REPORT
ON THE HOLDINGS OF
R.H. STANFIELD

Southeastern British Columbia

GEOLOGY and ORE POTENTIAL

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August 17, 1976

82G/ General

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REPORT
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SOUTHEASTERN BRITISH COLUMBIA

GEOLOGY AND ORE POTENTIAL

I) INTRODUCTION

The R.H. Stanfield holdings in southeastern British Columbia include the Bull River Mine, the Strathcona-Empire Crown Granted claims from which ore was shipped, and numerous mineral showings which have been partially exposed by near surface exploratory work.

Mining has been the major industry in this area since the turn of the century. This includes the Sullivan Mine which is one of the largest operations in the world.

In order to provide a complete understanding of the geology and character of the ore deposits of this region, and to define so far as practicable, the effects the mineralizing agencies have had on the rocks immediately surrounding them, this report includes pertinent information on each of the mines.

The object of such a compilation is directed towards application of this knowledge to the exploration and development of the extensive holdings of R.H. Stanfield.

II LOCATION AND ACCESSIBILITY

This report includes the area to the west and north of the R.H. Stanfield holdings in southeastern British Columbia.

The east boundary lies along the northeast flank of the Lizard Range of the Rocky Mountains from north latitude 49^{o} - 15', west longitude 115^{o} - 00' northwest to 49^{o} - 48': 115^{o} - 25'.
The north boundary extends due west to the Sullivan Hill at 116^{o} - 00'.
The west boundary is due south to 49^{o} - 15', six and one-half miles west of South Moyie Lake.
The south boundary is north latitude 49^{o} - 15'.

Cranbrook and Kimberley are located near the west boundary of the area. Highway 3-93 is directed east and south from Cranbrook and 3-95 south and west. Air and railway services are provided by Pacific Western Airlines and the Canadian Pacific Railway. (See Map #1)

III HISTORY

Gold was being mined on the Wild Horse River in the early 1860's and on the Bull River in 1880. From the rich placer gravels the miners directed their prospecting to hardrock deposits and and by 1885 numerous mineral claims had been staked.

inches
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centimetres

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R.H. STANFIELD HOLDINGS

LOCATION MAP

SCALE: 1" = 136 Mls.

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The Sullivan mine was discovered in 1892 and the St. Eugene in 1893. Colonel Samuel Steele, head of the local Royal Canadian Mounted Police acquired the Strathcona-Empire claims in the 1890's. The Estella and Kootenay King were located in the early 1900's.

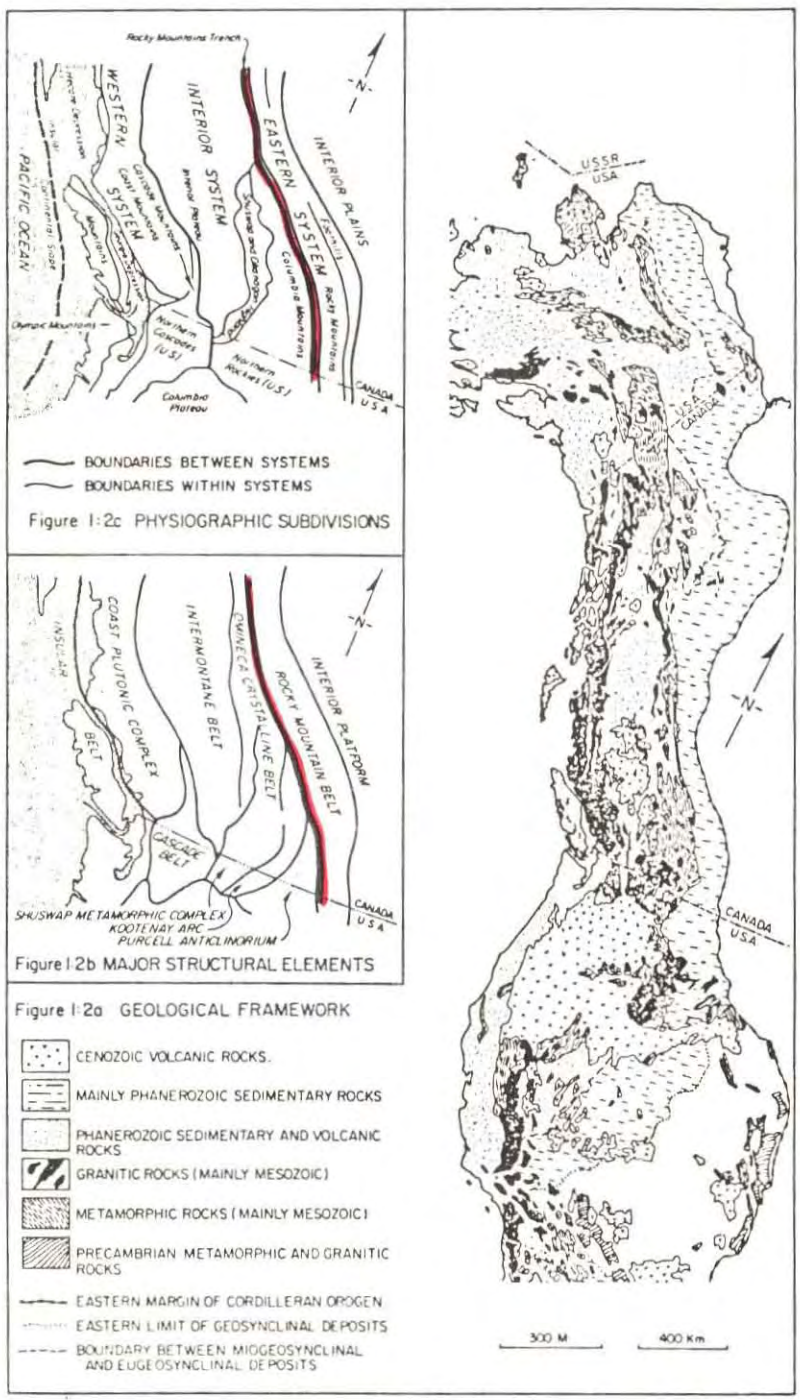
The Sullivan mine was brought into full production in the early 1920's, with the development by their staff members of selective flotation. The St. Eugene was mined until 1924. The Estella and Kootenay King were producers until the 1950's.

On the R.H. Stanfield holdings ore was shipped from the Strathcona-Empire in the late 1930's. The Bull River was in production from October 1971 until March 1974.

Intermittent investigations have been conducted on the many mineral showings of the R.H. Stanfield claims for the past twenty years. Currently, diamond drilling is providing valuable underground data at key locations.

IV TOPOGRAPHY

The Rocky Mountain Trench bisects the subject area. On the southwest the Purcell Range extends from low hills near the Trench to rugged mountainous topography along the west boundary. On the northeast, the Rocky Mountains rise abruptly to a series of jagged peaks and narrow deeply incised valleys.



By INTERNATIONAL GEOLOGICAL CONGRESS
WESTERN CORDILLERAN REGION

Map #6

To accompany report by Allen Geological Engineering Ltd.

The elevation of the Trench floor is 2,800 to 3,000 feet above sea level and it is three to seven miles wide. The Purcell and Rocky Mountain peaks are in excess of 7,000 and 9,000 feet above sea level.

The Kootenay River flows southeasterly in the Rocky Mountain Trench. The main tributaries from the east are the Elko, Bull and Wild Horse Rivers, and the St. Mary River flows from the west.

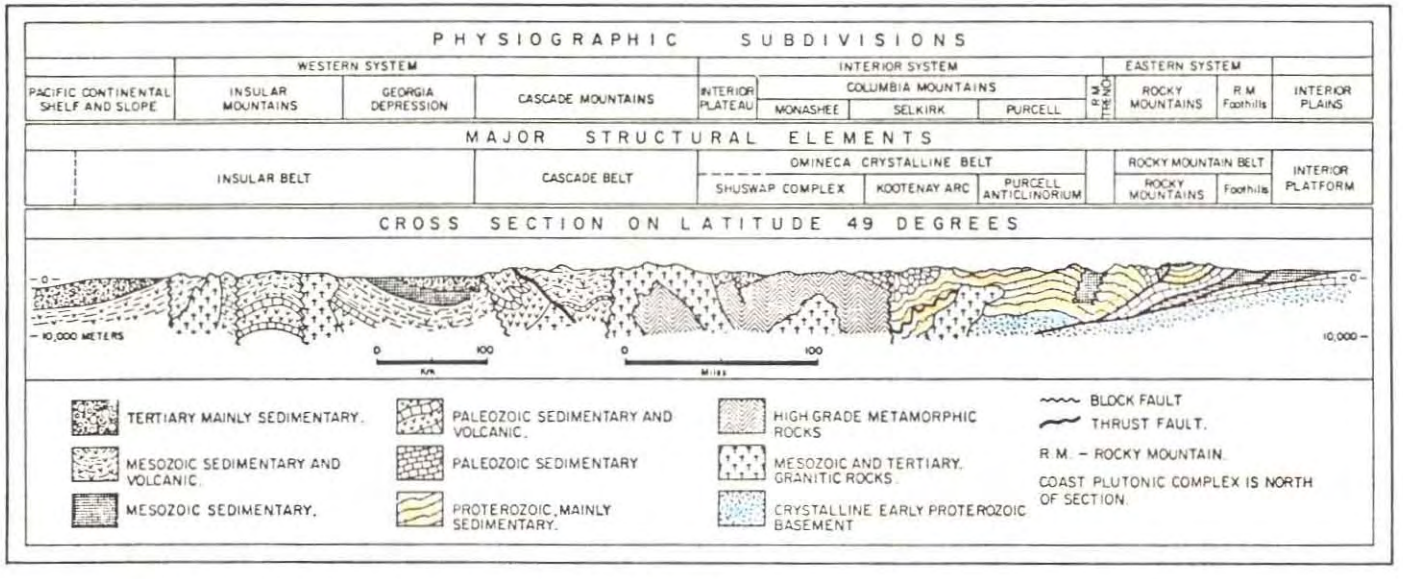
(See Map # 1)

V GEOLOGY

A. Introduction

The area encompassed by this report lies within the Southeastern Canadian Cordillera. Numerous geological reports have been published by government and private investigators since McConnel's Rocky Mountain Survey in 1886 and Daly's International Boundary Survey in 1912.

