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A MISSISSIPPIAN BEDDED BARITE DEPOSIT, BAR CLAIM GROUP, SOUTH CENTRAL YUKON

A MISSISSIPPIAN BEDDED BARITE DEPOSIT, BAR CLAIM GROUP, SOUTH CENTRAL YUKON

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ABSTRACT

The BAR CLAIM GROUP is located on the western margin of the Selwyn Basin geologic province in south central Yukon. The rock sequence is eugeosynclinal in nature, belonging to the Englishman's Group of the Mississippian. Chronologically, these rocks include massive limestone, white to red chert breccia, dark grey chert breccia, chert pebble conglomerate, lithic wacke, massive barite, grey green chert, and hornblende microdiorite. The clastic units in particular appear to be correlative with the units on the eastern margin of the Selwyn Basin.

The barite is light grey, bedded, massive, and contains rare relic rosette structures. Associated minerals include pyrite, galena and minor sphalerite. Extensive recrystallisation and mobilization has occurred, probably as a result of regional compression and faulting.

The barite may have had an exhalative origin along fault or extensional zones; however, sedimentogenic sources, such as the redistribution of pre-existing barite, cannot be precluded.

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CHAPTER I

INTRODUCTION

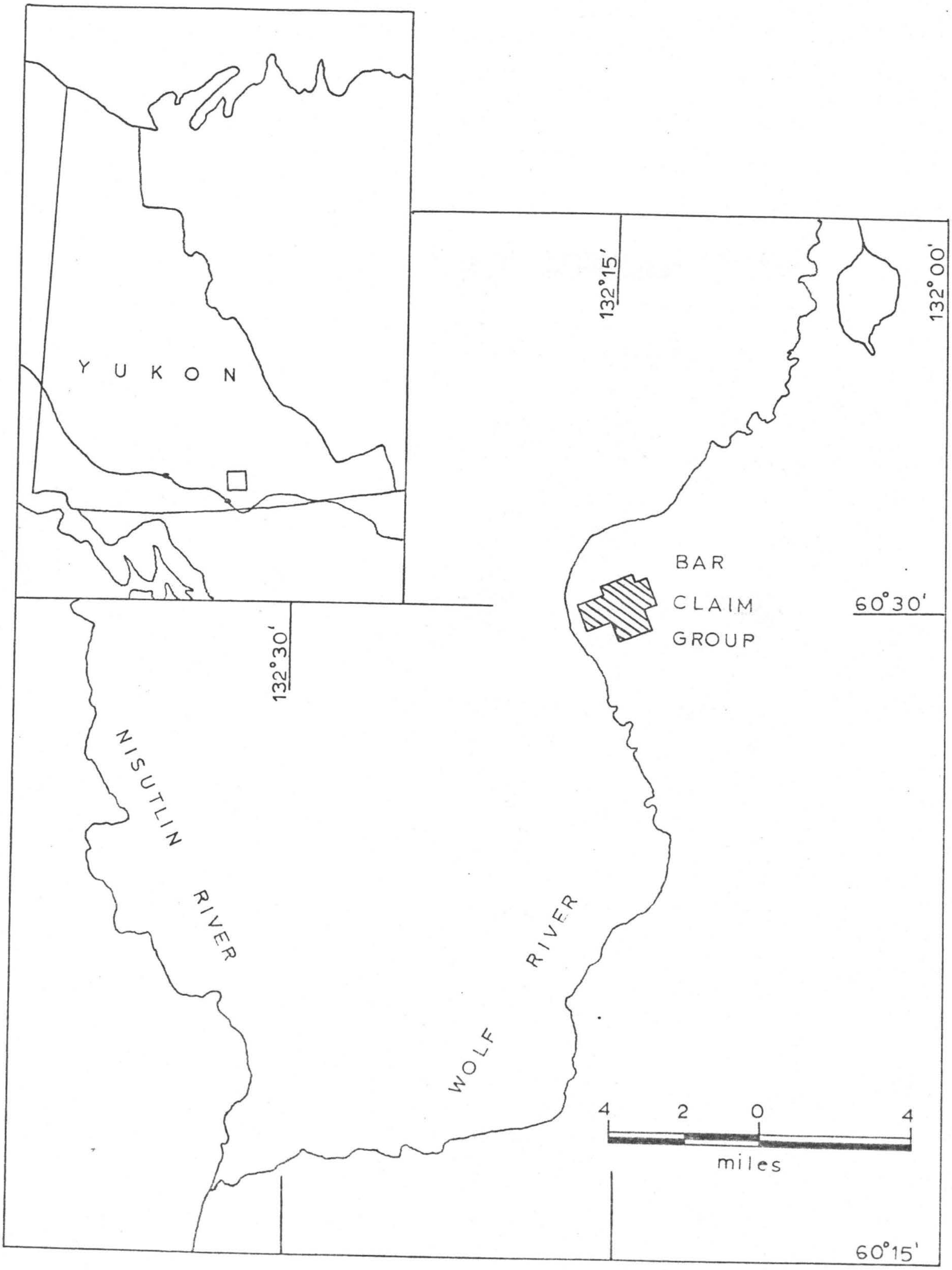
The BAR CLAIM GROUP is located in the south central Yukon, thirty miles northeast of Teslin, on the east side of Wolf River at approximately 060°30'N and 132°14'W (Figure 1).

The twenty-claim prospect was staked by the D.C. Syndicate throughout the summer of 1976. The major interest was centered about numerous rusty, limonite sinters, plus minor surface galena associated with massive barite and chert. A soil-geochemical survey and geological mapping was carried out, based on 200 foot tape-and-compass lines. This was followed up by an induced polarization survey (De Paoli, 1976) on 400 foot lines.

Previously, this area has been staked four times by various individuals and companies: in June 1956, September 1957, March 1969 and July 1971. Only preliminary evaluations were made (Archer, Cathro and Associates, 1972).

The object of this report is to compile the stratigraphy of the barite, cherts and limestone, investigate the depositional aspects of barite, and to relate this to regional barite deposits.

Figure 1. BAR CLAIM GROUP, South Central Yukon



CHAPTER II

GENERAL GEOLOGY

1. REGIONAL GEOLOGY

The geology of the Teslin map area (NTS 105C) has been mapped by Mulligan (1963). Accordingly, the rocks of the BAR GROUP are Mississippian and belong to the Englishman's Group, map units 2 and 3. Map unit 2 is a limestone and is overlain by unit 3 which varies from chert, argillaceous quartzite, arkosic grit, conglomerate, limestone, slate, phyllite, to greenstone.

