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Brucite in British Columbia, Canada

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Introduction

Brucite is a magnesium hydroxide, Mg(OH)₂, and consequently it has higher magnesium content than most minerals used as ore of magnesium. Brucite forms soft, waxy to glassy, white, pale-green, grey or blue crystals, plate aggregates, rosettes, fibrous masses and fracture fillings. It is relatively soft (2.5 on Moh's scale) and it has a low density (2.38-2.40 g/cm³). It is soluble in hydrochloric acid with no effervescence. It is unique by its oxidation of fresh surfaces from waxy to chalky appearance.

Brucite is widely distributed in ultramafic rocks and it is also found in a variety of exotic settings such as kimberlites and carbonatites, but nearly all the brucite deposits of economic interest appear to be hosted by marbles affected by high temperature, low pressure metamorphism (mainly contact metamorphic aureoles). The fibrous variety of brucite is referred to as nemalite, and is common in ultramafic rocks where it coexists with chrysotile. This association is one of the main reasons that a carbonate host is preferred to ultramafic rocks in search for economic brucite deposits. Ultramafic-hosted deposits were considered as potential sources of brucite in the past and recently brucite fiber from Shaan Nan Asbestos Mine in Shaan Xi Province, China, was tested as a reinforcing material for concrete. The early studies on the inhalation effects of brucite dust were proved to be invalid, as supposedly pure brucite samples that were used in experiments contained up to 10% chrysotile.

Examples of carbonate-hosted brucite deposits of economic significance are Cross Quarry near Wakefield, Que., Canada; Kuldur, eastern Russia; Granåsen, Norway, Gabbs magnesite-brucite deposit; Nye County, Nevada, USA and Marble Canyon, Culberson County, Texas, USA. Other undeveloped or exhausted brucite deposits are also documented elsewhere in China, Arizona, United Kingdom, Ireland and Canada. World brucite reserves and resources are impossible to estimate with a reasonable accuracy as there are many inconsistencies in reported reserves. USGS estimates brucite reserves for Nevada at 3 million tonnes and for North Korea at 2 million tonnes (no grades are indicated).

As brucite occurrences were recently recognized in new geological settings, such as in accumulations on the sea floor, it is possible that in the future, deposits of economic interest will not be restricted to contact metamorphic aureoles.