For the purposes of this report, available published information and the writer's experience in the region, has been capsuled into that data which directly or indirectly may be useful in the exploration and development of mineral deposits on the R.H. Stanfield holdings.



By: INTERNATIONAL GEOLOGICAL CONGRESS

SHOWING EASTERN SYSTEM

Proterozoic (Precambrian) overthrust on Palaezoic and Mesozoic sediments all lying on crystalline basement

Map #7 August 17, 1976.

To accompany report by Allen Geological Engineering Limited

B. Stratigraphy

The subject area is underlain chiefly by Precambrian sedimentary rocks. Younger strata are less in evidence but of significant importance and will be referred to briefly. Similarly, intrusive rocks outcrop in very limited areas but are described because of their importance in the complex geological environment.

The mines in the area are located in the Precambrian Aldridge formation.

The Table of Formations is herewith included in Appendix A of this report.

The Fort Steele Formation

The Fort Steele formation is essentially a light coloured quartzitic assemblage with an estimated maximum thickness of 6,000 feet.

Most of the strata are white, cross-bedded quartzite, topped by a relatively thin zone of argillaceous quartzite, argillite and locally dolomitic quartzite and grey-weathering dolomite.

The siliceous material is believed to have been deposited in shallow areas of turbulent water. It is now exposed along the Wild Horse River to the north boundary of the subject area.

The Aldridge Formation

The Aldridge formation outcrops prominantly throughout the area and underlies much of the R.H. Stanfield holdings.

The Sullivan mine has provided a wealth of detail on the Aldridge formation. At that location in the Purcells it is estimated to be 15,000 feet thick. On the east side of the Trench, however, it may be about 10,000 feet thick, with only minimal stratigraphic differences.
On the west side of the Trench at the Sullivan mine, the formation has been divided into the Lower, the Middle, and the Upper Aldridge members.

The Lower Aldridge

The beds are composed of grey-green, impure, fine-grained, hard, quartzite, siltstone, silty argillite and argillite. This thinly-bedded member weathers a distinctive rust to rusty-red. This is because of the iron content of the rock. Pyrrhotite occurs throughout the member in fine disseminations irregular blebs and thin laminations. In addition, minor pyrite, iron silicates and iron carbonates occur to a much lesser degree.

Graded bedding is rare, but mud cracks and ripple marks are present.

Locally the top of the member is characterized by distinctive layers of conglomerate.

The thickness of the Lower Aldridge member is estimated to be 4,000 feet.

The Middle Aldridge

The Middle member is characterized by thick zones of thin- to thick, fine-grained graded beds of impure quartzite and siltstone separated by thin black argillite partings. Alternate thick zones are composed of thin-bedded argillite and silty argillite.

The iron content of the Middle member is not sufficient to produce rusty surface weathering.

The Middle member is estimated to be about 9,000 feet thick.

The Upper Aldridge

The Upper Aldridge strata are composed of black and light grey laminated argillite. Near the top of the formation there are medium- to thick-bedded quartzites with interbeds of argillite and argillaceous quartzite. Pyrite and pyrrhotite occur in disseminations, blebs and laminae. The top several hundred feet are mainly thinly laminated dark grey to black argillite containing considerable pyrite.

The thickness of the Upper member is estimated at 2,000 feet.

The ore deposits of most of the mines in the area are believed to have been formed in Precambrian time, probably after the Upper Purcell deposition, about 1,200 million years ago.

The Sullivan orebody lies within the transition zone between the Lower and Middle members of the Aldridge formation. The St. Eugene, Estella and Kootenay King occur in the Lower Aldridge member, and the Bull River in the Upper Aldridge member.

On the east side of the Trench, the geology is complicated by extensive faulting and folding. In addition, there is considerably less detailed information available.

Between the Wild Horse and Bull Rivers, the Aldridge formation passes into the Trench. To the southeast, however, the Aldridge extends from the floor of the Trench to the crest of the Lizard Range. At this location on the R.H. Stanfield holdings, the upper half of the Aldridge formation appears to be exposed.

The Creston Formation

The Creston formation is composed of about 5,000 feet of white, grey, green and purple argillite, argillaceous quartzite and quartzite.
There is little or no rusty weathering.

The Kitchener - Siyeh Formation

This formation is estimated to be 5,000 to 7,000 feet thick. The basal beds are composed grey- to brown-weathering, grey and green argillite and dolomitic argillite; grey dolomite and sandy dolomite that weathers buff to red-brown and grey

quartzite. The Siyeh is composed of laminated grey and green argillite overlain by andesitic lava and tuff.

The Dutch Creek Formation

This formation may be divided into the Gateway, Phillips and Roosville formations but these divisions will not be included.

The base is composed of grey, green, red and purple dolomitic argillite, siltstone, dolomite and quartzite. These strata weather grey, green and brown. Algoloid layers occur in the lower beds, and abundant salt casts throughout characterize this zone. This is overlain by a 400-foot band of purple and red sandstone, siltstone and argillite. The top 1,700 feet consists of the same dolomitic beds as the basal formation.

The Mount Nelson Formation

This formation, outcropping only west of the Kootenay River, is composed of a base of quartzite overlain by grey and green dolomitic argillite and dolomite that weathers buff to red-brown. The top of the formation is composed of laminated green argillite.

The Toby Formation

Lying unconformably on top of the Mount Nelson formation, this marks the top of the Precambrian epoch. It is composed

of interbedded conglomerate, with lesser argillite and quartzite.
The conglomerate weathers reddish brown and represents a distinctive horizon marker for the top strata of the Precambrian Upper Purcell Series.

The Cranbrook and Eager Formations

The Lower Cambrian Cranbrook formation is made up of quartzite grit and conglomerate. The top of the formation is marked locally by magnesite and dolomite. This formation lies unconformably on the Precambrian strata.
The late Lower Cambrian Eager beds are composed of shale and limestone.

The Burton Formation

The Burton formation is composed of about 190 feet of Middle Cambrian sandstone, shale and silty limestone. Trilobite fragments occur in the shale.

The Elko and Jubilee Formations

These Middle and/or Upper Cambrian dolomites lie unconformably over the Burton formation. There is about 200 feet of Elko dolomite at the base. This is overlain by 3,000 to 3,500 feet of light grey, evenly-bedded, cliff-forming dolomite.

The McKay Group

The McKay group is made up of 2,800 to 4,000 feet of Upper Cambrian to Lower Ordovician thin-bedded shale and limestone.

The Glenogle Formation

This formation contains graptolites and is composed of about 500 feet of Lower and Middle Ordovician shale, limestone and siltstone.

The Wonah Formation

This Middle or Upper Ordovician lies unconformably on the Glenogle strata. It is composed of about 200 feet of quartzite grading upwards to calcaerous sandstone.

Beaverfoot - Brisco Formation

Lying disconformably on the Wonah sandstone is a widespread zone of megascopically similar limestone and dolomite. The age has been estimated to be Upper Ordovician to Lower Silurian. West of the upper Bull River it is about 1,800 feet thick.

The Basal Devonian Unit

This Middle Devonian or earlier and(?) Upper Devonian Unit is distributed irregularly throughout the subject area. It is composed of about 100 to 250 feet of dolomite, sandstone, dolomitic sandstone shale, quartzite and conglomerate. It lies unconformably on all underlying formations.

The Burnais and Harrogate Formations

The Burnais formation is made up of about 1,100 feet of black fine-grained limestone, weathering grey to tan, with silty or

shaly interbeds. There are lenses of gypsum and breccia within the formation.

The Harrogate contains fine-grained, fetid, black limestone, shaly limestone and some shale. Nodular black shaly limestone is fossiliferous. Both formations are classed as Middle Devonian.

The Fairholme Group and Alexo Formation

These two Upper Devonian formations are composed of about 1,335 feet of cliff-forming dolomitized limestone, overlain by interbedded black shale, black limestone and crystalline stromatolitic dolomite. Overlying this conformably is sandstone and sandy grey limestone.

The Palliser Formation

This Upper Devonian formation outcrops at the crest of the Lizard Range and in the Rocky Mountain Trench. It is composed of fine - to medium-grained, cliff-forming, mottled dark grey limestone. It weathers light grey. This basal 600 feet is overlain by 200 feet of fine-grained, thin-bedded, dark grey, nodular argillaceous limestone.

The Exshaw Formation

There is 57 feet of Mississippian shale conformably overlying the Upper Devonian formations. There are minor siltstone and black limestone beds included locally.

The Banff and Rundle Formations

The Banff is composed of about 1,300 feet of grey - and tan-weathering, fine-grained, cherty dark limestone. It is conformably overlain by the Rundle formation which is composed of about 2,500 feet of black shale and partly silty limestone. Both formations are Mississippian.

The Moyie Intrusions (Purcell Sills)

Dikes and sills of differentiated gabbro, meta-quartz-diorite and meta-diorite, in late Precambrian times, were intruded into the Purcell sequence of sedimentary rocks. The older rock at both hangingwall and footwall contacts may be altered for up to 100 feet by the addition of rosettes and bunches of biotite. Many of these intrusives carry disseminated pyrite, pyrrhotite and chalcopyrite. Also some stock-like intrusive bodies (namely the Hell Roaring Creek showing) are composed of granitic material, but age dating has classified them as Precambrian. One dike in the Sullivan orebody is almost wholly mineralized by sulphides similar to the local ore. Hence some controversy surrounds the part these intrusives played in the origin of the Sullivan orebody.

