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NOTES ON THE STRUCTURE AND STRATIGRAPHY

OF THE PHOENIX BASIN

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Mapping on scales of 1:2500 and 1:2400 and a review of the Granby files in the Kettle River office in Greenwood have substantially modified my understanding and interpetation of the geology of Phoenix derived from reconnaissance work in 1982 and 1983. The following notes summarize my present ideas and amplify the data on the attached maps and sections.

FAULTS

The structure of the Phoenix basin is so dominated by Tertiary faults that it is difficult to define and identify pre-tertiary structures. Many of the rock surfaces in the Ironsides pit and in the subsidence areas are slickensided fault planes. Granby maps show many small offsets particularly of tertiary dykes and the ore - argillite horizons. These small faults modify but tend to obscure the bigger picture. I have tried to define the attitudes and locations of the major faults which limit the extent of the members of the Brooklyn Formation that are known to be mineralized with copper and gold. They are shown on the map by surface expression and structure contours.

The Tertiary faults have a complex history probably resulting from extension (in an east-west direction) and collapse on a regional scale. The bounding faults are categorized as follows.

SNOWSHOE AND SNOWSHOE SET

The Snowshoe fault cuts off the Snowshoe orebody on the north, terminating it against Knob Hill cherts and greenstones which form the ridge north of the Snowshoe pit and old workings. Granby maps show a dip of 30 degrees to the southwest (Granby 4500 level plan) and the southwest dip conforms to the regional curvature of the surface trace. Splays and subparallel faults in the hangingwall of the Snowshoe fault are part of the same set and are found mainly close to it in the Snowshoe and the Stemwinder workings; the north end of the Ironsides pit at the lowest elevations and probably in the northend of the Brooklyn at deeper elevations. Noranda-Kettle River drill hole B 1-85 penetrated sheared Knob Hill rocks at elevation 4230 feet (depth 350 feet) which may be along the extension of the

Snowshoe fault. Regional mapping suggests the movement of this fault set is dominantly down on the southwest but there may be a significant right-hand strike slip. The important feature of this fault is that it lifts a rib of Knob Hill basement up into the Phoenix ore zones along the Snowshoe-Stemwinder-Brooklyn-Sylvester (?)-Canbec (?)- trend. This is the oldest fault recognized and is obscured and offset by later faults. While it probably has tertiary movement, the possibility that it is a pre-Brooklyn (Triassic) fault scarp and/or a Cretaceous structure must also be considered. Rocks of the Knob Hill group encountered in the bottom 300 feet of Hole SK 20 are along this trend and indicate that this "Knob Hill high" extends as far west as the Providence Lake road (200N - 20SE on the SK grid).

GOLD DROP FAULT

This is the main fault bounding the Tertiary volcanic rocks on the east and was named by H.W. Little (GSC Paper 79-29) from exposures in the Gold Drop glory hole. It is a gentle (10 degrees to 25 degrees) north and west dipping fault which has been fairly accurately located on surface and in drilling east of the Ironsides pit and in the Gilt Edge work. Judging from slickensides the dominant movement direction is hangingwall down toward the west. It is younger than the Snowshoe set and because of its low dip, covers them and offsets them. (However, I do not accept my origianl interpretation that the Gold Drop fault displaces the Snowshoe fault as far as the powerline which limits the Brooklyn formation at the northern edge of Canbec ground.)

VICTORIA FAULT

The Kettle River arkose (sandstone, siltstone and conglomerate) is in fault contact with various parts of the Brooklyn formation on the east side and northern end of the Ironsides pit. I have called this the Victoria fault. It curves from an attitude of 110/25N in drill holes north and east of the Ideho to 110/30N across the northend of the pit to 140/40NE along the east side of the pit and back to 120/35N southeast of the pit. It is followed by a feldspar porphyry (Tertiary pulaskite) dyke up to 30 feet thick which is commonly sheared and has heavy gouge on the upper margin with the arkose and I have shown that contact as the fault.

Faults and the pulaskite dyke exposed in the tailings spillway ditch, are probably the western continuation of this fault which from there swings northwestward along the base of the lower sharpstone west of Sylvester.

VICTORIA FAULT - con't

The Victoria fault may be the western continuation of the Gold Drop fault offset slightly by the War Eagle fault, or it may be complimentary fault of the same set with dominant slip direction east-west, any estimate of the net slip depends on the correlation of the Brooklyn limestone in the Idaho workings with the limestone exposed in the northwest corner of the Ironsides pit. If this is correct there is a left hand offset (east over west) in the order of 1000 feet.

