Geological Investigation of the Eaglet Fluorspar Deposits

By Clive W. Ball and Gupta Boggaram*

Eaglet Mines Ltd. is testing a large block of ground with promising fluorspar deposits at Quesnel Lake, British Columbia. Eight flat-lying lenticular zones within gneiss contain drill-indicated reserves of 24 Mt averaging 11.5% CaF_2 the deposits being open to depth and in lateral extension. The authors describe the current programme of investigations being carried out.

21.7 M tonnes

OWNERSHIP of the Eaglet fluorspar propety is vested in the name of Eaglet Mines Limited with head office and registered office in the Royal Bank Tower, 1400-1055 West Georgia Street, Vancouver, British Columbia. The Company was formed as an Ontario Company in 1971 and a continuance was registered as a British Columbia Corporation in 1978. The Company holds title to a solid block of 144 Mineral Claim units covering an area of over 3,600 ha at Quesnel Lake.

The Eaglet property is situated in the Wasko Creek area of the Cariboo District of British Columbia on the North Arm of Quesnel Lake at latitude 52° 33′ north and longitude 121° 00′ west. Elevations range from lake level (at 725 m) up to 950 m above sea level. The terrain is moderately steep, with widespread cover composed of soil and glacial drift.

Access is from the city of Williams Lake, a distance of 125 km by road to the south shore of Quesnel Lake at Haggens Point. Private motor launches and barges cross the lake from Haggens Point, a distance of 8 km, to a landing at the mouth of Wasko Creek on the property of Eaglet Mines Limited. (Fig 1).

The fluorspar showings were discovered by H. H. Forster who staked the first mineral claims in the spring of 1947 near the canyon of Barrett Creek. The surface showings of fluorspar are confined almost entirely to the latter canyon. Most of the surface of the property is covered by soil and glacial drift, which in the early stages hampered prospecting.

Canex Aerial Exploration Ltd. optioned the property in 1966 and carried out a programme of road construction, trenching, geochemical soil sampling, mapping and percussion drilling. Metallurgical testing was conducted on several large samples of fluorspar-bearing rock. Although the test results were encouraging, the mineralization, as seen at that time, was below economic tenor and the option was relinquished in 1967.

Eaglet Mines Ltd. was formed in 1971 and recognized that the Main Zone located 600 m west of Barrett Canyon carried a better grade of fluorspar mineralization. Furthermore, the Main Zone appeared to be flat lying and not prone to outcrop. With very little outcrop and no diagnostic alteration for a guide, it was advisable to test with a series of vertical diamond drill holes. From 1973 to 1976 surface exploration and diamond drilling on the Main Zone gave encouraging results and a decision was made to drive an exploratory adit into the mountain. No. 1 adit was driven north a distance of 290 m in 1980 and surface and underground drilling intersected zones of fluorspar mineralization.

When the decision was made to drive No. 1 adit, only nine surface diamond drill holes had tested the area. Although the fluorspar zone in the adit was wide, the grade was, however, unexceptional.

By 1982 a large number of drill holes in the eastern sector of the Main Zone cut a zone well above average grade, and No. 2 adit was located 300 m east of No. 1 adit. Upon completion of No. 2 adit in 1983 a raise was driven on fluorspar mineralization at 374 m from the portal, and sub-level drifts were completed from the top of the raise. Surface diamond drilling to the end of 1983 in conjunction with bulk sampling of No. 2 adit confirmed and augmented the previous reserves as well as the grade of fluorspar mineralization.

