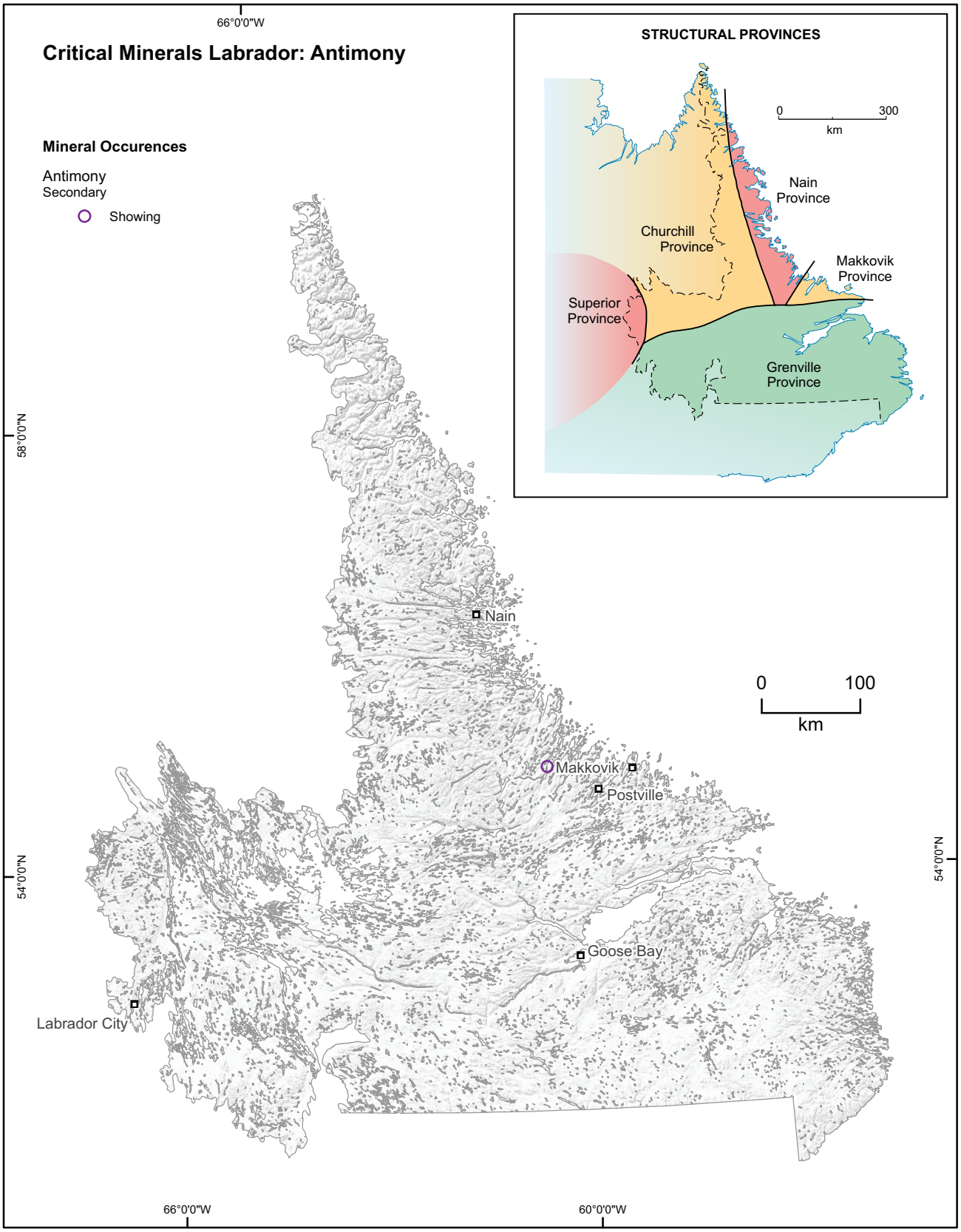

Figure 4. *Map showing the distribution of antimony occurrences in Labrador as well as illustrating all levels of development above indication.*

ARSENIC (As)

Description

Arsenic is a metalloid that occurs in several colours including grey, black and yellow, with grey (metallic) being the most stable form at room temperatures. It is widely distributed in the lithosphere and occurs as a native element but is more commonly bound in over 150 different minerals with sulphur, oxygen and iron; arsenopyrite is the most common arsenic mineral. Annual consumption of arsenic is small and most refining operations in the USA and Europe have closed over environmental concerns due to its toxicity. While often viewed with caution due to its toxicity, arsenic serves essential roles in several industries, including pharmaceuticals, agriculture, and electronics. Currently the primary use for arsenic is in metallurgy, particularly in lead alloys. Arsenic trioxide, an arsenic compound, plays a vital role in the production of glass and ceramics as well as in semiconductors and is a key component for enhancing conductivity (and reliability) of electronics.

Source Minerals

Arsenopyrite, orpiment, realgar, enargite, cobalt arsenides, smelter dust from copper, gold and lead processing.

Uses

Metallurgy, semiconductors, diodes, solar cells, LED lights, transistors, lasers, glass and ceramics, wood preservative, insecticide.

Global Mine Production

Annual production of arsenic in 2024 was estimated at 58 000 t (USGS, 2025). The top producers were Peru (27 000 t, 46.5%), China (24 000 t, 41.3%) and Morocco (6000 t, 10.3%).

Mineral Resource Supply and Demand Outlook

Demand for arsenic is expected to grow in the foreseeable future based on its rising utilization in industrial applications and its unique properties that enhance product performance, as well based on the rising demand for LED lights and photovoltaics (solar energy) (Verified Market Reports, 2025). More arsenic is produced (recovered) during the smelting of other metals than the current global consumption.

Recovery

Most commercial arsenic is recovered as a by-product of the smelting of copper, lead, cobalt and gold ores.

Recycling

Although it is not commonly recycled, arsenic can be recycled from semiconductor manufacturing (USGS, 2024).

Geological Setting

Elevated concentrations occur in sulphide deposits, with arsenopyrite commonly occurring in porphyry, VMS and epithermal gold deposits. Arsenic minerals also occur in coal, iron formations and phosphate rocks. Magmatic and hydrothermal processes can lead to arsenic enrichments in accessory phases with the partitioning behaviour of arsenic strongly dictated by the redox state of magmas.

MODS Occurrences

There are 374 arsenic/arsenopyrite occurrences in the MODS (43 primary). In Labrador, regional lake-sediment geochemistry results indicate arsenic is highest in the sedimentary and volcanic sequences of the Kaniapiskau Supergroup in the Labrador Trough, as well as within a corridor that includes the Seal Lake Group and the Central Mineral Belt located north of Lake Melville. In Labrador West, arsenopyrite occurs in paragneiss and mafic volcanic rocks associated with iron sulphide minerals in the Ashuanipi (granulite) Complex (*e.g.*, Locality 18 – 023J/11/As 002). In Labrador East, arsenopyrite is associated with gold at the Thurber North showing within the Florence Lake greenstone belt.

In Newfoundland, arsenic in lake sediments is highest in the Gander and Dunnage (Exploits Subzone) zones. It is abundant at the Mosquito Hill gold prospect, where up to 15% arsenopyrite occurs with gold as fine disseminations, and in networks of quartz–carbonate veins. At the

Yellow Fox gold showing, quartz–stibnite–arsenopyrite associations occur in late stage veined fractures hosted in porphyritic monzogranite and contain as much as 12.9% arsenic. Representative arsenic occurrences are included in Table 4 and illustrated in Figures 5 and 6.

Table 4. Representative arsenic occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
Mosquito Hill – 002D/05/Au 008	Developed Prospect (Au)	Structurally controlled mesothermal veins	Up to 15% disseminated euhedral arsenopyrite (Sandeman *et al.*, 2013)
Titan Gold – 002E/10/Au 046	Prospect (Au)	Structurally controlled vein system	Over 80 samples assayed >10 000 ppm As along 30 km strike length (MacVeigh, 2003)
Arran Back Cove – 001M/13/As 005	Showing	Structurally controlled hydrothermal veins	Up to 8800 ppm As assayed in trench; 44 sample avg. of 961 ppm As (McHale, 1985)
Little Spruce Pond No. 7 – 001M/13/As 003	Showing	Structurally controlled hydrothermal veins	Up to 6000 ppm As assayed in trench; 10 sample avg. of 2031 ppm As (McHale, 1985)
Yellow Fox – 002D/14/Au 007	Showing (Au)	Structurally controlled hydrothermal deposit	12.9% As in stibnite–quartz–arsenopyrite veined monzogranite (Sandeman and Spurrell, 2020)
Le Pouvoir No. 3 – 001M/14/As 001	Showing	Structurally controlled veins with wallrock alterations	5–10% disseminated pyrite and arsenopyrite over 10 cm (McHale, 1985)
Northwest Gander Road – 002D/11/As 001	Showing	Structurally controlled hydrothermal deposit	Massive, coarsely crystalline arsenopyrite and pyrrhotite veins 40–60 cm-wide within serpentinized peridotite. Veins assayed up to 6600–10 000 ppm As over 1 m interval (Graham, 1990)
True Grit No. 3 – 001M/13/Au 024	Showing (Au)	Insufficient data to classify	5108 ppm As in grab sample (Westhues, 2017)
LABRADOR			
Locality 18 – 023J/11/As 002	Showing	Stratabound metamorphic deposit	6600 ppm As in biotite–garnet quartzofeldspathic paragneiss (Thomas and Butler, 1987)
Thurber North – 013N/02/Au 001	Showing (Au)	Structurally controlled veins with wallrock alterations	>10 000 ppm As in quartz–carbonate veinlets hosted in altered mafic volcanics (Hussey and Moore, 2005)

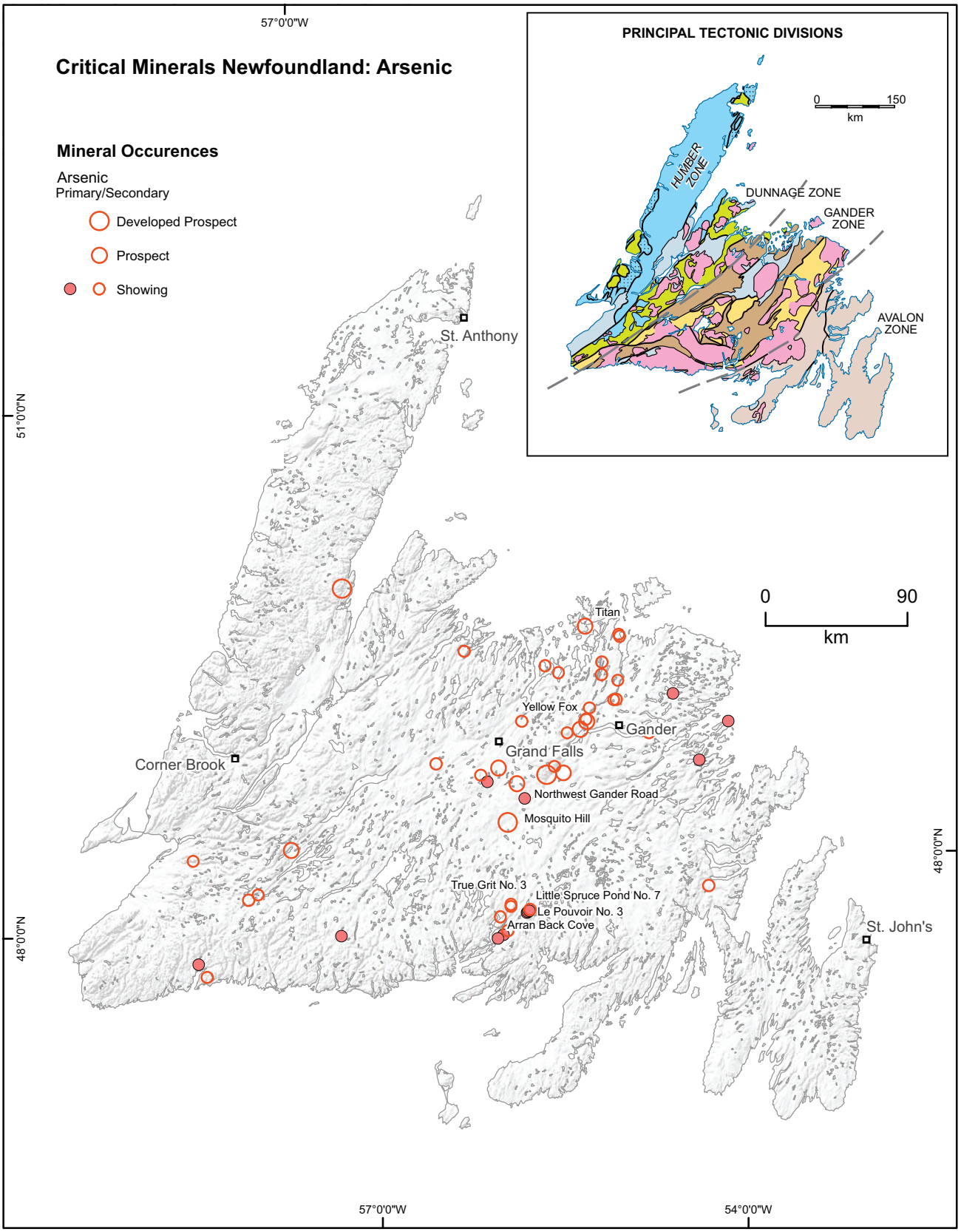

Figure 5. *Map showing the distribution of arsenic occurrences in Newfoundland as well as illustrating all levels of development above indication.*

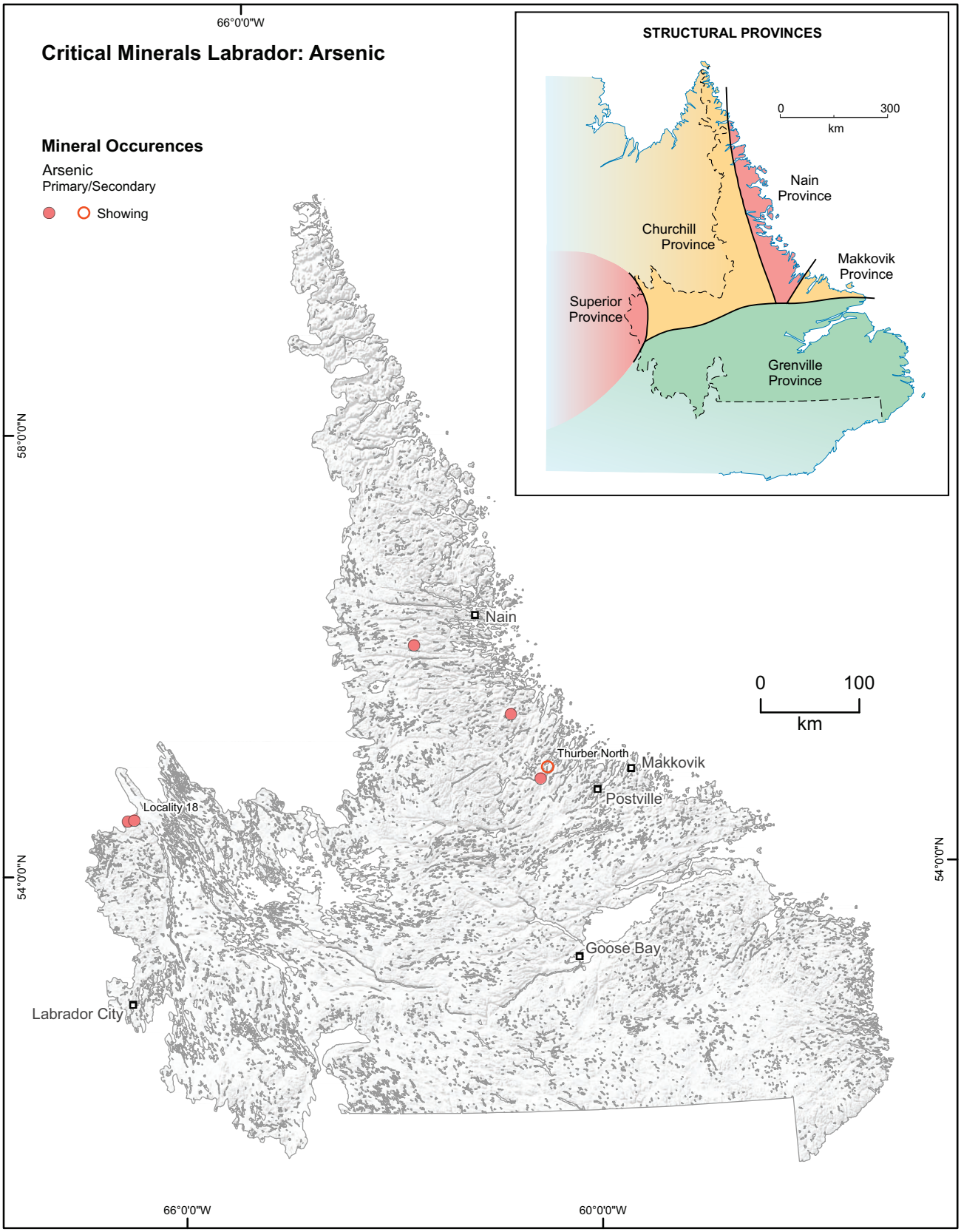

Figure 6. *Map showing the distribution of arsenic occurrences in Labrador as well as illustrating all levels of development above indication.*

BARIUM (Ba)

Description

Barium is a soft, silver-white alkaline metal that readily oxidizes when exposed to air, and is only stable when combined with other elements. The primary source of barium is the mineral barite ($BaSO_4$), which commonly occurs with celestite, a strontium sulphate mineral, and the two minerals form the end-members of a barite–celestite solid solution. Minerals containing barium like barite are dense, however elemental barium is light by comparison and is only 30% denser than aluminum. Over 80% of its production is used as heavy drilling muds. The name barium originated from the Greek word "baryta" which means heavy.

Source Minerals

Barite, witherite.

Uses

Drilling mud, paint pigment, rubber, glass and ceramics, superconductors, radiation shielding in cathode ray and televisions.

Global Mine Production

Annual production of barite in 2024 was estimated at 8.2 Mt (excluding USA production) (USGS, 2025). The top producers were India (2.6 Mt, 31.7%), China (2.1 Mt, 25.6%) and Morocco (1.0 Mt, 12.2%).

Mineral Resource Supply and Demand Outlook

World barite resources are estimated at 2 billion tonnes, 740 Mt of which are considered identified resource (USGS, 2025). Demand for barite is forecasted to stay strong with most sources predicting a compounded annual growth rate of 4–6% from 2025–2035 (*e.g.*, Future Market Insights, 2025b).

Recovery

Reserves of high-grade, easily accessible barite have experienced a sharp decline throughout barite mining's history. Most barite ores now face challenges such as low-grade, fine disseminated particle size, and complex mineral composition (Yue *et al.*, 2024; Liu *et al.*, 2024).

Recycling

Barite muds are currently not recycled.

Geological Setting

The most important barite deposits are associated with bedded and stratiform deposits, including clastic dominated Zn–Pb, VMS, carbonate-hosted Pb–Zn and evaporate-type deposits (salt flats). Less important types are represented by vein-hosted (polymetallic and monomineral), and residual deposits formed in tropical environments.

MODS Occurrences

There are 190 barium/barite occurrences in the MODS (75 primary), including 2 past producers and 1 developed prospect. The largest resource of barite ore is contained within the mine tailings of the Buchans VMS deposit. Barite is commonly present in VMS deposits as gangue minerals or as large clasts in debris-flow ores. Prominent examples include Buchans, Daniel's Pond, Pilley's Island and the Lemarchant prospect. Vein-type occurrences are common on the Avalon Peninsula, with minor occurrences elsewhere. The most significant occurrences are Collier Point, the Cuslett and Cross Point veins near St. Brides, and barite-rich veins associated with the St. Lawrence fluorspar deposit. Whereas some of the veins are monomineralic barite, most are polymetallic (base metals, tungsten, fluorite) and are associated with normal faults in Ediacaran and Early Cambrian sedimentary rocks. In western Newfoundland, barite–celestite mineralization conformable with bedding occurs within the Carboniferous Bay St. George subbasin at the Ronan deposit and is interpreted as a buried valley or paleo-karst channel. Representative barium occurrences are included in Table 5 and illustrated in Figures 7 and 8.

Table 5. Representative barium occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
Buchans Tailings – 012A/15/Ba 001	Past Producer (Dormant)	Undivided minerals deposited from hydrothermal solutions	Total tailings reserve estimated at 4.06 Mt grading avg. 30% barite (Mercer, 2009)
Collier Point – 001N/12/Ba 001	Past Producer (Dormant)	Undivided minerals deposited from hydrothermal solutions	Between 1902 and 1904 an estimated 4500 t of ore were exported from the mine. Reserves were estimated to be less than 27 000 t (Dean and Watson, 1981)
Ronan Deposit – 012B/10/Ba 001	Past Producer (Dormant)	Undivided evaporitic chemical sediment	Excess of 100 000 Mt of barite/celestite grading 40% $BaSO_4$ and 25% $SrSO_4$ (Mercer and Scott, 1998).
Buchan's River Delta Tailings – 012A/15/Ba 002	Developed Prospect	Undivided unconsolidated surficial deposit	Total tailings reserve estimated at 1.9 Mt grading 39.8% $BaSO_4$, 2.21% Zn, 0.65% Pb, 0.36% Cu, 0.96 ppm Au, 37.2 ppm Ag (Collins and Legrow, 1989)
Lemarchant – 012A/10/Zn 012	Developed Prospect (Zn)	VMS – felsic (epiclastic)	Ind. Res. of 2.42 Mt grading 23.5% barite, 0.68% Cu, 6.15% Zn, 1.6% Pb, 1.22 ppm Au, 64.0 ppm Ag (Cullen *et al.*, 2018)
Cross Point – 001L/16/Ba 001	Prospect	Undivided minerals deposited from hydrothermal solutions	Several veins ranging from 7.5 ft to 1 inch in thickness (Carr, 1958; Snelgrove, 1953)
Glitter Pond – 012A/06/Ba 001	Prospect	Undivided hydrothermal structurally controlled vein system	3 grab samples assayed from 32 to 46.7% $BaSO_4$ (Thurlow and Barbour, 1985)
Brooms Brook Barite – 011O/14/Ba 003	Showing	Undivided minerals deposited from hydrothermal solutions	Vein has a maximum width of 20 cm; grab sample returned 54.7% BaO (Howse, 1992)
Lawn Barite Vein – 001L/13/Ba 003	Showing	Undivided minerals deposited from hydrothermal solutions	15 to 60 cm-wide vein, two smaller veins (10 cm wide) were noted near the main vein (Collins, 1984)
Doe Hills Barite Vein – 001N/12/Ba 006	Showing	Undivided minerals deposited from hydrothermal solutions	Barite veins varying in thickness from <1 to 30 cm (Howse and Collins, 1983)
Tickle Cove Vein System – 001N/12/Ba 012	Showing	Undivided minerals deposited from hydrothermal solutions	The largest of the veins is 70 cm wide (Howse and French, 1983)
Bellevue Bog – 001N/12/Ba 017	Showing	Undivided minerals deposited from hydrothermal solutions	Vein examined below sea level estimated at 0.91 and 1.21 m in width, total known strike length of the BG Vein (visible from offshore and under water) estimated at 65 m (Howse and French, 1983)

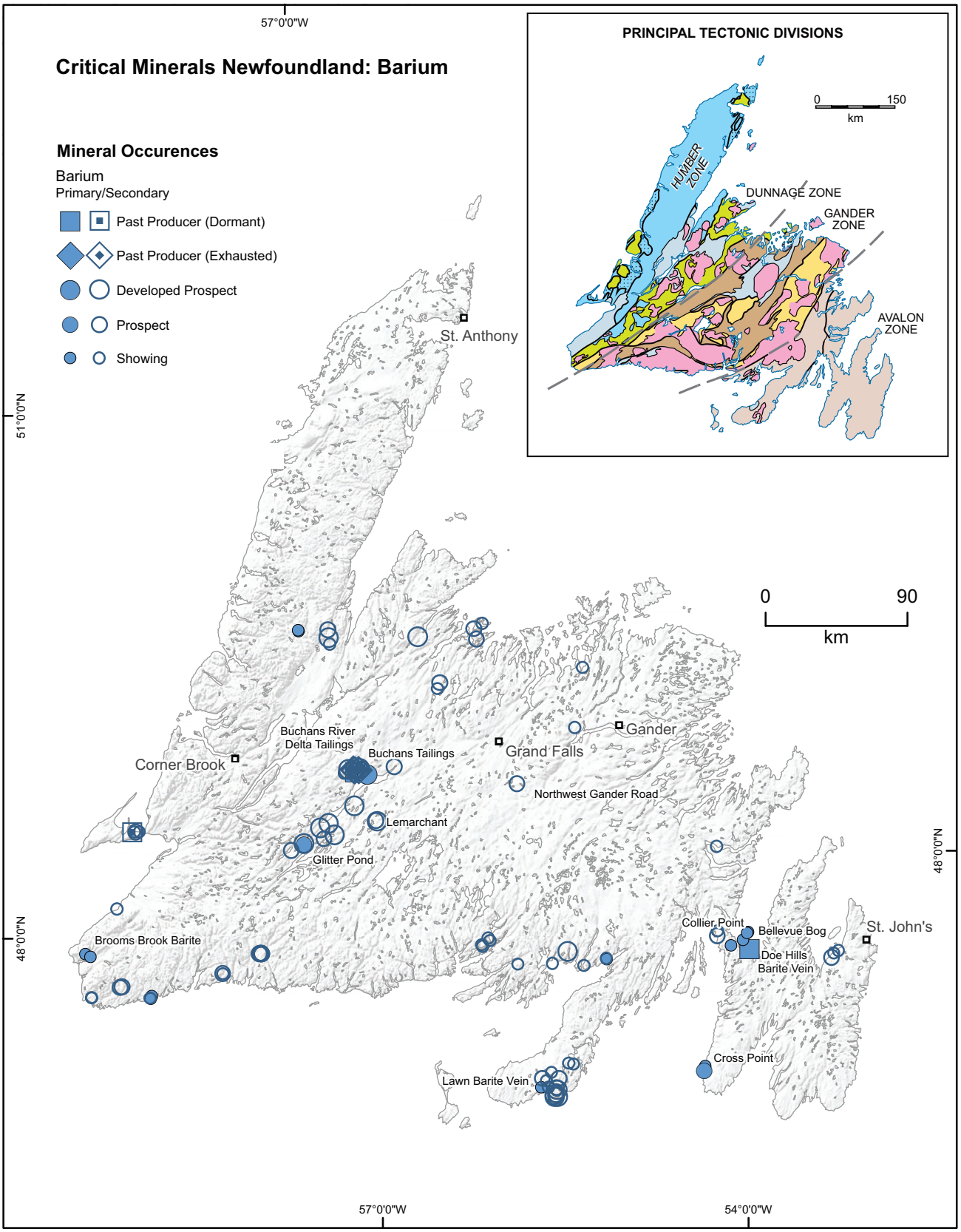

Figure 7. *Map showing the distribution of barium occurrences in Newfoundland as well as illustrating all levels of development above indication.*

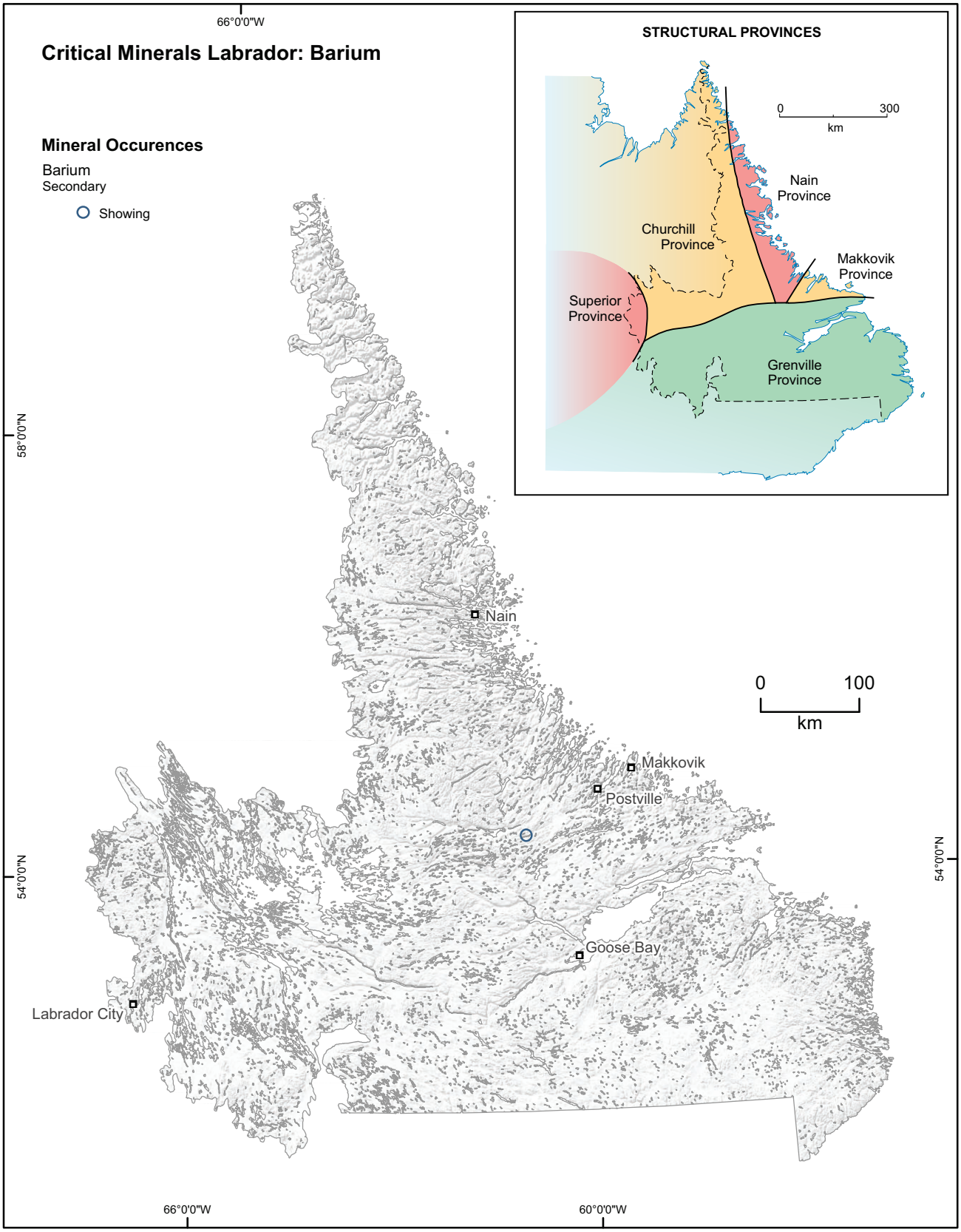

Figure 8. *Map showing the distribution of barium occurrences in Labrador as well as illustrating all levels of development above indication.*

BERYLLIUM (Be)

Description

Beryllium is a steel grey, brittle alkaline metal when isolated. It has a high melting point and is the lightest of the alkaline-earth elements. Beryllium possesses characteristics of flexural rigidity, thermal stability and conductivity, which makes it a useful material in the aerospace industry. However, beryllium's most important use is as a component in hard alloys of copper, nickel, and iron. It does not occur as a free element but occurs combined in over 100 minerals; most are uncommon and rare and beryllium is commonly extracted from the mineral beryl, most commonly obtained as a by-product of other mining operations.

Source Minerals

Beryl, bertrandite, chrysoberyl, phenakite, helvite–danalite.

Uses

X-rays, satellites, telescopes, non-magnetic substance in magnetic sensitive devices, nuclear industry, high frequency acoustic speakers, dental alloys, surgical instruments.

Global Mine Production

Annual production of beryllium in 2024 was estimated at 360 t (USGS, 2025). The top producers were the United States (180 t, 50%), Brazil (80 t, 22.2%) and China (77 t, 21.4%).

Mineral Resource Supply and Demand Outlook

Global beryllium reserve estimates are unavailable, however identified resources are estimated at 100 000 t (USGS, 2025). Demand is expected to stay strong in the next decade based on increasing adoption of beryllium in high-performance applications, notably in aerospace, electronics and defence.

Recovery

The extraction of beryllium is difficult partly due to its high affinity for oxygen at elevated temperatures (Rao, 2006)

Recycling

Manufacturing beryllium products from recycled beryllium only requires 20% of the energy required to manufacture from ore; the amount of recycled beryllium may be as much as 20 to 25% of total beryllium consumption (USGS, 2024).

Geological Setting

Enrichments occur in fractionated felsic magmas and are commonly associated with alkaline to peralkaline, and metaluminous to peraluminous magmas. Deposits occur in pegmatites, skarns and greisens, and volcanogenic rocks (Foley *et al.*, 2017). Volumetrically, the most important are rare-metal pegmatites and volcanogenic-hosted beryllium. Volcanogenic Be deposits can form by replacement of carbonate fragments through the interaction with hydrothermal fluids in lithophile-element-enriched volcanic rocks (lithic tuff); a key component of this model is the presence of volatile elements such as fluorine which enhances the solubility of beryllium in hydrothermal fluids (Foley *et al.*, 2017). Skarn- and greisen-type Be-deposits are similar to volcanogenic Be deposits in mineralogy and formational processes. They form by metasomatic replacement in carbonate rocks, or by alteration of aluminosilicates related to intruding Be-bearing plutons.

MODS Occurrences

There are 65 beryl/beryllium occurrences in the MODS (21 primary), including 1 developed prospect (as primary occurrence). In Labrador, beryllium occurrences are associated with the peralkaline Strange Lake Complex as well as the peralkaline Red Wine Complex (Letitia Lake area) northwest of Goose Bay (*e.g.*, North Red Wine – 013L/02/Ree004, Two Tom Lake – 013L/01/Ree001). Other peralkaline complexes with potential to host beryllium include the Flowers River Intrusive Suite located 70 km from Nain and the Fox Harbour Volcanic Belt in southeastern Labrador.

In Newfoundland, beryl occurs in granite and granitic pegmatites in several areas; notably the southeast coast (*e.g.*, Fox Roost Pegmatite – 011O/11/Fel001, Rapids Showing – 011P/13/Be 001), in granitoid rocks near the Ackley Granite (Bay du Nord River – 001M/14/Be 001, North West Brook Complex), in the Middle Ridge Granite (*e.g.*, Middle Ridge No 1 – 002D/10/Be

005), and in the northernmost part of the Gander Lake subzone around New-Wes-Valley (*e.g.*, West Powder Hill Pond – 002F/04/Be 003). Beryl was also reported to be hosted in pegmatite veins (Robertson, 1984) at the Baie d'Espoir Highway Quarry showing (002D/06/W 001). Representative beryllium occurrences are included in Table 6 and illustrated in Figures 9 and 10.

Table 6. Representative beryllium occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
Bay du Nord River – 001M/14/Be 001	Showing	Magmatic – pegmatite	Pale green beryl crystals (up to 15 mm in length) with well-developed terminations; beryl was estimated at >2% (Dickson *et al.*, 1980)
Rapids Showing – 011P/13/Be 001	Showing	Magmatic – hydrothermal (vein association)	Veins cutting mafic and felsic volcanic rocks host beryl, molybdenite, pyrite, chalcopyrite, and malachite mineralization (Chorlton, 1980)
Middle Ridge No 1 – 002D/10/Be 005	Indication	Magmatic – felsic intrusive	Beryl is found in several localities in the Devonian Middle Ridge Granite generally in the more evolved leucocratic phases, or in nearby dykes of the same material (Blackwood and Green, 1982)
West Powder Hill Pond – 002F/04/Be 003	Indication	Magmatic – pegmatite	Beryl mineralization reported in 6 inch-wide pegmatite vein within the Wareham Granite (Gale, 1967)
LABRADOR			
Strange Lake – 024A/08/Ree001	Developed Prospect (REE)	Magmatic – pegmatite	Overall estimated resource of 57.0 Mt grading 2.93% ZrO_3, 0.38% Y_2O_3, 0.31% Nb_2O_5, 0.08% BeO and 0.54% REE for Main Zone (Campbell *et al.*, 1985)
Two Tom Lake – 013L/01/Ree001	Developed Prospect (REE)	Magmatic – felsic intrusive	Inf. Res. of 41 Mt grading 1.18% TREO, 0.18% BeO (Daigle, 2012)
Mann #1 – 013L/01/Be 001	Developed Prospect	Magmatic – felsic Intrusive	Estimated 2.04 Mt avg. grading 0.35–0.40% BeO (Dujardin, 1960; Dujardin and Evans, 1961)
North Red Wine – 013L/02/Ree004	Showing (REE)	Magmatic – felsic intrusive	Grab samples assayed 0.03 to 3.75% TREO, 0.004 to 0.41% BeO (Penney and Nielsen, 2010)

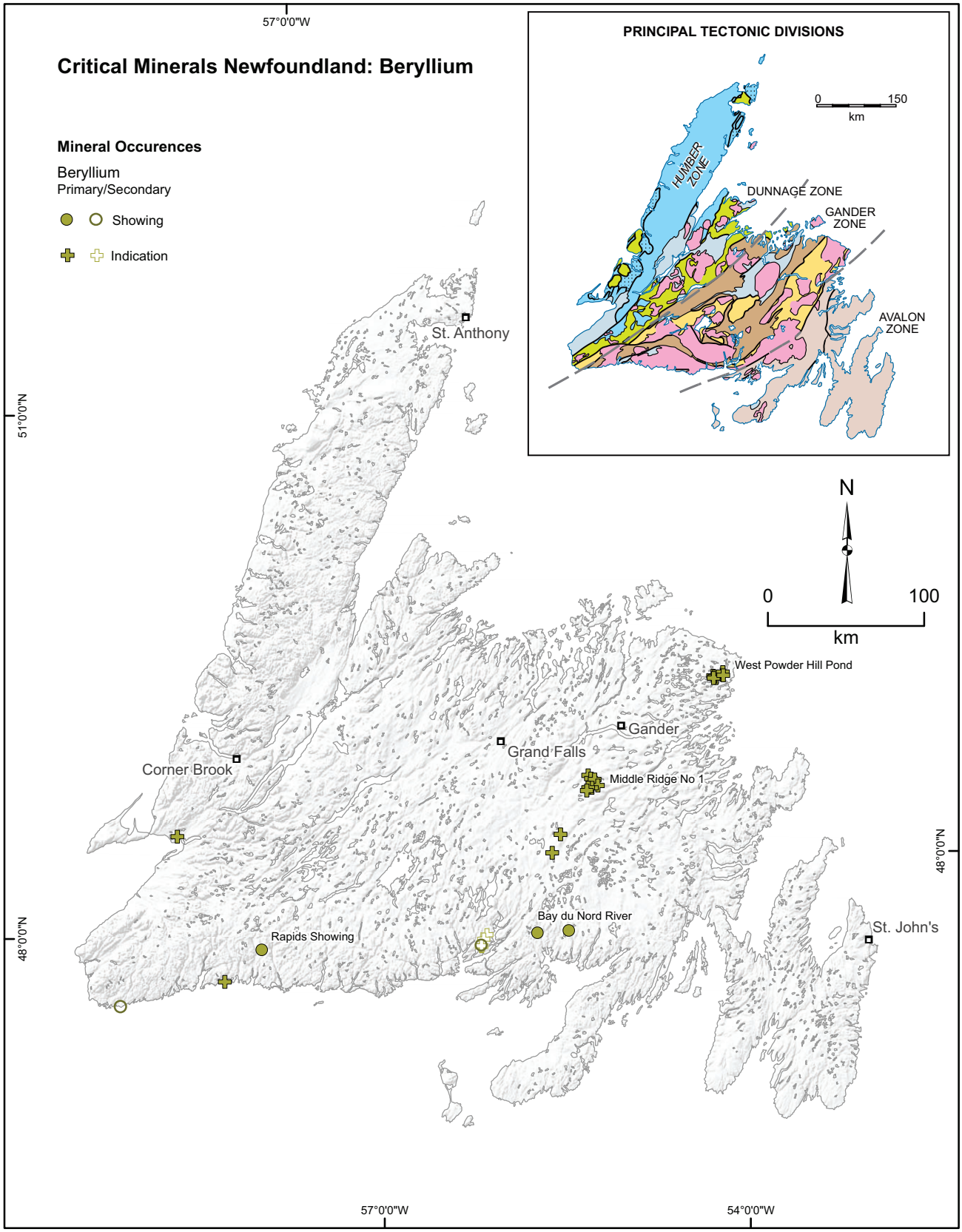

Figure 9. *Map showing the distribution of beryllium occurrences in Newfoundland as well as illustrating all levels of development.*

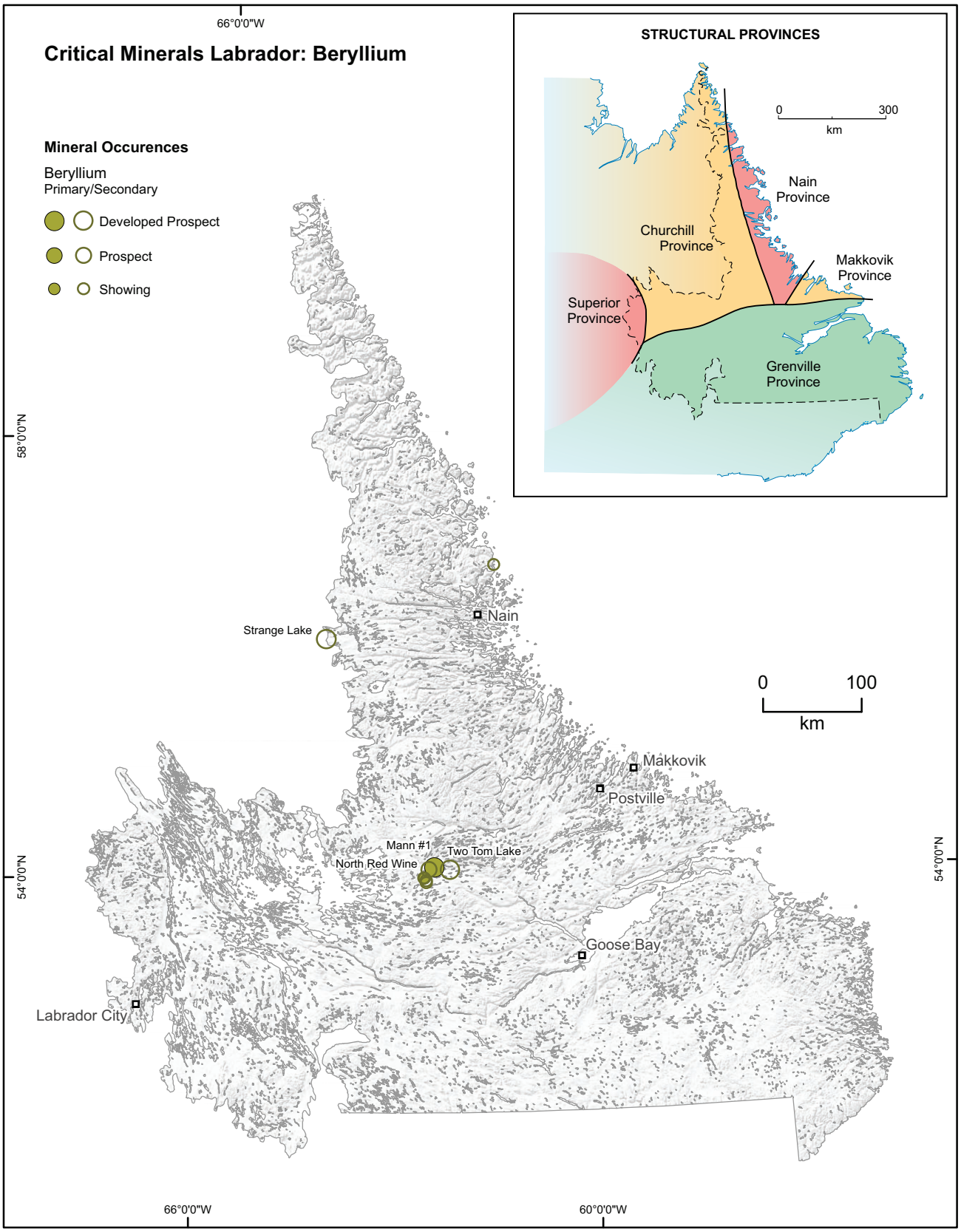

Figure 10. *Map showing the distribution of beryllium occurrences in Labrador as well as illustrating all levels of development above indication.*

BISMUTH (Bi)

Description

Bismuth is a post-transition metal chemically similar to arsenic and antimony and shares metallurgical similarities with lead and tin. In its native state, it is grey-white with a reddish tinge, and its oxidation produces an iridescent tarnish. Bismuth is brittle and volatile at high temperatures; it has a relatively low melting point and is known as the least thermally conductive of all metals. Metallic bismuth is used principally in alloys, and because of unusually low toxicity in elemental form, bismuth alloys are a popular replacement for more toxic lead compounds.

Source Minerals

Bismite, bismuthinite.

Uses

Replaces lead in alloys, cosmetics, pigments, pharmaceutical products.

Global Refinery Production

Annual refinery production of bismuth in 2024 was estimated at 16 000 t (USGS, 2025). The top three producers were China (13 000 t, 81.2%), Laos (1100 t, 6.9%) and the Republic of Korea (1000 t, 6.2%). Global bismuth resource data was generally not reported at a mine or country level and thus difficult to quantify (USGS, 2025).

Mineral Resource Supply and Demand Outlook

Most sources predict an increase in global bismuth demand at an average compounded annual growth rate of approximately 5% until 2035 (*e.g.*, Market Research Future, 2025; Future Market Insights, 2025d), driven largely by the continued replacement by bismuth in lead products and its use in solar powered generation of hydrogen fuel (Deady *et al.*, 2022). Deady *et al.* (2022) highlights that the global supply of bismuth is greater than previously understood and is related to the undervalued portion of bismuth contained as by-products in polymetallic prospects.

Recovery

Bismuth is primarily recovered as a by-product, or co-product, of the processing of lead, copper, zinc, tungsten and tin ores, and although it was historically regarded as a deleterious by-product, the European Commission classified it as a critical mineral in 2017.

Recycling

Bismuth is recycled most easily from large bismuth-containing fusible alloys or large soldered objects. The share of recycled bismuth over the total amount of bismuth consumed in the USA from 2019 to 2023 was estimated to be from 3 to 8% (USGS, 2024).

Geological Setting

Bismuth is concentrated within the continental crust in felsic rocks, particularly in fractionated granites. It occurs in a wide range of mineral deposits including skarns, polymetallic veins, magmatic greisens and porphyries, and orogenic, epithermal and VMS deposits. It is present in trace concentrations in porphyry-hosted Mo–W-mineralization and in some reduced intrusion-related Au, as well as some orogenic Au deposits; VMS deposits can host minor Bi mineralization, typically associated with the Au-rich parts of the mineralized system (Deady *et al.*, 2022). Due to chemical similarities, bismuth can substitute for lead in lead-rich VMS deposits.

MODS Occurrences

There are 22 bismuth occurrences in the MODS (2 primary), all located in Newfoundland. Bismuth occurs in late-stage hydrothermal veins in metamorphic rocks and granites of the Grey River area (*e.g.*, Grey River Tungsten – 011P/11/W 001), and in the Granite Lake area where it is associated with Mo and W in the North Bay Granite near its northern margin. Mineralization is found in sheeted quartz veins, quartz-greisen and quartz-pegmatite veins (*e.g.*, Granite Lake Trench #24 – 012A/02/Bi 001). Similar instances occur in other granites in Baie Verte (*e.g.*, Pond Island – 002E/06/Sb 001). Bismuth has also been noted in skarn-type occurrences on the Burin Peninsula (*e.g.*, Skarn – 001L/13/Zn 003; Lakeside – 001L/13/Zn 002), and is commonly associated with orogenic gold systems throughout Newfoundland. Representative bismuth occurrences are listed in Table 7 and illustrated in Figure 11.

Table 7. Representative bismuth occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
Grey River Tungsten – 011P/11/W 001	Developed Prospect (W)	Magmatic – hydrothermal (vein association)	Over 2000 ppm Bi assayed in several sections of drill core; NI 43-101 Inf. Res. of 852 000 t with average grade of 0.858% WO_3 (Harris and Dearin, 2007)
Granite Lake Bismuth #2 – 012A/02/Bi 002	Showing	Magmatic – hydrothermal (vein association)	The Bismuth #2 showing consists of pyrite, molybdenite, wolframite and chalcopyrite in a 0.6 m wide quartz vein; one of many grab samples yielded 0.5% Bi (Dimmell, 1979)
Granite Lake Trench #24 – 012A/02/Bi 001	Showing	Magmatic – hydrothermal (vein association)	A selected grab sample yielded 19 000 ppm Bi (Dimmell, 1982)
Granite Lake Trench #11 – 012A/02/W 008	Showing (W)	Magmatic – hydrothermal (vein association)	Two grab samples yielded 400 and 1500 ppm Bi (Dimmell, 1982)
Granite Lake Trench #1 – 012A/02/W 007	Showing (W)	Magmatic – hydrothermal (vein association)	Two grab samples within a 13 m long trench yielded 500 and 1700 ppm Bi (Dimmell, 1982)
Lloyd's Lake Bridge – 012A/06/Zn 001	Showing (Zn)	Undivided structurally controlled deposit (not associated with veining)	Several samples returned Bi values over 1000 ppm with one sample returning 9999 ppm in sheared volcanics of the Tulks Hill Volcanics (Thurlow *et al.*, 1987)
Pond Island – 002E/06/Sb 001	Showing (Sb)	Structurally controlled mesothermal vein system	Three small mineralized veins within the Long Island granodiorite batholith; grab sample assayed 1.5% Bi, 13.92% Sb, 3.65% Cu, 160 ppm Ag (Heyl, 1936); a more recent analysis from a grab sample from a quartz vein assayed 0.99% Bi, 5.82% Cu, 3.67% Sb, 1.67% Zn and 1330 ppm Ag (Evans, 1992)

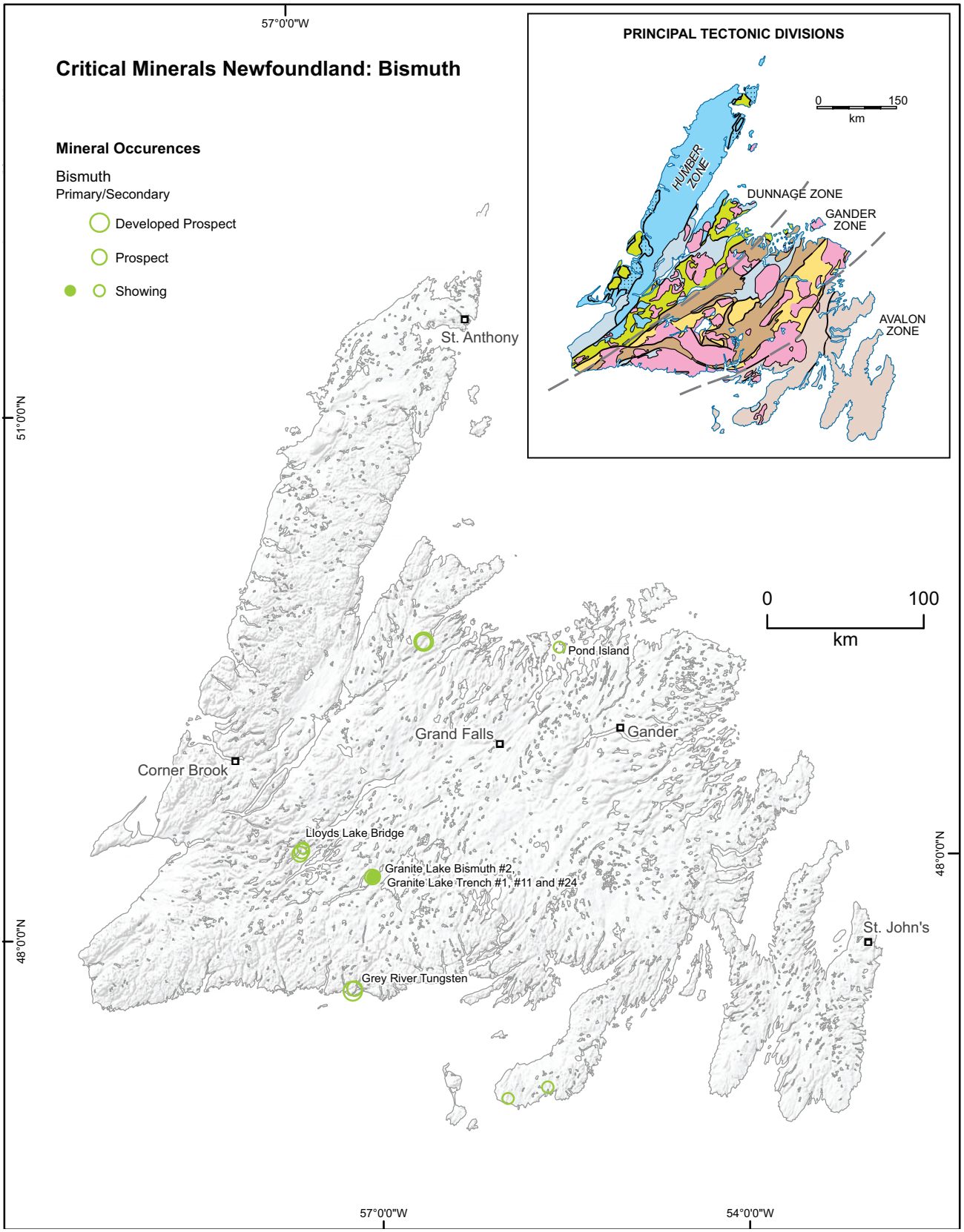

Figure 11. *Map showing the distribution of bismuth occurrences in Newfoundland as well as illustrating all levels of development above indication.*

CESIUM (Cs)

Description

Cesium is a soft, highly reactive, silver-gold metal that occurs as a liquid at a temperature of 28.4°C. It is the least electronegative of any element and has the largest atomic radius. Because it ignites spontaneously in air and reacts explosively with water, it is classified as a hazardous material. Cesium is not considered rare but occurs in few minerals; cesium and rubidium are very similar chemically and often occur together. Cesium metal is produced in rather limited amounts because of its high cost; the only economically important ore mineral of cesium is pollucite ($Cs\ (Si_2Al)\ O_6 \cdot nH_2O$). Its most significant application is as a lubricant in drilling for the petroleum extraction industry.

Source Minerals

Pollucite, lepidolite, beryl, petalite, cesium-137 extracted from nuclear reactors.

Uses

Drilling fluids, thermoluminescent radiation dosimetry (chemotherapy), cesium clock *i.e.*, atomic clock.

Global Mine Production

Cesium production data from official sources is unavailable for 2024. An estimation of reserves based on the occurrence of the mineral pollucite alone for the countries Australia, Canada, China and Namibia amounted to less than 200 000 t for the year 2024 (USGS, 2025).

Mineral Resource Supply and Demand Outlook

The cesium commercial market is expected to grow as much as 6.5% from 2025 to 2032 (Maximize Market Research, 2025). Cesium supply is generated on an industrial scale by three known cesium-bearing pegmatite fields: the Tanco pegmatite field in Canada, Bitika in Zimbabwe, and Sinclair in Australia. Cesium-bearing pegmatite deposits also exist in Namibia, and the United States of America, while lower concentrations in brines and geothermal systems exist in China, Chile, Germany and India (USGS, 2025).

Recovery

Most of the commercial cesium output is recovered as a by-product of lithium mining. One of the more significant problems of the recovery of cesium is the separation of rubidium from cesium ores (Liu, 2022).

Recycling

Cesium formate brines are recycled at a recovery rate of 85% and can be reprocessed for subsequent use (USGS, 2024).

Geological Setting

Cesium occurs in granite-related mineralization, commonly with lithium and tantalum within zoned pegmatites (LCT pegmatites) and veins related to fractionally crystallized peraluminous intrusions.

MODS Occurrences

A recently discovered cesium occurrence (Hydra – 011P/13/Cs 001) is the only cesium occurrence recorded in the MODS. It occurs within the Kraken pegmatite field on the south coast of Newfoundland in association with lithium and tantalum. The Hydra occurrence is shown in Table 8 and illustrated in Figure 12.

Table 8. Representative cesium occurrence for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
Hydra – 011P/13/Cs 001	Prospect	Magmatic – pegmatite	Cesium-rich dyke approx. 5–6 m wide traced for approx. 100 m along strike; a 1.2 m channel sample returned 8.76% Cs_2O, 0.41% Li_2O, 0.025% Ta_2O_5, 0.33% Rb_2O (Sokoman Minerals, 2022)

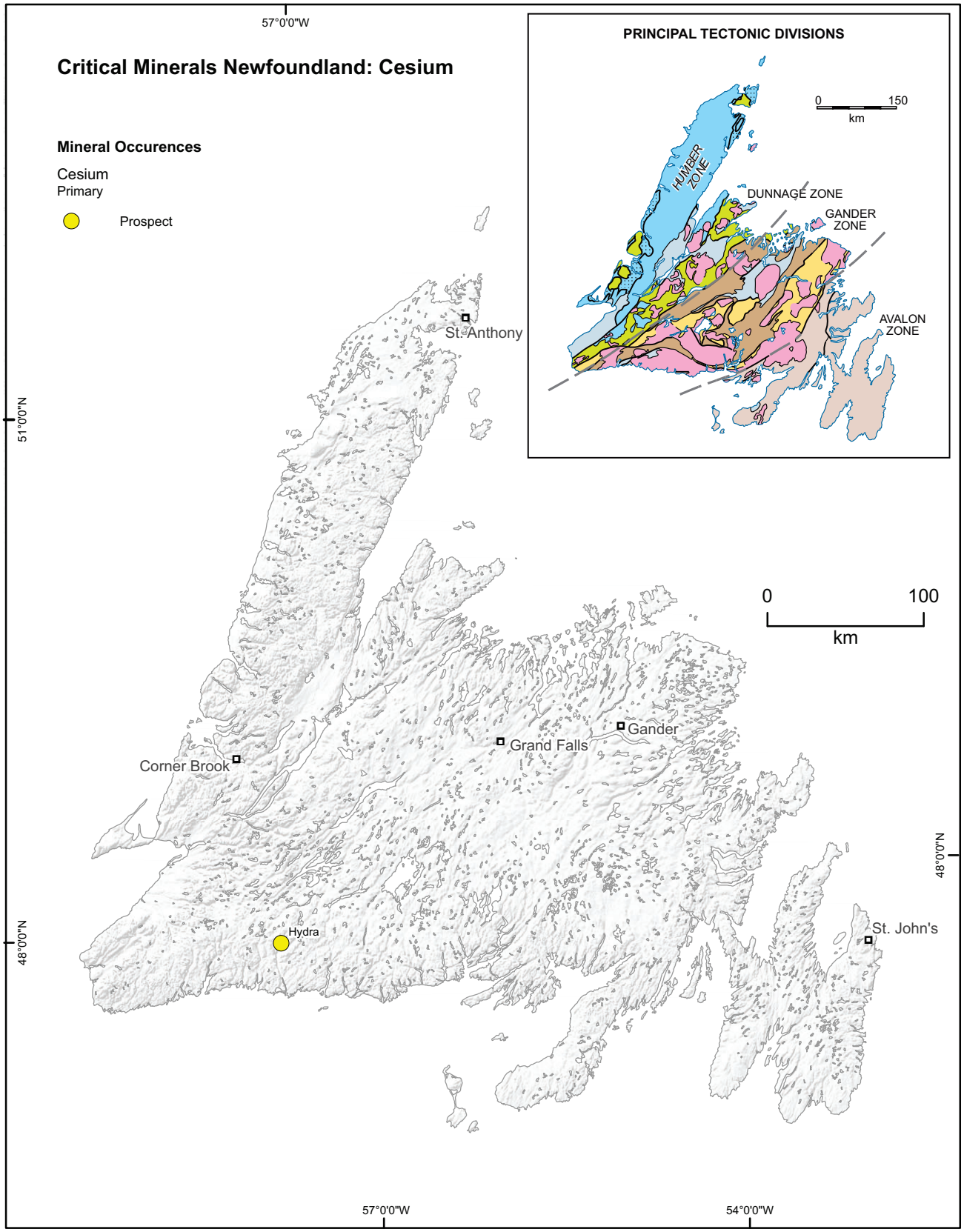

Figure 12. *Map showing the distribution of cesium in Newfoundland as well as illustrating all levels of development above indication.*

CHROMIUM (Cr)

Description

Chromium is a brittle, lustrous transition metal valued for its resistance to corrosion. With a Mohs hardness of 8.5, it is the third hardest element behind diamond (carbon) and boron, and the only elemental solid that shows antiferromagnetic ordering at temperatures of 20−22°C (atoms re-ordering resulting in no magnetization). It does not occur as a free element and is obtained from the mineral chromite ($FeCr_2O_4$). Chromium's most important application is as an ingredient in ferrous alloys for which the pure metal is not required, followed by uses in the chemical, refractory and foundry industries.

Source Mineral

Chromite.

Uses

Metal alloys, corrosion resistance, reflectivity, solar panels, wind turbines, oxidizing agent (cleaners), catalyst in the production of chemical compounds.

Global Mine Production

Annual production of chromium in 2024 was estimated at 47 Mt (USGS, 2025). The top three producers were South Africa (21 Mt, 44.7%), Turkey (8.0 Mt, 17%) and Kazakhstan (6.5 Mt, 13.8%).

Mineral Resource Supply and Demand Outlook

Growth in demand for chromium has been increasing continuously since 2018, driven by strong demand from stainless steel, foundry and chemical applications, and is projected to keep increasing until at least 2032 (Credence Research, 2024). World chromium supplies are estimated at greater than 12 billion tonnes and estimated to be sufficient for meeting conceivable demand for centuries (USGS, 2025).

Recovery

Challenges in the recovery process of chromium include fine grain size, where up to 25% chromium can be lost during processing, and complex mineralogy that requires comprehensive processing methods for optimal recovery (Abdulvaliyev *et al.*, 2025).

Recycling

Significant amounts of chromium are recycled from stainless steel scraps left over from the manufacturing process.

Geological Setting

Chromite deposits are almost exclusively mined from layered, mafic/ultramafic magmatic intrusions. Other deposit types (minor production) include eluvial and alluvial deposits. Based on their geometry and tectonic setting, chromite deposits are classified as either stratiform deposits, whereby they occur as sheet-like accumulations in large, layered intrusions located in stable cratonic settings, or podiform deposits, which form as lenticular-like bodies in alpine orogenic peridotite or ophiolite complexes. Platinum-group elements (PGE) are closely associated with chromite, and chromite may be an important constituent of PGE deposits in layered intrusions (Duke, 1996a, b).

MODS Occurrences

There are 96 chromium occurrences in the MODS (64 primary), including two past-producers and one developed prospect. Chromium mineralization in Newfoundland is associated with the Bay of Islands ultramafic ophiolitic complex on the west coast (*e.g.*, Bluff Head Mine – 012B/15/Cr 001, Blow-Me-Down Chromite #1 – 012G/01/Cr 001), as well with the Gander River Ultra Basic Belt (*e.g.*, Chrome Hill – 002E/08/Cr 001), a narrow belt of low-silica saturation, ultramafic rocks that run in a southwest–northeast direction and passing through Gander, and other ultramafic ophiolitic units such as the Pipestone Pond allochthon (*e.g.*, Chrome Pond – 012A/08/Cr 001) and Hare Bay allochthons (*e.g.*, Long Pond – 002E/05/Cu 002).

In Labrador, chromite mineralization is associated with Paleo- to Mesoproterozoic anorthositic, mafic to ultramafic intrusive rocks of the Nain Plutonic Suite (Kingurutik Lake D Zone –

014D/16/Ni 004), and with the gabbroic Shabogamo Intrusion in western Labrador (Brianna Prospect –023H/05/Cr 001). Representative chromium occurrences are listed in Table 9 and illustrated in Figures 13 and 14.

Table 9. Representative chromium occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
Bluff Head Mine – 012B/15/Cr 001	Past Producer (dormant)	Magmatic – ultramafic intrusive	Produced ~5.0 t of ore. Estimated reserves of 10–20 t (Wiseman, 1942a)
Blow-Me-Down Chromite #1 – 012G/01/Cr 001	Past Producer (exhausted)	Magmatic – ultramafic intrusive	One hundred tons of chromite is said to have been mined in 1918 (Snelgrove, 1934)
Springer's Hill-Main Showing – 012B/16/Cr 002	Developed Prospect	Magmatic – ultramafic intrusive	Estimates of 10 790 t grading 36.97% Cr_2O_3 (Horning, 1941); 8100 t grading 30% Cr_2O_3 (Berger, 1963)
Chrome Pond – 012A/08/Cr 001	Prospect	Magmatic – ultramafic intrusive	Several areas contain lenses and pods 6–8 m in length of solid chromite averaging 35–62% Cr_2O_3 (Barning, 1965)
Chrome Point – 012B/16/Cr 001	Prospect	Magmatic – ultramafic intrusive	Several hundred tons of chromite averaging 25–30% Cr_2O_3 (McKillop, 1961)
Stowbridge Prospect – 012G/01/Cr 004	Prospect	Magmatic – ultramafic intrusive	Channel samples yielded up to 9.5% Cr_2O_3 (Smith, 1958) and 11.3% Cr_2O_3 in dunite bands (Snelgrove, 1934)
Chrome Hill – 002E/08/Cr 001	Showing	Magmatic – ultramafic intrusive	A sample of massive chromite yielded 47.77% Cr_2O_3 in serpentinite (Snelgrove, 1934)
Red Rocks Bend – 002D/05/Cr 001	Showing	Magmatic – ultramafic intrusive	Chromite occurs in 6 or 7 locations in the Coy Pond ultramafics, two samples contain 49.48% and 55.7% Cr_2O_3 (Snelgrove, 1934)
Long Pond – 002M/05/Cr 001	Showing	Magmatic – ultramafic intrusive	Occurrences consist of schlieren type lenses about 2.54 cm wide and 0.3 m long in half a dozen places and occurring in peridotite. An assay returned 54.05% Cr_2O_3 (Cooper, 1937)
Lanes Brook Chromium – 012H/03/Cr 001	Showing	Magmatic – ultramafic intrusive	Several samples collected over hundreds of metres yielded 1200–3700 ppm Cr (Dearin, 1991)
LABRADOR			
Brianna – 023H/05/Cr 001	Prospect	Magmatic – ultramafic intrusive	A grab sample from gabbroic rocks of the Shabogamo Intrusion returned 1185 ppm Cr (Guinchard and Muggridge, 2018)
Kingurutik Lake D Zone – 014D/16/Ni 004	Prospect	Magmatic – ultramafic-mafic intrusive (anorogenic anorthosite massif association)	Best assay returned from 10 grab samples returned 1900 ppm Cr, 2440 ppm Cu, 8480 ppm Ni and 577 ppm Co (Farmer *et al.*, 2007)

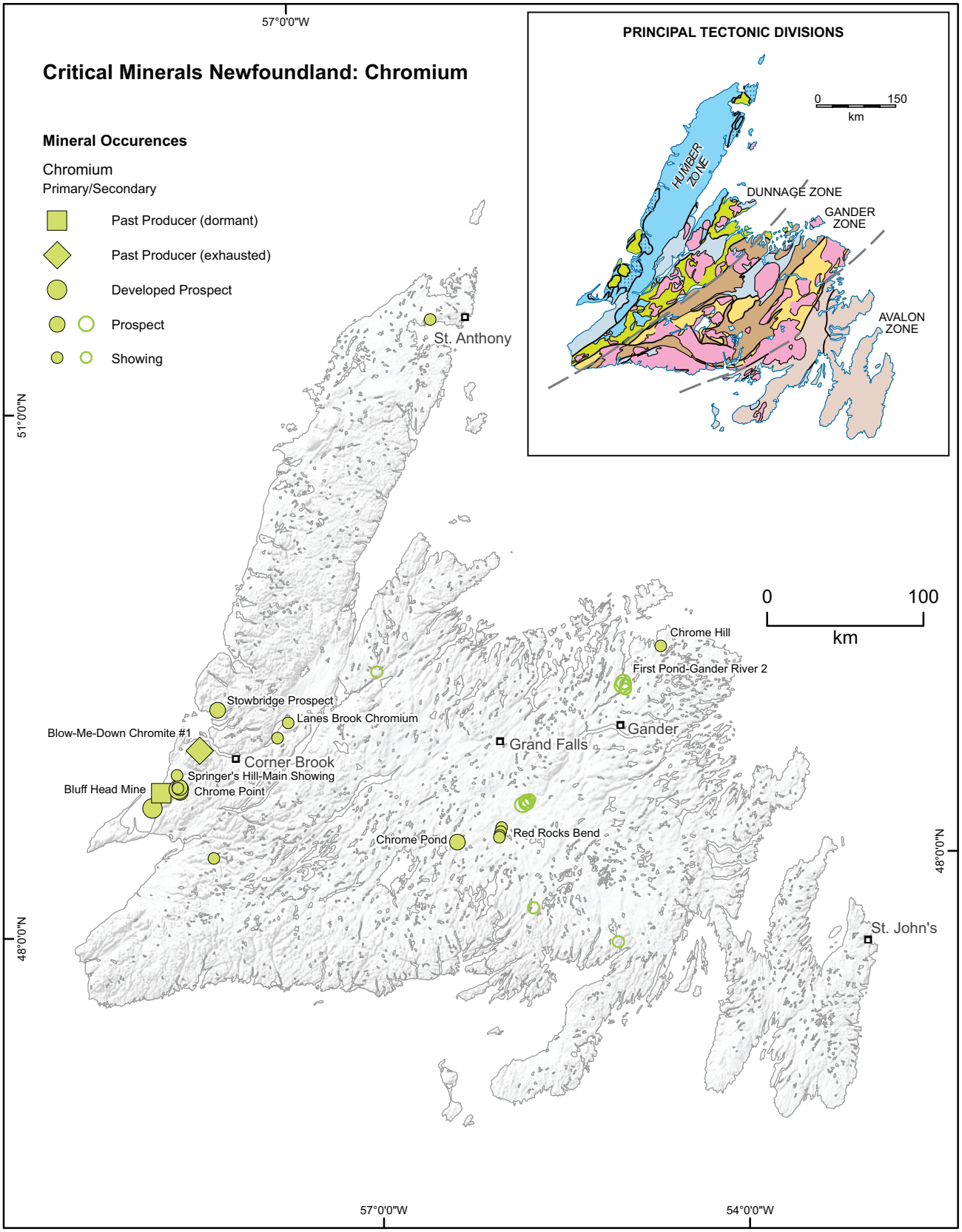

Figure 13. *Map showing the distribution of chromium occurrences in Newfoundland as well as illustrating all levels of development above indication.*

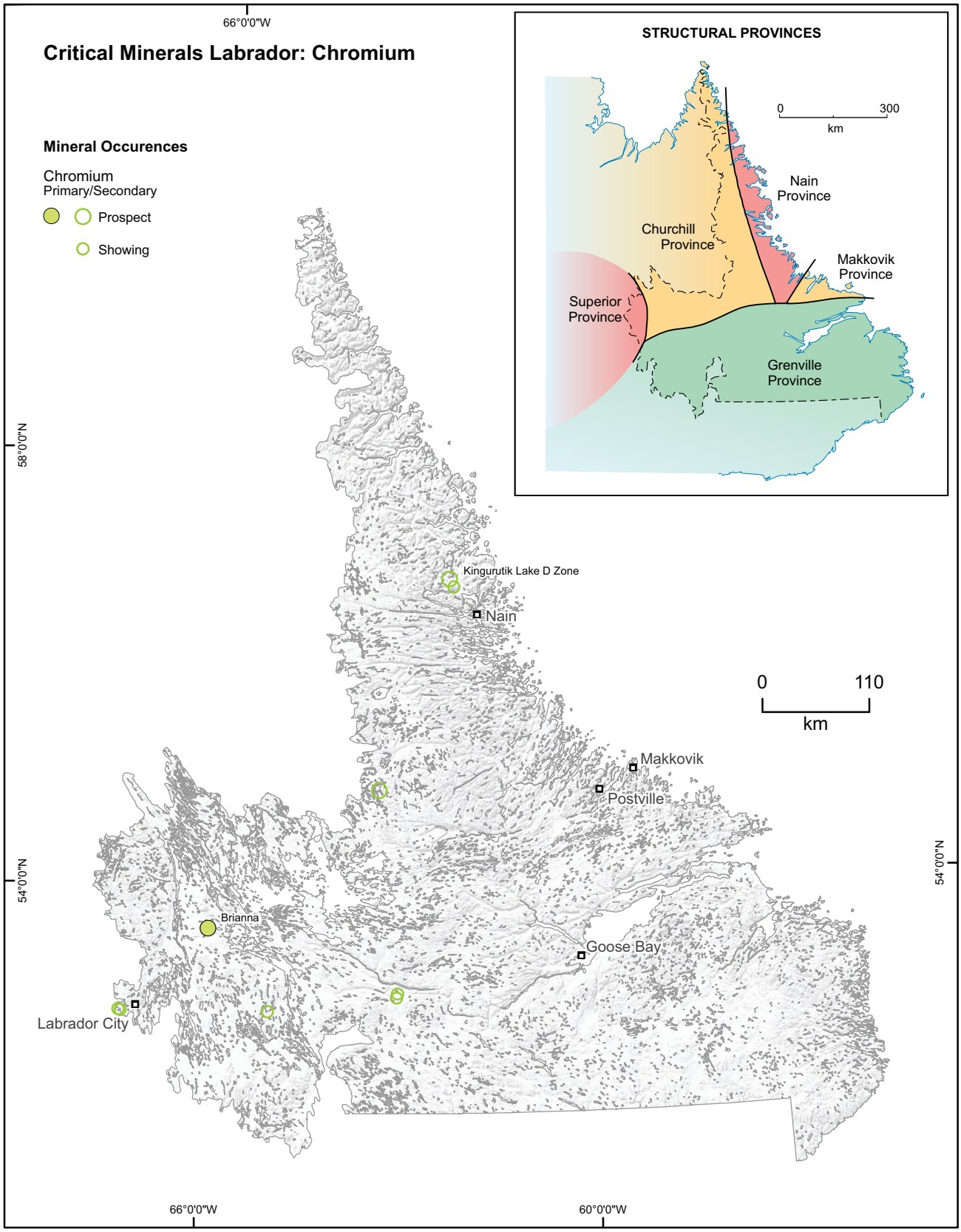

Figure 14. *Map showing the distribution of chromium occurrences in Labrador as well as illustrating all levels of development above indication.*

COBALT (Co)

Description

Cobalt is a silvery, hard metal that has a bluish tinge when polished. It occurs only in combination with other elements such as nickel, copper, manganese, zinc, arsenic and sulphur. It is one of three metals along with iron and nickel that is magnetic at room temperature. Cobalt-based blue pigments have been used since antiquity to impart a blue hue in jewellry and paint. Cobalt is used in a wide variety of compounds in the aerospace, manufacturing and biochemical industries, most significantly in batteries and superalloys.