GILT EDGE FAULT

The western side of the Kettle River arkose between the northeast corner of the Ironsides pit and the Gilt Edge showings is probably a fault, where exposed on the pit wall, it is a 2 foot gouge zone striking north and dipping east and lying above the Victoria fault which it may join (in the pit beneath the water level). In the Gilt Edge drilling the average dip is only 20 degrees east whereas the beds in the Kettle River above it dip on the average 40 to 50 degrees in the same direction. Both these observations are taken as evidence that this is a fault zone, possibly a split off the Victoria (and Gold Drop) faults.

WAR EAGLE AND PIT FAULTS

The War Eagle fault on surface truncates the Ironsides - Knob Hill ore bands as they pass through the War Eagle workings on the southeast slope of Knob Hill. It was picked out on Granby Level plans in drilling beneath the Tertiary east of the pit dropping the base of the Tertiary (Gold Drop - Victoria faults) down about 300 feet on the west. It strikes 35 degrees and dips more than 70 degrees to the west and probably flattens in dip to the south as it passes into the massive basal sharpstone.

At least 3 almost vertical steeply west dipping faults trending between 0 and 20 degrees are exposed in the headwall of the Ironsides pit. They are marked by rusty gouge and vuggy quartz breccia zones and have dropped the orezones down on the west by several tens of feet. They probably join the War Eagle fault on the War Eagle property.

FOOTWALL FAULTS

Prominent bedding plane and near bedding plane surfaces forming the footwall of the pit are clearly faults showing spectacular slickensides and linear growth crystals all pointing to down dip normal faulting. Along strike, these faults curve to the left transecting beds at oblique angles. Within the footwall siltstones they commonly curve right again to follow bedding. They appear to be relatively late structures not part of the interbed slippage caused by the pre-Tertiary folding and are considered to be Tertiary extension structures of the same group as those first described. They are offset by the pit faults and may be part of the Gold Drop - Victoria set.

FOLDS

A large fold, referred to as the Phoenix syncline is outlined by the attitudes of bedding in the Brooklyn formation and by the base of the Brooklyn. The vertical beds and members of the Brooklyn on the Canbec, Sylvester and Brooklyn properties form the western limb which trends about 15 degrees. The U-shaped form of the copper-skarn orebodies form the hinge zone and gently dipping eastern limb but close to the orebodies, the fold is obscured by faults. Structural data (not yet fully compiled) indicate that the trace of the axial plane trends 20 degrees to 30 degrees and lies east of the Ironsides pit. The axial plane dips at moderate angles (45 degrees) to the west and the axis plunges to the north at 15 to 25 degrees. The hinge zone is defined only on the southeast slopes of Knob Hill on the War Eagle and Monarch properties by the faulted outlines of the skarn and siltstone members and by attitudes of obscure bedding in the sharpstone. On the Rawhide and Snowshoe properties bedding obscured in the workings dips at angles of less than 30 degrees, dominantly to the east, but locally to the west and north. Beyond these workings to the southeast the Rawhide siltstone and interbedded sharpstones dip at low angles to the west. Thus, the eastern limb of the Phoenix syncline is a broadly folded gently dipping panel containing a series of small anticlines and synclines which at the copper-skarn horizon is complexly faulted.

I have not found minor folds related to the Phoenix syncline. Even in the Ironsides pit where well bedded siltstones are clearly exposed the rocks show only broad warps and variations in attitude. The only minor folds I have seen are on the Canbec ground where there are a few steeply plunging Z-shaped drag folds such as the large one north of the San Jacinto workings. They appear to be superimposed on the vertical limb of the Phoenix syncline and since there is no axial plane cleavage probably reflect a translatory movement of west side northward.

STRATIGRAPHY

The Brooklyn formation is characterized by rapid facies changes and an abundance of various sorts of breccia and by limestone members which change abruptly in thickness. A volcanic component includes pyroclastic plagioclase in the siltstones and sandstones, and irregular bodies of subvolcanic microdiorite and hornblende porphyry and related agglomerate which possibly is extrusive. The stratigraphic succession at four places in the Phoenix syncline is shown in the following tables and the map legends.