The BAR GROUP is located at the southern extremity of the Thirty Mile Range which belongs to the Pelly Mountain Range. Essentially, the BAR GROUP lies in the Pelly-Cassian Mountain Belt.

During the late Proterozoic and early Paleozoic, the Pelly-Cassian region possessed miogeosynclinal and shelf conditions, but by the Devonian to early Mississippian, a typical eugeosynclinal depositional system formed (Gabrielse and Wheeler, 1961; Gabrielse, 1967). Probably, the thick chert, arenite, chert pebble conglomerate and greywacke came from within the eugeosyncline. The presence of the Selwyn Basin to the east precludes an easterly source for these sediments. These eugeosynclinal rocks, plus some volcanics and limestones, were folded and metamorphosed to form the present-day Big Salmon Complex.

The Englishman's Group overlies the Big Salmon Complex with a pronounced angular unconformity. A brief orogeny and minor localized uplift separate the deposition of the Big Salmon Complex from the Englishman's Group.

Tempelman-Kluit et al. (1976) describe the rock sequence above this unconformity in the Pelly Mountain area. Basal, thick-bedded, light grey dolomite is followed by thin-bedded, brownish weathered, silty dolomite and dolomitic mudstone sequences, representing intertidal to subtidal deposition. Overlying, medium bedded, light grey, mature orthoquartzite and sandy dolomite represent a beach environment. Black siliceous slate and minor greywacke overlie the dolomite sequence, representing a return to deeper water following subsidence of the stable carbonate platform. The upper part of the black slate unit contains lenses of thinly laminated barite, locally as thick as 50 m. The black slate is overlain by pale green, tuffaceous chert which is overlain by bioturbated shale and siltstone. The chert grades southwestward into acid-to-intermediate, submarine, explosive volcanic rocks, and then back into chert again.

The general structure shows anticlines, moderate dips, and numerous low angle, partially undulatory thrust faults. Competent Siluro-Devonian rocks have been thrust northeast along Cambrian to lower Silurian phyllites and slates, onto Mississippian strata. These thrust sheets and anticlines were subsequently faulted by steep, northwest trending, normal faults producing elongate blocks. These in turn, were faulted by northeast trending faults. Locally, faults formed around the contacts of Cretaceous, granitic intrusions (Gabrielse and Wheeler, 1961).

2. MAP UNIT DESCRIPTIONS

The geology of the BAR GROUP was mapped (see folder at back of text) on 200 foot tape-and-compass lines. The compilation of the map units and their boundaries are based on field work, thin sections and air photo lineaments. The map units are placed in their chronological sequence as interpreted from their bedding and relative position.

Outcrop exposure is poor, covering approximately 10 to 15% of the map area. Exposures are limited to the ridges and irregular prominences which may be the result of faulted uplifts. In many areas, extensive mechanical weathering has produced chip-size felsenmeer which has enhanced soil development.

(i) Greenstone, Volcanics

In the northern portion of the map area the rock of unit 1 is massive and contains abundant vesicles filled with carbonate and chlorite. Close to the centre of the map area, the rocks of this unit contain relict subhedral phenocrysts (30%) in a fine grained matrix. The original phenocrysts have been replaced by carbonate and chlorite. The matrix of both these volcanic rocks is so fine that most of the mineralogy is indeterminable in thin section; however, fine grained leucoxene was observed in both rocks. Both rocks display greenschist alteration with abundant carbonate veinlets and aggregates.

In between these two areas, the rocks of unit 1 can best be described as greenstone. They are composed of a microcrystalline quartz-feldspar matrix and irregular aggregates of carbonate. Accessory black opaques are scattered throughout, occasionally being present as cavity linings. Fine grained leucoxene and late stage veinlets of carbonate and quartz appear extensively throughout the rock.

Although these two rock types may have different protoliths, their metamorphic grade and mineralogy are sufficiently similar yet entirely distinct from the overlying sediments, that they may be assigned to the same map unit. The overall unit thickness could not be estimated.

(ii) Grey Limestone, Chert Lenses

This unit is composed of massive grey limestone with 1-20 cm. thick chert interbeds and block-size chert nodules proximal to the chert map unit. Rare crinoids, horn corals and stromatolites are found preserved by silicification. No fossils were observed in thin section.

Approximately 80% of the limestone is micrite, 10-20% neomorphic sparry calcite, and from 5-20% fine grained subrounded detrital quartz. The northern outcrops contain a high proportion (20%) of detrital quartz grains while the southern outcrops contain only about 5%. The latter contain up to block-size nodules of chert.

This unit has an undetermined thickness; however, it appears to be in the form of a wedge, pinching out towards unit 1. The limestone has an estimated, minimum thickness of 100 feet in the southern part.

(iii) White to Red Chert, Breccia, Interbedded Dolomite

This unit is located between the grey limestone and the grey green chert in a central linear zone extending south from the centre of the map. Exposure is extremely poor; the largest outcrop is 100 by 200 feet in size and the total surficial exposure is less than 5%.

The rock is characterized by a light grey to white chert with thin (2 cm.), discontinuous interbeds of dolomite in the northern and southern extremities of this zone. The dolomite is composed of about 80% mosaic dolomite, 15% microcrystalline quartz, 5% rounded quartz grains, and trace euhedral pyrite.

In the central portions of this map unit, the chert varies from white to orange to reddish. Extreme intraformational breccia of pebble size, are outlined by microcrystalline quartz, and in places by a red iron oxide. Calcareous rocks were not observed in this part of the zone.

Maximum thickness as inferred from the assumed geologic boundaries, is approximately 400 feet.

(iv) Dark Grey Chert Breccia

The dark grey chert breccia unit is composed of pebble-size, intraformational breccia of microcrystalline quartz with minor needles of chlorite and sericite. From 20-70% of the rock is composed of clear, transecting veinlets of chalcedony and coarse crystalline quartz, exhibiting at least two periods of fracture filling. Opaques may be present up to 5% as pyrite or weathered sulphides.

This unit varies in colour across the map area. At the east end where the upper contact with the pebble conglomerate is sharp, the breccia is light grey (the lower contact with the limestone is covered by overburden). Further west, where the upper contact is gradational into the lithic wacke (see later), the colour is a very dark grey.

The estimated maximum thickness of this unit is 300 feet.