Source Minerals

Cobaltite, pentlandite, erythrite, smaltite, linnaeite.

Uses

Batteries, alloys for jet engines, gas turbines and space vehicles, magnetic materials, catalysts, desiccants, reagents, pigments and dyes.

Global Mine Production

Annual production of cobalt in 2024 was estimated at 290 000 t (USGS, 2025). The top three producers were the Democratic Republic of Congo (220 000 t, 73%), Indonesia (28 000 t, 7.4%) and Russia (8700 t, 3.8%). Statistics Canada estimated Canadian production at 3351 t for 2024, while the USGS estimated Canada produced 4500 t of cobalt in 2024.

Mineral Resource Supply and Demand Outlook

Cobalt prices continued to decline from their 2021 peak through early 2025, largely due to a combination of weakened demand prospects and persistent oversupply. Demand for cobalt grew by 10% over the last two years, but supply expanded even faster, with mined and refining output rising by about 25% each over the same period (IEA, 2025). Cobalt is predicted to remain a key raw material for electric batteries (Cobalt Institute, 2023). The global supply of cobalt currently relies heavily on the Democratic Republic of Congo's production (~70%).

Recovery

Cobalt is currently recovered mainly as a secondary commodity from nickel and copper mining. The co-existence of Co, Cu and Ni together in magmatic sulphide ores necessitates the use of innovative chemical techniques to extract cobalt (Sole, 2018; Crundwell *et al.*, 2020).

Recycling

Cobalt is endlessly recyclable; 5–8% of the world's cobalt currently comes from recycled sources. This figure is expected to increase dramatically as cobalt batteries become exhausted (Cobalt Institute, 2022).

Geological Setting

Cobalt is recovered from several types of deposits including hydrothermal, volcanogenic, orthomagmatic sulphides, IOCG, sediment-hosted and laterite deposits, and is commonly associated with nickel and copper in magmatic deposits. Sediment-hosted cobalt occurs in carbonate-hosted Pb–Zn and stratiform copper deposits, and these represent the largest sources of mined cobalt in the world, with most mines located in the Democratic Republic of Congo. Significant deposits exist in the form of manganese iron nodules found on the deep-sea floor with some deposits reaching up to 1.7% cobalt (International Seabed Authority, 2006). The feasibility and environmental impacts of deep-sea mining are currently being studied (Clark *et al.*, 2020).

MODS Occurrences

There are 181 cobalt occurrences in the MODS (4 primary), including one producer (Voisey's Bay). Cobalt is generally present as a secondary commodity in association with nickel and copper occurrences in mafic–ultramafic magmatic deposits. (Refer to these elements occurrences sections for more information related to their occurrence in the province) Representative cobalt occurrences are listed in Table 10 and illustrated in Figures 15 and 16.

Table 10. Representative cobalt occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
York Harbour Mine – 012G/01/Cu 002	Developed Prospect – (Cu)	VMS – mafic/ophiolite (stockwork?)	Best DDH intercept of 44.0 m grading 123 ppm Co (Van de Meer, 2022)
Whalesback Mine – 012H/09/Cu 001 Little Deer Mine – 012H/09/Cu 002	Prospect – (Cu)	VMS – mafic/ophiolite (stockwork?)	Whalesback and Little Deer Mine combined Ind. Res. of 2.88 Mt grading 0.02% Co, 2.13% Cu, 3.43 ppm Ag and 0.1 ppm Au at 1.0% Cu cut-off (Stone *et al.*, 2021)
Layden – 012H/11/Ni 001	Prospect (Ni)	Magmatic – ultramafic-mafic intrusive	Eleven grab samples from the Layden Prospect returned an average grade of 0.1% Co (Wilton *et al.*, 2023)
RPM Zone – 012A/08/Ni 002	Prospect	Magmatic – ultramafic-mafic intrusive (ophiolitic association)	Consistent 0.24% Ni and 0.32% Cr over 381.1 m with peaks of 0.31% Ni and 2.61% Cr (First Atlantic, 2025)
Powderhorn Lake–Main Showing – 012H/01/Ni 002	Prospect (Ni)	Magmatic – ultramafic-mafic intrusive (anorogenic gabbro)	Best assay from grab samples in gabbro or diorite up to 0.3% Co. Best intersection in DDH grading 0.07% Co over 1.5 m (Kerr, 1999)
LABRADOR			
Voisey's Bay – 014D/08/ Ni 001, -002, -003, -008	Producer	Magmatic – ultramafic-mafic intrusive (anorogenic anorthosite massif association)	Total proven and probable reserves of 31.1 Mt grading 0.11% Co (Vale SEC filing, 2023)
The Cirque – 014E/01/Ni 003	Prospect (Ni)	Magmatic – ultramafic-mafic intrusive (anorogenic anorthosite massif association)	Grab samples assayed up to 0.12% Co (Beesley, 1997). Higher Co in DDH (locally up to 0.14%) is associated with increased Cu (Kerr and Smith, 1997b)
OKG – 014E/08/Ni 001	Prospect (Ni)	Magmatic – ultramafic-mafic intrusive (anorogenic anorthosite massif association)	Pentlandite and chalcopyrite occur in pods and lenses; cobalt in DDH as much as 1.1% (Ryan and Malpage, 1996)
Northern Abitibi Nickel Zone – 013M/09/Ni 001	Prospect (Ni)	Magmatic – ultramafic-mafic intrusive (anorogenic anorthosite massif association)	DDH section (97-96) grading 1.13% Ni, 078% Cu and 0.20% Co over 15.7 m. DDH section (97-75) grading 11.9% Ni, 9.6% Cu, 0.43% Co and 54 ppm Ag over 1.1 m (Fitzpatrick *et al.*. 1998)
Paul Island, Project 43 Grid 1 – 014C/12/Ni 004	Prospect (Ni)	Magmatic – ultramafic-mafic intrusive (anorogenic anorthosite massif association)	Stringers and weak sulphide disseminations in troctolitic olivine-rich dyke. Assays range up to 0.11% Co over 0.92 m in DDH (Barbour *et al.*, 1996)
Kingurutik Lake A Zone – 014D/16/Ni 009	Prospect (Ni)	Magmatic – ultramafic-mafic intrusive (anorogenic anorthosite massif association)	Best assays in DDH include several zones from 0.7 to 4.4 m with up to 0.09% Co (House and Spencer, 2010)

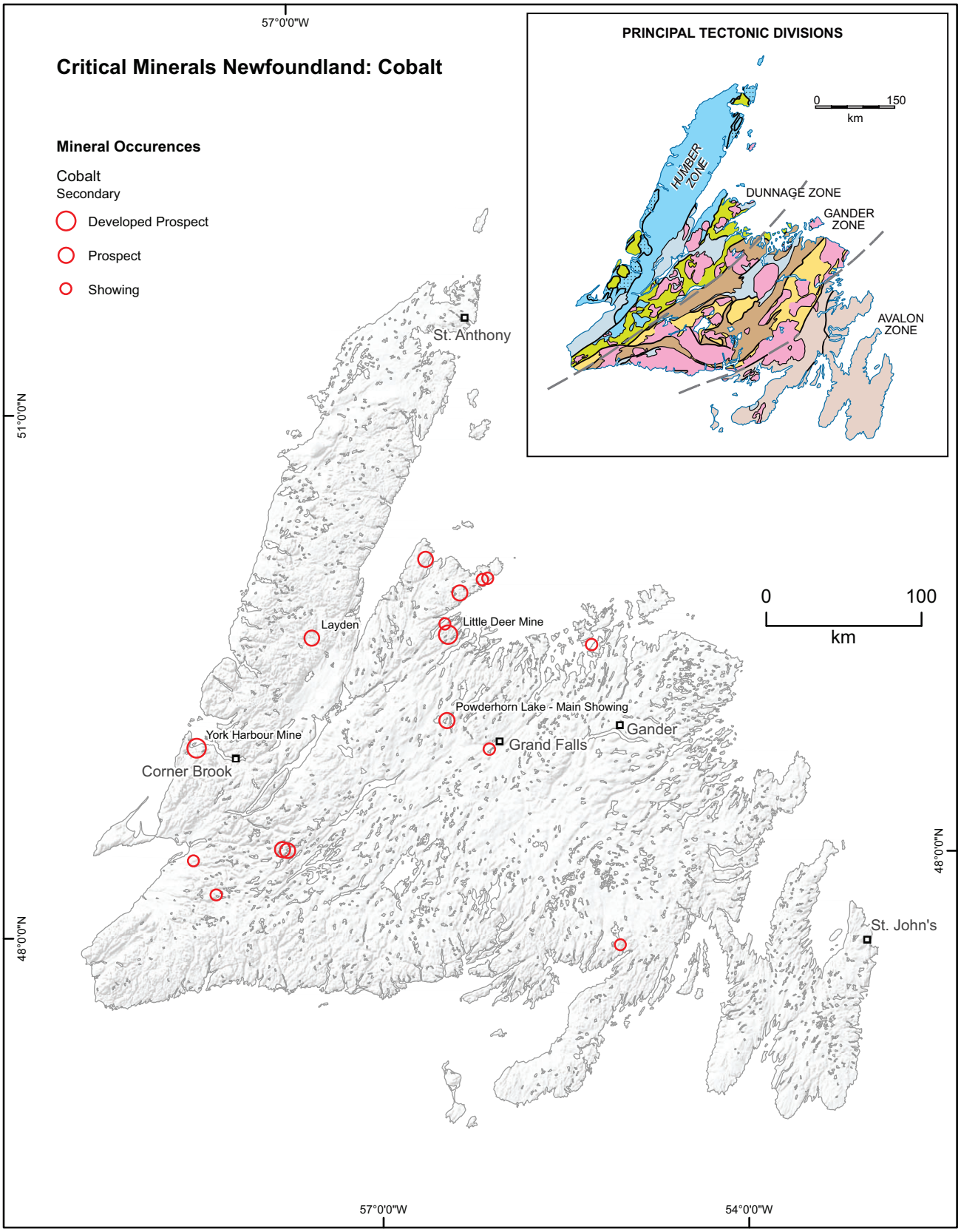

Figure 15. *Map showing the distribution of cobalt occurrences in Newfoundland as well as illustrating all levels of development above indication.*

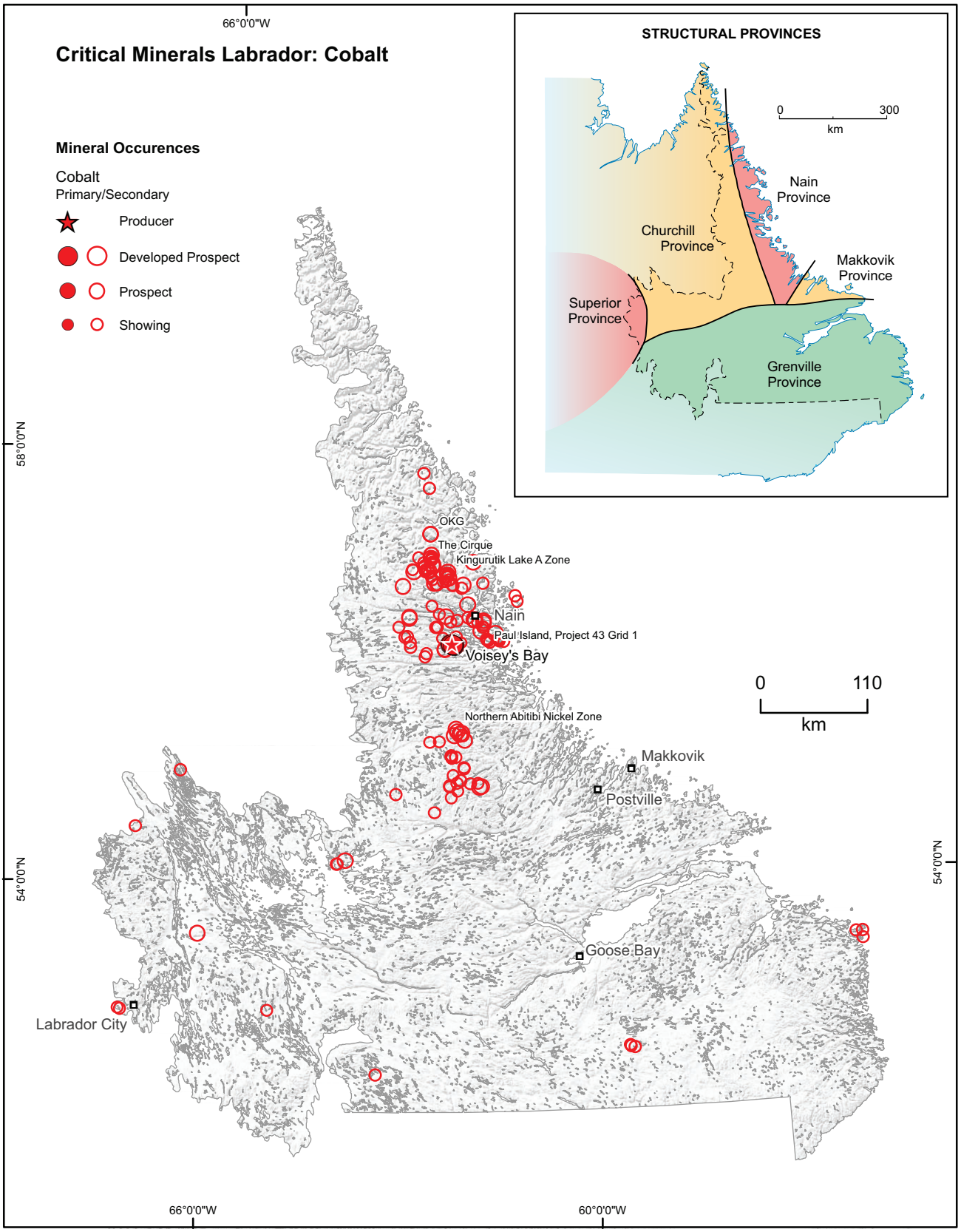

Figure 16. *Map showing the distribution of cobalt occurrences in Labrador as well as illustrating all levels of development above indication.*

COPPER (Cu)

Description

Copper is one of the most corrosion resistant, ductile and malleable metals; it is also one of a few elements that occur naturally as native, and one of few metallic elements that has a colour other than grey or silver. Due to its occurrence as a native element, copper was one of the first metals to be used in antiquity for making tools, weapons and adornments, lending its name to an age, the Copper Age (5000 to 2000 BC). The copper sulphide, chalcopyrite, is the most common copper ore mined. The excellent electrical and thermal conductivity of copper (second only to silver amongst pure metals) makes it a crucial component of major industries, especially in the shift to clean energy with respect to electrical grids. It had remained the second most used metal until aluminum replaced it by the 1960s. An average family home can contain more than 90 kg of copper.

Source Minerals

Chalcopyrite, bornite, azurite, malachite, chalcocite, acantite.

Uses

Electrical wires, pipes, various industrial parts, solar cells, electric vehicles.

Global Mine Production

Annual production of copper in 2024 was estimated at 23 Mt (USGS, 2025). The top three producers were Chile (5.3 Mt, 23%), Democratic Republic of Congo (3.3 Mt, 14.3%) and Peru (2.6 Mt 11.3%). Canada is estimated to have produced 514 582 t of copper in 2024 (Statistics Canada, 2025).

Mineral Resource Supply and Demand Outlook

Demand for refined copper increased by 3.2% in 2024, up from 2.7% in 2023 and 1.1% in 2022 (IEA, 2025). Long term demand is predicted to rise with some sources predicting a 70% growth in demand by year 2050 (BHP, 2023). Copper is entering a pivotal phase in its market cycle, prices have surged due to supply disruptions, while demand from AI data centres, electrification, and electrical grid upgrades is increasing (Umair, 2025).

Recovery

No significant challenges exist in the recovery of copper. A significant amount of copper can be lost to tailings during processing of low-grade ores (Bilal *et al.*, 2022).

Recycling

Recycled copper accounted for 33% of world copper consumption in 2021. Copper does not degrade during recycling and as much as two-thirds of the copper that has been produced in the last one hundred years is estimated to be still in use (International Copper Association, 2021).

Geological Setting

Copper mineralization occurs in a wide variety of geological settings and deposit types including porphyry, VHMS, orthomagmatic sulphides, IOCG, stratabound sediment hosted, epithermal, vein hosted, pegmatites and skarn deposits. Porphyry copper deposits are the most important source of copper mined, with stratabound sediment-hosted copper representing the second most; less important, but still significant are IOCG and VMS deposits. It is recognized that copper, like most other metals, is heterogeneously concentrated in the earth's crust, resulting in discrete copper provinces generated during different metallogenic epochs (Hedenquist *et al.*, 2012).

MODS Occurrences

Copper has the highest number of occurrences within the MODS with 2477 occurrences (1583 primary), including one producing mine in Voisey's Bay, Labrador, 47 past-producing deposits and 29 developed prospects. Copper has had the longest mining history in Newfoundland with VMS copper having been the most important type of copper deposit, with more than 20 deposits over 200 000 t located within the ophiolitic and arc-volcanic environments of the Dunnage Zone (Piercey *et al.*, 2023). Stratiform sedimentary copper is hosted in the Avalon (tectonic) Zone in redbed–basalt units of the Neoproterozoic Musgravetown Group located on the northern tip of the Bonavista Peninsula (*e.g.*, Blue Point – 002C/11/Cu 002). Also, within the Avalon Zone, copper occurs in basalts of the Harbour Main Group near St. John's, and in IOCG-type deposits at Dunn's Mountain hosted in fractured sedimentary and volcanic rocks (001M/15/Cu 001). Porphyry-style copper mineralization exists on the south coast of Newfoundland at Grey

River; vein-type deposits are present in southwest Newfoundland at Cape Ray (*e.g.*, Stackhouse – 011O/11/Cu 003), and in northwest Newfoundland at the Sail Pond prospect.

Magmatic-sourced copper became the dominant deposit type mined upon the opening of the Voisey's Bay nickel–copper–cobalt mine in Labrador. Potential for VMS deposits exist also in Labrador within the Florence Lake and Hunt River greenstone belts, and in the Paleoproterozoic volcanic rocks of the Blueberry Lake Group in western Labrador. Sediment-hosted copper mineralization occurs in central Labrador as native copper, bornite and chalcocite generally in veins in redbeds of the Seal Lake Group, and also as finely laminated pyrrhotite and chalcopyrite in black shales intercalated with gabbro sills in the Labrador Trough, western Labrador. Representative copper occurrences are listed in Table 11 and illustrated in Figures 17 and 18.

Table 11. Representative copper occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources
NEWFOUNDLAND			
Duck Pond Deposit – 012A/09/Zn 010	Past Producer (Dormant)	VMS – mafic/felsic (stockwork?)	In 2007 the mine was projected to produce 4.1 Mt of ore grading 3.3% Cu and 5.7% Zn (Whitford *et al.*, 2007). Total milled ore by Teck Resources from 2007–2015: 5.0 Mt avg. 2.7% Cu, 4.4% Zn, 0.6 ppm Au and 53 ppm Ag (Canadian Zinc Corporation, 2015)
Ming Mine – 012H/16/Cu 010	Past Producer (Dormant)	VMS (stockwork?/epiclastic)	NI 43-101 Meas. and Ind. Res. estimate of 23.45 Mt grading 1.64% Cu, 0.32 ppm Au and 2.52 ppm Ag for Ming Mine proper (WSP Consultants, 2018); Updated in 2024 to 50 Mt @ 2.0% CuEq (1.7% Cu and 0.3 g/t Au) (Firefly Metals, 2024); Historical production of 6.78 Mt grading 2.0% Cu between 1972 and 1982 (AuTECO Minerals, 2024)
Buchans Deposits – Historical Mining Camp	Past Producer (Dormant)	VMS – mafic/felsic (stockwork and breccia)	From 1935 to 1981 approximately 16.1 Mt of ore averaging 1.3% Cu, 14.5% Zn, 7.6% Pb, 126 ppm Ag and 1.4 ppm Au was mined from the Buchans deposits (Kirkham, 1987)
Lundberg Zone – 012A/15/Zn 019	Past Producer (Dormant)	VMS – felsic (stockwork)	Ind. Res. of 16.8 Mt grading 0.42% Cu, 1.53% Zn, 0.64% Pb, 5.69 ppm Ag and 0.07 ppm Au (Canterra Minerals, 2023)
York Harbour Mine – 012G/01/Cu 002	Past Producer (Dormant)	VMS – mafic/ophiolite (stockwork?)	DDH intercept of 25.0 m grading 2.7% Cu, 9.0% Zn, 17.8 ppm Ag and 164 ppm Co (Van De Meer, 2022). Noranda (MacDougall *et al.*, 1991) quoted reserves as totalling 200 000 t of ore grading 2.68% Cu, 8.25% Zn, 1–2 oz/t Ag and <1.0 g/t Au
Whalesback Mine – 012H/09/Cu 001 Little Deer Mine – 012H/09/Cu 002	Past Producer (Dormant)	VMS – mafic/ophiolite (stockwork?)	Whalesback and Little Deer Mine combined Ind. Res. of 2.88 Mt grading 2.13% Cu, 0.02% Co, 3.43 ppm Ag and 0.1 ppm Au at 1.0% Cu cut-off (Stone *et al.*, 2021)
Hope Brook – 011O/09/Au 003	Past Producer (Au – Dormant)	Structurally controlled epithermal precious metal with aluminous alteration	NI 43-101 Inf. Res. for the tailings deposits: total 9.5 Mlbs of copper metal (Cullen *et al.*, 2021). DDH intersect of 0.52% Cu over 29.2m in extension from previous underground operation (Pearson and Cullen, 2015)

Colchester-Main Zone – 012H/09/Cu 005	Past Producer (Dormant)	VMS – mafic/ophiolite (stockwork?)	The Colchester Main Zone comprises an 85-m-wide schist zone mineralized for a distance of 485 m; estimated 0.9 Mt avg. 1.3% Cu (Gibbs, 1967)
Upper Ming Footwall – 012H/16/Cu 032	Past Producer (Dormant)	VMS (stockwork/epiclastic)	NI 43-101 Ind. Res. of 365 000 t grading 2.73% Cu, 0.22 ppm Au, 2.67 ppm Ag and 0.05% Zn (Maloney and Pilgrim, 2012)
Tilt Cove Mine – 002E/13/Cu 001	Past Producer (Exhausted)	VMS – mafic/ophiolite (stockwork?)	424 305 t of Cu concentrate plus 42 425 oz Au produced from 1957 to 1967; estimated 55 333 t Cu content produced from 1864 to 1917 + estimated 289 to 373 t of Ni ore (Upadhyay and Watson, 1974; Snelgrove, 1931)
Little Bay Mine – 002E/12/Cu 030	Past Producer (Exhausted)	VMS (mafic/ophiolite - stockwork?)	Total of 25 770 t of Cu were produced from 1961 to 1969 plus 200 000 t of ore grading avg. 2.5 to 10% Cu was reported to have been produced from 1878 to 1892 (Douglas *et al.*, 1940; Peters, 1971)
Gullbridge Mine – 012H/01/Cu 007	Past Producer (Exhausted)	VMS (mafic/felsic stockwork/epiclastic)	Total of 11 357 t of Cu were produced from 1967 to 1971 (GSNL Return on Registry of Mines 1967–1971)
Long Lake Deposit – 012A/06/Zn 004	Developed Prospect	VMS – felsic (epiclastic)	NI 43-101 Ind. Res. of 407 000 t grading 0.97% Cu, 7.8% Zn, 1.6% Pb, 49 ppm Ag, 0.6 ppm Au + Inf. Res. of 78 000 t grading 0.7% Cu, 5.8% Zn, 1.2% Pb, 34 ppm Ag and 0.5 ppm Au (Keller *et al.*, 2012)
Lake Bond – 012H/01/Zn 001	Developed Prospect	VMS (mafic/felsic – stockwork/epiclastic)	Estimated resource of 1.2 Mt grading 0.31% Cu and 2.12% Zn (Harris, 1976)
Lemarchant – 012A/10/Zn 012	Developed Prospect	VMS – felsic (epiclastic)	Ind. Res. of 2.42 Mt grading 0.68% Cu, 6.15% Zn, 1.6% Pb, 1.22 ppm Au, 64.0 ppm Ag and 23.5% barite (Cullen *et al.*, 2018)
Boomerang/Domino – 012A/06/Zn 008 and 009	Developed Prospect	VMS – felsic (epiclastic)	Boomerang deposit Ind. Res. of 1.36 Mt grading 0.51% Cu, 7.1% Zn, 3% Pb, 1.66 ppm Au, 110.2 g/t Ag and 1.6 ppm Au; Domino deposit Inf. Res. of 411 200 t grading 0.4% Cu, 6.3% Zn, 2.8% Pb, 0.94 ppm Ag and 0.6 ppm Au (De Mark and Dearin, 2007)
Bobby's Pond Deposit – 012A/10/Zn 001	Developed Prospect	VMS – felsic (epiclastic)	Ind. Res. of 1.095 Mt grading 0.86% Cu, 4.61% Zn, 0.44% Pb, 16.56 ppm Ag and 0.02 ppm Au (Wilson, 2008)
Skidder Prospect – 012A/10/Cu 004	Developed Prospect	VMS – mafic (stockwork)	Best intercepts in DDH: 2.1% Cu, 1.8% Zn, 14 ppm Ag and 0.1 ppm Au over 13.0 m; 2.8% Cu, 2.4% Zn, 14 ppm Ag and 0.1 ppm Au over 6.54 m (O'Driscoll and Sparkes, 2008). A resource estimate of 0.9 Mt grading 2.0% Cu, 2.0% Zn with minor Pb and Ag was reported in 1977 based on 38 DDH by Asarco/Abitibi Price (O'Driscoll and Sparkes, 2008)
Sandfill Prospect – 012A/15/Zn 011	Developed Prospect	VMS – mafic/felsic (breccia/epiclastic)	80 000 t grading 1.4% Cu, 9.2% Zn, 4.8% Pb, 2.5 oz/t Ag and 0.02 oz/t Au (Barnes and Entwistle, 1971)
Clementine Prospect – 012A/15/Zn 006	Developed Prospect	VMS – mafic/felsic (breccia)	363 000 t grading 0.3% Cu (Calhoun and Hutchinson, 1981)
Great Burnt Lake Deposit – 012A/08/Cu 001	Developed Prospect	VMS – mafic/felsic (stockwork)	Ind. Res. of 667 000 t of Cu ore grading 3.21% and Inf. Res. of 482 000 t of Cu grading 2.35% (Barry *et al.*, 2022)

Indian Cove – 002E/05/Cu 003	Prospect	VMS (stockwork/epiclastic)	Best DDH intersections: 9.1 m grading 1.04% Cu (Butler and Stewart, 1993), 20.8 m grading 0.42% Cu (Vande Guchte, 1999)
Blue Point – 002C/11/Cu 002	Prospect	Stratabound – shale or mudstone-hosted Cu deposit – redbeds and evaporites	Best DDH intersections from 2 DDH: 9.7 m grading 0.8% Cu, and 14.25 m grading 1.0% Cu (Dessureault, 2002)
Rust Pond – 002E/05/Cu 006	Prospect	VMS (stockwork/epiclastic)	Best DDH intersection: 3.56 m grading 1.7% Cu (Brinex, 1962; Andrews, 1991)
LABRADOR			
Voisey's Bay – 014D/08/Ni 001,-002,-003,-008	Producer	Magmatic – ultramafic-mafic intrusive (anorogenic anorthosite massif association)	Total proven and probable reserves of 31.1 Mt grading 0.82% Cu (Vale SEC filing, 2023)
Moran Lake C-Zone – 013K/07/U 002	Developed Prospect (U)	Undivided hydrothermal, structurally controlled deposit	Best DDH intercepts: 0.10% Cu over 8.12 m, 0.15% Cu over 7.02 m and 0.13% Cu over 18.1 m (Gillies *et al.*, 2009)
North Whisky Lake (No 64 & 150) – 013K/05/Cu 003	Prospect	Stratabound Cu in volcanic rocks in a dominantly continental sedimentary succession	Best value assayed from Zone 150: 7.11% Cu and 82.8 g/t Ag along erratic and impersistent shears in diabase, mineralized zone is 1.5 m thick (Brummer, 1957)
Moran Heights – 013K/10/U 009	Prospect (U)	Stratabound – clastic sediments	Best assay in DDH: 0.24% Cu over 32.2 m, including 2.24% Cu over 0.6 m (Perry, 1979)
Ellis – 013K/05/Cu 002	Prospect	Stratabound – volcanic rocks	9.75 m in trench with 1.35% Cu and 43.9 ppm Ag (Moore, 2011)
Montgomery Lake – 023I/12/Cu 006	Prospect	Structurally controlled vein system accompanied by significant wallrock alteration	0.6 m DDH section grading 2% Cu in quartz carbonate conglomerate zone (Love, 1967)
Heggart Lake – 013K/10/Cu 005	Prospect	Undivided stratabound (conglomerate-hosted deposit)	Best assay from 32 channels: 0.6 m grading 2.25% Cu and 1.52 m grading 2.05% Cu; Best assay in DDH: 1.52 m grading 2.52% Cu (Collins, 1958)
Niatak Island – 014C/06/Cu 001	Prospect	Magmatic – ultramafic-mafic intrusive (anorogenic anorthosite massif association)	20 grab samples assayed 0.37–0.65% Cu; best assay in DDH: 6.4 m grading 0.71% Cu (Cullen and Churchill, 1996; Kerr and Smith, 1997a)

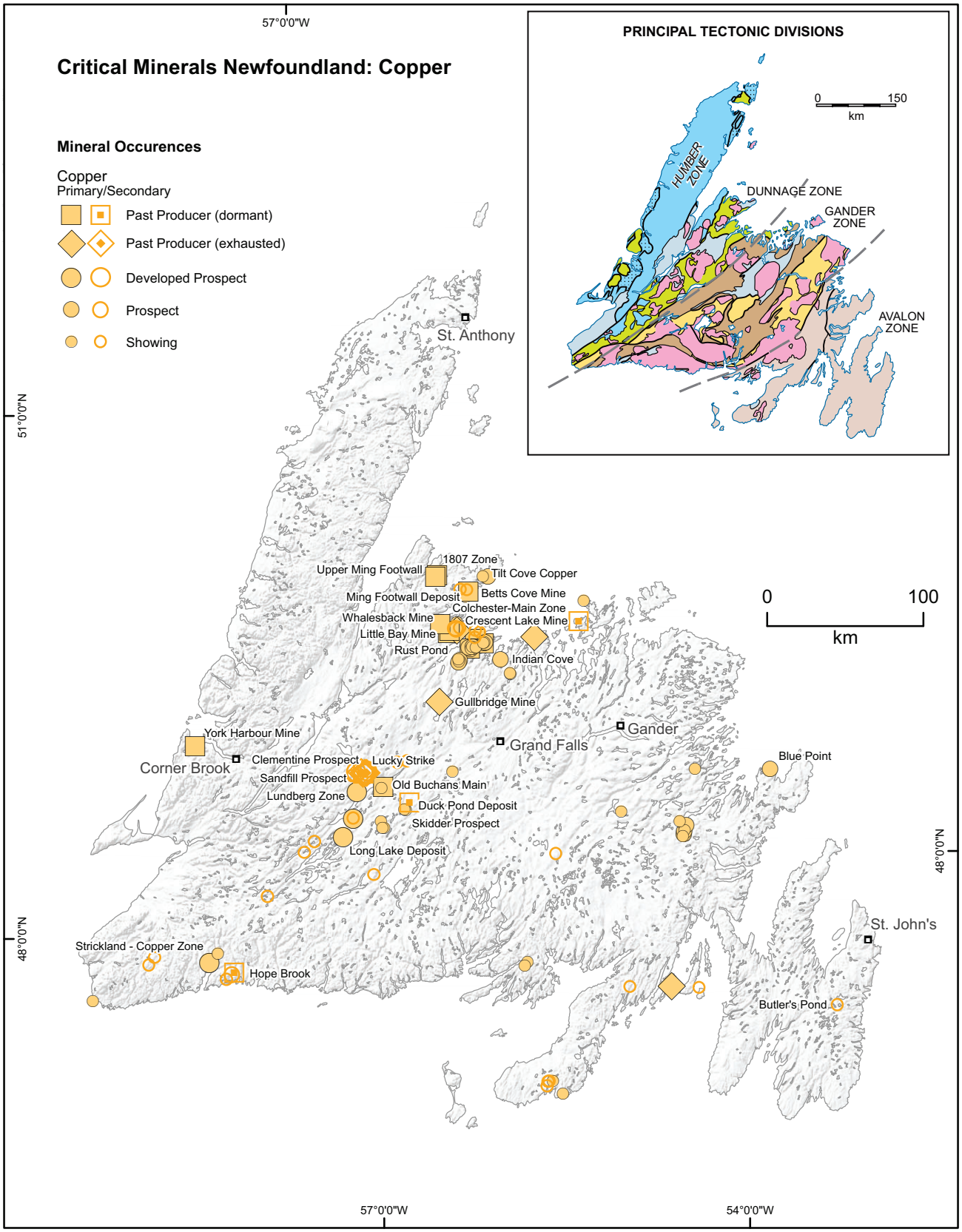

Figure 17. *Map showing the distribution of copper occurrences in Newfoundland as well as illustrating all levels of development above indication.*

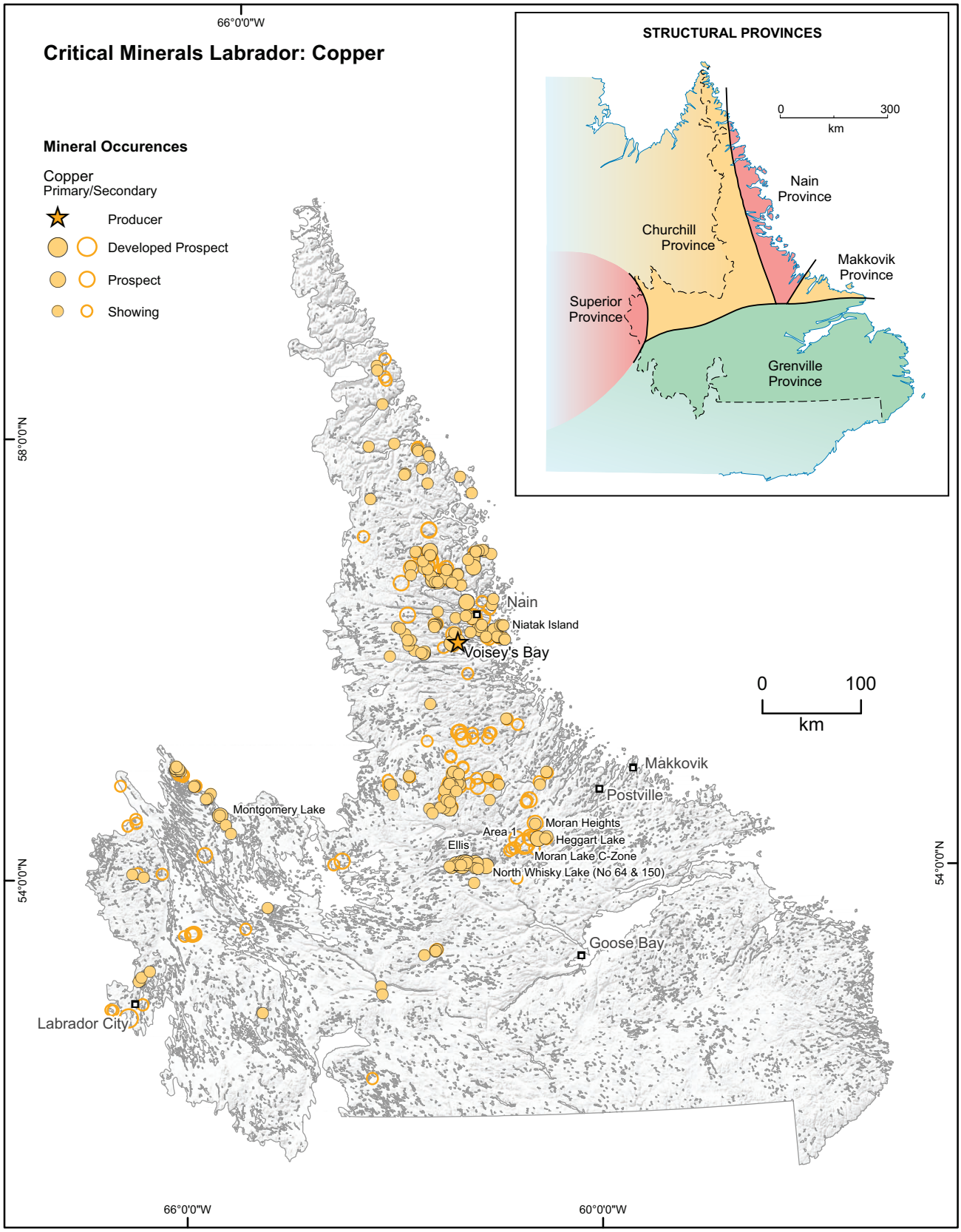

Figure 18. *Map showing the distribution of copper occurrences in Labrador as well as illustrating all levels of development above indication.*

FELDSPAR (Fsp)

Description

Feldspar minerals are important rock-forming aluminosilicates constituting about 60% of the earth's crust. Two families of feldspar are distinguished: alkali feldspar (potassium–sodium) and plagioclase feldspar (sodium–calcium), which are used as a source of aluminum, calcium, and sodium, mostly in ceramic and glass products related to the construction industries. Nepheline syenite has become the preferred source of alumina and alkalis for glass manufacturing because of its low silica content, which has the effect of reducing the energy required to produce glass while improving the yield and quality.

Source Minerals

Potassium feldspar and plagioclase feldspar endmembers: orthoclase–microcline, albite, anorthite, nepheline.

Uses

Ceramics and glass, reinforced plastics, fibreglass insulation, paints and coatings.

Global Mine Production

Annual production of feldspar in 2024 was estimated at 33 Mt (USGS, 2025). The top producers were Turkey (9.5 Mt, 28.8%), India (6.0 Mt, 18.2%) and Iran (3.1 Mt, 9.4%).

Mineral Resource Supply and Demand Outlook

Identified feldspar resources from granite, pegmatite and sand are estimated to meet demand. Accessibility to conveniently located mineable resources rather than existing resources determines market dynamics (USGS, 2025).

Recovery

The ceramics industry requires feldspar ore with low impurity which complicates their recovery from granites, iron being one of the most detrimental impurities for colour. The removal and liberation of iron-bearing minerals involves various mineral treatments, of which magnetic separation, leaching, and flotation are the main purification methods used (Baila *et al.*, 2023).

Recycling

Feldspar minerals are not currently recycled. As part of an environmental commitment, granite waste from mine tailings is currently recovered to obtain feldspar minerals (Baila *et al.*, 2023).

Geological Setting

As common rock forming minerals, potassium and plagioclase feldspar ubiquitously occur in igneous rocks. Deposits with low contents of unwanted accessory minerals are preferred for ore processing; these include pegmatites, granites, aplites and placer-type deposits. Plagioclase feldspar minerals tend to be associated with rocks of intermediate to mafic composition, such as basalts and gabbros, whereas potassium feldspar minerals are associated with more felsic rocks.

MODS Occurrences

There are 22 feldspar occurrences in MODS (16 primary), including 2 prospects. In southern Labrador, a 2-km-long nepheline feldspar syenite intrusion along the south coast transects the southern Labrador highway, 10 km from Red Bay (*e.g.*, Black Bay – 012P/16/Fel001; Red Bay – 012P/09/Fe 002). On the eastern coast of Labrador, amazonite (a green variety of potassium feldspar) was observed at the Spar Brook showing within granitic pegmatites and dykes related to the Manvers Granite, in the Benedict Mountains, and in granites at the eastern end of the Central Mineral Belt (Long Tickle, Adlavik Islands – 013J/15/Gem001).

At the Garrison Hill prospect in Newfoundland (001M/12/Sia001), a hydrothermal deposit contains separate quartz and feldspar zones devoid of granitic or gneissic inclusions and is estimated to contain 109 000 t of resources (Gale, 1965). On the south coast of southwestern Newfoundland, a pink microcline pegmatite up to 15 m wide is exposed over 500 m near Fox Roost (Fox Roost Pegmatite – 011O/11Fel001), and forms part of the Port aux Basques Granite. Potential for feldspar exists on the Baie Verte Peninsula near Teakettle Cove, where numerous dykes and sills related to the Dunamagon Granite occur within a 2.4 km zone and intrude rocks of the Ming's Bight Group. Representative feldspar occurrences are included in Table 12 and illustrated in Figures 19 and 20.

Table 12. Representative feldspar occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
Garrison Hill – 001M/12/Sia001	Prospect (silica)	Undivided minerals deposited from hydrothermal solutions	A feldspar zone was estimated to contain 109 000 t of resource (Gale, 1965)
Fox Roost Pegmatite – 011O/11/Fel001	Showing	Magmatic – pegmatite	Tater (1964) estimated 28 300 m^3 of mineable pegmatite exists. Gale (1967) suggests the vein may be much smaller.
LABRADOR			
Black Bay – 012P/16/Fel001, Red Bay Nepheline – 012P/16/Fel003, Red Bay #1 – 012P/16/Fel002 Black Bay #3 – 012P/16/Fel004 Black Bay #4 – 012P/16/Fel005	Prospect	Magmatic – felsic intrusive	Alkali feldspar syenite occurs continuously inside a 2.0 x 0.2 km area (Gower, 2010). The East Zone compares favorably to the typical raw composition at the Blue Mountain mine in Ontario in terms of silica (SiO_2), alumina (Al_2O_3), soda (Na_2O), potash (K_2O) and iron (Fe_2O_3) (Collins, 2017)
Spar Brook – 014C/14/Gem006	Showing (Gemstone)	Magmatic – pegmatite	Dykes related to the Manvers Granite cut the Kiglapait Intrusion on the north shore of Port Manvers Run. Amazonite is found in many of the dykes, but most profusely at this location (Morse, 1969)

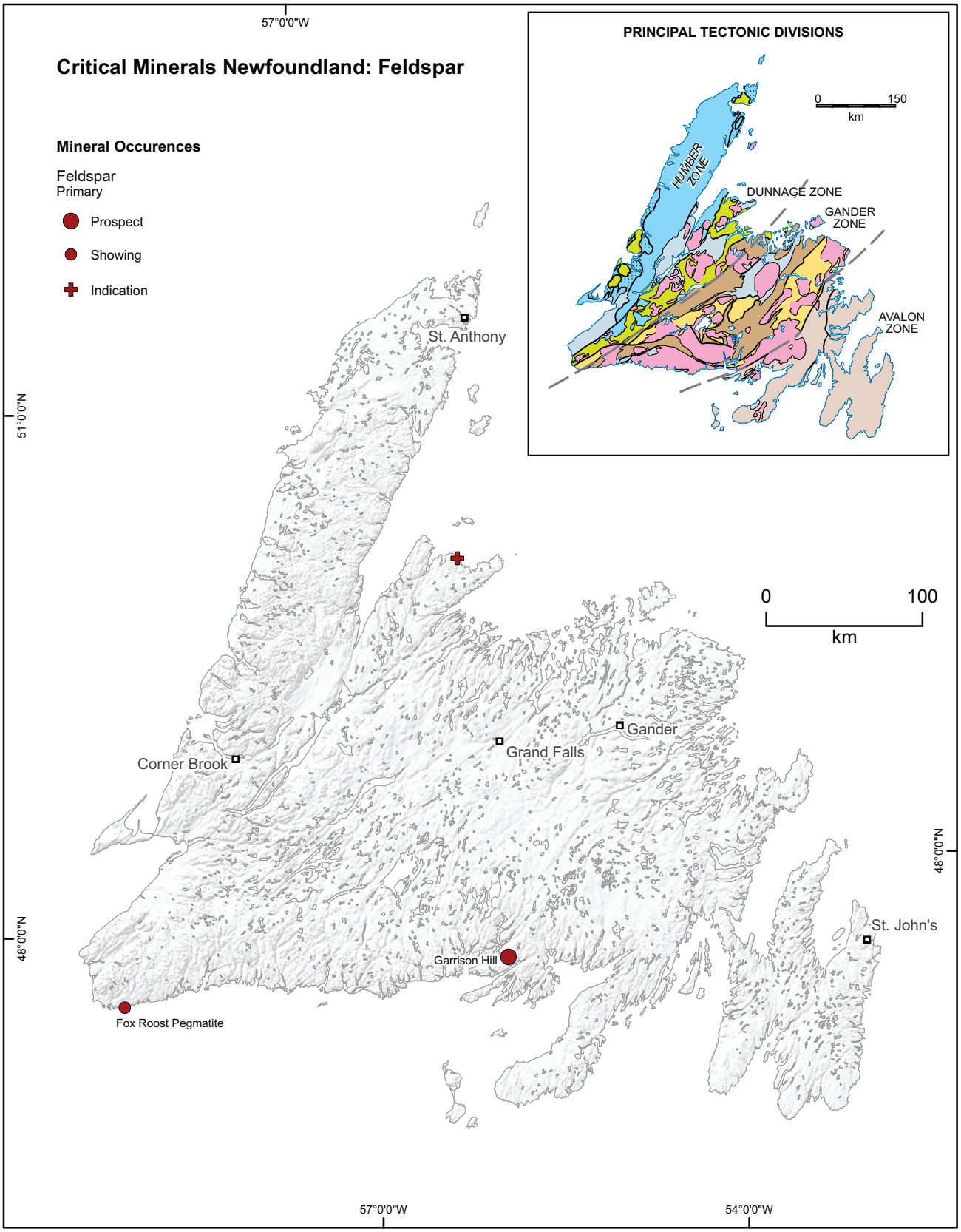

Figure 19. *Map showing the distribution of feldspar occurrences in Newfoundland as well as illustrating all levels of development.*

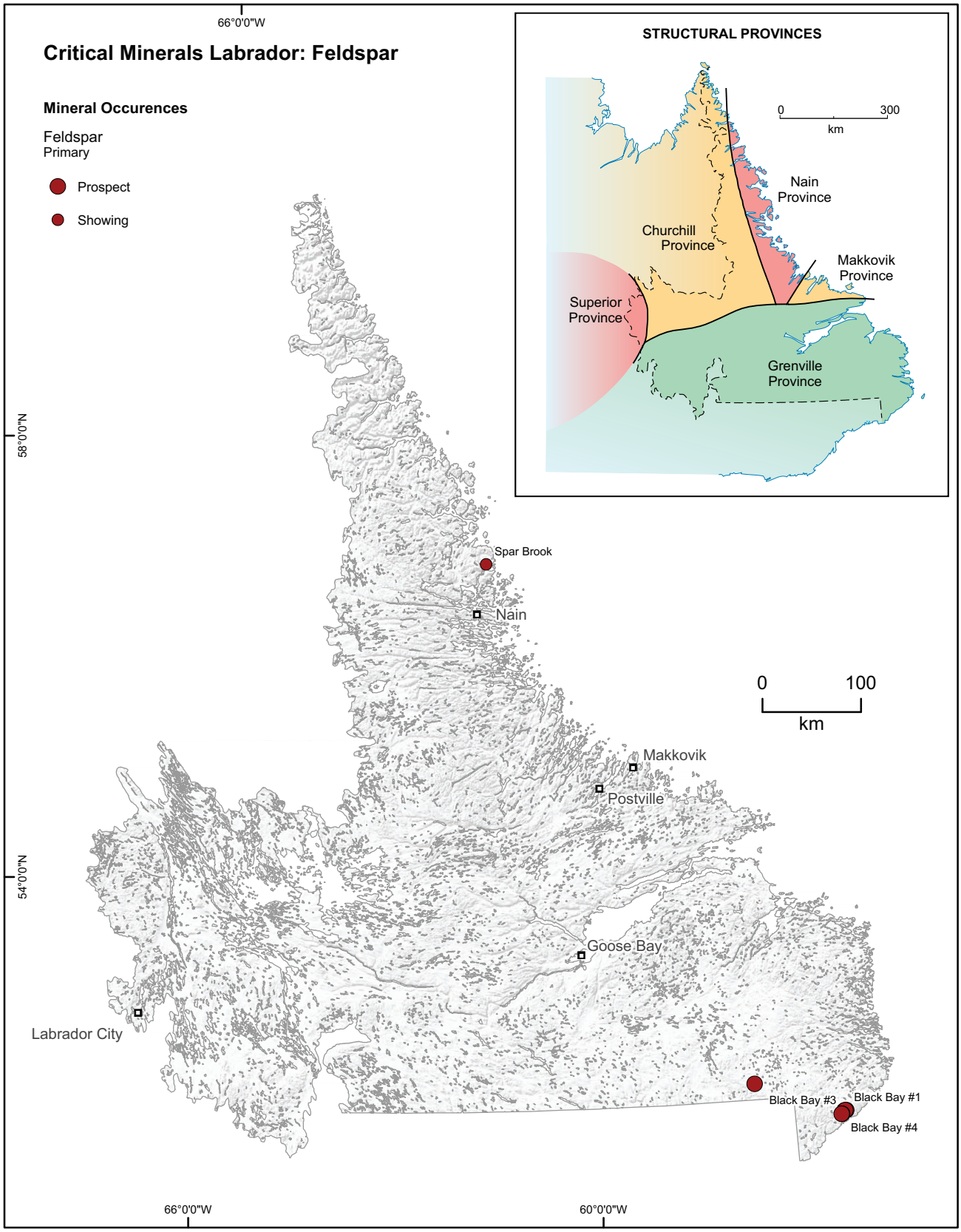

Figure 20. *Map showing the distribution of feldspar occurrences in Labrador as well as illustrating all levels of development above indication.*

FLUORINE/FLUORITE (F)

Description

Fluorine is the lightest of the halogen elements (excluding hydrogen); at standard conditions (1 atm pressure, 273.15 K (0°C), and 0% humidity) it exists as a highly reactive gas and is the most electronegative element. Fluorite (calcium fluoride), also named fluorspar, is the primary mineral source of fluorine. Other common fluorine bearing minerals are fluoroapatite, which contain most of world's fluorine, and cryolite, the most fluorine-rich mineral. Fluorite is a glassy, colourless mineral when pure, but because of impurities it commonly occurs in colours from green to blue to purple; as much as 20% yttrium or cerium may replace calcium in its composition. It has a hardness value of 4 on the Mohs scale, and some varieties of fluorite may exhibit fluorescence (emitting light) under ultraviolet light, a phenomenon that was named after it. Fluorine has unique chemical properties that make it a highly sought-after element in multiple sectors, from industrial to medical applications. Its largest application is as an ingredient in the nuclear fuel cycle, the series of stages that nuclear fuel undergoes during its production.

Source Minerals

Fluorite/fluorspar, fluoroapatite, cryolite, topaz, lepidolite.

Uses

Uranium enrichment, refrigerants, cement, enamels and glass, flux in steelmaking, aluminium smelting, welding rods, isotope for radiology, pharmacutical drugs, plastics, water treatment, dentistry.

Global Mine Production

Annual production of fluorite in 2024 was estimated at 9.5 Mt (USGS, 2025). The top three producers were China (5.7 Mt, 60%), Mexico (1.2 Mt, 12.6%) and Mongolia (1.2 Mt, 12.6%).

Mineral Resource Supply and Demand Outlook

World reserves of fluorite were estimated at 320 Mt in 2024, while world reserves of phosphate rock were estimated at 74 billion tonnes, which is equal to about 5 billion tonnes of fluorspar (assuming an average fluorine content of 3.5%) (USGS, 2025).

Recovery

Challenges to processing include complex mineralogy, variable impurities within ores, and variable ore grade (Huang *et al.*, 2022).

Recycling

Hydrofluoric acid is recycled from aluminum manufacturing. Synthetic fluorspar can be produced from the neutralization of waste from the enrichment of uranium and the petroleum alkylation process (USGS, 2023).

Geological Setting

Fluorite deposits occur in many geological environments and are mined as the main ore and as a secondary commodity of tin, silver, lead, zinc and copper deposits. In magmas, fluorine behaves as an "incompatible element" and is a common component in highly evolved and fractionated magmas, occuring in greisens within the roof zones of intrusions and in pegmatites, frequently associated with other incompatible elements such as REEs, tantalum, niobium, tungsten, lithium, cesium, zirconium, scandium and hafnium. Fluorite occurs as veins or replacement in carbonate replacement, epithermal, skarn, and hydrothermal vein/breccia deposits. Fluorine occurs as syngenetic enrichments in sedimentary rocks, most importantly in phosphorites due to F substituting for hydroxyl ions in apatite. Most fluorite deposits mined occur in alkaline intrusions (granites and pegmatites), alkaline-volcanic epithermal environments, carbonatite-related intrusions, and carbonate-hosted Pb–Zn deposits (Hayes, 2017).

MODS Occurrences

There are 226 fluorine occurrences in the MODS (153 primary), including 1 producer, 1 past producer, 1 developed prospect and 15 prospects. Fluorine is present as a secondary commodity in many different deposits, but as a primary commodity it is associated with peralkaline granites. The largest known deposits occur on the Burin Peninsula, near St. Lawrence, where there is a long history of recent and past fluorite mining; all past producers, developed prospects and 15 prospects recorded in the MODS are associated with the St. Lawrence Granite. Fluorite also occurs in the Granite Lake area with molybdenum and tungsten, within the Gander Lake

Granite, and in the White Bay area associated to the Devil's Room Granite and the Gull Lake Intrusive Suite.

In Labrador, fluorite is common in the Makkovik area associated with molybdenum, uranium and base metals. The Strange Lake peralkaline granite intrusion located on the Labrador–Québec border contains fluorite with rare-earth elements, zirconium and niobium; there is a defined resource for the portion of the deposit in Québec. Representative fluorine occurrences are listed in Table 13 and illustrated in Figures 21 and 22.

Table 13. Representative fluorine/fluorite occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
AGS Vein – 001L/14/Fl 013	Past Producer (Dormant)	Undivided minerals deposited from hydrothermal solutions	2014 NI 43-101 estimate prior to production: 9.389 Mt grading 32.88% fluorite (Sparkes and Reeves, 2015)
Blue Beach Mine – 001L/14/Fl 001, Tarefare Mine (and Blowout Veins) – 001L/14 Fl006	Past Producer (Dormant)	Undivided minerals deposited from hydrothermal solutions	2009 NI 43-101 total Ind. Res. of 9.09 Mt grading 42.0% CaF_2 for Blue Beach North, Tarefare Mine and Blowout Veins (Cooper *et al.*, 2010). A total of 9.27 Mt t of ore was estimated to have been removed at Blue Beach Mine between 1953 to 1967 (Farrell, 1967)
Mount Margaret Pond Vein – 001L/14/Fl 039	Developed Prospect	Undivided minerals deposited from hydrothermal solutions	Historical estimate of 161 000 t grading 56% CaF_2 (Buller Ltd., 1974)
West Grebes Nest – 001L/14/Fl 051	Prospect	Undivided minerals deposited from hydrothermal solutions	3 separate vein structures returned avg. 89.58% CaF_2 over 6.78 m, avg. 45.83% CaF_2 over 2.65 m, and avg. 47.03% CaF_2 over 1.98 m (Canada Fluorspar Inc, 2013)
Canal Vein – 001L/14/Fl 032	Prospect	Undivided minerals deposited from hydrothermal solutions	Vein deposit filling a fault fissure in the St. Lawrence Granite which can be traced for approx. 440 m and has avg. width of 0.6–1.2 m (Fowler and West, 1954)
Dillmans Lookout – 001M/10/Fl 003	Showing	Undivided minerals deposited from hydrothermal solutions	Fluorite is found in quartz veins stained with hematite (Dickson, 1983)
Highlands River – 012B/02/Fl 001	Showing	Undivided minerals deposited from hydrothermal solutions	Minor purple fluorite with calcite occurs as filled fractures or joints in the Ship Cove limestone (Knight and Fong, 1977)
Eddies Cove – 012I/14/Fl 001	Showing	Undivided minerals deposited from hydrothermal solutions	Fluorite occurs in 6 m^2 area in spherical vugs within laminated and flaser bedded dolostone of the Boat Harbour Formation (van de Poll, 1965)
Granite Lake Fluorite #1 – 012A/02/Fl 001	Showing	Undivided minerals deposited from hydrothermal solutions	Minor fluorite occurs within numerous joints in the northwest margin of the North Bay Granite (Dickson, 1983)
Old Baldy – 001M/11/Fl 001	Showing	Undivided minerals deposited from hydrothermal solutions	Locally abundant fluorite (up to 30%) as breccia filling usually associated with cherty quartz. Breccia zone traced over 365 m (Smith, 1953)

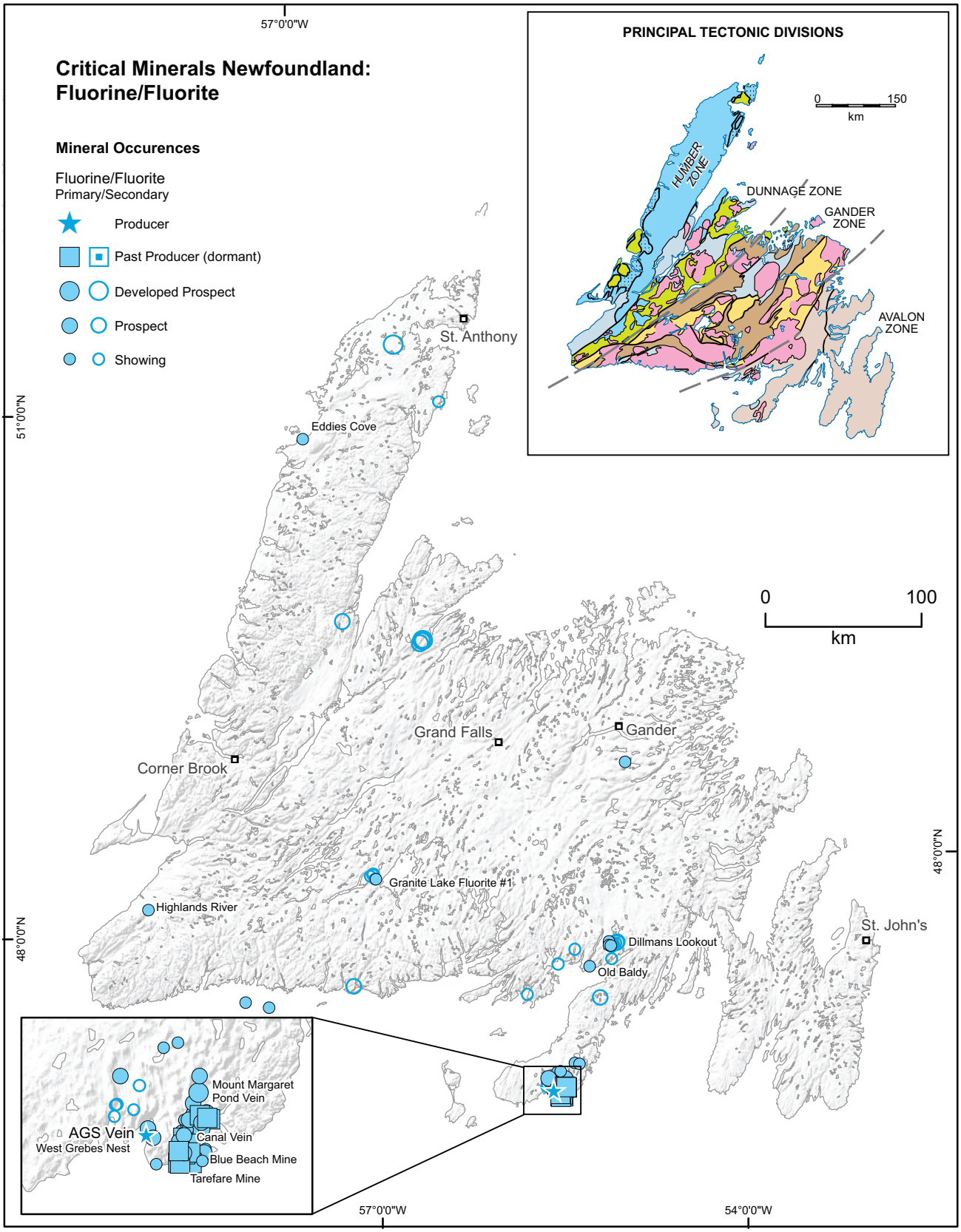

Figure 21. *Map showing the distribution of fluorite occurrences in Newfoundland as well as illustrating all levels of development above indication.*

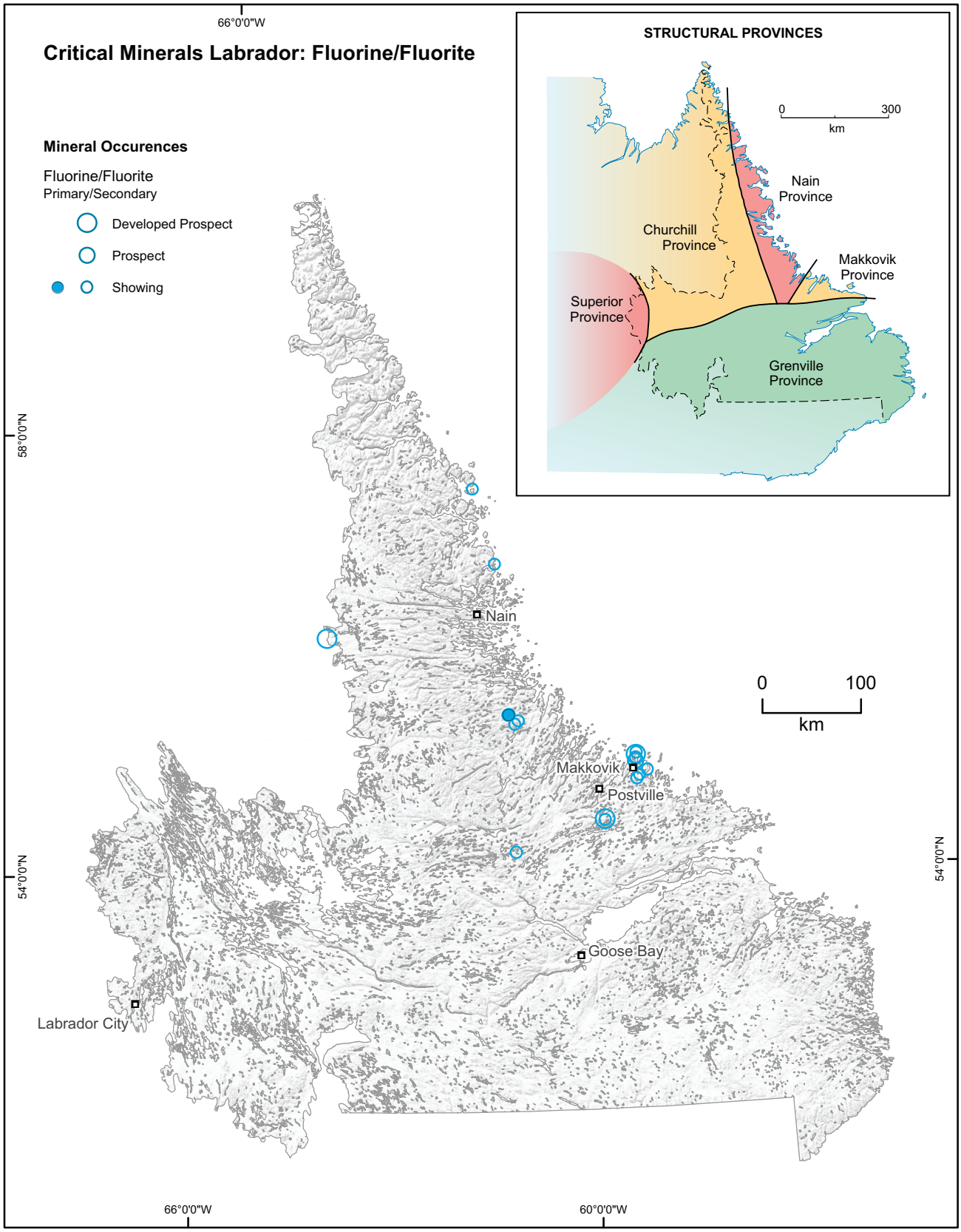

Figure 22. *Map showing the distribution of fluorite occurrences in Labrador as well as illustrating all levels of development above indication.*

GRAPHITE (C)

Description

Graphite consists of stacked layers of graphene and is the crystalline and most stable form of carbon. It is soft and flexible but not elastic, opaque, grey to black and has a metallic lustre. It exhibits metallic properties such as thermal and electrical conductivity, and also non-metal properties such as inertness and lubricity. Graphite can occur naturally or be produced synthetically; synthetic forms of graphite are obtained by multiple methods, and both naturally occurring and synthetic graphite are low-cost materials utilized extensively in high-energy and high-temperature processes.

Source Mineral

Graphite.

Uses

Refractory material (heat-resistance), electrodes in batteries, steelmaking, brake linings, solar panels, pencils, paint.

Global Mine Production

Annual production of graphite in 2024 was estimated at 1.6 Mt (USGS, 2025). The top three producers were China (1.27 Mt, 79.4%), Madagascar (89 000 t, 5.6%) and Mozambique (75 000 t, 4.7%). The USGS (2025) estimated Canada produced 20 000 t of graphite in 2024.

Mineral Resource Supply and Demand Outlook

The International Energy Agency estimated that global graphite consumption (natural and synthetic) grew by 8% in 2024, reaching 4.8 Mt, with most of the growth driven by batteries. Battery anode manufacturers increasingly favoured synthetic graphite in 2024, up 30% from the previous year (IEA, 2025). In recent years, graphite has experienced variability related to the significant increase in Chinese production which supplies the bulk of global demand, and the fluctuating prices for synthetic graphite relative to the increase in production of natural graphite. In contrast, demand for natural anode materials remains stable. Synthetic anode supply is rapidly expanding to meet rising graphite demand (IEA, 2025).