Mineralized meta-diorite dikes occur in Upper Aldridge at the Bull River mine and these contain mineralized quartz veins. At both the Estella and Kootenay King mines there are diorite-gabbro intrusive rocks within the Aldridge sediments.

There is a large dike of dioritic rock near the rich "G" zone on the R.H. Stanfield holdings and a pyrrhotite-bearing zone associated with it. It is not known if these are associated with the Moyie intrusives or younger igneous rocks.

Age dating by K-A procedure indicates that the Sullivan ore deposit may have been formed by mineralizing solutions emanating from the same source as the Moyie intrusions. This problem is still the subject of considerable controversy.

The Younger Instrusives

Late Cretaceous and younger monzonite, quartz monzonite and granodiorite outcrop near Summer Lake and the headwaters of Wild Horse River. In the Trench, about three miles west of the Bull River mine, there is a partially exposed stock of monzonite or granitic prophyry. This occurs within the Devonian and Mississippian formations that have been down-faulted against the Aldridge on the east, and which lie unconformably on the Precambrian strata to the west. Elsewhere along the east side of the Trench from the Estella mine to the R.H. Stanfield property, there are dikes of monzonite and granodiorite.

Stocks and batholiths of granodiorite occur in the Purcells, the nearest to the Sullivan mine being 10 miles to the southeast.

The hypothesis that the Sullivan mineralization may have originated from these younger intrusives is a controversial subject.

C. Structure

Within the scope of this report a brief description of the general structure of the area is provided. Emphasis is placed on descriptions of the Rocky Mountain Trench and the complexities of the west flank of the Rocky Mountains which includes the R.H. Stanfield properties.

The Rocky Mountain Trench divides the area into three distinctly different but equally important segments, namely the Trench, the Lizard Range on the northeast and the Purcell Range on the southwest.

The southwest segment includes the Sullivan and St. Eugene mines. It is underlain almost wholly by Aldridge, Creston and Kitchener formations. These have been folded into a gently north-plunging anticline, the axis of which passes west of both the mines. The Precambrian sequence is unconformably overlain by Devonian and Mississippian sedimentary formations which outcrop in and on the west side of the Trench. These are truncated on the east side of the Trench by a strong west-dipping normal fault.

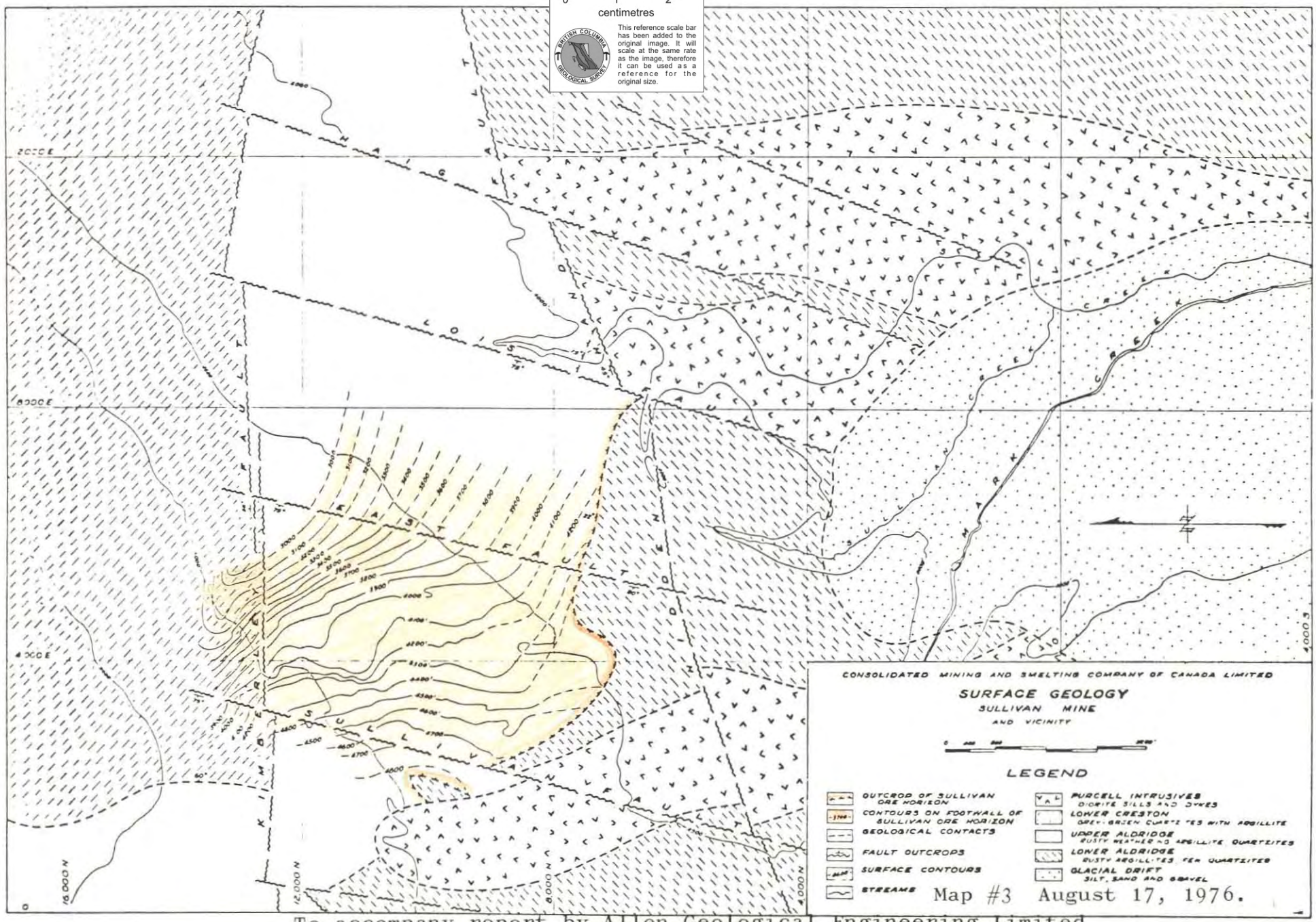
The central segment is the Rocky Mountain Trench. It extends from Northern Montana northwesterly for 1,000 miles to the northern boundary of British Columbia. A southern segment of the Trench bisects the subject area. It was formed after the building of the Rocky Mountains by a combination of strong erosional agencies and local block faulting. Major normal faulting near the east side resulted in down dropping the west block. This resulted in the Devonian and Mississippian formations being lowered to the present level in the Trench.

The northeast segment includes the R.H. Stanfield holdings, the Estella and the Kootenay King deposits. By a complexity of folds and faults, this part of the Rocky Mountain Lizard Range is partly made up of Precambrian formations. These were moved several miles northeasterly up and over the younger Palaeozoic rocks. From 4 miles northwest of the Bull River to the Hosmer fault (Sand Creek fault) near Galloway, the Aldridge formation, because of its consistent northwest strike and fairly flat northeasterly dip, extends over the crest of the Lizard Range. Hence for a length of 14 miles on the R.H. Stanfield holdings, the Upper and most of the Middle Aldridge formation is exposed.

D. Mineral Deposits

The major producer of the area is the Sullivan mine, one of the largest lead-zinc producers of the world. Smaller producers have been the St. Eugene, Estella and the Kootenay King. Copper-silver producers have been the Bull River, and Strathcona-Empire, which is located on the R.H. Stanfield holdings. They all occur within the Aldridge formation.

Short descriptions of each property is included in this report. It is possible that much of the data may be directly applicable to the planning of a comprehensive exploration programme contemplated on the R.H. Stanfield holdings. It is also possible that some apparently minor aspect of the structural control, or ore deposition in one of the mines may be the key to the location of a major orebody.


CONSOLIDATED MINING AND SMELTING COMPANY OF CANADA LIMITED
SURFACE GEOLOGY
SULLIVAN MINE
AND VICINITY
LEGEND
OUTCROP OF SULLIVAN ORE HORIZON
CONTOURS ON FOOTWALL OF SULLIVAN ORE HORIZON
GEOLOGICAL CONTACTS
FAULT OUTCROPS
SURFACE CONTOURS
STREAMS
PURCELL INTRUSIVES DIORITE SILLS AND DYKES
LOWER CRESTON GREY-GREEN QUARTZITES WITH ARGILLITE
UPPER ALDRIDGE RUSTY WEATHERING ARGILLITE QUARTZITES
LOWER ALDRIDGE RUSTY ARGILLITES, FEW QUARTZITES
GLACIAL DRIFT SILT, SAND AND GRAVEL
Map #3 August 17, 1976.
To accompany report by Allen Geological Engineering Limited