(v) Chert Pebble Conglomerate

The chert pebble conglomerate is clast supported and poorly sorted, ranging from pebble to sand size clasts. The clast shape varies from very angular and brecciated, to well rounded and abraded, to very ductile clasts that have been flattened extensively by regional compression. The colour of the pebbles varies from grey through the pastel colours to black, the black clasts being the most ductile. Occasional dissolution cavities produce a box-work structure.

In thin section, there are three major components. The pebbles are composed of microcrystalline quartz with a seriate texture. Between the pebbles and along shear zones are distorted lenticules of microcrystalline quartz and foliated chloride needles. The third component is made up of interlocking quartz crystals, which appear to be fracture and void fillings.

As a map unit, the chert pebble conglomerate has a sharp lower contact with the grey chert breccia, whereas the upper contact is gradational into the lithic wacke. The estimated thickness, to a first approximation, is about 175 feet.

(vi) Lithic Wacke

This unit contains four components in varying proportions. Brecciated clasts of microcrystalline quartz constitute about 40-70% of the rock. They range from elongate islands to distinctly lenticulate in form, and are often paralleled by voids.

Medium-size rock fragments occur in rounded to subrounded grains of various compositions. Two of the most frequent types include very fine grained dark chert, and quartz and feldspar grains within a microcrystalline quartz matrix.

The third component, quartz with minor feldspar, occurs as subrounded grains and aggregates, comprising approximately 5-30% of the rocks. The aggregates commonly possess sutured contacts. These grains, plus the rock fragments, are commonly wholly contained within the brecciated microcrystalline quartz clasts.

The clasts are set in a microcrystalline quartz matrix with minor, foliated chlorite needles. This matrix possesses a compressional or flow texture about the clasts.

The unit overlies the chert pebble conglomerate with a rapidly gradational contact. In the eastern section, the wacke possesses about 40% matrix, grading to about 25% in the northern area. The maximum estimated thickness is about 300 feet, but it could be as low as 50 feet.

(vii) Massive Barite

The massive barite is a grey to white fine grained rock of essentially pure barite with a mosaic texture. Occasionally, large subparallel needle shaped crystals appear loosely stacked within the mosaic texture. Rarely, larger, subhedral barite laths occupy a fracture-like habit, cutting through the mosaic texture. Two instances of possible relict radial growth of rosettes were seen in thin section. Not infrequently, a characteristic sulphuric odour is detectable upon breaking the rock.

The extent of cataclastic deformation appears to increase with the silica content. The pure barite shows only minor undulatory extinction and very rare kink banding. As the silica content increases toward the upper contact with the grey green chert, extensive cataclastic texture is seen, especially as granulated and brecciated quartz.

In the lower portions abundant marcasite is observed in a chip felsenmeer, barite host. The marcasite appears as subparallel, thin, elongate lenticules of finely disseminated to lumpy aggregates of rounded grains. The sulphide boundaries cut across the sulphate suggesting prior crystallization of the sulphate. This is further evidenced by occasional dendritic and vein-like marcasite. There is no evidence of corrosion or alteration of the barite or marcasite.

Figure 2. Small isolated outcrop of barite showing bedding traces (hammer is parallel to strike). The overturned rock in the lower left corner shows lenticular interbeds of barite in grey green chert.

In polished section, the marcasite, as identified in the field, was identified locally as pyrite. Minor disseminations of fine grained, irregular to rounded blebs of sphalerite, are contained by the barite proximal to, but not touching, the pyrite. Very minute, bleb- to lamellae-shaped tetrahedrite crystals (Cu_3SbS_{325}) are scattered throughout the sphalerite. These are either replacement or exsolution blebs.

The lower contact was not observed, but the outcrop extends very close to the chert pebble conglomerate outcrop. The upper contact is rapidly gradational into grey-green chert. The barite is coarsely crystalline where it is interbedded with the chert.

Surface weathering is of two types. Mechanical weathering into cobble-size felsenmeer is very extensive, extending to an unknown depth. Minor chemical weathering has produced small dissolution cavities with a box-work structure. Only one small outcrop was sufficiently preserved to display bedding of the massive barite (Figure 2).

The thickness of this unit is indeterminable. If the unit is close to vertically dipping, then it is about 300 feet thick. If the entire unit has a dip similar to that shown in Figure 2, then the thickness is about 50 feet.

(viii) Grey Green Chert

The grey green chert unit is composed of 60-90%

microcrystalline quartz with a seriate texture. Minor to trace sericite is also found evenly distributed throughout a given section, possessing a subparallel orientation. Up to 5% pyrite or pyritic dissolution vugs are found throughout the mass of the rock or in fractures. The weathered-out pyrite leaves a ferric oxide residual rim. From 10-40% of the unit is transected by veinlets of quartz, indicating at least two stages of fracture filling. Thin (1 cm.), discontinuous interbeds of coarsely crystalline barite were observed in the outcrop proximal to the massive barite.

Prominent macroscopic banding is the result of alternating intense and dispersed compressional shearing. The actual shearing texture is observable only in thin section.

Thickness and bedding characteristics are indiscernable on account of the extreme mechanical weathering, the fine grained nature of the rock, the extreme schistosity and the uppermost position of the unit.

(ix) Hornblende Microdiorite

The hornblende microdiorite unit is a massive grey dyke approximately 20 feet thick, cross-cutting the dark grey chert and lithic wacke. At the eastern end, the dyke widens to a circular form about 75 feet in diameter.

The rock contains euhedral phenocrysts (25%) of basalt hornblende, up to 4 mm. in length. Calcite (15%) is present as large patches of irregular aggregates,and occasionally they are found in the centre of the hornblende suggesting a replacement process. The matrix (55%) is composed of fine amphibole laths (35%) and very fine, granular to lath-like feldspar (20%).

3. STRUCTURE AND STRATIGRAPHY

Unit 1, the greenstones and volcanics, appears to be an older group and underlies the entire sedimentary sequence. This concept is established by the bedding of unit 4 at the northern central section of the map. This location is designated by the sample number CB 375 on the geological map. The bedding suggests an open antiform acting as a window to unit 1 along the axis.

About 600 feet to the east of this point, unit 1 is exposed adjacent to units 4 and 8. The steep sides of the outcrop, plus the correlation with aerial photo lineaments suggest that unit 1 has been upfaulted along a 025° trend at this location.