Geology

The area geology is covered by Geological Survey of Canada Open File Map 574 by R. B. Campbell (1978), and

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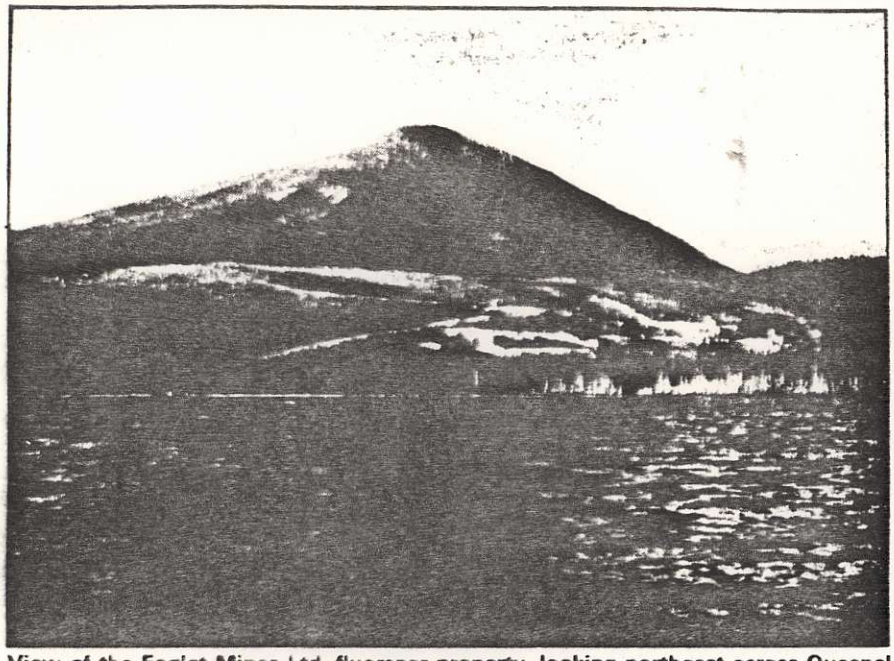
Fig. 1: Map showing the location of the Eaglet Mines Ltd. fluorspar property in British Columbia.



View of the Eaglet Mines Ltd. fluorspar property, looking northeast across Quesnel Lake.

Map 962 by L. C. Struick (1983). The deposits are located on N.T.S. Sheet No. 93A/10 West.

Granitic gneiss is the predominant rock type of the Wasko Lakes area. It belongs to the Snowshoe Formation, consisting of altered sedimentary rocks such as gneiss, phyllite, schist, quartzite, marble, amphibolite and pegmatite. The Snowshoe Formation is considered by R. B. Campbell to be of Hadrynian age (Late Proterozoic). Granite and granodiorite form intrusions which cut the Snowshoe Formation and, for the most part, are foliated. These intrusions are regarded as Late Cretaceous or Tertiary. The structural trend of the gneiss is northwesterly and the rocks have been overfolded to the southwest.

Most of the main faults in the area, as mapped by the Geological Survey of Canada, are steeply dipping. The earliest faults follow the grain of the country, trending northwesterly, and are mostly normal block faults, although some exhibit thrust or reverse displacements. Next in age is a system of normal faults striking north-south. A third system, striking northeast and north-northeast, is the youngest and dips to the southeast at moderate to steep angles. The pattern of the steeply dipping faults is reflected in the physiographic features such as stream patterns and lake shore alignments.

The country-rock gneiss on the Eaglet property strikes northwesterly and is a light-grey biotite gneiss that is fine to medium grained (range 0.5 mm to 2 mm) and commonly has a sugary texture. Predominant rock types, of altered nature, are salmon-pink gneiss or light-grey sericite gneiss. The nature of the original rock or pre-mineralized gneiss is uncertain owing to the widespread pervasive alteration.

A petrographic study by S. W. Campbell (1981) of drill-core samples, representing the gneissic rock type in the favourable horizon, indicates an average composition as follows: quartz 40%, microcline 20%, perthitic feldspar 25% and plagioclase 5%. Accessory and secondary minerals make up 10% of the rock and include biotite, chlorite, epidote, magnetite, zircon, apatite, hematite, calcite and kaolinite. The rock is highly altered and recrystallized, and carries interstitial calcite and fluorite. Close similarities exist between the Eaglet fluorspar deposit and those of St. Lawrence district, Newfoundland, in terms of main rock-forming minerals and alteration. Common to both areas is the assemblage of quartz, microcline, orthoclase and plagioclase, as well as the pink alteration of the country rock and development of sericite and chlorite.