Recovery

Difficulty in processing and separating graphite ores from gangue material during the beneficiation process represent challenges.

Recycling

Scraps from the production of electrodes is the most commonly recycled form of graphite along with recycling of spent electrodes.

Geological Setting

Graphite deposits most commonly form as a result of metamorphism of carbon-rich sedimentary rocks. Graphite ores are classified based on their geological setting and metamorphic grade as amorphous graphite in metamorphosed coal, crystalline flake graphite in carbonaceous metamorphic rocks, and lump or chip graphite in veins in high-grade metamorphic regions.

MODS Occurrences

There are 74 graphite occurrences in the MODS (13 primary), including 2 developed prospects. The Uguktok Fiord graphite prospect (014L/05/Gf 001) occurs near Saglek in northern Labrador and is hosted within the mylonitic Tasiuyak quartz-feldspar, garnet–graphite gneiss; the deposit was briefly mined during World War II. Large flake graphite prospects are present in western Labrador and neighbouring Québec, and occur in metasediments of the Knob Lake Group, where a number of graphite showings occur (*e.g.*, Mart Lake Graphite – 023B/14/Gf 001). A high-grade crystalline flake graphite deposit, the Lac Knife Project, is located in Québec about 27 km south of Fermont and is set in migmatized biotite-bearing quartz feldspar gneisses of the Gagnon Group.

In Newfoundland, graphite mineralization is associated with pelitic schist of the Birchy Complex, Humber Zone, and is located proximal to the Baie Verte Line, a major tectonic zone (*e.g.*, Cabot Graphite – 012I/01/Gf 002). Representative graphite occurrences are listed in Table 14 and illustrated in Figures 23 and 24.

Table 14. Representative graphite occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources
NEWFOUNDLAND			
Cabot Graphite – 012I/01/Gf 002	Prospect	Insufficient data to classify	Two separate graphite bearing bands with estimated width of 50 m and length of 1.6 km with total carbon ranging between 2.27–8.36 wt. % (Tawsho Mining Press Release, 2013)
Lost Pond Graphite – 012B/09/Gf 001	Showing	Insufficient data to classify	5–20 m-wide band of quartzite with 1–4% crystalline graphite. Graphite flake size averages 1–5 mm (Reid, 2012)
Fair & False Bay – 002C/12/Gf 001	Showing	Metamorphic mineral deposit	A 1.2 m-wide graphite zone occurs in cherty, grey-green shale and quartzite of the Connecting Point Group and assayed 11% carbon (McKillop, 1952)
LABRADOR			
Mart Lake Graphite – 023B/14/Gf 001	Developed Prospect	Metamorphic mineral deposit	10.51 Mt grading 21.9% graphitic carbon (Dumaresque *et al.*, 1994)
Uguktok Fiord Graphite – 014L/05/Gf 001	Prospect	Metamorphic mineral deposit	Estimates vary from 20 t (Carr, 1958) to up to 50 t (Douglas, 1953), deposits described as "remarkably free of impurity" coarse flake- to finely crystalline graphite located in mylonitic quartz–feldspar–garnet gneiss in different lenses up to 1.2 m in thickness (Meyer and Dean, 1988)
Moose Head Lake Southwest – 023B/15/Gf 001	Showing	Metamorphic mineral deposit	Graphite occurs as disseminated flakes to solid seam up to 5 cm thick in feldspar–quartz–biotite gneiss of the Attikamagen Formation (Boyko, 1953)

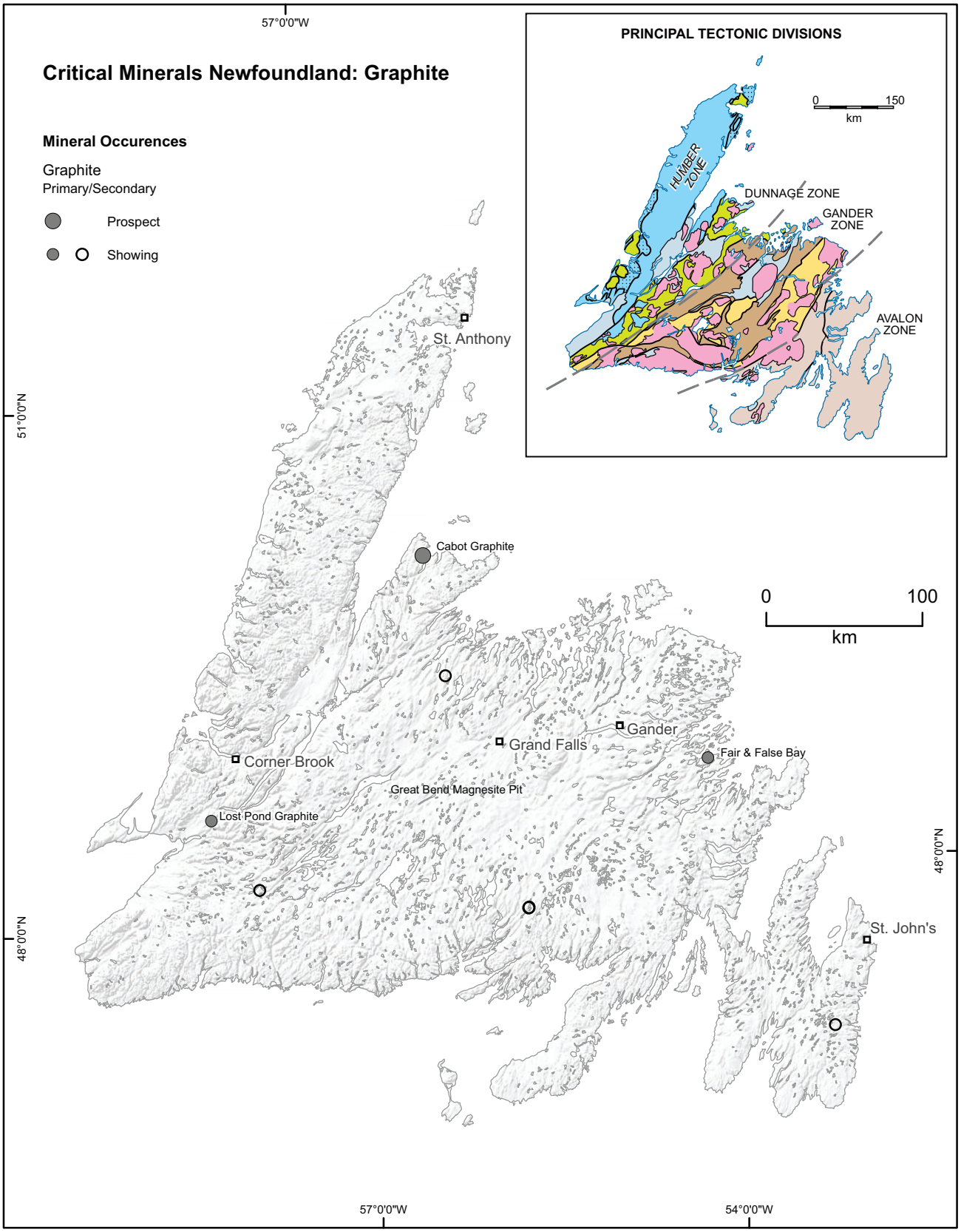

Figure 23. *Map showing the distribution of graphite occurrences in Newfoundland as well as illustrating all levels of development above indication.*

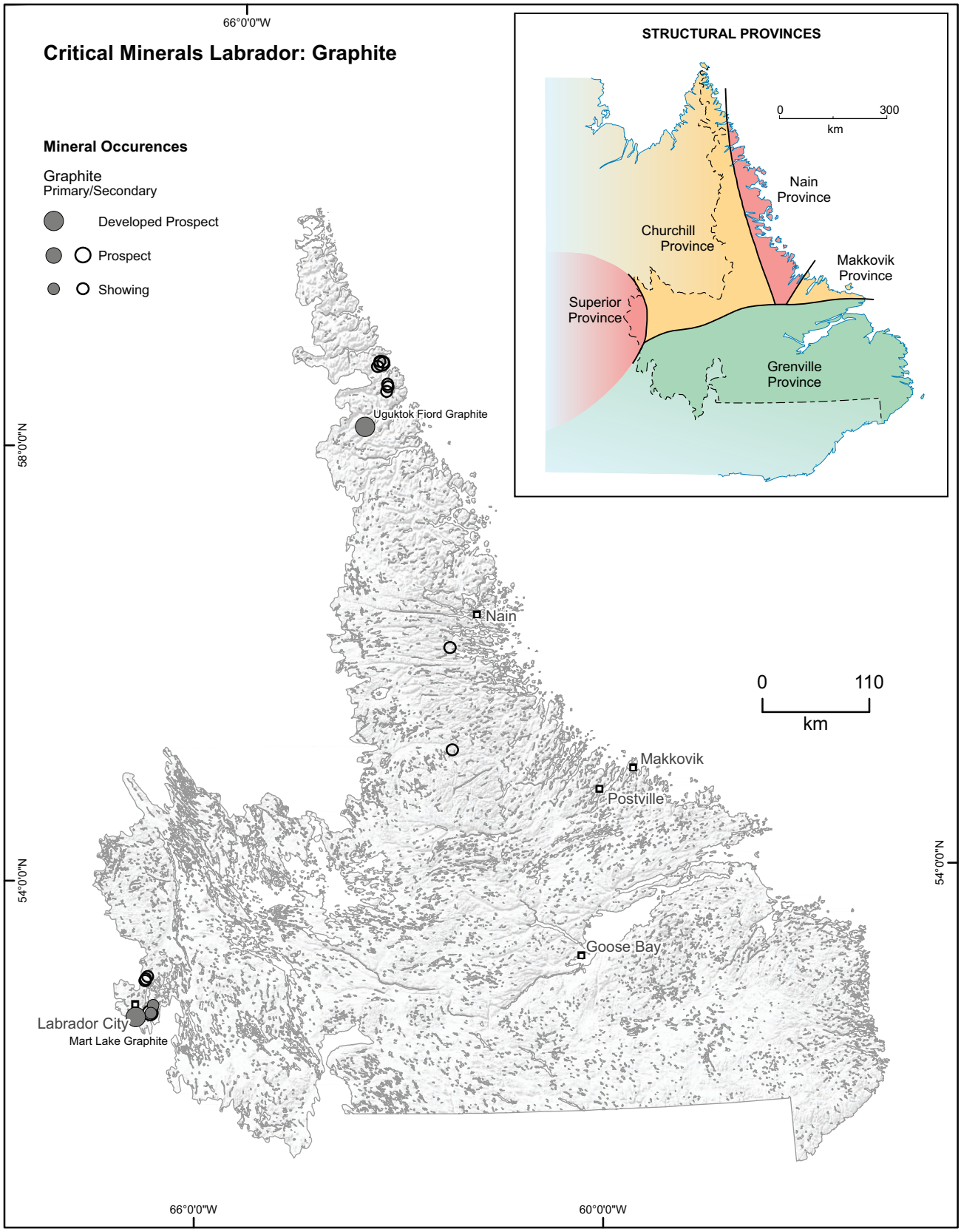

Figure 24. *Map showing the distribution of graphite occurrences in Labrador as well as illustrating all levels of development above indication.*

HAFNIUM (Hf)

Description

Hafnium, when isolated, is a silvery, shiny, ductile metal. It does not occur as a free element, and it readily forms alloys with iron, niobium, tantalum, titanium and other transition metals. The alloy tantalum–hafnium-carbide is one of the most refractory (resistant to heat and chemical attack) substance known (Cedillos-Barraza, 2016). A defining characteristic of hafnium is its chemical similarity with the element zirconium; both have similar ionic and atomic radii; however, hafnium is twice as dense as zirconium. The two elements exhibit similar behaviour (Gregersen, 2024) and hafnium mainly occurs in solid solution with zirconium in zircon minerals. Their similarities make it possible to use either in many applications, but zirconium's greater availability makes it more popular. Hafnium's ability to absorb neutrons makes it a material of choice in nuclear reactors; hafnium's most significant application.

Source Minerals

Zircon, baddeleyite.

Uses

Nuclear reactors, refractory in alloys, transistors in microprocessors, isotope geochemistry.

Mineral Resource Supply and Demand Outlook

Some sources predict a compounded annual growth rate of close to 5–8% until 2030 (*e.g.*, Fortune Business Insights, 2023; Global Info Research, 2024).

Recovery

Hafnium is sourced from the waste raffinate stream generated from zirconium extraction plants which contains on average 4 kg of hafnium per ton of zirconium sand processed (Pandey *et al.*, 2015). The nearly identical chemical properties of hafnium and zirconium make the two difficult to separate.

NOTE

Refer to the zirconium section of this report for mine production, geological setting and the province's occurrences (*see* Table 34, Figures 57 and 58).

IRON/GREEN STEEL (Fe)

Description

Green steel refers to the low-carbon footprint, environmentally friendly version of steel produced without fossil fuels (Vogl and Ahman, 2019). Due to conventional steel-making being one of the most energy and carbon-intensive processes, replacing steel production with green steel is part of a global effort towards decarbonization. The making of conventional steel requires the smelting of iron ore using either blast furnace (BF) or electric arc furnace (EAF). BFs are fed crude iron (pig iron) and scrap steel in a process known as basic oxygen steelmaking (BOS), while EAFs are fed scrap steel or direct reduction iron (DRI) as the main feed materiel (Poveromo and Chaigneau, 2024). In BFs, a coking agent (fossil fuel) is used to chemically reduce the iron (and remove oxygen) for producing elemental iron whereas in EAFs electricity is used to heat and reduce the iron. Using reduced iron in EAFs is not necessary but doing so in conjunction with green energy reduces CO_2 emissions in comparison to using crude iron in BFs and is part of how the process of steelmaking is rendered more environmentally friendly (Barrington, 2022). Direct-reduced iron (DRI) is produced as a feedstock material for the steelmaking process generally using iron ore or natural "lump ore" that has an iron content of 67% or greater. Additionally, EAFs typically require ore containing low concentrations of impurities, generally less than 2% combined $SiO_2 + Al_2O_3$ with low sulphur and phosphorus content. The removal of such impurities from iron ore is costly and ore containing high concentrations of iron and low amounts of impurities are of high value to the industry.

Source Minerals

Magnetite, hematite.

Uses

Infrastructure (50%+), mechanical and electrical equipment, transportation vehicles and appliances. *See* https://www.oecd.org/en/publications/oecd-steel-outlook-2025_28b61a5e-en/full-report.html

Recycling

The recycling of steel (conventional or green steel) can contribute to lowering carbon emissions, for every ton of steel recycled, about 1.5 tons of CO_2 emissions are avoided (The Climate Group, 2025).

Global Mine Production

There are no commercial volume data available for the amount of green steel, or high-grade low-impurity iron ore produced. Approximately 135.7 Mt of DRI iron was produced globally in 2023 (Midrex, 2023).

Mineral Resource Supply and Demand Outlook

The direct reduction-grade iron ore market was valued at USD$ 52.27 billion in 2023 and was projected to grow from USD$ 57.07 billion in 2024 to USD$ 115.41 billion by 2032 (Fortune Business Insight, 2025). In 2023, Rio Tinto signed a multi-year supply agreement for high-grade direct-reduction ore pellets with H2 Green Steel of Sweden, an industrial startup establishing large scale production of green steel (Rio Tinto, 2023). Global excess steel capacity has weighed heavily on steel markets in recent years and has weakened steelmakers' financial performance and their ability to invest in decarbonization (OECD, 2025).

Geological Setting

Iron ore can be recovered from magmatic, hydrothermal, lateritic or sedimentary deposits, but for commercially producing steel, iron is most significantly sourced from Precambrian sedimentary banded iron formations that contain at least 20–35% Fe content in the form of iron oxide minerals (hematite and/or magnetite). Iron ore suitable for producing green steel however requires higher grades, typically a minimum of 67% Fe ores with minimal impurities (less than 2% combined $SiO_2 + Al_2O_3$ with low sulphur and phosphorus contents), and thus most ores require beneficiation processes (upgrading) before it can be used as raw material for green steel. Deposits suitable for beneficiation are typically naturally high in Fe% content, they include coarse grain magnetite deposits (upgradable by magnetic separation), and high-purity, high-grade hematite deposits that contain 60–65% Fe, and are typically the product of upgrading

(secondary enrichment). Two models exist to explain the upgrading of iron ore deposits: 1) supergene and 2) hydrothermal. Supergene iron deposits have been modified by meteoric water circulation (deriving from precipitation) at or near earth's surface and they represent many of the largest deposits that comprise the removal of silica and the proportional increase of iron. Hydrothermally enriched deposits are less well understood due to the variability of geology and mineralogy; however, they are interpreted to have been enriched either by silica leaching and/or iron addition *via* hydrothermal fluids (*e.g.*, Beukes *et al.*, 2003; Gutzmer *et al.*, 2008).

MODS Occurrences

Examples of deposits capable of producing suitable high-grade, low-impurity iron ore concentrate are located in western Labrador within iron formations of the Knob Lake Group. These include the metataconites currently mined (*e.g.*, Carol Lake Project, Scully Mine, Bloom Lake). Large taconite resources, including lump ores, in northwestern Labrador also have the potential to produce DRI pellets as demonstrated by feasibility studies on the LabMag deposit (Balakrishnan *et al.*, 2016). Representative high-grade iron ore occurrences are included in Table 15 and illustrated in Figure 25.

Table 15. Representative iron (green steel) occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
LABRADOR			
Humphrey Mine/Carol East and West – 023G/02/Fe 002 and 003	Producer	Stratabound banded iron formation (metataconite)	NI 43-101 compliant proven reserves of 734 Mt avg. 39% Fe and probable reserves of 344 Mt avg. 37% Fe for the Humphrey Main, Humphrey South and Lorraine South deposits (IOC, 2014)
Luce No. 1 – 023G/02/Fe 005	Producer	Stratabound banded iron formation (metataconite)	Proven and probable reserves of 900 Mt grading 38% Fe and 20% Mn; Meas. and Ind. Res. of 200 Mt grading 37% Fe and 26% Mn (IOC, 2001)
Moss Pit – 023B/15/Fe 003	Producer	Stratabound banded iron formation (metataconite)	Total Meas. and Ind. Res. of 744 Mt grading 34.6% Fe (IOC, 2014)
Scully Mine – 023B/15/Fe 001	Producer	Stratabound banded iron formation (metataconite)	Total Meas. and Ind. Res. of 734 Mt grading 34.6% Fe (Lacelle *et al.*, 2021)
Julienne Lake – 023G/02/Fe 009	Developed Prospect	Stratabound banded iron formation (metataconite)	Total Meas. and Ind. Res. of 867 Mt grading 33.7% Fe (Coates. 2012)
Block 103 Green Bush (Iron Bear) Zone – 023J/14/Fe 043	Developed Prospect	Stratabound banded iron formation (taconite)	Total Ind. + Inf. Res. of 16.66 billion t grading 29% total Fe (Risto *et al.*, 2013)
Rose (Kami) – 023B/14/Fe 020	Developed Prospect	Stratabound banded iron formation (metataconite)	Total Meas. + Ind. + Inf. Res. of 705.1 Mt grading 28.5–29.9% Fe in all categories for Rose Central, and 835.9 Mt grading 29.8–30.3 % Fe for Rose North (Grandillo *et al.*, 2018)
Elizabeth No. 1 – 023J/15/Fe 031	Developed Prospect	Stratabound banded iron formation (taconite)	Inf. Res. of 620 Mt grading 31.8% Fe has been estimated within Elizabeth No. 1 (Wahl, 2013)
Howells Lake – 023O/03/Fe 006 Howells River North – 023O/03/Fe 007	Developed Prospect	Stratabound banded iron formation (taconite)	Total combined Ind. Res. of 7,631 Mt grading 30.39% total Fe for both deposits (Dupere and Balakrishnan, 2013)
Howells River West Zone A – 023J/14/Fe 001	Developed Prospect	Stratabound banded iron formation (taconite)	Meas. + Ind. Res. of 1942 Mt grading 29.6% Fe (Dupere and Balakrishnan, 2013)
Howells River West Zone B – 023J/14/Fe 002	Developed Prospect	Stratabound banded iron formation (taconite)	Meas. + Ind. Res. of 1722 Mt grading 29.6% Fe (Dupere and Balakrishnan, 2013)
Perrault Lake No. 1 – 023J/11/Fe 002 Sheps Lake 023J/11/Fe 001	Developed Prospect	Stratabound banded iron formation (taconite)	Ind. Res. of 4070 Mt grading 30.66% Fe at 15% for combined Perrault and Sheps Lake deposits at 15% davis tube weight recovery cutoff (SGS Canada/New Millenium NI 43-101 report, 2013)
Wabush No. 6 – 023G/02/Fe 006	Developed Prospect	Stratabound banded iron formation (metataconite)	Proven and probable resources of 220 Mt grading 36.3% Fe (Elliot *et al.*, 1980)
Goethite Bay North – 023G/02/Fe 041	Developed Prospect	Stratabound banded iron formation (metataconite)	Inf Res. of 654.9 Mt grading 28.84% total Fe (Kressall *et al.*, 2023)

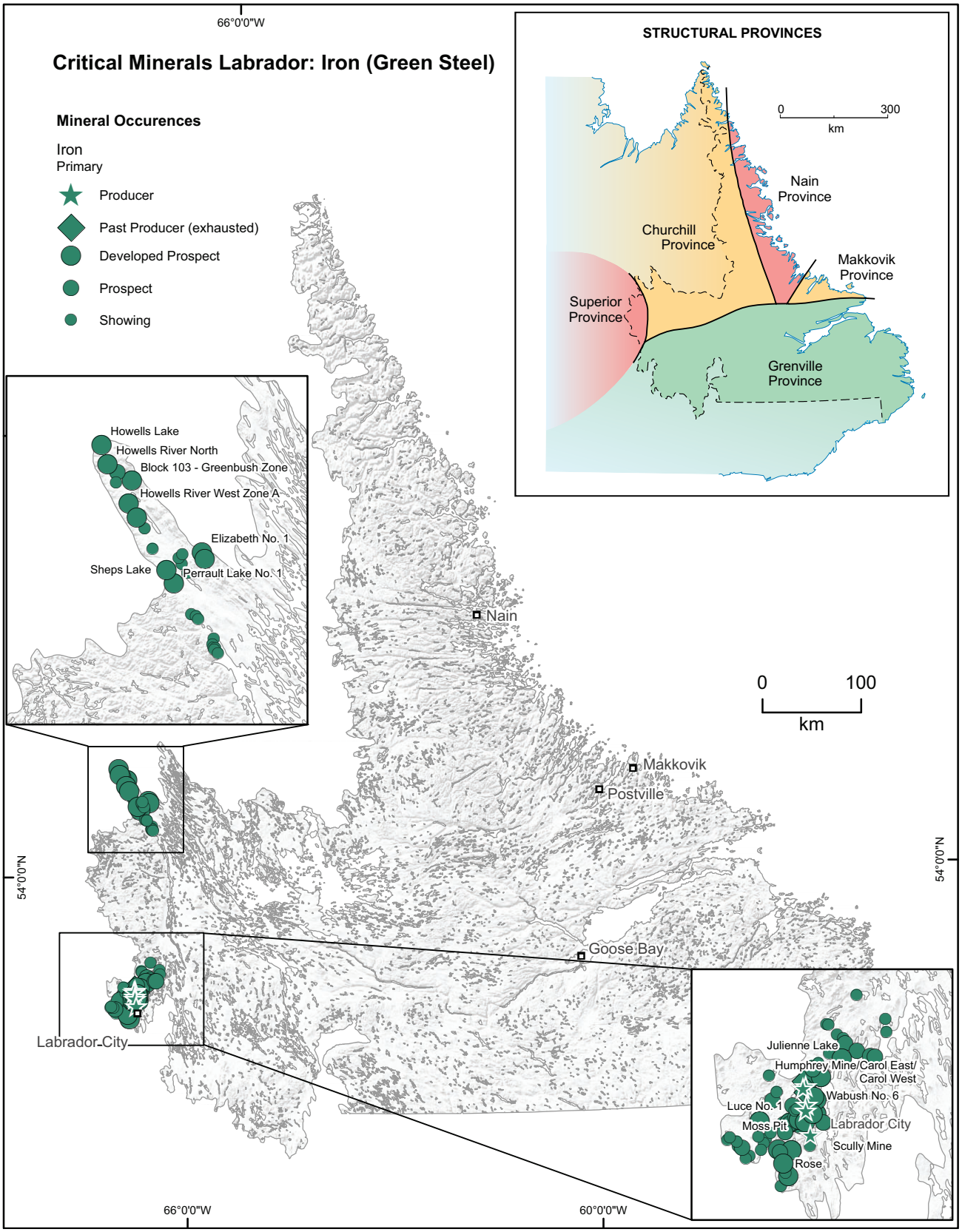

Figure 25. *Map showing the distribution of green steel occurrences in Labrador as well as illustrating all levels of development above indication.*

LEAD (Pb)

Description

Lead is a high-density, silver-grey, occasionally with a hint of blue, post-transition metal that is relatively inert and which has the highest atomic number of all stable elements. It is very malleable, soft, ductile, and highly resistant to corrosion. It is a poor conductor of electricity, however, when lead is cooled to below 7.2 K (-270°C) it becomes a superconductor. Rarely occurring as a native element, the main lead bearing mineral is galena (PbS). Lead is toxic to the human body, its toxicity was recognized at the end of the 19th century but was only identified as an environmental concern since the 1970s, stemming from its widespread use in gasoline. It has been mined and used in numerous applications since antiquity, and despite efforts to find replacements, lead is still an indispensable metal that is widely used today.

Source Minerals

Galena, cerussite, anglesite.

Uses

Lead-acid batteries, high voltage power cables, ballasts, alloys, radiation barriers, ceramics and glazes, munitions, architectural metal.

Global Mine Production

Annual production of lead in 2024 was estimated at 4.3 Mt (USGS, 2025). The top producers were China (1.9 Mt, 44.2%), Australia (430 000 t, 10%) and Peru (270 000 t, 6.3%).

Mineral Resource Supply and Demand Outlook

Identified and recoverable resources are estimated at 2 billion tonnes; significant lead resources have been identified in recent years in association with silver or copper ore deposits in Australia, China, Ireland, Mexico, Peru, Portugal, Russia and the USA (USGS, 2025). Growth in the lead market is being influenced by the global shift toward energy security and electrification, with rising investments in renewable energy and electric vehicle infrastructure (Future Market Insights, 2025f).

Recovery

90% of primary lead ores are a by-product of zinc and silver mining.

Recycling

More than half of the total lead refinery demand is met by the recycling of spent lead, mostly from reclaimed batteries.

Geological Setting

Due to their similar atomic electron configuration, lead and zinc both display similar chemical behaviour and are readily found together in deposits. Much of the worlds mined lead and zinc resources are associated with stratiform, stratabound and discordant ores, and are broadly represented by clastic-dominated Pb–Zn or carbonate-hosted Pb–Zn-type deposits (Emsbo *et al.*, 2016). Nine of the ten largest Pb–Zn deposits are classified as clastic-dominated Pb–Zn-type, whereas all other Pb–Zn deposit types, representing an equivalent amount of resource, occur as VMS, skarn, porphyry, epithermal and mixed sediment-hosted deposits.

MODS Occurrences

There are 769 lead occurrences in the MODS (215 primary), including 33 past-producing deposits, and 20 developed prospects. In the MODS, lead is overwhelmingly represented as a secondary commodity. The most important geological environments for lead mineralization in Newfoundland are the volcanic terranes of central Newfoundland that host VMS deposits (*e.g.*, Old Buchans Main – 012A/15/Zn 009, Lundberg zone – 012A/15/Zn 019, Boomerang – 013K/15/Ni 007, Domino – 012A/06/Zn 009). Pb–Zn mineralization is generally associated with the mature-arc and continental-rift environment, but also with mixed mafic/felsic primitive magmas in arc-type volcanic settings. Back-arc and primitive mafic-dominated arc sequences tend to be copper dominated with zinc and lead contained as a secondary commodity (Wardle, 2007, 2008). VMS deposits include genetically related stringer-stockworks, massive sulphide, and debris-flow deposits.

Minor lead mineralization is associated with zinc at Round Pond in the western carbonate platforms as void-fill, breccia, and vein-hosted sphalerite–galena. In the White Bay region on the

eastern side of the Humber Zone, a secondary void-fill deposit occurs in brecciated dolomites at the Turners Ridge prospect located at the base of the Silurian Sops Arm Group (Saunders, 1991).

Potential for lead in Labrador exists within the Paleoproterozoic volcanic rocks of the Blueberry Lake Group in western Labrador (Swinden *et al.*, 1991), as well as within the Flowers River Intrusive Suite in the Nain Province which hosts minor sphalerite–galena mineralization in association with veinlets and alteration zones in peralkaline granites and volcanic rocks. Local sphalerite–galena veins also occur in volcanic rocks in the Central Mineral Belt within the Makkovik Province (*e.g.*, Big Bight Vein No 2 – 013O/02/Pb 001). Representative lead occurrences are included in Table 16 and illustrated in Figures 26 and 27.

Table 16. Representative lead occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
Buchans Deposits – Historical Mining Camp	Past Producer (Zn –Dormant)	VMS – mafic/felsic (stockwork and breccia)	From 1935 to 1981 approximately 16.1 Mt of ore averaging 7.6% Pb, 1.3% Cu, 14.5% Zn, 126 ppm Ag and 1.4 ppm Au was mined from the Buchans deposits (Kirkham, 1987)
Lundberg Zone – 012A/15/Zn 019	Past Producer (Zn –Dormant)	VMS – felsic (stockwork)	Ind. Res. of 16.8 Mt grading 1.53% Zn, 0.42% Cu, 0.64% Pb, 5.69 ppm Ag and 0.07 ppm Au (Canterra Minerals, 2023)
La Manche – 001N/12/Pb 001	Past Producer (Dormant)	Undivided structurally controlled hydrothermal vein system	Estimated 196 200 t grading 12% Pb; 3150 t of ore grading 11–12% Pb were mined between 1863 and 1873 (George, 1935)
Lemarchant – 012A/10/Zn 012	Developed Prospect (Zn)	VMS – felsic (epiclastic)	Ind. Res. of 2.42 Mt grading 1.6% Pb, 6.15% Zn, 0.68% Cu, 1.22 ppm Au, 64.0 ppm Ag and 23.5% barite (Cullen *et al.*, 2018)
Boomerang/Domino – 012A/06/Zn 008 and 009	Developed Prospect (Zn)	VMS – felsic (epiclastic)	Boomerang deposit Ind. Res. of 1.36 Mt grading 3% Pb, 0.51% Cu, 7.1% Zn, 1.66 ppm Au, 110.2 g/t Ag, 1.6 ppm Au; Domino deposit Inf. Res. of 411 200 t grading 2.8% Pb, 0.4% Cu, 6.3% Zn, 0.94 ppm Ag and 0.6 ppm Au (De Mark and Dearin, 2007)
Bobby's Pond Deposit – 012A/10/Zn 001	Developed Prospect (Zn)	VMS – felsic (epiclastic)	Ind. Res. of 1.095 Mt grading 4.61% Zn, 0.86% Cu, 0.44% Pb, 16.56 ppm Ag and 0.02 ppm Au (Wilson, 2008)
Daniels Pond – 012A/10/Zn 009	Developed Prospect (Zn)	VMS – felsic (stockwork)	Ind. Res. of 929 000 t grading 5.1% Zn, 2.5% Pb, 0.3% Cu, 0.6 ppm Ag and 101.4 ppm Au (Webster *et al.*, 2008)
Tulks Hill Deposit – 012A/11/Zn 001	Developed Prospect (Zn)	VMS – mafic/felsic (stockwork?)	Ind. Res. of 430 200 t grading 0.9% Cu, 4.0% Zn, 1.6% Pb, 35.1 ppm Ag and 1.2 ppm Au (Agnerian, 2008)
Strickland-Silver Hill Zone – 011O/16/Zn 002	Developed Prospect (Zn)	VMS – felsic (stockwork)	750 000 t grading 2% combined Zn–Pb (Prince, 1981)
Strickland-Main Zone – 011O/16/Zn 001	Developed Prospect (Zn)	VMS – felsic (stockwork)	260 000 t grading combined 5.25% Zn + Pb and 195 ppm Ag (Prince, 1981)
Long Lake Deposit – 012A/06/Zn 004	Developed Prospect (Zn)	VMS – felsic (epiclastic)	560 000 t grading 16.0% Zn, 2.2% Cu, 1.3% Pb, 38 ppm Ag and 0.9 ppm Au (Banville *et al.*, 1998)
Turners Ridge – 012H/11/Pb 001	Developed Prospect	Stratabound epigenetic secondary void filling	Estimated tonnage of 200 000 tons (181 434 t) grading 3–4% Pb (Dimmell, 1979)

Mary March Zone – 012A/15/Zn 022	Prospect (Zn)	VMS – mafic/felsic (epiclastic)	DDH intersected massive sulphide zone containing avg 10.1% Zn, 1.68% Pb, 0.64% Cu, 122.1 ppm Ag and 4.2 ppm Au over 9.63 m (Jagodits and Thurlow, 2000)
Nancy April – 012A/15/Zn 021	Prospect (Zn)	VMS – mafic/felsic (stockwork?)	DDH intersected avg 3.02% Zn, 1.08% Pb, 0.13% Cu and 172.4 g/t Ag across 20.6 m (Waldie, 2004). DDH intersected 1.0% Zn, 0.04% Cu, 0.50% Pb across 18.9 m (Green and Wolfson, 2013)
20th Brook-SW Zone – 012B/09/Pb 003	Prospect	Stratiform syngenetic sulphides (Irish-type)	Galena as fracture filling replacement minerals in <20 cm-thick veins. Best channel sample assayed 28.8% Pb over 1.0 m (DeLazzer and Dimmel, 2010)
Traverstown – 012I/01/Pb 002	Prospect	Undivided structurally controlled hydrothermal vein system	8% Pb from grab sample in quartz vein and silicified stockwork related to 1.8 to 2.7 m wide fault zone (Fuller, 1941)
Goodyear Prospect – 012B/11/Pb 001	Prospect	Stratabound epigenetic veins within or closely associated with carbonate host rock	Narrow and lenticular crustified veins occupy prominent vertical joints with galena being the most plentiful sulphide. Channel sample from a 0.6 m vein returned 30% Pb (Dickie *et al.*, 1975)
Isle aux Morts Prospect-Twin Ponds – 011O/10/Zn 001	Prospect (Zn)	VMS – mafic/felsic (stockwork?)	Best DDH intersects: 4.73% Pb, 5.3% Zn, 0.11% Cu and 18.7 ppm Ag over 0.8 m; 0.66% Pb, 2.38% Zn, 0.21% Cu and 5.1 ppm Ag over 2.5 m (Legein, 1982)
LABRADOR			
Galena Lake – 023I/05/Pb 001	Prospect	Undivided structurally controlled hydrothermal vein system	Series of widely spaced quartz–carbonate veins contain discontinuous zones of galena. Two grab samples assayed 43.5 and 13.3% Pb (Kavanagh, 1952)
Big Bight Vein No 2 – 013O/02/Pb 001	Showing	Undivided magmatic-hydrothermal deposit	A narrow calcite vein (<0.3 m wide) carries local concentrations of argentiferous galena (up to 2% Pb), fluorite and chalcopyrite (Wardle and Wilton, 1984)

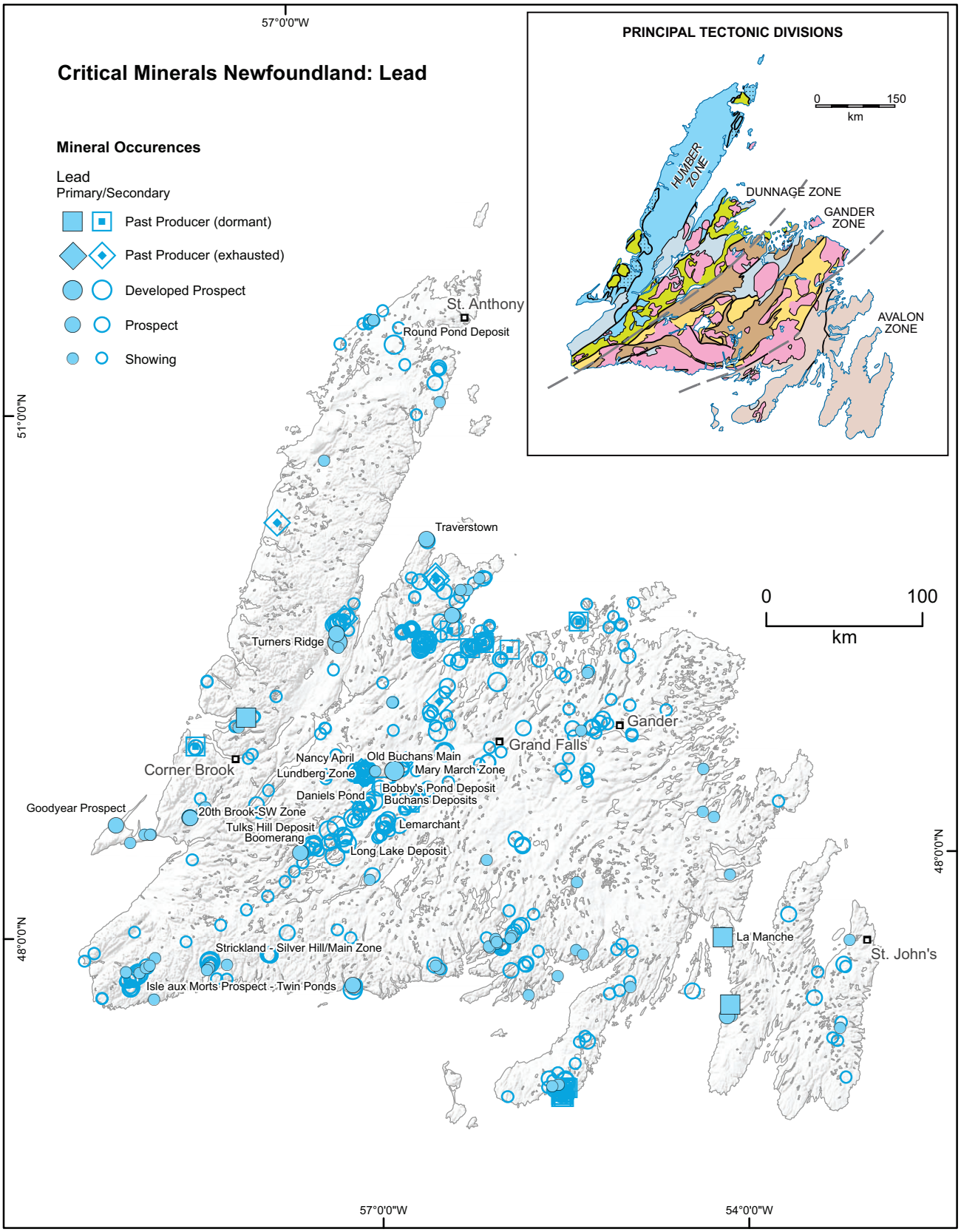

Figure 26. *Map showing the distribution of lead occurrences in Newfoundland as well as illustrating all levels of development above indication.*

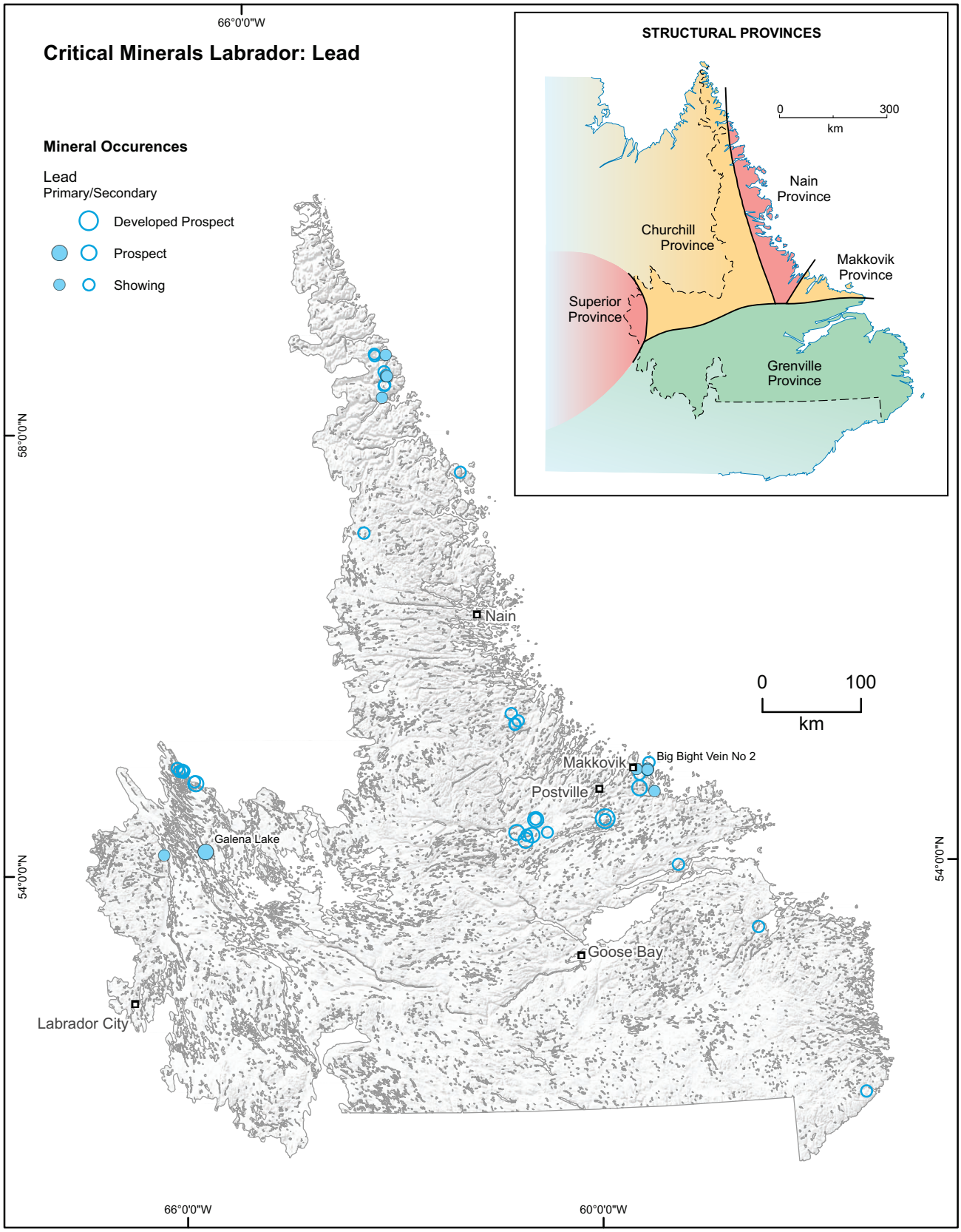

Figure 27. *Map showing the distribution of lead occurrences in Labrador as well as illustrating all levels of development above indication.*

LITHIUM (Li)

Description

Lithium is a soft, silvery-white alkali metal that has a metallic luster which quickly oxidizes to grey in contact with oxygen. It is highly reactive, flammable, and is the least dense of any solid element. Due to its high reactivity it occurs bound in minerals only. Its low atomic mass gives it a high charge- and power-to-weight ratio and high electrode potential, making it an important component of battery electrolytes and electrodes. Other applications for lithium include using it as a flux for processing silica related to the ceramics and glass industry, an additive in metallurgy for scavenging impurities during the refining process of iron, nickel, copper and zinc, and other applications related to the military, aerospace and medical industries. The expanding market for electric vehicles and renewable energy has driven up demand for lithium batteries.

Source Minerals

Spodumene, petalite, lepidolite, jadarite, elbaite, montrebasite, eucryptite.

Uses

Battery electrolytes and electrodes, additive in metallurgy, heat-resistant glass and ceramics, lubrication greases, pyrotechnics, optics, nuclear reactors, munitions, pharmaceutical drugs.

Global Mine Production

Annual production of lithium in 2024 was estimated at 240 000 t (USGS, 2025). The top three producers were Australia (88 000 t, 36.7%), Chile (49 000 t, 20.4%) and China (41 000 t 17.1%). Canada is estimated to have produced 4300 t in 2024 (USGS, 2025).

Mineral Resource Supply and Demand Outlook

World reserves of lithium were estimated at 30 Mt (USGS, 2025). Excluding USA production, the USGS estimated that global lithium production in 2024 increased by 18%. The International Energy Agency estimated global demand to have increased by 30% year-on-year in 2024. The bulk of lithium demand growth came from the EV sector, but energy storage is showing rapid growth and currently represents 9% of lithium demand, (IEA, 2025).

Recovery

The recovery of lithium in brines by solar evaporation has been traditionally the most widely used method. However, it is a process that is dependent on climatic conditions and which can take years to achieve. Direct lithium extraction (DLE), a more efficient and sustainable alternative, is achieved by various methods including adsorption, solvent extraction, ion-exchange processes, and crystallization (Mantilla *et al.*, 2024). The recovery of lithium from rocks involves more complex metallurgical processes than recovery from brines, and is achieved mainly by acid, alkaline, and chlorination processes (Meng *et al.*, 2021).

Recycling

Only about 5% of lithium batteries have been recycled in 2022 due to high cost, and the complexity and lack of efficiency of the process (Baum *et al.*, 2022).

Geological Setting

Lithium extracted from closed-basin brines constitutes the bulk of world lithium production currently. They consist of accumulations of saline groundwater enriched in dissolved lithium located in endorheic evaporitic basins. Endorheic basins retain water while allowing no outflow and are generally associated with high rates of solar evaporation. These basins are usually associated with areas of tectonically driven subsidence and geothermal or igneous activity. Lithium also occurs in other types of brines such as deep oilfield wells where brines can reach high concentrations of lithium (692 mg/L in Smackover Formation, south-central gulf, USA., Zheng *et al.*, 2023), and brines that are associated with geothermal activity. Lithium deposits mined in rocks are associated with peraluminous magmas, particularly in greisens within the roof zones of biotite and/or muscovite bearing peraluminous granites (*e.g.*, Zinwald in Germany), and within zoned lithium, cesium, and tantalum pegmatites (LCT pegmatites) such as those of the Tanco Mine in Manitoba. Lithium-bearing clay deposits are another type of lithium deposit which are often associated with hydrothermal activity and the alteration of volcanic-derived sediments (*e.g.*, King Valley hectorite deposits in Nevada). Finally the Jadar mine in Serbia is one of the largest lithium deposits in the world and is classified as a unique end-

member of volcano-sedimentary lithium (Putzolu *et al.*, 2025). It contains an estimated 3% of the world's lithium resource (Evans, 2012). Lithium there is recovered from the mineral jadarite, a lithium–boron aluminosilicate of the zeolite group discovered in 2004. It is the only documented occurrence of this mineral in the world.

MODS Occurrences

There are 10 lithium occurrences in the MODS database (9 primary). All but 3 occurrences, Snowshoe Pond Lithium (012A/07/Li 001), Deer Pond Lithium (001M/10/Li 001) and Area 2 (001M/10/Li 002), are related to the recently discovered Kraken pegmatite field near Burgeo and hosted in evolved LCT pegmatites, most of which are located in the southern and eastern parts of the Gander Zone. The Snowshoe Pond lithium occurrence is spatially associated with the North Bay Granite Suite in central Newfoundland. All lithium occurrences are listed in Table 17 and illustrated in Figure 28.

Table 17. Representative lithium occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
Kraken – 011P/13/Li (001 to 006)	Prospect	Magmatic – pegmatite	Spodumene-bearing pegmatite dykes from 0.5–5.25 m thick grading 0.95% Li_2O over 8.40 m in DDH, including 1.76% Li_2O over 0.8 m (Sokoman Minerals, March 2022)
Hydra – 011P/13/Cs 001	Prospect (Cs)	Magmatic – pegmatite	Three consecutive 0.4 m channels averaging 0.41% Li_2O (Sokoman Minerals, November 2022)
Snowshoe Pond Lithium – 012A/07/Li 001	Showing	Magmatic – pegmatite	399.4 ppm Li in coarse grained pegmatite (Magyarosi, 2019)
Deer Pond Lithium – 001M/10/Li 001; Area 2 – 001M/10/Li 002	Showing	Magmatic – hydrothermal (greisen association)	Zinnwaldite mineralization occurs in a greisen zone; grab sample assayed up to 1.1 % Li_2O in boulders and subcrop (Caprock Mining Corp, Jan 2024)

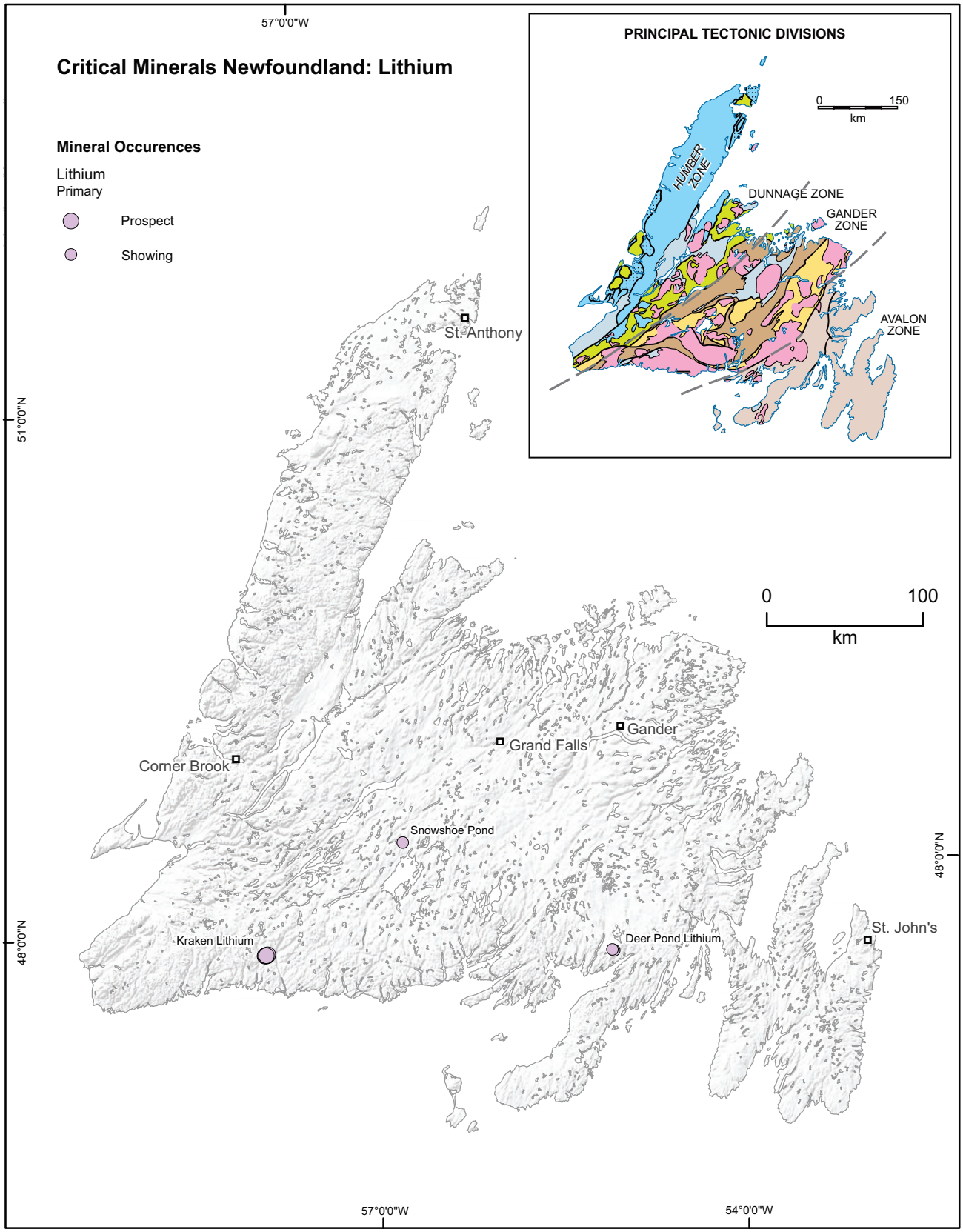

Figure 28. *Map showing the distribution of lithium occurrences in Newfoundland as well as illustrating all levels of development.*

MAGNESIUM (Mg)

Description

When isolated, magnesium is silver-grey, lightweight and very reactive. It occurs naturally in combination with other elements in over 60 minerals but is recovered only from a few. It is abundant on earth (8th most abundant element) constituting 2% of the earth's crust; the Mg^{2+} cation is the second most abundant cation in seawater. Magnesium and magnesium-derived alloys are critical to a diverse set of industries because of their intrinsic physicochemical properties, including biocompatibility, low density, mechanical dampening and hydrogen-storage capacity (Gonzàlez *et al.*, 2021). Magnesia (MgO) is the primary magnesium compound used as a raw material for products; the most commonly used source for magnesia is magnesium carbonate but the largest sources are magnesia-rich brines and seawater.

Source Minerals

Magnesite, serpentinite, dolomite, brines, seawater.

Uses

Structural metal, steel production, fertilizers, dietary supplements.

Global Mine Production

Annual production of magnesium (metal) in 2024 was estimated at just over 1 Mt (USGS, 2025). The top producer was by far China (950 000 t, 95%), followed by Brazil, Kazakhstan and Israel, all of which produced 20 000 t.

Mineral Resource Supply and Demand Outlook

Considering resources of dolomite, serpentine, and magnesium-bearing evaporite minerals, the supply of magnesium is enormous and estimated to constitute a resource in the billions of tons (USGS, 2025). Demand for magnesium is expected to increase in the next 10 years, supported by increasing demand for lightweight, high-strength metals in the automotive, aerospace and electronics industries (Future Market Insights, 2025c).

Recovery

Leaching is a critical step in the recovery of magnesium from magnesium-bearing ore, and the most common leaching agents are organic and inorganic acids, as well as ammonium salts (Gonzalez *et al.*, 2021).

Recycling

Magnesium is recycled from new scrap metal recovered during the production of magnesium metal alloys as well as scrap recovered from discarded items (USGS, 2021).

Geological Setting

In rocks, magnesium can be extracted from magnesite, serpentinite and dolomite. Magnesite and serpentinite occur as alteration products of ultramafic rocks, and most dolomites are formed from the modification or alteration of carbonate muds, a process known as dolomitization whereby magnesium replaces calcium in limestone.

Mods Occurrences

There are 38 magnesium occurrences in the MODS (24 primary), including 2 developed prospects, all of which are located in Newfoundland. The developed prospects occur in dolomite on the west coast of Newfoundland within the St. George Group Basin, an assemblage of carbonate rocks stretching 400 km north from the Port au Port Peninsula (*e.g.*, Norsk North Block – 012B/10/Dol003). Additional occurrences of potential magnesium resources exist as magnesite deposits associated with serpentinite in the Gander River Ultrabasic Belt (*e.g.*, Weir's Brook Magnesium – 002E/02/Mg 001, Caribou River North – 002D/10/Mg 001), and also with ultramafic rocks of the Advocate Complex in which the past producing Baie Verte asbestos mine (012H/16/Asb008) is located. Representative magnesium occurrences are listed in Table 18 and illustrated in Figure 29.

Table 18. Representative magnesium occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources
NEWFOUNDLAND			
Baie Verte Mine – 012H/16/Asb008	Past Producer (asbestos – Dormant)	Undivided minerals deposited from hydrothermal alterations	Asbestos deposit located within tectonically emplaced ultramafic body termed the Advocate Complex (harzburgite with minor dunite and rare lherzolite) (Collins, 1984). Ore reserves prior to mining were estimated at 52.7 Mt (Blagdon, 1974)
Norsk North Block – 012B/10/Dol003	Developed Prospect (dolomite)	Carbonates	54.5 Mt grading 19.14% MgO (Saunders, 1993)
Norsk South Block – 012B/10/Dol004	Developed Prospect (dolomite)	Carbonates	32.0 Mt grading 18.89% MgO (Saunders, 1993)
Weir's Brook Magnesium – 002E/02/Mg 001	Prospect	Undivided minerals deposited from hydrothermal alterations	Magnesite reserves were estimated to range from 4–15 Mt of ore grading 26.6–41.2% MgO from several grab samples (Coleman, 1954; Cooper, 1955)
Caribou River North – 002D/10/Mg 001	Prospect	Undivided minerals deposited from hydrothermal alterations	Magnesite deposits appear in a cliff 150 m long and 25 m high within the Gander River Ultrabasic Belt: 160 000 m^3 of magnesite–silica rock is estimated (Grady 1953)
Great Bend Magnesite Pit – 002D/11/Mg 008	Prospect	Undivided minerals deposited from hydrothermal alterations	Massive altered and foliated magnesite–talc zone within peridotite of the Great Bend Ultramafic Complex; avg. chemical composition of magnesite contains 29.9% MgO (Cooper, 1955)
First Pond-Gander River 2 – 002E/02/Mg 002	Prospect	Undivided minerals deposited from hydrothermal alterations	Five lensoidal magnesite areas occur within 1 km of each other. Three are within a narrow (200 m wide) belt of ultrabasic rocks (Coleman, 1954; Cooper, 1955)

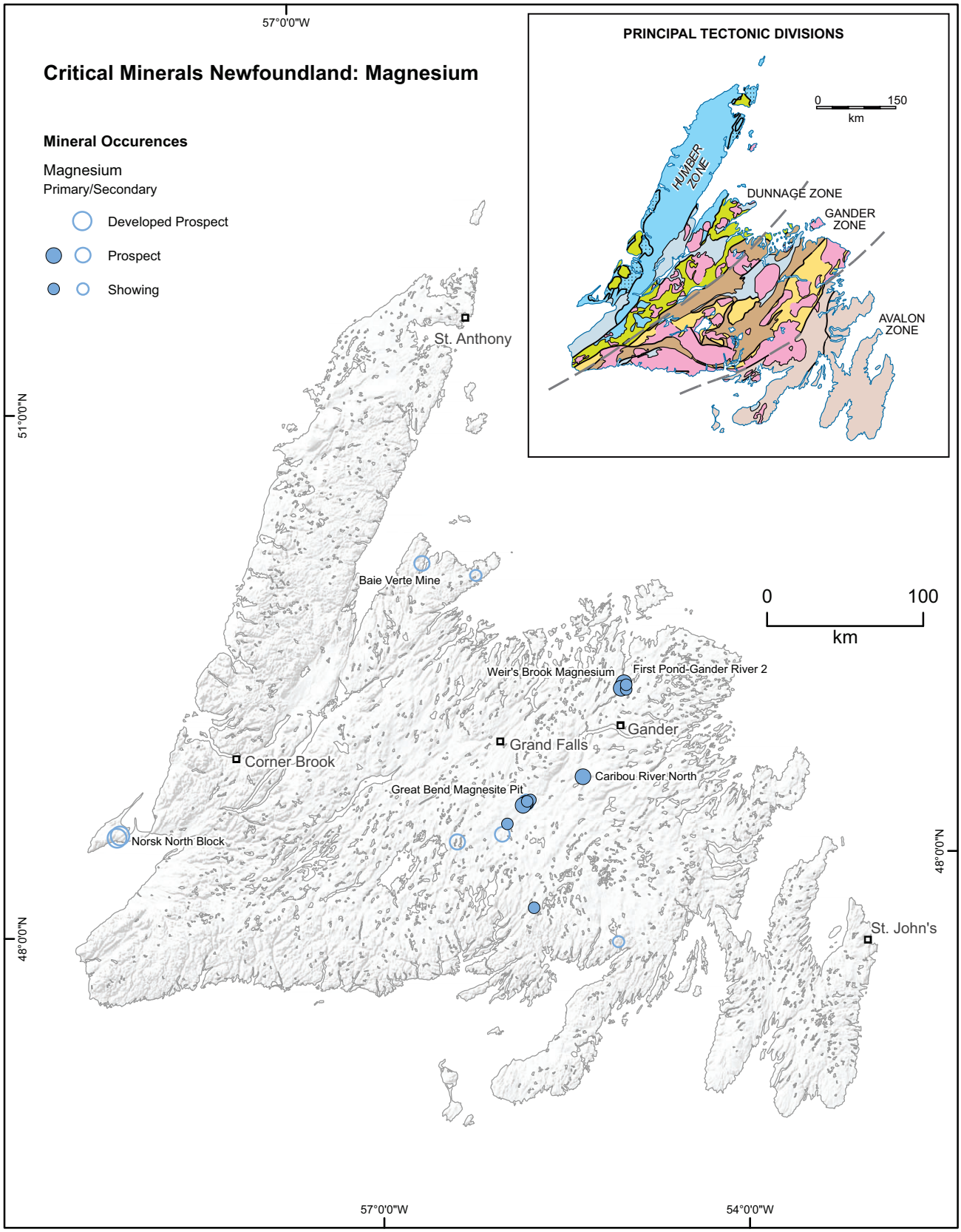

Figure 29. *Map showing the distribution of magnesium occurrences in Newfoundland as well as illustrating all levels of development above indication.*

MANGANESE (Mn)

Description

Manganese is a hard, brittle, silver-grey transition metal that resembles iron. As a transition metal it easily forms compounds with other elements and is most often alloyed with iron. It is second only to iron in abundance among transition elements in the earth's crust. Manganese is an indispensable element in steel, acting as a desulphurizing and deoxidizing agent, and represents by far its largest application. It is also an important alloying element in aluminum and copper. There are no known substitutes for manganese, making it a crucial component of modern industrial economies.

Source Minerals

Pyrolusite, rhodochrosite, psilomelane, cryptomelane, hausmannite.

Uses

Alloy (steel, manganese steel, aluminum and copper), batteries, resistors, fertilizer, fungicides, rubber, ceramics and glass.

Global Mine Production

Annual production of manganese ore in 2024 was estimated at 20 Mt (USGS, 2025). The top three producers were South Africa (7.4 Mt, 37%), Gabon (4.6 Mt, 23%) and Australia (2.8 Mt, 14.0%).

Mineral Resource Supply and Demand Outlook

Consumption of manganese is expected to rise, closely following steady demand from the steel industry and the development of the electric vehicle (EV) battery sector. The majority of global manganese reserves are concentrated in a few countries, primarily South Africa, Australia, Gabon and China, creating supply chain vulnerabilities that can be easily disrupted by geopolitical events (Shanghai Metals Market, 2024).

Recovery

Manganese ore processing can be challenging due to the complexity and variety in mineralogy, the presence of impurities such as phosphorus and iron, and the finely inter-grown nature of the ores (Steenkamp *et al.*, 2020).

Recycling

Negligible manganese is recovered from ferrous and nonferrous scrap along with iron from steel slag during steel production (USGS, 2023).

Geological Setting

The most significant type of manganese deposit consists of syngenetic (primary) manganese accumulations in shallow-marine sedimentary rocks. Two types of these deposits are distinguished, one that is interlayered with iron-rich strata, and manganiferous sediments that occur independent of iron concentrations. These enrichments may constitute ores themselves or the protore in deposits that are upgraded by secondary enrichment processes such as supergene leaching of silica. Other types of manganese deposits include volcanogenic, karst and hydrothermal vein deposits, and are generally small. Modern (currently forming) seabed-hosted deposits are another type that is significant and may be a source of manganese in the future. They occur as polymetallic nodules and crusts (concretions) on the deep-sea floor and may contain multiple commodities including Mn, Ni, Cu and Co. The following types are identified: hydrogenous – formed from seawater; diagenetic – formed as result of diagenetic redox reactions in sediments; and hydrothermal – formed in association with geochemical processes associated with hydrothermal activity (Cronan, 2019).

MODS Occurrences

There are 182 manganese occurrences in the MODS (58 primary). The most significant area is associated with the Knob Lake Group in western Labrador, the same group of rocks currently mined for iron in the Labrador City and Schefferville regions (Scully Mine).

In Newfoundland, manganese occurs on the Avalon Peninsula within the siliciclastic shales of the Adeyton Group, where 148 tonnes of manganese ore grading 37% Mn is reported to have been mined in 1920 (Flaherty, 1940). Representative manganese occurrences are listed in Table 19 and illustrated in Figures 30 and 31.

Table 19. Representative manganese occurrences for Newfoundland listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
Brigus (South Point) – 001N/11/Mn 001	Past producer (Dormant)	Undivided non-evaporitic precipitates	A shipment of 165 tons (148.5 t) of ore averaging 37% manganese was made in 1920 (Flaherty, 1940)
Sweeny's Prospect – 002E/11/Mn 001	Prospect	Undivided non-evaporitic precipitates	Two separate shafts intersected 6 and 4.5 m beds of manganiferous chert grading 2.66% Mn (Heyl, 1936)
Kelligrews River – 001N/06/Mn 001	Prospect	Undivided non-evaporitic precipitates	Manganiferous beds of variable thickness (1–5 m) grading 8.6–43.83% Mn (Wiseman, 1942b)
Marysvale – 001N/06/Mn 005	Showing	Undivided non-evaporitic precipitates	Manganese occurs at the base of Middle Cambrian beds in the upper part of a syncline. A grab sample yielded 41.7% Mn (McCartney, 1967)
Manuels River – 001N/10/Mn 002	Showing	Undivided non-evaporitic precipitates	Four bulk samples yielded an average of 9% Mn; approximate estimate of tonnage obtained for the Manuels and Kelligrews localities of 10Mt (Wiseman, 1942b)
Spread Eagle – 001N/12/Mn 006	Showing	Undivided non-evaporitic precipitates	Low-grade manganiferous beds are present at the base of the Middle Cambrian green slates (Chamberlain's Brook Formation). Grab sample assayed 19.86% Mn (McCartney, 1966, 1967)
Broad Cove Manganese – 002C/04/Mn 002	Showing	Undivided non-evaporitic precipitates	Manganese-bearing strata occurs at the boundary between the Lower and Middle Cambrian in shales and limestones of the Chamberlains Brook Formation. An assay in limestone yielded 25.6% MnO (Mattinson, 1950)
LABRADOR			
Scully Mine – 023B/15/Fe 001	Producer (Fe)	Stratabound banded iron formatioin	Manganese rich tailings stockpiled as by-product of iron production. Avg Mn content of 3 ore members is 1.18%, 1.73% and 2.24% Mn (O'Leary *et al.*, 1972). Proven and probable reserves estimated at 478.9 Mt grading 2.62% Mn and 34.89% Fe (Lacelle *et al.*, 2021).
Houston 1 to 3 – 023J/10/Fe 008 023J/10/Fe 009 023J/10/Fe 010	Developed prospects (Fe)	Stratabound banded iron formation	Total NI 43-101 resource estimate of 22 Mt of manganiferous iron and includes Mn at up to 6.2% (Dupéré and Taylor, 2012)
Bruce Lake Manganese – 023G/07/Mn 001	Prospect	Stratabound banded iron formation (possible secondary enrichment)	Manganese appears with goethite as a replacement mineral, filling vugs and cavities in cherty-carbonate iron formation, assays returned values averaging 21% Mn (Hansen, 1942).
Eagle Lake Northeast – 023J/09/Mn 001	Prospect	Insufficient data to classify	Two samples of carbonate iron formation returned grades of 21 and 25% (Evans, 1978)
Elross Lake 3 – 023J/14/Fe 011	Prospect (Fe)	Stratabound banded iron formation	Grab sample of ferruginous shale assayed 19.95% Mn and is interbedded with "altered metallic iron" (Perreault, 1950)
Shoal Lake Manganese – 023J/08/Mn 001	Showing	Stratabound banded iron formation	Manganese enrichments occur in a "leached" iron formation. Three grab samples yielded values of 34.9%, 19.25% and 25.0% Mn (Melihercsik, 1952)

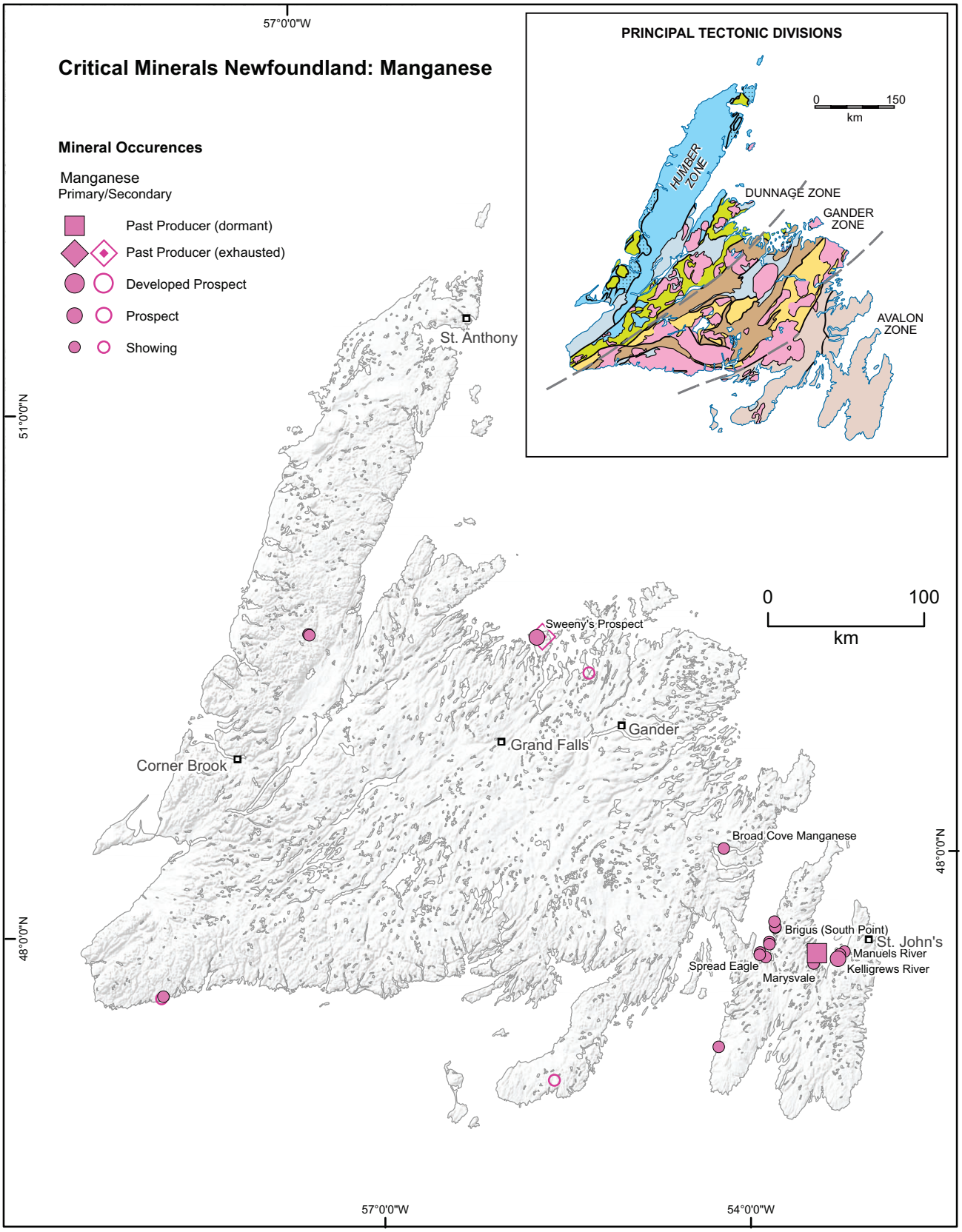

Figure 30. *Map showing the distribution of manganese occurrences in Newfoundland as well as illustrating all levels of development above indication.*

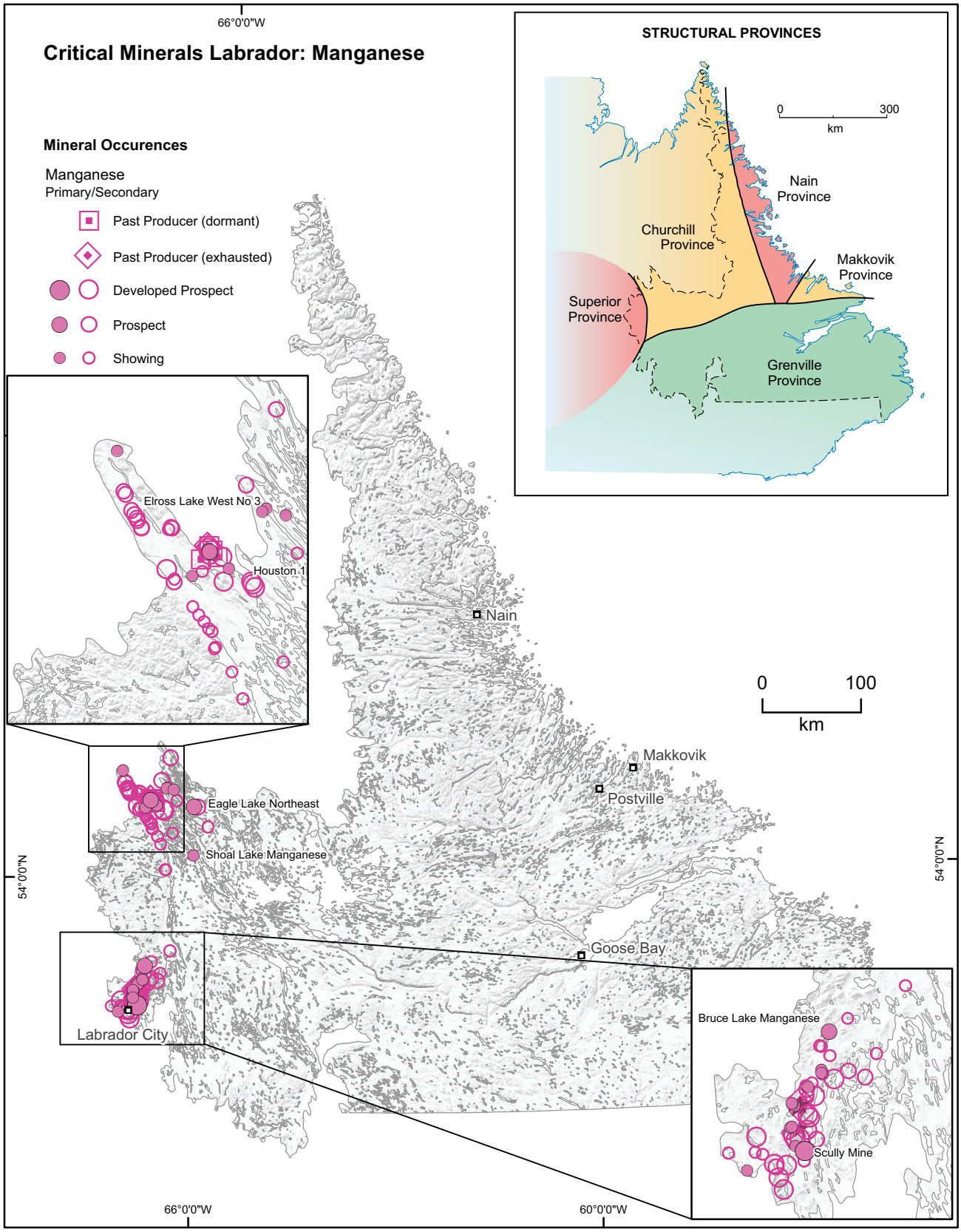

Figure 31. *Map showing the distribution of manganese occurrences in Labrador as well as illustrating all levels of development above indication.*

MOLYBDENUM (Mo)

Description

Molybdenum is silver-grey, ductile and has a high melting point (6th of any element). It is one of the five major refractory metals along with tungsten, rhenium, tantalum and niobium that readily forms stable carbides (important industrial compounds composed of carbon and a metal), and has one of the lowest coefficients of thermal expansion among commercially used metals (Emsley, 2001). Molybdenum does not occur as a free element and occurs mostly as the mineral molybdenite (MoS_2). Most molybdenum is used in alloys and superalloys to increase strength and corrosion resistance of components subjected to high heat such as jet engines and combustion liners.