The general lithological sequence in the northern part of the map area, passes southwards from younger grey green chert, to lithic wacke, to older dark grey chert breccia. In keeping with this sequence, the greenstones and volcanics are older and underly all the other map units.

Also, the induced polarization survey (De Paoli, 1976) suggests a window at location CB 375, and that the induced polarization values of percent frequency effect were similar at CB 375 and CB 808.

The foregoing relationships, plus the fact that unit 1 has a much higher degree of metamorphism, suggest that these rocks may belong to the Big Salmon Complex. They were probably deposited during the Devonian to early Mississippian in a eugeosynclinal environment, and then folded before the deposition of the Englishman's Group.

Unit 2, the grey limestone, outcrops in the north and south corners of the map. It is thought that they are linked together beneath the intervening cherts and clastics. This is based on the fact that the bedding of the cherts and clastics dip toward the centre suggesting a synformal structure. The compliment of this synform is present as an antiform to the west. This is demonstrated by the induced polarization survey results (De Paoli, 1976) which indicate a gently, north-plunging anticline. This was outlined by the difference in plan perspective of percent frequency effect between the limestone and the overlying cherts.

The absence of limestone between units 4 and 2 in the northern part of the map, indicates a lack of continuity of the limestone beneath the cherts in this particular area. Lack of deposition may have resulted from a dilution effect by silica in this zone. The limestone in the northeast corner of the map, contains up to 25% detrital quartz and feldspar, indicating that there has been a high silica input.

The limestone to the south has less than 5% detrital quartz but does contain substantial chert lenses and nodules. It is suggested that any lack of continuity of limestone may be a function of contamination of the carbonate depositional process by localized silica input.

Alternatively, the window to unit 1 at sample area CB 375, may represent a topographical island of older rock, thereby preventing deposition of limestone.

Units 3 and 4 are lateral equivalents to one another. Both have the same sedimentologic fabric and essential mineralogy except for local variations. The chert of unit 3 has thin interbeds of dolomite in the northern and southern extremities, and in the centre it is brecciated with a red iron oxide matrix. The chert of unit 4 changes colour from a light grey in the east to a dark grey towards the west, as it gets progressively contaminated by fine silt. In both cases, the internal variation of the chert units is as great as, if not greater than, the variation between these units.

Unit 4 appears on the west side of the plunging limestone anticline, while unit 3 appears on the east side. Furthermore, these two areas are connected by the same contour of percent frequency effect obtained from the induced polarization survey (De Paoli, 1976). Together these suggest that units 3 and 4 are laterally equivalent.

Units 5 and 6 represent a rapid clastic input along a northwest to southeast zone. A basal, poorly sorted pebble conglomerate grades upward into a lithic wacke. Judging from the outcrop positions, the pebble conglomerate appears to pinch out towards the west. The lithic wacke is slightly better sorted, and contains a higher proportion of microcrystalline matrix towards the west. These trends may suggest a wanning current flowing in a northwesterly direction.

This hypothesis is further enhanced by the colour variations in unit 4. Under the chert pebble conglomerate, the chert is light grey, whereas it is dark grey under the lithic wacke. This suggests that the rapid conglomerate deposition from the east did not mix with the underlying silica, whereas toward the west, the clastic fines appear to have contaminated the last depositional stages of the chert.

The easterly source for the clastics appears to conflict with the regional depositional conditions suggested by Gabrielse and Wheeler (1961). A localized easterly source may be the result of differential block uplifting which occurred during the mild orogeny, separating the early and middle Mississippian rocks.

Alternatively, these chert pebble conglomerates may represent a beach facies along an uplifted chert block to the north. In this case, the dark grey chert, contaminated with fine clastics, is suggestive of deepening water towards the west.

Unit 8, the grey green chert, is found overlying units 3,4 and 6. This could be a function of chert formation creating a depositional unconformity; however, it is more likely that intervening erosional processes have exposed lower units. This is also suggested by the outlier of grey green chert within unit 3. Since unit 3 dips about 40°E there was probably some erosion of unit 3 before the deposition of the grey green chert. In any case, the grey green chert appears to have blanketed the entire area.

Based on field data, there are two prominent hypotheses concerning the deposition of a barite: a fault controlled deposition and a conformable deposition.

Aerial photographs display two prominent lineaments that pass through the massive barite. One appears to be vertical and striking at 310°. Along this lineament are two occurrences of barite rubble and one barite outcrop. The other lineament strikes at 090° with an approximate dip of 45°S. Some barite is found on this lineament about 500 feet west of the massive barite. These aspects may suggest that the barite was deposited in, or injected into these lineament (possibly fault) zones.

The bulk of the field data, however, suggests a conformable deposition. This is evidenced by (a) all the barite occurrences appear near the base of the grey green chert, (b) the barite, in places, appears to be interbedded with the grey green chert, (c) at one locality the barite appears bedded, and (d) the fine grained nature of the barite suggests sedimentation. Thus, it is suggested that the barite is a basal facies of the grey green chert unit.

4. LINEAMENTS

Although only two faults are indicated on the geological map, faults are probably quite numerous. Many draws and open rock faces were observed in the field. These correlated with the numerous air photo lineaments; however, it is impossible to positively identify them as faults, rather than fractures, since no offsets were seen. These lineaments can best be described as fault/fracture planes.

These fault/fracture planes follow three major trends: 160°/90°, 085° with a vertical to steep dip south, and 025°/90°. These trends can be related to the tectonic evolution as suggested by Gabrielse and Wheeler (1961). The 085°/90° fault/fracture plane reflects the motion of the overthrusting Siluro-Devonian rocks towards the east. These lineaments are displayed prominently in the chert pebble conglomerate and the limestone.

The 160°/90° lineaments can be related to either sympathetic normal fracturing from the overlying thrust sheets, or from differential block upthrusting during the mild orogeny of the early Mississippian. Cross-cutting relationships with the 085° lineament were unable to provide relative ages. The regional schistosity also strikes at 160° with a moderate to steep dip west.

The 025°/90° fault/fracture plane correlates with the northeasterly trending faults of Gabrielse and Wheeler (1961), and according to the cross-cutting relationships, they appear to have occurred last.

CHAPTER III

BARITE

1. CHEMISTRY

The barium ion is relatively large; in its common valence state it is 1.43 angstrom units. Because of this, it exhibits good diadochy only with Sr^{+2} and K^{+}. The substitution in feldspar and micas is very common, making the K^{+} rich igneous rocks high in Ba^{+2}.

