Summary Report

ALDRIDGE-REVETT PROJECT - 1970

British Columbia, Idaho, Montana

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December 1970

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SUMMARY

1. Exploration in southeastern British Columbia and northern Idaho/Montana under the Aldridge-Revett project is directed to the discovery of stratabound base metals. Reconnaissance in 1970 was aimed at establishing the geological framework and developing concepts that would narrow the search. This report is part of a continuing programme and presents the more important results of 1970. No attempt has been made to describe all the areas examined or to present all the data collected.
2. Regional correlation by means of "varved" markers was validated. The delimiting of marker beds was initiated.
3. Depth below surface to the favourable Sullivan zone appears to be within reach of deep drilling for a distance southward to at least near the International Boundary.
4. Recommended work for 1971 includes the following:
   a. Evaluate the Polaris, Ace and Hilo properties in the Kimberley district.
   b. Follow-up the Hawkins Lakes geochemical anomaly.
   c. Investigate a metal environment northward of Yahk range.
   d. Delimit feeder systems of the Moyie Intrusive through the region.
   e. Reconnoitre G.S.C. mapping southwest of Kimberley.
   f. Further delineation of markers through the region.
   g. Additional structural sections through the region.

INTRODUCTION

General Statement

The Aldridge-Revett Project is directed to the discovery of base metal deposits in Belt rocks of British Columbia-Idaho-Montana. Orebodies of massive sulphide type with character akin to the famous Sullivan Mine are the target. The search is premised on the possibility that other stratabound orebodies, like the Sullivan, exist in host rocks of the Aldridge Formation.

The region of interest takes in part of southeastern British Columbia, northern Idaho and northwestern Montana for a total of 10,000 square miles (see Figure 1). The 1970 programme was directed to developing geological concepts that would narrow the area of search. The reconnaissance was a continuation of the project started in 1969.

Field Approach

Key beds having particular lamination characteristics were looked for in the Aldridge during 1970. Geologic sections to locate the markers were stepped at large intervals through the region. The marker framework is intended as an aid to positioning the Sullivan horizon, and to studying local environments having economic interest.

The marker study was started in the Moyie district (see Figure 3) using a diagnostic argillite unit. Work progressed southward to the Clark Fork area of Idaho-Montana (see Figure 4) and northward to the St. Mary's area, near the Sullivan Mine, in British Columbia. Through the course of the programme local stratigraphy was defined, mining properties were examined, geochemical surveys were undertaken and strategic ground was acquired. Stratigraphic work was assisted by the use of photographic enlargements and a portable drill. The drill

gave sequences of lamination of sufficient length to be identifiable. The cataloguing of natural-scale photos of these sections assisted in cross-matching laminae from area to area.

Three two-man crews were employed. One worked the Canadian section, another the American and the third, with the author, provided direction and liaison. Field work commenced May 1st on the Canadian side and June 15th on the American. The programme continued in force to mid-September, then finished in early October with a single remaining crew.

Base points for the project were located at the communities of Cranbrook, B.C. and Bonners Ferry, Idaho. Field support was provided by three vehicles. The company-owned G3B2 helicopter gave additional support in May and September. Local aircraft were occasionally chartered to assist reconnaissance and crew deployment.

GEOLOGY

General Statement

Precambrian sedimentary rocks in the Kootenay region comprise two sequences, the Purcell and Windermere, separated by an unconformity. The Purcell sequence consists of fine-grained clastic rocks up to 50,000 feet in measured thickness comprising siltstones, argillites, and quartzites, in part dolomitic in the upper half. The older Purcell formations - the Aldridge, Creston, and Kitchener - are the northern equivalents of the Prichard, Ravalli, and Wallace, respectively, of adjacent Montana and Idaho.

The Aldridge, of present interest, has a maximum exposed thickness of 18,000 feet. It is monotonous in gross aspect, fine in grain, dark in colour and uniform in mineralogy. Such similarities cause significant problems in correlation. Regional metamorphism has

been weak and has converted original clay-type components to sericite, chlorite and fine-grained biotite. Original textures are partly retained, and primary structures are well preserved.

Deformation at the south limit is dominated by three great transverse faults, the St. Joe, Osburn, and Hope from south to north respectively. Of these sub-parallel northwest faults the Osburn is the most extensive and forms a large part of the northwest-striking Lewis and Clark Linear.

Northward there is a series of domes and troughs with practically no net plunge to the International Boundary. The larger faults in this block, like the folds, trend north-north-westerly. These in turn pass into the Purcell geanticline, situated between the Rocky Mountain Trench and Kootenay Lake, and having a northerly trend with overall gentle northward plunge.

The geanticlinal structure of the Purcell Mountains is dislocated by three major faults, the Moyie, St. Mary, and Hall Lake which repeat the structure successively northward and between which the segments plunge ten to twenty degrees northward. The Moyie and Hall Lake faults are thrusts on which the apparent movement of the western blocks was obliquely northeastward and upward. The pattern of the St. Mary fault suggests upward movement of the north block, with probable strike-slip movement late in its history. The St. Mary fault is older than a nearby Cretaceous pluton.

Acidic Intrusions

Three batholiths, the White Creek, Kaniksu and Idaho, intrude Aldridge strata. The White Creek, on the north, cuts across Aldridge on the west limb of the Purcell geanticline. The Kaniksu, to the south, forms a western boundary to much of the Aldridge. The Idaho, on the

south, forms the southernmost boundary of the Aldridge. Satellites from the main masses are present in the northern and southern part of the region.

The granitic rocks, with one exception, are late Mesozoic in age or later. A Precambrian granitic cuts across Aldridge rocks in the Kimberley region, and is the only intrusion of such age yet recognised in the region west of the Canadian Shield and north of the Big Horn uplift.