BROOKLYN FORMATION - CANBEC AREA

THICKNESS IN FEET	MAP NUMBER	LITHOLOGY
	6	Microdiorite, diorite and minor hornblende porphyry-epidote and pyrite on fractures or disseminated.
1200 +	5	Massive grey to white crystalline limestone. - locally with whisps of silicates and thin beds of hornfelsic siltstone. - limestone conglomerate and breccia lenses in places.
0 - 500	4-4a	Brown weathering hornfelsic siltstone commonly crackled or brecciated.
0 - 400	4b	Limestone.
	4c	Limey chert pebble conglomerate.
	4d	Chert breccia.
300 - 500	3a	Limestone, mainly light grey massive,some dark grey.
	3b	Limey chert pebble conglomerate.
	3c	Thin bedded cherty hornfels.
800 - 1000	2	Mineralized volcanic siltstone member mainly hornfelsic siltstone with lenses and interbeds of 2c-2h.
	2a	Massive dark green to brown hornfelsic siltstone.
	2b	Thin bedded hornfelsic siltstone.
	2c	Grey-white crystalline limestone.
	2d	Massive sulphides-mainly pyrrhotite and pyrite.
	2e	Skarn, epidote-chlorite-garnet-calcite, rarely garnet- magnetite.
	2f	Dark grey argillite.
	2g	Chert breccia.
	2h	Limey chert pebble conglomerate.
	1	Lower sharpstone.
2000	1b	Interbedded sandstone and chert breccia.
500	1a	Massive chert breccia.

********************UNCONFORMITY********************

KNOB HILL

5700 TOTAL

BROOKLYN FORMATION-SYLVESTER K-BROOKLYN-STEMWINDER

THICKNESS IN FEET	MAP NUMBER	LITHOLOGY
		"Black sharpstone conglomerate" not seen in present exposure but described in drill logs above (east of) Stemwinder limestone in Stemwinder mine area.
800 -	6c	Agglomerate and greenstone.
0 - 200	5	Stemwinder limestone lenses of grey limestone and limestone breccia.
900	4	Upper sharpstone, chert breccia, green chert sandstone and chert-limestone breccia.
1200	3	Brooklyn limestone. Grey to white crystalline limestone with a few interbeds of hornfelsic siltstone, minor dark grey argillite.
500	2	Mineralized volcanic siltstone member, mainly green and brown hornfelsic siltstone with lenses and interbeds of units 2c to 2h.
	2a	Massive dark green to brown hornfelsic siltstone.
	2b	Thin bedded hornfelsic siltstone.
	2c	Grey-white crystalline limestone.
	2d	Massive sulphides-mainly pyrrhotite and pyrite.
	2e	Skarn, epidote-chlorite-garnet-calcite, rarely garnet-magnetite.
	2f	Dark grey argillite.
	2g	Chert breccia.
	2h	Limey chert pebble conglomerate.
1000	1	Lower sharpstone.
	1b	Interbedded sandstone and chert breccia.
	1a	Massive chert breccia.

***********************VICTORIA FAULT*****************

4600	TOTAL	
		Knob Hill chert, dark grey phyllite and greenstone.

BROOKLYN FORMATION-SNOWSHOE-RAWHIDE-MONARCH

THICKNESS IN FEET	MAP NUMBER	LITHOLOGY
****************GOLD DROP FAULT***********************		
	4	Upper sharpstone - green chert breccia more or less skarnified locally containing pyrite and chalcopyrite.
0 - 30	3	Brooklyn (?) limestone - grey and white thin bedded silicate - leaving limestone and mineralized skarn - local calcareous chert pebble conglomerate. (3b)
20 - 100	2	Mineralized member.
	2a	Copper - iron skarn.
	2b	Green and brick red siltstone calcareous and hornfelsic siltstone.
400	1	Lower sharpstone - green chert breccia with interbeds of green chert sandstone.
400		Rawhide shale - grey to black massive to thin bedded siltstone with interbeds of chert breccia and sandstone at the top.
700		Buff to grey chert breccia - mainly buff chert fragments.
200		Massive dark grey to black siltstone.
100		Green chert breccia like the lower sharpstone.
********************SNOWSHOE FAULT*******************		
		Knob Hill greenstone.

BROOKLYN FORMATION - IRONSIDES PIT AREA

Brooklyn - Stemwinder - Kettle River arkose.

*******************VICTORIA FAULT****************

THICKNESS IN FEET	MAP NUMBER	LITHOLOGY
500 +	4	Upper sharpstone - green chert breccia ranging from fine to coarse angular fragments of quartz, chert, minor limestone and green volcanic rocks, etc., thin green sandstone (?) at the base.
	4a	Skarnified sharpstone-epidote, garnet quartz breccia locally containing chalcopyrite and pyrite.
0 - 500	3	Brooklyn limestone. - grey and white crystalline limestone. - greenish thin bedded limestone.
	3a	Skarn with chalcopyrite.
	3b	Calcareous chert pebble conglomerate.
100 - 200	2	Mineralized member.
	2a	Copper-iron skarn.
	2b	Green and brick red skarny hornfelsic siltstone.
2500	1	Lower sharpstone.
	1b	Interbedded sandstone and chert breccia.
	1a	Massive chert breccia.