Brucite Uses

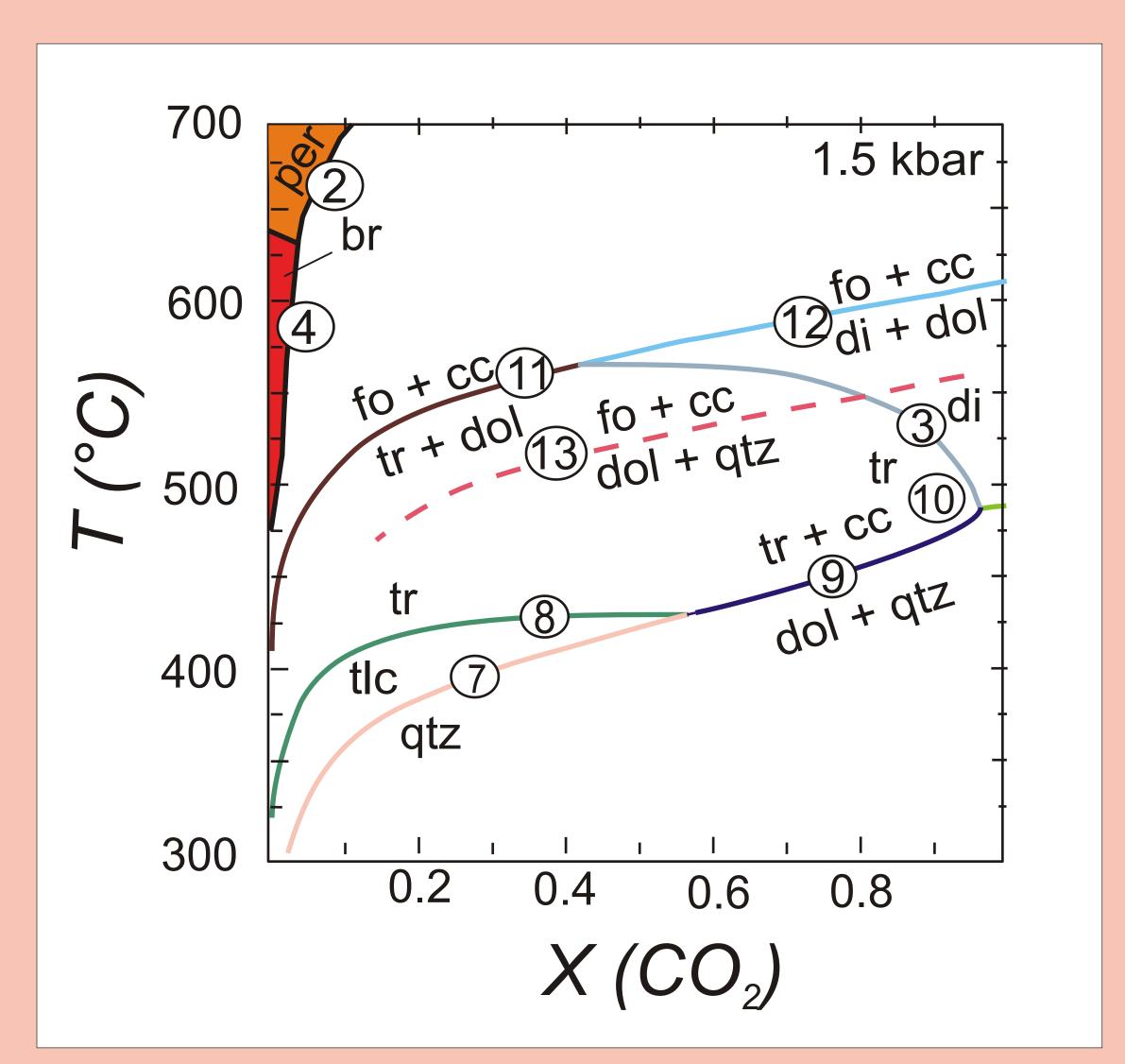
The brucite market is currently relatively small, but it is growing rapidly. It is a mineral that can be classified either as magnesium metal ore or as an industrial mineral. According to the International Magnesium Association, the magnesium metal market for 2005 is estimated at 500 000 tonnes. Although magnesium is found in many common rock-forming minerals, dolomite, magnesite, brucite and carnallite are the main ore minerals. Hydrated chlorites, other than carnalite, brines and seawater, also represent important resources. Serpentine (including asbestos tailings) and olivine are also considered as possible magnesium ore minerals, but extraction of magnesium from silicates is technologically and economically challenging as was proven by the recent closure of Noranda's Magnola plant in Quebec. Elemental magnesium (metal) and magnesium compounds are also produced from bitterns, seawater and well and lake brines. Because large, high-grade brucite deposits are uncommon, it is not the main raw material used in magnesium production.

As an industrial mineral, brucite can be used in caustic and dead-burned magnesia production. It also has a variety of other industrial mineral applications such as a functional filler in plastic compounds, fire and smoke retardant, electric wire insulation and carpet backing. There are no reliable statistics for the brucite market in any of these fields, but world market for flame retardant mineral fillers was estimated at 500 000 tonnes and magnesium hydroxide is believed to account for approximately 10% of it. The magnesium hydroxide estimate includes natural brucite which probably accounts for less than 20 000 tonnes.