Moyie Intrusions

Dioritic intrusions, commonly quartz diorite, are widespread in Purcell strata. These are the Moyie Intrusions and have their greatest development in the Aldridge Formation. Typically the intrusions form sills of a few hundred feet thickness.

Reconnaissance in 1970 suggests these intrusions into the Aldridge were restricted essentially to three stratigraphic zones. The topmost zone is about 5,000 feet below the top of the formation in Middle Aldridge strata, and consists of approximately three sills across an interval of 1,500 to 2,000 feet. The next zone is about 10,000 feet below the top, in the transition to Lower Aldridge strata, and again comprises a few sills across a limited stratigraphic interval. This sill-zone includes the Sullivan horizon in the Kimberley area. A third zone, at the base of the column, is about 15,000 feet below the top of the Aldridge Formation.

There is also a suggestion that southward on regional scale the uppermost sill-zone rises higher in the stratigraphic column and decreases in quantity of material.

Stratigraphy

Major Units

The Aldridge, the oldest formation in the district, has been separated in the northern sector into three lithologic parts: Upper, Middle and Lower. Elsewhere it is undivided.

The thickness of the formation, base unexposed, varies between 18,000 feet in the Clark Fork map-area, 17,000 feet in the Plains section, 7,500 feet in the Moyie Lake district, 14,000 feet (combined Aldridge-Ft. Steele) in the Skookumchuck sector, and 15,000 feet in the St. Mary Lake/Dewar Creek region.

Measurement in the St. Mary Lake/Dewar Creek region, where subdivision is most cohesive, gives 1,000 to 1,500 feet stratigraphic thickness for the Upper Aldridge, 9,000 to 10,000 feet for the Middle and about 4,000 feet, base not exposed, for the Lower. The thickness of Middle Aldridge includes some 500 feet of sill-material in its central section and another 1,500 feet in the basal transition zone.

Preliminary sections generalized from the White Creek, St. Eugene and Quinns Hot Spring areas (see Figure 2) are appended. The Quinns Hot Springs section indicates an Aldridge shore-line to the south. Evidence in favour is given by the dominance of such structures as cross-bedding, ripple marks and mud cracks. Ribbon-like forms in the section suggest a stromatolitic reef.

Consideration of the St. Eugene section provides a guide to further breaking down the monotonous character of the Aldridge, and gives a reference for comparing lithologic changes within the basin. (1 BASIN only?) The Middle Aldridge is viewed as an interbedded series of 'quartzite/argillite' and 'argillite' rock units. The rocks in subsurface are often calcareous (LOWER?) and pyrrhotitic, particularly in the 'argillite' units.

The 'quartizite/argillite' sequences are 100 to 500 feet in thickness, blocky and consist of quartzite and argillite beds in roughly equal proportion. The quartzite beds are generally two to six feet thick, fine to medium-grained, commonly graded from fine quartzite at the base through argillaceous siltstone to argillite at the top, locally concretionary and frequently with mould, flammate and botryoid structures at the base. Individual beds are non-uniform and discontinuous along their strike.

The 'argillite' units are generally 100 to 200 feet in thickness, flaggy, rusty weathering and recessive. One type, referred to as the turbulent-type, consists dominantly of argillite and silty argillite beds one to six inches thick, often finely laminated, frequently graded and commonly forming thin cross-stratified lenticular sedimentation units with scour features. Distributed through the column are several more distinctive 'argillite' units referred to as the marker-type. In contrast the marker-type is non-silty, non-graded and carbonaceous. It is noteworthy by the presence of remarkably regular colour laminations which persist for great distances.

A few descriptive field terms to provide consistency in future work are appended.

Marker Units

Three markers are presently recognized. All are in the Middle Aldridge in a stratigraphic interval spanning 2,000 feet. The deepest of these lies about 5,000 feet below the top of the Aldridge. For comparison the Sullivan ore horizon would be expected some 5,000 to 6,000 feet deeper in the section.

The highest of the markers, termed the Sunrise, is the best known. It is the easiest to identify, both in gross aspect and in

detail, and has a greater possible outcrop distribution. The marker is known through a width of ten miles and a length of 100 miles, from near the Sullivan Mine at Kimberley, British Columbia southward to the fringe of the Coeur d'Alene mining district at Clark Fork, Idaho.

The Sunrise marker retains its identity across the Purcell geanticline as well as across such major, transcurrent faults as the Moyie, St. Marys and a splay of the Hall Lake which have dextral shifts measurable in miles. A graphic section showing the main features of the Sunrise is included in the Appendix.

The marker-type units are believed to be closely time parallel rather than transgressive with respect to time. The repeated interlayering of carbon-rich and carbon-poor material indicates a significant change in the sedimentation process. The colour lamination or 'varve' can be considered seasonally dependent. It would be expected to form essentially in the same time interval throughout the depositional basin.

The basis for tracing and correlation of these units is the exact line for line match of their colour lamination. The cross-match is precise for sequences of lamination at least some tens of feet in thickness.

Variations in sedimentary structures in the marker beds apparently are not common. In one instance a washout, or churned zone, was noted. Another instance was "thinning", that is, proportional variation in thickness for every lamina in the same degree for a particular marker unit. The thinning was noted by comparison of two sites 56 miles apart and may be a function of differential compaction, structural distortion, or distance from distributary. The latter seems plausible, in which case an Aldridge delta to the north is indicated.