*******************UNCONFORMITY*****************

3500	TOTAL	
		Chert and greenstone - Knob Hill.

DISCUSSION

This review of the structure and stratigraphy of the Phoenix area has led to the following conclusions and observations.

1) The lower sharpstone (Unit 1) is thickest on the western limb and hinge zone of the Phoenix syncline. It thins rapidly on the slopes southeast of the Monarch workings and near the Snowshoe is only a few hundred feet thick, relatively fine grained and shows bedding (sorting). In this area, also below the Rawhide it grades into the Rawhide siltstone which is underlain by two other sharpstone members whereas to the west and north it always rests unconformably on the Knob Hill group.

In the Ironsides pit the upper sharpstone (Unit 4) probably joins the lower sharpstone not far south of the face of the pit - ie. the sharpstones probably form coalescing fans. It is tempting to speculate on the shape of these fans and the direction of their source, but I do not think we have sufficient data for this.

2) There are two contrasting facies of the mineralized siltstone (Unit 2). One is the ore and footwall argillite of the Ironsides pit - War Eagle, Rawhide etc. workings. This is a green and brick red siltstone with 1 to 2 inch color banding. I include the copper iron skarn in this facies speculating that it was originally a calcareous siltstone, rich in copper and iron and not the Brooklyn limestone as suggested by earlier workers.

The other facies is the hornfelsic siltstone with interbeds and lenses of massive sulphides, banded tuffaceous siltstones, skarn, limestone and calcareous chert pebble conglomerate, etc. of the Sylvester - Canbec area. Both facies probably have a tuffaceous component (pyroclastic feldspars) and grade from one to the other in the area obscured by the Twin Creek tailings. It may be that the Ironsides facies with its red bed component was laid down in a shallower water environment than the Canbec facies. Also the microdiorite (Unit 6) of the Canbec facies which was emplaced soon after sedimentation is rare or not present in the Ironsides facies. This suggests that the Canbec facies was closer to a Triassic volcanic center.

DISCUSSIONS - con't

3) All members of the Brooklyn higher in the succession than Unit 2 change facies abruptly from north to south. Noteably, the two major limestones lens out into siltstone (Unit 2) and sharpstone (Unit 4). If the correlation of the thick Brooklyn limestone east of Sylvester (Unit 3) with the relatively thin limestone (Unit 3) on the Oanbec grid is correct, the upper sharpstone (Unit 4) is equivalent to the brown siltstone, (Unit 4) on the Canbec ground. This siltstone has a vague brecciated structure and contains lenses of limestone, chert pebble conglomerate and chert breccia in the northern part of the Canbec grid. We can speculate that the Brooklyn quiet reef building interval was followed by a highly erosive and disturbed interval, which was followed by the extensive build up of the very thick limestones of the Stemwinder interval.

4) The Snowshoe fault and postulated pre-Brooklyn fault scarp which it followe is an important geometric and possible genetic control of mineralizetion. They form the northern limit not only of the Snowshoe but also of all the other copper orebodies. They also form a unique northwest trend along which are the higher-than-average grade gold zones in the Stemwinder, Brooklyn, Sylvester K and Marshall Lake workings. One frustrating feature of the Snowshoe fault zone is that it does not have an expression on surface west of the Tertiary cover above the Gold Drop fault. The possibilities that it is obscured by the Tertiary monzonite or folows the microdiorite south of Providence Lake are not entirely satisfactory explanations. It seems more likely that it does not reach the surface in this area. This leads to further speculation that the Snowshoe fault is along an irregular pre-Brooklyn high or that somehow it becomes a very gently dipping fault lying beneath ali the Brooklyn rocks to the north.

Identification of the Snowshoe fault trend gives us added incentive to thoroughly test mineralized beds and structures along this trend, including a review of all geochemical and geophysical data and continued drilling.