1. The Sullivan Mine

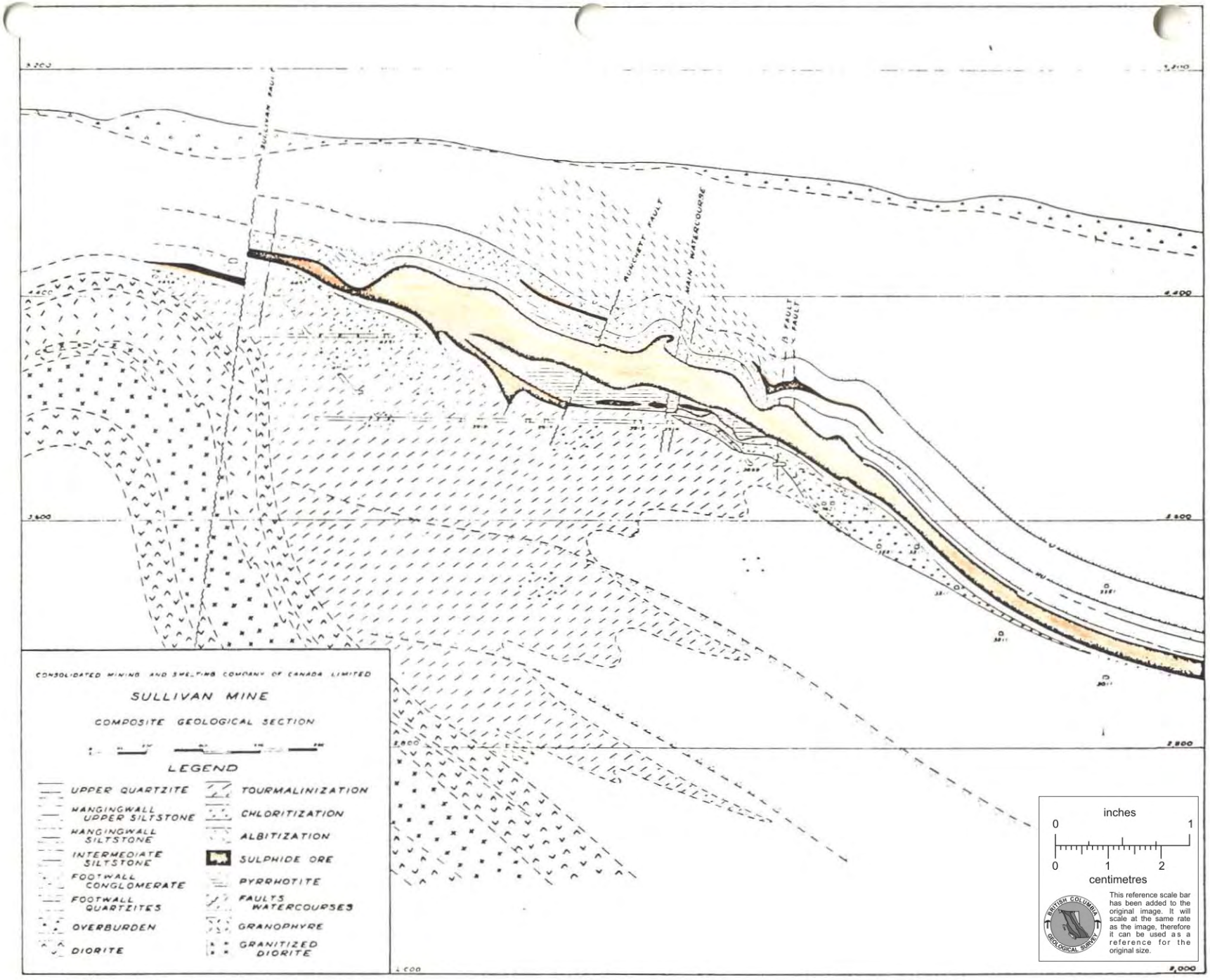
The Sullivan mine at Kimberley was discovered in 1892 and has become a major producer of lead, zinc, silver, tin and other metals and industrial products.

The orebody was formed in late Precambrian (1,200 million years ago - by K-A dating). It is believed to be an epigenetic hydrothermal replacement of argillaceous rocks located in the transition zone between the Middle and Lower Aldridge formation. Precambrian and Cretaceous or younger intrusive rocks occur in, and several miles from, the mine; but their influence, if any, on ore deposition is not definitely established.

The mineral zone lies in a subsidiary domal structure on the gently sloping east limb of an anticline plunging north. The anticlinal axis is located some miles to the west.

The footwall of the deposit is about 500 feet of conglomerate and thin-bedded argillite and silty argillite. The ore occupies a 200 to 300-foot sequence of argillite and silty argillite. Diagnostic beds are a foot of siltstone grading up to 16 feet of fine-grained quartzite. The hangingwall is made up of 40 to 80 feet of thin-bedded argillite and silty argillite similar to the footwall band, but this is overlain by 20 to 50 feet of fine- to coarse-grained quartzite with argillaceous partings. Alternate thick beds of argillite and silty argillite top the distinctive hangingwall sequence. For at least 1,000 feet above, however, there is thin-bedded argillite and siltstone and a few 10-foot beds of quartzite.

The strata-bound ore zone contains mainly galena, sphalerite, pyrite and pyrrhotite along with lesser chalcopyrite, boulongerite,



Map #4 August 17, 1976.
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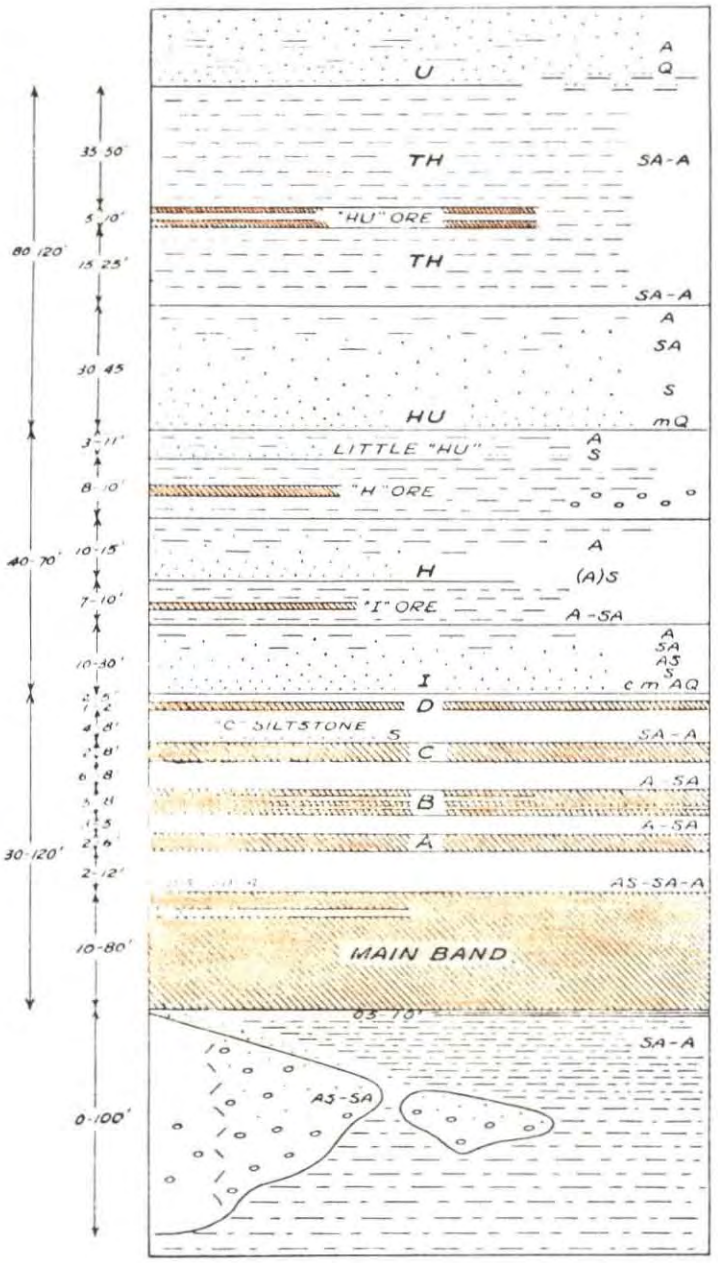
SULLIVAN MINE

IDEAL GEOLOGICAL SECTION



UPPER QUARTZITE
Quartzite with argillite partings Base not recognized as definite horizon.

THIN BEDDED HANGINGWALL
Beds, fraction of inch to several feet.

HANGINGWALL UPPER ORE ZONE
Laminated sulphide horizon.

HANGINGWALL UPPER SILTSTONE
Prominent Q or AQ base with Q grains for several feet.

LITTLE "HU" SILTSTONE

HANGINGWALL CONGLOMERATE
Recog. south and east of mine.

HANGINGWALL SILTSTONE
Q grains rarely concentrated at base.

INTERMEDIATE SILTSTONE
Q grains usually prominent.

Color zone D to I - fine Pand Zn lams.

"B" Band triplets - two 2-12" Arg. bands separating three narrow sulphide bands.

MAIN BAND ORE
Massive to laminated sulphides.

FOOTWALL "SLATES"

FOOTWALL LAMINATED ZONE

FOOTWALL CONGLOMERATE

FOOTWALL THIN BEDDED SERIES

LEGEND

Map #5 August 17, 1976.

Q	Quartzite.
S	Siltstone.
A	Argillite.
AQ	Argillaceous quartzite.
AS	Argillaceous siltstone.
SA	Silty argillite.

	Quartzite.
	Siltstone.
	Sulphide Ore.
	Thin bedded.
	Laminated.
	Conglomerate.

To accompany report by Allen Geological Engineering Limited

arsenopyrite, tetrahedrite and jamesonite. The gangue includes quartz, sericite, magnetite, chorite, muscovite, tremolite, titanite, cassiterite, tourmaline, garnet, albite and minor fluorite and calcite. These almost completely replace the folded, fractured and well-bedded sediments.

Extending from the main ore zone are fracture zones containing quartz-carbonate veins containing galena, sphalerite, pyrrhotite and pyrite.

Around a central core of barren sediments and heavy pyrite and pyrrhotite, there is a zonal arrangement of the other minerals.

Wall-rock alteration has been outlined as follows:

Tourmalinization of the footwall argillites resembles chert and has been detected in weak concentrations 1,500 feet from the ore zone. Minor zones also are included with the ore zone.

Chloritization is strongly developed adjacent to the hangingwall, commonly grading into massive pyrite and albite.

Albitization of some hangingwall sediments has been complete, with only pyrite and minor chlorite included.

Pyrrhotite occurs within and at considerable distances from the ore zone. It is usually in blebs, irregular disseminations and laminations in the argillite, often just below the principal siltstone beds.

2. The St. Eugene Mine

High-grade lead-silver mineralization was discovered 30 miles south of the Sullivan mine in 1893. The most productive of the deposits, the St. Eugene, lies on the east side of Lower Moyie Lake. It was acquired by the Consolidated Mining and Smelting Company in 1905 and was successfully operated until 1924.