Paleogeography

The monotonous character of Aldridge rocks is generally interpreted as reflecting a long, uniform history of deposition. Published views on sources of the sediment and their environment of deposition are differing and vague, little is known respecting erosion, transport and sedimentation. The overall character of Aldridge rocks suggests a remarkable stability in both source area and depositional basin. The sediments were apparently transported in streams of low gradient and deposited in a marine environment under possibly periodic conditions of aridity. The sediments can be ascribed to eastern and southern source areas from present evidence. Changes in lithofacies are subtle over long distances.

Further consideration suggests the Middle Aldridge sea experienced several cycles of transgression and regression, evidenced by the non-turbulent, transitional and turbulent character of its three repetitive sedimentation units. The non-turbulent, marker-type 'argillite unit' indicates deposition below wave base toward the axis of the trough in a reducing environment low in salinity and sensitive to climatic changes. The transitional 'quartzite/argillite' unit indicates proximity to unstable accumulations of sediment at the basin margin which are periodically distributed by density flows. The turbulent 'argillite' unit indicates deposition in a zone of intermittent turbulence with shifts in current direction, perhaps within an estuary or close to distributaries.

PROPERTY

General Statement

Three properties, the Polaris, Ace and Hilo, were staked in 1970 in the Kimberley district to further investigate possibilities for stratabound ore. The acquisitions are wholly owned by TGS and total 171 mineral claims.

Polaris

The Polaris group of 131 claims 6 miles south of the Sullivan Mine, Kimberley, B.C. was recorded for TGS on August 10th. The possible presence of the Sullivan horizon, on trend with Sullivan mineralization, is to be investigated. Some minor occurrences of Pb-Zn are present.

Ace

The Ace group of 36 claims, 24 miles north-northwest of Kimberley was recorded for TGS on August 26th. Stratigraphy believed to contain the Sullivan horizon in a region cut by Ag-rich fractures is to be investigated. Conglomerate marking the horizon of interest projects under cover to the property from exposures bordering the claims.

Hilo

The Hilo group of 12 claims, 16 miles west-northwest of Kimberley, was recorded for TGS on September 11th. An occurrence of stratabound Pb-Zn sulphide believed to be in the Sullivan horizon is to be investigated. A thick section of conglomerate underlies the prospect. Sampling across five feet of better material in the prospect gave 0.3 oz/ton Ag, 0.5% Pb. Sparse amounts of lead border this section to give a total mineralized width of 23 feet.

GEOCHEMISTRY

Stream silt surveys in 1970 were undertaken in the Yaak River Quadrangle of Idaho-Montana and in the Tepee Creek catchment, NTS 82-G4/5. A total of 358 samples were collected, all were analyzed for HCl Cu and CxZn in the -80 mesh fraction.

Anomalous copper/zinc values of distinct interest were obtained near Hawkins Lakes, Yaak River area. No response of obvious interest was obtained in the Tepee Creek survey.

Investigation of a copper anomaly obtained in 1969 at Doctor Creek, NTS 82K-1 proved discouraging. A local CxZn response from Sunrise Creek, NTS 82G-4, in 1969 merits further consideration. This is in view of lead/zinc mineralization recently discovered at nearby Sundown Creek.

Yaak River

At Hawkins Lakes a strong response, three to five times background, was obtained for copper and zinc in silt samples. The sampling was from two separate drainages off the same height of land.

At Davis Mountain spotty copper/zinc values were obtained from several drainages to roughly define an area of further interest. Aldridge rocks, possibly in the same stratigraphic zone as nearby Hawkins Lakes, underlie the anomaly. The section of interest in both these areas is possibly 8,000 feet below the Sunrise Marker. If so, this should place the expected mineralization near the favourable Sullivan horizon.

In the Mt. Obermayer area some interest is directed to a tributary of Garver Creek which gave anomalous zinc values in very limited sampling. Dense forest cover and smooth topography combine to obscure much of the bedrock. The survey was extended to this area of Creston rocks since the formation in this district is host to an important copper deposit (Kennco) at Bull Lake, Montana.

Doctor Creek

High copper values in stream silt samples were obtained in 1969 from a tributary of Doctor Creek 28 miles north-northwest of Kimberley. The anomaly was attributed by follow-up reconnaissance to small but widespread amounts of copper (chalcopyrite) occurring with quartz and carbonate veins in a metadiorite host. The intrusive,

probably a sill, invades sediments of the Aldridge Formation. The nature and amount of mineralization present did not encourage further exploration.

CONCLUSIONS

Present reconnaissance points out the need for systematic stratigraphic work to gain a cohesive, regional subdivision of the Aldridge Formation. The best and perhaps only means to obtain this as presently known is by the delimitation of Marker units. The objective is to areally position the Sullivan Line and gain insight to environments of deposition as they may relate to metal accumulation. This initial work will provide guides to the search for stratabound ore in the district.

Ore genesis by sedimentary-exhalative processes is taken as a guiding theme, and Sullivan-time is taken to be the principal period of metal concentration. The possible bracketing of the Sullivan period by the application of marker 'varves' could prove a distinct aid to further exploration.

Depth to the Sullivan zone as inferred from preliminary reconnaissance proceeding from north to south is: (1) at or near surface in and north of the Kimberley area, (2) 2,500 to 3,500 feet below surface in the Moyie district, and (3) at or near surface in the Yaak River section.

Correlation by means of the cross-matching of marker 'varves' was shown to be practicable in 1970 reconnaissance work. At present a consistent subdivision of the Aldridge Formation from area to area is non-existent in geological literature.

RECOMMENDATIONS

Properties

The three properties Polaris, Ace and Hilo require detail mapping as a first step to the definition of drill targets. Data from the property work will greatly assist areal reconnaissance.