James T. Fyles

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August 15, 1985
WPS KRR 2.27

LEGEND-CANBEC GRID

TERTIARY INTRUSIONS:

17	Mainly fine to medium grained biotite monzonite.

TRIASSIC-BROOKLYN FORMATION:

6		Microdiorite, diorite and minor hornblende porphyry-epidote and pyrite on fractures or disseminated.
5		Massive grey to white crystalline limestone. - locally with whisps of silicates and thin beds of hornfelsic siltstone. - limestone conglomerate and breccia lenses in places.
4	4a	Brown weathering hornfelsic siltstone commonly crackled or brecciated.
	4b	Limestone.
	4c	Limey chert pebble conglomerate.
	4d	Chert breccia.
3	3a	Limestone, mainly light grey massive, some dark grey.
	3b	Limey chert pebble conglomerate.
	3c	Thin bedded cherty hornfels.
2		Mineralized volcanic siltstone member.
	2a	Massive dark green to brown hornfelsic siltstone.
	2b	Thin bedded hornfelsic siltstone.
	2c	Grey-white crystalline limestone.
	2d	Massive sulphides-mainly pyrrhotite and pyrite.
	2e	Skarn, epidote-chlorite-garnet-calcite, rarely garnet-magnetite.
	2f	Dark grey argillite.
	2g	Chert breccia.
	2h	Limey chert pebble conglomerate.
1		Sharpstone conglomerate member.
	1a	Massive chert breccia.
	1b	Interbedded sandstone and chert breccia.

Areas of outcrop

Significant rubble

Shaft

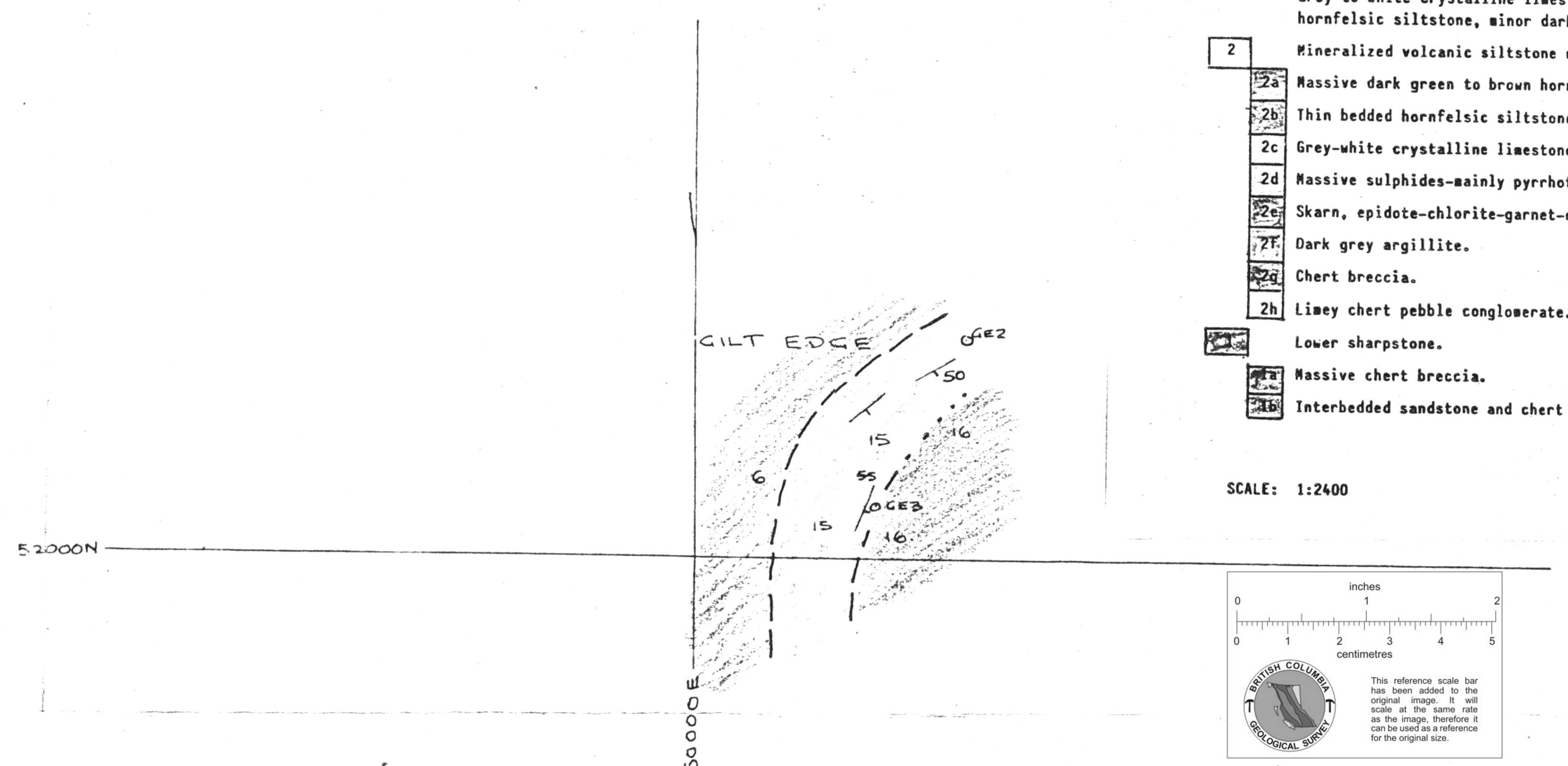
Trench and bulldozer stripping

Road

Trail

SCALE: 1:2500

JTF June 1985



LEGEND

SYLVESTER K. BROOKLYN STEMWINDER

TERTIARY INTRUSIONS:

17	Biotite monzonite and feldspar porphyry.

TRIASSIC-BROOKLYN FORMATION

6		Microdiorite, hornblende porphyry and agglomerate.
	6a	Microdiorite.
	6b	Hornblende porphyry.
	6c	Agglomerate.
5		Stemwinder limestone. Coarse limestone breccia.
4		Upper sharpstone. Chert breccia, green chert sandstone and chert-limestone breccia.
3		Brooklyn limestone. Grey to white crystalline limestone with a few interbeds of hornfelsic siltstone, minor dark grey argillite.
2		Mineralized volcanic siltstone member.
	2a	Massive dark green to brown hornfelsic siltstone.
	2b	Thin bedded hornfelsic siltstone.
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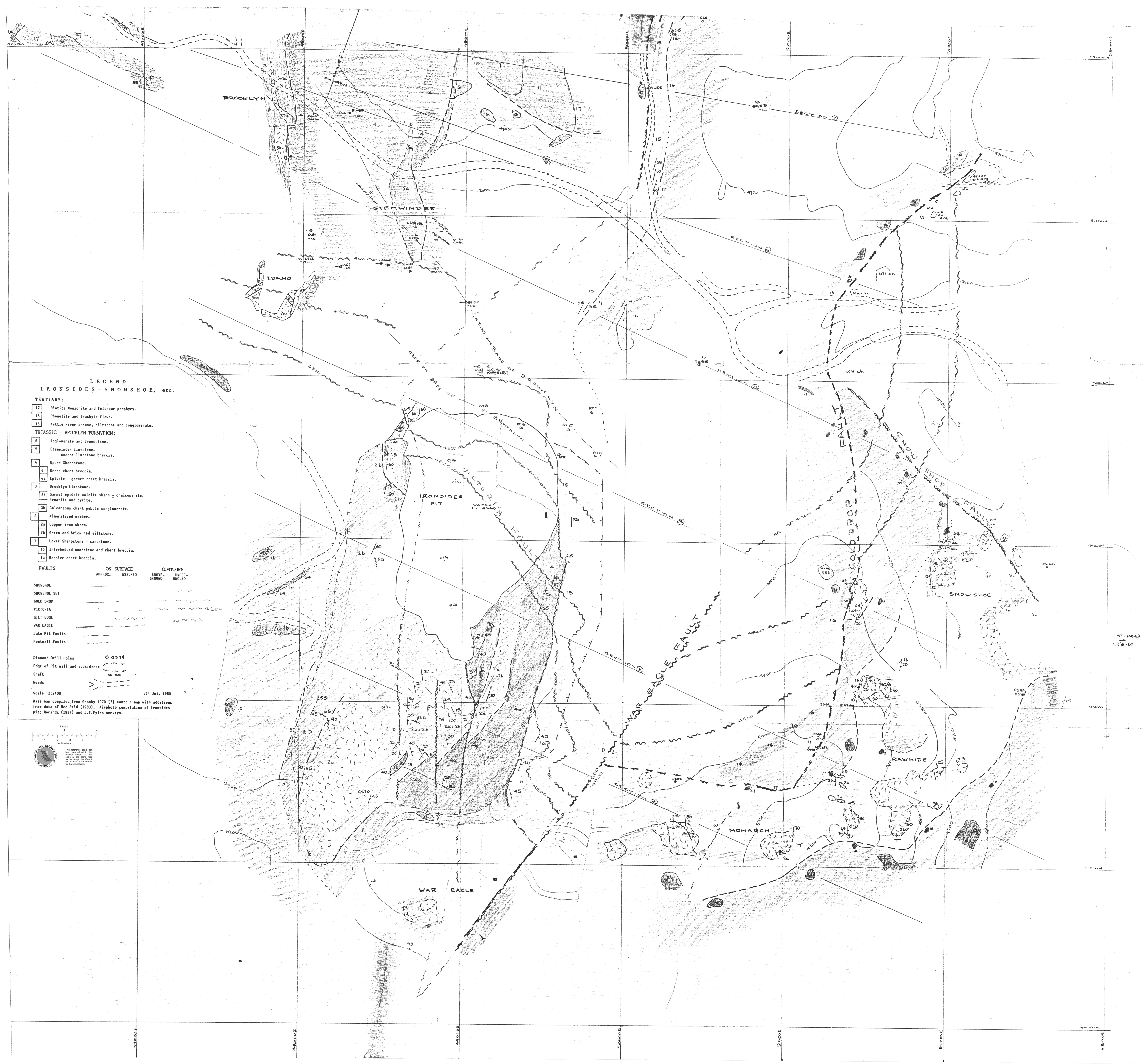
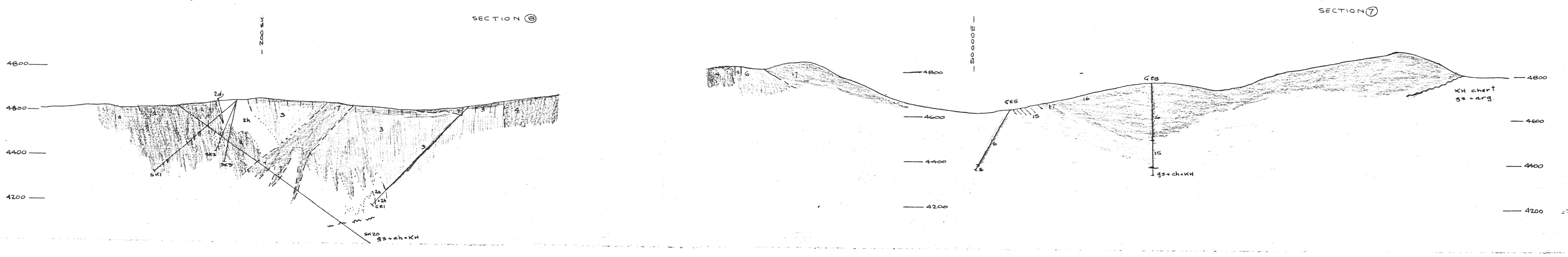
	2e	Skarn, epidote-chlorite-garnet-calcite, rarely garnet-magnetite.
	2f	Dark grey argillite.
	2g	Chert breccia.
	2h	Limey chert pebble conglomerate.
1		Lower sharpstone.
	1a	Massive chert breccia.
	1b	Interbedded sandstone and chert breccia.