Source Mineral

Molybdenite.

Uses

Alloys (high-strength steel, high-temperature superalloys), wind turbines, fertilizer, electronics, low voltage X-rays, lubricant, catalyst, pigment in ceramics.

Global Mine Production

Annual production of molybdenum in 2024 was estimated at 260 000 t (USGS, 2025). The top three producers were China (110 000 t, 42.3%), Peru (41 000 t, 15.7%) and Chile (38 000 t, 14.2%). Statistics Canada estimated Canadian production at 1583 t for 2024, while the USGS estimated Canadian production at 1200 t.

Mineral Resource Supply and Demand Outlook

Existing global resources of molybdenum are assessed at 20 Mt (USGS, 2024). There is a higher demand for the application of the metal in clean energy technologies, specifically solar cells, batteries, and hydrogen production, and demand is expected to be increasingly influenced by green technologies (Future Market Insights, 2025e).

Recovery

Processing requirements can vary based on whether molybdenite is recovered as a primary, co-product, or by-product commodity (IMOA, 2023).

Recycling

As much as 30% of the apparent supply chain (part of the supply chain remains undocumented) comes from recycled components of catalysts, and ferrous and superalloy scrap from steelmaking (USGS, 2023).

Geological Setting

Mineralization occurs in fractionated and evolved granitoid magmas, copper-rich porphyries, pegmatites and aplites, and associations with Sn, Pb, Zn and F are common. Primary economic resources of molybdenum occur in Mo-dominant porphyries, with additional resources as a by-product in other deposit types (*e.g.*, porphyry–Cu–Mo, greisen, skarn and pegmatite deposits). Mo-dominant porphyries are classified separately from Cu-dominant porphyries and are rarer than the latter. Molybdenite in porphyries can occur as disseminations, in veins, veinlets, sheeted veins or stockworks, or within greisenous zones located in cupolas that are above and surrounding pluton apices, and multiple mineralization events superimposed over each other are common. Molybdenite also occurs from contact metamorphism in skarn deposits, and as enrichments in black shales, scavenged by adsorption from the ocean column.

MODS Occurrences

There are 279 molybdenum occurrences in the MODS (190 primary), including 2 developed prospects. In Newfoundland, granite-related Mo-mineralization is best known in Silurian and Devonian igneous rocks of the Ackley Granite, and in the Grey River and Granite Lake areas, and there is a spatial association between Mo and W (Kerr *et al.*, 2009). At the composite Devonian Ackley Granite, molybdenite is hosted in altered aplite (fine-grained granite) at the contact with volcanic rocks (Whalen, 1980). Nearby granite-related molybdenite is also found within the Harbour Breton and Old Woman Stock granites. In the vicinity of Grey River, extensive low-grade Mo at Moly Brook (011P/11/Mo 001) occurs primarily along the rims of a series of sheeted quartz veins that intrude a porphyritic composite intrusion (Tenajon Resources,

2009 – Ind. Res. 124 Mlbs Mo at 0.04% cut-off). In the Granite Lake area, most Mo mineralization is hosted within a subunit of the North Bay Granite, the Wolf Mountain Granite, in sheeted quartz veins, quartz-greisen and quartz pegmatite veins (*e.g.*, Moly Hill – 012A/02/Mo 009). Additionally, vein-style hydrothermal deposits occur on the Burin Peninsula and are related to the St. Lawrence Granite (*e.g.*, Lawn Molybdenum No. 2 – 001L/13/Mo 003).

In Labrador, molybdenite occurrences are most prevalent within the Central Mineral Belt; the Aillik Prospect (developed prospect –013O/03/Mo 003) is found within mylonitic quartzofeldspathic rocks and is one of several occurrences that define a favourable stratigraphic/structural zone in the Upper Aillik Group that stretches from Cape Makkovik to Retreat Lake. Minor occurrences of molybdenite are found within the copper-rich Seal Lake Group (North Whiskey Lake – 013K/05/Cu 003) and also within the Ashuanipi Complex (Superior Province) in western Labrador, where mineralization is seemingly associated with mafic dykes hosted in quartzofeldspathic paragneiss (McPhadyen River South-No 9 – 023J/03/Cu 001). Representative molybdenum occurrences are listed in Table 20 and illustrated in Figures 32 and 33.

Table 20. Representative molybdenum occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
Moly Brook – 011P/11/Mo 001	Developed Prospect	Magmatic – hydrothermal (porphyry type)	Ind. Res. of 124 Mlbs Mo and Inf. Res of 38.6 Mlbs Mo at 0.04% Mo cut-off (Scott *et al.*, 2009)
Ackley City – 001M/11/Mo 002	Developed Prospect	Undivided magmatic – hydrothermal deposit	80 000 t grading 0.6% MoS_2 (Nolan, 1969)
Moly Hill – 012A/02/Mo 009	Prospect	Magmatic – hydrothermal (vein association)	Several 130 m up to 225 m thick intersections in DDH ranging from 0.009 to 0.027% Mo (Moore, 2008a)
Granite Lake Molybdenum #1 – 012A/02/Mo 001	Prospect	Undivided magmatic – hydrothermal deposit	Channel assay returned 1110 ppm Mo over 5.0 m (Tuach, 1996)
Wylie Hill – 001M/11/Mo 005	Prospect	Magmatic – felsic Intrusive	Total mineralized surface area covers approx. 72 000 m^2. An enriched zone of 216 m^2 grades 0.3 percent MoS_2 or better (Dickson and Howse, 1982)
Parrell – 012I/01/Mo 001	Prospect	Undivided stratabound deposit in metamorphic rocks	Molybdenite is found in three distinct, northerly plunging, shoots or lodes which carry 1–10% (MoS_2) in altered vein rocks. Avg. of 10 samples yielded 1.5% MoS_2 (Fuller, 1941)
Molypeak – 012A/06/Mo 001	Prospect	Undivided hydrothermal structurally controlled vein system	Veins with less than 5% sulphide contain molybdenite, pyrite + pyrrhotite, and rare chalcopyrite and sphalerite with grab samples ranging from 0.023 to 0.55% Mo. Best DDH intersections: weighted avg. of 0.37% Mo over 5 m, and 0.2% Mo over 9.6 m (French *et al.*, 2012)
Coronation Lake South #1 – 012A/16/Mo 001	Showing	Magmatic – felsic Intrusive	Disseminated molybdenite–chalcopyrite–pyrite occurs within the Crippleback Lake Quartz Monzonite. Assay in float yielded 0.25% Mo (Dimmell, 1975)
Dunphey Brook Molybdenum – 001M/11/Mo 004	Showing	Undivided magmatic – hydrothermal deposit	Mineralization present over a width of 3 m. Assays from channel sample yielded 0.4% MoS_2 (Whalen, 1980)
Lawn Molybdenum No. 2 – 001L/13/Mo 003	Showing	Undivided magmatic – hydrothermal deposit	Appreciable molybdenite occurs in four quartz veins locally up to 2 inches in width within the St Lawrence granite (Walthier, 1948). Assay by BP minerals yielded 370 ppm Mo (Hoffman *et al.*, 1978)
Main Showing – 011P/13/U 004	Showing (U)	Undivided stratabound volcanic-related uranium deposit	Mo and U mineralization is restricted to metasediments and metavolcanics of the Bay du Nord Group; grab sample assayed 1400 ppm Mo and 2.88% U (Smeltzer and Kahlert, 2006)
LABRADOR			
Aillik Prospect – 013O/03/Mo 003	Developed Prospect	Undivided magmatic – hydrothermal deposit	Molybdenite occurs as disseminations and stringers on avg. 0.25–0.30% MoS_2 and is associated with pyrite, fluorite, chalcopyrite and minor U. The deposit is one of a number which define a favourable stratigraphic/structural zone in the Upper Aillik Group, stretching from Cape Makkovik to Retreat Lake (Gandhi, 1970; Peach, 1960)

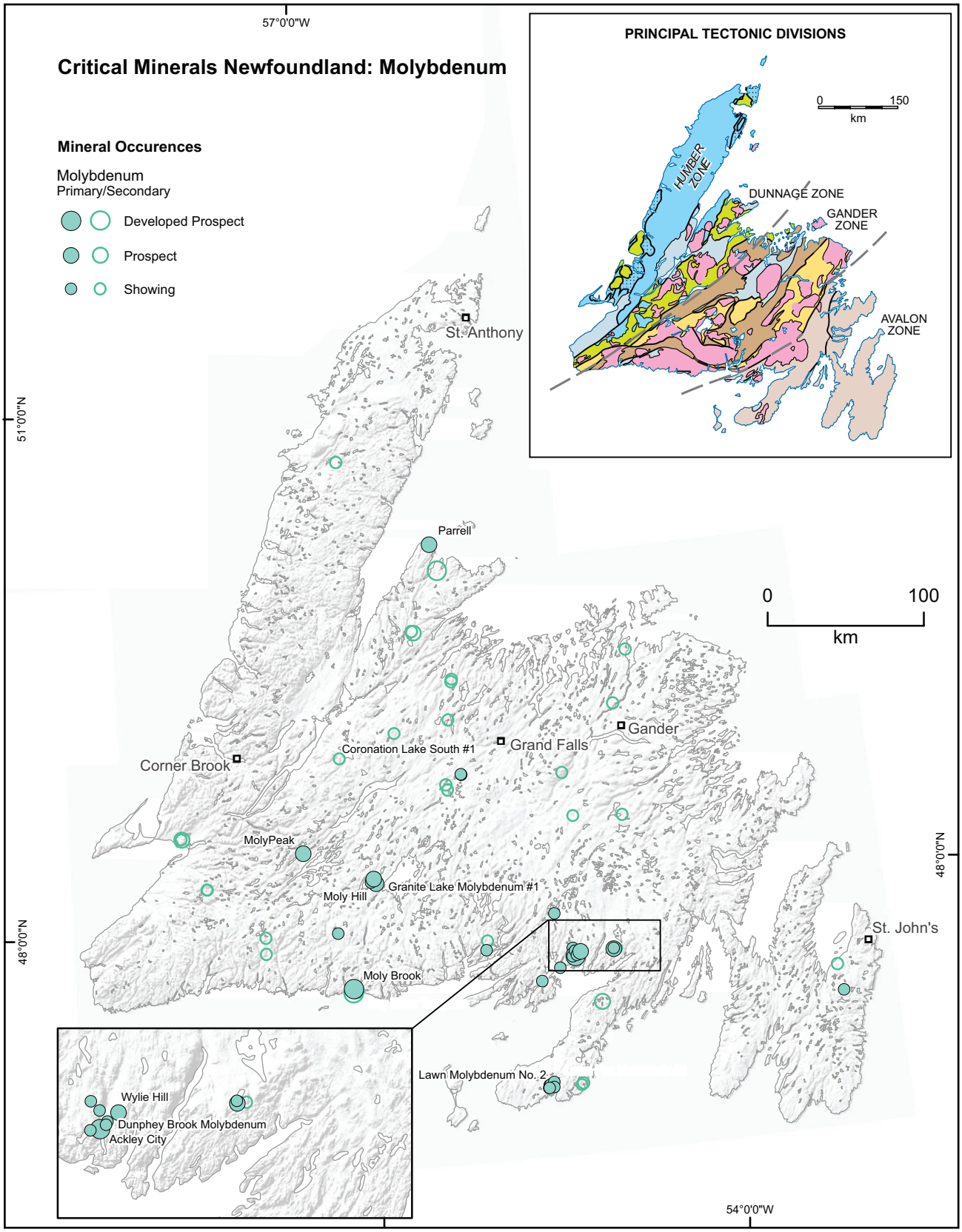

Figure 32. *Map showing the distribution of molybdenum occurrences in Newfoundland as well as illustrating all levels of development above indication.*

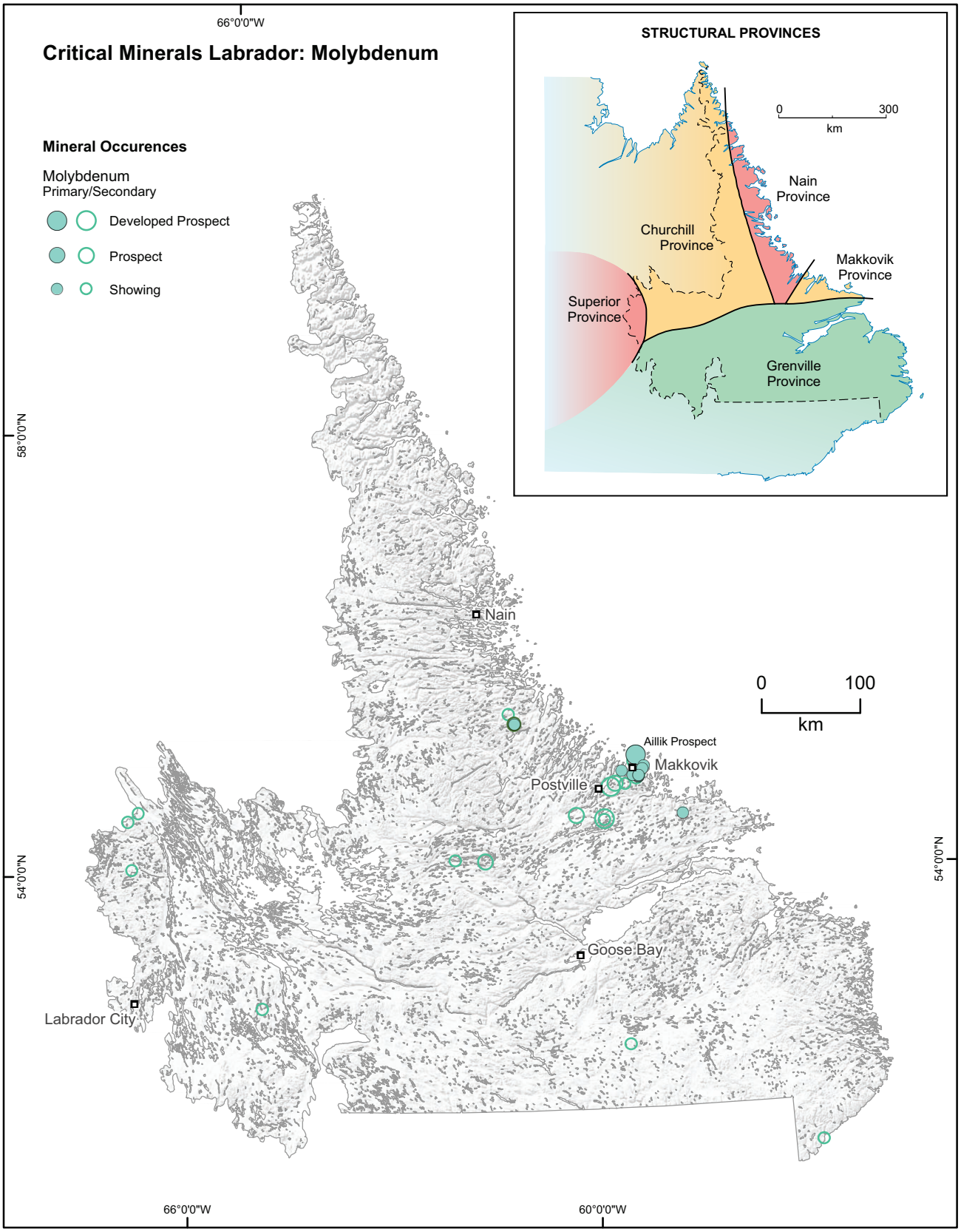

Figure 33. *Map showing the distribution of molybdenum occurrences in Labrador as well as illustrating all levels of development above indication.*

NICKEL (Ni)

Description

Nickel is a lustrous, silver-white metal with a slight golden tinge. It is similar to iron in strength but more like copper in resistance to oxidation and corrosion, ferromagnetic at room temperatures (20–22°C), and has a high electrical and thermal conductivity. Nickel is an important metal in alloys and is well known for its use in coinage. Much of the world's nickel is used as a component in stainless steel and other alloys such as nickel brasses and bronzes and alloys with copper, chromium, aluminum, lead, cobalt, silver and gold. Nickel compounds have uses in niche chemical manufacturing such as catalyst for hydrogenation, pigments and metal-surface treatment. Nickel is also important for renewable energy, its use in batteries enhances battery energy density and efficiency, making it essential for long-range electric vehicles.

Source Minerals

Pentlandite, nickeliferous limonite, garnierite, awaruite.

Uses

Stainless steel, nickel plating and alloys, batteries, wind turbines, solar panels, magnets, plumbing fixtures, tinting agent in glass.

Global Mine Production

Annual production of nickel in 2024 was at estimated 3.7 Mt (USGS, 2025). The top three producers were Indonesia (2.2 Mt, 59.5%), the Philippines (330 000 t, 8.9%), and Russia (210 000 t 5.6%). Statistics Canada estimated Canadian production at 125 363 t for 2024, while the USGS (2025) estimated it at 190 000 t.

Mineral Resource Supply and Demand Outlook

Nickel prices remained subdued in early 2025; several factors contributed to the downturn in late 2024, including the faster adoption of LFP chemistries and persistent downstream inventory overhang, the primary driver continued to be oversupply, driven largely by high production volumes from Indonesia (IEA, 2025).

Recovery

The recovery of nickel has many steps and is energy intensive. New and more cost-effective environmental processes are being developed such as replacing the smelting step by ultra fine grinding, and bioleaching (Crundwell *et al.*, 2011).

Recycling

The recycling of nickel is very efficient, and approximately 68% of nickel was recycled in 2010 (Nickel Institute, 2024). Demand for recycled nickel is growing and is seen as an important aspect of global sustainability.

Geological Setting

Global nickel deposits are predominantly associated with nickeliferous limonite and garnierite in laterite deposits, magmatic sulphide deposits and ultramafic komatiite-flows; minor enrichments are associated with polymetallic VMS deposits. Magmatic sulphide deposits consist of accumulations of nickel-enriched sulphides that form within specific parts of the magmatic chamber or outside of it (Barnes and Maier, 1999; Mudd and Jowitt, 2014). Nickel in awaruite (Ni_2Fe), a sulphur-free nickel-iron-cobalt mineral, occurs in serpentinized ultramafic rocks and represents a potential source of nickel (Steinthorsdottir *et al.*, 2022); it has the benefit of being able to be processed by magnetic separation.

MODS Occurrences

There are 435 nickel occurrences in the MODS (189 primary), including one producing mine and 41 prospects. Nickel is currently mined, along with copper and cobalt, from magmatic sulphides hosted by the troctolitic Voisey's Bay intrusion in northern Labrador. The best known example of magmatic nickel sulphide mineralization outside of Voisey's Bay in Labrador is located 100 km to the southwest and is hosted in the mafic–ultramafic Pants Lake Intrusion (*e.g.*, Northern Abitibi Nickel Zone – 013M/09/Ni 001). Nickel mineralization is also associated with ultramafic (komatiite) volcanic rocks of the Florence Lake greenstone belt (*e.g.*, Baikie Showing – 013K/15/Ni 001), one of two greenstone belts, that occur within the Hopedale Block in Labrador. A series of Mesoproterozoic mafic intrusions occurring on the northern margin of the Grenville Province also hold potential for hosting magmatic nickel mineralization.

In Newfoundland, nickel was historically mined in stringers and pods at the contact between altered andesitic volcanic and talc–carbonate rocks located near a larger body of serpentinized peridotite at the Tilt Cove Mine. Nickel–copper–cobalt mineralization occurs at the Taylor's Brook Project (Layden – 012H/11/Ni 001) and is interpreted to be associated with the Silurian Taylor Brook Gabbro Complex (Wilton *et al.*, 2023). Mafic/ultramafic Silurian intrusive rocks in the Dunnage Zone also host nickel–copper–cobalt occurrences (*e.g.*, Portage Lake – 012A/05/Ni 001, Powderhorn Lake – 012H/01/Zn 003). Nickel in awaruite exists in the Pipestone Pond Ophiolite Complex located within the Exploits Subzone of the Dunnage Tectonic Zone (*e.g.*, RPM Zone – 012A/08/Ni 002). Representative nickel occurrences are listed in Table 21 and illustrated in Figures 34 and 35.

Table 21. Representative nickel occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
Layden – 012H/11/Ni 001	Prospect	Magmatic – ultramafic-mafic intrusive	Channel sample returned 3.23% Ni, 0.75% Cu and 0.06% Co over 1.54 m. Massive/net-textured sulphide intersection in DDH: 4.44 m grading 2.79% Ni (Wilton *et al.*, 2023)
Chapel Island – 002E/07/Ni 001	Prospect	Magmatic – ultramafic-mafic intrusive	Highest values from 3 samples collected from rock dump site near main working (historical adit) returned 2.2% Ni and 1.21% Cu (Shinkle, 2005)
Powderhorn Lake-Main Showing – 012H/01/Ni 002	Prospect	Magmatic – ultramafic-mafic intrusive (anorogenic gabbro)	Best assay from grab samples in gabbro or diorite up to 4.7% Ni. Best intersection in DDH grading 0.82% Ni over 1.5 m (Kerr, 1999)
Portage Lake – 012A/05/Ni 001	Prospect	Undivided ultramafic-mafic magmatic deposit	Up to 2.18% Ni over 1.0 m in channel sample taken in olivine-bearing gabbroic to troctolitic rocks (Moore *et al.*, 2009)
RPM Zone – 012A/08/Ni 002	Prospect	Magmatic – ultramafic-mafic intrusive (ophiolitic association)	Consistent 0.24% Ni and 0.32% Cr over 381.1 m with peaks of 0.31% Ni and 2.61% Cr (First Atlantic, 2025)
Red Cross Dam – 012A/06/Ni 001	Showing	Magmatic – ultramafic-mafic intrusive (large stratiform complex association	Grab sample returned 2300 ppm Ni, 620 ppm Cu and 125 ppm Co (Nuri, 1980). Resampling of historic DDH intersections returned nickel values over 1000 ppm peaking at 2260 ppm (Evans and Kean, 1987)
LABRADOR			
Voisey's Bay Deposits – 014D/08/Ni 001, -002, -003, -008	Producer	Magmatic – ultramafic-mafic intrusive (anorogenic anorthosite massif association)	Total proven and probable reserves of 31.1 Mt grading 1.8% Ni (Vale SEC filing, 2023)
Northern Abitibi Nickel Zone – 013M/09/Ni 001	Prospect	Magmatic – ultramafic-mafic intrusive (anorogenic anorthosite massif association)	15.7 m in DDH section grading 1.13% Ni, 078% Cu and 0.20% Co + 1.1 m in DDH section grading 11.9% Ni, 9.6% Cu and 0.43% Co (Fitzpatrick *et al.*, 1998)
Baikie Showing – 013K/15/Ni 001	Prospect	Magmatic – extrusive/ komatiites	13.0 m grading 1.43% Ni in DDH (Sutton, 1971)
Toll – 014E/02/Ni 001	Prospect	Magmatic – extrusive/ tholeiites	Several drill core sections up to 1.0 m in length grade 0.1–0.95% Ni (Stuckless *et al.*, 2008)

The Cirque – 014E/01/Ni 003	Prospect	Magmatic – ultramafic-mafic intrusive (anorogenic anorthosite massif association)	Extensive gossan zone exposed in cliff walls, best DDH intersections yielded up to 0.44% Ni in widths up to 5 m (Nash *et al.*, 1998)
OKG – 014E/08/Ni 001	Prospect	Magmatic – ultramafic-mafic intrusive (anorogenic anorthosite massif association)	Pentlandite and up to 3% chalcopyrite occur in pods and lenses with up to 1.7% Ni in DDH (O'Sullivan *et al.*, 1999)
West Margin – 014D/15/Ni 001	Prospect	Magmatic – ultramafic-mafic intrusive (anorogenic anorthosite massif association)	Best assay from grab samples returned 0.66% Ni. Best assay in DDH returned 0.24% over 0.8 m (Squires *et al.*, 1997)
Fraser Lake – 013L/05/Ni 001	Prospect	Magmatic – ultramafic-mafic intrusive (anorogenic anorthosite massif association)	Best assay from channel sampling returned 0.9% Ni, 0.3% Cu and 0.15% Co over 3.0 m. Best assay from DDH intersection returned 0.31% Ni and 0.18% Cu over 5.0 m (Burgess and Gamble, 1993)
Okak Bay 2381 – 014E/08/Ni 002	Prospect	Magmatic – ultramafic-mafic intrusive (large stratiform complex)	Disseminated, net-textured and massive pyrrhotite with minor chalcopyrite and pentlandite in pyroxenite and anorthosite; best intersection returned 1.98% Ni over 2.3 m (Cullen *et al.*, 1997)
Paul Island, Project 43 Grid 1 – 014C/12/Ni 004	Prospect	Magmatic – ultramafic-mafic intrusive (anorogenic anorthosite massif association)	Stringers and weak sulphide disseminations occur in troctolitic olivine-rich dyke. Best assay returned 1.29 % Ni over 0.92 m in DDH (Barbour *et al.*, 1996)
Kingurutik Lake A Zone – 014D/16/Ni 009	Prospect	Magmatic – ultramafic-mafic intrusive (anorogenic anorthosite massif association)	Best assay in DDH include several zones from 0.7 to 4.4 m with up to 1.47% Ni (House, 2011)

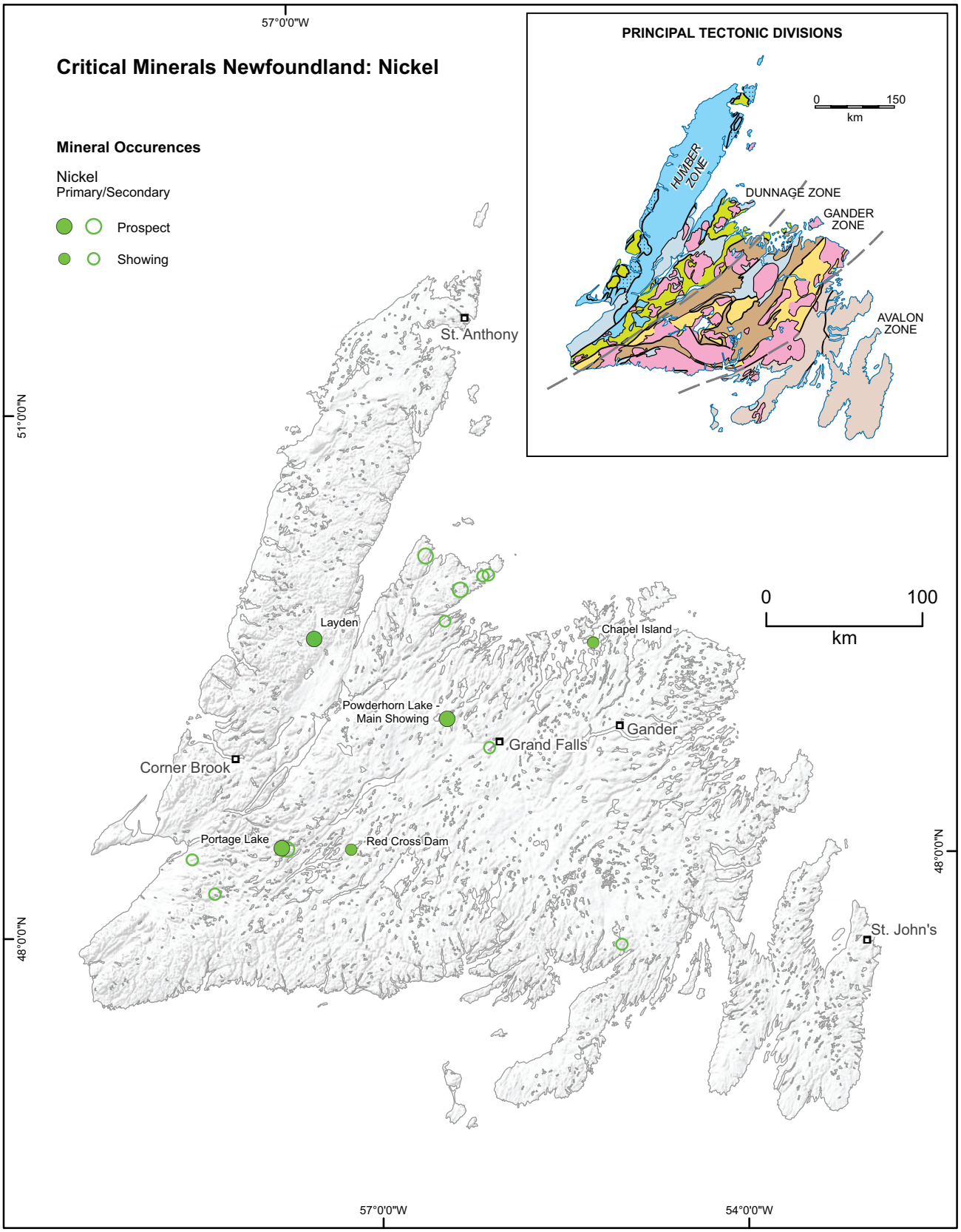

Figure 34. *Map showing the distribution of nickel occurrences in Newfoundland as well as illustrating all levels of development above indication.*

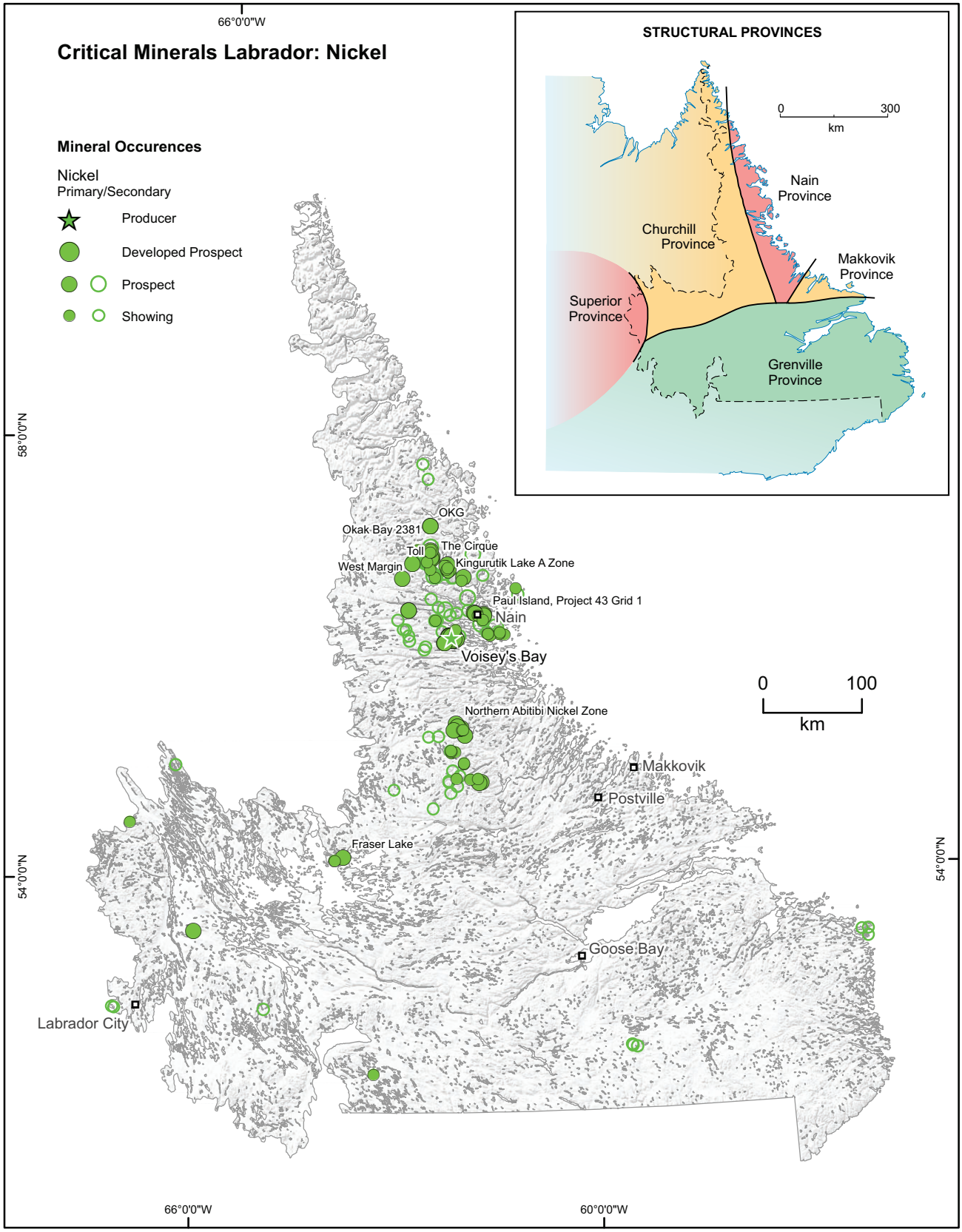

Figure 35. *Map showing the distribution of nickel occurrences in Labrador as well as illustrating all levels of development above indication.*

NIOBIUM (Nb)

Description

Niobium, is a light grey, crystalline and ductile metal that is part of the 5 most refractory metals. Impurities harden it, but it is comparatively soft and ductile when pure. It occurs in relatively low abundance in the earth's crust, frequently with tantalum in the mineral columbite–tantalite (coltan), as the two elements have similar chemical characteristics; its name related to the Greek mythological figure Niobe, daughter of Tantalus, reflects this fact. Niobium becomes a superconductor at cryogenic temperatures (very low temperature). Its corrosion resistance is not as good as that of tantalum but the lower price and greater availability make it popular with less demanding applications. High-grade structural steel consumes most niobium produced, with the remainder used in applications related to the superconductor and electronic industries. Niobium is finding new applications in the transition to low-carbon energy solutions, such as in components of wind turbines (Mudd *et al.*, 2018).

Source Minerals

Pyrochlore, columbite–tantalite.

Uses

High-strength steel, superalloys, pipelines, superconducting magnets, electronics, prosthetics and implantable medical supplies.

Global Mine Production

Annual production of niobium in 2024 was estimated at 110 000 t (USGS, 2025). The top three producers were Brazil (100 000 t, 90.9%), Canada (7100 t, 6.5%) and Democratic Republic of Congo (700 t, 0.6%).

Mineral Resource Supply and Demand Outlook

Reserves are estimated at over 17 Mt (USGS, 2025). Demand for niobium has significantly increased over the past seven decades driven by its essential role as an alloying element in the steel industry. Estimated niobium reserves, primarily located in Brazil, are considered capable of satisfying future global demand for decades and even centuries (Chaves, 2019; USGS, 2023).

Recovery

Niobium ores often require complex separation processes when refractory gangue minerals such as metal oxides, REE and radioactive elements are present (Nzeh *et al.*, 2022).

Recycling

Niobium is recycled from niobium-bearing steels and superalloys. The amount of recycled material is unreported but up to 20% of apparent consumption (calculated from available data) could come from recycled sources (USGS, 2024).

Geological Setting

Niobium is an incompatible element in magmas and is commonly enriched with tantalum and REE (Rare-Earth Elements) in highly fractionated peralkaline granites and carbonatite intrusions (*e.g.*, Niobec Mine). In near-surface environments, magmatic niobium deposits may be enriched by weathering to form laterite and placer deposits.

MODS Occurrences

There are 52 niobium occurrences in the MODS (2 primary), including three developed prospects. Nb, Ta and REE + Y mineralization is typically associated with peralkaline to metaluminous igneous complexes. In Labrador, Mesoproterozoic examples of these rocks can be found within the Fox Harbour Volcanic Belt, the Red Wine Intrusive Suite and Letitia Lake Group, the Strange Lake Complex, and the Flowers River Intrusive Suite. Within the Grenville Province at Fox Harbour, mineralization is hosted in the Mesoproterozoic peralkaline Fox Harbour Volcanic Belt and include REE, Zr and Nb mineralization (*e.g.*, Foxtrot – 003D/05/ Ree001). The most common rock types are gneissic porphyritic granitoids and granodiorites; mafic gneissic rocks are also common (Magyarosi and Rayner, 2023). In the Letitia Lake area, peralkaline volcanic and metavolcanic rocks are intruded by locally undersaturated peralkaline plutons (syenite to granite) assigned to the Red Wine Intrusive Suite, and Nb, Be and Zr mineralization is present in both plutonic and volcanic settings (*e.g.*, Mann #1 – 013L/01/Be 001). The peralkaline Strange Lake Complex intrudes gneisses and granitoid rocks of the Churchill Province. It is a very large undeveloped rare-metals deposit, with ore zones and associated rocks that include a range of un-

common Zr, Y, Be, Nb and REE-bearing minerals; Nb is hosted largely in pyrochlore (Strange Lake – 024A/08/Ree001). The Flowers River Intrusive Suite is the largest peralkaline complex known in Labrador; a volcanic unit known as the Nuiklavic volcanics exhibits local enrichment in Nb and Zr in ash-flow tuff (*e.g.*, Flowers River South #28 – 013N/11/Ree001). Pegmatites and pegmatite–aplite dykes likely associated with high-level granites also contain mineralization and host potential for REE (Kerr and Rafuse, 2011).

In Newfoundland, the largest peralkaline granites are represented by the Silurian Topsails Intrusive Suite (Topsail Zr – 012H/02/Zr 001), and the Devonian St. Lawrence Granite. Other potential areas include the Ediacaran Hare Hill Granite in southwestern Newfoundland, the late Ediacaran Cross Hills Plutonic Suite near Fortune Bay (Bark Pond Rare Earths No 1 – 001M/10/Zr 001), and peralkaline rhyolites at Clode Sound near the Bonavista Peninsula (Clode Sound – 002C/05/Pb 002). Representative niobium occurrences are listed in Table 22 and illustrated in Figures 36 and 37.

Table 22. Representative niobium occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
Bark Pond Rare Earths No 1 – 001M/10/Zr 001	Showing (Zr)	Magmatic – felsic Intrusive	Chip sample from peralkaline aplite veins intruding peralkaline granite returned 2334 ppm Nb and 20 000 ppm Zr (Hopfengaerther, 1982)
Topsails Zr – 012H/02/Zr 001	Showing (Zr)	Magmatic – felsic intrusive	Grab sample assayed 1000 ppm Nb (O'Reilly *et al.*, 2010)
Clode Sound – 002C/05/Pb 002	Showing (Pb)	Insufficient data to classify	Grab sample returned 936 ppm Nb from sheared purple-red felsic volcanic rock (Hutchings, 1999)
LABRADOR			
Foxtrot – 003D/05/Ree001	Developed Prospect (REE)	Magmatic – pegmatite	Ind. Res. of 9.23 Mt grading 789 ppm Nb_2O_5 (Srivastava *et al.*, 2013; Magyarosi, 2022)
Strange Lake – 024A/08/Ree001	Developed Prospect (REE)	Magmatic – pegmatite	Overall estimated resource of 57.0 Mt grading 2.93% ZrO_3, 0.38% Y_2O_3, 0.31% Nb_2O_5, 0.08% BeO and 0.54% REE for Main Zone (Campbell *et al.*, 1985)
Mann #1 – 013L/01/Be 001	Developed Prospect (Be)	Magmatic – felsic Intrusive	Six DDH at Mann #1 intersected REE/niobium/beryllium zone over 600 m strike length with best results of 0.24% Nb_2O_5, 1.71% TREO and 0.20% BeO over 27.0 m (Penney and Nielsen, 2011a, b)
Ocean View – 003D/04/Ree001	Prospect (REE)	Insufficient data to classify	Best Nb values range from 2509 to 11669 ppm in samples from 3 channels (Butler, 2011)
Mann #2 – 013L/01/Nb 001	Prospect	Magmatic – felsic Intrusive	Grab sample in schist and gneiss assayed 0.63% Nb_2O_5, grab sample in syenite assayed 0.22% Nb_2O_5 (Cruft and Robinson, 1958)
Michelin #1 – 013L/01/Nb 002	Prospect	Magmatic – felsic intrusive	Up to 2.18% Nb_2O_5 and from 0.17 to 5.29% TREO reported from 67 sample program (Reid and Penney, 2011)
High Ree Island – 013A/08/Ree002	Prospect (REE)	Magmatic – pegmatite	Up to 2.03% Nb returned from pegmatite aplite dykes and veins from 2 cm to 1.5 m in width, and in 1.2 km long mineralized zone (Butler, 2013)
Pesky Hill – 013A/08/Ree001	Prospect (REE)	Magmatic – pegmatite	Up to 2.16% Nb returned from pegmatites up to 15 m in width that form a discontinuous zone in outcrop over 200 m (Delaney, 2011, 2010; Butler, 2013)
Pope's Hill – 013F/04/Ree001	Prospect (REE)	Magmatic – pegmatite	Up to 0.22% Nb returned from sheared, porphyroblastic, dark grey, mafic intrusive (Delazzer and Dimmel, 2012)
Flowers River South #28 – 013N/11/Ree001	Showing (REE)	Insufficient data to classify	8070 ppm and 4550 ppm Nb assayed from 2 different samples (Seymour *et al.*, 2008)

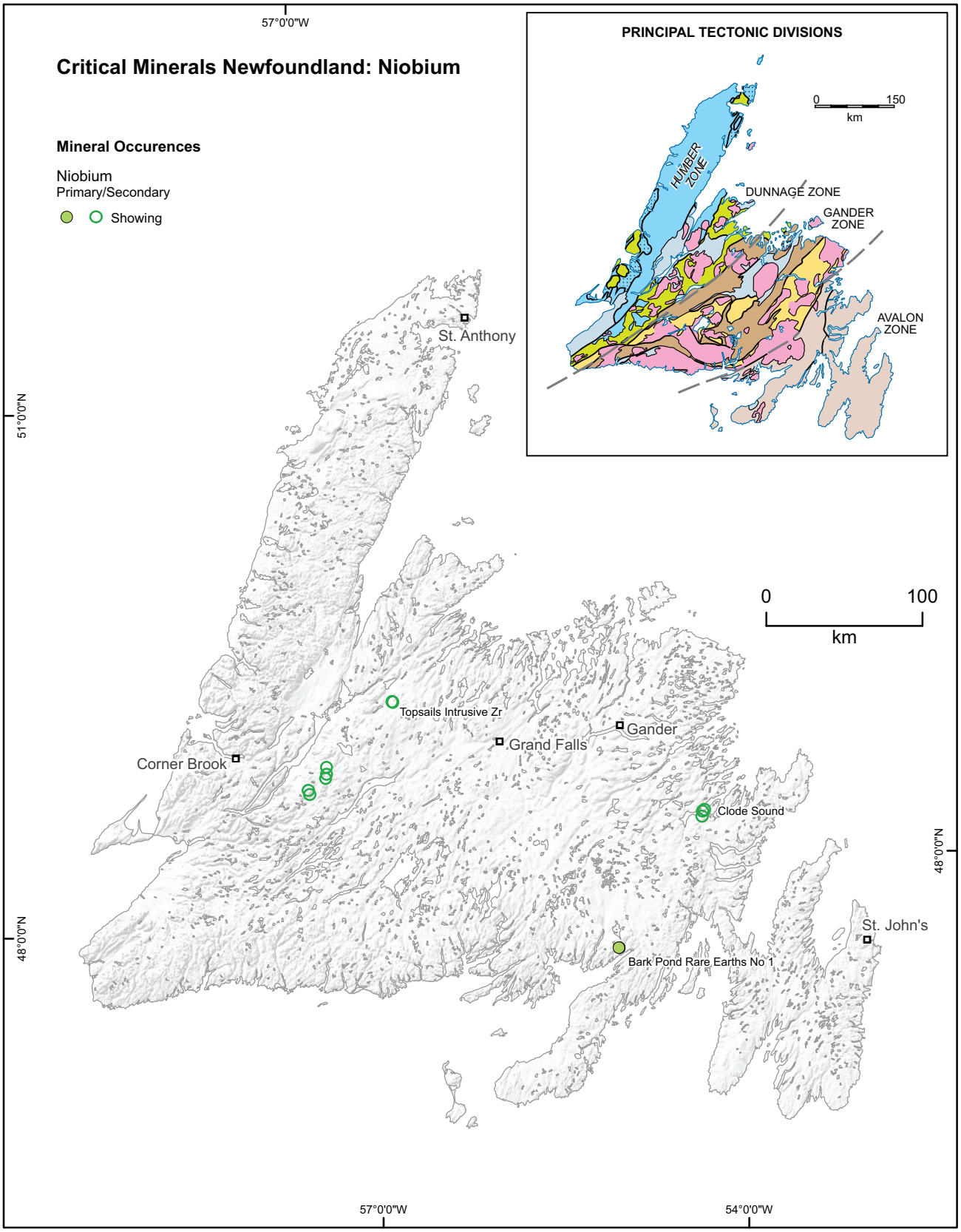

Figure 36. *Map showing the distribution of niobium occurrences in Newfoundland as well as illustrating all levels of development above indication.*

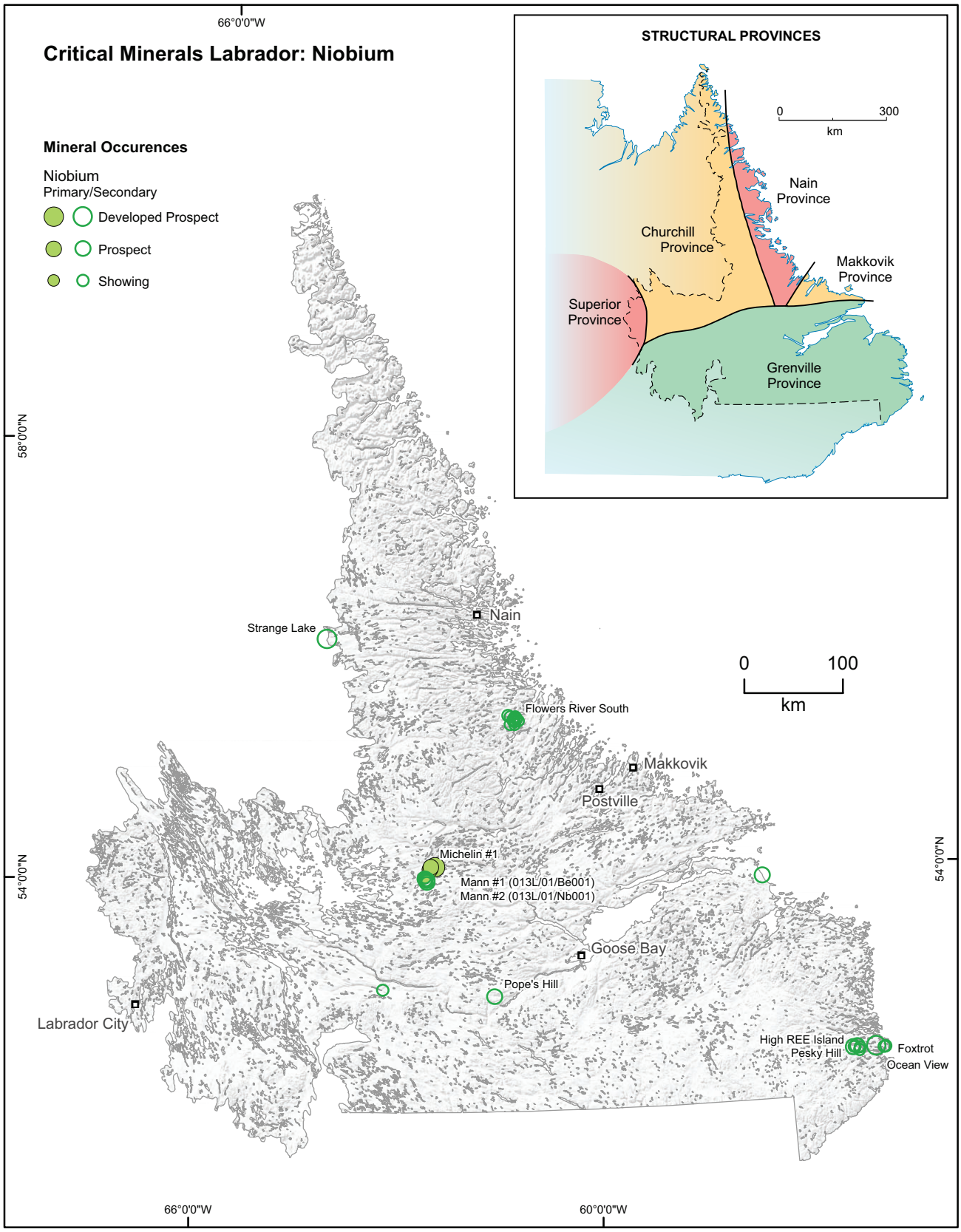

Figure 37. *Map showing the distribution of niobium occurrences in Labrador as well as illustrating all levels of development above indication.*

PLATINUM-GROUP ELEMENTS (PGE)

Description

The PGE, or platinum-group metals (PGM), are a group of 6 noble metallic elements: ruthenium, rhodium, palladium, osmium, iridium and platinum. They are grouped together based on similar chemico-physical properties and tend to occur together in rocks. Newfoundland and Labrador has palladium and platinum occurrences from the PGE group of elements, hence these will be the focus.

Palladium is lustrous, silver-white, has the lowest melting point and is the least dense of all PGE. Platinum is silver-white to dark-grey, malleable and highly resistant to corrosion. It is one of the densest and rarest of all metals. Palladium and platinum occur as native elements in rocks, and in compounds with other transition metals, post-transition metals, and metalloids. Both palladium and platinum are resistant to wear, tarnish and chemical attack, as well they possess good mechanical strength, good ductility and have stable electrical properties. More than 100 different minerals contain one of the PGE as an essential component. Since the end of World War I, PGE have been regarded as minerals of strategic military importance, and subsequently after World War II, were recognized as critical minerals for science and industry. Platinum is increasingly viewed as a precious metal asset and its physical characteristics make it valuable in a wide array of applications in the electronics, medical and industrial/chemical industry. Palladium and platinum are crucial components of catalytic converters in gas-powered vehicles, and around 80% of palladium produced is used in catalytic converters.

Source Minerals

Solid solution in nickel–copper sulphides, PGE arsenides, PGE tellurides, PGE antimonides, PGE bismuthides, natural alloys of gold and silver.

Uses

Catalytic converters, petroleum refining industry, fuel cell catalyst in green hydrogen production, ceramic capacitors, investment metals, jewelry, dental and medical devices, pharmaceutical drugs, glass-making equipment, electrical contacts, liquid crystal displays (LCD), fibreglass.

Global Mine Production

Annual production of palladium in 2024 was estimated at 190 000 kg (USGS, 2025). The top producers were Russia, (75 000 kg, 39.5%), South Africa (72 000 kg, 37.9%), and Canada and Zimbabwe, both of which produced 15 000 kg (7.9%). Annual production of platinum in 2024 was estimated at 170 000 kg (USGS, 2025). The top three producers were South Africa (120 000 kg, 70.6%), Zimbabwe (19 000 kg, 11.2%) and Russia (18 000 kg, 10.6%). The USGS estimated Canadian production at 5200 kg in 2024. Statistics Canada estimated Canadian production for all palladium and platinum at 21 300 kg for the same year.

Mineral Resource Supply and Demand Outlook

World resources of PGE are estimated at more than 100 million kilograms. Concerns about the criticality of PGE are related to the likelihood of disruptions because of social, environmental and economic impacts rather than geological resource depletion (Mudd *et al.*, 2018).

Recovery

PGE ores require complex and costly processes to optimize their recovery, these include froth flotation, gravity separation and magnetic separation (Sahu *et al.*, 2022).

Recycling

Approximately 28% of the world's platinum and palladium's supply was extracted from recycled sources in 2022 (NRCan, 2023). In 2024, about 120 000 kg of palladium and platinum were recovered globally from manufacturing scrap, and scrap recovered from discarded materiel (USGS, 2025).

Geological Setting

PGE have some of the lowest concentrations of all elements in the earth's upper crust. Enrichments occur in magmatic, hydrothermal, sedimentary, residual and placer-type deposits; however, nearly all PGE are commercially mined from magmatic deposits and platinum and palladium are recovered commercially from nickel–copper deposits. They mostly occur as accumulations of PGE-enriched sulphide minerals in mafic and ultramafic rocks of layered ig-

neous intrusions. PGE magmatic deposits are further classified as reef-type and contact-type. Reef-type deposits are accumulations of PGE (and other metals) associated with one or more strata in a layered igneous intrusions. The mineralization intervals are usually thin but laterally persistent. Contact-type deposits instead occur near the contacts of layered igneous intrusions.

MODS Occurrences

There are 35 PGE occurrences in the MODS (10 primary, 3 Pd and 7 Pt), including 7 prospects. Potential exists for magmatic-type deposits associated with numerous mafic/ultramafic intrusive and extrusive rocks located in both Newfoundland and Labrador. In Labrador, PGE occur within the large and layered intrusions of the Mesoproterozoic Nain Plutonic Suite, associated with nickel and copper in troctolitic rocks at the Christa prospect (014D/08/Ni 014), within the Florence Lake and Hunt River greenstone belts (Baikie – 013K/15/Ni 001), and associated with copper within pyroxenite in Labrador West (Cissy Lake – 023H/05/Cu 001). Additionally, Mesoproterozoic to Paleoproterozoic mafic intrusions across the northern margin of and throughout the Grenville Province have potential to host PGE mineralization.

In Newfoundland, PGE are associated with mafic/ultramafic oceanic crustal rocks of the Dunnage Zone (Clyde – 012A/12/Cu 005), ophiolitic rocks that occur in Baie Verte (Bett's Pond – 002E/13/Cu 013) and western Newfoundland (York Harbour Mine – 012G/01/Cu 002). Representative PGE occurrences are listed in Table 23 and illustrated in Figures 38 and 39 with other PGE occurrences.

Table 23. Representative platinum-group element occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
Bett's Cove PGE – 002E/13/Pd 001	Showing	Stratabound volcanogenic stockwork in ophiolite	Three continuous 1-m channel samples returned up to 1.606 ppm Pt and 7.461 ppm Pd (Myllyaho, 2010)
Lower Sheep Brook – 012B/08/Cu 001	Showing (Cu)	Magmatic – ultramafic intrusive (anorogenic anorthosite)	Grab sample assayed up to 2.72 ppm Pt, 4.3 ppm Pd (Dunsworth, 2007)
Kettle Pond North – 012A/12/Cu 002	Showing (Cu)	VMS – mafic (epiclastic)	An assay returned 0.3 g/t Pd, 0.16 g/t Pt, 7% Cu and 0.3% Ni from the contact between the quartz–sericite–chlorite schist unit (Kettle Pond formation) and interbedded mafic and felsic volcanic rocks (French, 1990)
Clyde – 012A/12/Cu 005	Showing (Cu)	Magmatic hydrothermal	Channel sampling returned 2.0% Cu, 0.26% Ni, 0.3 g/t Pd and 0.16 g/t Pt over 2 m. Mineralization forms pyrite–pyrrhotite–chalcopyrite rich sulphide along a shear zone in gabbro, in ophiolite sequence (Basha *et al.*, 2001)
LABRADOR			
West Margin – 014D/15/Ni 001	Prospect (Ni)	Magmatic – ultramafic-mafic intrusive (anorthosite)	Two samples assayed 0.66 ppm Pt, 1.79 ppm Pd and 0.36 ppm Pt, 2.15 ppm Pd (Kerr, 2002)
Toll – 014E/02/Ni 001	Prospect (Ni)	Magmatic – ultramafic-mafic intrusive (anorthosite)	Several samples assayed with values up to 622 ppb Pt, 433 ppb Pd (Stuckless *et al.*, 2008)
TL, Long Pond – 014D/10/Ni 001	Prospect (Ni)	Magmatic – ultramafic-mafic intrusive	Best DDH intersection grading 0.11 ppm Pd and 0.25 ppm Pt over 23.7 m (Walsh *et al.*, 2008)
Christa – 014D/08/Ni 014	Prospect (Ni)	Magmatic – ultramafic-mafic intrusive (large stratiform complex association)	Grab samples of the mineralization (pyrrhotite and chalcopyrite) in leucotroctolite returned values of 1.23 ppm Pd, 0.33 ppm Pt and 0.29% Ni (Fitzpatrick *et al.*, 1996)
Natashquan – 013D/06/Ni 001	Showing (Ni)	Insufficient data to classify	Cu–Ni–PGE-bearing massive sulphide occurrences uncovered over 250 m in strike length. Best PGE assay retuned 0.38 ppm Pt (Devereaux *et al.*, 2011). Best assay from grab samples from Hussey and Dyke (2004) returned 2.82 ppm combined Pt, Pd and Au
Hogan #3 – 014C/11/Pd 001	Showing	Magmatic – ultramafic intrusive (large stratiform complex association)	1425 ppb Pd and 385 ppb Pt in Mesoproterozoic mafic intrusive with 50 to 75% magnetite, and trace sulphides (Butler and Osmond, 1996)
Sword Far North – 013L/05/Ni 002	Showing (Ni)	Magmatic – ultramafic-mafic (large stratiform complex association)	Highest values assayed amongst 5 grab samples returned 0.2 ppm Pt and 0.076 ppm Pd (Masters, 2007)

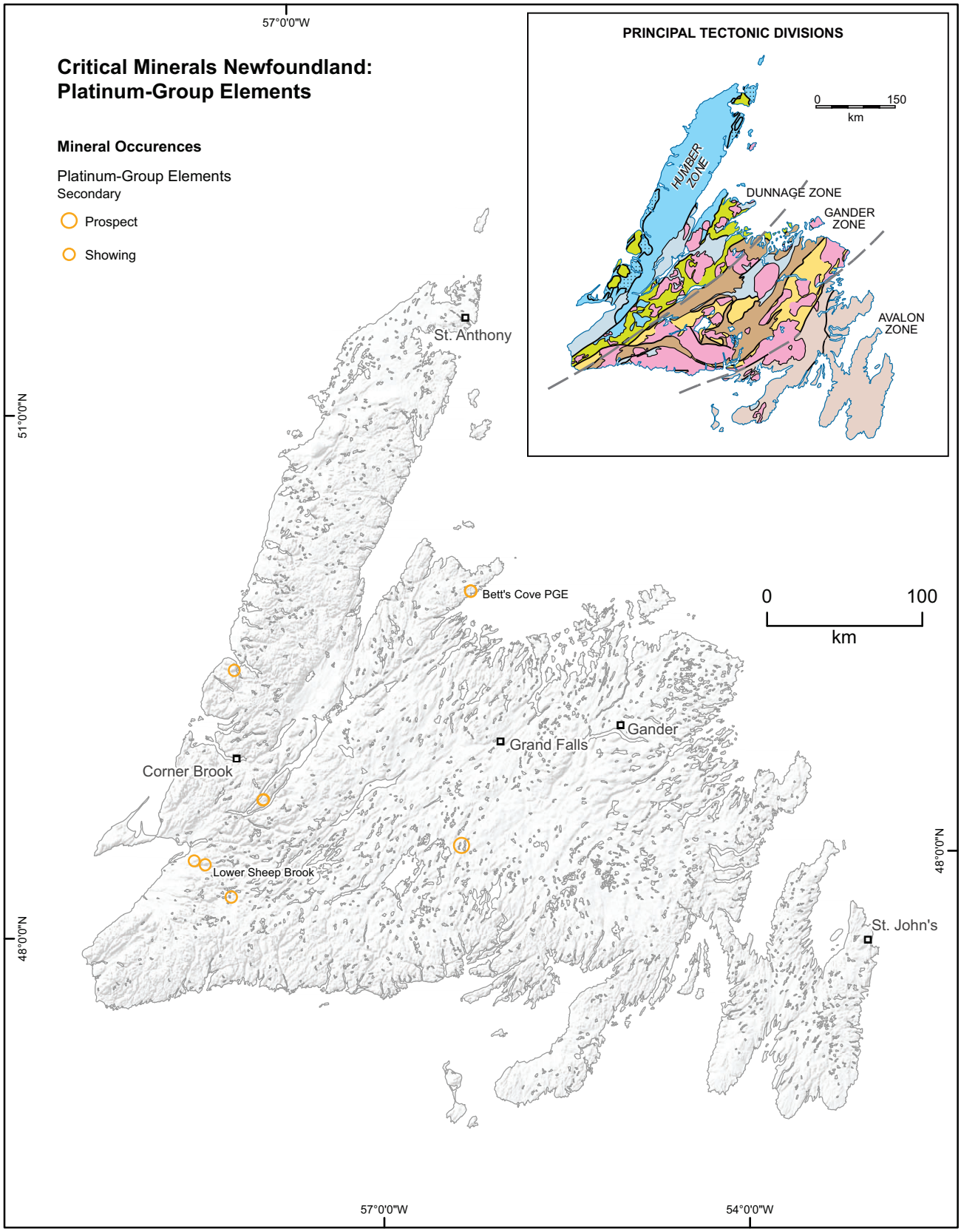

Figure 38. *Map showing the distribution of platinum-group elements occurrences in Newfoundland as well as illustrating all levels of development above indication.*

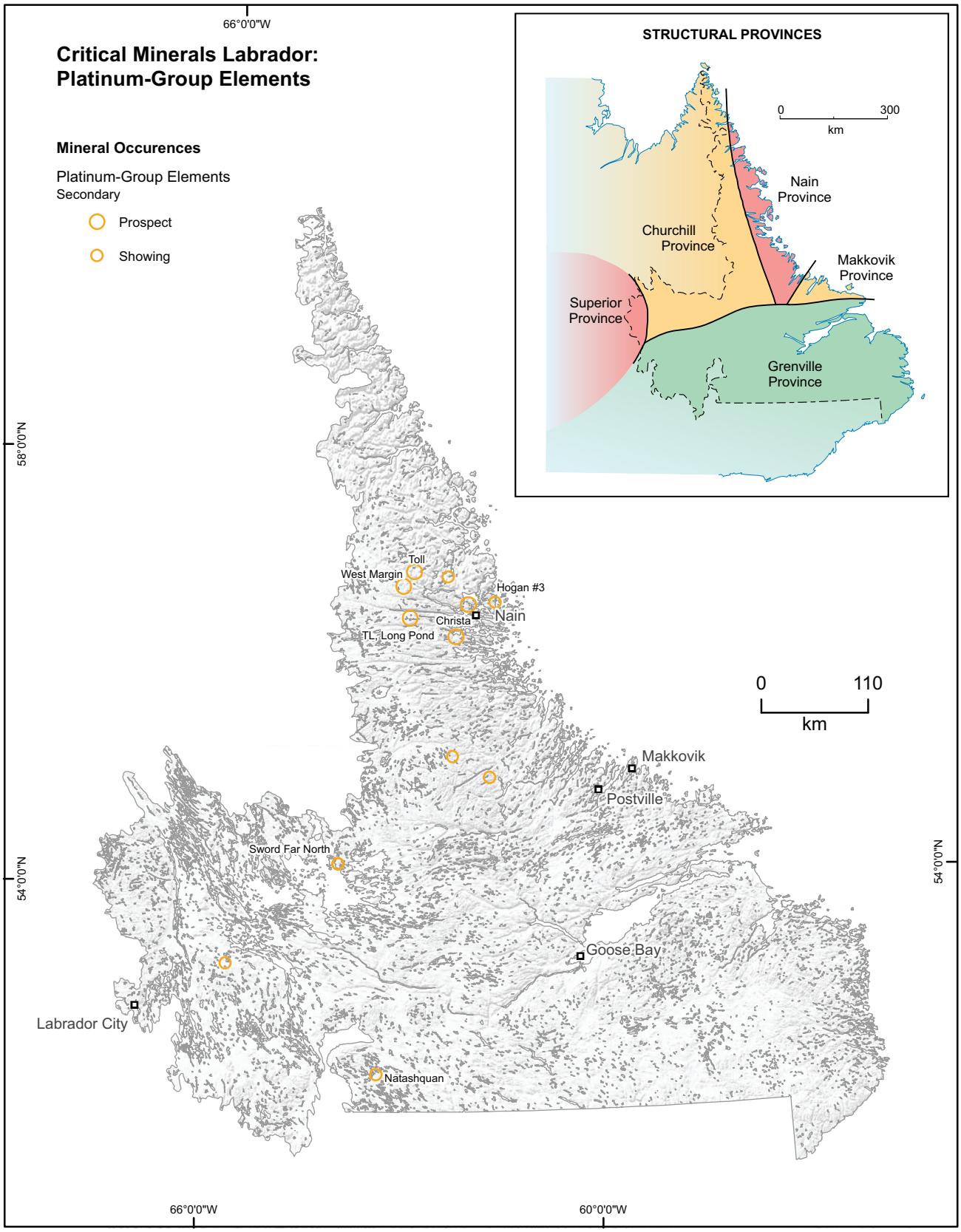

Figure 39 *Map showing the distribution of platinum-group elements occurrences in Labrador as well as illustrating all levels of development above indication.*

POTASSIUM–POTASH (K)

Description

Potassium is a silver-white, soft metal that has a low melting point and is a good conductor of heat and electricity; it is the least dense metal after lithium. Potassium is an abundant element in the Earth's crust (7th most) and many saline bodies of water are rich in potassium. Although abundant in rocks, potassium in minerals such as muscovite and orthoclase feldspar are difficult to recover. Hence, most commercially used potassium is recovered from compounds known as potash, the broad term used to describe a group of potassium salts mined primarily as a source for agricultural fertilizers. Most industrial applications exploit the high solubility of potassium compounds. The compounds potassium hydroxide, potassium carbonate, potassium sulphate and potassium chloride are produced in megatons annually and used in a broad range of industrial chemical applications.