Yaak River

Follow-up to the Hawkins Lakes geochemical anomaly is recommended. Stratabound base-metal is the target. Prospecting and mapping, with soil sampling as a contingency, is the initial work requirement.

Yahk Range

It is recommended that a metal environment northward of the Yahk range be assessed (see shaded area on Figure 3). Of interest is the Monroe Lake lead-zinc prospect (under option to Cominco) that has indications of being stratabound within a middle Middle Aldridge host. This stratigraphic zone conceivably relates to other noteworthy features in the district such as: (1) the Kid Creek lead-zinc prospect (in a chert? setting), (2) the Sunrise geochemical kick, (3) the Sundown lead-zinc occurrence, and (4) the Hawkins Creek chert body. Chert is viewed with interest due to its close spatial association with the Sullivan ore-body. Within this sector is an additional area of interest involving the intersection of two major faults (inferred revision of Moyie Fault) that should be examined for mineral association.

Moyie Intrusions

The Moyie Intrusions may relate to formationally controlled ore deposits by provision of an exhalative source. Work should be directed to the location of conduit centres. Observations should include the extent and thickening direction of individual sills, the

degree of dyking and the overall amount of intrusive material within the column. Marker beds are necessary for stratigraphic control.

Pudifin

The Pudifin area, 23 miles west of Cranbrook, mapped as Cambrian by the G.S.C. bears further validation. The area includes rusty argillites that could be taken for Aldridge strata. In this respect they resemble rocks, also labelled Cambrian, but possibly Aldridge, located 8 miles north-northwest of Cranbrook.

Markers

Further work is required on the delineation of marker beds. The present framework should be expanded by reconnaissance to the Doctor Creek, White Creek, Kootenay King, Goat River, Pend Oreille and Coeur d'Alene areas. Markers need to be pursued down-section in the Kimberley area to permit bracketing of the Sullivan Line.

Stratigraphy

Additional structural sections are recommended for the Doctor Creek, Tower Creek, Mathew Creek, Lumberton Hill, Ruby Mountain, and Lightning Creek areas. The Tower Creek section observed in reconnaissance contains an unusually large amount of carbonate in an area of marker-type rock. It offers the possibility of some insight to environmental conditions in proximity to the Sullivan mine.

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FRYKLUND, V.C. et al	1964	Ore deposits of the Coeur d'Alene District, Shoshone County, Idaho: U.S.G.S. Paper 445.