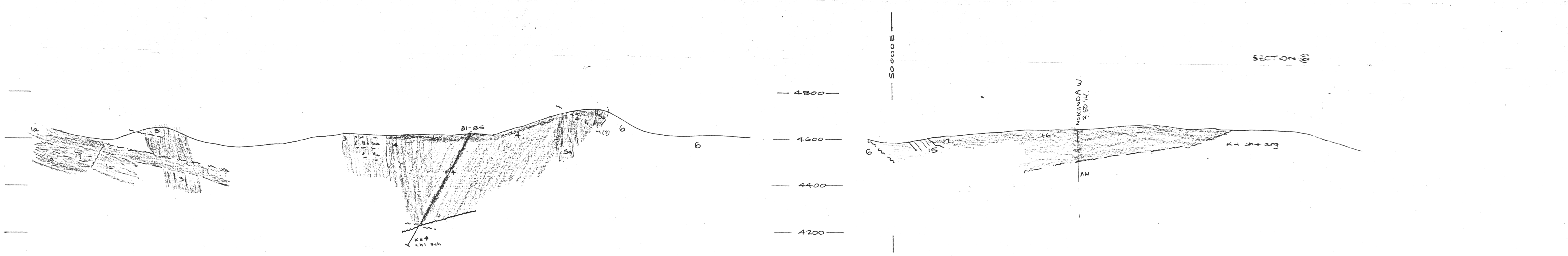
SCALE: 1:2400

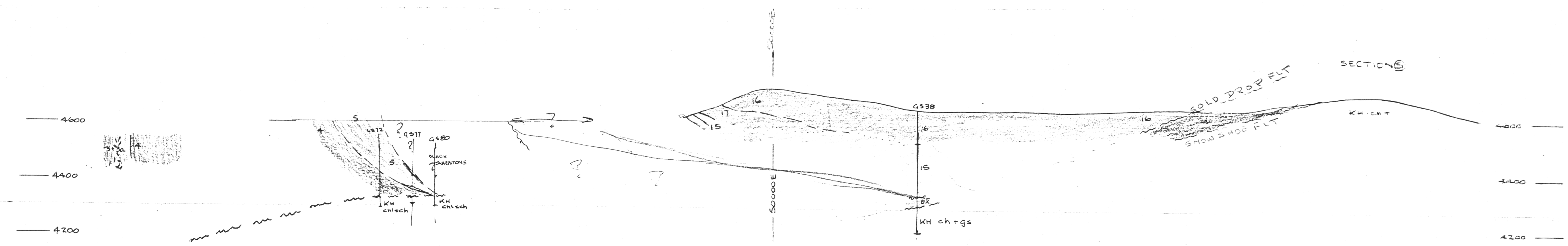
JTF June 1985

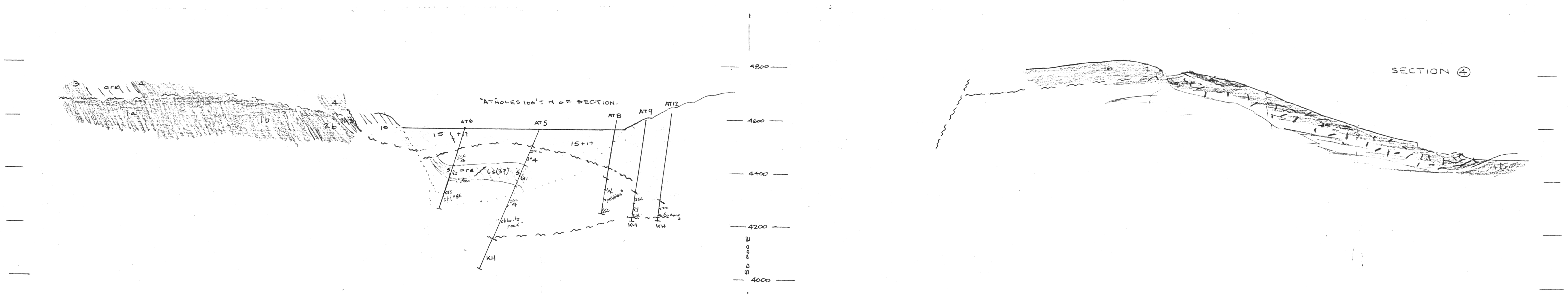


BROOKLYN
STEMWINDER
IDAHO
IRONSIDES PIT
WATER EL 4560
SECTION 7
SECTION 6
SECTION 5
SECTION 4
SECTION 3
SECTION 2
BASE OF BROOKLYN
VICTORIA FAULT
GOLD DROP FAULT
SNOWSHOE FAULT
WAR EAGLE FAULT
SNOWSHOE
RAWHIDE
MONARCH
WAR EAGLE
LEGEND
IRONSIDES - SNOWSHOE, etc.
TERTIARY:
17 Biotite Monzonite and feldspar porphyry.
16 Phonolite and trachyte flows.
15 Kettle River arkose, siltstone and conglomerate.
TRIASSIC - BROOKLYN FORMATION:
6 Agglomerate and Greenstone.
5 Stemwinder limestone.
- coarse limestone breccia.
4 Upper Sharpstone.
4 Green chert breccia.
4a Epidote - garnet chert breccia.
3 Brooklyn Limestone.
3a Garnet epidote calcite skarn ± chalcopyrite, hematite and pyrite.
3b Calcareous chert pebble conglomerate.
2 Mineralized member.
2a Copper iron skarn.
2b Green and brick red siltstone.
1 Lower Sharpstone - sandstone.
1b Interbedded sandstone and chert breccia.
1a Massive chert breccia.
FAULTS
ON SURFACE
APPROX.
ASSUMED
CONTOURS
ABOVE-GROUND
UNDER-GROUND
SNOWSHOE
SNOWSHOE SET
GOLD DROP
VICTORIA
GILT EDGE
WAR EAGLE
Late Pit Faults
Footwall Faults
Diamond Drill Holes
Edge of Pit wall and subsidence
Shaft
Roads
Scale 1:2400
JTF July 1985
Base map compiled from Granby 1970 (?) contour map with additions from data of Ned Reid (1983). Airphoto compilation of Ironsides pit; Noranda (1984) and J.T.Fyles surveys.
inches
centimetres
BRITISH COLUMBIA GEOLOGICAL SURVEY
This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.









PHOENIX AREA

DIAGRAMMATIC VERTICAL CROSS SECTIONS

SCALE 1:2400

FOR LEGEND SEE MAP

KH = KNOB HILL GROUP
chl sch chlorite schist
ch chert
gs greenstone
arg argillite
bx breccia

J.T.F AUGUST '85