Mineralization

At the Eaglet property, fluorspar occurs as veins, disseminations, and replacement lenses in the gneiss, and is generally attended by a decrease in or loss of gneissic character, and an increase in a sugary textured mixture of potash feldspar, quartz and fluorite. Moreoever, the host rock tends to develop a distinct salmon-pink colour in the fluorspar zones, caused by finely dispersed hematite. The fluorspar itself is usually medium to fine grained and varies from white to cream, but dark purple is common and a light-green fluorspar has been more rarely observed.

Fine-grained galena is present in association with late pyrite in quartz veins up to 50 mm thick, and is commonly attended by high silver values. Tetrahedrite, black sphalerite, molybdenite, wolframite, white scheelite and allanite have been observed, in small amounts as a rule. Molybdenite is prominent, however, in some sectors such as No. 2 adit. Concentrations of molybdenite have been mapped and sampled over a distance of 70 m in the adit and it is prominent in the raise. Calcite occurs to the extent of about 5% in the fluorspar zones and is usually interstitial. Minor epidote and chlorite are present and fine disseminated pyrite is erratically distributed in the host-rock in amounts up to 1% by volume.

Fluorspar mineralization may have multiple stages of emplacement but the timing is unknown. The mineralization is accompanied by silicification, pink feldspar, sericite and kaolin. The original feldspars have been altered to form secondary calcite, sericite and kaolinite. Likewise, alteration of biotite to chlorite and epidote has taken place, and the degree of alteration suggests intense hydrothermal activity that is convincingly linked to the development of fluorspar.

Zones of crushing, brecciation and shattering have played an important part in concentration of fluorite. Faults mapped in the underground workings follow the same general pattern as the steeply dipping faults identified in regional mapping by the Geological Survey of Canada namely, the northeast and northwest striking faults. Northeast-trending fractures, faults and shears identified in No. 1 adit have influenced fluorspar mineralization. The foliation of the gneiss and strong joints in No. 1 adit strike north east and dip at 30° to 50° southeast. Dykes are not common, but a few, thin lamprophyre and feldspar porphyry dykes have been observed. The lamprophyre dykes are probably post-ore whilst the feldspar porphyry dykes may be pre-ore.

Although no distinct markers have been found, zones of alteration can be traced laterally over considerable distances. For example, similar sequences in zones of brecciation in salmon-pink gneiss and assay patterns can be correlated from hole to hole in a parallel manner (Fig. 2). The favourable gneiss is underlain by a relatively barren footwall gneiss which is coarse-grained, and has an abundance of biotite and large crystals of quartz and feldspar. No discordance exists between the foliation of the favourable gneiss and that of the footwall zone. One zone of high-grade

fluorspar has a strike of 015° and dip of 45° to the west, and in this sector at least, the foliation of the gneiss does not agree with the attitude of the fluorspar zone but strikes 070° and dips 30° to 50° to the northwest.

The possibility should not be overlooked that pre-ore flat thrusting may have contributed to the brecciation in the mineralized Eaglet gneiss. This would account for the rather flat attitude of the fluorite layers which lie within linked or anastamosing zones of brecciation and shattering. Steep isoclinal folding has been observed in the canyon of Barrett Creek and, in conjunction with faults, shears, fractures and joints, probably influenced the location of the fluorspar mineralization.

The thickness of the flat-lying mineralized zones varies from 6 m to 30 m with an average of 8 m for all the fluorspar zones. There are eight distinctive zones known, of which four are designated "main zones". It is remarkable that the separation between the eight zones is so similar (range 10 m to 15 m) and resembles a rhythmic succession which must be more than a coincidence and a reflection of the origin of the deposit.

Surface drilling

From 1973 to 1984, a total of 126 diamond-drill holes were completed from surface for a total of 19,687 m. The area of close-spaced drilling lies within a square measuring 1,500 m east-west and 1,500 m north-south. The nominal spacing between holes is 30.5 m. Potential for additional fluorspar zones exists well beyond the latter area and also at depths below the presently known mineralization.