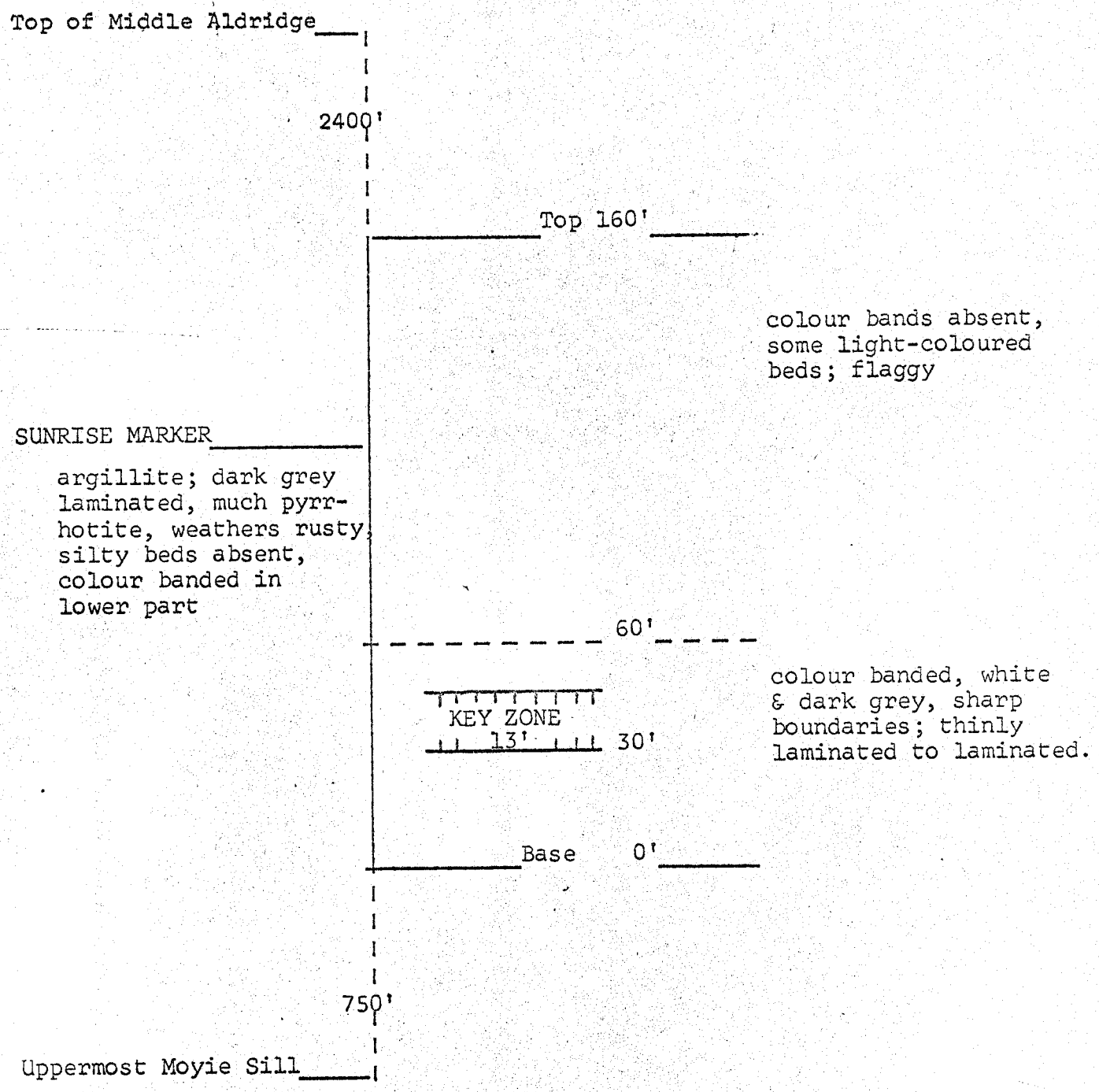
Geological Maps

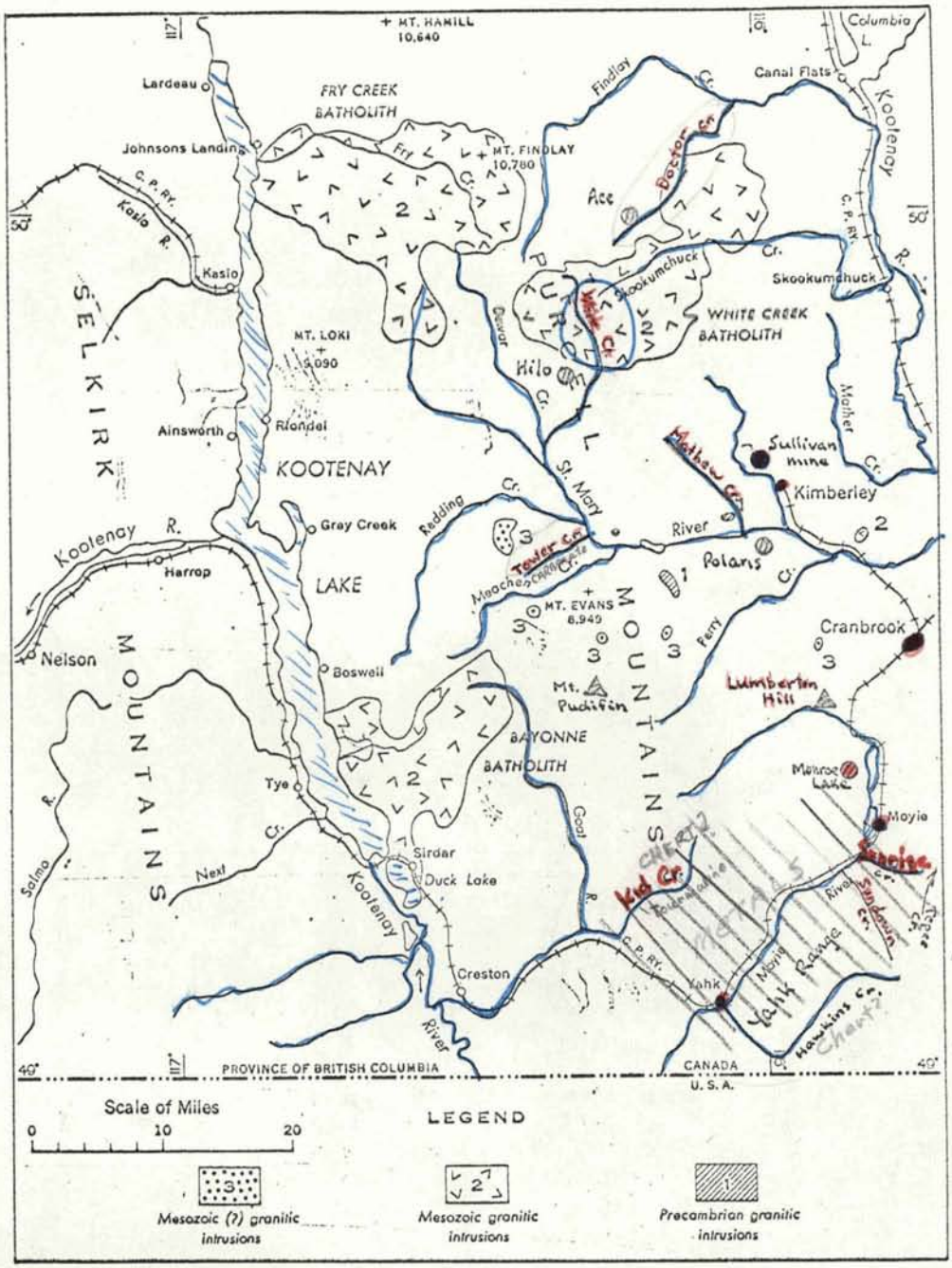
Kimberley District	1937	Cranbrook area, British Columbia, G.S.C. Mem. 207
	1954	Findlay Creek area, British Columbia, G.S.C. Paper 53-34.

Geological Maps (cont'd.)

	1957	St. Mary Lake area, British Columbia, G.S.C. Map 15-1957.
	1958	Dewar Creek area, British Columbia, G.S.C. Mem. 292.
Moyie District	1941	Nelson East Half, British Columbia, G.S.C. Mem. 228.
	1960	Fernie West Half, British Columbia, G.S.C. Map 11-1960.
Yaak River District	1926	Boundary County, Idaho; Idaho Bureau Mines Bull. 10
	1959	Western Lincoln County, Montana, Montana Bureau Mines Bull. 12
	1961	Northern Lincoln County, Montana Montana Bureau Mines Bull. 23.
Clark Fork District	1948	Libby Quadrangle, Montana: U.S.G.S. Bull. 956.
	1963	Clark Fork Quadrangle, Idaho/Montana: U.S.G.S. Bull. 1141-K.
	1967	Bonner County, Idaho: Idaho Bureau Mines County Report 6.
Coeur d'Alene District	1956	St. Regis area, Mineral County, Montana, US.G.S. Bull. 1027-M.
	1960	Superior area, Mineral County, Montana, US.G.S. Bull. 1082-I
	1965	Coeur d'Alene area, Idaho. U.S.G.S. Paper 478.