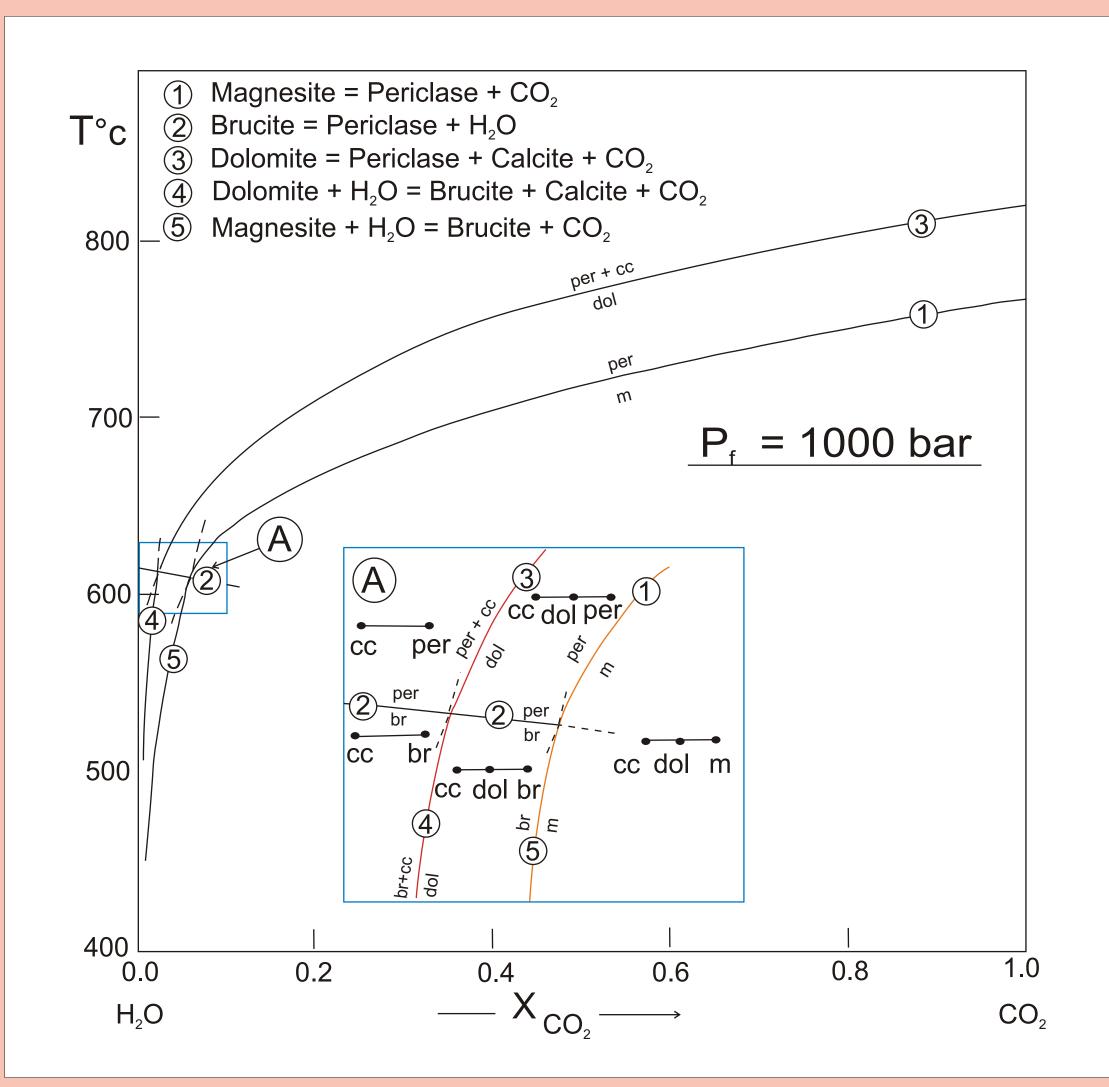
Brucite is used as a waste water treatment chemical. For example, it was proposed as one of the key minerals in the Britannia mine's (British Columbia) effluent treatment as a neutralizing reactant (Kus and Mavis, 2001). It is also used as agriculture feed, a dietary magnesium supplement, in odour control and in specialty cement preparations as an additive to Portland cements. There is promising laboratory-scale research into the use of brucite in stabilization of swelling clays and it may become important in radioactive

Depending on the intended industrial mineral use, brucite competes for a share of the market with synthetic brucite, which is commonly referred to in the manufacturing industry by its chemical formula as magnesium hydroxide and with other minerals and compounds such as magnesite, dolomite, huntite, hydromagnesite, MgO, CaO, zeolites