Table 1: Typical results of diamond drilling at Eaglet Mines

Hole No.	Core Intersections (metres)			Assay
	From	To	Intercept	% CaF_2
S.1	140.2	161.4	21.2	19.5
S.45	126.2	138.4	12.2	15.0
S.47	105.2	135.6	30.4	10.7
S.48	98.1	122.5	24.4	17.5
S.71	82.6	105.1	22.5	11.0
S.77	31.0	40.0	9.0	12.5
S.93	108.0	129.0	21.0	14.17
S.95	127.0	133.5	6.5	11.06
S.101	136.0	139.0	3.0	11.8

The greatest part of the drilling programme was carried out from 1980 to 1984 and consisted of vertical holes, BQ wire line. Core recovery ranges from 90 to 95%. In 1983, an analytical laboratory was installed at the minesite in order to obtain early returns by chemical analysis, the results being reported as weight-percentage CaF_2. Table 1 illustrates typical diamond drill-hole intersections and assays.

Underground Sampling

No. 1 adit was driven for exploratory purposes, under an area with very little outcrop, prior to completing the programme of surface diamond drilling. It is 292 m long, not including a drift 67 m long driven for diamond-drill stations. Nine flat diamond-drill holes, totalling 1,525 m, were completed from underground and outlined the zones of fluorspar mineralization. Rib samples were taken at 3-m intervals from both walls of the adit, and muck samples were taken after every round. The rock encountered throughout the working is salmon-pink gneiss with visible fluorspar as disseminations, lenses and massive fracture-fillings. The rock is very competent and a minimum of timbering was required. The adit, moreover, is essentially dry.

No. 2 workings include an adit that extends north from the portal a total distance of 374 m, and a raise driven 40 m on high-grade fluorspar mineralization with sub-level drifts from the top of the raise. The country-rock in No. 2 adit is very competent and free-standing, except in the limited areas of post-ore faulting where timbering was required. Some water was encountered in the fault zones but soon diminished.

Reserves

The published drill-indicated reserves at Eaglet Mines total about 24 Mt with an average grade of 11.5% CaF_2 using a conservative mine cut-off grade. These reserves include 2 Mt grading 15% CaF_2 in the vicinity of No. 2 adit. It is reasonable to assume that the surface diamond-drill programme planned for the 1985 field-season will augment the above fluorspar reserves. The programme will involve deepening of existing holes and drilling a series of step-out holes in potentially favourable areas. The optimism for deeper reserves is supported by one particular drill hole to the north which intersected an apparent lower zone projecting below the present block of reserves.

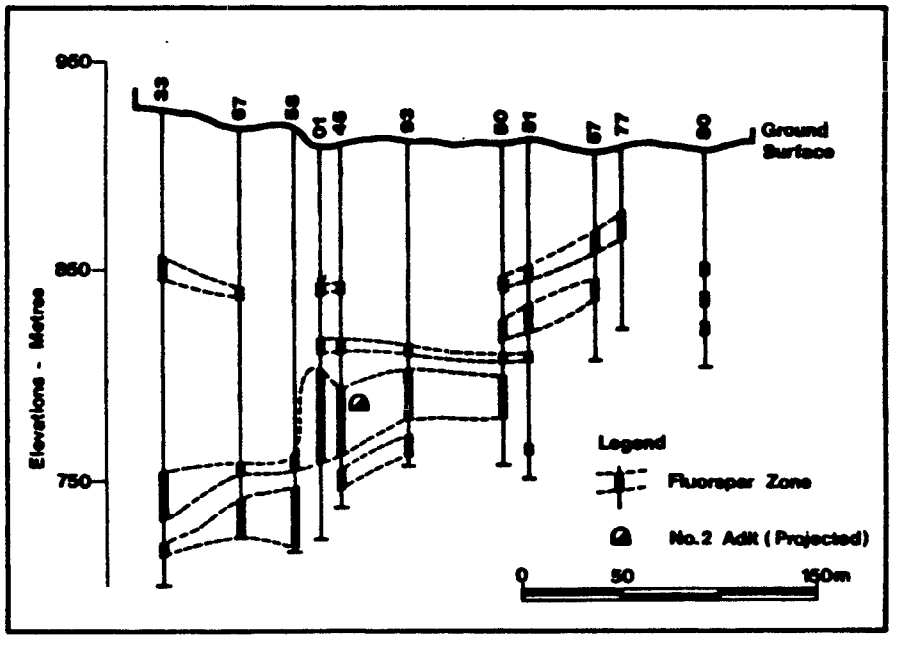


Fig. 2: Cross-section of surface diamond-drill holes.