APPENDIX A - Graphic Section of Sunrise Marker; Moyie Area

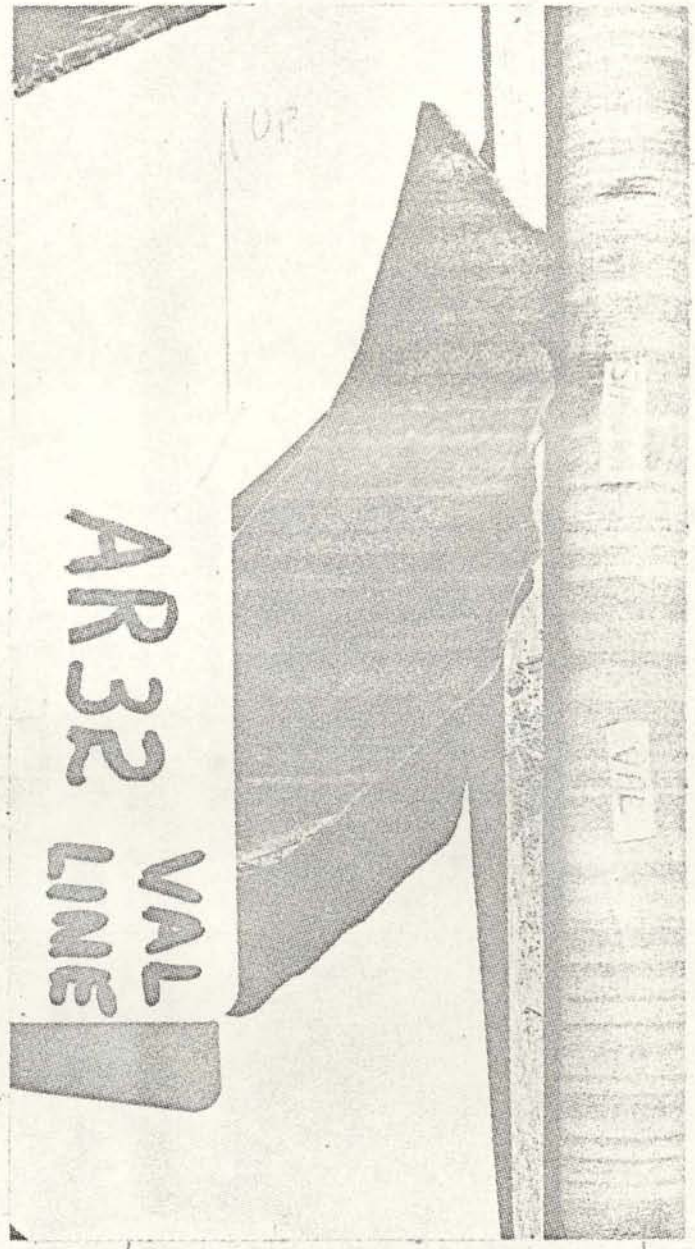




Aldridge-Revett Project, 1970

Location, British Columbia

Figure No. 3



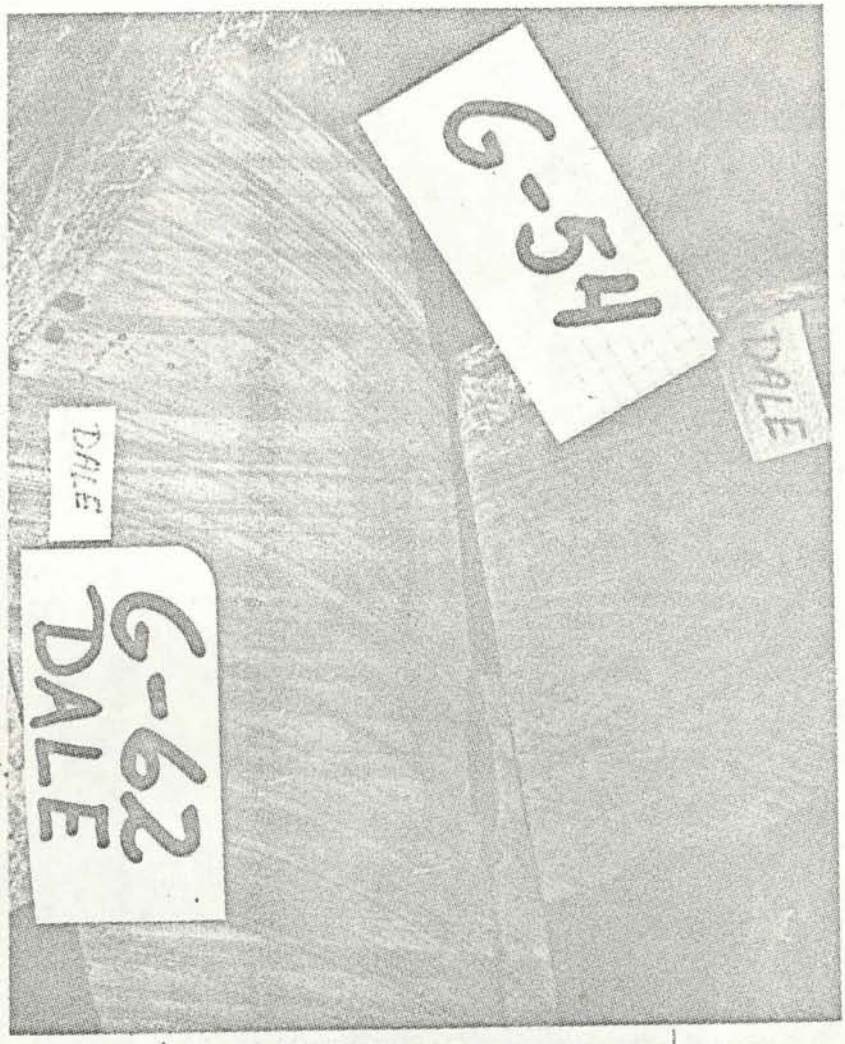
SUNDOWN CREEK (AR 32)

BRAUNAGLE CREEK (DD 70-5)

Across Moyie anticline, 7 miles between sites.