Source Mineral

Potassium salts in evaporite deposits: carnallite, sylvite, langbeinite, polyhalite.

Uses

Fertilizers, metal electroplating, drilling fluid, de-icing agent, steel heat-treating, water softener, industrial cleaners, neutralizer of strong/weak acids, gold production, inks, dyes, explosives, fireworks.

Global Mine Production

Annual production of potash in equivalent potassium oxide in 2024 was estimated at 48 Mt (USGS, 2025). The top three producers were Canada (15 Mt, 31.3%), Russia (9 Mt, 18.8%) and Belarus (7.0 Mt, 14.6%). Statistics Canada estimated Canadian production at 14.4 Mt for 2024.

Mineral Resource Supply and Demand Outlook

Total resources are estimated at about 250 billion tonnes. World potash consumption was estimated at 38.8 million tons in 2024, an increase from 37.5 million tons in 2023, and was projected to increase to 40.9 million tons in 2025 (USGS, 2025).

Recovery

Most mined potassium mineral ends up as potassium chloride after processing. The mineral industry refers to potassium chloride either as potash or muriate of potash.

Recycling

Potassium metal is not widely recycled, some efforts exist to recover potassium compounds from industrial waste streams.

Geological Setting

Potassium is recovered from evaporate deposits, which are layered crystalline sedimentary rocks that form from brines generated in basins/areas where the amount of water lost by evaporation exceeds the total amount of water from rainfall and influx via rivers and streams. Evaporite basins can occur as marine deposits, and non-marine deposits such as lakes.

MODS Occurrences

There are 9 potash occurrences in the MODS (secondary occurrences), including 2 developed prospects. All potash occurrences in the province are associated with salt deposits within the Bay St. George subbasin in western Newfoundland. The basin is part of the much larger Carboniferous Maritime Basin that underlies the Gulf of St. Lawrence. Representative potash occurrences are listed in Table 24 and illustrated in Figure 40.

Table 24. Representative potassium (potash) occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
Fischells Brook – 012B/07/Slt001	Developed Prospect (salt)	Evaporites	Extensive folded carnalite intervals returned up to 9.7% K_2O over 6.2 m in assay; sylvite zones with best intervals are 14.1% K_2O over 1.2 m and 13.2% K_2O over 4.1 m (Anderle, Rogers and Ratcliffe, 1981)
Captain Cook #1 – 012B/07/Slt003	Developed Prospect (salt)	Evaporites	Multiple sections in DDH up to 75 cm thick returned values from 4.44 to 20.4% K_2O (Walsh, 2010)

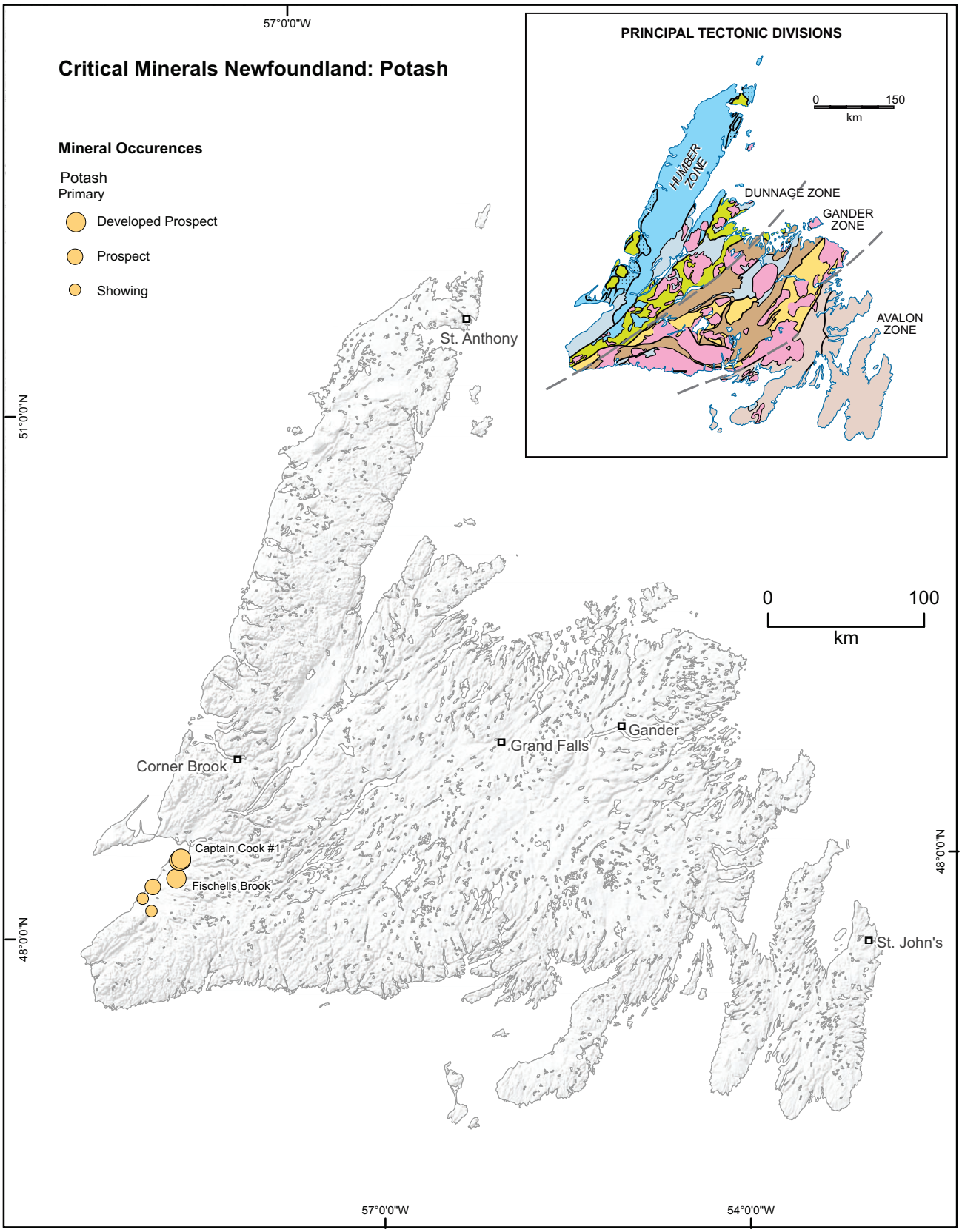

Figure 40. *Map showing the distribution of potassium (potash) occurrences in Newfoundland as well as illustrating all levels of development above indication.*

RARE-EARTH ELEMENTS (REE)

Description

Rare-earth elements (REE) are a group of at least 14 heavy metals in the Periodic Table (La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb) that belong to the lanthanides series, and (often) include the elements lutetium, yttrium and scandium. They are grouped together based on their chemical similarities and affinities in rocks and are classified as light-rare-earth (LREE), or heavy-rare-earth-(HREE)-elements based on their atomic weight. The name 'rare' reflects the difficulty in isolating these elements from each other within the group, while 'earth' refers to the uncommon oxide-type minerals from which they were originally isolated. Elements within the REE group are nearly indistinguishable from each other. When isolated, they occur as lustrous silver-white to grey soft metals. Rare-earth elements are found in over 250 minerals in the earth's crust; however, they are typically mined from a small group of minerals. Much of global REE produced is used for catalysts (production of gasoline, catalytic converters) and magnets.

Source Minerals

Bastnäsite, monazite, loparite, xenotime, apatite, laterite clays.

Uses

Industrial catalysts, rare-earth magnets, green energy technologies, electronics, rechargeable batteries, cell phones, fluorescent lamps, medical imaging machines, lasers, fibre optics.

Global Mine Production

Annual production of REE, estimated in rare-earth-oxide equivalent, was 390 000 t in 2024 (USGS, 2025). The top three producers were China (270 000 t, 69.2%), the United States (45 000 t, 11.5%) and Myanmar (31 000 t, 7.9%).

Mineral Resource Supply and Demand Outlook

The supply for neodymium, praseodymium, dysprosium and terbium that seemed sufficient to meet demand requirements in early 2024 was threatened by several risks that emerged during 2024 and early 2025, the most significant being the growing geopolitical tension between regions and domestic governance of one of the largest supplier, Myanmar (IEA, 2025). Demand for rare earth magnets used in EVs, wind turbines, industrial motors and robotics is expected to increase albeit at slightly slower rates in some sectors (IEA, 2025)

Recovery

The processing of REE ores is energy intensive, requiring many different chemical processes due to the considerable range in mineralogy of the ores. Monazite generates small amounts of radioactive waste due to the co-extraction of uranium and thorium.

Recycling

Similar to the recovery process, the recycling (extracting) of rare-earth metals is energy intensive due to the refractory nature of the REEs and because they are bounded with other metal complexes. Limited amounts of REEs are recycled from batteries, permanent magnets and fluorescent lamps (USGS, 2023). Research focuses on increasing recycling rates and finding more environmentally friendly ways of recycling REEs; Wayman (2023) estimates that up to 25% of REE could eventually come from recycled sources.

Geological Setting

REE are typically enriched in highly fractionated magmas as they are incompatible elements of the high-field-strength elements group (HFSE). They occur in a diverse range of peralkaline and carbonatite igneous rocks or their volcanic equivalents and are widely distributed; occurring as primary rock forming minerals in magmatic deposits (*e.g.*, aplites and pegmatites) and volcanic equivalents with limited hydrothermal alterations. They can also become enriched by metasomatic– hydrothermal processes and get deposited in replacement zones as stockworks and veins (Balaram, 2022).

MODS Occurrences

There are 88 occurrences of REE in the MODS (77 primary), including 4 developed prospects. Significant REE deposits and areas with potential in Labrador include several peralkaline complexes. REE mineralization occur in both gneissic granitoids and gneissic mafic rocks at Fox

Harbour (*e.g.*, Deep Fox – 003D/05/Ree007, Fox Meadow – 013A/09/Ree004, Foxtrot – 003D/05/Ree001; Magyarosi and Rayner, 2023) and are part of the Fox Harbour Volcanic Belt in the Pinware Terrane. The Central Mineral Belt hosts REE mineralization in its western extremity, in the Red Wine Intrusive Suite and Letitia Lake Group (*e.g.*, Two Tom Lake – 013L/01/Ree001, Pinot Rose – 013L/02/Ree008). A large REE deposit exists within the Strange Lake Complex (Strange Lake – 024A/08/Ree001) and include REE + Y, Zr, Nb, U and Be mineralization in phases of the "exotic-rich" granite and pegmatites. Uncommon minerals include elpidite, armstrongite, gittinsite, pyrochlore, kainosite and gadolinite, in addition to more familiar minerals such as allanite, thorite, titanite and zircon (Kerr and Rafuse, 2011). The Nuiklavik volcanics sit stratigraphically above the main granite batholith at the peralkaline Flowers River Intrusive Suite and form the Flowers River Cauldron Complex (Miller, 1994). A number of aplitic dykes likely associated with high-level granites (Kerr and Rafuse, 2011) contain REE, Nb, Zr and Zn mineralization (*e.g.*, Flowers River South #28 – 013N/11/Ree001), the area is generally underexplored for REE.

In Newfoundland, potential for REE exists in the Cross Hills Plutonic Suite near Fortune Bay. The suite includes granitoid and mafic intrusions, and subaerial mafic and felsic volcanics with REE, Zr and Y mineralization, and show evidence of multiple intrusive events (Smith and Lentz, 2011) (*e.g.*, Cross Hills – 001M/10/Ree001, Bark Pond Rare Earths No 1 – 001M/10/Zr 001). At the lost pond showings (*e.g.*, Lost Pond-U3 REE – 012B/09/Ree002) in southwestern Newfoundland, up to 4.47% total rare earths was assayed in drillcore in 2007 (Penney *et al.*, 2008). More recent channel sampling returned up to 2.28% total rare earth oxide (York Harbour Metals, 2024) at Bottom Brook, 750 m to the south-southwest of the lost pond occurrence; mineralization in the area is believed to be associated with the Ediacaran peralkaline Hare Hill Granite (Penny and Reid, 2008). At Clode Sound near the Bonavista Peninsula, peralkaline felsic volcanic units contain Nb–Zr–Y mineralization associated with sulphides (Ken's Mountain Rare Metals – 002C/05/Zr 002), the source of mineralization is unknown but suspected to be related to the Bull Arm Volcanics. The largest peralkaline granites in Newfoundland are represented by the Topsails Intrusive Suite and is an area that is generally underexplored for REE. Representative REE occurrences are listed below in Table 25 and illustrated in Figures 41 and 42.

Table 25. Representative rare-earth elements occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
Lost Pond-U3 REE 012B/09/Ree002	Showing	Magmatic – felsic intrusive	4.47% total REO (%TREO) obtained in drilling over 5.64 m (Penny *et al.*, 2008)
Cross Hill #4 – 001M/10/Ree001	Showing	Magmatic – felsic intrusive	Grab sample yielded 0.12% total REO, of which 0.07% is total HREO (Smith and Lentz, 2011)
Bark Pond Rare Earths No 1 – 001M/10/Zr 001	Showing	Magmatic – felsic intrusive	Peralkaline aplite intruding peralkaline granite shows a variety of REE-rich minerals with up to 2% Zr and 0.23% Y in scanning electron microscopy (Hopfengaerther, 1982)
LABRADOR			
Strange Lake – 024A/08/Ree001	Developed Prospect	Magmatic – pegmatite	Overall estimated resource of 57.0 Mt grading 2.93% ZrO_3, 0.38% Y_2O_3, 0.31% Nb_2O_5, 0.08% BeO and 0.54% REE for Main Zone (Campbell *et al.*, 1985)
Deep Fox – 003D/05/Ree007	Developed Prospect	Magmatic – felsic Intrusive	Ind. Res. of 5.05 Mt grading (ppm) 394 Pr, 1469 Nd, 202 Dy and 34 Tb (Ciuculescu, 2022)
Foxtrot – 003D/05/Ree001	Developed Prospect	Magmatic – pegmatite	Ind. Res. of 10.04 Mt grading (ppm) 366 Pr, 1358 Nd, 176 Dy and 30 Tb (Ciuculescu, 2022)
Two Tom Lake – 013L/01/Ree001	Developed Prospect	Magmatic – felsic intrusive	Inf. Res. of 41 Mt grading 1.18% TREO, 0.26% Nb_20_5, 0.18% BeO and 0.06% ThO_2 (Penney and Nielson, 2011a)
Ocean View – 003D/04/Ree001	Prospect	Magmatic – pegmatite	Best intercept from 3 different channel assays: 0.51% TREE over 3.30 m, 0.53% TREE over 2.00 m, 2.29% TREE over 0.45 m and 0.32% TREE over 6.06 m (Butler, 2011)
Fox Meadow – 013A/09/Ree004	Prospect	Magmatic – felsic intrusive	Channel assays returned 26.8% HREE + Y over 18.24 m, 29.2% HREE + Y over 10.95 m (MacFarlane and Butler, 2013)
Pope's Hill – 013F/04/Ree001	Prospect	Magmatic – pegmatite	7 km strike length mineralized zone with best grab sample assay of 3.85% Nd, 2.11% Y, 5.0% La, 0.09% Nb and 0.06% Zr. Best DDH grading 0.11% TREE + Y over 140.0 m (Delazzer and Dimmel, 2012)
Pesky Hill – 013A/08/Ree001	Prospect	Magmatic – pegmatite	Pegmatite veins that vary in size up to 15 m in width form a discontinuous zone over 200 m. Significant results in DDH include 0.66% Y, 1.04% Zr, 1.02% Nb and 0.12% Dy over 2.56 m (Delaney, 2011, 2010; Butler, 2013)
High REE Island – 013A/08/Ree002	Prospect	Magmatic – pegmatite	Grab samples from channel returned values up to 0.38% Dy and 0.23% Er, 3.28% Zr, 1.95% Y and 2.03% Nb (Butler, 2013)
Pinot Rose – 013L/02/Ree008	Prospect	Magmatic – felsic intrusive	Best intersection from 6 DDH returned 2553 ppm TREE + Y, 1790 ppm LREE, 29.9% HREE + Y over 13.4 m; highest values in DDH were 9712 ppm TREE + Y, 4554 ppm LREE, 53.1% HREE + Y over 0.4 m (Chabanole and Crocker, 2012)
Cabernet – 013L/02/Ree006	Prospect	Magmatic – felsic intrusive	Best DDH intersection from 5 DDH: 0.01% Dy, 0.86% Zr, 0.08% Y and 0.24% TREE (0.32% Y + TREE) over 9.0 m and 0.06% Dy, 0.35% Y and 1.25% TREE (1.59% Y + REE) over 4.0 m (Chabanole and Crocker, 2012)

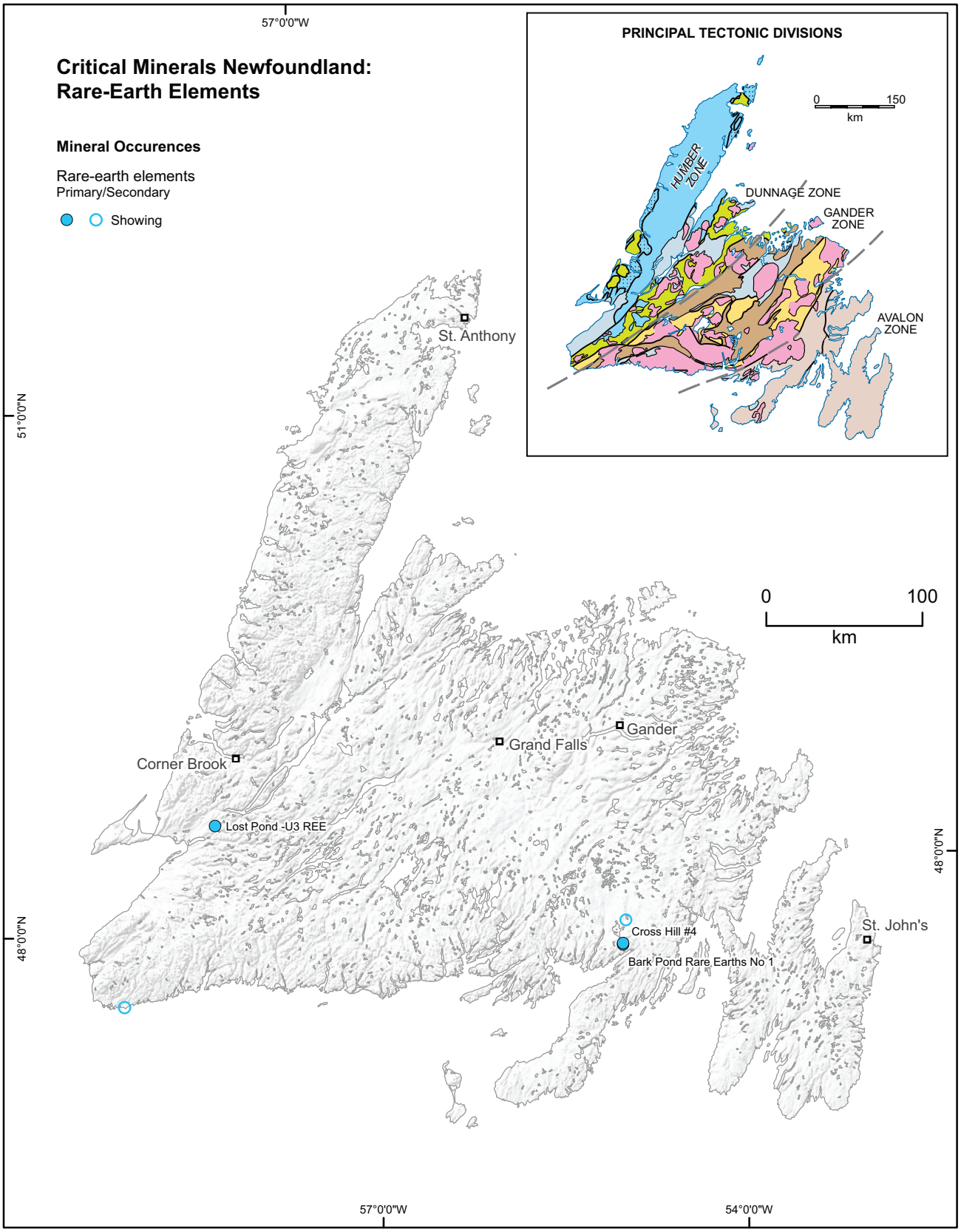

Figure 41. *Map showing the distribution of rare-earth elements occurrences in Newfoundland as well as illustrating all levels of development above indication.*

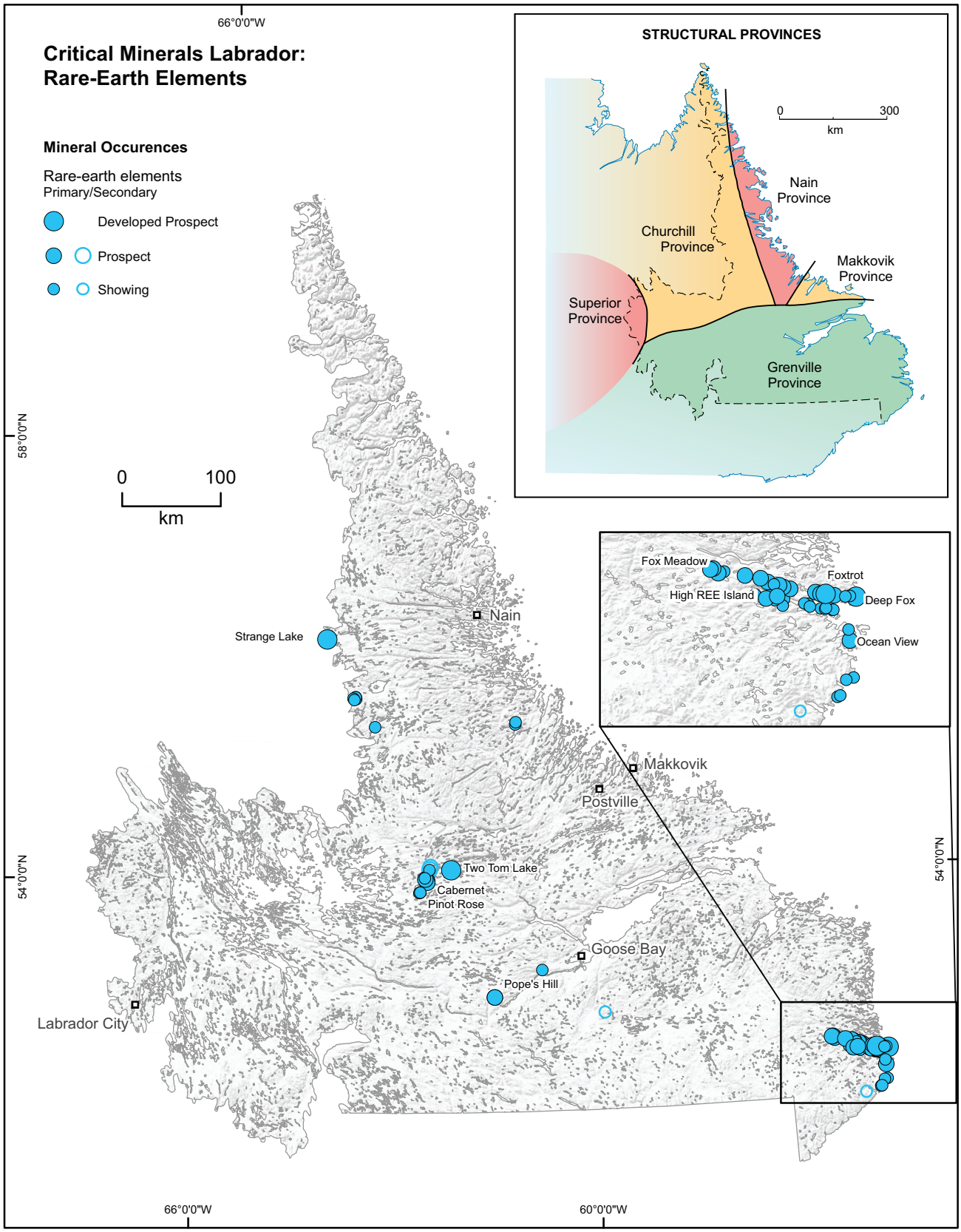

Figure 42. *Map showing the distribution of rare-earth elements occurrences in Labrador as well as illustrating all levels of development above indication.*

SILICON (Si)

Description

In its pure form, the metalloid silicon is a hard, brittle crystalline solid with a blue-grey metallic lustre. It is the second most abundant element in the lithosphere after oxygen; pure silicon is too reactive to occur in abundance but its high chemical affinity with oxygen makes silicon dioxide (quartz) and silicate minerals the main constituent of more than 95% of known rocks. High Purity Quartz (HPQ), defined as having less than 100 part per million in impurities, is an important basic crucial material used to produce silicon in many strategic emerging industries that require strict controls on thermal stability and optical properties. Applications for HPQ include semiconductors, fibre optics and photovoltaic cells. Ferrosilicon is a manufactured mixture of iron and silicon, it is used as a raw material in the production of other important raw materials like steel, pure silicon, hydrogen, and concrete.

Source Minerals

Quartzite, quartzose sandstone, quartz veins, quartzose sand.

Uses

Alloying agent in steel, aluminum, brass and bronze, cement, bricks and ceramics, semiconductors, solar panels, photovoltaic cells, optical fibre, quartz lighting.

Global Mine Production

Annual production of ferrosilicon in 2024 was estimated at 5.1 Mt (USGS, 2025). The top three producers were China (3.5 Mt, 68.6%), Russia (470 000 t, 9.2%) and Brazil (200 000 t, 3.9%). Annual production of silicon metal in 2024 was estimated at 4.6 Mt (USGS, 2025). The top three producers were China (3.9 Mt, 84.7%), Brazil (190 000 t, 4.1%) and Norway (120 000 t, 2.4%).

Mineral Resource Supply and Demand Outlook

World and domestic resources for producing silicon metal and alloys are abundant and, in most producing countries, adequate to supply world requirements for many decades (USGS, 2025). HPQ deposits are considered scarce; global producers are highly concentrated, and the demand currently exceeds the supply (Ma *et al.*, 2025).

Recovery

The production of HPQ is achieved through a multi-step process that combines mechanical, chemical, and advanced purification techniques to remove impurities. Quartz ores can vary greatly, and the purification potential is influenced by grain size characteristics and inclusions, and lattice impurities (Ma *et al.*, 2025).

Recycling

The silicon and ferrosilicon alloy industries produce silica fume as a by-product that can be used as a direct agent in cement or further purified to make high-purity silicon. High purity silicon can be recovered from expended solar panels.

Geological Setting

Silica is produced from quartz-rich sand deposits, quartz-rich sandstones or their metamorphic equivalent (quartzite), hydrothermal vein quartz, and granite quartz pegmatite. Quartz rich sand deposits occur as a function of compositionally mature sediments, and quartz veins are a ubiquitous aspect of many tectonic settings. Most of HPQ is currently mined from granite pegmatites and hydrothermal vein quartz.

MODS Occurrences

There are 112 silicon occurrences in the MODS (102 primary), including 3 past producers and 6 developed prospects. In Newfoundland, silica-rich deposits occur in orthoquartzites of the Random Formation on the Avalon Peninsula (Jigging Cove–East Head), and in intermittent quartzite lenses that occur from Grey River to LaHune Bay (*e.g.*, Gulch Cove – 011P/11/Sia001). On the west coast, the Hawkes Bay Formation of the Labrador Group hosts the main deposits of silica occurring as quartzites (*e.g.*, Hawkes Bay – 012I/11/Sia001). Potential for quartz vein stockwork-style deposits exist in central Newfoundland at Jocko Pond near Dolland, and in the Garisson Hills within the Baie d'Espoir Group (*e.g.*, Dollard Brook Quartz No 1 – 011P/15/Sia001). High-purity silica in quartz veins occurs in southwestern Newfoundland at

Diamond Cove, and on the north coast in porphyritic granite (La Scie Quartz Vein – 002E/13/Sia001). Additionally, silica-rich sand deposits are found on the west coast in the Stephenville, Corner Brook and Deer Lake areas (*e.g.*, Batstone Quarry – 012A/13/Sia001).

In Labrador, silica deposits exist in the Wabush/Labrador City area within the Wishart (quartzite) Formation of the Knob Lake Group (*e.g.*, Roy's Knob – 023B/15/Sia003). Quartzites have also been mapped at Ramah Bay in northern Labrador. They are associated with a nearly 400-m-thick package of volcanic flows interbedded with quartzite, mudstone, and shale (*e.g.*, Reddick Bight – 014L/14/Sia003) that belong to the Reddick Bight Formation, the lowermost formation of the Ramah Group. Representative silicon/silica occurrences are included in Table 26 and illustrated in Figures 43 and 44.

Table 26. Representative silicon occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
Villa Marie – 001N/05/Sia002	Past Producer (Dormant)	Consolidated clastic sedimentary rocks	Estimated minimum quartzite reserves of 6.8 Mt averaging 9.7% SiO_2 (Butler and Green, 1976). 1.4 Mt of ore was mined from 1968–1987 (Kirby *et al.*, 1983)
Batstone Quarry – 012A/13/Sia001	Past Producer (Exhausted)	Unconsolidated surficial sand and gravel aggregate deposit	28 252 m^3 of silica sand were mined from 1981–1987 (Kirby *et al.*, 1983). Ricketts (1987) roughly estimated 367 500 m^3 of silica sand reserves based on aerial photo analysis
La Scie Quartz Vein – 002E/13/Sia001	Developed Prospect	Undivided minerals deposited from hydrothermal solutions	Ind. Res. of 747 368 t averaging 98.0% SiO_2, 1.2% Al_2O_3 and 0.33% total Fe (Butler and Howse, 1975)
Dicks Point – 012H/05/Sia001	Developed prospect	Consolidated clastic sedimentary rocks	Estimated 732 000 t of pyrometallurgical-grade quartzite grading 97.5% SiO_2 and 0.9% Al_2O_3 and 1.48 Mt of flux-grade quartzite grading 96.5% SiO_2 and 0.43% Fe_2O_3 (Butler, 1970)
Gulch Cove – 011P/11/Sia001	Developed Prospect	Undivided minerals deposited from hydrothermal solutions	Reserves estimated at 12.0 Mt grading 95.5% SiO_2 and 1.9% $A1_2O_3$ (Butler and Greene, 1976)
Fortune – 001M/04/Sia001	Developed Prospect	Consolidated clastic sedimentary rocks	8.04 Mt of material averaging 96.37% SiO_2, 1.53% Al_2O_3 and 0.49% Fe_2O_3 (Bartlett, 1967)
Jigging Cove-East Head – 001K/13/Sia002	Prospect	Consolidated clastic sedimentary rocks	15.0 Mt of silica is estimated in an 8 m thick quartzite averaging 96.5% SiO_2 (Harris and Andrews, 1997)
Dollard Brook Quartz No 1 – 011P/15/Sia001	Showing	Undivided minerals deposited from hydrothermal solutions	Several 10–15 m wide by 200 m long quartz veins occur along faults which cut the North Bay Granite (Blackwood, 1984)
Hawkes Bay (Gull Point) – 012I/11/Sia001	Showing	Metamorphic mineral deposit	Gross estimate of 500 000 t (Fong, 1968)
LABRADOR			
Roy's Knob – 023B/15/Sia003	Past Producer (Dormant)	Metamorphic mineral deposit	Reserves estimated at 5–6 Mt based on 10 DDH (Bartlett, 1997); the deposit was partially mined from 1999 to 2008, 54 000 t of quartzite were shipped in 2005 alone (Montague, 2007)
Fermont Highway Quartzite – 023B/15/Sia002	Developed Prospect	Metamorphic mineral deposit	Estimated 4 Mt at least of high purity silica reserves (>99.2% SiO_2) (Dean and Meyer, 1985)
2907 Hill – 023B/15/Sia001	Developed Prospect	Metamorphic mineral deposit	Deposit thickness suggested to be at least 45 m (possibly 100 m) and 750 m in diameter (Dean and Meyer, 1985)
M.E.O. Ridge – 023G/02/Sia001	Prospect	Metamorphic mineral deposit	One of many quartzite ridges that vary from 100 m to 3 km in length and from 10 to 700 m in width (Meyer and Dean, 1986)
Reddick Bight – 014L/14/Sia003	Showing	Undivided non-evaporitic precipitates	Silica content varies from 98.3% to 87.7% SiO_2, with an average of approximately 95% SiO_2 from 4 samples (Meyer and Dean, 1988)

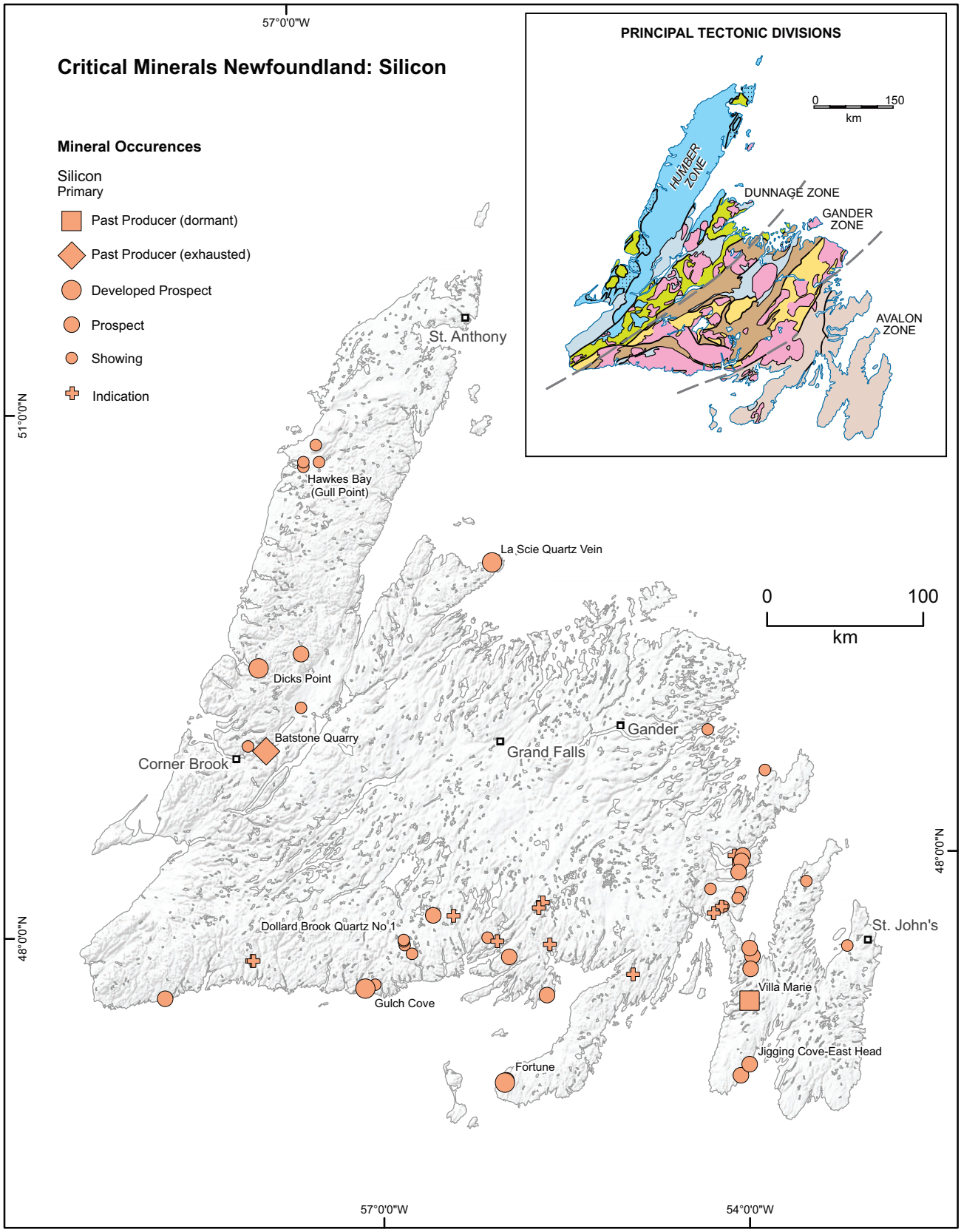

Figure 43. *Map showing the distribution of silicon occurrences in Newfoundland as well as illustrating all levels of development.*

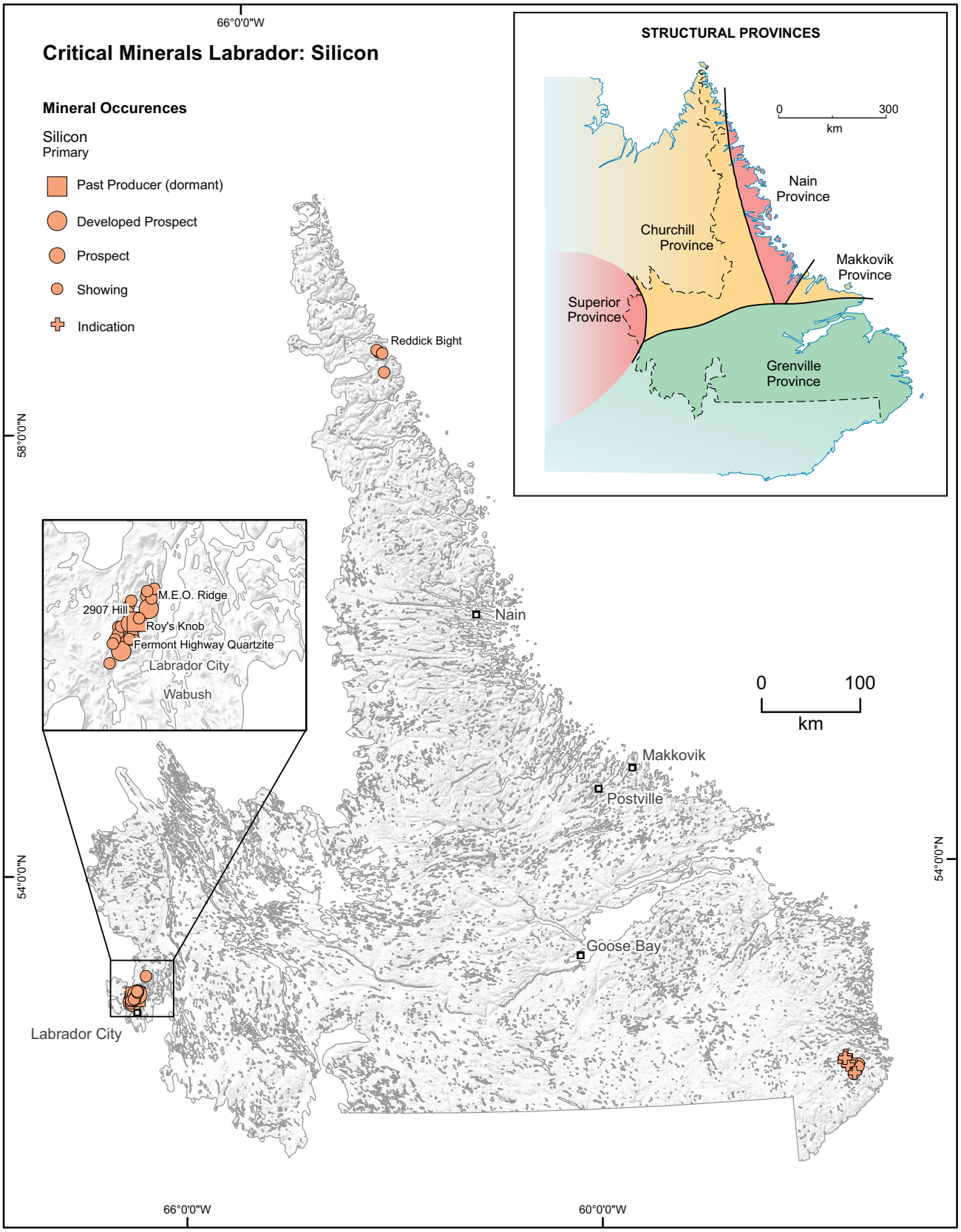

Figure 44. *Map showing the distribution of silicon occurrences in Labrador as well as illustrating all levels of development.*

TANTALUM (Ta)

Description

Tantalum is named after the Greek mythological figure Tantalus, a son of Zeus. It is a hard (Mohs hardness 6.5), dense, and silver-grey metal that is known as one of the five most refractory metals. As such it has a very high melting point and is highly resistant to acidic corrosion. Tantalum and niobium have similar physical and chemical characteristics, and the two elements occur together in the mineral columbite–tantalite (coltan). Tantalum has similar applications to niobium except that it is more widely used in electronics than in alloys; its chemical inertness and high melting point makes it a useful material for laboratory and industrial equipment. The main use for tantalum metal is in the production of electronic components and alloys.

Source Minerals

Columbite–tantalite (coltan), tantalite.

Uses

Electronic capacitors, alloys, telecommunications, data storage, refractory, implantable medical supplies, surgical blades.

Global Mine Production

Annual production of tantalum in 2024 was estimated at 2100 t (USGS, 2025). The top three producers were the Democratic Republic of Congo (880 t, 41.9%), Nigeria (390 t, 18.6%) and Rwanda (350 t, 16.7%).

Mineral Resource Supply and Demand Outlook

Current supplies in Australia, Brazil, Canada and China are expected to meet global demand (USGS, 2024).

Recovery

The refining of tantalum is one of the more demanding and complex separation process in industrial metallurgy due to refractory gangue minerals and elements, particularly niobium which it shares chemical properties with (Nzeh *et al.*, 2022).

Recycling

Tantalum recycled from scraps generated during the manufacturing of tantalum electronic components, cemented carbides and superalloys may account for as much as 30% of consumption by domestic (USA) facilities (USGS, 2023).

Geological Setting

Tantalum is an incompatible element in magmas and is commonly concentrated with niobium and REEs in highly fractionated peralkaline intrusions, *i.e.*, granites and pegmatites (*e.g.*, Tanco Mine), and in carbonatite intrusions (*e.g.*, Niobec Mine). In near surface environments, primary deposits are commonly enriched by weathering to form laterite and placer deposits.

MODS Occurrences

There are 2 tantalum occurrences in the MODS (secondary occurrences). In Labrador, prospective rocks/areas for tantalum include the peralkaline Strange Lake Complex, the Flowers River Intrusive Suite, the Fox Harbour area and the Central Mineral Belt (Letitia Lake, Red Wine Mountains, Aillik Domain). Additionally, the Porcupine Strand North Beach titanium-rich placer deposit located in southeast Labrador may hold potential for niobium–tantalum.

In Newfoundland, lake-sediment geochemistry shows high concentrations of tantalum along the South Coast, especially within the Gander and Avalon tectonic zones. This is reflected in rocks at the Kraken and Hydra occurrences near Burgeo which host tantalum mineralization in LCT pegmatites. All tantalum occurrences are listed in Table 27 and illustrated in Figures 45 and 46.

Table 27. Representative tantalum occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
Hydra – 011P/13/Cs 001	Prospect (Cs)	Magmatic – felsic intrusive (pegmatite)	5–6 m wide dyke: grab sample assayed 1.56% Cs_2O and 0.022% Ta_2O_5 (Sokoman press release, 2022)
LABRADOR			
Pope's Hill – 013F/04/Ree001	Prospect (REE)	Magmatic – pegmatite	196 ppm Ta assayed from grab sample in granite (Delazzer *et al.*, 2012)

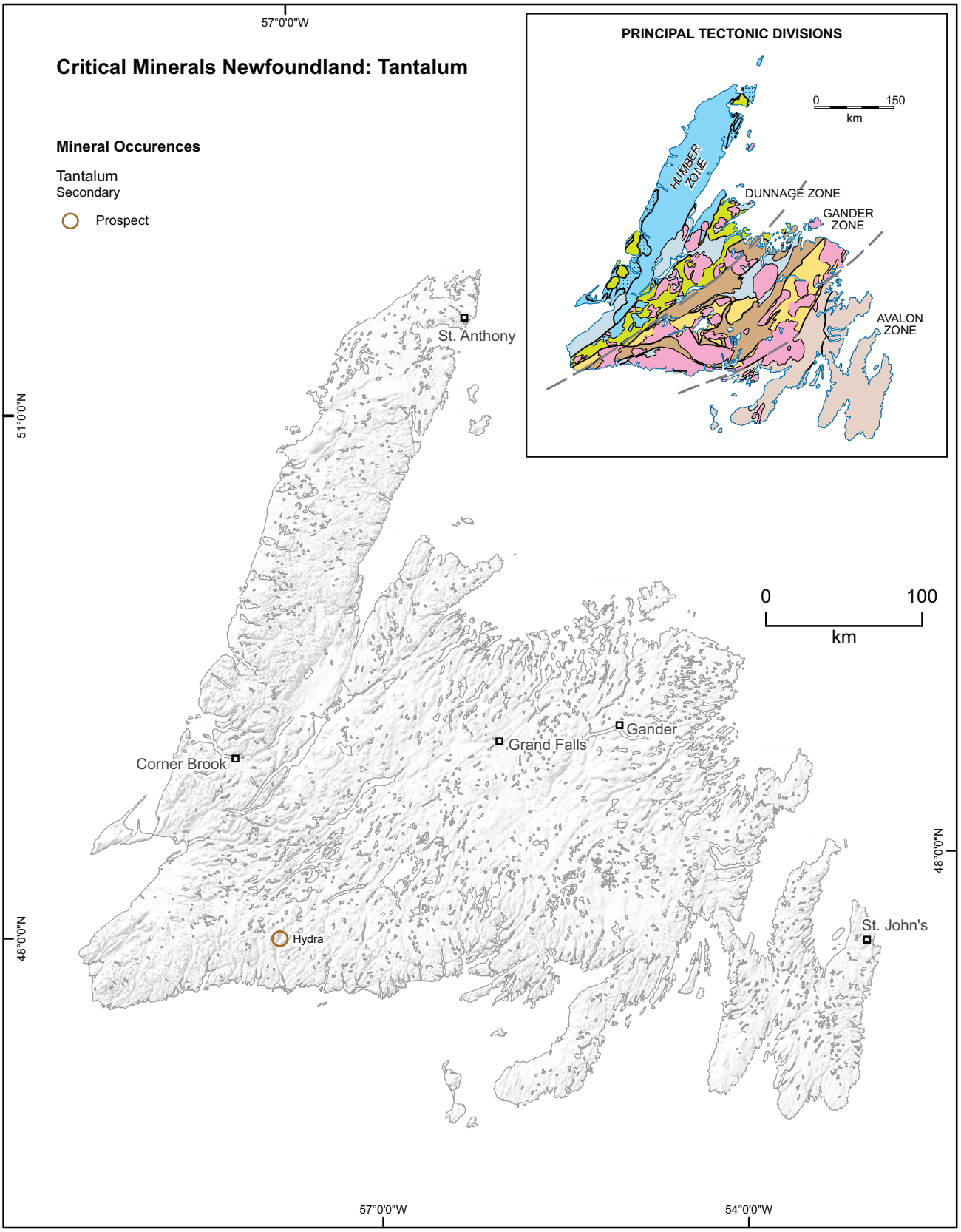

Figure 45. *Map showing the distribution of tantalum occurrences in Newfoundland as well as illustrating all levels of development.*

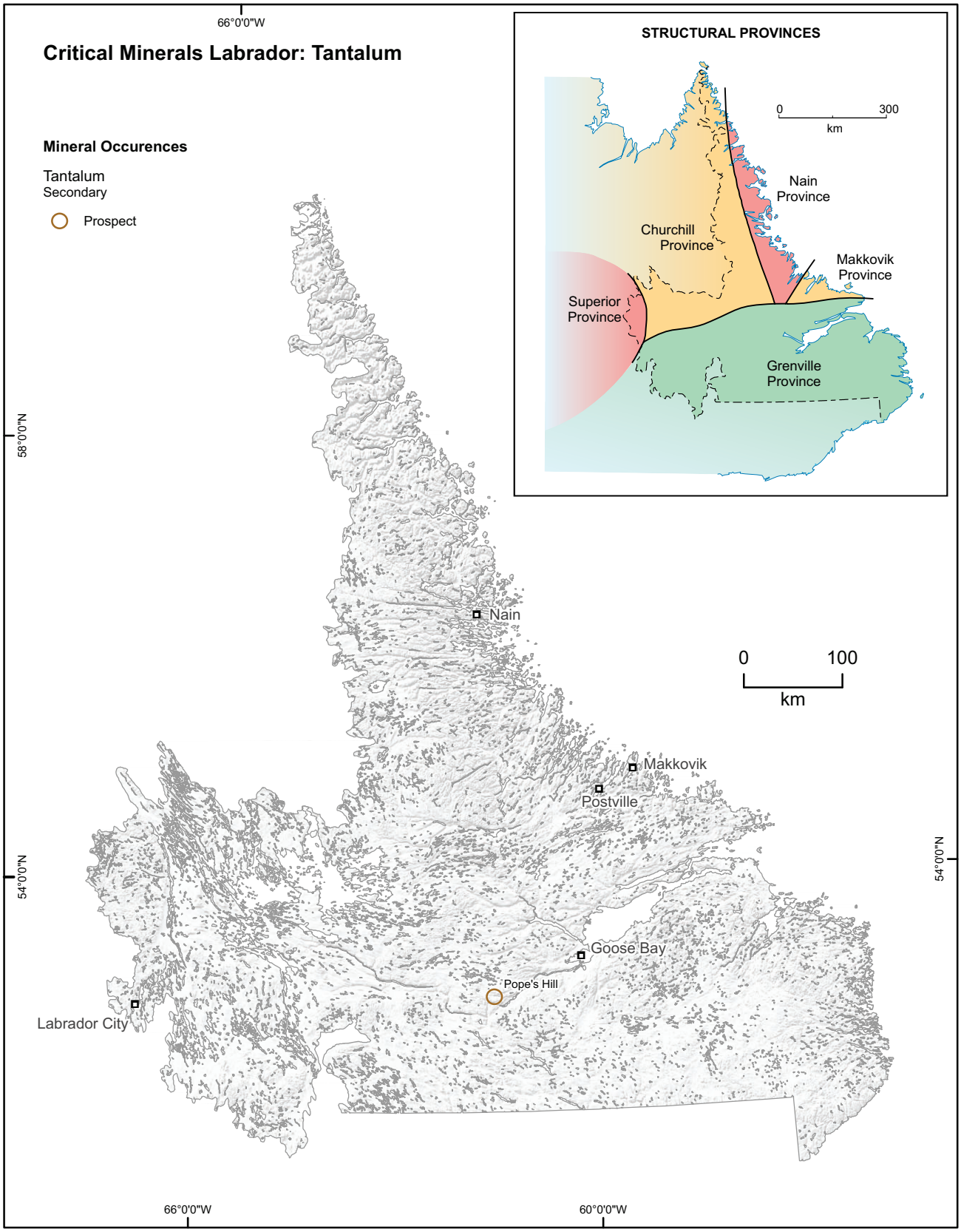

Figure 46. *Map showing the distribution of tantalum occurrences in Labrador as well as illustrating all levels of development.*

TIN (Sn)

Description

Tin is a soft, silvery-white, ductile, and highly crystalline metal that occurs as a native metal, but mainly as stannic oxide in the mineral cassiterite (SnO_2). Being highly malleable and non-toxic, it is suitable for all kinds of cold-working, such as rolling, spinning and extrusion. It resists corrosion from water but can be corroded by acids and alkalis, and can be used as a protective coat for other metals. Tin's abundance in the earth's crust is considered scarce but not rare. Most tin produced is consumed as solder, tin plating and metal alloys.

Source Minerals

Cassiterite, stannite, franckeite, canfieldite, teallite.

Uses

Solder, pigments, tin plating (food preservation), specialized alloys, cement, specialized glass, fire retardants, biocides and fungicides.

Global Mine Production

Annual production of tin in 2024 was estimated at 300 000 t (USGS, 2025). The top three producers were China (69 000 t, 23.0%), Indonesia (50 000 t, 16.6%) and Myanmar (34 000 t, 11.3%).

Mineral Resource Supply and Demand Outlook

Global tin resources were estimated at 15.4 Mt in 2019 (International Tin Association, 2020), and global tin reserves, a subset of the aforementioned figure, totalled 5.5 Mt. In 2020, the International Tin Association estimated 18 to 50 years of remaining consumption considering estimated resources and reserves and rates. During 2021–2022 tin prices reached historic highs above $40 000 per tonne; prices later fell by almost 12% in July of 2024, demonstrating the market's extreme sensitivity to supply–demand dynamics (Zadeh, 2025).

Recovery

Variability within tin ores related to grade, deposit type, texture and mineralogy requires tailored recovery methods for each deposit (*i.e.*, disseminated versus vein, or silicates versus sulphide ores).

Recycling

In the USA, 18 000 t of tin from old (recycled) and new scrap generated from manufacturing is estimated to have been recycled in 2022, most of which came from Canada (USGS, 2023).

Geological Setting

Primary tin deposits occur in magmatic–hydrothermal systems related to late-stage granitic phases and may be enriched in near-surface environments by weathering to form laterite and placer deposits. Fractional crystallization is the main process controlling the magmatic evolution of tin, and low oxidation states favour its incompatibility resulting in its concentration in liquid rather than solid phases (Zhan *et al.*, 2024). Low oxidation states in magmas may be indicated by the presence of ilmenite over magnetite. Although tin may become enriched in reduced magmas, precipitation of cassiterite minerals involve an oxidation reaction (Lehmann, 2021).

MODS Occurrences

There are 41 tin occurrences in the MODS (6 primary); all are in Newfoundland except for Flowers River South #28 (013N/11/Ree001). The latter is located within the Flowers River Intrusive Suite in northern Labrador where tin occurs associated to elevated rare-earth elements and within aplitic dykes; the dykes intrude peralkaline granites (Hill, 1991).

In Newfoundland, numerous tin prospects are located along the southern margin of the Ackley Granite; associated with late stage, highly evolved leucocratic granitic phases (Dickson, 1983; Tuach, 1996). Examples include greisenous zones at the Wylie Hill (001M/11Mo 005) and Moulting Pond South prospects (001M/10/Sn 002, 003, 008) where cassiterite occurs with molybdenite and fluorite at the contact zone between granite and the host metasediments. On the Burin Peninsula, up to 0.4 m-wide tin bearing quartz–pegmatite–magnetite veins occur in the St. Lawrence Granite (Lawn Fox Hummock #2). Representative tin occurrences are listed in Table 28 and illustrated in Figure 47.

Table 28. Representative tin occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
Moulting Pond Hill #1, #2 – (Dicks Pond West) 001M/10/Sn 001 and 002	Showing – Prospect	Magmatic – hydrothermal (greisen association)	Assays returned up to 3300 ppm Sn (Dickson and Howse, 1982)
Anesty Hill South – 001M/10/Mo 001	Prospect (Mo)	Undivided magmatic – hydrothermal deposit	Studies have interpreted these "quartzites" as being very large topazite greisen veins. An assay returned 103 ppm Sn (Dickson and Gibbons, 1983, Tuach, 1984)
Cochrane Pond C – 011P/14/W 001	Prospect (W)	Magmatic – hydrothermal (vein association)	Anomalous values (100 ppm Sn) were detected in quartz veins and aplite dykes cutting deformed unit near contact with Cochrane Pond Granite (Barry, 1980)
Lawn Fox Hummock #2 – 001L/14/Sn 001	Showing	Magmatic – hydrothermal (vein association)	Tin bearing quartz–pegmatite–magnetite veins occur in the St. Lawrence granite. A panned sample of crushed rock assayed 2000 ppm Sn. A block of float found north of the Three Sticks Pond assayed 15 000 ppm Sn (Davenport, 1978)
South Sage Pond – 001M/10/Fe 005	Showing (Fe)	Magmatic – hydrothermal (greisen association)	An altered granite dyke in the Devonian–Carboniferous Ackley City Granite assayed 372 ppm Sn (Dickson and Gibbons, 1983)
Dead Wolf Brook No 1 – 002D/10/Zn 001	Showing	Undivided magmatic – hydrothermal deposit	262 ppm Sn assay from massive sulphide vein in small granite body (Dean, 1978)
Bark Pond Rare Earth No 1 – 001M/10/Zr 001	Showing (Zr)	Magmatic – felsic intrusive	Peralkaline aplite veins that intrude peralkaline granite assayed up to 240 ppm Sn (Hopfengaerther, 1982)
Topsails Pb – 012H/02/Pb 001	Showing (Pb)	Undivided hydrothermal structurally controlled vein system	100 ppm Sn assayed from grey quartz with galena in granite (O'Reilly *et al.*, 2010)
LABRADOR			
Flowers River South #28 – 013N/11/Ree001	Showing (REE)	Insufficient data to classify	1460 ppm and 1490 ppm Sn assayed from 2 samples (Seymour *et al.*, 2008)

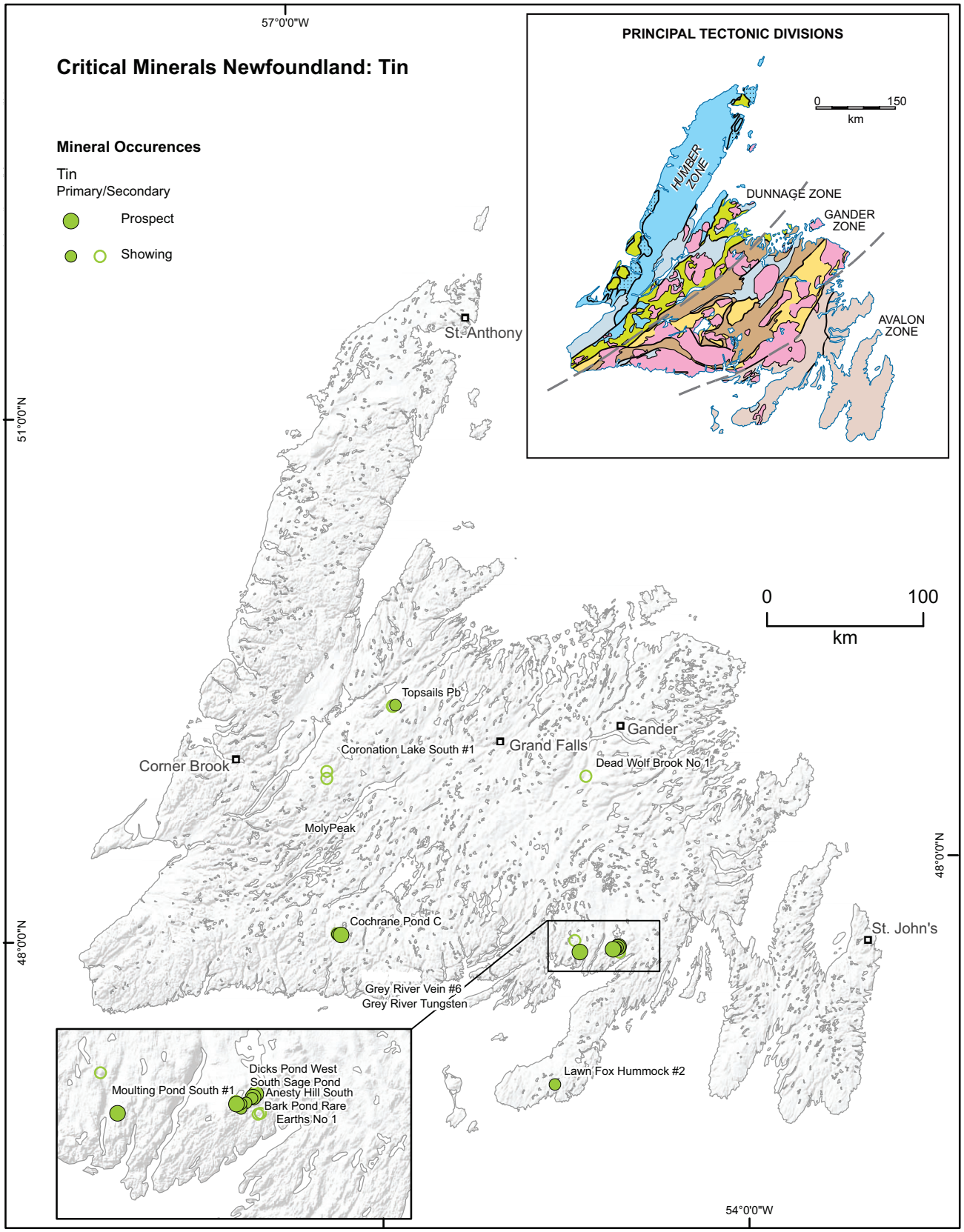

Figure 47. *Map showing the distribution of tin occurrences in Newfoundland as well as illustrating all levels of development above indication.*

TITANIUM (Ti)

Description

Titanium is a lightweight, hard, ductile metal resistant to corrosion and has the highest strength-to-density ratio of any element. It is silvery-grey and like magnesium and aluminum it oxidizes in air to form a non-porous passivation layer that protects it from further oxidation in many environments. It is abundant (9th most abundant element in the earth's crust) and occurs only as an oxide. Titanium and its compounds are an essential component of the modern industrial economy and used in a wide variety of applications from structural parts in the aerospace industry to pigments in paint; the most common compound, titanium dioxide (TiO_2), is a popular photocatalyst (converts light into chemical energy) and is used in the manufacture of white pigments.

Source Minerals

Rutile, ilmenite, leucoxene.

Uses

Alloy in steel and other metals, pigments in paints and plastics, parts for the aerospace and marine industry, paper, wind turbines, automotive industry parts, agent in graphite, medical parts, jewellry.

Global Mine Production

Annual production of ilmenite in 2024 was estimated at 8.9 Mt (USGS, 2025). The top three producers were China (3.3 Mt, 37.1%), Mozambique (1.9 Mt, 21.3%) and South Africa (1.3 Mt, 14.6%), with Canadian production amounting to 350 000 t (3.9%). Annual production of rutile in 2024 was estimated at 450 000 t (USGS, 2025). The top three producers were Australia (200 000 t, 44.4%), South Africa (100 000 t, 22.2%) and Sierra Leone (60 000 t, 13.3%).

Mineral Resource Supply and Demand Outlook

World resources of titanium (ilmenite, rutile, slag and synthetic rutile) were estimated at 2 billion tonnes (USGS, 2025). The titanium market now faces supply disruptions and regional deficits as geopolitical challenges and rising defence industry demands increase pressure; growth in regional dominance of the global pigment market has also driven supply deficits of high value titanium dioxide (The Oregon Group, 2025a).

Recovery

Titanium production is mainly divided into porous titanium metal "sponge", titanium oxide pigment, and titanium mineral concentrates used for the production of sponge, pigment, metal ingots and other titanium products.

Recycling

Recycled titanium can only be used for limited applications due to iron impurities. Development of new methods of recycling is expected to recover and produce more high-quality titanium from contaminated scraps (Takeda *et al.*, 2020).

Geological Setting

Titanium is primarily mined from the minerals ilmenite and rutile that occur in many different rock types. Economic deposits of titanium are typically associated with magmatic intrusions related to anorthosite, gabbro and norite. Titanium minerals may form economic concentrations in heavy-mineral placer deposits.

MODS Occurrences

There are 160 titanium occurrences in the MODS (60 primary). Titanium occurs in magmatic intrusions and in placer deposits. An abundance of titanium exploration targets exist in Labrador, predominantly associated with Fe–Ti bearing Mesoproterozoic and Paleoproterozoic mafic and ultramafic intrusions (*e.g.*, Nain Plutonic Suite, Harp Lake Intrusive Suite, intrusions in the Grenville Province). Magmatic intrusions in Labrador are the source for several titanium and heavy-mineral placer deposits that occur in the Lake Melville area and near Saglek Bay in northern Labrador. In Newfoundland, low-grade titanium ore has been estimated at the Lower and Upper Drill Brook Mine (012B/09/Fe 002, -003) and at the Indian Head Mine (012B/10/Fe 001) in association with iron-oxides in felsic and mafic gneisses. At the Keating/Four Corners prospect, titanium-vanadium mineralization occurs in magnetite and ilmenite within mafic intrusive rocks of the Puddle Pond Complex (012A/05/V 001). Representative titanium occurrences are listed in Table 29 and illustrated in Figures 48 and 49.

Table 29. Representative titanium occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
Upper/Lower Drill Brook Mine – 012B/09/Fe 002-003	Past Producer/ Dormant (Fe)	Magmatic – ultramafic-mafic intrusive (anorthosite association)	Deposit estimated at 51 300 t; avg. grade for 3 samples is 4.67% TiO_2 (Heyl and Ronan, 1943)
Bishop North/South – 012B/08/Fe 001-002	Past Producer/ Dormant (Fe)	Magmatic – ultramafic-mafic intrusive (anorthosite association)	Estimated combined resource of 1.04 Mt grading 7.25% Ti for Bishop North and South (Baird, 1943)
Indian Head Mine – 012B/10/Fe 001	Past Producer/ Dormant (Fe)	Magmatic – ultramafic-mafic intrusive (anorthosite association)	Considerable low-grade tonnage was estimated with an average grade of 0.5% Ti (Rose, 1973)
Fox Island River Area – 012B/10/Cr 001	Developed Prospect (Cr)	Placer	Total Inf. Res. of 351 Mt of heavy mineral sands containing 12–53% ilmenite (Hicks, 2011; Scott *et al.*, 2006)
Keating Prospect/Four Corners – 012A/05/V 001	Prospect (V)	Magmatic – mafic intrusive	A weighted avg. of 5.08% TiO_2 was assayed from a 217 m intersection in DDH (French *et al.*, 2010)
LABRADOR			
Churchill River Mineral Sands – 013F/08/Fe 001	Developed Prospect (Fe)	Placer	Meas. and Ind. Resource. of 259 Mt of 9.43 wt. % heavy mineral concentrate sands; Fe–Ti mineral species are reported to typically account for 20–30% of the *in-situ* mineral suite (Pittman, 2014); TiO_2 grading up to 13.5% (Emory-Moore and Meyer, 1991)
Porcupine Strand North Beach – 013I/03/Ti 001	Developed Prospect	Placer	Inf. Res. of 30 Mt grading 2.0% ilmenite (4.6% TiO_2 when considering Ti-enriched hematite) (Emory-Moore and Meyer, 1991; Szabo 1992)
Iron Strand South Beach – 014M/12/Gnt001	Developed Prospect (garnet)	Placer	Total Meas. Res. of 512 150 t onshore + 348 750 t offshore, with approx. 14 wt. % titanium (Hora and Hansink, 2001)
Nain Bay South #2 – 014C/12/Ti 003	Showing	Magmatic – mafic intrusive	Schlieren of massive ilmenite (± magnetite) with about 20% hypersthene are hosted by coarse-grained, light grey anorthosite of the Nain Plutonic Suite; grab sample returned 41.5% TiO_2 (Beavan, 1954)

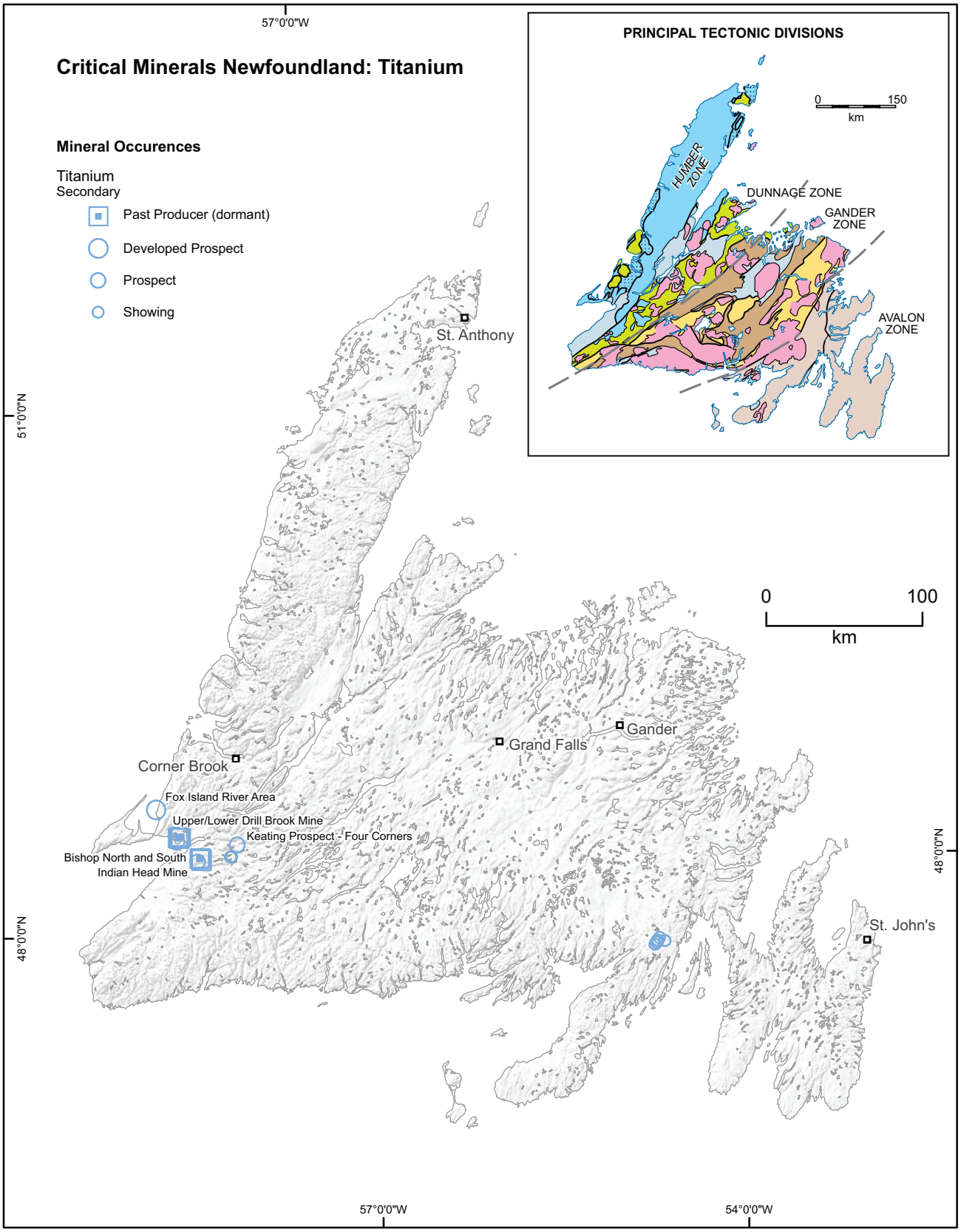

Figure 48. *Map showing the distribution of titanium occurrences in Newfoundland as well as illustrating all levels of development above indication.*

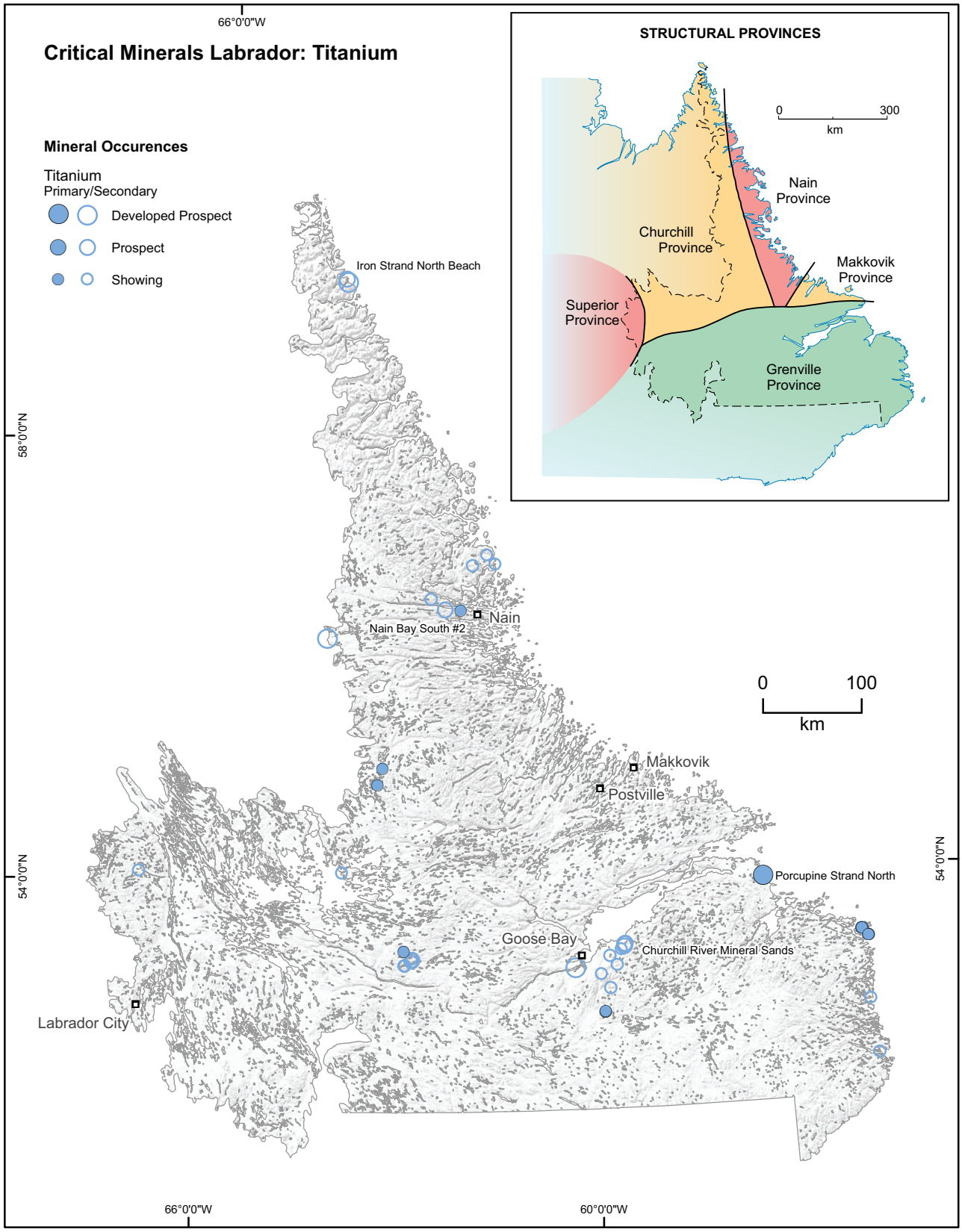

Figure 49. *Map showing the distribution of titanium occurrences in Labrador as well as illustrating all levels of development above indication.*

TUNGSTEN (W)

Description

Tungsten is silver to greyish white, it has high-density and high-strength, is one of the five most refractory metals, and has the highest melting point of any metal. Tungsten does not occur as a free element; although it occurs as tungstenite (WS_2), the most important ores are tungstates such as scheelite ($CaWO_4$) and wolframite, the latter is a mineral composed of the solid-solution between ferrous tungstate ferberite ($FeWO_4$) and manganese tungstate hübnerite ($MnWO_4$). In many European countries tungsten is known as "wolfram", derived from the mineral wolframite, and is the reason W is used as the chemical symbol. Approximately half of the tungsten produced is consumed for use in hard materials, namely tungsten carbide, a material with a hardness close to diamond.