Barium is distinctive from most other metals; as a sulphide it is water soluble, as a sulphate poorly soluble, and as a chloride it is very transportable. This has important applications to the source, transportation and deposition of barium. The barium ion reacts rapidly with sulphate to precipitate insoluble barite ($BaSO_4$). Barium chloride ($BaCl_2$) is transported in connate brines to sulphate rich waters where it precipitates as barite.

Barite crystallizes in the orthorhombic system in prismatic to tabular crystals. Pure barite contains 58.8% Ba^{+2} and 41.2% $SO_4^{=}$, but Pb^{+2}, Sr^{+2} and Ca^{+} can substitute for Ba^{+2} creating solid solutions of angleso-barite, baryte-celestite, and calcio-barite (Fischer, 1972). Barite has a specific gravity of 4.5 and a Mohs hardness of 3. The habit of barite may be as irregular masses, concretions, nodules, rosette-like aggregates, or massive to laminated in beds. The colour ranges from whitish grey to black.

2. DISTRIBUTION MECHANISMS

The barium ion is initially brought to the earth's surface by volcanic and intrusive activity. Weathering, alteration and transportation distribute the barium ion essentially throughout all rock and water systems. Depending upon solubility, and substitutional and biological effects, some phases contain more barium than others.

Dunham et al. (1967) suggested that the diadochy of K^+ and Ba^{+2} enables an enrichment in non-alkaline and non-basic magmatic rocks. If potassium feldspar crystallizes early, before the melt is saturated with respect to water, then the Ba^{+2} will be tied up in the potassium feldspar. Conversely, if plagioclase crystallizes first, then the Ba^{+2} will be concentrated in the melt. Also, the Ba^+ content generally increases with the silica content. These concentration mechanisms may be employed in the formation of Ba^{+2} for vein and cavity filling deposits (see later).

Generally the Ba^{+2} content of magmatic rocks decreases during metasomatism (except during emplacement of pegmatites in granites), wall rock alteration, and greisenization. Thus, magmatic-hydrothermal fluids probably obtain their Ba^{+2} by leaching suitable wall rocks (Puchelt, 1972).

Sedimentological transport of Ba^{+2} is accomplished by: (1) particles of fine mineral material; (2) absorbed ions on clay size particles, and (3) attached to sols such as $Mn(OH)_4$ (Brobst, 1973). The amount of Ba^{+2} absorbed by suspended matter depends on the type of suspension and the concentration of the ions competing for adsorption sites (Puchelt, 1972). These mechanisms tend to increase the Ba^{+2} content of the silt fractions of nearshore and shelf sediments.

The formation of barite depends largely upon the availability of the sulphate ion. The sulphate ions of the sea combine readily with ionic barium to precipitate barite. Thus, the Ba^{+2} content of the sea is very low, in the range of 0.03 to 10 ppm (Shawe et al., 1969). Also, it is possible that barium may be trapped by precipitating aragonite (Brobst, 1973) since it will fit into the lattice structure. However, the change of lattice size during conversion of aragonite to calcite or dolomite will cause the Ba^{+2} to be expelled. Depending upon whether its environment contains sulphates or chlorides, the barium will either be precipitated or transported in solution elsewhere. Barite is commonly associated with the carbonates calcite, dolomite, siderite and rhodochrosite.

There appears to be a strong relationship between the barium highs of deep sea pelagic sediments with the estimate

Table I. Abundance of Barium in Earth's Crust with Respect to Major Tectonic Units (in weight ppm) (from Lee et al., 1970)

REGIONS				CRUSTS			ROCKS	
Deep Oceanic	Sub Oceanic	Continent	Folded Belt	Oceanic	Continent	Earth	Crystal-line	Sediments
320	430	400	390	370	400	390	390	460

Table II. Abundance of Barium in Earth's Crust (from Puchelt, 1972)

Igneous intrusive rocks (mean)	728 ppm
gabbroic rocks	246 ppm
granites	732 ppm
granodiorites and quartzdiorites	873 ppm
diorites	714 ppm
Consolidated sediments (mean)	538 ppm
sandstones (including greywackes)	316 ppm
shales	628 ppm
carbonate rocks	90 ppm
Sea water	0.02 ppm

of biological productivity and phosphate content of the water (Goldberg et al., 1958; Turekian et al., 1963). This may be a consequence of the production of sulphate during the oxidation of organic sulphur during sinking, thereby fulfilling an important criteria for the precipitation of barite. Because the sea is undersaturated with respect to barite, it tends to dissolve. Pressure and temperature studies (Chow et al., 1960) indicate that the solubility of barite decreases markedly with depth. If barite approaches saturation at depth, then the deposition of barite in pelagic sediments becomes a possibility. Also, barite may be precipitated directly as detrital organic remains. In the Pacific Ocean, Protozoa remnants containing Ba^{+2} form at depths of 3,000 to 16,000 feet, which is below the calcite compensation level (Shawe et al., 1969). Barite is commonly associated with shales, quartz, cherts and jasperoids (Brobst, 1973).

Since barite formation depends on the availability of sulphate, the environment of precipitation must be compatible with the stability of sulphate. Consequently, barite is commonly associated with other sulphates. Barite is also found as a gangue mineral in many sulphide deposits, especially with pyrite, chalcopyrite, galena, sphalerite and their oxidation products (Brobst, 1973).

3. DEPOSITS

There are three major types of deposits: vein and cavity filling deposits, residual deposits, and bedded deposits. These have been described thoroughly by Brobst (1973).

(i) Vein and Cavity Filling Deposits

In these deposits barite occurs along faults, fracture joints, bedding planes, breccia zones and solution channels, and in various sink structures. It is commonly thought that these deposits form by precipitation from low temperature solutions of an epithermal or perhaps a hydrothermal suite. The term telethermal is preferred since the solutions have travelled considerably from their source and are somewhat cooler than expected of epithermal suites. Since Ba^{+2} may also be freed from surface rocks by weathering, it may also be possible to form vein deposits from circulating meteoric or supergene waters.

Usually the barite of vein and cavity filling deposits is fine grained to coarsely crystalline, and lightly coloured to white to grey. It is commonly associated with fluorite, calcite, dolomite, ankerite, quartz, pyrite, chalcopyrite, galena, sphalerite, and occasionally gold and silver minerals. The latter two are usually associated with the sulphides.

Wall rock contacts are usually sharp with only very rare large scale replacement. Host rocks include igneous, sedimentary and metamorphic rocks of Precambrian to Tertiary age; however, deposits in Mesozoic rocks are uncommon.