The St. Eugene ore bodies are located on the east limb of a northerly plunging anticline of Aldridge quartzite and argillaceous quartzite.

Two east-west faults, dipping about 70 degrees south extend across the lake. The faults are connected by numerous cross fissures. Controlled by the fissure system, lead-silver-zinc replacement deposits were formed in the quartzite in the fissures and at the intersections of the fissures and faults. Argillite beds were poorly mineralized host rocks.

The ore zones contained coarsely crystalline galena and lesser sphalerite, along with minor pyrite, pyrrhotite, magnetite and chalcopyrite. Gangue minerals were minimal and included pink garnet, actinolite quartz and some calcite.

Wall-rock alteration was confined to some silicification of the quartzite adjacent to the heavy sulphides and was limited to garnet, actinolite and quartz in fissures and replacements.

In summary, the St. Eugene mine contained sizeable bodies of massive sulphides replacing pure Aldridge quartzite within a system of parallel faults and cross fissures.

3. The Estella Mine

The mine is located near the northeast corner of the subject area at the head of Tracy Creek, a tributary of Lewis Creek.

The mineral bodies are associated with strong shears and in folded Lower Cambrian argillaceous quartzite. Mineralization is chiefly galena and sphalerite with pyrite replacing argillaceous strata.

A gabbro dike is located at the mine and monzonite-granodiorite stocks occur six miles to the northeast and seven miles to the southeast.

4. The Kootenay King Mine

This mine is located 3 miles south of the Estella mine in Lower Aldridge quartzite and dolomitized argillite.

Northerly trending fissure veins contains high-grade sphalerite and galena near the surface but depth development was limited. Aplitic sills occur near the veins.

5. The Bull River Mine

The Bull River mine is located on the north side of the Bull River, five miles east of the Kootenay River, on the east side of the Rocky Mountain Trench. It is 30 miles southeasterly from the Sullivan mine.

The Bull River mine is a vein deposit in the middle and upper beds of the Upper Aldridge formation. The quartz veins occupy shear zones in medium - to thick-bedded quartzite and argillaceous quartzite. The beds contain disseminations of pyrite, pyrrhotite and traces of chalcopyrite. A series of meta-diorite dikes cut the bedding at low angles. Quartz-siderite veins containing galena, sphalerite, pyrite, chalcopyrite and pyrrhotite occur near and within the dikes.

Southeast of the mine, on the banks of the Kootenay River, there are outcrops of Devonian limestone and shale and a bed of foliated gypsum. To the west in the Trench, Devonian and Mississippian rocks lie unconformably on Precambrian Upper Purcell strata. These rocks are faulted and folded and intruded by Cretaceous or younger quartz monzonite and granodiorite.

This assemblage lies on the hangingwall of the Bull River fault which lies along the east side of the Trench. The fault is a major break which strikes northwest and dips southwest at about 40 degrees. The Aldridge formation occupies the footwall.

The veins in the Bull River mine are white quartz with some siderite and minor calcite, garnet and epidote. Chalcopyrite occurs in disseminations, irregular masses, small veins and blebs along with lesser pyrite, some galena and traces of sphalerite and hematite. Silver, cadmium and gold ore are included with the sulphides. The veins strike east-west and dip south.

The Placid Oil Company produced on the basis of 750 tons per day from October 1971 to March 1974. The mine was closed down because of a depressed copper market and adverse government regulations. About 1,200,000 tons of reserves were partially outlined and the potential for additional tonnage is considered excellent.

6. The R.H. Stanfield Holdings

The R.H. Stanfield holdings are located on the east side of the Rocky Mountain Trench. They extend from Galloway to Bull River.

This large claims area is underlain by sedimentary formations ranging from Upper Precambrian to Mississippian. Instrusive rocks include Precambrian meta-diorite sills and dikes, also Cretaceous and younger monzonite and granodiorite stocks and dikes. Mineral deposits of lead-silver and copper-silver have been partially exposed within the Aldridge formation. Two copper-silver deposits occur in the Gateway or younger formation.

The Aldridge formation is without doubt the most favourable host for the occurrence of mineral deposits in the area. The most complete data regarding this formation has been assembled in and around the Sullivan Mine.

For as complete an understanding as possible, therefore, the Lower, Middle and Upper members of the Aldridge are herewith briefly described.

Lower Member

This basal member is made up of 4,000 feet of thinly interbedded, fine-grained siltstone, silty argillite, argillite and quartzite. The rock is dark green to black and it weathers a distinctive rust to red. Pyrrhotite is prevalent in thin bands parallel to the bedding, irregular small blebs and bunches and fine disseminations. Pyrite is present to a lesser degree. Cross bedding is prevalent, and graded beds are rare. In places a band of intraformational conglomerate lies near the top of this member.

Middle Member

This is composed of 9,000 feet of thin- to medium-thick bedded fine-grained siltstone and quartzite separated by thin partings of argillite. The quartzite beds alternate with about equal thicknesses of argillite and silty argillite.

Upper Member

This is composed of light and dark grey thinly-bedded argillite, grading into thick-bedded quartzite with some interbeds of argillite, to approximately 1,800 feet. Included are disseminations, blebs and fracture fillings of pyrite, some pyrrhotite and traces of chalcopyrite. The upper 200 feet is black argillite with widely spaced beds of argillaceous quartzite, containing pyrite but no pyrrhotite or chalcopyrite.

There is a comparative lack of detail available regarding the Aldridge formation east of the Trench, but available data indicates that at that location it may be 10,000 feet thick.

The Sullivan, Estella and Kootenay King mines are located in the upper part of the Lower Member, or in the transition zone between the Middle and Lower Members.

The lead-silver deposits on the R.H. Stanfield holdings are located above the level of the Trench. They occur over a limited difference in elevation and appear to be within the Middle Aldridge. Short descriptions of the deposits are as follows:

The "G" Zone lies within a strong shear that strikes north 65 degrees east and is practically vertical. It is about 16 feet wide where a body of massive galena occurs. The galena contains little or no gangue minerals but has been broken by post mineral movememt on the shear. The breaks are coated with limonite which was deposited from near surface iron charged waters.

The zone was exposed by an open pit about 30 feet deep. About 15 tons was mined which assayed 85% lead and 37 ounces of silver.

The Great West Vein is located about 3 miles northeast of the "G" zone. A 100-foot adit tunnel has been driven on a 4-foot quartz vein which contains galena and sphalerite with some pyrite. Open cuts expose the vein for an additional 50 feet. A sample of strongly mineralized vein from a surface cut assayed 6.58% lead and 8.84 ounces of silver per ton.

The Burt Zone is 2 miles southwest of the O.K. zone. Open cuts and 2 adit tunnels exposed a $2\frac{1}{2}$ foot quartz-siderite vein which is reportedly 2,000 feet long.

The vein is mineralized with galena, sphalerite and pyrite and a sample of a sulphide zone assayed 6.5% lead, 3.4% zinc and 0.9 ounces of silver per ton.

The copper-silver deposits on the R.H. Stanfield holdings are exposed at Trench level except for the Strathcona-Empire which reaches 2,000 feet higher at the upper tunnel.

The Strathcona-Empire Zone is $2\frac{1}{2}$ miles northeast of Galloway on the steep west flank of the Lizard Range. It is a fissure vein exposed intermittently for 950 feet with an erratic strike ranging from 15 to 30 degrees west of north. It dips 55 to 80 degrees southwesterly.

There are some surface outcrops of the vein, and it had been exposed by tunnels and open cuts at elevations of 4,525, 4,360, 4,235 and 3,950 feet above sea level. Heavy concentrations of chalcopyrite occur in the vein which averages about 6 feet wide and is composed of quartz and siderite. Samples across 3 to 18 feet of vein average 1% copper and 0.53 ounces of silver per ton. Dump samples, by engineers of the B.C. Department of Mines contained 6% copper and 2 ounces of silver per ton.

In the late 1930's smelter shipments were made from the lowest adit tunnel. Where exposed, the deposit appears to have a tonnage potential of about one-half million tons. This ore would be amenable to treatment by the Bull River mill.

The Rex Zone is located about 2 miles westerly from the Strathcona-Empire. It is located on the floor of the Trench. A quartz vein strikes north 65 degrees west and dips 70 degrees southwest. The brown-weathering vein contains siderite, pyrite and chalcopyrite. A 5-foot sample assayed 2.39% copper, 1.7 ounces of silver per ton and 0.01 ounces of gold per ton.

The Dean Zone is located about a mile south of the Rex zone in the Trench. A 2 to 5-foot quartz vein strikes east-west and dips steeply north. Chalcopyrite and pyrite occur with siderite in the vein. An adit tunnel was driven east on the vein. A second vertical vein strikes north 60 degrees.

The Treasure Zone is located in the Trench $\frac{1}{2}$ mile northeast of Galloway. Dump material from a shaft and an adit contains massive pyrrhotite and chalcopyrite.

The Don Zone is 2 miles southeasterly from Galloway. It is a quartz-siderite vein in calcaerous argillite of the Gateway formation.

It contains chalcopyrite and hematite along with some barite.

Exposures extend over a mile and the vein is over 30 feet wide. When held by Canadian Colleries in the 1950's, one drill hole beneath the surface showings intersected the zone which carried chalcopyrite.