Brucite in Contact Metamorphic Settings

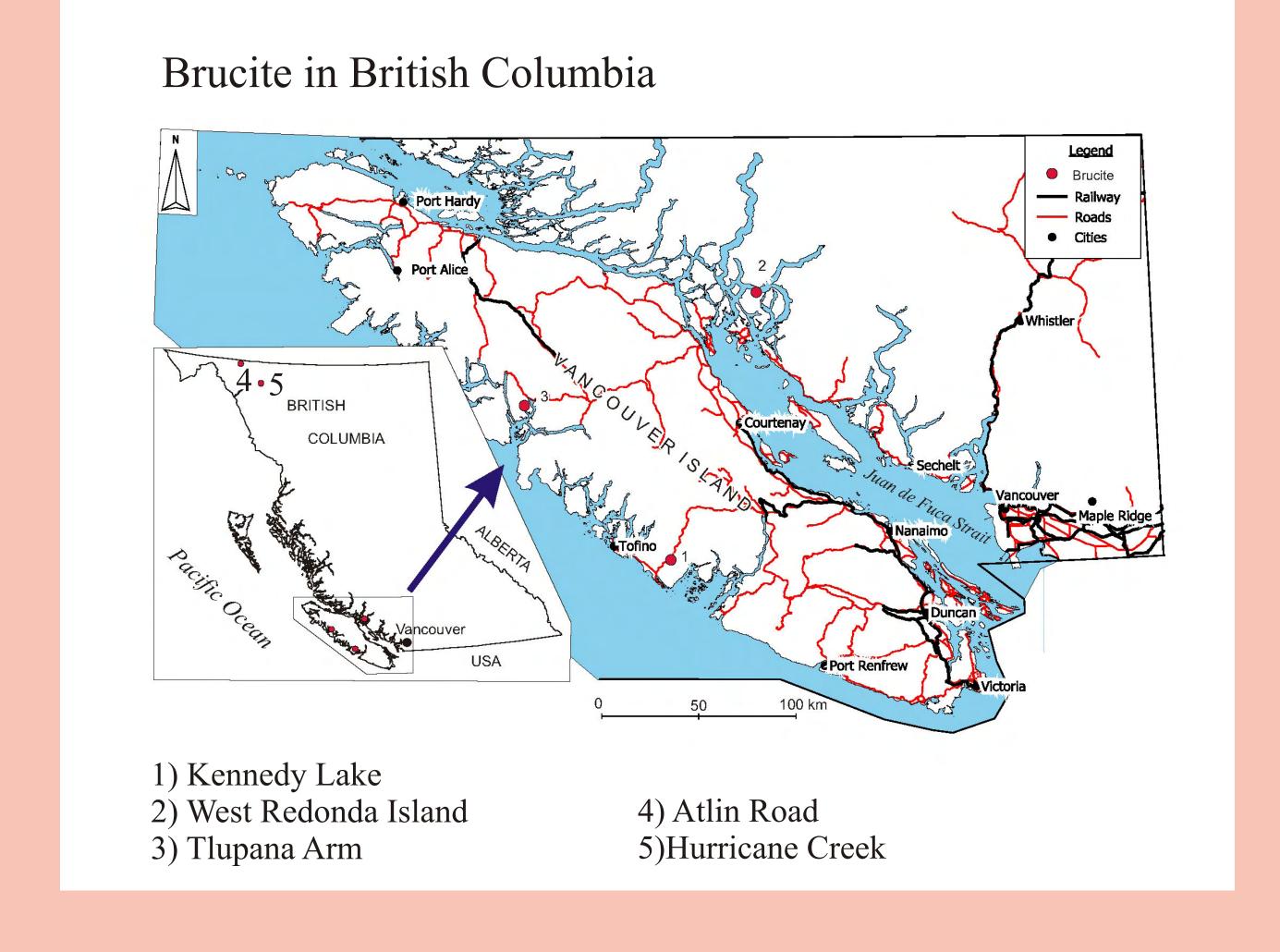


Example of metamorphic assemblages and reactions (identified by numbers) that are expected in siliceous dolomite marbles (Butcher-Nurminen, 1982); Symbols: dol- dolomite, qtz - quartz; tlc - talc; tr - tremolite; cc - calcite; per- periclase; fo - forsterite; di - diopside; br-brucite



Origin of brucite in carbonates affected by contact metamorphism. Diagram from: von Trommsdorff and Schwander (1969). Symbols: dol-dolomite; cc-calcite; per-periclase; br-brucite; m-magnesite