Source Minerals

Scheelite, wolframite (ferberite–hübnerite).

Uses

Tungsten-carbide tools, lightbulb filaments, electronic circuits, wires and electrodes.

Global Mine Production

Annual production of tungsten in 2024 was estimated at 81 000 t (USGS, 2025). The top three producers were China (67 000 t, 82.7%), Vietnam (3400 t, 4.2%) and Russia (2000 t, 2.5%).

Mineral Resource Supply and Demand Outlook

Future demand is expected to increase based mostly on the increase in consumption of cemented carbide. Tungsten supply is expected to increase based on new mines becoming operational; there were 2 new mines added in Australia recently and the Sangdong Mine in the Republic of Korea. Additional projects outside China were awaiting funding for further development (USGS, 2025).

Recovery

Processing of tungsten ores happens in many stages and eventually results in tungsten oxide (WO_3). It is then heated with hydrogen or carbon to produce powdered tungsten.

Recycling

The amount of tungsten produced and consumed from secondary sources is poorly constrained (USGS, 2025).

Geological Setting

Tungsten is commonly associated with highly fractionated granitoid rocks of peraluminous composition. Magmatic–hydrothermal enrichments occur specifically within greisen zones located in the roof of intrusions; some deposits are zoned, with mineralization emplaced in veins and pegmatites occurring less frequently away from the source pluton. Tungsten, tin, and occasionally bismuth, commonly occur together in porphyritic sheeted veins and stockwork deposits, and tungsten and tin are sometimes spatially associated with porphyry molybdenite mineralization. Tungsten mineralization is also commonly associated with skarn deposits where carbonate rocks serve as chemical traps for hot, metal-enriched magmatic fluids.

MODS Occurrences

There are 83 tungsten occurrences in the MODS (48 primary), including one developed prospect; all occurrences are located in Newfoundland. There is a spatial association between molybdenum and tungsten, and the latter is most prevalent in the Gander and western Avalon tectonic zones in Newfoundland. Tungsten mineralization is best known in the Grey River area on the south coast where an inferred 18.8 Mlbs WO_3 deposit is located (Grey River Tungsten). The deposit is interpreted to have formed by multiple stage hydrothermal events and consists of wolframite and scheelite bearing quartz veins emplaced in altered metasediments (Higgins and Kerrich, 1985).

In the Granite Lake area, tungsten occurs as wolframite in sheeted quartz veins hosted within a subunit of the North Bay Granite. Tungsten mineralization occurs at the Charles Cove prospect (002E/08/W 001), where sporadic scheelite occurs in one of three generations of quartz veining hosted within the Devonian Charles Cove Granodiorite. The Great Gull Lake Tungsten

(002D/03/W 001) and Baie d'Espoir Highway Quarry (002D/06/W 001) occurrences consist of scheelite hosted in a calc-silicate horizon within sedimentary rocks of the Davidsville Group and in leucocratic quartz–granite veins intruding the Davidsville Group; the veins are likely related to the Middle Ridge Granite (Robertson, 1985). Representative tungsten occurrences are listed in Table 30 and illustrated in Figure 50.

Table 30. Representative tungsten occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assays Samples
NEWFOUNDLAND			
Grey River Tungsten – 011P/11/W 001	Developed Prospect	Magmatic – hydrothermal (vein)	Inf. Res. of 1.17 Mt grading 0.73% WO_3 at 0.2% cutoff (Moore, 2008b; Moreton, 2007)
Grey River Vein #6 – 011P/11/W 002	Prospect	Magmatic – hydrothermal (veins)	Four separate DDH with best WO_3 intersections: 0.55% over 0.9 m, 0.4% over 0.4 m, 0.19% over 1.3 m, 0.19% over 1.0 m (Moore, 2008b)
Charles Cove – 002E/08/W 001	Prospect	Magmatic – hydrothermal (veins)	A grab sample returned 2.81% WO_3 in quartz vein (O'Toole, 1970)
Great Gull Lake Tungsten #2 – 002D/03/W 001	Prospect	Undivided magmatic deposit	6 kg assay sample with two horizons combined resulted in 0.55% W (Robertson, 1986; Kohlsmith, 1986)
Granite Lake Molybdenum #1 – 012A/02/Mo 001	Prospect (Mo)	Undivided magmatic hydrothermal deposit	Two channel assays returned values of 710 ppm W and 1110 ppm Mo over 5.0 m and 476 ppm W and 2100 ppm Zn over 5.5 m (Tuach, 1996)
Granite Lake Tungsten #10 – 012A/02/W 010	Showing	Magmatic – hydrothermal (vein association)	A grab sample from a quartz vein crosscutting a two mica granite yielded 1.98% W (Dimmell, 1979)
Granite Lake Road – 012A/02/W 001	Showing	Magmatic – hydrothermal (vein association)	A quartz vein crosscutting foliated granodiorite assayed 1.45% WO_3 over 0.82 m and 2.32% WO_3 over 0.2 m (Bucknell, 1981)
Baie d'Espoir Highway Quarry – 002D/06/W 001	Showing	Undivided magmatic – hydrothermal deposit	Avg. of 27 mineralized vein channel samples from swarm of scheelite-bearing veins covering an area at least 200 by 300 m assayed 1.79% WO_3; a 0.9 m section in DDH assayed 2.77% WO_3 (Robertson, 1986; Kohlsmith, 1986)

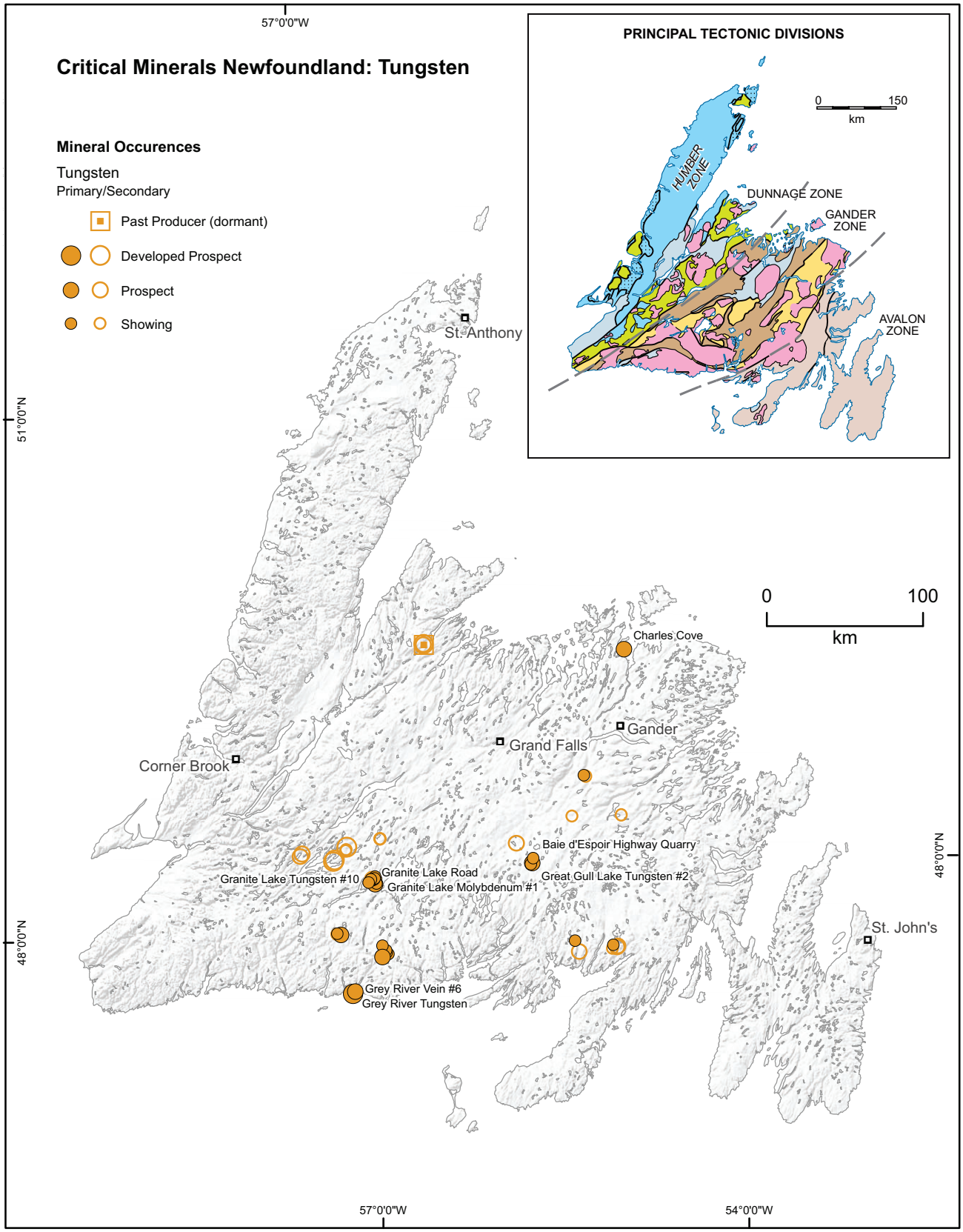

Figure 50 *Map showing the distribution of tungsten occurrences in Newfoundland as well as illustrating all levels of development above indication.*

URANIUM (U)

Description

Uranium is a weakly radioactive, silvery-white metal that has the highest atomic weight of the 83 primordially occurring elements (elements that have existed since before the Earth was formed). It is malleable, ductile and a poor conductor of electricity; it occurs most often as the mineral uraninite. Uranium is the only element that has a naturally occurring isotope that can undergo nuclear fission (uranium-235(U^{235})). Uranium-238 (U^{238}) is the most common uranium isotope, and uranium-235 (U^{235}) used in nuclear power plants only forms about 0.7% of all uranium isotopes, not enough to supply the needs for power generation and requiring the enrichment of uranium-238 (U^{238}) to reconcile the shortfall. Depleted uranium (by-product of the uranium enrichment process) is a dense, mildly radioactive metal that is used primarily in military applications for its high density, hardness (when alloyed to other metals) and pyrophoricity (spontaneous combustion). Depleted uranium is more effective than lead at blocking radiation and is used as a shielding materiel in containers for transporting radioactive materials.

Source Minerals

Uraninite (pitchblende), coffinite, brannerite, carnotite, torbernite.

Uses

Energy, munitions, historically used in photographic chemicals, dentures, glass and pottery.

Global Mine Production

Annual production of uranium in 2022 was approximately 49 355 t. The top three producers were Kazakhstan (21 227 t, 45%), Canada (7351 t, 12%) and Namibia (4693 t, 10%) (World Nuclear Association, 2024). Statistics Canada estimated Canadian production at 15 952 t for 2024.

Mineral Resource Supply and Demand Outlook

Global demand for uranium is forecasted to increase in the next decade as some countries are expected to shift to nuclear energy to curb greenhouse gas emissions. Current supplies are expected to fall short of rising demand and new assets will be required to fill the shortfall (World Nuclear Association, 2024).

Recovery

The biggest challenge in the recovery of uranium is the health risk posed by the exposure to radiation from very high-grade ores.

Recycling

Used nuclear fuel may be reprocessed for providing new fuel for existing and future power generation.

Geological Setting

Uranium is a common accessory mineral in magmatic intrusions and volcanic rocks. It is characterized as an incompatible element of the high-field-strength elements (HFSE) and as such gets concentrated in residual (evolved) magmas. Uranium is highly mobile and its behaviour in magma, rocks and the environment is strongly controlled by redox conditions. It is found in a wide range of deposit types; deposits commonly form by the fixing (reducing) of uranium circulating in fluids through porous or fractured rock. Mined deposit types include unconformity, detrital quartz–pebble conglomerate, breccia complexes, sandstone-hosted, magmatic/volcanic − magmatic−hydrothermal, IOCG, metamorphic and metasomatic. Syngenetic enrichments also occur in black shales and lignite (coal) deposits where carbonaceous material acts as reductant for uranium.

MODS Occurrences

There are 329 uranium occurrences in the MODS (294 primary), including 11 developed prospects. In Labrador, the bulk of occurrences are located within the Central Mineral Belt (CMB) and most are located within supracrustal rocks (metavolcanic and sedimentary) of the Moran Lake, Post Hill, Aillik and Bruce River groups and associated intrusive rocks, including pegmatites, aplites and leucocratic granites.

Uranium in metre-scale pegmatitic dykes and sheets of leucogranite that intrude Archean basement rocks are the oldest known U-mineralization in the region (1870 Ma; Ketchum *et al.*, 2001), located within the southern Nain and northern Makkovik provinces (*e.g.*, Dandy –

013O/04/U 006, Kanairiktok Bay –013O/04/U 007). Epigenetic magmatic-style U-mineralization occurs in Archean basement rocks (*e.g.*, Anomaly no 7 – 013K/11/U 001) and is characterized by intense hematitic alteration developed within or marginal to fracture zones with a close relationship to structural lineaments. Some of the highest-grade mineralization known in the CMB is of this type and is located in boulders at the Melody Hill prospect (013J/12/U 027).

Volcanic-hosted uranium without widespread alteration occurs within network-style fractures and permeable layers of the Bruce River Group. The mineralization is interpreted to have formed from the late remobilization of U from surrounding volcanic rocks (Sparkes, 2017). Volcanic-hosted uranium with widespread metasomatism occurs in intermediate to felsic metavolcanic rocks of the Aillik Group, the same group that hosts the 22.2 Mlbs Michelin Deposit (013J/12/U 001: Agnerian, 2006). The deposit is hosted in variably porphyritic metavolcanic rocks affected by pervasive Na-metasomatism and moderate to strong hematitic alteration.

Metasedimentary-hosted, structurally controlled U-mineralization is found at the High-grade Kitts deposit (up to nearly 20% U_3O_8 – 013J/14/U 001) within a shear zone and developed in an argillitic horizon of the Post Hill Group (Evans, 1980), as well as in rocks of the Moran Lake Group, interpreted as the stratigraphic equivalent of the Post Hill Group on the western side of the CMB (Armstrong – 013K/07/U 009). Also in that area, U-mineralization shares close spatial association with the unconformable contact between the Moran Lake and Bruce River groups at the Moran Lake C-Zone (013K/07/U 002), and is generally hosted in reduced sandstones and interbedded pebble conglomerate layers in an otherwise oxidized sedimentary sequence (Sparkes, 2017). The Moran Lake Group is host to hydrothermal breccia-hosted mineralization in pillow basalts associated with iron metasomatism and locally developed along structural conduits, it displays many common characteristics of IOCG-style mineralization (Sparkes, 2017).

In Newfoundland, many of the uranium occurrences are located within sandstone and limestone rocks of the Carboniferous Deer Lake Basin and Bay St. George subbasin, the metasedimentary and metavolcanic rocks of the Hermitage Flexure, and peralkaline intrusions of the Topsails Intrusive Suite. Known mineralization styles within the basins vary from seemingly stratabound and syngenetic (North Brook – 012H/04/U 003), to structurally remobilized or unconformity related (*e.g.*, Lost Pond – 012B/09/U 001), with highest concentrations (up to 11.5% U3O8) located within boulders (Wigwam Brook – 012/06/U 001). In the Bay St. George subbasin specifically, mineralization is known to be localized in coal fragments and fossil wood (Grand Codroy River No 4 – 011O/14/U 005). At a different occurrence (Portland Creek – 012I/03/U 001), a series of highly anomalous soils recently assayed up to 7.5% U3O8 at the contact zone between the Precambrian Grenville Inlier and Ordovician carbonate rocks (Infini Resources, 2025). The soils are coincident with a structural corridor and a 3.2 km long radiometric anomaly. The Hermitage Flexure contains U-mineralization in association with the volcano-sedimentary sequence of the Bay du Nord Group (*e.g.*, He2 – 011P/13/U 004, Main Showing – 011P/13/U 004). Representative uranium occurrences are listed In Table 31 and illustrated in Figures 51 and 52.

Table 31. Representative uranium occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
Doucette – 011P/14/U 004	Prospect	Undivided stratabound volcanic-related uranium deposit	Values ranging from 0.13% to 1.32% U_3O_8 from chip samples. Six of the samples contained over 0.67% U_3O_8 (Hutchings *et al.*, 2006)

Wigwam Brook – 012H/06/U 001	Showing	Stratabound sandstone-hosted uranium deposit	Values up to 1.28% U_3O_8 in chip samples, boulder assayed 11.5 % U_3O_8 (Byrne, 1979a)
Lost Pond – 012B/09/U 001	Showing	Structurally controlled unconformity - related uranium deposit	Values up to 1.68% U_3O_8 in schist with tuffaceous volcanic interbeds and cut by quartz veins (Penney *et al.*, 2008)
Grand Codroy River No 4 – 011O/14/U 005	Showing	Stratabound sandstone-hosted uranium deposit	U mineralization localized in organic rich nodules and veins occurs in conglomerate horizons, nodules and veins constitute <1% of conglomerate; a grab sample returned 2.2% U (Sherwin, 1981)
North Brook 3 – 012H/04/U 003	Showing	Stratabound argillite-hosted uranium deposit	Uraniferous nodules and veins of organic rich material occur in calcareous mudstone, U mineralization also occurs in limestone and red siltstone. Grab samples of organic rich material assayed up to 3.73% U_3O_8, 1.05% Cu and 65.9 g/t Ag (Froude, 2007)
He2 – 011P/14/U 005	Showing	Vein-hosted; volcanic	U mineralization in fine-grained quartzite and metasediments interbedded with felsic volcanic units; mineralized boulders returned 2.79% and 1.64% U_3O_8 (Kahlert and Hitchcock, 2007)
Main Showing – 011P/13/U 004	Showing	Undivided stratabound volcanic-related uranium deposit	U mineralization is restricted to metasediments and metavolcanics of the Bay du Nord Group; grab sample assayed 2.88% U and 1400 g/t Mo (Smeltzer and Kahlert, 2006)
LABRADOR			
Michelin Deposit – 013J/12/U 001	Developed Prospect	Stratabound volcanic-related uranium deposit	Estimated Meas. and Ind. Res. of 84.1 Mlbs U_3O_8 (Barrett *et al.*, 2014)
Two Time – 013K/11/U 005	Developed Prospect	Magmatic – felsic intrusive	Estimated resource of 3.16 Mt grading 0.053% U_3O_8 (Sparks and Wallis, 2009)
Moran Lake C-Zone – 013K/07/U 002	Developed Prospect	Undivided hydrothermal, structurally-controlled deposit	Estimated Ind. Res. of 5.19 Mlbs U_3O_8 + Inf. Res. of 4.44 Mlbs U_3O_8 (Gillies *et al.*, 2009)
Nash Lake (Main Zone) – 013J/13/U 006	Developed Prospect	Stratabound volcanic-related uranium deposit	Meas. + Ind. Res. – Underground: 152 000 t grading 0.06% U_3O_8, open pit: 527 000 t grading 0.09% U_3O_8 (Hertel *et al.*, 2009)
Gear Lake – 013J/13/U 010	Developed Prospect	Sandstone-hosted	Meas. + Ind. Res. – Underground: 303 000 t grading 0.08% U_3O_8, open pit: 48 000 t grading 0.06% U_3O_8 (Hertel *et al.*, 2009)
Burnt Lake North (Main Zone) – 013J/12/U 012	Developed Prospect	Stratabound volcanic-related uranium deposit	Estimated 140 000 t grading 0.082% U_3O_8 (Cunningham-Dunlop *et al.*, 2006)
Inda Lake – 013J/13/U 009	Developed Prospect	Sandstone-hosted	Ind. Res. of 2.037 Mlbs U_3O_8 + Inf. Res. of 4.538 Mlbs U_3O_8 (Gillies *et al.*, 2009)
Jacques Lake – 013J/12/U 018	Developed Prospect	Insufficient data to classify	Meas. + Ind. Res. – Underground: 1.76 Mt grading 0.08% U_3O_8, open pit: 5.13 Mt grading 0.07% U_3O_8 (Hertel *et al.*, 2009)
Area 1 – 013K/07/U 007	Developed Prospect	Stratabound volcanic-related uranium deposit	Estimated Inf. Res. of 0.48 Mlbs U_3O_8 (Gillies *et al.*, 2009)
Rainbow Deposit – 013J/12/U 008	Developed Prospect	Stratabound volcanic-related uranium deposit	Meas. + Ind. Res. – Underground: 26 000 t grading 0.06% U_3O_8, open pit: 947 000 t grading 0.09% U_3O_8 (Hertel *et al.*, 2009)
Kitts – 013J/14/U 001	Developed Prospect	Argilite-hosted	Estimated resource of 203 880 t grading 0.57% U_3O_8 (Meyer and Wagg, 1968)

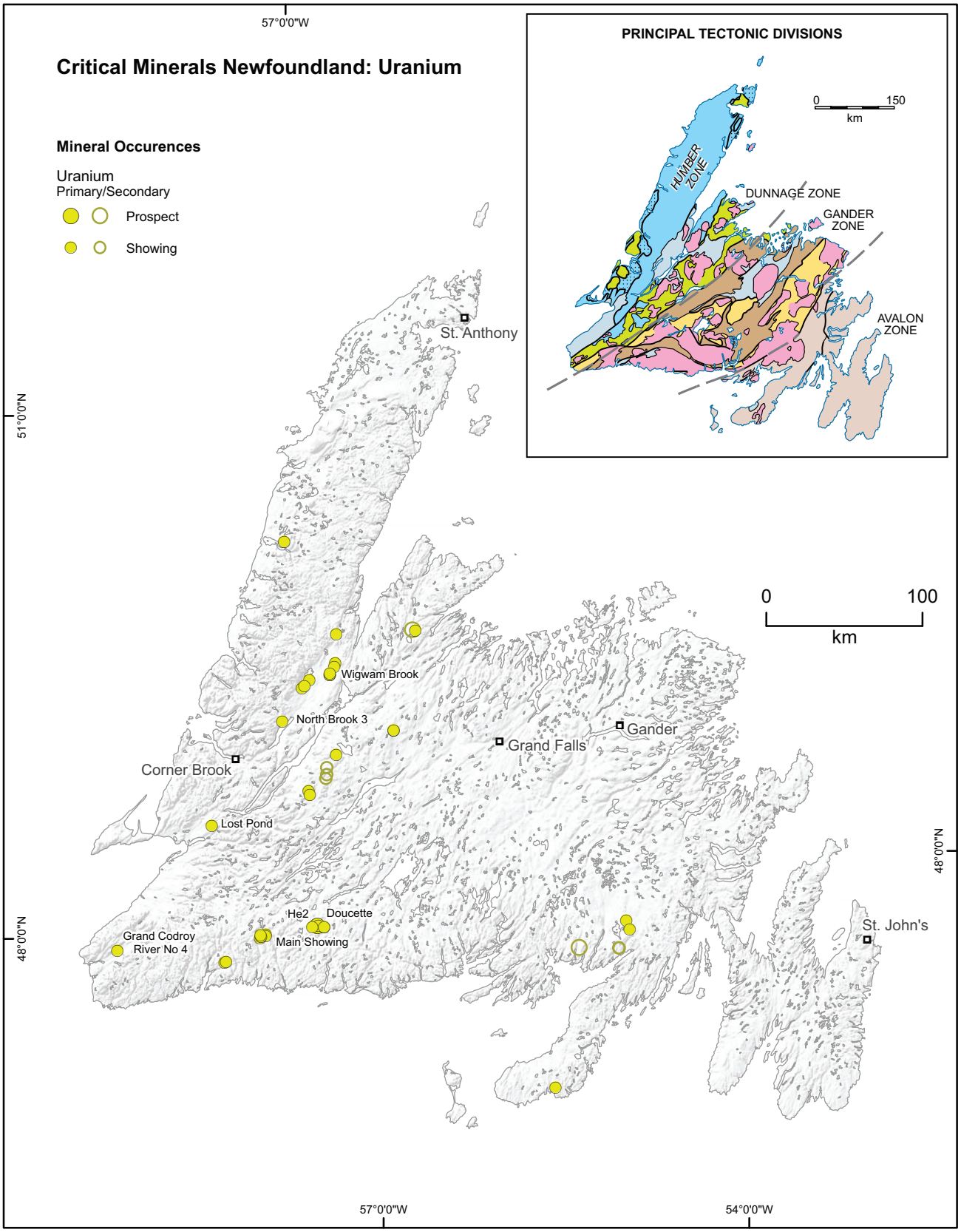

Figure 51. *Map showing the distribution of uranium occurrences in Newfoundland as well as illustrating all levels of development above indication.*

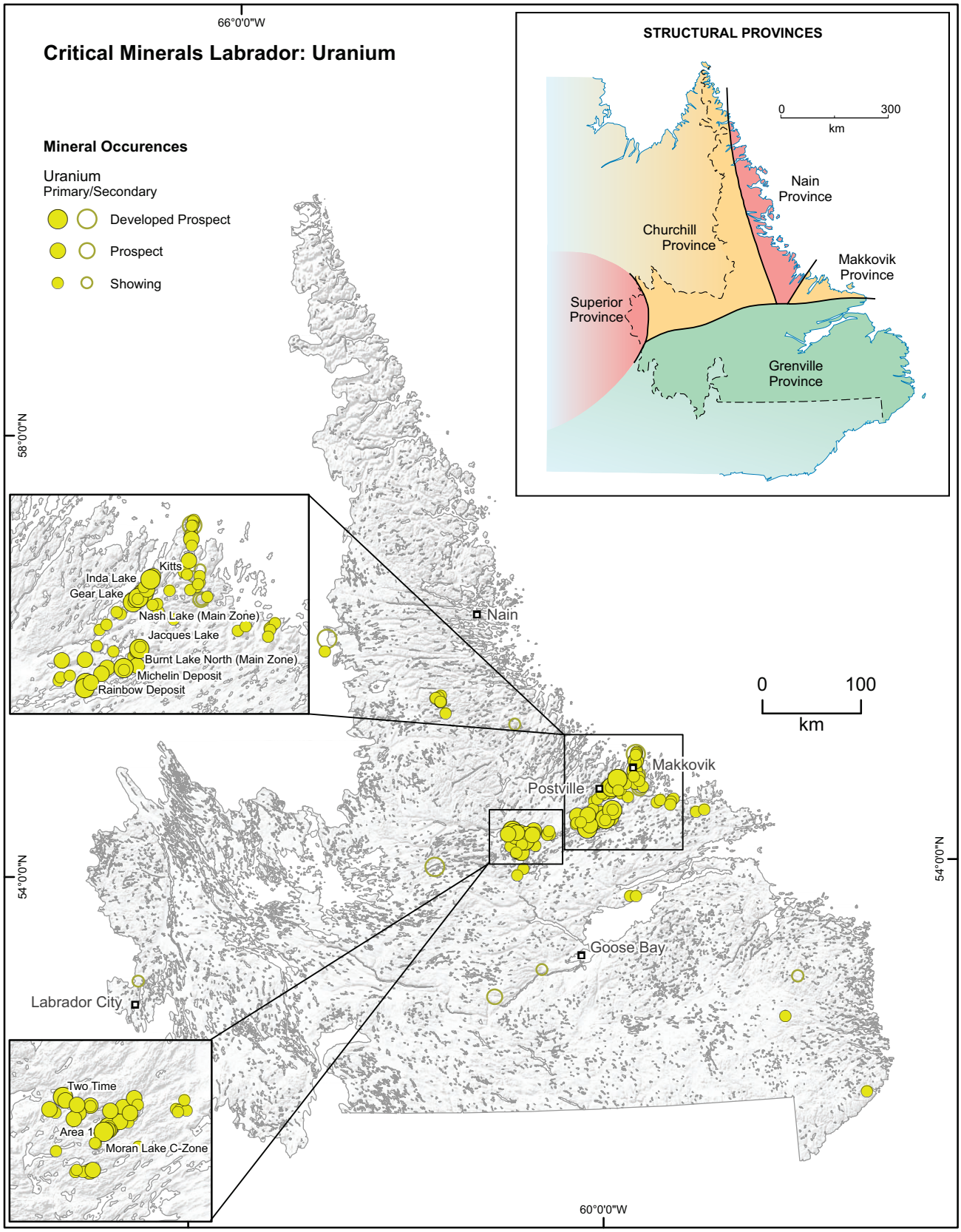

Figure 52. *Map showing the distribution of uranium occurrences in Labrador as well as illustrating all levels of development above indication.*

VANADIUM (V)

Description

Vanadium is a soft, ductile, steel blue metal that has a Mohs hardness value of 6.7 and a good resistance to corrosion. Based on the wide range of colours found in vanadium compounds it was named after the Scandinavian goddess of beauty and fertility, Vanadis (Freyja); in aqueous solution, vanadium complexes of varying oxidation states appear as lilac, green, blue and yellow. Vanadium is a widely distributed element in the earth's crust that occurs in various types of deposits and in over 65 minerals. Native vanadium is rare; most vanadium is sourced from vanadium-bearing magnetite. It is also recovered in bauxite and crude oil. Approximately 85% of vanadium is used as ferrovanadium or as a steel additive for enhancing its strength and hardness.

Source Minerals

Magnetite, ilmenite, clay minerals (bauxite and laterite), fossil fuels, vanadinite.

Uses

High-temperature alloys, catalyst for manufacturing sulphuric acid and other substances, batteries, corrosion protection.

Global Mine Production

Annual production of vanadium in 2024 was estimated at 100 000 t (USGS, 2025). The top three producers were China (70 000 t, 70%), Russia (21 000 t, 21%) and South Africa (8000 t, 8.0%).

Mineral Resource Supply and Demand Outlook

Resources of vanadium are in excess of 63 Mt, substantially exceeding the current needs (USGS, 2025). The market base is expected to grow rapidly due to the increase in the use of vanadium for redox flow batteries (Simandl and Paradis, 2022).

Recovery

Environmental concerns constrained earlier recovery methods (*e.g.*, sodium roasting); newer methods avoid this problem but are energy intensive. Overall, vanadium recovery is a process that is still underdeveloped (Liu *et al.*, 2022).

Recycling

Recycled vanadium sources mainly consist of reprocessed vanadium catalysts. The range in vanadium concentrations in spent catalysts varies significantly (USGS, 2023).

Geological Setting

Vanadium is widely distributed in igneous and sedimentary rocks as a mildly incompatible, refractory and lithophile element, but concentrated mineral deposits are rare (Huang *et al.*, 2015). The main types of deposits are magmatic vanadiferous titanomagnetite (VTM), sandstone-hosted and uranium sandstone-hosted, shale-hosted and base-metal vanadium deposits, which share spatial and genetic relationships with carbonate hosted Pb–Zn deposits. (Kelley *et al.*, 2017). Other types include vanadate deposits (VO^{3-}_4), they typically form in the oxidized zones of copper–lead–zinc deposits (*e.g.*, Otavi Mountainland, Namibia), and although not as common, placer deposits can represent valuable resources of VTM minerals (Waiuku Black Sands, New Zealand). Vanadium also occurs in bauxite, coal, and crude oil deposits.

MODS Occurrences

There are 28 vanadium occurrences in the MODS (5 primary), including 2 developed prospects; most occurrences are recorded in the MODS as a secondary commodity. In western Newfoundland, vanadium at the Keating Prospect (012A/05/V 001) is found in mafic intrusive rocks of the Silurian Puddle Pond Complex, where it occurs associated with disseminated to semi-massive magnetite and ilmenite. Elsewhere in western Newfoundland, coarse-grained titaniferous magnetite dykes crosscut the Steel Mountain Anorthosite Suite (*e.g.*, Hayes Prospect – 012B/08/Fe 004) and have returned up to 0.28 % V (Baird, 1943). Vanadium also occurs in 1- to 12-cm-thick iron oxide rich lenses within high grade metamorphic gneisses; the latter is interpreted as being genetically related to the anorthosite portion of Indian Head Range in western Newfoundland (Rose, 1973).

In Labrador, vanadium (VTM) is known to be associated with numerous Fe–Ti-bearing mafic and ultramafic intrusions and anorthositic complexes of the Mesoproterozoic Nain Plutonic Suite,

the Harp Lake Intrusive Suite, and the Michikamau Intrusive Suite. Additionally, the Grenville Province is host to numerous anorthositic complexes that hold potential for hosting VTM. Vanadium is associated with uranium in sandstone-hosted and breccia mineralization at the Moran Lake C-Zone developed prospect (013K/07/U 002) in the Central Mineral Belt, and VTM also occur in heavy mineral placer deposits in the Lake Melville area (Churchill River Mineral Sands) and near Saglek Bay (Porcupine Strand North – 013I/03/Ti 001). Representative vanadium occurrences are listed in Table 32 and illustrated in Figures 53 and 54.

Table 32. Representative vanadium occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

Name/NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
Upper/Lower Drill Brook Mine – 012B/09/Fe 002, -003	Past Producer (Fe – Dormant)	Magmatic – ultramafic-mafic intrusive (anorthosite association)	Estimated resource of 51 300 t; avg. grade from 3 samples is 0.23% V (Heyl and Ronan, 1943)
Bishop North/South – 012B/08/Fe 001-002	Past Producer (Fe – Dormant)	Magmatic – ultramafic-mafic intrusive (anorthosite association)	Estimated combined resource of 1.04 Mt grading 0.23% V for Bishop North and South (Baird, 1943)
Indian Head Mine – 012B/10/Fe 001	Past Producer (Fe – Dormant)	Magmatic – ultramafic-mafic intrusive (anorthosite association)	Considerable low-grade tonnage was estimated with an average of 1.0% V (Rose, 1973)
Keating Prospect/Four Corners – 012A/05/V 001	Prospect	Undivided magmatic mafic intrusive	Weighted avg. of 0.12% V_2O_5 from a 217 m section of drill core (French and Mugford, 2013)
Hayes Prospect – 012B/08/Fe 004	Prospect (Fe)	Magmatic – ultramafic-mafic intrusive (anorthosite association)	Ore reserves were estimated at 9000 t (Baird, 1943), later figures estimated 27 000 t; magnetic concentrate of titaniferous magnetite sampled from vein/dyke returned 0.2% V (Byrne, 1979b)
Long Pond #2 – 012B/08/V 002	Showing	Magmatic – ultramafic-mafic intrusive	Vanadium bearing titanomagnetite assayed 0.211% V_2O_5 in coarse grained gabbro with 50% magnetite (Burt, 2019)
LABRADOR			
Moran Lake C-zone – 013K/07/U 002	Developed Prospect (U)	Hydrothermal-structurally controlled deposit	Estimated Ind Res. of 11.76 Mt grading 0.181% V_2O_5, and Inf. Res. of 24.22 Mt grading 0.171% V_2O_5 at 0.15% cutoff (Wallis *et al.*, 2011)
Area 1 – 013K/07/U 007	Developed Prospect (U)	Undivided stratabound volcanic-related uranium deposit	NI 43-101 Inf. Res. of 1.00 Mlbs of V (Gillies *et al.*, 2009)
Croteau West – 013K/06/U 010	Showing (U)	Structurally controlled unconformity related deposit	Up to 0.803% V_2O_5 was assayed in a grab sample from a deformed iron formation at unconformable contact between shale and slate of the Warren Creek Formation (Froude *et al.*, 2006)
Riviere St. Augustin #1 – 013B/11/Cu 001	Showing (Cu)	Insufficient data to classify	Grab samples from gossan assayed up to 0.23% V in planar vein/joints hosted in gabbro (Lyons, 2016)
Magnetite Lake – 013L/04/Fe 001	Showing (Fe)	Undivided ultramafic-mafic magmatic deposit	Oxide-rich rocks from the Michikamau Anorthosite contain as much as 1.5% V_2O_5 (Emslie, 1970)

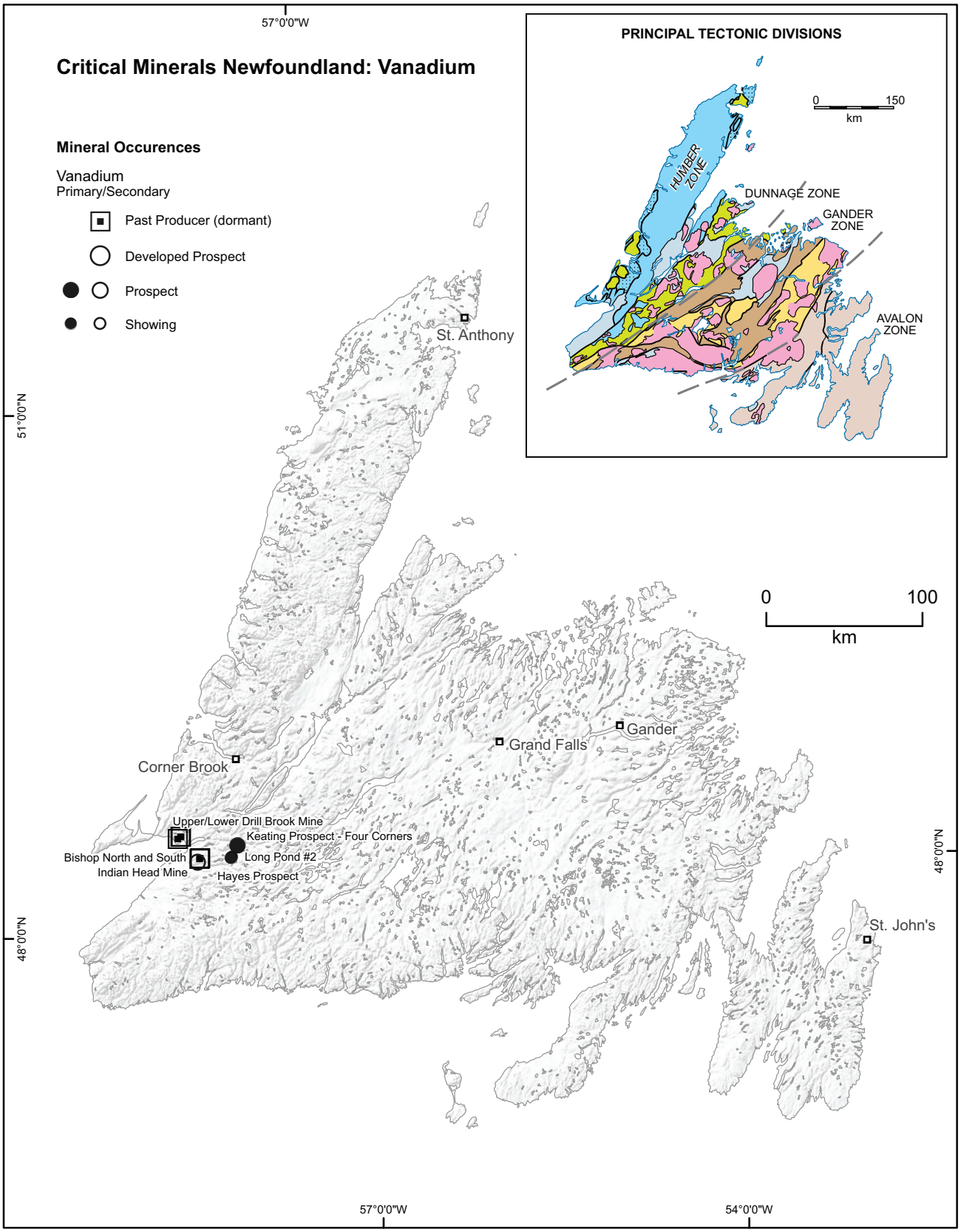

Figure 53. *Map showing the distribution of vanadium occurrences in Newfoundland as well as illustrating all levels of development above indication.*

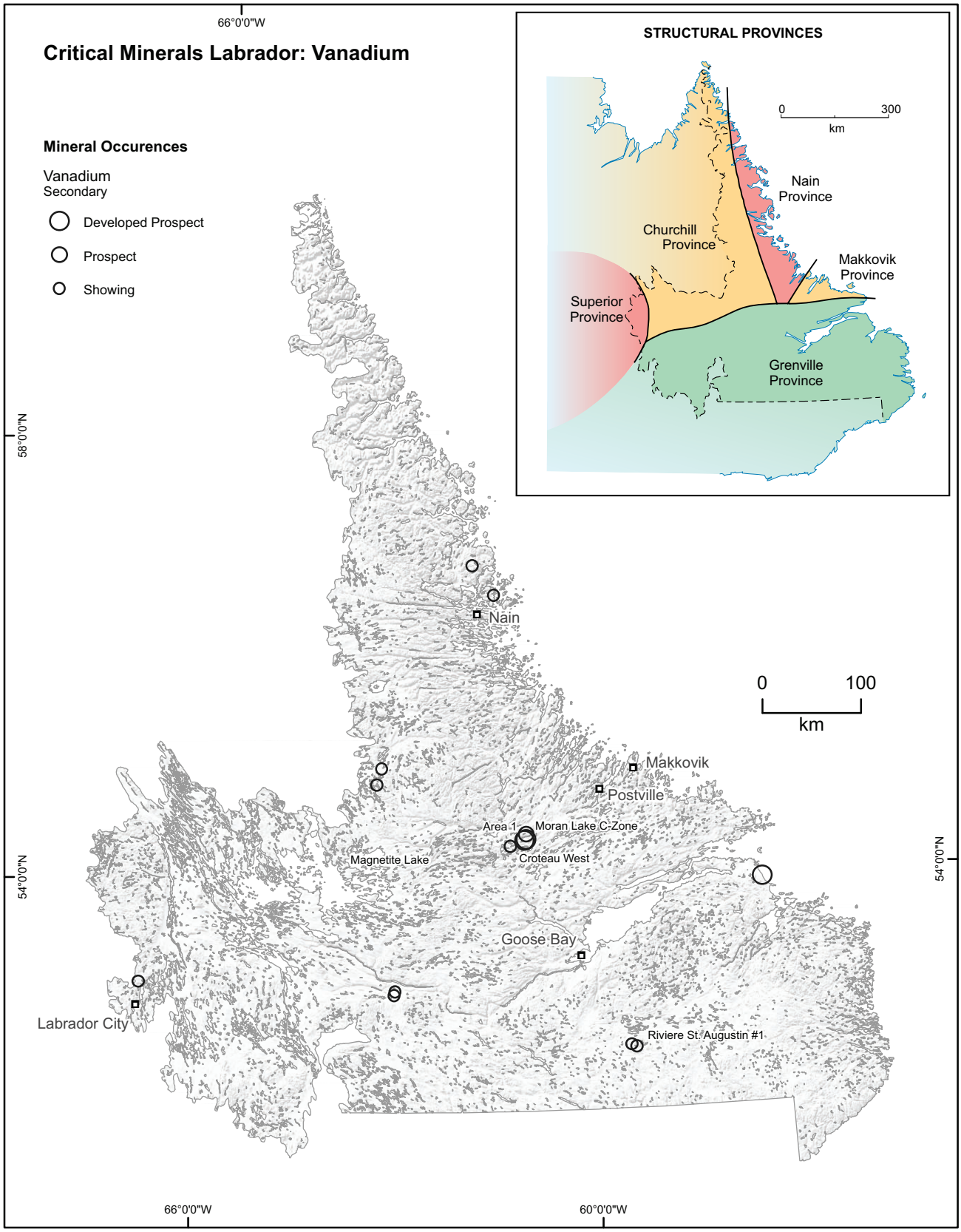

Figure 54. *Map showing the distribution of vanadium occurrences in Labrador as well as illustrating all levels of development above indication.*

ZINC (Zn)

Description

Zinc is a transition metal that is brittle below 100°C, and bluish-white when freshly cut but which oxidizes quickly to form a dull greyish film. It is diamagnetic (repelled by magnetic fields), and has the lowest melting point of all transition metals, while being better than iron, but inferior than aluminum at conducting electricity. As a transition metal, it readily forms complex compounds with other elements such as sulphur, copper and lead. Zinc is the fourth most used metal after iron, aluminum, and copper; and is mostly used for anti-corrosive galvanization of iron and steel.

Source Minerals

Sphalerite, zincite, hemimorphite, smithsonite.

Uses

Corrosion protection, alloyed in brass and bronze, fertilizers, batteries, solar panels, wind turbines.

Global Mine Production

Annual production of zinc in 2024 was estimated at 12 Mt (USGS, 2024). The top three producers were China (4.0 Mt, 33.3%), Peru (1.3 Mt, 10.8%) and Australia (1.1 Mt, 9.2%). Statistics Canada estimated Canadian production at 129 202 t for year 2024.

Mineral Resource Supply and Demand Outlook

Identified zinc resources worldwide are estimated at 1.9 billion t (USGS, 2025). Long term supply and demand is difficult to predict partly due to rapidly evolving green technologies (Mohr *et al.*, 2018) and the possibility of zinc replacing lithium in lithium ion batteries (Lionetto *et al.*, 2024).

Recovery

Nearly all commercially produced zinc is from sulphidic ores and most often mixed with copper, lead and iron.

Recycling

Approximately 34% of zinc production originates from recycled or secondary zinc (International Zinc Association, 2022).

Geological Setting

Zinc is mined globally in a wide variety of settings and occurs in association with lead, with 90% of global zinc supply hosted in four broad types, defined by Redmond (2023) and listed in order of importance as shale-hosted massive sulphide (SHMS), volcanogenic massive sulphide (VMS), carbonate replacement deposits (CRD) and Irish-type/Mississippi Valley (IT/MVT). However, ore deposit classification is a complex and challenging subject and classifications are not always clear-cut or universally agreed upon (Redmond, 2023). Leach *et al.* (2010) separates sediment hosted Pb–Zn deposits into two major sub-types: clastic dominated lead–zinc (CD Pb–Zn) ores, and Mississippi Valley-type (MVT Pb–Zn) with Irish-type considered as a subset of MVT deposits. CD Pb–Zn deposits include those that have been traditionally referred to as sedimentary exhalative (SedEx) and occur in passive margins, back-arc and continental rift tectonic settings. MVT Pb–Zn deposits occur in platform carbonate sequences, typically in passive margin tectonic settings (Redmond, 2023).

MODS Occurrences

There are 786 zinc occurrences in the MODS (368 primary), with 53 past producing deposits, and 37 developed prospects. Like copper, zinc has had a long mining history in the province and was the most produced non-ferrous metallic commodity in Newfoundland from 1928 to 1990. Two significant types of zinc deposits occur in Newfoundland, VMS and carbonate-hosted Pb–Zn deposits.

The volcanic terranes of the Dunnage Zone in central Newfoundland host polymetallic VMS deposits (*e.g.*, Duck Pond – 012H/09/Cu 018, Lundberg Zone – 012A/15/Zn 019, Old Buchans Main – 012A/15/Zn 009, Lemarchant – 012A/10/Zn 012). Lead and zinc mineralization is generally associated with the mature-arc and continental-rift association, but also

with mixed mafic/felsic sequences in the primitive-arc association. VMS deposits include genetically related stringer-stockworks, massive sulphide and debris-flow deposits.

Carbonate-hosted Pb–Zn deposits are hosted in Cambro-Ordovician carbonate platform rocks in western Newfoundland. The largest known deposit is the past producing Daniel's Harbour Mine (*e.g.*, Daniel's Harbour Mine A-Zone – 012I/06/Zn 001) which produced about 7 Mt of zinc ore between 1975 and 1990, and which consists of a stratabound epigenetic secondary void filling deposit. Other smaller deposits and prospects have been identified in similar geological settings across western Newfoundland (*e.g.*, Round Pond – 002E/05/Cu 008, Twin Ponds No 2 –002D/15/Po 001, Salmon River No 6 – 012P/01/Zn 006) and previous work has suggested these occurrences are geologically similar to the Daniel's Harbour Mine deposits (Conliffe *et al.*, 2018). Additionally, zinc mineralization has been recorded in Neoproterozoic felsic volcanic rocks in the western Avalon Tectonic Zone (*e.g.*, Winter Hill – 001M/12/Zn 002).

In Labrador, potential for VMS deposits exist within the Archean Florence Lake and Hunt River greenstone belts of eastern Labrador, and in the Paleoproterozoic volcanic rocks of the Blueberry Lake Group in western Labrador. Local galena–sphalerite veins in volcanic rocks (*e.g.*, Big Bight Vein #2 – 013O/02/Pb 001) occur in the Central Mineral Belt within the Makkovik Province. Representative zinc occurrences are listed in Table 33 and illustrated in Figures 55 and 56.

Table 33. Representative zinc occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources
NEWFOUNDLAND			
Duck Pond Deposit – 012A/09/Zn 010	Past Producer (Dormant)	VMS – mafic/felsic (stockwork?)	In 2007 the mine was projected to produce 4.1 Mt of ore grading 3.3% Cu and 5.7% Zn (Whitford *et al.*, 2007). Total milled ore by Teck Resources from 2007 to 2015: 5.0 Mt avg. 4.4% Zn, 2.7% Cu, 0.6 ppm Au and 53 ppm Ag (Canadian Zinc Corporation, 2015)
Buchans Deposits – Historical Mining Camp	Past Producer (Dormant)	VMS – mafic/felsic (stockwork and breccia)	From 1927 to 1984 approximately 16.1 Mt of ore averaging 14.51% Zn, 7.56% Pb, 1.33% Cu, 126 ppm Ag was mined from the Buchans deposits (Kirkham, 1987)
Lundberg Zone – 012A/15/Zn 019	Past Producer (Dormant)	VMS – felsic (stockwork)	Ind. Res. of 16.8 Mt grading 1.53% Zn, 0.42% Cu, 0.64% Pb, 5.69 ppm Ag and 0.07 ppm Au (Canterra Minerals, 2023)
Buchan's River Delta Tailings – 012A/15/Ba 002	Past Producer (Dormant)	Undivided minerals deposited from hydrothermal solutions	Total tailings reserve estimated at 1.9 Mt grading 2.21% Zn, 39.8% $BaSO_4$, 0.65% Pb, 0.36 % Cu, 0.96 ppm Au and 37.2 ppm Ag (Collins and Legrow, 1989)
Point Leamington Deposit – 002E/05/Zn 001	Developed Prospect	VMS – mafic (stockwork)	Ind. Res. of 14.1 Mt grading 1.9% Zn, 0.42% Cu, 0.02% Pb, 1.07 ppm Au and 17.12 ppm Ag (Callinex, 2021)
Tulks East Deposit – 012A/11/Zn 002	Developed Prospect	VMS – mafic/felsic (stockwork)	A-zone estimated resource of 4.3 Mt grading 2.92% Zn, 0.41% Cu, 0.22% Pb and 14.7 ppm Ag (Banville *et al.*, 1998)
Lemarchant – 012A/10/Zn 012	Developed Prospect	VMS – felsic (epiclastic)	Ind. Res. of 2.42 Mt grading 6.15% Zn, 0.68% Cu, 1.6% Pb, 1.22 ppm Au, 64.0 ppm Ag and 23.5% barite (Cullen *et al.*, 2018)

Boomerang/Domino – 012A/06/Zn 008 and 009	Developed Prospect	VMS – felsic (epiclastic)	Boomerang: Ind. Res. of 1.36 Mt grading 7.1% Zn, 3% Pb, 0.51% Cu, 1.66 ppm Au, 110.2 g/t Ag and 1.6 ppm Au; Domino Inf. Res. of 411 200 t grading 6.3% Zn, 2.8 % Pb, 0.4% Cu, 0.94 ppm Ag and 0.6 ppm Au (De Mark and Dearin, 2007)
Bobby's Pond Deposit – 012A/10/Zn 001	Developed Prospect	VMS – felsic (epiclastic)	Ind. Res. of 1.095 Mt grading 4.61% Zn, 0.86% Cu, 0.44% Pb, 16.56 ppm Ag and 0.02 ppm Au (Wilson, 2008)
Daniels Pond – 012A/10/Zn 009	Developed Prospect	VMS – felsic (stockwork)	Ind. Res. of 929 000 t grading 5.1% Zn, 2.5% Pb, 0.3% Cu, 0.6 ppm Ag and 101.4 ppm Au (Canterra Minerals Corporation, 2023)
Strickland - Silver Hill Zone – 011O/16/Zn 002	Developed Prospect	VMS – felsic (stockwork)	750 000 t grading 2% combined Zn–Pb (Prince, 1981)
Strickland - Main Zone – 011O/16/Zn 001	Developed Prospect	VMS – felsic (stockwork)	260 000 t grading 5.25% combined Zn+Pb and 195 ppm Ag (Prince, 1981)
Tulks Hill Deposit – 012A/11/Zn 001	Developed Prospect	VMS – mafic/felsic (volcanogenic stockwork?)	Ind. Res. of 430,200 t grading 4.0% Zn, 1.6% Pb, 0.9% Cu, 35.1 ppm Ag and 1.2 ppm Au (Agnerian, 2008)
Lochinvar/Rendell-Jackman Property – 012H/09/Zn 003	Developed Prospect	VMS – mafic/felsic stockwork)	588 000 t grading 3.9% Zn, 1.4% Pb, 0.4% Cu, 60 ppm Ag and 0.45 ppm Au (Lebel, 2010). Drilling in 2020 intersected 7.62% Zn, 0.73% Cu and 3.33% Pb over 11.6 m (Maritime Resources, 2020)
Lake Bond – 012H/01/Zn 001	Developed Prospect	VMS – mafic/felsic (volcanogenic stockwork)	Estimated resource of 1.2 Mt grading 2.12% Zn and 0.31% Cu + possible 1.4 Mt grading 2.06% Zn and 0.29% Cu (Harris, 1976)
Long Lake Deposit – 012A/06/Zn 004	Developed Prospect	VMS – felsic (epiclastic)	NI 43-101 Ind. Res. of 407 000 t grading 7.8% Zn, 0.97% Cu, 1.6% Pb, 49 ppm Ag, and 0.6 ppm Au + Inf. Res. of 78 000 t grading 0.7% Cu, 5.8% Zn, 1.2% Pb, 34 ppm Ag and 0.5 ppm Au (Keller *et al.*, 2012)
Round Pond Deposit – 012P/08/Zn 015	Developed Prospect	Epigenetic stratabound deposit in carbonate rocks	Outlined mineralized zone is 250 m long by 50 m wide and 11.3 m thick with estimated resource of 400 000 t grading 2.0% Zn (Gize *et al.*, 1982)
Clementine Prospect – 012A/15/Zn 006	Developed Prospect	VMS – mafic/felsic (breccia)	363 000 t grading 4.9% Zn, 2.6% Pb, 0.3% Cu and 10.3 ppm Ag (Calhoun and Hutchinson, 1981)
Sandfill Prospect – 012A/15/Zn 011	Developed Prospect	VMS – mafic/felsic (breccia)	80 000 t grading 9.2% Zn, 1.4% Cu, 4.8% Pb, 2.5 oz/t Ag and 0.02 oz/t Au (Barnes and Entwistle, 1971)
Mary March Zone – 012A/15/Zn 002	Prospect	VMS – mafic/felsic (epiclastic)	DDH intersected massive sulphide zone containing avg 10.1% Zn, 1.68% Pb, 0.64 % Cu, 122.1 ppm Ag and 4.2 ppm Au (Jagodits and Thurlow, 2000)
Nancy April – 012A/15/Zn 021	Prospect	VMS – mafic/felsic (volcanogenic stockwork?)	Significant intersection in DDH include avg 3.02% Zn, 1.08% Pb, 0.13% Cu and 172.4 g/t Ag over 20.6 m (Waldie, 2004) and 1.00% Zn, 0.04% Cu and 0.50% Pb over 18.9 m (Greene and Wolfson, 2013)
Goodyear Prospect – 012B/11/Pb 001	Prospect	Epigenetic stratabound veins in carbonate rocks	Zinc sulphide occurs principally as finely colloform banded, brown sphalerite with bladed structure normal to banding (Dickie *et al.*, 1975)

Winter Hill – 001M/12/Zn 002	Prospect	VMS – mafic/felsic (volcanogenic stockwork)	Best results from 9 holes: 11.0 m intersection with 6.17% Zn, including 4.0 m with 10.1% Zn and 6.0 m with 1.41% Cu (Graves, 1986; Simpson, 1990)
Salmon River #6 – 012P/01/Zn 006	Prospect	Stratabound epigenetic secondary void filling deposit in carbonate rocks	Grab samples of sphalerite-rich pseudobreccias have Zn contents ranging from 10.49 to 20.04 wt. % Zn (Conliffe *et al.*, 2018)
Isle aux Morts Prospect-Twin Ponds – 011O/10/Zn 001	Prospect	VMS – mafic/felsic (volcanogenic stockwork?)	The semi-massive mineralization grades between 10–20% combined Zn–Pb with a 2:1 (Zn to Pb) ratio, as well as 0.15% Cu and 0.50 oz/T (15.53 g/t) Ag (Thicke and Yee, 1990)
LABRADOR			
Green Pond No 1 – 013K/10/Zn 001	Prospect	Undivided hydrothermal structurally controlled vein system	Two subparallel quartz veins 8.1 m apart host galena, sphalerite and chalcopyrite; 3 grab samples yielded 6.5%, 5.3% and 17.9% Zn (Moore, 1954)
Martin Lake North No 1 – 023J/16/Zn 001	Prospect	Shale-hosted deposit	Up to 6.0% Zn and 0.5% Cu reported in impure marble (Grant, 1971). An assay from the Martin Lake area returned 155 ppm Zn, 2680 ppm Cu, and 2.2 ppm Ag (Hoag, 1971)

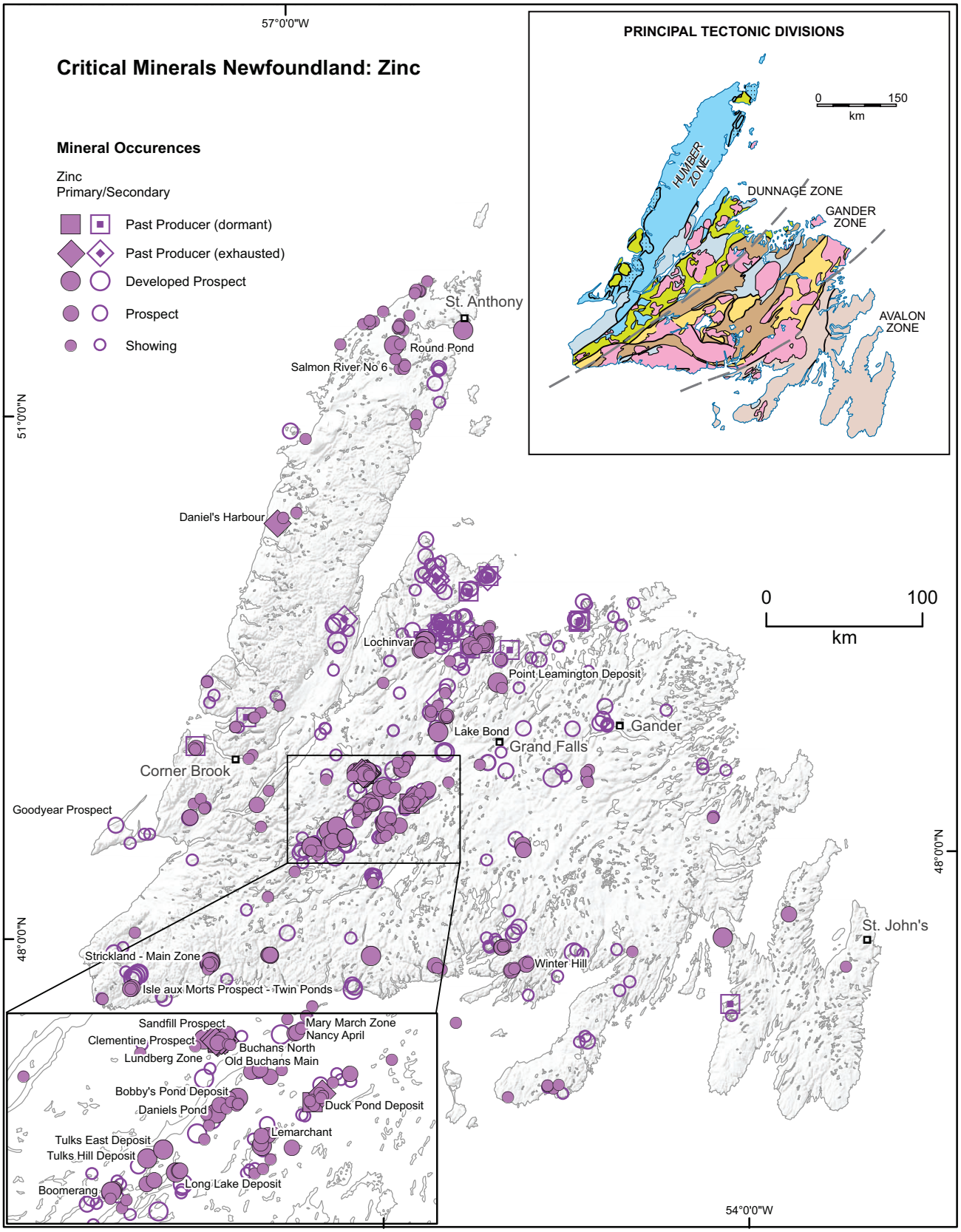

Figure 55. *Map showing the distribution of zinc occurrences in Newfoundland as well as illustrating all levels of development above indication.*

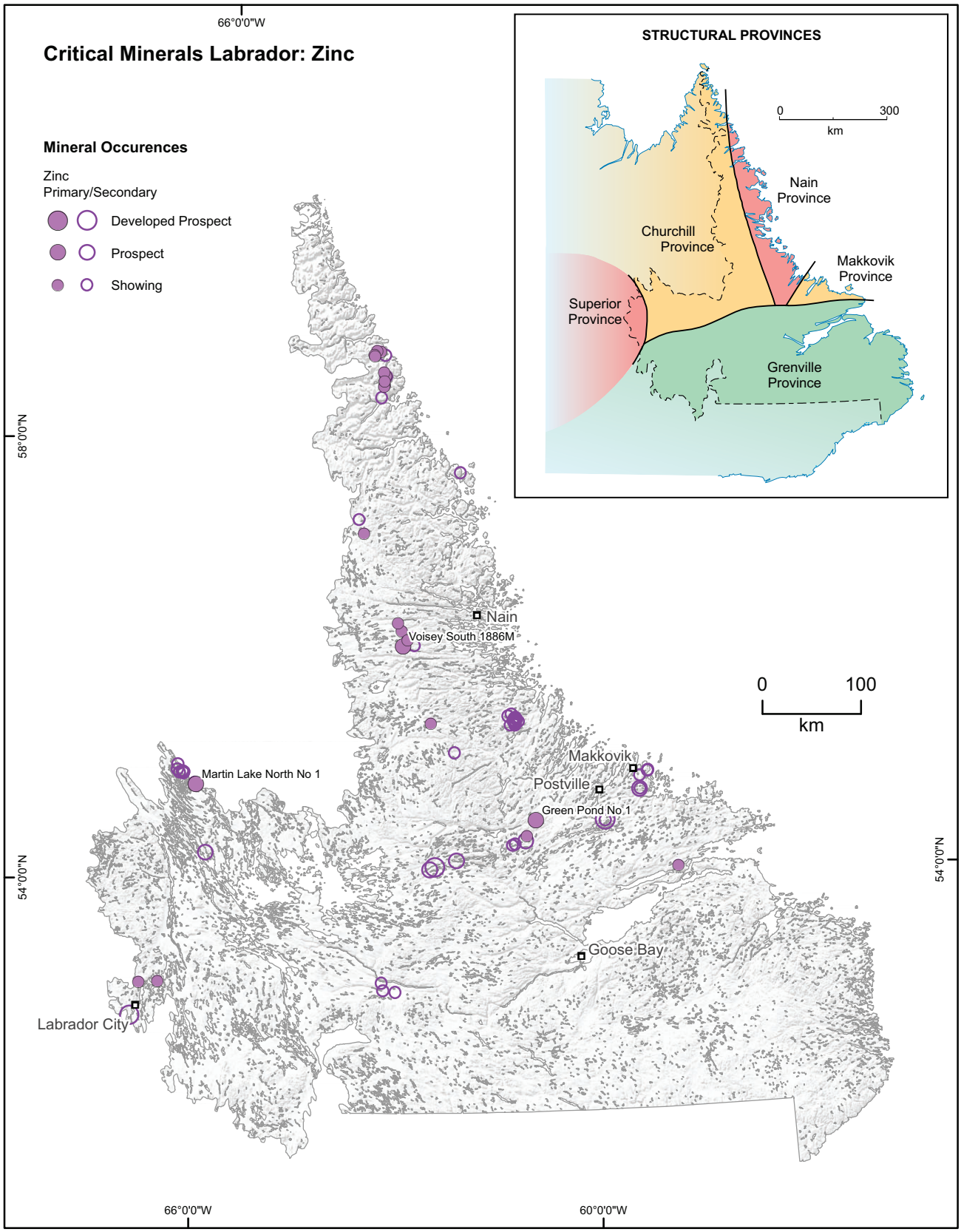

Figure 56. *Map showing the distribution of zinc occurrences in Labrador as well as illustrating all levels of development above indication.*

ZIRCONIUM (Zr)

Description

Zirconium is a soft, ductile transition metal in its purest form (lesser purities will be hard and brittle); at room temperature it has a grey-white lustre. The metal is known for its high resistance to corrosion, and for being transparent to neutrons, which implies that a nucleus can absorb neutrons without significant interaction between particles and nuclei. For this reason it is used for cladding fuel rods in nuclear reactors. Zirconium does not occur in its native form, and zircon is the principal commercial source of zirconium. Hafnium and zirconium have similar chemical characteristics due to their close proximity in the periodic table and the two can coexist in the mineral zircon in a solid solution. Zirconium finds many applications in high-temperature and aggressive environments due to its resistance to heat.