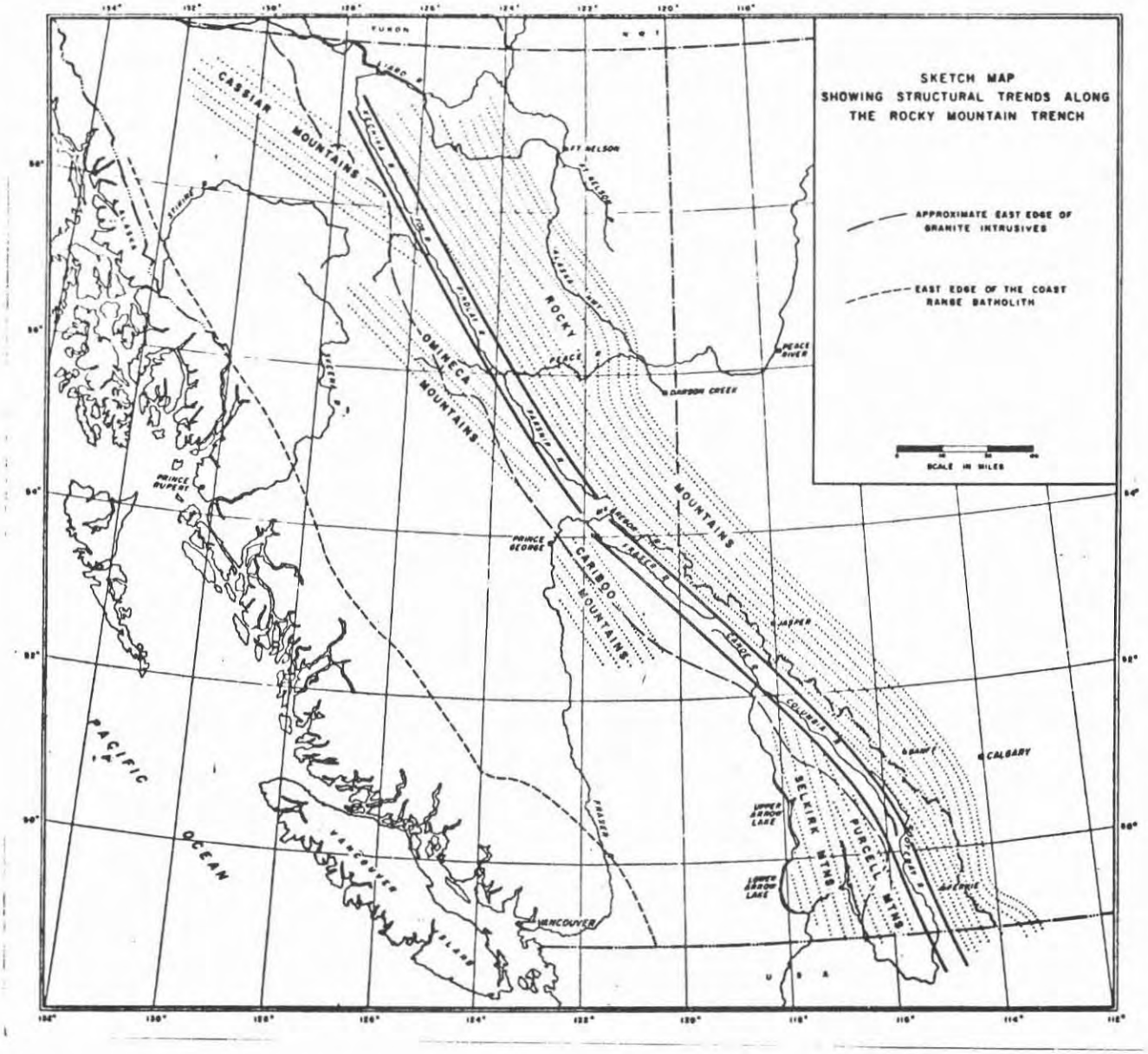
The Rimrock Zone is located 2 miles northerly from Elko about 1,000 feet above the Trench.

A strong fissure vein of quartz, siderite and calcite strikes north 55 degrees east. It is nearly verticl and is in light grey silicified argillite beds, probably of the Gateway formation. The vein contains disseminations and bunches of chalcopyrite.

The surface exposure 80 feet above the upper tunnel is well mineralized. The upper tunnel encountered well mineralized sections, but a lower tunnel failed to encounter similar mineralization.

In summary, the R.H. Stanfield holdings include a 15 mile by up to 6 mile area, lying along the east flank of the Rocky Mountain Trench.

The geology is complicated by extensive faulting and folding, but the entire southeastern part of the area is underlain by Aldridge strata in which there are eight showings of lead-silver and copper-silver mineralization.



By: CALIFORNIA STANDARD COMPANY

ROCKY MOUNTAIN TRENCH IN BRITISH COLUMBIA

Map #8 August 17, 1976.

To accompany report by Allen Geological Engineering Limited

VI THE ROCKY MOUNTAIN TRENCH

A. Introduction

The Rocky Mountain Trench is a remarkable topographic feature extending from northern Montana over 900 miles northwest to near the Yukon border. The southeastern Canadian sector bisects the subject area of this report. An understanding of the origin and nature of the Trench is of prime importance in the interpretation of the geology and mineral deposits which are located on its eastern flank.

B. Origin

The origin of the southeastern Canadian part of the Rocky Mountain Trench has been the subject of numerous technical studies. The consensus of opinion is that the Trench was formed partly by bl ck faulting and partly by erosion.

After the formation of the Rocky Mountain Trench, in Eocene time, massive thrust plates moved easterly bringing the Precambrian strata up and over the Palaeozoic formation. Subsequently a normal fault near the east side of the Trench dropped Devonian and Mississippian rocks to the present Trench. level. These younger rocks rest unconformably on Precambrian strata and extend from the fault to west of the Trench.

To the southeast, hinge faulting caused blocks to drop successively lower towards the middle of the Trench.

During glaciation there was 4,500 feet of ice in the Trench. The combination of ice and water erosion resulted in a highly irregular bottom surface. Gravel and glacial debris that now fills the Trench is estimated to be 5,000 feet deep in the middle section near the southwest of Elko. (See Maps # 9 and # 10)

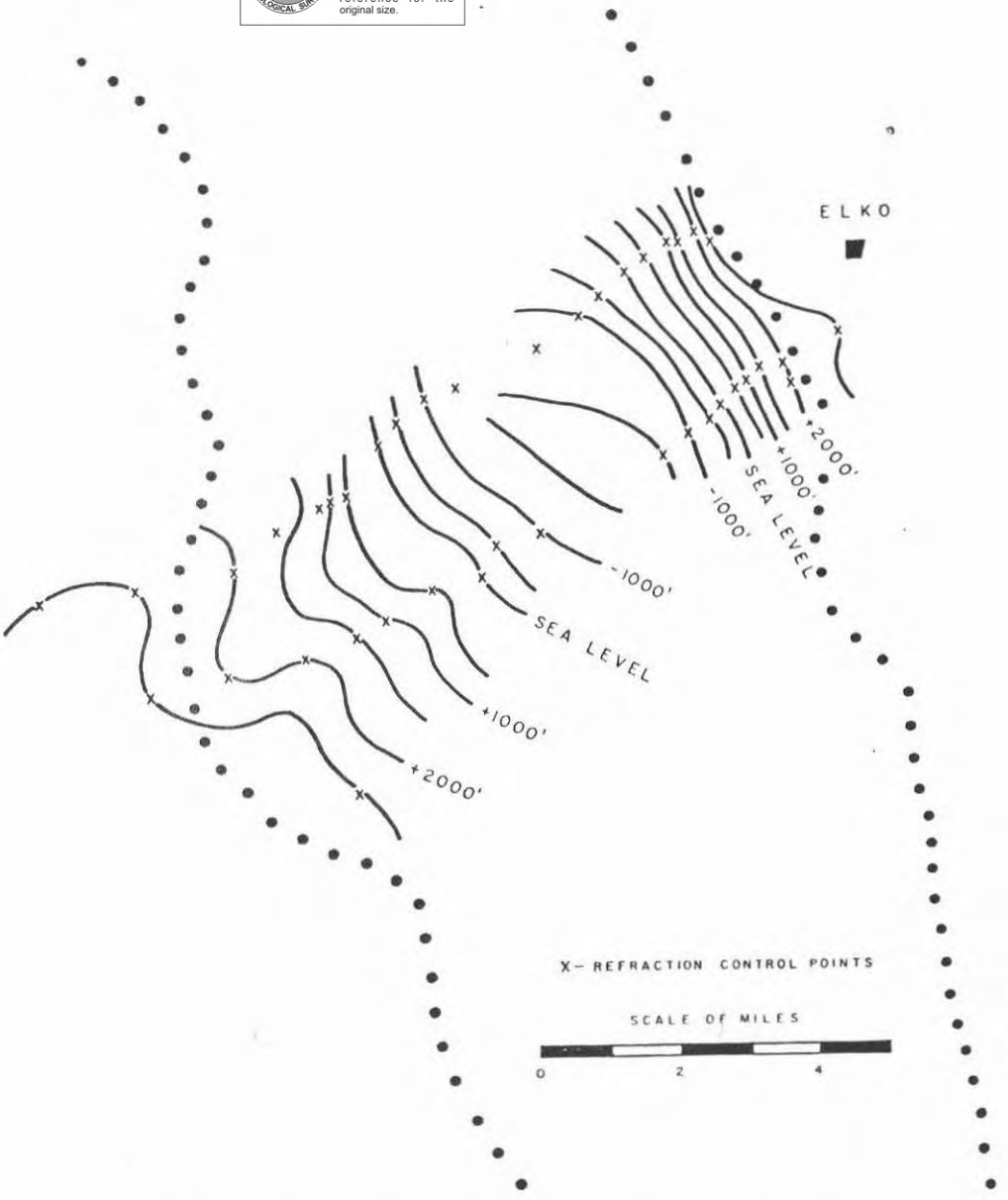
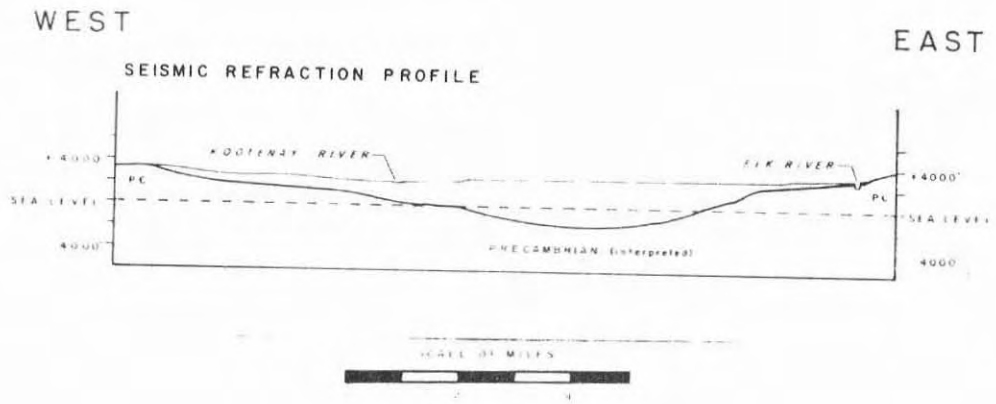


Fig. 9.—Refraction Depth Map to High Velocity Layer.