Dunham et al. (1967) have suggested that barite mineralization may be controlled by domal or linear uplift and regional magmatic activity of a non-alkaline and non-basic nature. The uplift creates extensional zones allowing a plumbing mechanism. The magmatic activity of diorite-granodiorite and latite monzonite may be related to, but not necessarily associated with, the availability of Ba^{+2}. This is a consequence of the diadochy of Ba^{+2} and K^{+}, the low K^{+} magmas having more available Ba^{+2}.

Engelhardt (1967) also associated uplift with the formation of barite. In this mechanism, barite is produced diagenetically during uplift, not subsidence. This is because barium is present at depths, whereas the sulphate is present only in shallow zones. Uplift combines the two enabling precipitation of barite.

(ii) Residual Deposits

These are formed from the weathering of pre-existing barite deposits. They are usually unconsolidated and contain fragments, usually of chert and jasperoid, and clayey residuum derived from the host rock.

The barite is commonly white and translucent to opaque. Common forms include mamillary, fibrous, platy or dense fine grained irregular masses. Pyrite, galena, and sphalerite are often associated with the barite.

The form of the deposit depends upon the form of the original deposit. Vein and breccia deposits tend to form elongate residual deposits whereas collapse and sink structure deposits tend to form circular deposits.

Common deposits lie in Cambrian and Ordovician limestones and dolomites. Aragonite is the only major carbonate that can incorporate Ba^{+2} into its lattice. Upon calicitization or dolomitization, Ba^{+2} is rejected and is free to either precipitate as barite or be redistributed. This mechanism may possibly be related to the origin of these deposits. Also, Revelle et al. (1955) suggested that this process may provide a measurement of the rate of dissolution (and diagenesis) of carbonates.

(iii) Bedded Deposits

Bedded deposits contain barite as either a primary or cementing mineral in stratiform rock bodies. It is often interbedded with dark chert, siliceous siltstone, shale or limestone, and may be massive to laminated. The barite ranges in thickness from a few inches to 50 feet, whereas the barite zone may be as much as 200 feet thick. In general, the bedded deposits usually occur in mid-Paleozoic rocks.

The barite is usually grey to black and fine grained (less than 0.1 mm.). Nodules and rosettes may be present suggesting adequate room for growth. The rocks are generally 50-90% barite with inverse proportions of fine grained quartz and minor clay, and pyrite. The black colour and the fetid smell released by crushing may be a result of organic influence during deposition.

Shawe et al. (1969) have described an Ordovician bedded barite deposit in a eugeosynclinal siliceous facies in Nevada. Graded bedding, lateral continuity, and conformity of the barite with the enclosing cherts and shaley mudstones suggest a sedimentary origin. The barite is dark grey, fine grained and massive with some rosettes and minor conglomeratic barite rock. Radiolaria tests sometimes form the nucleus of the rosettes. All the barites contain the fetid H_2S smell. Also, white to light grey, massive, sugary-textured barite was found about 5 miles away. This deposit was traced into a dark grey, chert laminated barite. It was suggested that the white barite has undergone a history of bleaching and recrystallization by hydrothermal alkaline or acidic solutions. These solutions may have been associated with a nearby granitoid stock.

Bedded deposits may be formed directly from submarine volcanic emanations and hot springs (Brobst, 1973), hydrothermal solutions (Dunham et al., 1967), metamorphic fluids (Puchelt, 1972), or by organisms in sea water (Puchelt, 1972; Shawe et al., 1969). These processes may act separately or together, as either primary or enrichment process.
Brobst (1973) also suggested that the dissolution and

redistribution of pre-existing rocks may play an important role. Connate or chloride-rich waters are able to transport Ba^{+2} readily. In this case, barite deposits would be expected in lakes, swamps and coastal areas where sulphate is suddenly made available.

CHAPTER IV

REGIONAL BARITE DEPOSITS

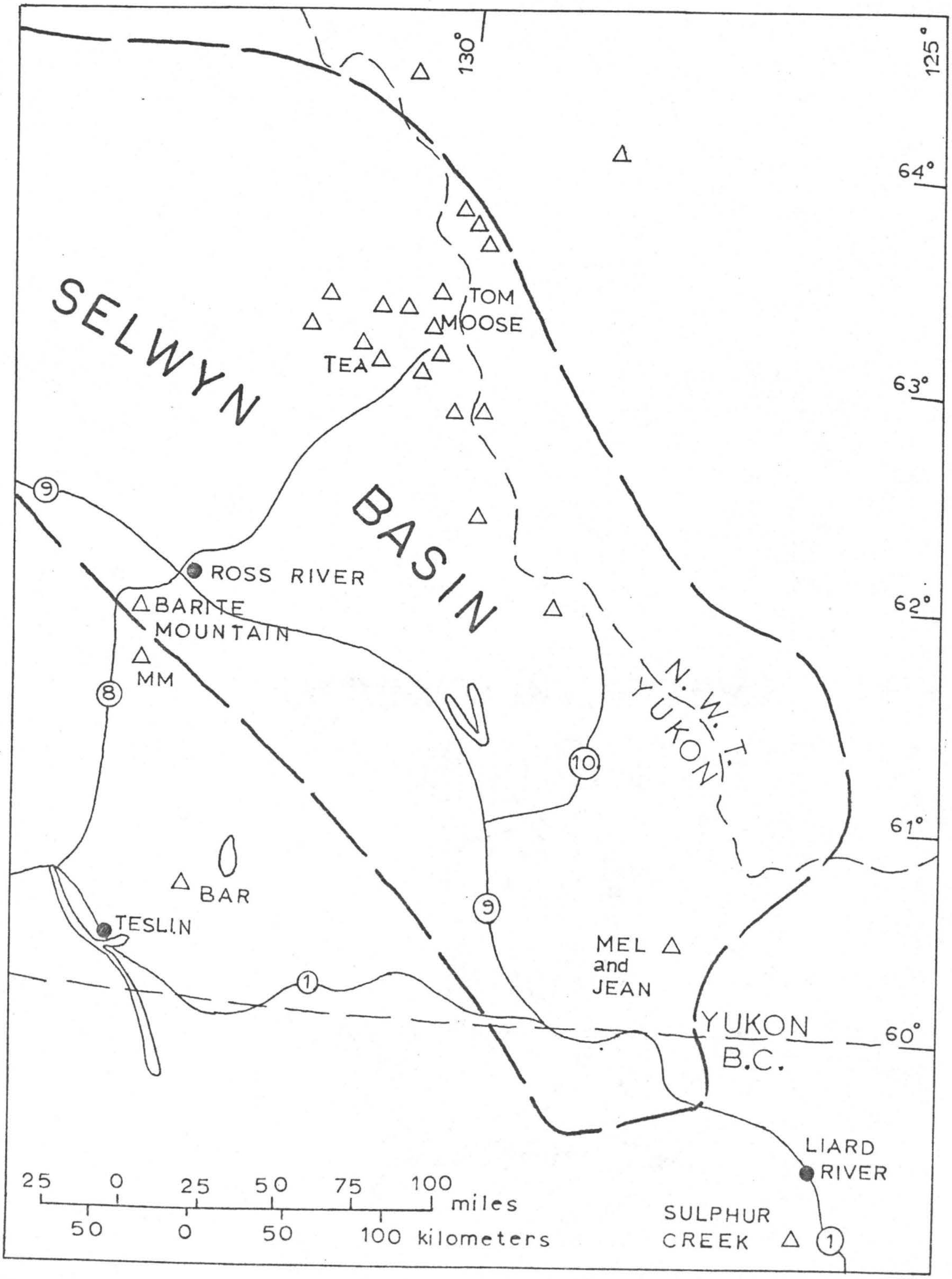
There appears to be a broad metallogenic belt hosting bedded barite, in the Devono-Mississippian shales of the Selwyn Basin geologic province (Dawson, 1976). Bedded barite occurs extensively along the eastern margin of the Selwyn Basin in units of varying thickness. The major deposits are described briefly; their locations are shown in Figure 3.