Brucite in British Columbia



West Redonda Island - Minfile: 092K 002

The granitic intrusions of the Coast Plutonic Complex contain numerous carbonate roofpendants. Along Georgia Strait, these roof-pendants belong to the Permian Marble Canyon Formation and/or the Upper Triassic Quatsino Formation (Grant, 1987). A deposit of carbonate (mainly limestone) is reported about 1.2 kilometres west of George Point and was quarried from 1920 to 1926 for use in the paper industry, however it was not known to contain brucite before 1929 (Gouge, 1944). The carbonate exposure is about 40 metres wide and at least 135 metres high. The limestone is medium to coarse grained, white and grey with a mottled texture locally. Brucite occurs as granules 1 to 3 millimetres in diameter and are reported to account for up to 30% of the rock. Brucite grains have a concentric structure and most are surrounded by white dolomite within a calcite matrix. Serpentine grains appear as the main silicate impurity. Grant (1987) reports a second limestone occurrence nearby. Although the mining of brucite-bearing rocks along the shore in this area may involve some permitting difficulties, ongoing logging activity and new logging roads are apparent on satellite images of the West Redonda Island. It would not be surprising if brucite-bearing rocks were present elsewhere on this island.

Tlupana Arm - Minfile: 092E 061

Metamorphosed equivalent of northwest-trending Upper Triassic Quatsino limestone and dolomite were reported along Deserted Creek where the Quatsino Formation is intruded by granitic plugs and stocks of the Jurassic-Cretaceous Coast intrusions (Grant, 1987). The chemical composition of carbonates provided by Gouge (1944) corresponds to limestone.

Atlin Road - Minfile: 104N 061

Brucite is reported immediately south of the Yukon border and east of the Atlin road. It occurs in high magnesian limestones of the Cache Creek Group that have been thermally metamorphosed at their contact with the Black Mountain granite (Grant, 1987). The above information is probably based on work of Aitken (1959), who also reports that brucite coexists with serpentine. The extent of mineralization and brucite content of carbonates are not reported. No chemical analyses are available.

Hurricane Creek - Minfile: 104N 062

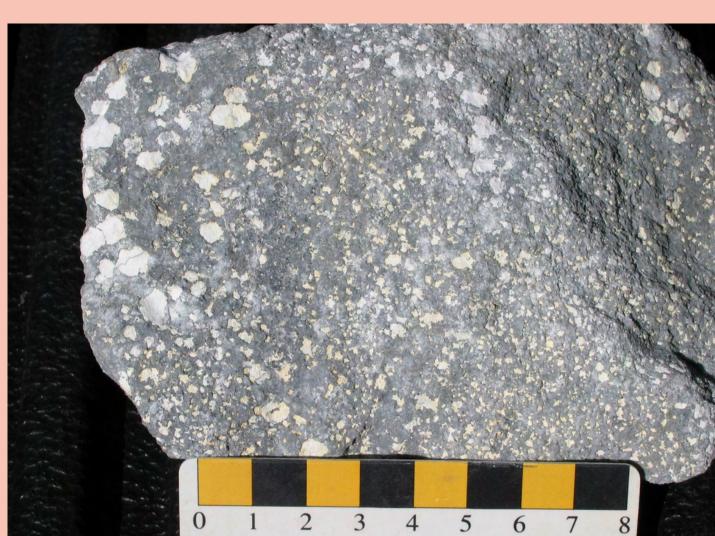
Brucite is reported in the area east of Hurricane Creek and south of Hayes Peak. The host rocks are contact-metamorphosed limestones and limestone breccias of the Cache Creek Group at the contact with Jurassic Mount McMaster granitic intrusions (Grant, 1987). Aitken (1959) reports that brucite in the area coexists with serpentine. The extent of mineralization and brucite content of carbonates are not reported. No chemical analyses are available.

Kennedy Lake - Minfile: 092F 431

Carbonates of the Upper Triassic Quatsino Formation are exposed along the south shore of Kennedy Lake and the north slope of Salmonberry Mountain (Eastwood, 1962, 1968). At least twelve different mappable units were recognized in the area. Carbonate rocks are divided into Upper and Lower Quatsino limestone. The fine-grained Upper Quatsino limestone is recrystallized. It is medium or coarse grained and bleached. This poorly exposed limestone is reported to be at least locally brucite-bearing along its contact with intrusive rocks on the northeast slope of Salmonberry Mountain. Brucitebearing carbonate blocks can be seen in the proximity of the Kennedy Lake mine. They are also present on the mine dump, where they account for less than 1% of rock by volume. Carbonates and skarn lithologies consisting of serpentine, garnet, amphiboles, magnetite and sulphides are more abundant than brucite-bearing rocks. Low proportion of brucitebering blocks relative to blocks of other lithologies may reflect relative proximity to magnetite ore rather than relative volume of lithological units. Since alteration and metamorphic assemblages are not shown on mine cross sections produced by Eastwood (1968) and in documents produced by company geologists and consultants, the extent of brucite zones and brucite grade is not known.