Source Minerals

Zircon, baddeleyite.

Uses

Molds for molten metals, metallurgical furnaces, laboratory crucibles, cladding in nuclear reactors, anti-corrosive agent, dental implants and prosthetics, gemstones, abrasives.

Global Mine Production

Annual production of zirconium ores and concentrates in 2024 was estimated at 1.5 Mt (USGS, 2025). The top three producers were Australia (500 000 t, 33.3%), South Africa (300 000 t, 20%) and Mozambique (160 000 t, 10.6%).

Mineral Resource Supply and Demand Outlook

Zirconium demand was restrained in 2024 mainly related to a decline in Chinese construction which accounts for 50% of the global zircon demand (Zircomet, 2025). Additionally, the introduction of new heavy mineral concentrate suppliers in 2024 has led to a surplus of material. Medium term outlook for zircon continues to indicate a supply deficit beyond 2026 as mature operations start to decline their output.

Recovery

Zirconium production usually results in a product containing 1–3% hafnium, which in most application (other than nuclear) is not a problem due to their similar chemical and physical characteristics.

Recycling

Zirconium can be recycled from manufacturing and recycled scrap.

Geological Setting

Zirconium behaves as an incompatible element in magmas and is enriched in fractionated and evolved felsic intrusions. Owing to its relatively high specific gravity and resistance to weathering, zircon is an important constituent of heavy mineral sands and the largest mined zircon deposits are of this type (Cyclone Project; eastern Australia). It is obtained from placer deposits as primary deposits or as co-products of the mining of titanium in ilmenite and rutile in heavy mineral sands. There are few primary igneous deposits of zirconium (and hafnium)-bearing minerals that have an economic value (Jones *et al.*, 2017); the world's largest primary deposits (zircon and baddeleyite) are within alkaline igneous rocks, associated with REE, niobium and tantalum mineralization (Kogarko, 1990; Jones *et al.*, 2017).

Mods Occurrences

There are 78 zirconium occurrences in the MODS (17 primary), including 2 developed prospects, and 6 prospects where zirconium is mostly secondary to REE. In Labrador, potential for zirconium/hafnium mineralization exists in the Strange Lake Complex, the Flowers River Intrusive Suite in northern Labrador (*e.g.*, Flowers River South #30 – 013N/11/Zr 002), the Red Wine Intrusive Suite and Letitia Lake areas northwest of Goose Bay (*e.g.*, Pinot Rose – 013L/02/Ree008, Cabernet – 013L/02/Ree006), and the Fox Harbour Volcanic Belt around Port Hope Simpson (*e.g.*, Foxtrot – 003D/05/Ree001, Ocean View – 003D/04/Ree001). Both the Red Wine/Letitia Lake (Chabanole and Crocker, 2012) and Fox Harbour volcanic belt (Magyarosi, 2022) areas may contain primary REE occurrences that have high zirconium contents and that could be considered primary zirconium occurrences. Potential for placer zirconium

deposits may exist associated with the titanium-rich Churchill River Mineral Sands deposit (013F/08/Fe 001) near Goose Bay, Labrador, as well as the Porcupine Strand North deposit (013I/03/Ti 001) located on the southeast coast of Labrador.

In Newfoundland, felsic igneous rocks of peralkaline composition are widespread but remain underexplored. Examples of areas having potential for zirconium mineralization include the Topsails Intrusive Suite in west-central Newfoundland (*e.g.*, Topsails Zr – 012H/02/Zr 001, Rainy Lake Zr – 012A/14/Zr 001), granitoid suites in the Terrenceville area (*e.g.*, Bark Pond Rare Earths No 1 – 001M/10/Zr 001) and peralkaline rhyolites near Bonavista (*e.g.*, Ken's Mountain Rare-Metals – 002C/05/Zr 002). Representative zirconium occurrences are included in Table 34 and illustrated in Figures 57 and 58.

Table 34. Representative zirconium occurrences for Newfoundland and Labrador listed from most to least developed as derived from the Mineral Occurrence Data System (accessed July 1, 2025)

NAME-NMINO	Development	Deposit Type	Resources/Assay Samples
NEWFOUNDLAND			
Bark Pond Rare Earths No 1 – 001M/10/Zr 001	Showing	Magmatic – felsic intrusive	Grab sample in trench assayed 2.0% Zr (Hopfengaerther and Taylor, 1982)
Topsails Zr – 012H/02/Zr 001	Showing	Magmatic – felsic intrusive	Grab sample assayed 23 300 ppm Zr (O'Reilly *et al.*, 2010)
Rainy Lake Zr – 012A/14/Zr 001	Showing	Magmatic – felsic intrusive	Grab sample assayed 8250 ppm Zr (O'Reilly *et al.*, 2010)
Ken's Mountain Rare-Metals – 002C/05/Zr 002	Showing	Insufficient data to classify	Best returned value in assay of 4400 ppm Zr (Hutchings, 1998)
Star Lake Zr – 012A/11/Zr 001	Showing	Magmatic or magmatic-hydrothermal	Consistent anomalous REE geochemistry in outcrop. The occurrence is defined by 2 anomalous granitic samples, one of which returned 6370 ppm Zr, 505 ppm Nb, and 307 ppm Y (Devereaux *et al.*, 2009)
LABRADOR			
Strange Lake – 024A/08/Ree001	Developed Prospect (REE)	Magmatic – pegmatite	Overall estimated resource of 57.0 Mt grading 2.93% ZrO_3, 0.38% Y_2O_3, 0.31% Nb_2O_5, 0.08% BeO and 0.54% REE for Main Zone (Campbell *et al.*, 1985)
Foxtrot – 003D/05/Ree001	Developed Prospect (REE)	Magmatic – felsic intrusive	Ind. Res. of 3.4 Mt grading 9640 ppm Zr (Ciuculescu, 2022)
Ocean view – 003D/04/Ree001	Prospect (REE)	Magmatic – pegmatite	Best of 21 samples assayed 88 000 ppm Zr (Butler, 2011)
Pesky Hill – 013A/08/Ree001	Prospect (REE)	Magmatic – pegmatite	Zr ranges from 5512 to 16 557 ppm in 4 samples of granitic pegmatite (Srivastava *et al.*, 2013)
Pope's Hill – 013F/04/Ree001	Prospect (REE)	Magmatic – pegmatite	Anomalous trend 7 km in strike length with best assay of 0.46% Zr (Delazzer and Dimmel, 2012)
High REE Island – 013A/08/Ree002	Prospect (REE)	Magmatic – pegmatite	Channel sampling program evaluated 500 x 600 m zone with best grab sample assay of 3.28% Zr (Butler, 2013)
Pinot Rose – 013L/02/Ree008	Prospect (REE)	Undivided magmatic felsic intrusive	Drill core logging from the Pinot Rose Prospect confirms eudialyte (Na–Ca–Zr–REE silicate) in several zones with up to 22 960 ppm Zr over 0.4 m (Chabanole and Crocker, 2012)

Merlot – 013L/02/Ree007	Prospect (REE)	Undivided magmatic felsic intrusive	Peralkaline syenites and nepheline syenites contain up to 30% of the Zr–Y–REE-bearing mineral eudialyte; up to 2050 ppm Zr over 2.84 m in channel sample (Chabanole and Crocker, 2012)
Cabernet – 013L/02/Ree006	Prospect (REE)	Undivided magmatic felsic intrusive	Best DDH intersection from 5 DDH assayed 0.86% Zr over 9.0 m (Chabanole and Crocker, 2012).
Long Point 7 – 003D/05/Ree014	Showing (REE)	Insufficient data to classify	Channel samples in pegmatite/fine grained mafic returned 7.9% Zr over 0.48 m (Butler, 2015)
Echo Hill – 013A/08/Ree014	Showing (REE)	Insufficient data to classify	Channel sample returned values as high as 58 800 ppm Zr over 0.16 m (Moran, 2012)
Playfair South #3 – 013L/02/Ree003	Showing (REE)	Magmatic – pegmatite	Grab sample values range from 0.19% to 5.37% TREO and 0.05% to 2.56% ZrO_2 (Nielsen, 2010)
Flowers River South – #30 – 013N/11/Zr 002	Showing	Insufficient data to classify	Fourteen samples were assayed and yielded significant Zr with highest value of 17 270 ppm (Seymour *et al.*, 2008)

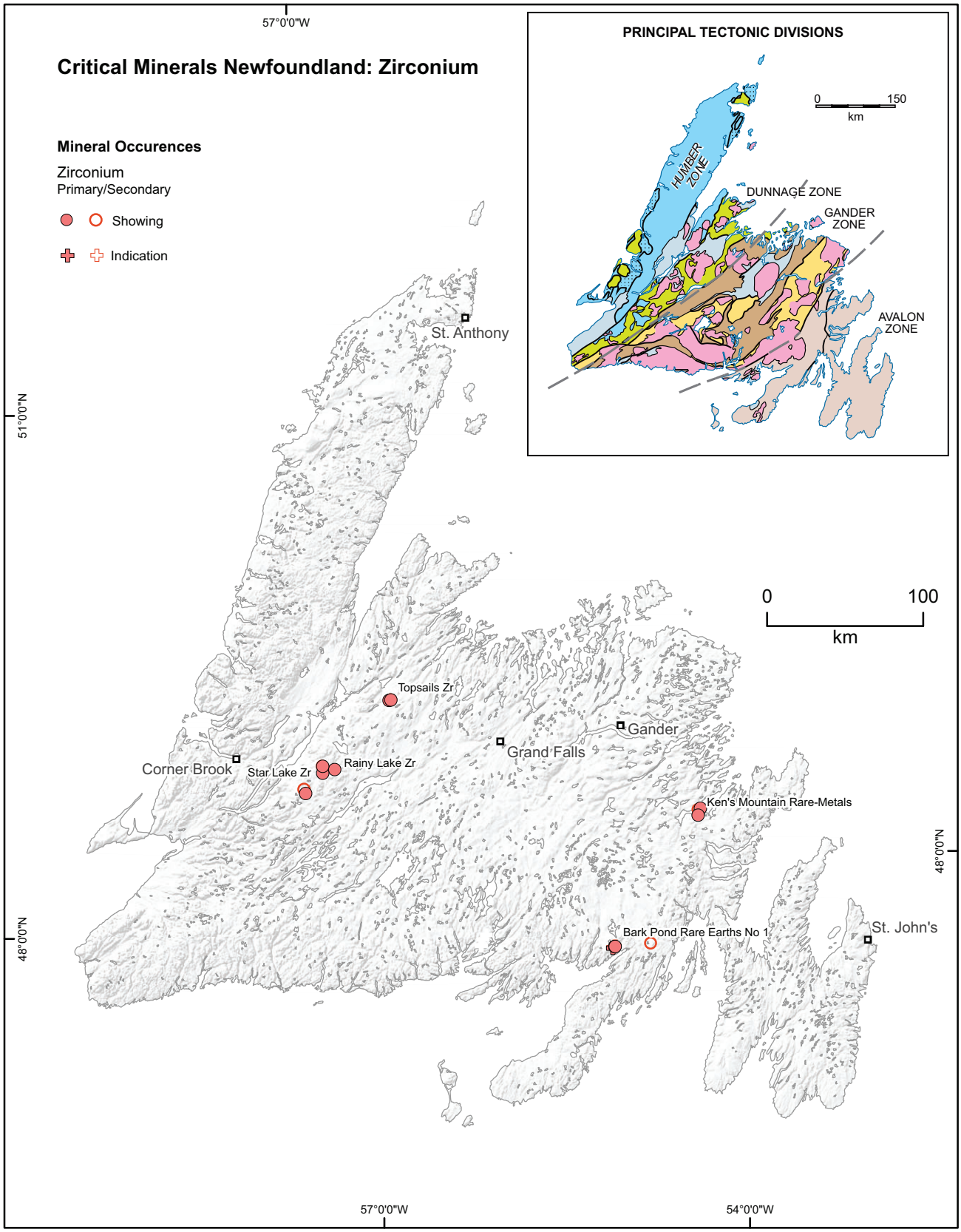

Figure 57. *Map showing the distribution of zirconium occurrences in Newfoundland as well as illustrating all levels of development.*

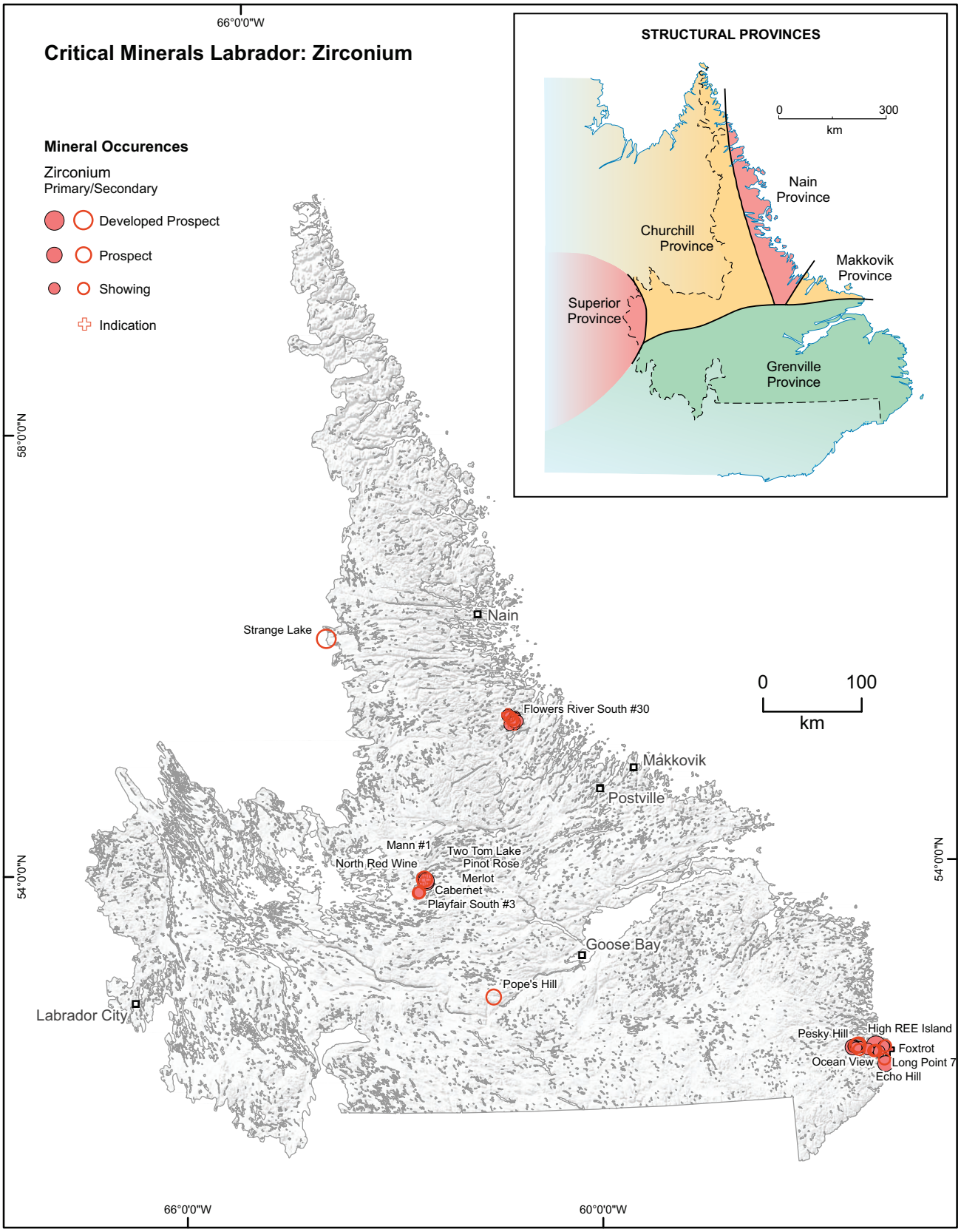

Figure 58. *Map showing the distribution of zirconium occurrences in Labrador as well as illustrating all levels of development.*

GLOSSARY

Alluvium/Alluvial Non-consolidated sediment accumulation (clay, silt, sand or gravel) deposited by running water in a stream bed, flood plain, alluvial fan, beach or similar setting.

Alteration Chemical and/or physical changes in the mineral composition of a rock after its initial formation.

Aplite Uniformly fine-grained (may be indiscernible) intrusive igneous rock of granitic composition.

Breccia Rock composed of angular fragments cemented together by a fine-grained matrix.

Carbonatite Rare igneous rock intrusion composed of greater than 50% carbonate minerals.

Carbonate-hosted Pb–Zn Deposit Sub-type of sediment-hosted Pb–Zn ore deposit (± Ag, Ba) that includes Mississippi Valley (MVT) and Irish Type which are hosted in carbonate-dominated platform sequences where low temperature (50–250°C) carbonate replacement mineralization is an important process. Faults and fractures usually play an important role on fluid control, and mineralization is typically hosted in open-space filling, collapse breccias, faults and hydrothermal cavities.

Clastic Dominated (CD) Sediment-hosted Stratiform Pb–Zn Deposit A sub-type of sediment-hosted massive sulphide deposit (± Ag, Au, Ba) that has been referred to in the past as SEDEX deposits (Sedimentary Exhalative Deposits). It is defined as having formed by discharge of metal-bearing basinal fluids onto the seafloor. Current understanding suggests that "SedEx" ore fluids are primarily basin brines, which either exhaled onto the basin floor or replace sediments within the shallow subsurface of the basin (Redmond, 2023).

Compatible/ Incompatible Element In geochemistry, compatibility refers to the chemical fractionation of trace elements in magmas and their predisposition for entering solid or liquid phases of magma; compatible elements favour solid phases; incompatible elements favour liquid phases.

Eluvium/Eluvial Residual mineral deposit (*see* laterite) that has undergone minimal gravitational movement/displacement from its point of origin.

Extrusive Body of magma erupted onto the Earth's surface.

Felsic Rock rich in quartz and feldspar silicate minerals.

Granite Related Mineralization A diverse and complex group of mineral deposits associated with the formation of granites. Granite-related mineralization is typically related to chemical fractionation of compatible/incompatible elements that occur in magmas as they evolve over time; elements considered to be granite-related mineralization included in this document are Be, Bi, Cs, F, Li, Mo, Ta, Sn, W, REE, U and Zr.

Greisen Self-generated magmatic–hydrothermal alteration of a granitic rock related to the late-stage release of volatiles contained in magma.

Intrusive Crystallization of magma beneath the Earth's surface.

HFSE High Field Strength Element – A group of elements of high valency (greater than 2) that behave incompatibly in magmas and are generally immobile when subject to hydrothermal activity.

IOCG Deposit Iron Oxide Copper Gold Deposit – Concentrations of copper, gold and uranium that share a common genetic origin, and which are commonly hosted in iron-oxide dominant gangue assemblages.

Laterite, Eluvial (Residual Deposit)	Rock or soil rich in residual minerals and formed by intense weathering (dissolution) in hot and humid climates.
LILE	Large-Ion Lithophile Element – Trace elements characterized by having a large ionic radius that behave incompatibly in magmas and that are generally mobile when subject to hydrothermal activity (fluid mobile).
LCT Pegmatite	Lithium–Cesium–Tantalum pegmatite.
Mafic	Rocks rich in ferromagnesian silicate minerals.
Metamorphism	Physical transformation of rock produced by extreme pressure and/or heat.
Metasomatism	Fluid alteration of a rock unrelated to the initial process that created the rock.
NPS	Nain Plutonic Suite – Mesoproterozoic predominantly anorthositic intrusions in northern Labrador.
Peralkaline	Intrusions subdivided on the basis of their chemistry: Peralkaline intrusions have a molecular proportion of aluminium oxide lower than the combination of sodium oxide, potassium oxide and calcium oxide.
Peraluminous	Intrusions subdivided on the basis of their chemistry: Peraluminous intrusions have a molecular proportion of aluminium oxide higher than the combination of sodium oxide, potassium oxide and calcium oxide.
Pegmatite	A rock in which the rate of new crystal nucleation is much slower than the rate of crystal growth during its formation, resulting in large and small crystals of similar compositions existing within the same rock.
Porphyry	A rock formed with a porphyritic texture where larger crystals are consistently set in a finer grained matrix.
Recovery	In metallurgy, it is the ability to extract an element during the processing of ore.
Refractory	A material that is resistant to decomposition by heat or chemical attack.
Scrap (New)	Scrap generated from the manufacturing of new parts.
Scrap (Old)	Scrap recovered from the recycling of old parts.
Silicate	Minerals containing silicon and oxygen in their formula and which form the largest and most important class of minerals constituting 90% of the earth's crust.
Skarn	Ore deposit formed by metasomatic replacement (see Glossary: metasomatism) of minerals in carbonate rocks and induced by contact metamorphism (heat) from an intrusion.
Stockwork	A dense network of variously oriented veins, sometimes referred to as stringers.
Stratabound	Mineral deposit confined to a stratigraphic unit with no specified shape (*i.e.*, veins, alteration halos).
Stratiform	Mineral deposit confined to specific strata and in the form resembling a sedimentary layer or a tabular body.

Superalloy An alloy that exhibits outstanding strength and surface stability at high temperatures.

Supergene Refers to the process of enrichment that occurs near or at the earth's surface as opposed to hypogene processes that occur deeper in the earth's crust.

Ultramafic Rock consisting of over 90% ferromagnesian silicate minerals.

VHMS/VMS Volcanic-Hosted Massive Sulphide – Deposits that form on the seafloor and below at, or close to, submarine volcanic vents where metal-rich exhalative fluids (brines) react with seawater and hydrogen sulphide discharging their metal contents; these are predominantly Cu–Zn (± Pb, Au) stratiform accumulations.

REFERENCES

Abdulvaliyev, R., Abikak, Y., Akhmadiyeva, N., Gladyshev, S., Manapova, A. and Kasymzhanova, A., 2025: Towards sustainable processing of chromite resources: A review of methods for magnesium and platinum-group metal extraction. Inorganics, Volume 13, 353 pages. https://doi.org/10.3390/inorganics13110353

Agnerian, H., 2006: Technical report on the Michelin Uranium Deposit, Newfoundland and Labrador, Canada. Prepared for Aurora Energy. Roscoe Postle Associated Inc.

Agnerian, H., 2008: Technical report on the Tulks Hill Cu-Zn Project, Newfoundland and Labrador, Canada, prepared for the Tulks Hill Joint Venture between Prominex Resources Corp. and Buchans River Limited. Scott Wilson Roscoe Postle Associates Inc.

Anderle, J.P., Rogers, D.P. and Ratcliffe, J.H., 1981: Report on geological evaluation, geophysics and drilling on claim blocks 1361-1362, 1563, 1565, 1568 and 2121-2123 in the Fischells Brook area, Newfoundland. Atlantic Analytical Services Limited and Pronto Explorations Limited. Newfoundland and Labrador Geological Survey, Assessment File 12B/0245, 356 pages.

Andrews, P.W., 1991: Second year assessment report on geological, geochemical and geophysical exploration for licence 3564 on claim blocks 6428-6429 and licence 3630 on claim blocks 4491-4493 in the Island Pond, Ghost Pond and Second Pond areas, north-central Newfoundland. Noranda Exploration Company Limited, 28 pages. Newfoundland and Labrador Geological Survey, Assessment File 2E/05/0800, 28 pages.

Aral, H. and Vecchio-Sadus, A., 2008: Toxicity of lithium to humans and the environment–A literature review. Ecotoxicology and Environmental Safety, Volume 70, Issue 3, pages 349-356.

AuTECO Minerals, 2024: https://www.autecominerals.com/project/green-bay-copper-gold-project-mineral-resources/

Baila, F., Labbilta, T. and Darmane, Y., 2023: Feldspar purification from iron impurities: A review of treatment methods. Mineral Processing and Extractive Metallurgy Review, Volume 45(6), pages 564-572.

Baird, D.M., 1943: Titaniferous magnetites in anorthosite east of St Georges, Newfoundland. Government of Newfoundland and Labrador, Geological Survey, Internal Collection, Individual Report. GeoFile Number 012B/08/0026.

Balakrishnan, T., Buro, Y.A., Ibrango, S., Cassoff, J., Belanger, L., Giroux, E., Julien, P., Poveromo, J., Bilodeau, M.L. and Cauchon, C., 2014: First year supplementary, second year, fourth year and twelfth year supplementary assessment report on feasibility studies for licences 15975M, 15977M, 18380M, 20412M, 20427M-20428M and 21557M on claims in the Howells River area, western Labrador, 2 reports. New Millenium Iron Corporation, LabMag GP Incorporated, LabMag Limited Partnership and Tata Steel Global Minerals Holdings Pte Limited. Newfoundland and Labrador Geological Survey, Assessment File LAB/1738, 2014, 403 pages.

Balaram, V., 2022: Rare earth element deposits: Sources, and exploration strategies. Journal of the Geological Society of India, Volume 98, pages 1210-1216.

Banville, R., Huard, A., Sheppard, D., Woods, G., Drolet, B. and Bertrand, M.J., 1998: Assessment report on geological, geochemical, geophysical and diamond drilling exploration for 1997 submission for the Anglo-Newfoundland Development Limited Charter, Reid Lots 227, 229, 234 and 247 and fee simple grants volume 1 folio 61 and volume 2 folio 29 in the Victoria Lake-Red Indian Lake areas, central Newfoundland, 10 reports, Noranda Mining and Exploration Incorporated and Major General Resources Limited. Newfoundland and Labrador Geological Survey, Assessment File 12A/1015, 786 pages.

Barbour, D., Dearin, C. and de Carle, R.J., 1996: First year assessment report on geological, geochemical and geophysical exploration for licence 757m on claims in the Paul Island area, northern Labrador, 3 reports, NDT Ventures Limited and Takla Star Resources Limited. Newfoundland and Labrador Geological Survey, Assessment File 14C/12/0116, 116 pages.

Barnes, M.P. and Entwistle, L.P., 1971: Report on the exploration possibilities at the Buchans Unit, Newfoundland. American Smelting and Refining Company. Newfoundland and Labrador Geological Survey, Assessment File 12A/15/0129, 34 pages.

Barnes, S-J. and Maier, W.D., 1999: "The fractionation of Ni, Cu and the noble metals in silicate and sulphide liquids." *In* Dynamic Processes in Magmatic Ore Deposits and their Application in Mineral Exploration. *Edited by* R.R. Keays, C.M. Lesher, P.C. Lightfoot and C.E.G. Farrow. Geological Association of Canada, Short Course, Volume 13, pages 69-106.

Barning, K., 1965: Report on chromite survey in central and western Newfoundland. Newfoundland and Labrador Geological Survey, Internal Report, Miscellaneous. GeoFile Number NFLD/0283.

Barrett, S., Otto, A., Thomas, W., Jory, J., Ash, S., Gillespie, J. and Walsh, M., 2014: Eleventh year assessment report on geological, geochemical, geophysical and diamond drilling exploration for licences 17198M, 17288M, 17291M, 17294M and 22148M-22149M on claims in the Ranjan Lake - Melody Lake - Tom Hill Pond area, northeastern Labrador, Aurora Energy Limited. Newfoundland and Labrador Geological Survey, Assessment File LAB/1729, 169 pages.

Barrington, C., 2022: The iron ore challenge for direct reduction on road to carbon-neutral steelmaking. Tech article by International Iron Metallics Association chief advisor.

Barry, J.M., 1980: Assessment report on geological, geochemical and geophysical surveys performed during 1979 for licence 12125 on claim 12478 in the area of Cochrane Pond C, Newfoundland. Atlantic Analytical Services Limited and Falconbridge Nickel Mines Limited. Newfoundland and Labrador Geological Survey, Assessment File 11P/14/0070, 28 pages.

Barry, J., Feasby, D.G., Froude, T., Puritch, E. and Stone, W., 2022: Updated mineral resource estimate, and preliminary economic assessment of the Great Burnt copper-gold property, central Newfoundland, NI-43-101 & 43-101F1 technical report, Spruce Ridge Resources LTD. https://minedocs.com/22/Great_Burnt-PEA-3092022.pdf

Bartlett, G.S., 1967: Silica assessment, Fortune area, Newfoundland. Government of Newfoundland and Labrador, Department of Mines, Agriculture and Resources, Mineral Resources Division, 29 pages. GeoFile Number 001M/04/0072.

Bartlett, L., 1997: Third year assessment report on promotion of property for licence 677m on claims in the Labrador City area, Labrador, Shabogamo Mining and Exploration Limited. Newfoundland and Labrador Geological Survey, Assessment File 23B/15/0167, 6 pages.

Basha, M., Frew, A., Cain, M.J., Woods, D.V., Kubo, W.K. and Leitch, C.H.B., 2001: First, seventh and fifteenth year assessment report on geological, geochemical, geophysical and trenching exploration for licences 7584M-7585M and 7588M-7590M on claims in the Glover Island area, west-central Newfoundland, 4 reports. New Island Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 12A/1183, 2001, 362 pages.

Baum, Z.J., Bird, R.E., Yu, X. and Ma, J., 2022: Lithium-ion battery recycling-overview of techniques and trends. American Chemical Society, ACS Energy Letters, Volume 7(2), pages 712-719. https://doi.org/10.1021/acsenergylett.1c02602

Beavan, A.P., 1954: Report on exploration in 1953 in Labrador and Newfoundland. British Newfoundland Corporation Limited. Newfoundland and Labrador Geological Survey, Assessment File NFLD/0119, 97 pages.

Beesley, T., 1997: First year supplementary assessment report on geological and geochemical exploration for licences 1764m-1765m on claims in the Cirque Lake area, Labrador, Cartaway Resources Corporation and Cartaway Container Corporation. Newfoundland and Labrador Geological Survey, Assessment File 14E/01/0128, 30 pages.

Berger, A.R., 1963: Chromite explorations 1962, Table Mountain, North Arm Mountain and Lewis Hills, Newfoundland. Newfoundland and Labrador Geological Survey, Miscellaneous. GeoFile Number NFLD/0252.

Beukes, N., Gutzmer, J. and Mukhopadhyay, J., 2003: The geology and genesis of high-grade hematite ore deposits. Applied Earth Science, Volume 112(1), pages 18-25. https://doi.org/10.1179/037174503225011243

BHP, 2023: BHP Insights: How copper will shape our future. https://www.bhp.com/-/media/project/bhp1ip/bhp-com-en/documents/news/2024/240930_; bhpinsights_howcopperwillshapeourfuture.pdf; https://www.bhp.com/news/bhp-insights/2024/09/how-copper-will-shape-our-future

Bilal, M., Ilhwan, P., Vothy, H., Mayumi, I., Fawad, U.H., Sanghee, J. and Naoki, H., 2022: The challenges and prospects of recovering fine copper sulfides from tailings using sifferent flotation techniques: A Review. Minerals, Volume 12, No. 5, Article 586. https://doi.org/10.3390/min12050586

Blackwood, R.F., 1984: Geology of the west half of the Dolland Brook map area (11P/15), southern Newfoundland. *In* Current Research. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Report 84-1, pages 198-209.

Blackwood, R.F. and Green, L., 1982: Geology of the Great Gull Lake (2D/6)–Dead Wolf Pond area (2D/10), Newfoundland. *In* Current Research. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Report 82-1, pages 51-64.

Blagdon, S., 1974: The Advocate asbestos mine. *In* Plate Tectonic Setting of Newfoundland Mineral Occurrences. *Edited by* D.F. Strong. A Guidebook for the NATO Advanced Studies Institute on Metallogeny and Plate Tectonics, pages 116-126. GeoFile Number NFLD/0738.

Boyko, W.P., 1953: Geological report on the Wabush Lake area, Labrador. Newfoundland and Labrador Corporation Limited. Newfoundland and Labrador Geological Survey, Assessment File LAB/0668, 11 pages.

Brinex (British Newfoundland Exploration Limited), 1962: Diamond drilling data from Rust Pond and Crescent Lake areas, Newfoundland. British Newfoundland Exploration Limited. Newfoundland and Labrador Geological Survey, Assessment File 2E/05/0161, 31 pages.

Brummer, J.J., 1957: Report on operations including geology maps, diamond drilling, geophysical, and geochemical plans in the Frobishers Seal Lake concession, central Labrador. Kennco Explorations Canada Limited. Newfoundland and Labrador Geological Survey, Assessment File 13K/0011, 162 pages.

Bucknell, W.R., 1981: Report on trenching and geochemistry for the Meelpaeg project for licence 1223 on claim block 140 in the Granite Lake area, Newfoundland. Atlantic Analytical Services Limited and Rio Tinto Canadian Exploration Limited. Newfoundland and Labrador Geological Survey, Assessment File 12A/02/0273, 32 pages.

Buller, A.E., 1974: Report on Cera fluorite project on Nalco lot 4 in the Mount Margaret area of the St Lawrence area, Newfoundland. A.E. Buller Limited, David S. Robertson and Associates Limited, Newfoundland and Labrador Corporation Limited and CERA. Newfoundland and Labrador Geological Survey, Assessment File 1L/14/0052, 29 pages.

Burgess, J.R. and Gamble, D., 1993: First year and second year supplementary assessment report on geological, geochemical, geophysical and diamond drilling exploration for licences 402m, 407m, 418m, 420m-424m and 501m-503m in the Fraser Lake and Hook Lake areas, west-central Labrador, 2 reports, Kennecott Canada Incorporated and Noranda Exploration Company Limited. Newfoundland and Labrador Geological Survey, Assessment File 13L/0077, 287 pages.

Burt, K., 2019: First year assessment report on prospecting and geochemical exploration for licence 026533M on claims in the Jack Joes Pond area, western Newfoundland. Newfoundland and Labrador Geological Survey, Assessment File 12B/08/0722, 11 pages.

Butler, A.J., 1970: Silica assessment, East Arm, Bonne Bay, Newfoundland. Newfoundland and Labrador Geological Survey, Internal Collection. Geofile Number 012H/05/0241.

Butler, A.J. and Greene, B.A., 1976: Silica resources of Newfoundland. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Report 76-02, 78 pages.

Butler, A.J. and Howse, A.F., 1975: Evaluation of the La Scie quartz vein, Burlington Peninsula, Newfoundland. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Open File 002E/13/0312, 32 pages

Butler, D.J. and Osmond, R., 1996: Report of Work. Voisey's Bay Nickel Company Limited. Volume I: Nain Bay South Block, Project No. 2000. Licence Nos. 713M, 714M, 715M, 732M, 733M, and 734M. Volume II: Newark Island Block, Project No. 3000. Licence Nos. 716M, 717M, and 718M. Volume III: Nain Bay Islands Block, Project No. 4000. Licence Nos. 719M, 720M, 721M. Archean Resources Limited. Newfoundland and Labrador Geological Survey, Assessment File LAB/1161, 245 pages.

Butler, S., 2015: Third and fifth year assessment report on prospecting and geochemical exploration for licences 17332M, 19576M and 22073M on claims in the Long Point area, near St Lewis, southeastern Labrador. Search Minerals Incorporated and Alterra Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 3D/05/0053, 205 pages.

Butler, S., 2013: Third year assessment report on prospecting and geochemical, trenching and diamond drilling exploration for license 20187M on claims in the St Lewis Inlet area, southeastern Labrador, Search Minerals Incorporated and Alterra Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 13A/08/0104, 492 pages.

Butler, S., 2011: First year assessment report on prospecting and geochemical exploration for license 17833M on claims in the area southeast of Marys Harbour, southeastern Labrador, Search Minerals Incorporated and Alterra Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 3D/04/0041, 162 pages.

Byrne, C., 1979a: Report on Uranium mineralization location in Reid lot 218 in the Wigwam Brook area, Newfoundland. Westfield Minerals Limited. Newfoundland and Labrador Geological Survey, Assessment File 012H/06/0549, 77 pages.

Byrne, C., 1979b: Results of reconnaissance geochemical and geophysical surveys on Reid lots 6, 7, 8, 9, 11, 13, 17 and 21 in the Codroy-St Georges Basin area, Newfoundland. Westfield Minerals Limited. Newfoundland and Labrador Geological Survey, Assessment File NFLD/0698, 39 pages.

Calhoun, T.A. and Hutchinson, R.W., 1981: Determination of flow direction and source of fragmental sulphides, Clementine deposit, Buchans, Newfoundland. *In* The Buchans Orebodies: Fifty Years of Geology and Mining. *Edited by* E.A. Swanson, D.F. Strong and J.G. Thurlow. Geological Association of Canada, Special Paper Number 22.

Callinex Mines Inc., 2021: Press Release (January). https://callinex.ca/callinex-files-technical-report-on-point-leamington-property/

Campbell, D.S., Hazen, W.C., Hazen, N., Meador, C.E., Robichaud, A.E., Chanda, B. and Homier, J., 1985: Report on feasibility, metallurgical and market studies for Mining Lease 124 in the Strange Lake area, northern Labrador, 5 reports, Iron Ore Company of Canada. Newfoundland and Labrador Geological Survey, Assessment File 24A/08/0029, 782 pages.

Canadian Zinc Corporation, 2015: Press Release. https://norzinc.com/wp-content/uploads/2016/01/pr120215.pdf

Canterra Minerals Corporation, 2023: Press Release. https://canterraminerals.com/news-releases/canterra-minerals-acquires-the-past-producing-buchans-mine-lundberg-deposit-and-other-critical-and-precious-metals-projects-in/

Caprock Mining, 2024: Ackley Property. https://caprockmining.com/lithium-in-newfoundland/

Carr, G.F., 1958: The industrial minerals of Newfoundland. Canada Mines Branch, Publication 855, 158 pages. https://doi.org/10.4095/307989

Cedillos-Barraza, O.Manara, D., Boboridis, K., Watkins, T., Grasso, S., Jayaseelan, D.D., Konings, R.J.M., Reece, M.J., Lee, W.E., 2016: Investigating the highest melting temperature materials: A laser melting study of the TaC-HfC system. Scientific Reports #37962. https://doi.org/10.1038/srep37962

Chabanole, L. and Crocker, M., 2012: Fifth year assessment report on geological, geochemical and diamond drilling exploration for licence 13144M on claims in the area east of Isabella Falls, central Labrador, Search Minerals Incorporated and Alterra Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 13L/02/0150, 2569 pages.

Chaves, L.R., 2019: The niobium controversy. https://revistapesquisa.fapesp.br/en/the-niobium-controversy (accessed October 2025).

Chorlton, L., 1980: Peter Snout, Newfoundland. Map 80-201. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, GeoFile Number 011P/13/0081.

Ciuculescu, T., Masun, K.M. and Goode, J.R., 2022: Technical report on the Deep Fox and Foxtrot Project, Newfoundland and Labrador, Canada. Report for NI 43-101. Prepared by SLR Consulting (Canada) Ltd for Search Minerals Inc.

Clark, M.R., Durden, J.M. and Christiansen, S., 2020: Environmental impact assessments for deep-sea mining: Can we improve their future effectiveness? Marine Policy, Volume 114.

Coates, H., 2012: Report on the 2010 exploration program Julienne Lake iron deposit, western Labrador, Newfoundland and Labrador, 4 volumes. Newfoundland and Labrador Geological Survey, Internal Collection, Company or Consultant Report, 894 pages. GeoFile Number 023G/02/0287.

Cobalt Institute, 2023: Cobalt market report. https://www.cobaltinstitute.org/resource/cobalt-market-report-2023/ (accessed July 2023).

Coleman, L.C., 1954: Geological report of the Lower Gander River area, Newfoundland. Newfoundland and Labrador Geological Survey, Assessment File 2E/0069.

Collins, C.J., 1984: Genesis of the St Lawrence fluorite veins, as indicated by fluid inclusion and trace element data from three selected veins. B.Sc. thesis, Memorial University of Newfoundland, St. John's, Newfoundland and Labrador, 117 pages.

Collins, J.E., 1958: Geological report on Ferguson-Brown lakes area, Labrador. British Newfoundland Exploration Limited. Newfoundland and Labrador Geological Survey, Assessment File 13K/0028, 37 pages.

Collins, M.J., 1984: Baie Verte mines asbestos deposit. *In* Mineral Deposits of Newfoundland-A 1984 Perspective. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Report 84-3, pages 98-102.

Collins, P., 2017: First year assessment report on geological and geochemical exploration for licences 24050M, 24580M and 24581M on claims in the Black Bay area, southeastern Labrador, Red Moon Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 12P/16/0118, 67 pages.

Collins, M.J. and Legrow, P.C., 1989: Report mill tailings assessment, Buchans Mines, central Newfoundland [12A/15], part of Abandoned Properties Assessment Program. Government of Newfoundland and Labrador, Department of Mines and Energy, 63 pages. GeoFile Number 012A/15/0523.

Colman-Sadd, S.P., Hayes, J.P. and Knight, I., 1990: Geology of the Island of Newfoundland. Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey Branch, Map 90-001.

Conliffe, J., King, R. and Wilton, D.H.C., 2018: Genesis of carbonate-hosted Zn mineralization in the Hare Bay and Pistolet Bay areas, Great Northern Peninsula, Newfoundland. *In* Current Research. Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Report 18-1, pages 71-93.

Cooper, G.E.,1955: Magnesite occurrences in central Newfoundland. Newfoundland and Labrador Geological Survey, Internal Collection, Individual Report, 22 pages. GeoFile Number NFLD/0101.

Cooper, J.R.,1937: Geology and mineral deposits of the Hare Bay area. Government of Newfoundland and Labrador, Department of Natural Resources, Geological Section, Bulletin No. 09, 40 pages. GeoFile Number 002M/0002.

Cooper, P., Wilson, N., Weick, R.J., Pittman, G. and Agnerian, H., 2010: Fourteenth year assessment report on compilation, resource estimation and diamond drilling exploration for licence 11590M on claims in the St Lawrence area, on the Burin Peninsula, Newfoundland, 3 reports, Canada Fluorspar Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 1L/14/0212, 2010, 676 pages.

Core Market Research, 2025: Antimony market size, trends & forecast 2025-2035. https://coremarketresearch.com/report/antimony (accessed August 2025)

Credence Research, 2024: Chrome ore concentrate market by product grade (metallurgical grade, refractory grade, chemical grade); by end user (metallurgy, foundry, chemical industry, construction, others); by region – growth, share, opportunities & competitive analysis, 2024–2032 Read more at: https://www.credenceresearch.com/report/chrome-ore-concentrate-market (accessed October, 2025).

Cronan, D.S., 2019: Manganese nodules. Encyclopedia of Ocean Sciences (Third Edition), Academic Press, pages 607-614.

Cruft, E.F. and Robinson, W.G., 1958: Report on exploration in 1957 in the Ten Mile Lake area of the Frobisher Seal Lake concession, Labrador. Frobisher Limited. Newfoundland and Labrador Geological Survey, Assessment File 13K/0013, 38 pages.

Crundwell, F., Moats, M., Ramachandran, V., Robinson, T. and Davenport, W.G., 2011: Extractive Metallurgy of Nickel, Cobalt and Platinum Group Metals, Elsevier Science, Oxford.

Crundwell, F.K., du Preez, N.B. and Knights, B.D.H., 2020: Production of cobalt from copper-cobalt ores on the African Copperbelt–An overview. Minerals Engineering, Volume 156. https://doi.org/10.1016/j.mineng.2020.106450

Cullen, M. and Churchill, R., 1996: Second year assessment report on geological, geochemical and geophysical exploration for licence 923m on claims in the Niatak Island area, northern Labrador, Goldnev Resources Incorporated and Starcore Resources Limited. Newfoundland and Labrador Geological Survey, Assessment File 14C/06/0122, 31 pages.

Cullen, M.P., Churchill, R. and Burton, G.B., 1997: Second year assessment report on geological, geophysical and diamond drilling exploration for licence 2381m on claims in the Umiakoviarusek Lake area, northern Labrador, Golden Trump Resources Limited and Noront Resources Limited. Newfoundland and Labrador Geological Survey, Assessment File 14E/08/0103, 282 pages.

Cullen, M., Harrington, M. and Burke, J., 2021: NI 43-101 technical report for the Hope Brook gold project, Newfoundland and Labrador, Canada, Mercator Geological Services, sedar.com.

Cullen, M., Harrington, M. and Vande Guchte, M.J., 2018: NI 43-101 Technical Report and updated Mineral Resource Estimate on the Lemarchant Deposit South Tally Pond Property, central Newfoundland, Canada. Report prepared for NorZinc Limited, 166 pages. https://canterraminerals.com/properties/newfoundland/lemarchant/

Cunningham-Dunlop, I., Barbour, D., Buschman, A., Howson, S., King, M., Lennox-King, M., Trevors, M., Valenta, R., Wilton, D., Hannan, K., Farquhar, E. and Smith, R., 2006: First year supplementary, second year and third year assessment report on geological, geochemical, geophysical and diamond drilling exploration for licences 9410M-9415M, 9482M, 9718M-9723M, 10022M, 10046M-10056M, 10058M-10059M, 10343M-10344M and 10726M on claims in the Kaipokok Bay area, northeastern Labrador, 5 reports, Aurora Energy Incorporated, Fronteer Development Group Incorporated and Altius Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File LAB/1415, 906 pages.

Daigle, P., 2012: Resource estimate and technical report for the Two Tom REE deposit of the Red Wine Complex, Rare Earth Metals Inc. Labrador, Canada. http://www.canadarareearth.com/upload/documents/twotom-43-101.pdf

Davenport, P.H., 1978: Uranium distribution in the granitoid rocks of eastern Newfoundland. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Open File NFLD/0946, 148 pages.

Deady, E., Moon, C., Moore, K., Goodenough, K.M. and Shail, R.K., 2022: Bismuth: Economic geology and value chains. Ore Geology Reviews, Volume 143.

Dean, P.L., 1978: Report on geological reconnaissance of the New Bay Pond, Gander Lake south and Kaegudeck Lake areas in the Nalco lot 2 area, Newfoundland. Hudsons Bay Oil and Gas Company Limited and Newfoundland and Labrador Corporation Limited. Newfoundland and Labrador Geological Survey, Assessment File NFLD/1061, 26 pages.

Dean, P.L. and Meyer, J.R., 1985: Industrial minerals in Labrador west. *In* Current Research. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Report 85-01, pages 1-3.

Dean, P.L. and Watson, D.M., 1981: Newfoundland and Labrador. Industrial Minerals, Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, pages 10-12. Geofile Number NFLD/1268.

Dearin, C., 1991: Third year assessment report on geological and geochemical exploration for licence 3207 on claim blocks 5261-5267 in the Deer Lake, Lanes Brook and Little Harbour Brook areas, western Newfoundland. Long Range Resources Limited. Newfoundland and Labrador Geological Survey, Assessment File 012H/04/1232, 71 pages.

Delaney, P., 2011: Third and fourth year assessment report on geological, geochemical, geophysical, trenching and diamond drilling exploration for licences 14055M, 15131M-15132M, 15150M-15153M and 15374M-15375M on claims in the Port Hope Simpson - St Lewis Inlet area, southeastern Labrador, Lewis, G E, Alterra Resources Incorporated and B and A Minerals Limited. Newfoundland and Labrador Geological Survey, Assessment File LAB/1641, 470 pages.

Delaney, P., 2010: Second year assessment report on geological, geochemical, geophysical and trenching exploration for licences 14955M, 15113M, 15131M-15132M, 15150M-15153M and 15374M-15375M on claims in the Port Hope Simpson - St Lewis River area, southeastern Labrador, Alterra Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File LAB/1635, 235 pages.

Delazzer, A. and Dimmell, P.M., 2012: Second year assessment report on geological, geochemical, geophysical, trenching and diamond drilling exploration for licences 17717M and 18101M on claims in the Popes Hill area, south-central Labrador, Silver Spruce Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 13F/0085, 421 pages.

Delazzer, A. and Dimmell, P.M., 2010: Sixth year assessment report on geological, geochemical and trenching exploration for licence 11840M on claims in the 20th Brook area, near Stephenville, western Newfoundland. Benoit, J M and Silver Spruce Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 12B/09/0606, 117 pages.

De Mark, P. and Dearin C., 2007: Tulks South Property technical report, central Newfoundland, Canada, Snowden. https://canterraminerals.com/site/assets/files/5757/tulks_south_technical_report_snowden.pdf

Department of Industry, Energy and Technology (DIET) 2023: Our Critical Minerals Advantage. Government of Newfoundland and Labrador, Department of Industry, Energy and Technology, Available from the website: https://www.gov.nl.ca/iet/files/Critical-Minerals-Plan-Our-Critical-Advantage.pdf

Dessureault, M., 2002: First, second and third year assessment report on geological, geochemical and diamond drilling exploration for licences: 6363M, 6364M, 7821M, 7866M-7869M, 7938M-7949M, 8023M, 8024M, 8096M-8099M, 8101M and 8329M on claims in the Red Cliff-Port Rexton-Random Island-Deer Harbour area, Bonavista Peninsula and Trinity Bay, Newfoundland. Noranda Incorporated, Cornerstone Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File NFLD/2778, 198 pages.

Devereaux, A., Churchill, R., Winter, L., King, L. and Northcott, C., 2011: Third year assessment report on prospecting, geophysical intrepretation and geochemical and trenching exploration for licences 13807M and 13819M-13820M on claims in the Natashquan River area, southern Labrador, Altius Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 13D/06/0038, 171 pages.

Devereaux, A., O'Reilly, D., Churchill, R., Annesley, I., Wasyliuk, K. and Shives, R.B.K., 2009: First year assessment report on geological, geochemical and geophysical exploration for licences 14016M, 14040M, 14042M, 14044M, 14046M-14047M, 14050M, 14054M, 14444M, 15591M-15619M and 15621M-15637M on claims in The Topsails area, west-central Newfoundland, 5 reports, JNR Resources Incorporated and Altius Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File NFLD/3083, 464 pages.

Dickie, G.J., Hady, J.L. and Saunders, C.E., 1975: Report on Pb-Zn exploration for the Brinex Freeport joint venture in the Stephenville-Port au Port area, Newfoundland. British Newfoundland Exploration Limited and Freeport Canadian Exploration Company. Newfoundland and Labrador Geological Survey, Assessment File 012B/0196, 115 pages.

Dickson, W.L., 1983: Geology, geochemistry and mineral potential of the Ackley Granite and parts of the North West Brook and eastern Meelpaeg Complexes, southeast Newfoundland [parts of map areas 1M/10, 11, 14, 15, 16; 2D/1, 2, 3 and 7]. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Report 83-06, 139 pages.

Dickson, W.L., Elias, P. and Talkington, R.W., 1980: Geology and geochemistry of the Ackley Granite, southeast Newfoundland. *In* Current Research. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Report 80-01, pages 110-119.

Dickson, W.L. and Howse, A.F., 1982: Geochemistry of whole rock and stream sediment samples from two mineralized areas of the Ackley Granite: Rencontre Lake molybdenite and Anesty Hill molybdenite-cassiterite prospects. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Open File 001M/0203, 17 pages.

Dimmell, P.M., 1982: Third year assessment report of geophysical surface work and geology for licence 1932 on claim blocks 1157 and 1161 for project 327 in the Granite Lake area, Newfoundland. Noranda Exploration Company Limited, Atlantic Analytical Services Limited, Metriclab Incorporated, and Canada Centre for Remote Sensing. Newfoundland and Labrador Geological Survey, Assessment File 12A/02/0304, 49 pages.

Dimmell, P.M., 1979: First year assessment report including geological, geochemical and geophysical surveys, for project 327 for licences 1193-1194 on claim block 1157 and 1161 in the Granite Lake, north area, Newfoundland, Noranda Exploration Company Limited. Newfoundland and Labrador Geological Survey, Assessment File 12A/02/0250, 37 pages.

Dimmell, P.M., 1979: Report on 1979 field work for project 324 in the Sops Arm-White Bay concession area, Newfoundland 3 volumes. Brinex Limited and Noranda Exploration Company Limited. Newfoundland and Labrador Geological Survey, Assessment File 12H/0565, 153 pages.

Dimmell, P.M., 1975: Report on claims 7007-7036 in the Coronation Lake area, Newfoundland. Noranda Exploration Company Limited. Newfoundland and Labrador Geological Survey, Assessment File 12A/16/0158, 31 pages.

Douglas, G.V., 1953: Notes on localities visited on the Labrador coast in 1946 and 1947. Geological Survey of Canada, Paper 53-01. https://doi.org/10.4095/123921

Douglas, G.V., Williams, D., Rove, O.N., MacLean, H.J., Heyl, G.R., Snelgrove, A.K., Fuller, J.O., Howse, C.K., MacQuarrie, W.R., Cooper, J.R., Kelly, S.F. and Stoiber, R.E., 1940: Copper deposits of Newfoundland. Government of Newfoundland and Labrador, Geological Survey, Bulletin No. 20, 85 pages. GeoFile Number NFLD/0051.

Dujardin, R.A., 1960: Beryllium bearing rocks of the Ten Mile Lake area in the Seal Lake area, Labrador. British Newfoundland Exploration Limited. Newfoundland and Labrador Geological Survey, Assessment File 13L/01/0021, 6 pages.

Dujardin, R.A. and Evans, E.L., 1961: A unique beryllium deposit in the vicinity of Ten Mile Lake, Seal Lake area, Labrador, Rio Tinto Canadian Exploration Limited and Rio Tinto Company Limited. Newfoundland and Labrador Geological Survey, Assessment File 13K/0018, 1961, 24 pages.

Duke, J.M., 1996a: Stratiform chromite. *In* Geology of Canadian Mineral Deposit Types. *Edited by* O.R. Eckstrand, W.D Sinclair and R.I. Thorpe. Geological Survey of Canada, Geology of Canada, No. 8, pages 617-620. (also Geological Society of America, The Geology of North America, Volume P-1)

Duke, J.M., 1996b: Podiform (ophiolitic) chromite. *In* Geology of Canadian Mineral Deposit Types. *Edited by* O.R. Eckstrand, W.D Sinclair and R.I. Thorpe. Geological Survey of Canada, Geology of Canada, No. 8, pages 621-624 (also Geological Society of America, The Geology of North America, Volume P-1)

Dumaresque, C., Pike, C., Kenan, W.M. and Leduc, M., 1994: Third year assessment report on trenching, diamond drilling and geochemical exploration for licence 342M on claims in the Mart Lake area, Labrador, 3 reports. Mart Mining and Exploration Limited. Newfoundland and Labrador Geological Survey, Assessment File 23B/14/0157, 73 pages.

Dunsworth, S., 2007: First and second year assessment report on geological and geochemical exploration for licences 11126M, 11238M, 13364M-13365M, 13544M, 13558M, 13560M, 13780M and 13972M on claims in the Sheep Brook area, southwestern Newfoundland, Marathon PGM Corporation. Newfoundland and Labrador Geological Survey, Assessment File 12B/0566, 138 pages.

Dupere, M. and Balakrishnan, T., 2013: First year, second year supplementary, seventh year supplementary and eleventh year supplementary assessment report on resource estimation for licences 15977M, 18380M, 20411M-20412M, 20427M and 21228M on claims in the Howells River area, western Labrador, 2 reports, New Millenium Iron Corporation and LabMag GP Incorporated. Newfoundland and Labrador Geological Survey, Assessment File LAB/1700, 97 pages.

Dupéré, M.P. and Taylor, J.P., 2012: Technical Report; Mineral Resource Update of the Houston Property, Labrador West Area, Newfoundland Labrador, Canada For Labrador Iron Mines Holdings Limited, SGS Canada Inc. https://www.labradorironmines.ca/pdf/HoustonMalcolmTR%20(1).pdf

Elliott, R.A., McVeigh, H.G., Neal, H.E. and Rolling, F.J., 1980: Potential for further iron ore development in Newfoundland and Labrador. Government of Newfoundland and Labrador, Department of Mines and Energy, Internal Collection, Company or Consultant Report, 175 pages. GeoFile Number LAB/0523.

Emory-Moore, M. and Meyer, J.R., 1991: Origin and economic potential of the placer deposits in the Lake Melville and the Porcupine Strand area of eastern Labrador, Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey Branch, Open File LAB/0939, 21 pages.

Emsbo, P., Seal, R.R., Breit, G.N., Diehl, S.F. and Shah, A.K., 2016: Sedimentary exhalative (SEDEX) zinc-lead-silver deposit model. U.S. Geological Survey, Scientific Investigations Report 2010–5070–N, 57 pages. http://dx.doi.org/10.3133/sir20105070N.

Emsley, J., 2001: Nature's Building Blocks. Oxford University Press, pages 262-266. ISBN 978-0-19-850341-5.

Emslie, R.F., 1970: Geology of the Michikamau Intrusion, Labrador. Geological Survey of Canada, Paper 68-57, 85 pages.

Evans, D.F., 1980: Geology and petrochemistry of the Kitts and Michelin uranium deposits and related prospects, Central Mineral Belt, Labrador. Ph.D, Queen's University, Kingston, Ontario, 1980, 342 pages.

Evans, D.T.W., 1992: Gold metallogeny of the eastern Dunnage Zone, central Newfoundland. *In* Current Research. Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey Branch, Report 92-01, pages 231-243.

Evans, D.T.W. and Kean, B.F., 1987: Gold and massive sulfide mineralization in the Tulks Hill volcanics, Victoria Lake Group, central Newfoundland. *In* Current Research. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Report 87-01, pages 103-111.

Evans, J.L., 1978: The geology and geochemistry of the Dyke Lake area (parts of 23J/8, 9) Labrador. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Report 78-04, 43 pages.

Evans, R.K., 2012: An overabundance of lithium?: Lithium Supply & Markets Conference, 4th, Buenos Aires, Argentina, January 23-25, 2012, Presentation, unpaginated.

Farmer, R., LeClair, C., Rudd, J. and Lajoie, J., 2007: First year assessment report on geological, geochemical and geophysical exploration for licences 12736M, 12769M, 12772M, 12774M, 12804M, 12807M, 12813M, 12919M-12920M, 12970M, 13354M, 13520M and 13594M-13595M on claims in the Kingurutik Lake area, northern Labrador, 2 reports, Benton Resources Corporation and Teck Cominco Limited. Newfoundland and Labrador Geological Survey, Assessment File LAB/1513, 191 pages.

Farrell, H., 1967: Report of the Mining Properties of St. Lawrence Corporation. Newfoundland and Labrador Geological Survey.

Firefly Metals, 2024: Ming Underground Mine, Green Bay Gold Project. https://fireflymetals.com.au/ming-underground-mine

Fitzpatrick, D., Moore, P., MacGillivray, G., House, S. and Emon, K., 1998: First year, second year supplementary and third year assessment report on geological, geophysical and diamond drilling exploration for licences 1081M, 1082M, 1084M, 1448M, 1456M, 1457M, 1550M, 2255M, 2256M, 2406M, 2663M, 2664M, 2904M, 2905M, 3104M, 3300M, 3303M-3308M, 3311M, 3312M, 3314-3318M, 3340M-3342M, 3704M, 4264M, 4483M, 4493M, 5431M, 5515M-5518M, 5626M, 5670M and 5698M on claims in the Pants Lake area, central Labrador, 4 reports. Newfoundland Mining and Exploration Limited, Major General Resources, Cypress Minerals Limited, Northern Abitibi Mining Corporation, PIL Productions, Thistle Creek Resources, Donner Minerals Limited and Teck Exploration Limited. Newfoundland and Labrador Geological Survey, Assessment File LAB/1390, 720 pages.

Fitzpatrick, D., Osmond, R., Campbell, K.V., Pattison, E.F., Phipps, D., Makela, J., Babineau, J. and Garrie, D.G., 1996: First and second year assessment report on geological, geochemical, geophysical and diamond drilling exploration for licences 657m-658m, 669m-671m, 686m-694m, 707m and 710m-712m on claims in the Voisey Bay area, Labrador, 7 reports, Voiseys Bay Nickel Company Limited. Newfoundland and Labrador Geological Survey, Assessment File LAB/1159, 1243 pages.

Flaherty, B.G., 1940: Brigus Head manganese deposit, Newfoundland, memo. Newfoundland and Labrador Geological Survey, Internal Report, Miscellaneous.

Fogwill, W.D. and Wahl, H., 1965: Results from exploration in the Mortons Harbour area in Nalco lot 2, Newfoundland, Newfoundland and Labrador Corporation Limited. Newfoundland and Labrador Geological Survey, Assessment File 2E/10/0148, 12 pages.

Foley, N.K., Jaskula, B.W., Piatak, N.M. and Schulte, R.F., 2017: Beryllium, Chapter E. *In* Critical Mineral Resources of the United States–Economic and Environmental Geology and Prospects for Future Supply. *Edited by* K.J. Schulz, J.H. DeYoung, Jr., R.R. Seal II and D.C. Bradle. U.S. Geological Survey Professional Paper 1802, pages E1-E32. https://doi.org/10.3133/pp1802E

Fong, C.C.K., 1968: Preliminary report on silica assessment, western Newfoundland. Newfoundland and Labrador Geological Survey, Assessment File NFLD/0435.

Fortune Business Insight, 2025: Direct reduced iron (DRI) market size, share & industry analysis, by form (pellets and others), by production process (gas-based and coal-based), by application (steel production, construction and others), and regional forecast, 2024–2032. https://www.fortunebusinessinsights.com/direct-reduced-iron-market-107381 (accessed August 2025)

Fortune Business Insight, 2023: Hafnium market size, share and COVID-19 impact analysis, by type (hafnium metal, hafnium oxide, hafnium carbide, and others), by application (super alloy, optical coating, nuclear plasma cutting, and others), and regional forecast 2023–2030. https://www.fortunebusinessinsights.com/hafnium-market-108578 (accessed October 2023)

Fowler, H.S. and West, P.W., 1954: Engineering report on fluorspar investigations in the St Lawrence area, Newfoundland. Kaiser Aluminum and Chemical Corporation. Newfoundland and Labrador Geological Survey, Assessment File 1L/14/0032, 41 pages.

French, V. A., 1990: Fifth year assessment report on geological, geochemical and trenching exploration for licence 3688 on claim blocks 4267-4268, 4589, 4702, 4707-4708 and 4768-4770 in the Kettle Pond area on Glover Island in Grand Lake, western Newfoundland. Newfoundland Goldbar Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 012A/12/0590, 144 pages.

French, V.A., Mugford, C., Kean, B.F., Venter, N., Kwan, K. and Prikhodko, A., 2012: Fifth year assessment report on geological, geochemical, geophysical, trenching and diamond drilling exploration for licence 17484M on claims in the Lloyds River area, south-central Newfoundland, 3 reports, Puddle Pond Resources Incorporated and North Range Resources Limited. Newfoundland and Labrador Geological Survey, Assessment File 12A/06/1643, 458 pages.

French, V.A., Mugford, C. and Northcott, C., 2010: First and third year assessment report on geological, geochemical, geophysical, trenching and diamond drilling exploration for licences 17369M and 17894M on claims in the Southwest Brook area, southwestern Newfoundland, 3 reports, Triple Nine Resources Limited. Newfoundland and Labrador Geological Survey, Assessment File NFLD/3237, 373 pages.

Froude, T., 2007: First year assessment report on diamond drilling exploration for licence 12374M on claims in the North Brook area, near Deer Lake, western Newfoundland, Spruce Ridge Resources Limited. Newfoundland and Labrador Geological Survey, Assessment File 12H/04/1953, 17 pages.

Froude, T., Roscoe, W.E., Cook, R.B., Wilton, D., Honarvar, P., Bowslaugh, E., Scott, W.J. and Woods, D., 2006: First, second and fourth year assessment report on compilation, prospecting and geochemical and geophysical exploration for licences 9781M, 9783M, 10367M-10368M, 10562M, 10613M-10616M, 10657M-10658M, 10715M-10723M, 11383M and 11395M-11396M on claims in the Moran Lake area, Central Labrador, 5 reports, Crosshair Exploration and Mining Corporation, and Triassic Properties Limited. Newfoundland and Labrador Geological Survey, Assessment File 13K/0293, 332 pages.

Fuller, J.O., 1941: Geology and mineral deposits of the Fleur-de-Lys area. Ph.D, thesis, Contributions from the Department of Geology, Columbia University, Volume 56, No 4. Geological Survey of Newfoundland, Bulletin No. 15, 47 pages. GeoFile Number 012I/01/0011.

Future Market Insights, 2025a: Antimony market growth – trends & forecast 2025 to 2035. https://www.futuremarketinsights.com/reports/antimony-market (accessed August 2025)

Future Market Insights, 2025b: Gulf Cooperation Council (GCC) barite market trends – growth, demand & forecast 2025–2035, GCC barite market size, growth & insights 2025–2035 (accessed October 2025)

Future Market Insights, 2025c: Magnesium metal market report – demand, growth & industry outlook 2025 to 2035, magnesium metal market size & forecast 2025–2035 (accessed October 2025)

Future Market Insights, 2025d: Bismuth oxide market growth – trends & forecast 2025 to 2035. https://www.futuremarketinsights.com/reports/bismuth-oxide-market (accessed October 2025)

Future Market Insights, 2025e: Molybdenum market outlook 2025 to 2035. https://www.futuremarketinsights.com/reports/molybdenum-market (accessed November 2025)

Future Market Insights, 2025f: Lead market growth – trends & forecast 2025 to 2035. https://www.futuremarketinsights.com/reports/global-lead-market (accessed November 2025)

Gale, G.H., 1967: Economic assessment of pegmatites, Newfoundland. Government of Newfoundland and Labrador, Department of Mines, Agriculture and Resources, Mineral Resources Division, 117 pages. GeoFile Number NFLD/0314.

Gale, G.H., 1965: Garrison Hills quartz prospect, Bay d'Espoir, Newfoundland. Government of Newfoundland and Labrador,Department of Mines, Agriculture and Resources, Mineral Resources Division, 10 pages. GeoFile Number 001M/0063.

Gandhi, S.S., 1970: Report on exploration during 1969-70 in the Aillik-Makkovik area, Labrador. British Newfoundland Exploration Limited. Newfoundland and Labrador Geological Survey, Assessment File 13O/03/0018, 17 pages.

George, P.W., 1935: Asarco, La Manche area, Placentia Bay, Newfoundland, correspondence on La Manche lead mine.

Gibbs, G.H., 1967: Primary report on the Green Bay properties, Newfoundland. Colchester Mines Limited. Newfoundland and Labrador Geological Survey, Assessment File 12H/09/0113.

Gillies, S.L., Clarke, E.J. and Northcott, C., 2009: First, second, third, fourth, fifth and seventh year assessment report on geological, geochemical, geophysical, trenching and diamond drilling exploration for licences 9781M, 9783M, 10367M-10368M, 10715M-10720M, 10722M-10723M, 11395M, 11770M, 11833M-11835M, 12616M-12618M, 13427M, 13634M-13635M and 14515M on claims in the Moran Lake - Otter Lake area, central Labrador, 2 reports. Crosshair Exploration and Mining Corporation. Newfoundland and Labrador Geological Survey, Assessment File 13K/0313, 2723 pages.

Gize, A., Born, P., Barnes, H.L., Slingerland, R., Goss, B. and Sterner, S.M., 1982: Assessment report on geological exploration for licence 2269 and a review of literature and reconnaissance exploration for lead and zinc mineralization in the Cambro-Ordovician carbonate belt of southwestern Newfoundland, 3 reports, Narex Ore Search Consultants Incorporated. Newfoundland and Labrador Geological Survey, Assessment File NFLD/1358, 170 pages.

Global Info Research, 2024: Global hafnium supply, demand and key producers, 2024–2030. https://www.globalinforesearch.com/reports/2227547/hafnium (website accessed August 2025)

Gonzáles, Y., Navarra, A., Jeldres, R.I. and Toro, N., 2021: Hydrometallurgical processing of magnesium minerals – A review. Hydrometallurgy, Volume 20. https://doi.org/10.1016/j.hydromet.2021.105573

Gowans, R.M., Lewis, W.J. and Zalnieriunas, R.V., 2017: NI 43-101 technical report for the updated mineral resource estimate for the Strange Lake property Québec, Canada for Quest Rare Minerals Ltd., Micon International Limited.

Gower, C.F., 2010: Mineral occurrences and metallogenesis in eastern Labrador. Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Open File LAB/1571, 155 pages.

Grady, J.C., 1953: The geology of the southern half of the Serpentine Belt in east-central Newfoundland. Government of Newfoundland and Labrador, Department of Mines and Natural Resources, Geological Survey. GeoFile Number 002D/11/0005.

Graham, D.R., 1990: Second, third and fifth year assessment report on prospecting, trenching, diamond drilling and geochemical exploration for the Great Bend project for licence 3270 on claim block 5457, licence 3271 on claim block 5458, licence 3272 on claim block 5460, licence 3563 on claim block 4113, licence 3836 on claim blocks 4112 and 4396 and licence 4023 on claim blocks 6403-6404 in the Northwest Gander River area, central Newfoundland. BP Resources Canada Limited. Newfoundland and Labrador Geological Survey, Assessment File 002D/11/0232, 188 pages.

Grandillo, A., Cassoff, J., Powell, J., Kociumbas, M. and Merry, P., 2018: Updated feasibility study of the Kamistiatusset (Kami) iron ore property, Labrador, prepared for: Alderon Iron Ore Corp. BBA Inc./Gemtec Ltd./Watts, Griffis and McOuat Ltd./Golder Associate Ltd. NI 43-101 Technical Report (SEDAR filing), 371 pages.

Grant, D.R., 1971: Report on geochemical exploration for Labrador Mining and Exploration Company Limited Block 135 in the Moss Lake area, Labrador, Labrador Mining and Exploration Company Limited. Newfoundland and Labrador Geological Survey, Assessment File LAB/0230, 8 pages.

Graves, G., 1986: Second and fourth year assessment reports on diamond drilling for licence 2539 on claim blocks 3312-3316 and licence 2474 in the Winter Hill and Frenchmans Head areas, southern Newfoundland, 2 reports. Granges Exploration Limited. Newfoundland and Labrador Geological Survey, Assessment File 1M/12/0245, 54 pages.

Greene, B. and Wolfson, I., 2013: First year supplementary assessment report on diamond drilling exploration for licence 20398M on claims in the Buchans Junction area, central Newfoundland, Canstar Resources Incorporated and Xstrata Zinc Canada. Newfoundland and Labrador Geological Survey, Assessment File 12A/15/1651, 116 pages.

Gregersen, E., 2024: "Hafnium". Encyclopedia Britannica. https://www.britannica.com/science/hafnium (website accessed July 2024)

GSNL Return on Registry of Mines, 1967-1971: Amendment Act, 1952. Government of Newfoundland and Labrador, Department of Mines and Agriculture, Financial and Project Analysis File# 8350010.