SUNRISE MARKER - Val Line

Figure 5.



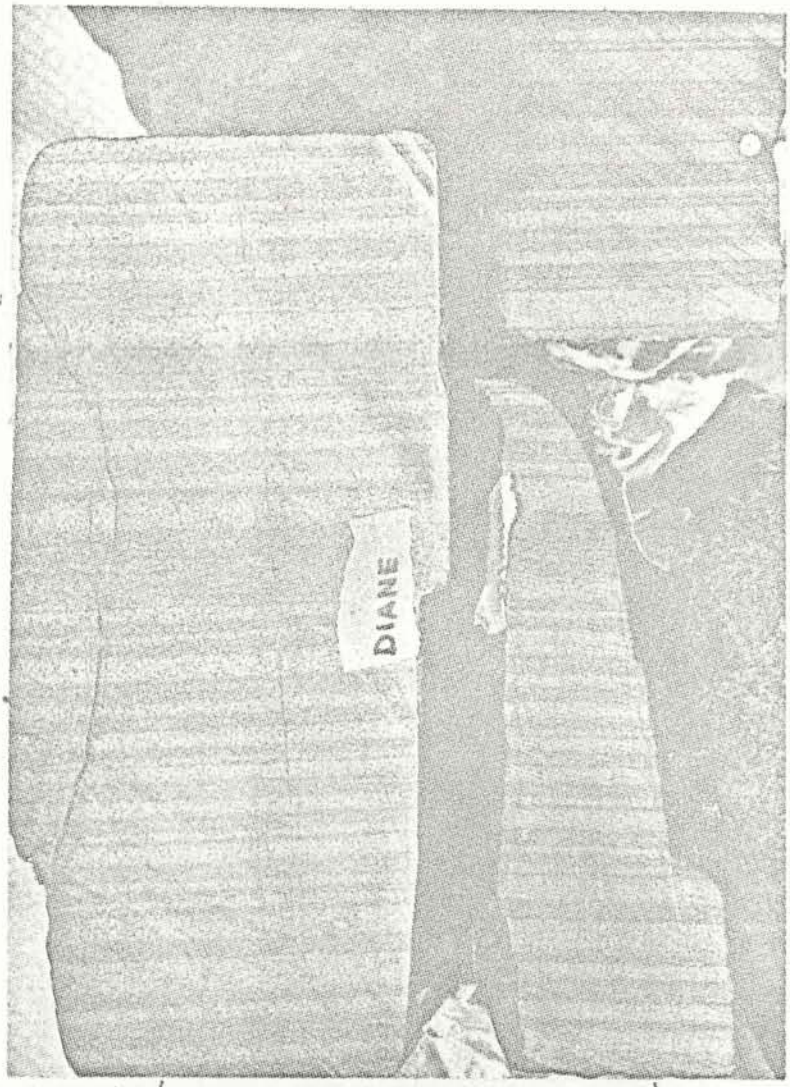
MARK CREEK (G62)

KREIST CREEK (G54)

Across St. Mary and Moyie faults, 56 miles between sites.