Brucite and host carbonates are commonly recessive, therefore boulder-tracing is a of recommended prospecting technique.



Subrounded brucite-bearing boulder, Kennedy Lake area. Pale colour is characteristic of inequigranular, irregular and weathered brucite



On fresh surface brucite has a greasy appearance and dark blue-gray colour. It occurs as individual, Where the fractures are open, it alters to white



Brucite-bearing boulder from Kennedy Lake mine area. On weathered surfaces, brucite alters to white, soft, chalk-like patches consisting of





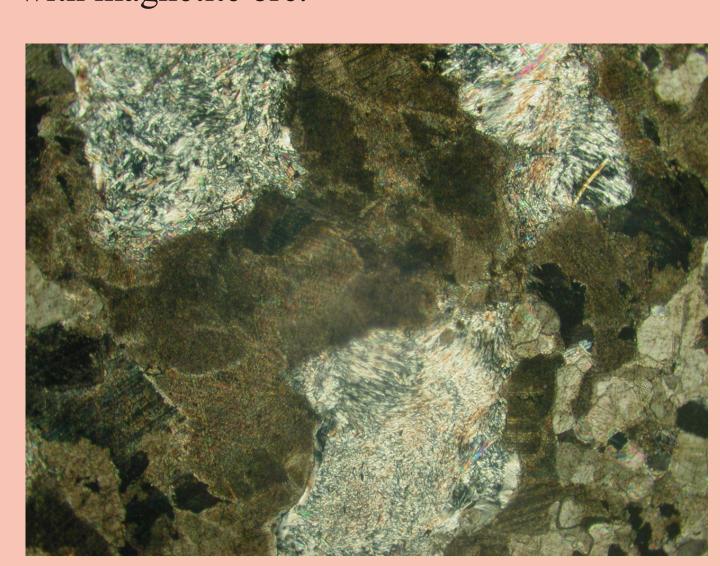
rounded or angular aggregates or as fracture fillings. chalky material.



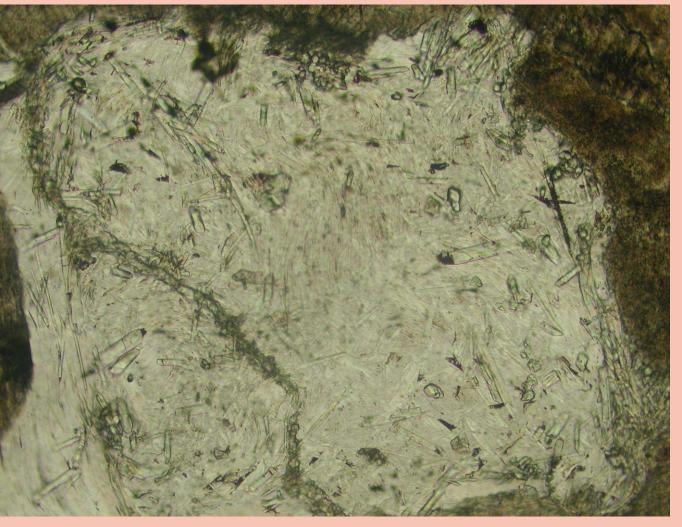
hydromagnesite and other secondary minerals.