Uses of Fluorspar

Fluorspar, or fluorite, is calcium fluoride (CaF_2), an industrial mineral with a broad spectrum of uses. The most important of these are: in the manufacture of hydrofluoric acid and other fluorine chemicals; as a fluxing agent in various metallurgical processes, the most important being steel manufacture; in the manufacture of artificial cryolite for the production of aluminium; in the refining of uranium ores; in the glass and ceramic industries.

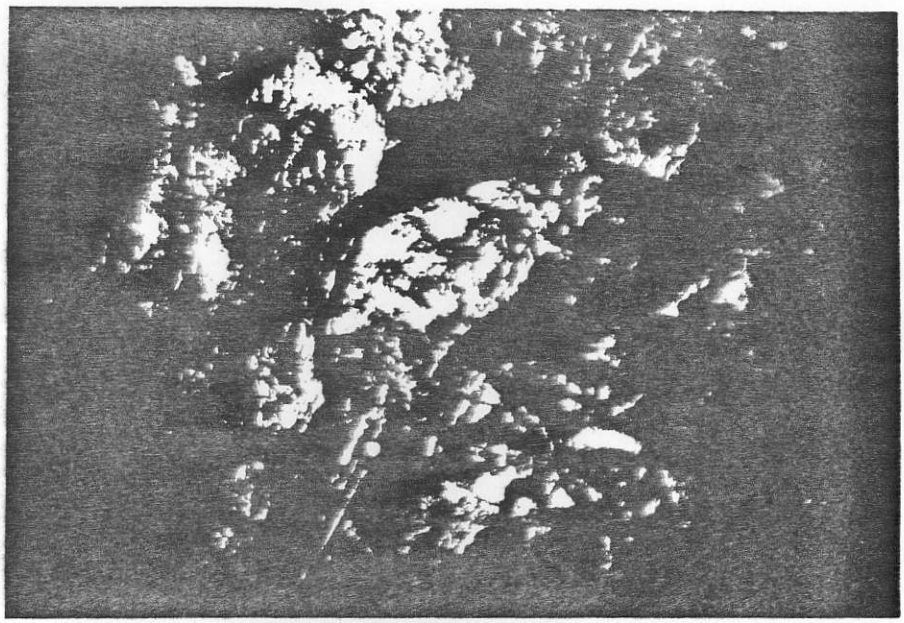
Fluorspar is marketed in three grades according to the end-use:

Acid Grade — Containing a minimum of 97% CaF_2

Metallurgical Grade — Containing 60 to 80% CaF_2

Ceramic Grade — Containing 88 to 97% CaF_2.

Acid grade: Roughly half the world's production of fluorspar is used in the manufacture of hydrofluoric acid, which



High grade fluorspar in No. 2 adit. Field of view about 1.7 m across.

has a variety of uses, the most important of which are in the aluminum and chemical industries. The manufacture of fluor-carbons such as solvents, resins, plastics, refrigerants and aerosol propellants requires large quantities of hydrofluoric acid.

Fluorspar is also a key ingredient in uranium refining.

Metallurgical grade: Normally, 40% of all fluorspar produced is consumed as a flux in the manufacture of steel. Fluorspar is also used as a flux in foundries and in the production of magnesium.

Ceramic grade: Ceramic grade fluorspar is used as an opacifier in enamels and opalescent glass.

Preliminary metallurgical tests of Eaglet Mines Ltd. fluorspar ore samples indicate that excellent recoveries can be achieved in producing concentrates which meet specifications for both the acid grade and metallurgical grade qualities of fluorspar.

Acknowledgements

The authors are indebted to the management and the President and Chief Executive Officer of Eaglet Mines Limited, Mr. Andrew Robertson, for permission to publish this article.

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