1. MACMILLAN PASS AREA

This area contains most of the known bedded barite deposits of the Selwyn Basin. These include the TOM, JASON, TEA (Carne, 1976), MOOSE (Dawson, 1975), and CATHY and LORRAINE GROUPS (Sinclair et al., 1975). Generally these are lead-zinc-silver-barite stratiform assemblages underlain by marine, black clastics of either the Besa or Canal Formation (Carne, 1976). The barite is fine grained, grey to black, and bedded with accessory interbeds of baritic limestone, witherite, siltstone, limestone, chert or shale.

The TOM GROUP contains a lead orebody which is characterized by (a) a marked thickening of host or overlying shales, (b) an abrupt transition from barren wallrock

Figure 3. Barite Deposits of the Selwyn Basin Fold Belt (adapted from Dawson, 1975)



to stratiform sulphides, and (c) a presence of distal barite facies (Carne, 1976).

The TEA GROUP (Carne, 1976) is underlain by a rubble-exposure of chert pebble conglomerate with minor greywacke and chert sandstone. This is followed by the Canal Formation which is composed of a recessive black shale, followed by bedded barite. The barite is grey to black, dark grey weathering, well laminated, and thinly bedded with interbeds of baritic limestone, witherite, limestone, chert and shale. It is overlain by more clastics with minor, basal barite nodules.

The abundance of pyrite and carbon in the hosts suggests a biogenetic source for the lead and zinc, perhaps in an euxinic, trough environment. However, the entire assemblage of lead-zinc-silver-barite-silica, plus the presence of mineral zoning through distance and time, suggest an external source, possibly of an exhalative nature (Carne, 1976).

Since the mineralization occurs at the base of the thickest, least laminated sequence of shale fillings in a graben-like structure, Blusson (1976) has suggested an origin similar to the Red Sea Type.

2. MEL AND JEAN GROUP

These claims are 82 km east-northeast of Watson Lake (Carne, 1976). Stratabound barite-sphalerite-galena mineralization occurs conformably between early Paleozoic brown phyllite and a light grey limestone. The baritic phyllite is light brown, highly sheared and brecciated, and contains varying proportions of barium. Galena may be found in the purer barite zones. In places the sphalerite has oxidized to smithsonite leaving boxwork structures in the baritic phyllite. Although primary sedimentary textures are lacking, Carne (1976) has interpreted this deposit as being sedimentary like those of the Macmillan Pass area because of (a) the large size of the deposit, (b) the lack of symmetry across the zone, and (c) the complete concordancy with the host. The temperature and pressure required for recrystallization of the economic minerals may have been derived from the thrust fault motions.

3. SULPHUR CREEK GROUP

These claims are located south of the Liard River bridge, about 80 km southeast of the Selwyn Basin fold belt (Dawson, 1975). Here, the barite is nearly pure white and displays a cyclical repetition of interbeds of grey to buff argillite or limestone. Dawson (1975) interprets these to be primary baritiferous sediments.

4. BARITE MOUNTAIN

This deposit is on the western margin of the Selwyn Basin fold belt near Ross River. It is clearly defined as a vein-type deposit (Dawson, 1975). Very high grade barite veins cross-cut the bedding of carbonate sediments. There is no apparent spatial proximity to igneous rocks. This deposit possesses many characteristics common to the Mississippi Valley type deposits (Dawson, 1975).

5. MM GROUP

Located 37 miles south of Ross River, this deposit is the closest barite deposit to the BAR CLAIM GROUP. Mineralized beds of lead, zinc, silver and barite occur within fragmented intermediate to acid volcanic rocks and related phyllites. The barite horizon is underlain by black slate of probable middle Mississippian age (Sinclair et al., 1975). These stratigraphic horizons are possibly correlative with those hosting the Macmillan Pass base metals (Dawson, 1976).

6. DISCUSSION

The stratigraphic position of the barite at the BAR CLAIMS matches that of the Macmillan Pass area, especially at the TEA CLAIMS. Both are underlain by chert pebble conglomerate with minor greywacke and chert sandstone (map units 5 and 6 of the BAR CLAIM geology). The recessive black shale was not observed at the BAR CLAIMS. Presumably it is absent or covered by overburden. The contact between the barite and the chert pebble conglomerate unit was not observed at the BAR CLAIMS.

The barite at the BAR CLAIMS possesses some relict, radiating sedimentary structures. Generally, the barite resembles the recrystallized and bleached barite of the MEL and JEAN GROUP. The MEL and JEAN barite is light brown, highly sheared and brecciated, and has a varying barite content. The BAR barite is light to medium grey with numerous fracture fillings of barite. Mobilization of the iron and zinc sulphides is evident from their textural relationships with barite. Both these deposits contain fine grained, disseminated to network galena in the purer barite zones. Both deposits exhibit dissolution boxwork structures. Both deposits are intimately associated with prominent faulting and regional compression that could possibly supply the necessary temperature and pressure requirements for recrystallization.