SUNRISE MARKER - Dale Line

Figure 6



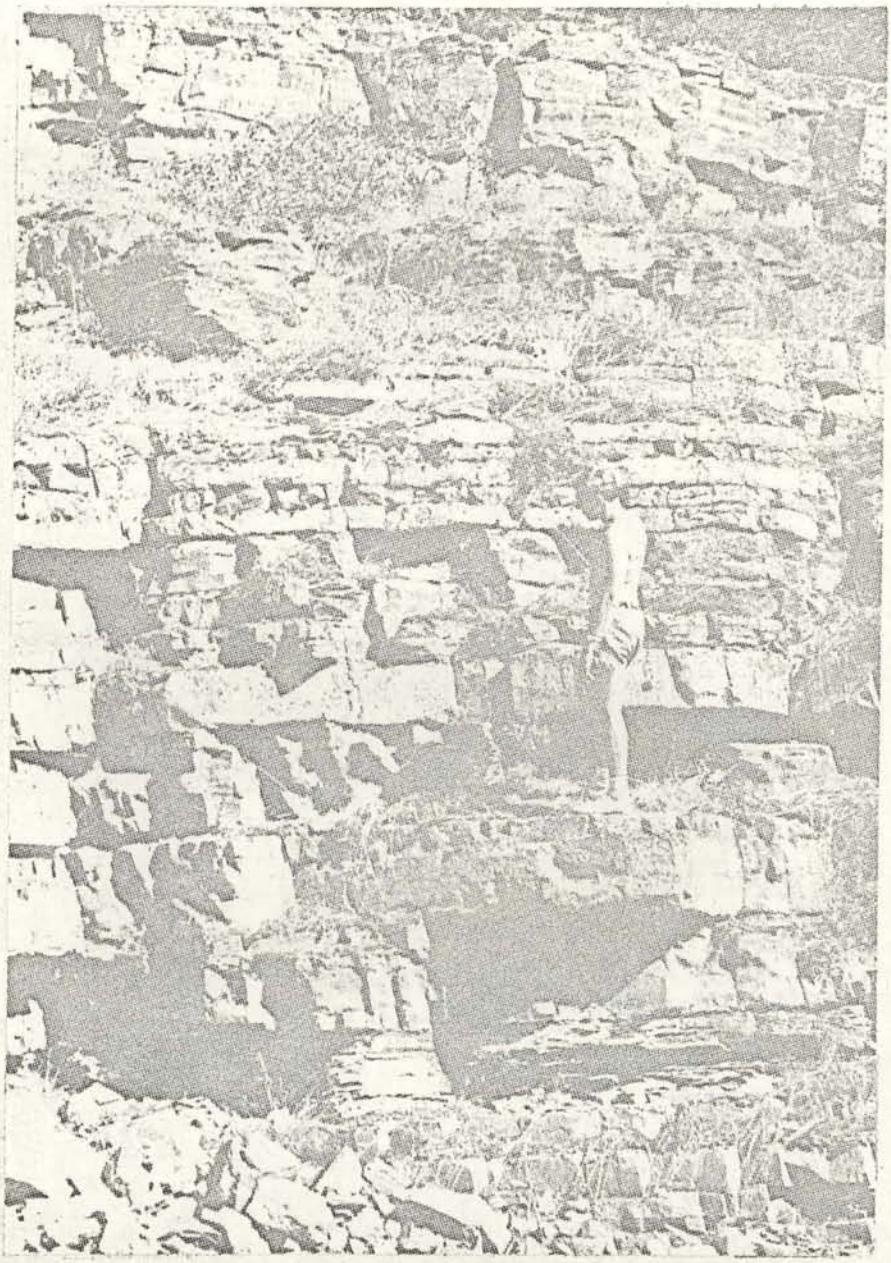
PYRAMID CREEK (AR 101)

MEACHAM CREEK (AR 110)

Across splay of Hall Lake fault, 11 miles between sites.

PYRAMID MARKER - Diane Line

Figure 7



Turbidite Sequence, Cranbrook area

Figure 8

3. Term Usage

The terms carbonaceous, carbonate-bearing, calcareous and dolomitic signify the presence of: some carbonaceous material, some calcite and/or dolomite, some calcite and some dolomite, respectively.

The carbon content? of carbonaceous rocks is low, probably less than one percent. Enough is present in hand specimen to impart a dark colour to the rock.

PERMIT NO 71
PERMIT NO 68
PERMIT NO 141
PERMIT NO 65
PERMIT NO 64
PERMIT NO 63
PERMIT NO 66
PERMIT NO 67
PERMIT NO 72
PERMIT NO 62
PERMIT NO 58
PERMIT NO 70
PERMIT NO 140

HARLAND LAKES THRUST
TWIN BUTTE THRUST
LEWIS THRUST
NOTE A
FLATHEAD FAULT
NOTE B
NOTE C
MONOCLINE
SHEEP PASS FAULT
Gable
AKAMINA Minerals
AKAMINA SYNCLINE
SOUTH KOOTENA PASS
WATERTON LAKE
NATIONAL PARK
Kishinena Creek
Bauerman
Blakiston
Cameron Lake
Waterton R. 1

Tp. 5
Tp. 4
Tp. 3
Tp. 2
Tp. 1

PURCELL

10 ROOSVILLE FORMATION (Kintla Formation, Member D): green and grey argillite, siltstone and sandstone; light coloured argillaceous and stromatolitic dolomite

9 PHILLIPS FORMATION (Kintla Formation, Member C): red and purplish red sandstone, siltstone and argillite

8 GATEWAY FORMATION, UPPER MEMBER: (Kintla Formation, Members A and B): red, purplish red and grey argillaceous siltstone and argillite; green and greenish grey argillite, dolomitic argillite and sandstone; dolomite; dolomitic sandstone

7 SHEPPARD FORMATION (Gateway Formation, Lower Member): light grey quartzitic and dolomitic sandstone, dolomite, and oolitic dolomite; green argillite and dolomitic argillite; red siltstone and sandstone; chloritized andesite and pillowed andesite

6 PURCELL LAVA: dark green, purplish green, and reddish green, chloritized andesite, amygdaloidal andesite, and pillowed andesite

5 SIYEH FORMATION: grey limestone, dolomite, argillaceous dolomite, and sandy dolomite; green and red argillite, stromatolitic limestone

4 GRINNELL FORMATION: red argillite, white and red sandstone and siltstone

3 APPEKUNNY FORMATION: green and greenish grey argillite; white, grey, and green quartzose sandstone

2 ALTYN FORMATION: dark grey and black argillaceous limestone and dolomite; black argillite; grey dolomitic argillite and argillaceous dolomite; sandy dolomite; stromatolitic dolomite

1 WATERTON FORMATION: dense banded and streaked grey limestone and dolomite; green dolomite, argillaceous dolomite, and argillite; brownish red dolomite and argillaceous dolomite; dense white limestone

PRECAMBRIAN

30' U. S. A. 15'

PRINTED BY THE SURVEYS AND MAPPING BRANCH

49°00' 114°00'

MAP 35-1961
TO ACCOMPANY PAPER 61-24
GEOLOGY

FERNIE
(EAST HALF)
BRITISH COLUMBIA - ALBERTA

Scale: One Inch to Two Miles = $\frac{1}{126,720}$

Miles 2 1 0 2 4 6

MAP 35-1961
FERNIE
BRITISH COLUMBIA—ALBERTA
SHEET 82 $\frac{G}{NE}$ AND 82 $\frac{G}{SE}$