By: SHELL OIL COMPANY

ROCKY MOUNTAIN TRENCH
PLAN NEAR ELKO
SHOWING BEDROCK CONTOURS

Map #9 August 17, 1976.
To accompany report by Allen Geological Engineering Limited



By: SHELL OIL COMPANY

ROCKY MOUNTAIN TRENCH
SECTION NEAR ELKO
SHOWING BEDROCK PROFILE

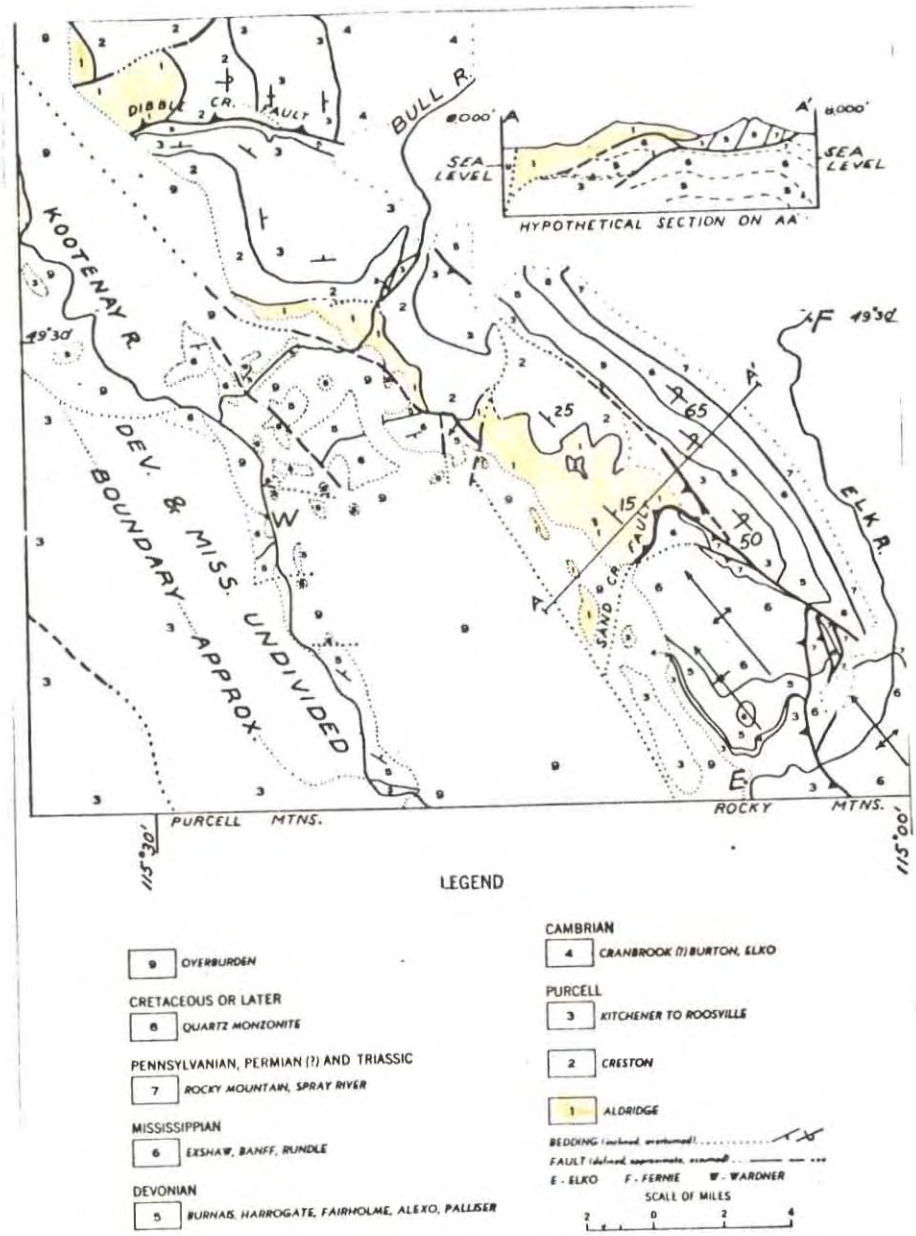
Map #10 August 17, 1976.

To accompany report by Allen Geological Engineering Limited

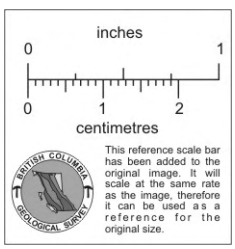
GEOLOGY

PLAN AND SECTION - R.H. STANFIELD HOLDINGS

By: G.B. Leech



.—Geology near the Trench east of Cranbrook.



THE ALDRIDGE FORMATION UNDERLIES THE LIZARD RANGE AND MUCH OF THE TRENCH

Map #11 August 17, 1976.

To accompany report by Allen Geological Engineering

VII DISCUSSION

The geology of the subject area has been detailed by numerous field studies. These have ranged from areal mapping by members of the Geological Survey of Canada to special projects by staff geologists of the local mining companies. From the standpoint of mine-making, the area is small and the Sullivan orebody is large, hence the search for ore may best be guided by the application of geological data supplied from this great mine. This information has been used in the evaluation of the R.H. Stanfield holdings and will be applied in the planning of an accelerated programme directed towards the detection of possible major orebodies.

A. Stratigraphy

Stratigraphy is one of the important factors in ore occurrences of the area, as evidenced by the Aldridge formation being the host for the Sullivan, St. Eugene, Estella and Kootenay King mines. It has been established that the Sullivan ore zone lies in the upper part of the Lower Aldridge or the transition zone between the Lower and Middle Aldridge strata.

On the H.R. Stanfield claims these zones appear to be located below the surface, therefore it is essential that the following markers be recognized in diamond drill core.

> First, the bottom of the Middle Aldridge may be thin to quite thick beds of quartzite and siltstone. The quartzite may be impure with noticeable grading in impurities and grain size from the bottom to the top of each bed. There may be some thin argillite partings between these beds. This combination of strata may form

thick layers, but these may alternate with equally thick layers of thin-bedded argillite and silty argillite.

Second, the top of the Lower Aldridge may be laminated and thin-bedded, fine-grained siltstone, argillite and quartzite. Also there may be a band of conglomerate and beds of dolomite and dolomitic argillite.

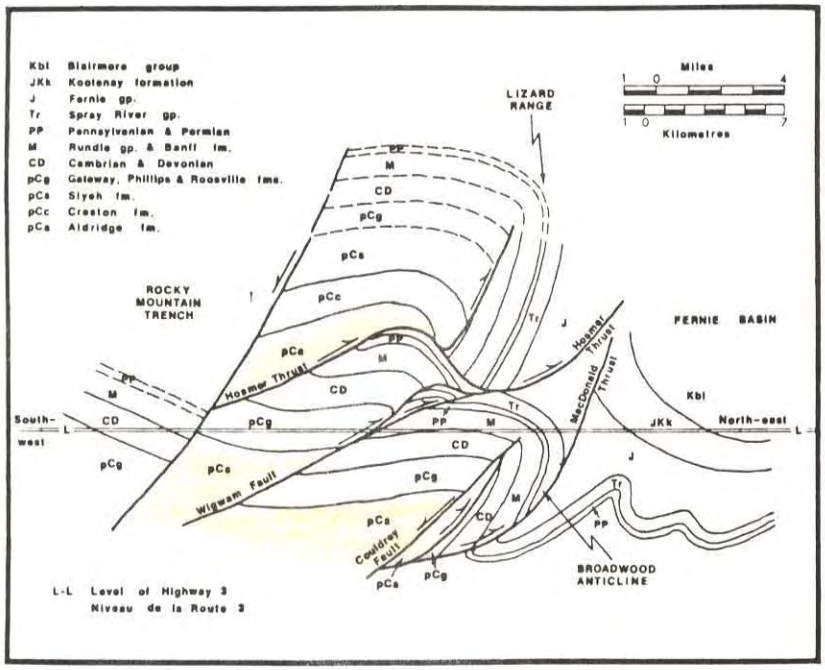
B. Structure

In Precambrian time when the Sullivan orebody was formed, the Aldridge formation now underlying the R.H. Stanfield holdings was five miles to the west. In the more recent Tertiary Era the Precambrian mass was thrust easterly over Palaeozoic formations to become the west flank of the Rocky Mountains.

Most of the Middle and all of the Upper Aldridge now lie above the surface, east of the Trench. Equally important, the slope to the north of the Hosmer fault (Sand Creek fault) indicated that there is ample Lower Aldridge strata underlying the R.H. Stanfield holdings to contain large mineral deposits.

The normal fault lying on the east side of the Trench dips at 40 degrees to the west under the Trench, hence Lower Aldridge strata are located at depth well into the Trench area.

The Sullivan ore zone is strata bound but there are other controls such as local shearing and folding which control the location of mineral deposits and these are to be expected on the east side of the Trench. (See Maps # 11 and # 12)



SCHEMATIC SECTION

By: R.A. Price, 1972.