CHAPTER V

CONCLUSIONS

The rocks of the BAR CLAIMS belong to the Englishman's Group of the Mississippian. The rock sequence is eugeosynclinal in nature with a basal greenschist unit (which may belong to the Big Salmon Complex). This is followed by massive grey limestone with abundant chert lenses near the top. This is overlain, in the south, by white to red chert breccia with minor dolomite interbeds, and by dark grey chert breccia in the northeast. This is sharply overlain by chert pebble conglomerate which grades upward into a lithic wacke. Overlying massive barite may be separated by a thin layer of black slate; however, this was not observed in the field. The massive barite grades rapidly upward into sheared, grey green chert. This chert is correlative with a tuffaceous chert to the north (Tempelman-Kluit et al., 1976).

The barite of the BAR CLAIMS is overlain by grey chert and underlain by the chert pebble conglomerate, both of Mississippian age. It is a stratiform deposit of massive, recrystallized barite with minor iron and zinc sulphides. The deposit is located on the western margin of the Selwyn

Basin geologic province and is probably related to the numerous stratiform barite-lead-zinc deposits along the eastern margin.

The presence of fragmented volcanics to the north suggests that the barite may be exhalative in nature along synsedimentary faults or graben-like structures similar to the Red Sea type. However, a sedimentogenic mechanism such as dissolution and redistribution of pre-existing baritiferous rocks, or enrichment by organic influences, cannot be precluded.

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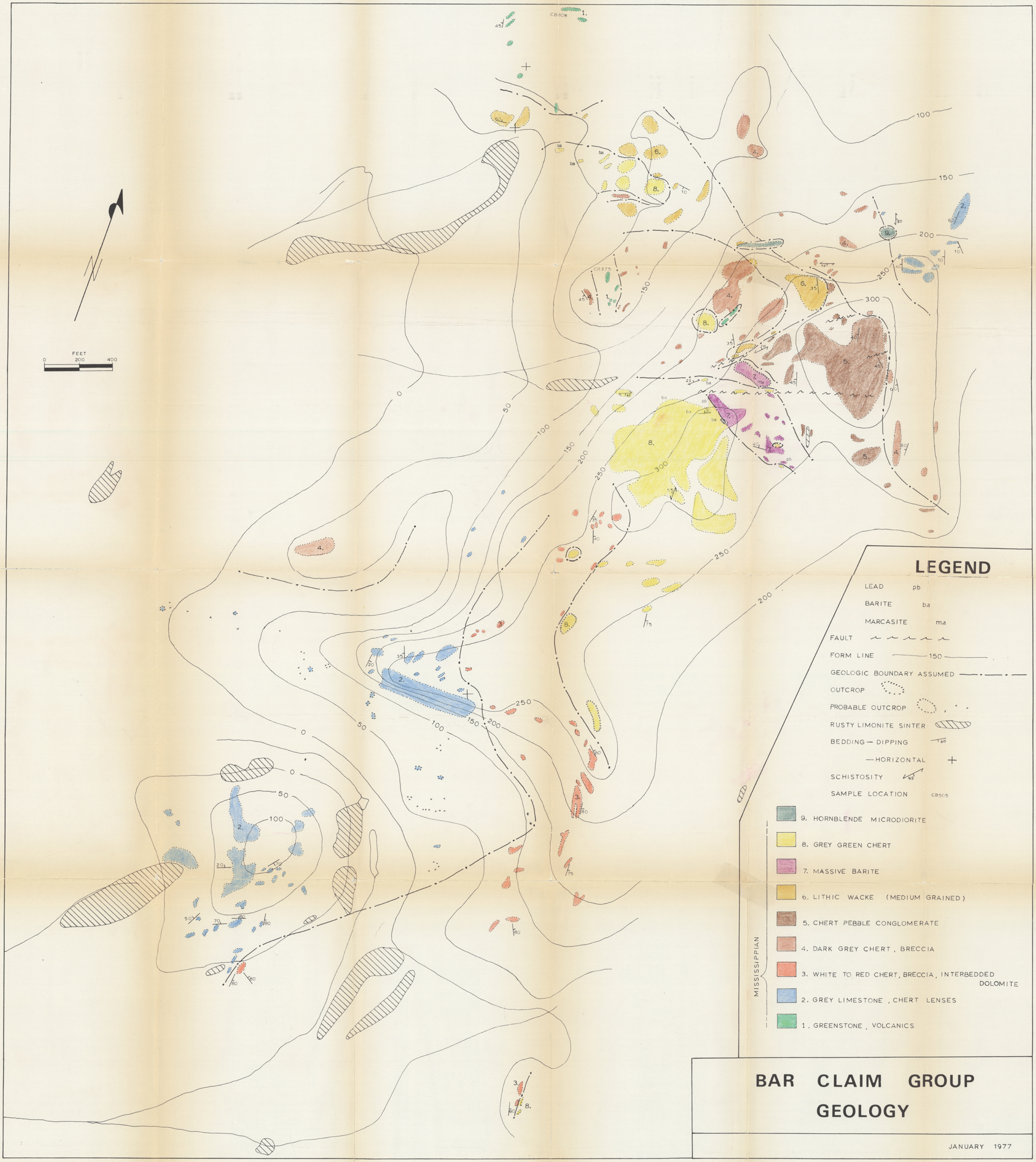
LEGEND
LEAD pb
BARITE ba
MARCASITE ma
FAULT
FORM LINE 150
GEOLOGIC BOUNDARY ASSUMED
OUTCROP
PROBABLE OUTCROP
RUSTY LIMONITE SINTER
BEDDING — DIPPING
— HORIZONTAL
SCHISTOSITY
SAMPLE LOCATION CB505
MISSISSIPPIAN
9. HORNBLENDE MICRODIORITE
8. GREY GREEN CHERT
7. MASSIVE BARITE
6. LITHIC WACKE (MEDIUM GRAINED)
5. CHERT PEBBLE CONGLOMERATE
4. DARK GREY CHERT, BRECCIA
3. WHITE TO RED CHERT, BRECCIA, INTERBEDDED DOLOMITE
2. GREY LIMESTONE, CHERT LENSES
1. GREENSTONE, VOLCANICS
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BAR CLAIM GROUP
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