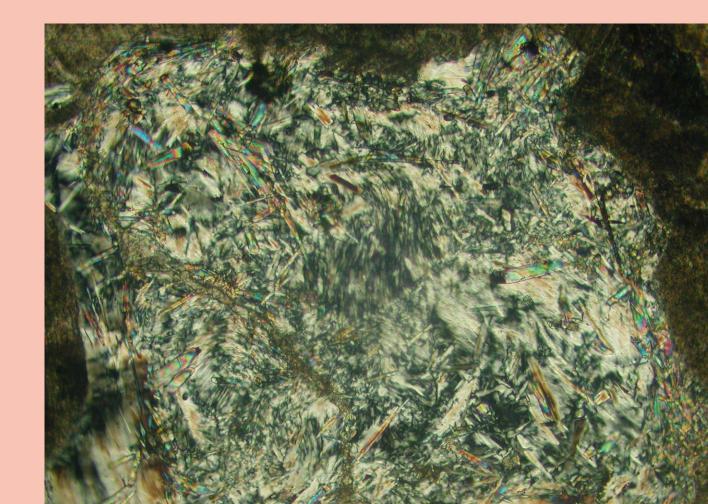
Angular brucite-bearing rock fragment, Kennedy Lake mine dump. Its presence suggests that brucite-bearing rocks may have been closely associated with magnetite ore.



Microphotograph - brucite aggregates in carbonate matrix (brown). Matrix consists predominantly of calcite and minor dolomite. Field of view approximately 2.5 mm, polarized light.



carbonate matrix (brown) consisting of calcite matrix (brown) consisting of calcite and mm, plain light.



Microphotograph - brucite aggregate (pale) in Microphotograph - brucite (pale) in carbonate and dolomite. Field of view approximately 2 dolomite. Field of view approximately 2 mm,

Exploration Guidelines

Although brucite is relatively widespread as an accessory mineral in a variety of lithologies. Mg-rich carbonate horizons within contact metamorphic aureoles have the best exploration potential. Dolostone or magnesitebearing protoliths are most favourable as they provide in situ source of magnesia. Brucite deposits share this preferred setting with a variety of skarn deposits. Consequently, the presence of skarn deposits may be used as an indirect exploration indicator of favourable environment for brucite formation. It is possible that commercial deposits may be found in areas of regionally metamorphosed sedimentary belts affected by intense retrograde overprints due to igneous activity. Existing orientation studies suggest that visible and near infrared spectra surveys could be used as an exploration tool.

Brucite is an ore of magnesium metal and raw material for magnesia production. It is an industrial mineral with an excellent market growth potential over the next 5 to 10 years. It is used in a variety of niche markets such as functional fillers and flame retardants. There are several brucite occurrences in British Columbia where the extent of brucite-bearing zones and its brucite content are unknown and worthy of geological follow-up. These occurrences also mark regions and geological settings favourable for grass-root exploration. Development of brucite deposits, as is the case with most industrial minerals, is more than establishing ore reserves and mining them. Strong marketing and intensive research and development efforts will be required if deposits with economic potential are confirmed.

Selected References

Aitken, J.D. (1959): Atlin Map Area, British Columbia (104N); Geological Survey of Canada; Memoir 307, 89 pages.

Butcher-Nurminen, K. (1982): On the mechanism of contact aureole formation in dolomitic country rock by the Adamello intrusion (northern Italy); American Mineralogist, vol 67, pages, 110-117.

Eastwood, G.E.P. (1962): Geology of the Kennedy Lake Area; British Columbia Ministry of Energy and Mines, EMPR Annual Report 1962, pages 111-121.

Eastwood, G.E.P. (1968): Geology of the Kennedy Lake Area, Vancouver Island, British Columbia; British Columbia Ministry of Energy and Mines, EMPR Bulletin 55, 63 pages.

Goudge, M.F. (1944): Limestones of Canada, Part IV, Western Canada; Geological Survey of Canada, Geology Branch Report No.811, 253 pages.

Grant, D.B (1987): Magnesite, Brucite and Hydromagnesite; British Columbia Ministry of Energy, Mines and Petroleum Resources Open File 1987-13, 81 pages.

Kus, J. and Mavis, J. (2001): Britannia Mitigation Program Interim Treatment, Britannia Mine Remediation Project, Corporate Land and Resource Governance; Ministry of Sustainable Resource Management, Memorandum, 2 pages.

Parks W.A, (1917): Report on building and ornamental stones of Canada, vol.V, Province of British Columbia, Geological Survey of Canada, Mines Branch Report No. 452, pages 162-168.

von Trommsdorff, V. and Schwander, H. (1969): Brucitmarmore in den Bergelleralpen; Bulletin Suisse de Mineralogie und Petrographie, 49, 2, pages 333-340.