Through the R.H. Stanfield holdings near Galloway the Hosmer Thrust is plunging northwest, under the R.H. Stanfield holdings. This thrust plate has moved the Precambrian-Mississippian formations 5 miles northeasterly.

Map #12 August 17, 1976.

To accompany report by Allen Geological Engineering Limited.

C. Mineralogy

The lead-zinc-silver and other minerals in the Sullivan Mine are believed to have been deposited during the late Upper Precambrian time. The source for such a large tonnage of minerals is unknown but it was obviously strong and extensive.

When the mineralizing agencies were active, the segment of Aldridge formation now east of the Trench was located far to the west. It is conceivable, therefore, that the agencies responsible for the Sullivan mine could, under favourable conditions, have been the source of similar deposits.

D. Ore Control

The Sullivan ore zone appears to have been localized by quartzite on the hangingwall, conglomerate on the footwall and permeable siltstone and argillite strata in between, allowing the mineralizing solutions to percolate within a 200- to 300-foot zone and deposit the ore minerals, largely by replacement of the original beds.

The St. Eugene orebodies were controlled by parallel faults with joining cross-shears which allowed the mineralizing solutions access to beds of quartzite that were replaced by sulphide minerals.

E. Wall-Rock Alteration

In the St. Eugene, Estella and Kootenay King mines, wall rocks are altered for a short distance from the ore. Well developed wall-rock alteration extends from the ore zone of the Sullivan.

Argillite in the hangingwall is replaced by chlorite, and for some distance from the ore there are silty and quartzitic beds containing weakly dispersed chlorite, pyrite, biotite and quartz.

Albite has irregularly replaced large zones above the orebody. This rock is almost pure albite with only small clusters of chlorite and pyrite included.

Fractures containing sulphide mineralization extends up to 100 feet above the orebody. Beyond these fissures the strata contain weakly dispersed sulphides.

The footwall alteration is a cherty brown to black rock composed of tourmaline with imbedded quartz grains. The zone is up to 1,500 feet thick.

Less discernable are marker beds that extend thousands of feet from the orebody. The most persistent of these is a 40-foot bed which is weakly mineralized and has a 16-foot zone at the base made up of impure quartzite which is graded in texture and colour from bottom to top.

From an exploration point of view, wall-rock alterations of this magnitude could be of inestimable value in the search for large ore deposits.

In review, the R.H. Stanfield holdings are underlain by the Aldridge formation. This formation is established as having been an exceptionally favourable host for mineral deposition.

The Sullivan ore zone is an immense replacement of argillaceous beds located in the transition horizon between the Middle and Lower members.

The St. Eugene ore bodies are replacements of pure quartzite in the Lower member.

The Estella and Kootenay King ore is in fissure replacements in the Lower member.

The origin of the extremely large quantity of metal-bearing solutions is not established, but it may have been from the same source as the Precambrian Moyie Intrusions.

From an exploration standpoint, important aspects of the Sullivan deposit are as follows:

The weakly mineralized beds that extend many thousands of feet from the ore.

Mineralized shear zones that project well into the hangingwall.

Chlorite alteration zones in the hangingwall.

Albite alteration of large segments of the hangingwall.

VIII SUMMARY

This report on the geology and ore potential of the R.H. Stanfield holdings in southeastern British Columbia also includes all available technical data pertaining to the local mines of the area.

The world famous Sullivan mine, along with the rich St. Eugene and Estella, Kootenay King, Bull River and Strathcona-Empire mines all occur within the Aldridge formation.

This wealth of information pertaining to the mines, particularly the Sullivan, may provide the key to the discovery of similar ore deposits.

A large area of the R.H. Stanfield holdings is underlain by the Aldridge formation. The Middle and Upper members are well exposed and eight zones of mineralization have been discovered in these strata.

It is clearly evident from the information included herein that the R.H. Stanfield holdings are located in a geological environment exceptionally favourable for the occurrence of large mineral deposits.

IX CONCLUSIONS

In accordance with the information assembled in this report, and the results from many years of work on the R.H. Stanfield holdings, it has been established that the geology thereon is favourable for the occurrence of Sullivan-type ore deposits.

It is concluded that the current works programme should be escalated to include penetration of the deeper Aldridge strata. Drill sites should be carefully located to provide access to the Lower member.

Proximity to an ore zone may be indicated by the following:

(a) Weakly mineralized beds beneath which mineralized fissure veins may be encountered.

(b) Strong replacement zones of albite, chlorite, pyrrhotite and pyrite.

(c) Probably a sequence of quartzite strata underlain by thin-bedded argillite and siltstone.

(d) A conglomerate band or dolomite and dolomitic argillite beds.

(e) A thick bed containing sparse sulphide mineralization, the bottom half may be light grey impure quartzite with the constituent grains and impurities graded from bottom to top.

X RECOMMENDATIONS

It is herewith recommended that the current works programme on the R.H. Stanfield holdings be phased into a deep drilling project.

The accumulation of mineralogical, stratigraphic and structural detail from the deeper Aldridge strata will be invaluable.

Data from the first deep hole, particularly from the Middle to Lower transition zone, by comparison with the Sullivan section, will be the control for the planning of the full drilling programme.

Concurrent with the deep drilling project, it is recommended that a geological map be made of the Aldridge formation on the R.H. Stanfield holdings.

Further, it is recommended that the mineral showings thereon be re-surveyed and re-sampled.

Time and cost estimates may be provided after the general plan and scope of the project is finalized.

Respectfully submitted,

ALLEN GEOLOGICAL ENGINEERING LIMITED

Per Alfred R. Allen P.Eng.

Alfred R. Allen

August 17, 1976.

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Vancouver, B.C.

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APPENDIX A

GENERAL GEOLOGY

TABLE OF FORMATIONS

Era	Period or epoch	Formation	Lithology
Cenozoic	Pleistocene and Recent		Till, gravel, sand, silt, alluvium
	Unconformity		
Mesozoic and(?) Cenozoic	Lower Cretaceous and(?) later		Monzonite, quartz monzonite granodiorite. Granodiorite (White Creek batholith)
	Intrusive contact		
Mesozoic	Triassic	Spray River formation	Dark siltstone and silty shale
	Not in contact		
Palaeozoic or Mesozoic	Devonian(?) or Cretaceous(?)		Shale, limestone; conglomerate, tuff, breccia; greenstone
	Not in contact		
Palaeozoic	Pennsylvanian and (?) Permian	Rocky Mountain formation	Dolomitic or limy sandstone, quartzite; sandy dolomite and limestone; siltstone, chert
	Mississippian	Rundle group	Grey crystalline limestone, crinoidal in part, dark fine-grained limestone, cherty in part, all commonly fetid
		Banff formation	Dark cherty limestone and laminated silty limestone, grey limestone, limy siltstone
		Exshaw formation	Black shale; black limestone
	Upper Devonian	Palliser formation	Lower (main) member: massive mottled grey limestone; nodular grey limestone. Upper member: thin bedded argillaceous limestone, mostly nodular
		Alexo formation	Sandstone and sandy limestone; argillaceous limestone

Palaeozoic (cont'd)	Upper Devonian (cont'd)	Fairholme group	Lower part: fine-grained black and grey limestone, stromatolitic and coralline in part; dolomite. Upper part: shale and limestone
	Middle Devonian	Harrogate formation	Fine-grained, black limestone, shaly limestone; shale
	Middle Devonian or earlier	Burnais formation	Gypsum, dolomite, limestone
	Middle Devonian or earlier and(?) Upper Devonian	"Basal Devonian unit"	Dolomite, sandy dolomite, dolomitic sandstone, shale; quartzite, conglomerate
	Unconformity		
	Upper Ordovician Lower and (?) Middle Silurian	Beaverfoot-Brisco formation	Dolomite, limestone; conglomerate and sandstone locally at base, thin graptolitic shale near top
	Disconformity?		
	Middle or Upper Ordovician	Wonah formation	Quartzite, sandstone
	Unconformity?		
	Lower and(?) Middle Ordovician	Glenogle formation	Shale, siltstone, limestone
	Upper Cambrian and Lower Ordovician	McKay group	Limestone, shale; intraformational limestone-conglomerate
	Middle and/or Upper Cambrian	Jubilee and Elko formations	Dolomite
	Disconformity?		

	Middle Cambrian	Burton formation		Shale, limestone; sandstone, conglomerate
	Lower and(?) Middle Cambrian	Eager formation		Shale, limestone, siltstone, sandstone
	Lower Cambrian	Cranbrook formation		Quartzite, grit, conglomerate; sandstone
Unconformity				
Windermere		Toby formation		Conglomerate, argillite; sandstone
Unconformable on Purcell strata				
Purcell or(?) later	Upper Purcell or(?) later	Moyie intrusions		Meta-diorite, meta-quartz diorite
Intrusive contact				
Purcell	Upper Purcell	Mount Nelson formation		Dolomite, argillite, quartzite
		Dutch Creek formation	Roosville formation	Grey and green siltstone and argillite, grey quartzite, dolomite, and limestone; algaloid structures
			Phillips formation	Purple and red sandstone, siltstone and argillite
			Gateway formation	Grey and green siltstone and argillite, commonly dolomitic, dolomite, and quartzite; purple and red siltstone and argillite; salt casts algaloid structures
		Kitchener-Siyeh formation		Kitchener (main) part: grey and green argillite and dolomitic argillite, grey dolomite and sandy dolomite; quartzite. Siyeh part: laminated green and grey argillite locally purple. Purcell extrusions (at top): andesitic lava and tuff

	Lower Purcell	Creston formation	Grey and green argillite and argillaceous quartzite, grey, white and purple quartzite
		Aldridge formation	Rusty-weathering dark laminated argillite, grey and rusty-weathering grey argillaceous quartzite and quartzite
		Fort Steele formation	White quartzite, grey argillaceous quartzite, dark argillite, grey and black dolomitic and calcareous argillite, dolomite