Guinchard, W. and Muggridge, M., 2018: First year assessment report on prospecting, diamond drilling and compilation for licence 25183M on claims in the Colville River area, western Labrador. Big Land Exploration Limited. Newfoundland and Labrador Geological Survey, Assessment File 23H/12/0165, 55 pages.

Gutzmer, J., Chisonga, B., Beukes, N. and Mukhopadhyay, J., 2008: The geochemistry of banded iron formation-hosted high-grade hematite-martite iron ores. Reviews in Economic Geology, Volume 15, pages 157-183.

Hansen, W.H., 1942: Report on manganese deposit in the Bruce Lake area, Labrador, Labrador Mining and Exploration Company Limited. Newfoundland and Labrador Geological Survey, Assessment File 23G/0178, 9 pages.

Harris, A., 1976: Report on compilation and economic analysis for Reid Lot 50 in the Lake Bond area, central Newfoundland, Reid Newfoundland Company Limited and Consolidated Morrison Explorations Limited. Newfoundland and Labrador Geological Survey, Assessment File 12H/01/1941, 38 pages.

Harris, J. and Dearin, C., 2007: Sixth year assessment report on diamond drilling exploration for licence 12723M on claims in the Grey River area, on the South Coast of Newfoundland, 2 reports, Playfair Mining Limited. Newfoundland and Labrador Geological Survey, Assessment File 11P/0230, 97 pages.

Harris, A. and Andrews, J.A., 1997: First year assessment report on geological and geochemical exploration for licence 5409m on claims in the Jigging Cove area, St Marys Bay, Newfoundland, Burin Minerals Limited. Newfoundland and Labrador Geological Survey, Assessment File 1K/13/0034, 22 pages.

Hayes, T.S., Miller, M.M., Orris, G.J., and Piatak, N.M., 2017: Fluorine, Chapter G. *In* Critical Mineral Resources of the United States–Economic and Environmental Geology and Prospects for Future Supply. *Edited by* K.J. Schulz, J.H. DeYoung, Jr., R.R. Seal II and D.C. Bradle. U.S. Geological Survey Professional Paper 1802, pages G1-G80. https://doi.org/10.3133/pp1802G

Hedenquist, J.W., Harris, M. and Camus, F., 2012: Geology and genesis of major copper deposits and districts of the world: A tribute to Richard H. Sillitoe. Society of Economic Geologists, Volume 16. https://doi.org/10.5382/SP.16

Heyl, G.R., 1936: Geology and mineral deposits of the Bay of Exploits area. Government of Newfoundland and Labrador, Department of Natural Resources, Geological Section, Bulletin No. 03, 69 pages. GeoFile Number 002E/06/0028.

Hertel, M., Podhorski-Thomas, M., Durston, K., Edwards, C. and Allard, S., 2009: Michelin Uranium Project Labrador, Canada NI 43-101 Technical Report on Preliminary Assessment, Fronteer Development Group Inc. https://secure.kaiserresearch.com/i/jk/tr16/TRFRG20090801.pdf

Hicks, D., 2011: First year assessment report on compilation and exploration history for licence 18052M on claims in the Fox Island River area, western Newfoundland. Newfoundland and Labrador Geological Survey, Assessment File 12B/10/0609, 13 pages.

Higgins, N.C. and Kerrich, R., 1985: Progressive 18O depletion during CO2 separation from a carbon dioxide-rich hydrothermal fluid: evidence from the Grey River tungsten deposit, Newfoundland. Canadian Journal of Earth Sciences, Volume 22, Number 9, pages 1381-1382.

Hill, J.D., 1991: Emplacement and tectonic implications of the Mid-Proterozoic peralkaline Flowers River Igneous Suite, north-central Labrador. Precambrian Research, Volume 49, No. 3/4, pages 217-227.

Hoffman, S.J., Pitman, P. and Walker, J.L., 1978: Report on geological, geochemical and geophysical investigations on Nalco lot 4 on the Burin Peninsula, Newfoundland, 3 volumes, Newfoundland and Labrador Corporation Limited and BP Minerals Limited. Newfoundland and Labrador Geological Survey, Assessment File NFLD/1059, 304 pages.

Hoag Jr, R.B., 1971: Exploration report on the Martin Lake area, Labrador, Labrador Mining and Exploration Company Limited. Newfoundland and Labrador Geological Survey, Assessment File 23J/16/0074, 20 pages.

Hopfengaerther, F., 1982: Airborne spectrometry survey over the Ackley and Middle Ridge plutons in the Belleoram area, Newfoundland. Saarberg-Interplan Canada Limited. Newfoundland and Labrador Geological Survey, Assessment File NFLD/1295, 13 pages.

Hopfengaertner, F., 1982: First year assessment report on geological, geochemical and geophysical exploration for licence 1989 on claim block 2455 in the Grand le Pierre area, Newfoundland. Saarberg-Interplan Canada Limited. Newfoundland and Labrador Geological Survey, Assessment File 001M/10/0205, 19 pages.

Hora, Z.D. and Hansink, J., 2001: Prefeasibility report and marketing study, hutton garnet beaches, northern labrador. Freeport Resources Inc., March 11, 2001.

Horning, A.C., 1941: Fox Island River, Newfoundland-chromite property. Newfoundland and Labrador Geological Survey, Internal Report, Miscellaneous.

House, S., 2011: Third year assessment report on geological exploration for licence 12774M on claims in the Kingurutik Lake area, northern Labrador, Benton Resources Corporation and Teck Resources Limited. Newfoundland and Labrador Geological Survey, Assessment File 14D/16/0336, 21 pages.

House, S. and Spencer, M., 2010: First, third and fourth year assessment report on prospecting and diamond drilling exploration for licences 12736M, 12772M, 12807M, 12813M, 12919M-12920M, 13594M, 13706M-13708M, 13712M-13713M, 15506M and 15643M on claims in the Kingurutik Lake area, northern Labrador. Newfoundland and Labrador Geological Survey, Assessment File LAB/1639, 113 pages.

Howse, A.F., 1992: Barite resources of Newfoundland. Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey Branch, Mineral Resources Division, Mineral Resources Report 06, 59 pages.

Howse, A.F. and Collins, C.J., 1983: Barite evaluation in three areas of southeastern Newfoundland. *In* Preliminary Current Research Reports. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Preliminary Progress Reports, pages 119-123. GeoFile Number NFLD/2241.

Howse, A.F. and French, V.A., 1983: Barite evaluation-eastern and western Newfoundland. *In* Current Research. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Report 83-01, pages 150-156.

Huang, J., Huang, F., Evans, L. and Glasauer, S., 2015: Vanadium: Global (bio)geochemistry. Chemical Geology, Volume 417, pages 68-89.

Huang, J., Zhang, Q., Li, H. and Wang, C., 2022: Difficulties and recent achievements in flotation separation of fluorite from calcite–An overview. Minerals 2022, Volume 12. https://doi.org/10.3390/min12080957

Hussey, A.M. and Dyke, B., 2004: Second year assessment report on prospecting and geochemical exploration for licence 9661M on claims in the Natashquan River area, southern Labrador, Cornerstone Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 13D/06/0034, 55 pages.

Hussey, A.M. and Moore, P.J., 2005: Second year assessment report of geology and lithogeochemistry on Licence 10783M, Adlatok property, NTS 13N/02, Labrador. Cornerstone Resources Inc. Newfoundland and Labrador Geological Survey, Assessment File 13N/02/0127, 41 pages.

Hutchings, C., Dwyer, L. and Scott, W.J., 1999: First and second year assessment report on geological, geochemical and geophysical exploration for licences 5643m, 5693m, 5707m, 5742m, 5823m, 5824m, 5905m, 6011m, 6013m-6017m, 6019m, 6020m, 6023m, 6024m and 6184m-6187m on claims in the Musgravetown area, on the Bonavista Peninsula, Newfoundland, 2 reports, Cornerstone Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File NFLD/2678, 297 pages.

Hutchings, C., Kahlert, B.H., Mullen, D.V., Campbell, K.V., Le Couteur, P.C. and LeBel, J.L., 2006: First year, first year supplementary and second year assessment report on geological, geochemical, geophysical and trenching exploration for licences 10019M-10021M, 10455M, 10470M, 10619M-10621M, 10646M and 10695M on claims in the Blue Hills of Couteau and White Bear River areas, southern Newfoundland, 2 reports, Commander Resources Limited, Nfld and Lab Minerals. Newfoundland and Labrador Geological Survey, Assessment File 11P/0213, 284 pages.

Idoine, N.E., Raycraft, E.R., Hobbs, S.F., Everett, P., Evans, E.J., Mills, A.J., Shaw, I.R., Watkins, I. and Shaw, R.A., 2025: World Mineral Production 2019-23. British Geological Survey, Keyworth, Nottingham.

IEA (International Energy Agency), 2025: Global critical minerals outlook 2025. IEA Publications. https://www.iea.org/reports/global-critical-minerals-outlook-2025

Infini Resources, 2025: Portland Creek project. https://infiniresources.com.au/portland-creek-project/ (accessed October 2025).

International Copper Association, 2021: Copper recycling. https://internationalcopper.org/wp-content/uploads/2022/02/ICA-RecyclingBrief-202201-A4-R2.pdf (website accessed March 2024)

International Iron Metallics Association, 2018: The global HBI/DRI market: Outlook for DR Grade pellet supply. https://www.metallics.org/assets/files/Public-Area/Presentations/AMM_181128.pdf (accessed August 2025).

International Molybdenum Association (IMOA), 2023: The voice of the molybdenum industry worldwide. https://www.imoa.info/index.php (accessed July 2024).

International Seabed Authority, 2006: International seabed authority workshop on mining of cobalt-rich ferromanganese crusts and polymetallic sulphides – Technological and economic considerations. Background paper prepared by the secretariat. https://www.isa.org.jm/

International Tin Association, 2020: Report on global tin resources and reserves. https://www.internationaltin.org/wp-content/uploads/2020/02/Global-Resources-Reserves-2020-Update.pdf

International Zinc Association, 2022: About cycles, recycling and circular economy. https://www.zinc.org/resources (accessed July 2023).

INN (Investing News Network), 2024: Graphite market forecast: Top trends that will affect graphite in 2024 https://investingnews.com/daily/resource-investing/battery-metals-investing/graphite-investing/graphite-forecast/ (accessed July 2024)

Iron Ore Company of Canada (IOC), 2014: Wabush 3 Open Pit Mine Project: Environmental Impact Statement.

Iron Ore Company of Canada (IOC), 2001: Luce Pit Continuation of the Carol Mining Progect Registration/Referal. Iron Ore Company of Canada. Newfoundland and Labrador Geological Survey, Internal Collection, Company or Consultant Report, 98 pages.

Jagodits, F.L. and Thurlow, J.G., 2000: Assessment report on geological, geochemical, geophysical and diamond drilling exploration for 1999 submission for the Anglo-Newfoundland Development Company Limited Charter, fee simple grant Volume 2 Folio 29 and Reid Lot 247, and for first and ninth year assessment for licence 4117 on claim block 8058 and licences 6967M-6970M on claims in the Buchans Junction area, central Newfoundland, 2 reports, Phelps Dodge Corporation of Canada Limited and Noranda Mining and Exploration. Newfoundland and Labrador Geological Survey, Assessment File 12A/1026, 342 pages.

Jones III, J.V., Piatak, N.M. and Bedinger, G.M., 2017: Zirconium and hafnium, Chapter V. *In* Critical Mineral Resources of the United States–Economic and Environmental Geology and Prospects for Future Supply. *Edited by* K.J. Schulz, J.H. DeYoung, Jr., R.R. Seal II and D.C. Bradle. U.S. Geological Survey Professional Paper 1802, p. V1-V26. https://doi.org/10.3133/pp1802V

Kahlert, B.H. and Hitchcock, D., 2007: Second year and third year supplementary assessment report on prospecting and geochemical and geophysical exploration for licences 11410M-11412M, 11414M, 11418M, 11421M, 11426M, 11455M, 12199M and 13327M on claims in the Blue Hills and White Bear River areas, south-central Newfoundland, Commander Resources Limited. Newfoundland and Labrador Geological Survey, Assessment File NFLD/3022, 116 pages.

Kavanagh, P.M., 1952: Geology of the Point Lake area, Labrador. Iron Ore Company of Canada. Newfoundland and Labrador Geological Survey, Assessment File 023J/0014, 66 pages.

Keller, D.G., Bernier, S. and Couture, J.-F., 2012: Independent Technical Report for the Main Zone of the Long Lake Volcanic Massive Sulphide Project, Newfoundland and Labrador, Canada, SRK Consulting (Canada) Inc. https://www.gov.nl.ca/iet/files/mines-investments-companysheets-base-metals-long-lake-vms.pd

Kelley, K.D., Scott, C.T., Polyak, D.E. and Kimball, B.E., 2017: Vanadium, Chapter U. *In* Critical Mineral Resources of the United States–Economic and Environmental Geology and Prospects for Future Supply. *Edited by* K.J. Schulz, J.H. DeYoung, Jr., R.R. Seal II and D.C. Bradle. U.S. Geological Survey, Professional Paper 1802, pages U1–U36. https://doi.org/10.3133/pp1802U

Kerr, A., 2002: A reconnaissance study of platinum-group-element (PGE) contents from magmatic sulphide mineralization in Labrador. *In* Current Research. Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey, Report 02-1, pages 327-341.

Kerr, A., 1999: The Powderhorn Lake Ni–Cu showings and the potential for magmatic sulphide mineralization in central Newfoundland. *In* Current Research. Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey, Report 99-1, pages 205-214.

Kerr, A. and Rafuse, H., 2011: Mineral commodities of Newfoundland and Labrador: Rare earth Elements (including Y, Zr, Nb, Be). Geological Survey of Newfoundland and Labrador, Mineral Commodities Series Number 6.

Kerr, A. and Smith, J.L., 1997a: A summary of 1997 exploration activities in the northern Labrador nickel play. *In* Report of Activities. Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey, Report of Activities, pages 21-25.

Kerr, A. and Smith, J.L., 1997b: The search for magmatic Ni–Cu–Co mineralization in northern Labrador: A summary of active exploration programs. *In* Current Research. Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey, Report 97-1, pages 73-91.

Kerr, A., van Nostrand, T.S., Dickson, W.L. and Lynch, E.P., 2009: Molybdenum and tungsten in Newfoundland: A geological overview and a summary of recent exploration developments. *In* Current Research. Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Report 09-1, pages 43-80.

Ketchum, J.W.F., Barr, S.M., Culshaw, N.G. and White, C.E., 2001: U–Pb ages of granitoid rocks in the northwestern Makkovik Province, Labrador: Evidence for 175 million years of episodic synorogenic and post-orogenic plutonism. Canadian Journal of Earth Sciences, Volume 38, pages 359-372.

Kirby, F.T., Ricketts, R.J., Vanderveer, D.G. and Gibbons, R.V., 1983: Inventory of aggregate resources in Newfoundland and Labrador, information report and index maps to accompany aggregate resource map series, 1:250,000. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Report 83-02, 41 pages.

Kirkham, R.V., 1987: Buchans Geology, Newfoundland. Geological Survey of Canada, Paper 86-24, 288 pages.

Knight, I. and Fong, C.C.K., 1977: St Fintans-Dashwood Pond, St Georges District. Map 77-3. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Open File 012B/0209.

Kogarko, L.N., 1990: Ore-forming potential of alkaline magmas. Lithos, Volume 26, Issues 1-2, pages 167-175. https://doi.org/10.1016/0024-4937(90)90046-4

Kohlsmith, R.L., 1986: Third year assessment report on diamond drilling for licence 2886 on claim blocks 3277 and 3537 in the Great Gull Lake area, Newfoundland. Kidd Creek Mines Limited. Newfoundland and Labrador Geological Survey, Assessment File 2D/0168, 52 pages.

Kolesnikova, A., 2023: Rare earth elements: small market, big necessity, Adamas Intelligence report. https://www.adamasintel.com (accessed January 2024)

Kressall, R., Harrington, M., Pelletier, C. and Cassoff, J., 2023: NI 43-101 Technical Report mineral resource estimate Labrador West Iron Project Newfoundland and Labrador, Canada. https://www.gov.nl.ca/iet/files/Labrador-West.pdf

Lacelle, J., Champagne, A., Accad, E., Purchase, J., Sirois, R., de Freidberg, A.S., Copeland, A., Jansons, K. and Berton, A., 2021: Feasibility Study Technical Report – Update Scully Mine Re-start Project Wabush, Newfoundland & Labrador, Canada, G mining Services for Tacora Resources. https://minedocs.com/22/Scully_Mine-FS-05312021.pdf

Leach, D., Bradley, C.D., Huston, D., Pisarevsky, S.A., Taylor, R.D. and Gardoll, S.J., 2010: Sediment-hosted lead-zinc deposits in earth history. Economic Geology, Volume 105(3), pages 593-625. https://doi.org/10.2113/gsecongeo.105.3.593

Leach, D., Sangster, D.F., Kelley, K.D. Large, R.R., Garven, G., Allen, C.R., Gutzmer, J. and Walters, S., 2005: "Sediment-hosted lead-zinc deposits: A global perspective". *In* One Hundredth Anniversary Volume. *Edited by* J.W. Hedenquist, J.F.H. Thompson, R.J. Goldfarb and J.P. Richards. Society of Economic Geologists. https://doi.org/10.5382/AV100

Leach, D.L., Taylor, R.D., Fey, D.L., Diehl, S.F. and Saltus, R.W., 2010: A deposit model for Mississippi Valley-type lead-zinc ores: U.S. Geological Survey, Scientific Investigations Report 2010-5070-A, Mineral Deposit Models for Resource Assessment, 64 pages.

Lebel, L., 2010: First and seventeenth year assessment report on geophysical exploration for licences 9813M and 15579M-15581M on claims in the Kings Point area, central Newfoundland, Commander Resources Limited. Newfoundland and Labrador Geological Survey, Assessment File 12H/09/2142, 64 pages.

Lee, C., 2024: We rely heavily on lithium batteries – but there's a growing array of alternatives. BBC article: https://www.bbc.com/future/article/20240319-the-most-sustainable-alternatives-to-lithium-batteries (accessed August 2025).

Legein, P., 1982: Second year assessment report on geological, geochemical, geophysical and diamond drilling exploration for licence 1686 on claim block 1951 in the Isle aux Morts and Twin Ponds areas, southwestern Newfoundland. Utah Mines Limited. Newfoundland and Labrador Geological Survey, Assessment File 011O/0138, 75 pages.

Lehmann, B., 2021: Formation of tin ore deposits: A reassessment. Lithos, Volumes 402-403. https://doi.org/10.1016/j.lithos.2020.105756

Lionetto, F., Arianpouya, N., Bozzini, B., Maffezzoli, A., Nematollahi, M. and Mele, C., 2024: Advances in zinc-ion structural batteries. Journal of Energy Storage, Volume 84, Part A. ISSN 2352-152X. https://doi.org/10.1016/j.est.2024.110849

Liu, J., Huang, Y., Li, H. and Duan, H., 2022: Recent advances in removal techniques of vanadium from water: A comprehensive review. Chemosphere, Volume 287, Part 1. https://doi.org/10.1016/j.chemosphere.2021.132021

Liu, B., Ma, B., Lv, Y., Wang., C. and Chen, Y., 2022: Selective recovery and efficient separation of lithium, rubidium, and cesium from lepidolite ores. Separation and Purification Technology, Volume 288, ISSN 1383-5866. https://doi.org/10.1016/j.seppur.2022.120667

Liu, J., Tao, Y., Chang, T., Ge, W., Jiang, K., Lv, L., Zhu, Y. and Yuan, S., 2024: Study on flotation separation of barite fluorite by citric acid under new collector system. Colloids and Surfaces A: Physicochemical and Engineering Aspects, Volume 692, ISSN 0927-7757. https://doi.org/10.1016/j.colsurfa.2024.134058

Love, H.D., 1967: Report on diamond drilling, geochemical and geophysical surveys of lease block No 135 in the Montgomery Lake area, Labrador. Labrador Mining and Exploration Company Limited. Newfoundland and Labrador Geological Survey, Asessment File 23I/0015, 127 pages.

Lyons, E., 2016: NI 43-101 technical report on the Lynx Lake copper-cobalt property Happy Valley-Goose Bay, Labrador, Canada. Tekhne Research Inc; for Kings Bay Gold Corporation.

Ma, Y., Li, J., Wu, Z., Zhang, H., Tan, X., Yi, Y., Tan, Q. and Liu, L., 2025: Characteristics of high-purity quartz raw materials for crucibles and exploration of key purification technologies. Minerals Engineering, Volume 231, Article 109446, ISSN 0892-6875.

MacDougall, C., Perry, I. and MacInnis, D., 1991: Exploration potential of the York Harbour deposit-a high grade Cu-Zn, Cyprus-type volcanogenic massive sulphide deposit. In Ore Horizons. Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey Branch, Ore Horizons Volume 1, pages 99-118.

MacFarlane, A. and Butler, S., 2013: Fifth year assessment report on prospecting and geochemical, and trenching exploration for licences 15374M-15375M and 21295M on claims in the Port Hope Simpson - St Lewis Inlet area, southeastern Labrador, Search Minerals Incorporated and Alterra Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 13A/0105, 265 pages.

MacVeigh, J.G., 2003: First and third year assessment report on prospecting and geochemical exploration for licence 7497M, 8668M-8670M, 8678M and 8740M on claims in the New World Island area, Notre Dame Bay, Newfoundland, Rubicon Minerals Corporation. Newfoundland and Labrador Geological Survey, Assessment File 2E/1301, 241 pages.

Magyarosi, Z., 2022: Preliminary investigation of rare-earth-element mineralization, Fox Harbour Volcanic Belt, southeastern Labrador. *In* Current Research. Government of Newfoundland and Labrador, Department of Industry, Energy and Technology, Geological Survey, Report 22-1, pages 57-83.

Magyarosi, Z., 2019: Geochemical data from granitic rocks in south-central Newfoundland (NTS map areas 12A/07, 08, 09 and 10). Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Open File 012A/1802, 9 pages.

Magyarosi, Z. and Rayner, N., 2023: Petrography, geochemistry and geochronology of the REE-mineralized Fox Harbour Volcanic Belt, southeastern Labrador. *In* Current Research. Government of Newfoundland and Labrador, Department of Industry, Energy and Technology, Geological Survey, Report 23-1, pages 47-75.

Maloney, S. and Pilgrim, L., 2012: Assessment report on mine development and diamond drilling exploration for 2011 submission for Mining Leases 141L [4532] and 188L [10241M] and for twelfth year assessment for licence 14692M on claims in the Three Corner Pond area, on the Baie Verte Peninsula, Newfoundland, Rambler Metals and Mining Canada Limited. Newfoundland and Labrador Geological Survey, Assessment File 12H/16/2211, 222 pages.

Mandoakar, A., 2019: Manganese market research report information by type (high carbon ferromanganese, medium carbon ferromanganese, low carbon ferromanganese, silico-manganese, electrolyte manganese metal, and electrolyte manganese dioxide), by application (coloring agent, oxidizing agent, alloying additive, polarizer, and others), and by region (North America, Europe, Asia-Pacific, and rest of the world) – Market Forecast Till 2027. Manganese Market Size, Share and Growth | Report, 2032. (accessed August 2023)

Mantilla, R.F.R., Sanchez, A.C., Figueroa, R.R. and Roberto, R.A.R., 2024: Lithium recovery from brines, hard rock deposits, and clay. International Journal of Recent Advances in Multidisciplinary Topics, Volume 5, Issue 11. https://www.ijramt.com | ISSN (Online): 2582-7839

Maritime Resources, 2020: Green Bay project summary, Lochinvar Deposit (Zn, Pb, Cu, Ag, Au). https://maritimeresourcescorp.com/exploration/green-bay-project/

Market Research Future, 2025: Bismuth market, https://www.marketresearchfuture.com/reports/bismuth-market-2468 (accessed October 2025).

Mattinson, C.R., 1950: Manganiferous and calcareous sediments at Broad Cove, Trinity Bay, Newfoundland. B.Sc. thesis, Queen's University, Kingston, Ontario, 72 pages.

Maximize Market Research, 2025: Cesium market: Global industry analysis and forecast (2025–2032). www.maximizemarketresearch.com (accessed August 2025).

McCartney, W.D., 1966: Geology, Whitbourne, St Johns, west half, Newfoundland. Geological Survey of Canada, "A" Series Map 1168A.

McCartney, W.D.,1967: Whitbourne map area, Newfoundland. Geological Survey of Canada, Memoir 341, 135 pages.

McHale, K.B., 1985: First year assessment report on geological, geochemical and trenching exploration for licence 2527 on claim blocks 4002-4009 in the Little River area, south-central Newfoundland. Westfield Minerals Limited. Newfoundland and Labrador Geological Survey, Assessment File NFLD/1493, 120 pages.

McKillop, J.H., 1961: Preliminary report on chromite exploration, Newfoundland. Government of Newfoundland and Labrador, Department of Mines, Agriculture and Resources. GeoFile Number 012B/15/0074.

McKillop, J.H., 1952: Graphite prospect, Fair and False Bay, Bonavista Bay, Newfoundland. Government of Newfoundland and Labrador, Department of Mines, Agriculture and Resources. GeoFile Number 002C/12/0008.

McNutty, B.A. and Jowitt, S.M., 2021: Barriers to and uncertainties in understanding and quantifying global mineral and element supply. iScience, Volume 24, Issue 7, 102809, ISSN 2589-0042.

Melihercsik, S.J., 1952: Geology of the Gaisson Lake-Bray Lake area, Labrador. Iron Ore Company of Canada. Newfoundland and Labrador Geological Survey, Assessment File 23J/0015, 24 pages.

Meng, F., McNeice, J., Zadeh, S.S. and Ghahreman, A., 2021: Review of lithium production and recovery from minerals, brines, and lithium-ion batteries. Mineral Processing and Extractive Metallurgy Review, Volume 42(2), pages 123-141. https://doi.org/10.1080/08827508.2019.1668387

Mercer, R., 2009: Eleventh year assessment report on sampling, geochemical exploration and environmental studies for licence 6123m on claims in the Buchans area, Newfoundland, 2 reports, Atlantic Barite Limited. Newfoundland and Labrador Geological Survey, Assessment File 12A/15/1494, 53 pages.

Mercer, R. and Scott, W.J., 1998: First year assessment report on industrial mineral quality tests, trenching and diamond drilling exploration for licences 5923m, 5924m on claims in the Boswarlos area, on the Port au Port Peninsula, western Newfoundland, 10324 Newfoundland Limited. Newfoundland and Labrador Geological Survey, Assessment File 12B/10/0410, 58 pages.

Meyer, J.R. and Dean, P.L., 1988: Industrial minerals and follow-up of lake- and stream- sediment geochemical anomalies in Labrador. *In* Current Research. Government of Newfoundland and Labrador, Department of Mines, Mineral Development Division, Report 88-01, pages 247-259.

Meyer, J.R. and Dean, P.L., 1986: Industrial minerals in Labrador. *In* Current Research. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Report 86-01, pages 1-8.

Meyer, W.T. and Wagg, D.M., 1968: A statistical study of uranium-U308-accumulation in the Kitts deposit, Labrador. British Newfoundland Exploration Limited. Newfoundland and Labrador Geological Survey, Assessment File 13J/14/0045, 32 pages.

MIDREX (Midrex Technologies Inc.), 2023: World direct reduction statistics. https://www.midrex.com/wp-content/uploads/MidrexSTATSBook2023.Final_.pdf

Miller, R.R., 1994: Rare-metal metallogeny in Newfoundland and Labrador. Final Report. Geoscience Contract, Project NC.1.2.1. Canada-Newfoundland Cooperation Agreement on Mineral Development (1990-1994). Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey Branch, Geofile Number NFLD/2727

Mohr, S., Giurco, D., Retamal, M., Mason, L. and Mudd, G., 2018: Global projection of lead–zinc supply from known resources. Resources, 7. 17. 10.3390/resources7010017

Montague, E., 2007: Thirteenth year assessment report on prospecting and geochemical exploration for licence 678M on claims in the Labrador City area, western Labrador. Shabogamo Mining and Exploration Limited. Newfoundland and Labrador Geological Survey, Assessment File 23B/15/0191, 11 pages.

Moore, J.C.G., 1954: Report on the Kaipokok River Concession, Labrador. Amco Exploration Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 13K/0007, 30 pages.

Moore, M., 2011: First year assessment report on compilation and diamond drilling exploration for licences 17252M-17253M, 17279M and 17341M on claims in the Seal Lake area, central Labrador. Playfair Mining Limited. Newfoundland and Labrador Geological Survey, Assessment File LAB/1649, 230 pages.

Moore, M., 2008a: Second, third- and thirteenth-year assessment report on prospecting and geochemical, trenching and diamond drilling exploration for licences 7739M, 10678M and 11296M on claims in the Granite Lake area, central Newfoundland, Buchans River Limited and Playfair Mining Limited. Newfoundland and Labrador Geological Survey, Assessment File 12A/1448, 149 pages.

Moore, M., 2008b: First year assessment report on prospecting and geochemical exploration for licence 13436M on claims in the Grey River area, southern Newfoundland, Playfair Mining Limited. Newfoundland and Labrador Geological Survey, Assessment File 11P/11/0236, 37 pages.

Moore, P., Butler, D., Au, K., Legault, J., Hefford, S., Kaminski, V. and Osmond, R.T., 2009: First, third and fifth year assessment report on prospecting and geochemical, geophysical and trenching exploration for licences 10062M, 11409M, 14324M-14325M, 14331M-14332M, 14335M and 14337M-14338M on claims in the Puddle Pond to Lloyds River area, central Newfoundland, 2 reports, Royal Roads Corporation, Benton Resources Corporation, Golden Dory Resources Limited, Quest Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 12A/05/1391, 138 pages.

Moran, C., 2012: Second year assessment report on prospecting and geochemical, geophysical and trenching exploration for license 17333M on claims in the St Lewis Inlet area, southeastern Labrador. Search Minerals and Alterra Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 13A/08/0087, 799 pages.

Moreton, C., 2007: Grey River Property, NL. NI 43-101 Compliant Resource Study, Wardrop Engineering. https://playfairmining.com/site/assets/files/3719/grey-river-june-2007-43-101.pdf#:~:text=The%20Grey%20River%20Tungsten%20property%20is%20located%20on

Morrissy, C. and House, G., 1998: Tenth year assessment report on diamond drilling exploration for licence 4813 on claim blocks 7809-7813 and 8015 and claims 16304-16305, 17152-17154 and 17629, and 1997 submission for mining lease 146 in the Beaver Brook area, central Newfoundland, 2 reports. Newfoundland and Labrador Geological Survey, Assessment File 2D/11/0325, 345 pages.

Morse, S.A., 1969: The Kiglapait Layered Intrusion, Labrador. Geological Society of America, Memoirs 112, 212 pages.

Mudd, G.M. and Jowitt, S.M., 2014: A detailed assessment of global nickel resource trends and endowments. Economic Geology, Volume 109, Number 7. https://doi.org/10.2113/econgeo.109.7.1813

Mudd, G.M., Jowitt, S.M. and Timothy, T.W., 2018: Global platinum group element resources, reserves and mining – A critical assessment. Science of The Total Environment, Volumes 622–623, pages 614-625, ISSN 0048-9697.

Mungall, J.E. and Naldrett, A.J., 2008: Ore deposits of the platinum-group elements. Elements; Volume 4, Number 4, pages 253-258. https://doi.org/10.2113/GSELEMENTS.4.4.253

Myllyaho, J., 2010: Third and fifth year assessment report on compilation and exploration history for licences 10310M and 12980M on claims in the Betts Big Pond area, on the Baie Verte Peninsula, Newfoundland, Metals Creek Resources Limited. Newfoundland and Labrador Geological Survey, Assessment File 2E/13/1681, 21 pages.

Nash, W.A., Grammatikopoulos, T. and Watson, D., 1998: Third year assessment report on geophysical and diamond drilling exploration for licence 5446m on claims in the Puttuaalu Brook area, Labrador, 3 reports, Cartaway Resources Corporation, International Canalaska Resources Limited and International Freegold Mineral Development Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 14E/01/0193, 104 pages.

Nickel Institute, 2017: Nickel recycling. https://nickelinstitute.org/en/policy/nickel-life-cycle-management/nickel-recycling/ (accessed March 2024).

Nielsen, P.E., 2010: First year and first year supplementary assessment report on geophysical exploration for licences 16277M-16278M, 16347M-16348M, 16451M-16452M, 16472M, 16475M, 16479M, 16521M-16524M, 16529M, 16545M-16548M, 16550M-16554M, 16560M, 16591M-16592M, 16597M, 16608M, 16610M, 16612M, 16615M, 16617M-16619M, 17128M, 17140M-17151M, 17228M, 17229M, 17371M-17372M, 17660M-17662M AND 17723M on claims in the Letitia Lake - Shallow Lake area, central Labrador, 2 reports, Rare Earth Metals Incorporated, Dahrouge Geological Consulting Limited, Cornerstone Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File LAB/1647, 55 pages.

Nolan, F.J., 1969: Report on molybdenite deposit in the Rencontre East area, Newfoundland. Norlex Mines Limited. Newfoundland and Labrador Geological Survey, Assessment File 1M/11/0120, 48 pages.

NRCan: Natural Resource Canada, 2024: Lithium facts. https://natural-resources.canada.ca/minerals-mining/mining-data-statistics-analysis/minerals-metals-facts/lithium-facts (accessed August 2025)

NRCan: Natural Resource Canada, 2023: Cobalt facts. https://natural-resources.canada.ca/our-natural-resources/minerals-mining/mining-data-statistics-and-analysis/minerals-metals-facts/cobalt-facts/24981#L2 (accessed May 2024)

NRCan: Natural Resource Canada, 2023: Zinc facts: https://natural-resources.canada.ca/our-natural-resources/minerals-mining/mining-data-statistics-and-analysis/minerals-metals-facts/zinc-facts/20534 (accessed May 2024)

NRCan: Natural Resource Canada, 2023: Platinum facts: https://natural-resources.canada.ca/our-natural-resources/minerals-mining/mining-data-statistics-and-analysis/minerals-metals-facts/platinum-facts/20520 (accessed May 2024)

NRCan: Natural Resource Canada, 2022: The Canadian Critical Minerals Strategy, from Exploration to Recycling: Powering the Green and Digital Economy. https://www.canada.ca/content/dam/nrcan-rncan/site/critical-minerals/Critical-minerals-strategyDec09.pdf

Nuri, A., 1980: Geological reconnaissance of a portion of the AND Grant and Reid lots 227 and 228 for the Victoria Lake project in the Burnt Pond area, south-central Newfoundland. Hudsons Bay Oil and Gas Company Limited, Reid Newfoundland Company Limited, Atlantic Analytical Services Limited, X-Ray Assay Laboratories Limited, and Abitibi-Price Incorporated. Newfoundland and Labrador Geological Survey, Assessment File, 12A/0290, 35 pages.

Nzeh, N.S., Popoola, A.P.I., Adeleke, A.A. and Adeosun, S.O., 2022: Factors and challenges in the recovery of niobium and tantalum from mineral deposits, recommendations for future development – A review. Materials Today: Proceedings, Volume 65, Part 3, pages 2184-2191.

O'Driscoll, J. and Sparkes, K., 2008: First and third year assessment report on geological, geochemical, geophysical and diamond drilling exploration for licences 9742M, 9744M-9746M and 12697M on claims in the Skidder Brook area, near Red Indian Lake, central Newfoundland, 2 reports, South Coast Ventures Incorporated and Messina Minerals Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 12A/1443, 145 pages.

OECD (Organization for Economic Co-operation and Development), 2025: OECD Steel Outlook 2025, OECD Publishing, Paris https://doi.org/10.1787/28b61a5e-en

O'Leary, J., Cannell, R. and Honsberger, D., 1972: Ore reserve estimation methods and grade control at the Scully Mine, Canada – An integrated geological/geostatistical approach. Mining Magazine, pages 300-314.

O'Reilly, D., Devereaux, A., Courage, D., Winter, L., Churchill, R., Annesley, I.R. and Bradley, K., 2010: First and second year assessment report on geological, geochemical and trenching exploration for licences 16779M, 16829M-16830M, 16832M, 16836M-16837M, 16842M, 16848M, 16854M and 16858M-16867M on claims in The Topsails area, west-central Newfoundland, 3 reports, JNR Resources Incorporated and Altius Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File NFLD/3148, 390 pages.

O'Sullivan, J., Ralph, K., Ruygrok, G.M., Ryan, T., St-Hilaire, C., Piercey, S.J. and Wilton, D.H.C., 1999: Castle Rock Exploration Corporation, United Compass Resources Limited, Arc Resources Incorporated, Absolut Resources and Newfoundland Mining and Exploration Limited. Newfoundland and Labrador Geological Survey, Assessment File LAB/1286, 602 pages.

O'Toole, K.C., 1970: Preliminary report on diamond drilling for tungsten in the Gander Bay area, Newfoundland. Newfoundland and Labrador Corporation Limited. Newfoundland and Labrador Geological Survey, Assessment File 002E/07/0343, 8 pages.

Pandey, G., Mukhopadhyay, S., Renjith, A.U., Joshi, J.M. and Shenoy, K.T., 2015: Recovery of Hf and Zr from slurry waste of zirconium purification plant using solvent extraction. Chemical Engineering Division, Bhabha Atomic Research Centre, Trombay, Mumbai 400 085, India.

Peach, P.A., 1960: Molybdenum mineralization on the Aillik Peninsula in the Makkovik Bay area, Labrador. British Newfoundland Exploration Limited. Newfoundland and Labrador Geological Survey, Assessment File 13O/03/0042, 35 pages.

Pearson, C.D. and Green, J.D., 1993: Vanadium and nickel complexes in petroleum resid acid, base, and neutral fractions. Energy & Fuels, Volume 7(3), pages 338-346. National Inst. for Petroleum and Energy Research, Bartlesville, OK United-States.

Pearson, W.N. and Cullen, M., 2015: Twelfth year assessment report on compilation and resource estimation for licence 11130M on claims in the Hope Brook area, southern Newfoundland, 2 reports, Coastal Gold Corporation. Newfoundland and Labrador Geological Survey, Assessment File 11O/09/0434, 300 pages.

Penney, G. and Nielsen, P., 2011a: Third year assessment report on diamond drilling exploration for licence 16277M on claims in the Two Tom Lake area, central Labrador, Rare Earth Metals Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 13L/01/0148, 140 pages.

Penney, G. and Nielsen, P., 2011b: Second year assessment report on prospecting and geochemical and diamond drilling exploration for licences 16472M, 16475M and 16479M on claims in the Dory Pond area, southwest of Letitia Lake, central Labrador, Rare Earth Metals Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 13L/0147, 331 pages.

Penney, G. and Nielsen, P., 2010: First year, first year supplementary, second year and fifth year assessment report on prospecting and geochemical exploration for licences 12352M, 16277M-16278M, 16347M-16348M, 16451M-16452M, 16472M, 16475M, 16479M, 16521M, 16524M, 16529M, 16545M-16546M, 16548M, 16553M-16554M, 16591M, 17121M, 17128M, 17140M-17141M and 17371M-17372M on claims in the Letitia Lake - Shallow Lake area, central Labrador, Rare Earth Metals Incorporated, Cornerstone Resources Incorporated, Playfair Mining Limited, Belmont Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 13L/0144, 309 pages.

Penney, G., Reid, W. and Pintson, H., 2008: Second and fourth year assessment report on prospecting and geochemical, geophysical, trenching and diamond drilling exploration for licences 10146M, 11844M, 12038M, 15055M and 15084M-15087M on claims in the Lost Pond area, near Stephenville, western Newfoundland, Ucore Uranium Incorporated. Newfoundland and Labrador Geological Survey, Assessment File NFLD/3121, 348 pages.

Piercey, S.J., Hinchey, J.G. and Sparkes, G.W., 2023: Volcanogenic massive sulfide (VMS) deposits of the Dunnage Zone of the Newfoundland Appalachians: Setting, styles, key advances, and future research. Canadian Journal of Earth Sciences, Volume 60(8), pages 1104-1142.

Perreault, G., 1950: Report on the geology of the Howells River area, Labrador, Iron Ore Company of Canada. Newfoundland and Labrador Geological Survey, Assessment File 23J/0009, 96 pages.

Perry, J., 1979: Annual exploration report for 1978 with appendix 5-9 on the Moran and Seal Lake areas, Labrador. Brinex Limited and Canadian Nickel Company Limited. Newfoundland and Labrador Geological Survey, Assessment File LAB/0437, 282 pages.

Peters, H.R., 1971: Resume of exploration from 1955 to 1970 with a geological appraisal of Halls Bay south area, Newfoundland. British Newfoundland Exploration Limited. Newfoundland and Labrador Geological Survey, Assessment File NFLD/0627, 16 pages.

Pittman, K., 2014: Second and third year assessment report on compilation and exploration history for licences 18728M, 18730M and 18732M on claims in the Churchill River area, central Labrador, Grand River Ironsands Incorporated. Newfoundland and Labrador Geological Survey, Assessment File LAB/1735, 22 pages.

Poveromo, J. and Chaigneau, R., 2024: Obms & carbon neutral steelmaking. Paper 4: Blast furnace/basic oxygen furnace technologies. International Iron Metallics Association. IIMA_Decarbonisation_Whitepaper4_Blast_Furnace_Basic_Oxygen_Furnace.pdf

Prince, D.R., 1981: Summary of work performed from 1977 to 1980 on the Strickland-Porter fee simple property, Newfoundland. Falconbridge Nickel Mines Limited, Giant Yellowknife Mines Limited, and United Keno Hill Mines Limited. Newfoundland and Labrador Geological Survey, Assessment File 11O/16/0139, 26 pages.

Putzolu, F., Armstrong, R.N., Boyce, A.J., Hepburn, L.E., Bompard, N., Najorka, J., Lefebvre-Desanois, M., Milton, A.J., Salge, T., Erak, D., Abad, I. and Herrington, R.J. 2025: Origin of the Jadar volcano-sedimentary Li-B deposit, Serbia. Economic Geology, Volume 120(3), pages 599-625. https://doi.org/10.5382/econgeo.5132

Ramachandra Rao, S., 2006: Chapter 9 - By-product processing and utilization. Waste Management Series, Elsevier, Volume 7, pages 329-374. https://doi.org/10.1016/S0713-2743(06)80094-2

Redmond, B.R., 2023: Irish-type Zn-Pb deposits in the context of global zinc supply. In: Andrew, C.J., Hitzman, M.W. & Stanley, G. 'Irish-type Deposits around the world', Irish Association for Economic Geology, Dublin. 19-34. DOI: https://doi.org/10.61153/WKKY6664

Reeves, J.H., 2009: First year assessment report on geophysical exploration for licence 12649M on claims in the Beaver Brook area, central Newfoundland. Newfoundland and Labrador Geological Survey, Assessment File 2D/11/0740, 25 pages.

Reid, W., 2012: Fifth year assessment report on prospecting for licence 10146M on the Lost Pond claims in the Caribou Brook area, western Newfoundland. Kirrin Resources Incorporated and Ucore Rare Metals Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 12B/09/0647, 14 pages.

Reid, W. and Penney, G., 2011: First and second year assessment report on prospecting, geophysical intrepretation and geochemical exploration for licences 16523M-16524M, 16529M, 16545M-16548M, 16550M-16553M, 16560M, 16591M-16592M, 16597M, 16608M, 16610M, 16612M, 16614M-16615M, 16617M-16619M, 17141M, 17228M-17229M and 17660M-17662M on claims in the Letitia Lake - Shallow Lake area, central Labrador, Rare Earth Metals Incorporated. Newfoundland and Labrador Geological Survey, Assessment File LAB/1672, 138 pages.

Ricketts, M.J., 1987: Silica-rich sands, western Newfoundland. *In* Current Research. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Report 87-01, pages 63-69.

Rio Tinto, 2023: Rio Tinto and H2 Green Steel partner to accelerate the green steel transition. https://www.riotinto.com/en/news/releases/2023/rio-tinto-and-h2-green-steel-partner-to-accelerate-the-green-steel-transition (accessed August 2025).

Risto, R.W., Kociumbas, M. and Grandillo, A., 2013: Technical report and mineral resource estimate on the Greenbush Zone, Block 103 property, Newfoundland and Labrador for Cap-Ex Iron Ore Ltd. Watts, Griffis and McOuat Ltd./BBA Inc. NI 43-101 Technical Report. https://www.gov.nl.ca/iet/files/mines-investments-companysheets-iron-block-103-pea-iron.pdf

Robertson, D.J., 1985: Second year assessment report on geological, geochemical and diamond drilling exploration for licence 2369 on claim block 3277 in the Great Gull Lake area, Newfoundland. Kidd Creek Newfoundland Limited. Newfoundland and Labrador Geological Survey, Assessment File 002D/0159, 82 pages.

Robertson, D.J., 1986: Third year assessment report on geological, geochemical, trenching and diamond drilling exploration for licence 2426 on claim blocks 3215-3217 and 3538 in the Great Gull Lake area, Newfoundland, Kidd Creek Mines Limited. Newfoundland and Labrador Geological Survey, Assessment File 2D/0165, 55 pages.

Rose, E.R., 1973: Geology of vanadium and vanadiferous occurrence of Canada. Economic Geology, Report No. 27, 130 pages.

Ryan, T. and Malpage, B., 1996: First year supplementary assessment report on geological, geochemical, geophysical and diamond drilling exploration for licences 1446m, 1539m and 1582m on claims in the Umiakoviarusek Lake area, Labrador, 2 reports, Castle Rock Exploration Corporation, United Compass Resources Limited and Newfoundland Mining and Exploration Limited. Newfoundland and Labrador Geological Survey, Assessment File 14E/0196, 71 pages.

Sahu, P., Dash, P., Jena, M.S. and Mandre, N.R., 2022: Flotation of platinum group elements ores: A review. Mineral Processing and Extractive Metallurgy Review, Volume 44(2), pages 102-124. https://doi.org/10.1080/ 08827508.2022.2027768

Sandeman, H.A.I. and Spurrell, C., 2020: The Yellow Fox Showing: monzogranite-hosted, fracture related antimony-silver-gold mineralization near the eastern margin of the Mount Peyto Intrusive Suite, central Newfoundland (Nts map area 2D/14). *In* Current Research. Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Report 20-1, 27 pages.

Sandeman, H.A., Wilton, D.H.C., Conliffe, J., Froude, T. and O'Driscoll, J.M., 2013: Geological setting, geochronological constraints and the nature of mineralization at the Mosquito Hill (Huxter Lane) gold deposit, central Newfoundland. *In* Current Research. Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Report 13-1, pages 167-188.

Saunders, C.M., 1990: Mineralization in western White Bay. *In* Current Research. Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey Branch, Report 91-01, pages 335-347.

Saunders, P., 1993: Bulk sampling of the Lower Cove Dolostone Deposit, Port au Port Peninsula, western Newfoundland, Norsk Hydro. Newfoundland and Labrador Geological Survey, Assessment File 12B/0371, 16 pages.

Schwarz-Schampera, U., 2014: Antimony. *In* Critical Metals Handook. *Edited by* G. Gunn. Wiley and Sons, Hoboken, N.J., pages 70-98. http://dx.doi.org/10.1002/9781118755341.ch4

Scott, F., Scott, G., Andjelkovic, D., Dillman, R. and Wagg, C.A., 2006: First year assessment report on geological and geochemical exploration for licence 10606M on claims in the Fox Island River area, Port au Port Bay, western Newfoundland, Markland Resource Development Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 12B/10/0556, 205 pages.

Scott, S., Kirkham, P. and Taggart, P.P., 2009: Technical report, Moly Brook property, Grey River Area, Kirkham Geosystems and Tenajon Resources Corp.

Seal II, R.R., Schulz, K.J. and DeYoung, J.H., 2017: Antimony, Chapter C. *In* Critical Mineral Resources of the United States–Economic and Environmental Geology and Prospects for Future Supply. *Edited by* K.J. Schulz, J.H. DeYoung, Jr., R.R. Seal II and D.C. Bradle. U.S. Geological Survey Professional Paper 1802, pages C1-C17. https://doi.org/10.3133/pp1802C

Seymour, C., Churchill, R. and Winter, L., 2008: First year supplementary assessment report on prospecting and geochemical exploration for licences 12743M-12746M, 12764M and 12776M on claims in the Flowers River area, northern Labrador, Golden Cross Resources Limited and Altius Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 13N/11/0138, 76 pages.

SGS Canada/New Millenium, 2013: New Millennium reports initial 3.58 billion tonnes resources at Sheps Lake and Perrault Lake. https://www.gov.nl.ca/iet/files/mines-investments-companysheets-iron-sheps-lake-and-perault-lake-iron.pdf

Sherwin, J.G., 1981: Summary report on uranium exploration in the Codroy-St Georges Basin area, Newfoundland. Bondar-Clegg and Company Limited, Northgate Exploration Limited, Shell Canada Resources Limited, and Westfield Minerals Limited. Newfoundland and Labrador Geological Survey, Assessment File NFLD/1231, 99 pages.

Shinkle, D.A., 2005: The Chapel Island Nickel-Copper Prospect: A petrographical, geochemical, and isotopic study. Unpublished B.Sc. Thesis, Memorial University of Newfoundland and Labrador, St. John's, Newfoundland and Labrador.

Simandl, G.J. and Paradis, S., 2022: Vanadium as a critical material: economic geology with emphasis on market and the main deposit types. Applied Earth Science, Volume 131(4), pages 218-236. https://doi.org/10.1080/25726838.2022.2102883

Simpson, A., 1990: Sixth year assessment report on diamond drilling exploration for the Hermitage project for licence 2474e on claim blocks 3715-3716 and 3718 in the North Twin Pond, South Twin Pond and Winter Pond areas on the Hermitage Peninsula, south coast of Newfoundland. Noranda Exploration Company Limited, 81 pages. Newfoundland and Labrador Geological, Assessment File 1M/12/0320, 81 pages.

Shanghai Metals Market, 2024: Future outlook on manganese ore capacity and supply-demand changes. https://news.metal.com/news-content/102963045/Future-Outlook-on-Manganese-Ore-Capacity-and-Supply-Demand-Changes (website accessed October 2025)

Smeltzer, D. and Kahlert, B.H., 2006: First year assessment report on prospecting and geochemical exploration for licences 10019M, 10021M, 10455M, 10470M and 10619M on claims in the Blue Hills of Couteau and White Bear River areas, southern Newfoundland, Commander Resources Limited, Newfoundland and Labrador Minerals. Newfoundland and Labrador Geological Survey, Assessment File 11P/0212, 43 pages.

Smith, B.L., 1953: Fluorite deposits of Long Harbour, Fortune Bay. Government of Newfoundland and Labrador, Department of Mines and Resources, Mines, Geological Survey, Report No. 2, 22 pages. GeoFile Number 001M/11/0024.

Smith, C.H., 1958: Bay of Islands Igneous Complex, western Newfoundland. Geological Survey of Canada, Memoir, No. 00290, 132 pages.

Smith, A.J.D. and Lentz, D., 2011: First year assessment report on prospecting and geochemical exploration for licences 16603M and 16678M on claims in the Cross Hills area, southern Newfoundland, Cache Exploration Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 1M/0806, 32 pages.

Snelgrove, A.K., 1934: Chromite deposits of Newfoundland. Government of Newfoundland and Labrador, Department of Natural Resources, Geological Section, Bulletin No. 1, 29 pages. GeoFile Number NFLD/0031.

Snelgrove, A.K., 1931: Geology and ore deposits of Betts Cove-Tilt Cove area Notre Dame Bay Newfoundland. Ph.D. thesis, Princeton University. Canadian Mining and Metallurgical Bulletin, No. 9, 43 pages.

Snelgrove, A.K., 1953: Mines and mineral resources of Newfoundland. Government of Newfoundland and Labrador, Department of Mines and Resources, Geological Survey, Information Circular No. 04, 154 pages. GeoFile Number NFLD/0078.

Sokoman Minerals, 2022: Press Release. https://www.sokomanmineralscorp.com/new/sokoman-and-benton-kraken-lithium-prospect-phase-2-drill-results-exploration-update

Sokoman Minerals, 2022: (March) Sokoman and Benton report first drill assay results from the Kraken Pegmatite Field – Golden Hope Project, SW Newfoundland. https://pigeon-star-xyj6.squarespace.com/new/sokoman-and-benton-report-first-drill-assay-results-from-the-kraken-pegmatite-field-golden-hope-project-sw-newfoundland

Sokoman Minerals, 2022: (November) Sokoman and Benton discover high-grade cesium mineralization in outcrop 12 km NE of the Kraken Lithium Pegmatite Swarm in southwestern Newfoundland. https://www.sokomanmineralscorp.com/new/sokoman-andbenton-discover-high-grade-cesium-mineralization-in-outcrop-12-km-ne-of-the-kraken-lithium-pegmatite-swarm-in-southwesternnewfoundland

Sole, K.C., 2018: The evolution of cobalt–nickel separation and purification technologies: Fifty years of solvent extraction and ion exchange. *In* Extraction 18, The Minerals, Metals & Materials Series. *Edited by* B. Davis and others. Springer, Cham. https://doi.org/10.1007/978-3-319-95022-8_95

S&P Global Commodity Insights, 2022: Graphite supply a concern in meeting growing battery demand. www.spglobal.com/commodityinsights/en/market-insights/latest-news/energy-transition/021622-feature-graphite-supply-a-concern-in-meeting-growing-battery-demand

Sparkes, B.A. and Reeves, J.R., 2015: AGS Project, project review and resource estimate, Canada Fluorspar Inc. Presentation, Baie Verte Mining Conference.

Sparkes, G.W., 2017: Uranium mineralization within the Central Mineral Belt of Labrador: A summary of the diverse styles, settings and timing of mineralization. Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, St. John's, Open File LAB/1684, 198 pages.

Squires, G., Mitton, B. and Kendle, F., 1997: Second Year Assessment Report (Geology, Geochemistry, Geophysics and Drilling) on Licences 766M - 770M, 772M, 774M-776M, 778M, 779M, 781M, 782M, 915M, 1033M-1035M, 1037M, 1322M-1324M, 3749M, 3751M, 3978M-3980M, Cu, Ni, Co exploration in the areas between Hebron Fiord and Shapio Lake, Labrador. NTS 13K/14, 13N/3,6, 14C/4,5,12, 14D/1,8,9,10,15,16, 14E/1,8,10,14; for Noranda Mining and Exploration Inc. Newfoundland and Labrador Geological Survey, Assessment File LAB/1339, 566 pages.

Srivastava, R., Gauthier, J., Cox, J. and Krutzelmann, H., 2013: Technical report on the Foxtrot project in Labrador. Newfoundland & Labrador, Canada NI 43-101 Report. Search Minerals Inc., 203 pages.

Statistics Canada, 2025: Annual statistics of Mmineral production, 2024. https://mmsd.nrcan-rncan.gc.ca/prod-prod/ann-ann-eng.aspx#TTA2

Steenkamp, J.D., Chetty, D., Singh, A. and Hockaday, S.A.C., 2020: From ore body to high temperature processing of complex ores: Manganese–A South African perspective. Minerals, Metals & Materials Society, Journal, Volume 72, pages 3422-3435.

Steinthorsdottir, K., Dipple, G.M., Cutts, J.A., Turvey, C.C., Milidragovic, D. and Peacock, S.M., 2022: Formation and preservation of brucite and awaruite in serpentinized and rectonized mantle in central British Columbia: Implications for carbon mineralization and nickel mining, Journal of Petrology, Volume 63, Issue 11 pages 1-25. https://doi.org/10.1093/petrology/egac100

Stone, W., Brown, F., Barry, J., Feasby, D.G., Puritch, E. and Froude, T., 2021: NI 43-101 & 43-101F1 Technical report, and updated mineral resource estimate of the Little Deer complex copper deposits, Newfoundland, Canada, P&E Mining Consultants Inc. Report 401, Rambler Metals and Mining Canada limited and 1948565 Ontario Inc., Sedar.com.

Straits Research, 2023: Platinum market size, share and trends analysis report by source (primary, secondary), by form (metal, powder, alloys), by end use (automotive, jewellry, chemical, electronics, industrial, others) and by region (North America, Europe, APAC, Middle East and Africa, LATAM) forecasts, 2023-2031. https://straitsresearch.com/report/platinum-market

Stuckless, E., Kumar, H., Legault, J., Marich, M., Sinclair, R.H., Fernley, O. and Selman, D., 2008: First year assessment report on prospecting and geochemical, geophysical and diamond drilling exploration for licences 13428M, 13459M-13460M, 13501M, 13681M, 13751M, 13754M, 13769M, 13832M-13838M, 13888M, 13966M, 13994M, 14127M-14129M, 14143M, 14159M and 14212M-14214M on claims in the Kingurutik River area, northern Labrador, 5 reports, Intrinsic Minerals Limited and Celtic Minerals Limited. Newfoundland and Labrador Geological Survey, Assessment File LAB/1552, 727 pages.

Sutton, J.S., 1971: Geological report with nickel assays for the area northwest of Florence Lake in the Udjuktok Bay area, Labrador. British Newfoundland Exploration Limited. Newfoundland and Labrador Geological Survey, Assessment File 13K/15/0084, 11 pages.

Swinden, H.S., Wardle, R.J., Davenport, P.H., Gower, C.F., Kerr, A., Meyer, J.R., Miller, R.R., Nolan, L., Ryan, A.B. and Wilton, D.H.C., 1991: Mineral exploration opportunities in Labrador: A perspective for the 1990's. *In* Current Research. Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey Branch, Report 91-1, pages 349-390.

Szabo, N.L., 1992: First year assessment report on geological, geochemical and vibracore drilling exploration for licences 388m and 390m in the Porcupine Strand area, eastern Labrador. Cominco Limited. Newfoundland and Labrador Geological Survey, Assessment File LAB/0953, 18 pages.

Takeda, O., Ouchi, T. and Okabe, T.H., 2020: Recent progress in titanium extraction and recycling. Metallurgical and Materials Transactions, 50th Anniversary Collection, Volume 51, pages 1315-1328. https://doi.org/10.1007/s11663-020-01898-6

Tater, J.M., 1964: A field report on pegmatitic occurrences of Newfoundland. University of Alberta and Department of Mineral Resources, Province of Newfoundland. Newfoundland and Labrador Geological Survey, Internal Collection, University Report, 55 pages. GeoFile Number NFLD/0258.

Tawsho Mining, 2013: Press Release. https://stockhouse.com/news/press-releases/2013/09/11/tawsho-mining-inc-completes-drillingon-cabot-graphite-project

Tenajon Resources, 2009: Press Release. https://www.gov.nl.ca/iet/files/mines-investments-companysheets-tungsten-molybdenum-molybrook-molybdenum.pdf

The Climate Group, 2025: The role of scrap in steel decarbonization: Key facts and considerations for the construction sector. https://www.theclimategroup.org/sites/default/files/2025-05/The-role-of-scrap-steel-in-decarbonisation-April-2025.pdf

The Oregon Group – Critical Minerals and Energy Intelligence, 2025a: Turbulence in global titanium supply (accessed October, 2025).

The Oregon Group – Critical Minerals and Energy Intelligence, 2025b: Antimony: Caught in the geopolitical crossfire (accessed October, 2025).

Thomas, A. and Butler, J., 1987: Gold reconnaissance in the Archean Ashuanipi Complex of western Labrador. *In* Current Research. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Report 87-01, pages 237-255.

Thurlow, J.G., Barbour, D.M., Desnoyers, D.W., Burton, G.B., MacNeil, J., Salib, P., Reed, L. and Balch, S.J., 1987: Assessment report on geological, geochemical, geophysical, trenching and diamond drilling exploration for 1986 submission for the Anglo Newfoundland Development Company Limited charter, Reid lots 227-229, 231-235 and 247, crown lease lots A-B, E and R and fee simple grants volume 1 folios 61-62 and 110 and volume 2 folios 23 and 29 in the Buchans, Great Burnt Lake, Valentine Lake, Mary March, Victoria Lake and Bobbys Pond areas, Newfoundland, 8 reports. Noranda Exploration Company Limited, Canacord Incorporated, and Canacord Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File NFLD/1737, 2422 pages.

Tolliday, B., 2014: Significant growth in lead usage underlines its importance to the global economy, International Lead Association. https://web.archive.org/web/20170228171821/http://www.ila-lead.org/news/lead-in-the-news/2012-11-30/significant-growth-in-lead-usage-underlines-its--importance-to-the-global-economy-

Tuach, J., 1996: Tungsten-molybdenum mineralization in the Granite Lake-Meelpaeg Lake area (NTS 12A/2, 7), Newfoundland. Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Mineral Resource Report 7, 63 pages.

Umair, M., 2025: Why copper is set to soar: Grasberg Shutdown, Electrification, and AI Boom. FXempire article, https://www.fxempire.com/ forecasts/article/why-copper-is-set-to-soar-grasberg-shutdown-electrification-and-ai-boom-1552874 (accessed October, 2025).

United States Geological Survey, 2025: Mineral commodity summaries. https://www.usgs.gov/publications/mineral-commodity-summaries-2025

United States Geological Survey, 2024: Mineral commodity summaries. https://www.usgs.gov/publications/mineral-commodity-summaries-2024

United States Geological Survey, 2023: Mineral commodity summaries. https://www.usgs.gov/publications/mineral-commodity-summaries-2023

United States Geological Survey, 2022: Mineral commodity summaries. https://www.usgs.gov/publications/mineral-commodity-summaries-2022

United States Geological Survey, 2021: Mineral commodity summaries. https://www.usgs.gov/publications/mineral-commodity-summaries-2021

United States Geological Survey, 2020: Mineral commodity summaries. https://www.usgs.gov/publications/mineral-commodity-summaries-2020

Upadhyay, H.D. and Watson, R.K., 1974: Report on the geology and the mineral potential of the Betts Cove-Tilt Cove area, Newfoundland. Consolidated Morrison Explorations Limited. Newfoundland and Labrador Geological Survey, Assessment File 2E/13/0329, 49 pages.

Vale, 2023: Form 20-F annual report pursuant to section 13 or 15(d) of the securities exchange act of 1934, For the fiscal year ended: December 31, 2023, Commission file number: 001-15030, VALE S.A: https://www.sec.gov/Archives/edgar/data/917851/ 000129281424001463/ valeform20f_2023.htm#form20f_009

Van De Meer, L., 2022: National Instrument 43-101 Technical Report on the York Harbour Property, Western Newfoundland, Canada. SEDAR geological technical report on the York Harbour Property, Western Newfoundland. https://www.sedarplus.ca

Van de Poll, H.W., 1965: Report on the geological reconnaissance of the Brinex concession in the Hawkes Bay area, Newfoundland. Newmont Mining Corporation of Canada Limited. Newfoundland and Labrador Geological Survey, Assessment File 12I/11/0069, 19 pages.

Vande Guchte, M., 1999: Twelfth year assessment report on geological, geochemical and diamond drilling exploration for licence 4843 on claim blocks 4678, 5876 and 7619 in the Seal Bay area, north-central Newfoundland. Rubicon Minerals Corporation and Falconbridge Limited. Newfoundland and Labrador Geological Survey, Assessment File 2E/05/1059, 197 pages.

Vogl, V. and Ahman, M., 2019: What is green steel? - Towards a strategic decision tool for decarbonising EU steel. Department of Environmental and Energy System Studies, Lund University.

Wahl, G.H., 2013: Mineral Resource Technical Report Elizabeth Taconite Project Labrador: https://www.sedarplus.ca/csaparty/records/ document.html?id=4e2e3879e011045eab12840c7a96f262c4f67b6e9f4cb4921464950ce1bf7287

Waldie, C.W., 2004: Report on line cutting, B-horizon soil geochemical sampling and prospecting, licence 4117 fee simple vol. 2, fol. 29 (B.E.S. Dunfield Lot) Buchans Junction, Newfoundland, June 2004. Newfoundland and Labrador Geological Survey, Assessment File 12A/1124, 42 pages.

Wallis, C.S., Sparkes, B.A. and Giroux, G.H., 2011: Technical report on the Central Mineral Belt (CMB) uranium – vanadium project, Labrador, Canada, prepared for Crosshair Exploration & Mining Corp. https://www.gov.nl.ca/iet/files/projects-c-zone-res-est.pdf

Walsh, D., 2010: Fifth and eleventh year assessment report on geochemical and diamond drilling exploration for licences 6107M and 10069M on claims in the Flat Bay area, western Newfoundland, Vulcan Minerals Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 12B/07/0624, 27 pages.

Walsh, D., Bournas, N., Legault, J. and Marich, M., 2008: First year assessment report on geophysical and diamond drilling exploration for licence 14138M on claims in the Kingurutik River area, northern Labrador, 2 reports, Nortec Ventures Corporation and Vulcan Minerals Incorporated. Newfoundland and Labrador Geological Survey, Assessment File LAB/1482, 98 pages.

Walthier, T.N., 1948: Geology of the Lawn sulfide prospects, Burin Peninsula, Newfoundland. Newfoundland and Labrador Geological Survey, Internal Collection, Individual Report, 25 pages.

Wardle, R.J., 2008: Zinc and Lead. Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey, Mineral Commodities Series 1, 11 pages.

Wardle, R.J., 2007: Copper. Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Mineral Commodities Series 3, 11 pages.

Wardle, R.J., Gower, C.F., Ryan, B., Nunn, G.A.G., James, D.T. and Kerr, A., 1997: Geological map of Labrador. Map 1997-07. Government of Newfoundland and Labrador, Department of Mines and Energy, Open File LAB/1226.

Wayman, E., 2023: Recycling rare earth elements is hard. Science is trying to make it easier. Science News Magazine. https://www.sciencenews.org/article/recycling-rare-earth-elements-hard-new-methods

Westhues, A., 2017: Updated geology of the St. Alban's map area (NTS 1M/13), Dunnage and Gander zones. *In* Current Research. Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Report 17-1, pages 87-103.

Webster, P.C., James, P., Barr, J.F. and Cavalcanti de Albuquerque, R., 2008: Revised Technical Report on the Daniels Pond Deposit and Property Holdings of Royal Roads Corp., Red Indian Lake Area, Newfoundland, Canada; Mercator Geological Services Limited. https://minedocs.com/23/Lundberg-TR-05282019.pdf

Whalen, J.B., 1980: Geology and geochemistry of the molybdenite showings of the Ackley City Batholith, southeast Newfoundland. Canadian Journal of Earth Sciences, Volume 17, No. 9, pages 1246-1258.

Whitford J. Limited, Pheeney, P.E. and Powell, J.K., 2007: Assessment report on environmental studies for 2006 submission for Reid Lot 234 and mining leases 117, 121, 133, 135, 183 and 192 and for first year, first year supplementary, third year supplementary, fourth year, fifth year, fifth year supplementary, sixth year, sixth year supplementary, ninth year supplementary, eleventy year, eleventh year supplementary, twelfh year supplementary, and twentieth year supplementary assessment on licences 4674M, 4782M, 5632M, 7571M, 7966M-7967M, 7990M-7992M, 8019M, 8137M, 8186M, 9131M, 9687M, 10044M, 10216M-10217M and 10417M on claims in the Duck Pond area, central Newfoundland, 5 reports, Aur Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 12A/1294, 355 pages.

Williams, H., 1979: Appalachian Orogen in Canada. Canadian Jornal of Earth Sciences, Volume 16, pages 792-807.

Wilson, S., 2008: Technical report on the Bobby's Pond Cu-Zn deposit, mineral resource estimate by Scott Wilson RPA. https://www.gov.nl.ca/iet/files/mines-investments-companysheets-base-metals-bobbys-pond-vms.pdf

Wilton D.H.C., Brett, J.S. and Sobie, P., 2023 : NI 43-101 Technical Report on the Taylor Brook Project, Western White Bay Area, West-Central Newfoundland, Newfoundland and Labrador for Churchill Resources Inc.

Wiseman, R., 1942a: Report on chromite deposits situated at Bluff Head-Newfoundland. Geological Survey of Newfoundland. GeoFile Number 012B/15/0023.

Wiseman, R., 1942b: Kelligrews manganese prospect, Newfoundland, 6 ddh records. Geological Survey of Newfoundland, 6 pages. GeoFile Number 001N/10/0150.

Woods, G., 2010: Second year, second year supplementary and fourth year assessment report on prospecting and geochemical, trenching and diamond drilling exploration for licences 15458M and 16095M-16096M on claims in the Little River area, southern Newfoundland, Mountain Lake Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 1M/0763, 125 pages.

World Nuclear Association, 2024: https://world-nuclear.org/Information-Library/Facts-and-Figures/Uranium-production-Figures (accessed May 2024).

World Steel Association, 2023: Direct reduced iron. https://worldsteel.org/data/world-steel-in-Figures-2023/#direct-reduced-iron-production-%3Cbr%3E-2018-to-2022 (accessed July 2024).

WSP Consultants, 2018: Rambler updates reserves at its producing Canadian copper & gold mine demonstrating a profitable 20 year mine life. https://www.gov.nl.ca/iet/files/mines-investments-companysheets-base-metals-ming-mine.pdf

Yue, Y., Sun, Y., Zhang, X., Jin, J. and Li, Y., 2025: Sustainable and efficient barite recovery from low-grade tailings waste: A combined and innovative solution for resource utilization. Minerals Engineering, Volume 234. https://doi.org/10.1016/j.mineng.2025.109767

Zadeh, J., 2025: Global tin supply and demand forecast: Navigating the 40,000-tonne deficit. https://discoveryalert.com.au/news/global-tin-market-supply-demand-2025/ (accessed October 2025).

Zhan, Y., Shao, Y., Xiong, Y-Q., Brzozowski, M.J., Liu, Z., Liu, Q. and Zhang, Y., 2024: The key controlling factors on Sn–Cu mineralization: A case study from the world-class Gejiu Sn–Cu-polymetallic deposit. Ore Geology Reviews, Volume 175, Article 106351, ISSN 0169-1368.

Zheng, M., Xing, E., Zhang, X., Li, M., Che, D., Bu, L., Han, J. and Ye, C., 2023: Classification and mineralization of global lithium deposits and lithium extraction technologies for exogenetic lithium deposits. China Geology, Volume 6, Issue 4, pages 547-566. https://doi.org/10.31035/cg2023061

Zircomet, 2025: Zircon market outlook 2025. http://www.zircomet.com/sec/11189/Zirconium-Market-Update (accessed October 2025)