COMINCO LTD | WESTERN DISTRICT

1996 ANNUAL PROJECT REPORT

SULLIVAN PROJECT

DEEP DRILL HOLE NORTH OF KIMBERLEY FAULT

SUMMARY

P.W. RANSOM

FEB 1998

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SULLIVAN PROJECT

SUMMARY

The first successful intersection of formal Sullivan mine stratigraphic units north of the Kimberley Fault was obtained in DDH 6465, completed to a depth of 8557 feet (2608 metres) in 1996. Unfortunately a normal, probably 50° NW dipping, fault of 100 to 300 feet displacement was hit at 8100 feet, 30 feet above of where the first of the ore bands is projected; below the fault were fairly characteristic footwall rocks. Bottom hole rock temperature is 80.4°C. Temperature at the level of the ore horizon would be about 76°C. Geochemical analyses of core show anomalous concentrations of several indicator elements within the immediate ore hanging wall interval. What appears to be albitite near the base of middle Aldridge is silicified quartz arenite in which there is a small amount of fine tourmaline. Down hole UTEM was conducted in the hole and readings were obtained from loops in 4 different positions. Conductors were interpreted 150 m east and 10 metres west of the hole at the level of the fault. That on the east is inferred to be several kilometres across, that on the west is much smaller. Conductor thickness is <125 metres and conductivity is >40 Siemens. A computer depth image profiling (CDI) variation of UTEM surveying over a grid straddling DDH 6465 failed to see to Sullivan Horizon (2.5 km deep) because the upper middle Aldridge formation is less resistive than rocks below. Other geophysical work being contemplated is seismic work, and evaluation of new techniques capable of outlining sulphide bodies was started. Drill consultant W.B. Griffith prepared comments on the drill rig. J.B. Hancock outlined some thoughts on deep mining at high temperatures.

LOCATION

The Sullivan Mine is located near Kimberley in southeast B.C. Deep DDH 6465 site is 4 km NW of Sullivan mine.

TENURE

At time of writing, May 1998, Sullivan Property comprises 680 Crown granted mineral claims and 766 claim units held by assessment.

HISTORY

Sullivan was discovered in 1892. Ore was treated in smelters in Nelson and Trail from 1901 to 1903, then at a smelter in Marysville (5 miles from Kimberley). The mine and smelter were closed in 1907. In 1909 bond holders and creditors re-organized the mine ownership under the name Fort Steele Mining and Smelting Co., with control vested in the Federal Mining and Smelting Co., the predecessor of Asarco. In Dec 1909 CM&S took a lease and bond on Federal's holdings. In late 1910 CM&S took control of Sullivan by exercising their options on those holdings and those of some of the other share holders. At about the same time other critical claims were acquired. In 1914 Sullivan became the largest lead producer in Canada. Full-scale milling commenced in 1923.

RESULTS - GEOLOGY

Sullivan is offset on the 55° north-dipping Kimberley normal fault (Fig 1). It had been determined following drilling deep DDH 6464 in 1988 that net horizontal offset of the deposit was less than 4300 m NW, with a left lateral component of offset of less than 3000 m and vertical component of about 1900 m.

DDH 6465 was collared in 1991 with the same Longyear 55 that drilled DDH 6464 and drilled to 598 feet. Funding to continue the hole was not available until 1995 and by that time the contractor, Connors, had sold the rig. It was decided with Connors to proceed using a Boyles 56 and the hole was advanced to 6352 feet when it was decided that the practical limit of the drill was close, and that another 1400 feet of strata remained to the target horizon. The core angle was close to 60° so a machine capable of drilling well beyond 8500 feet was needed. Connors could not obtain a machine anywhere so built one. One of the features of Kimberley area drilling is that deep holes like this must be collared at -68° west and most deep rigs are only able to collar holes vertically. The last stage in drilling began in August and ended in October 1996. The drill performed very well and only one significant problem turned up. Chrome on the 11 foot feed frame ram flaked off in places, however it was still usable for 4 feet which is how the last 600 feet were drilled. Bruce Griffith visited the rig and his report with photos is in Appendix 1. The rig stayed on site for down-hole geophysical surveying until early December 1996.

DDH 6465 (Fig. 2) was collared in the vicinity of the Shaft marker, the topmost marker unit in the middle Aldridge Fm. The first marker intersected was the "Shaft minus 90" (ie, 90 feet below Shaft). A normal progression of markers, strata and essentially conformable gabbro intrusions was cored. The Fringe marker (690' above Sullivan) is the only marker that was not recognized. A log of the hole is in Appendix 2.

Three major thrusts at 3639, near 4280 and at 4487 repeat the lower of two thick gabbros in the section. The third thrust at 4487 repeats only a portion of the gabbro in the hole. These faults merge to the west, and in DDH 6464, 1 km SW, only one fault is present. Where the fault projects in DDH 5489, 1 km SE, is only a 2000' overturned fold limb. In 1982, McClay (verbally) interpreted the overturn as a fault propagation fold cored by a blind thrust. The two subsequent deep holes confirm that structure. Another fold deeper in DDH 5489 indicates there may be another blind thrust below the other two holes.

From 7423 to 7823.6 is the U Quartzite interval, the basal portion of middle Aldridge. A number of small gabbro bodies intrude this interval. Below 7483 rocks have a pale brownish cream colour and are extremely hard indicating they may be altered to albitite. However thin section study and whole rock analysis show alteration and fragmentation expected of albitite is present, however Na_2O content is less than 4%, whereas over 8% is generally expected in albitite. Of importance is the presence of occasional 50 cm intervals where core is fractured on close-spaced wavy surfaces and <u>buttons</u> sometimes develop, a characteristic of high internal stress that might be of concern to mining at this depth.

SULLIVAN PROJECT

A <u>20 metre</u> thick carbonaceous wacke laminite marks the top of the lower Aldridge Fm over the area considered the second-order basin within the Aldridge – Prichard basin. The second order basin is recognized over an area of about 50 by 100 km. This lithotype is 20 metres thick west of Sullivan (the western facies).

The third-order basin, or eastern facies, consists of a <u>10 metre</u> thick unit of carbonaceous wacke laminite above Concentrator Hill Horizon (CHH), plus the <u>10 metre</u> thick CHH itself, and a few intervening turbiditic beds. The CHH is a greenish grey argillite with pyrrhotite lamellae and associated sphalerite. Grey carbonaceous laminations are present throughout the CHH, however they appear faint alongside the sulphides. The lower half of the regional expression of the carbonaceous wacke laminite combined with exhaled sulphides and phyllosilieates from Sullivan to form the CHH. Abundant sericite in CHH gives the rock its characteristic geeen colour.

At Sullivan is the Sullivan facies, developed in a fourth-order sub-basin. It is in the western part of the third-order basin and comprises the entire stratigraphic sequence from sedimentary fragmentals in the footwall to the base of middle Aldridge (Fig. 3). Within Sullivan facies a carbonaceous wacke laminite about 10 metres thick occurs below the U Quartzites. Also within Sullivan facies five exhalite type horizons resemble CHH (Footwall Slates, "D" to "I", I Lams, H Lams and HU Lams); these plus exhalite distal to the ore bands are inferred to coalesce as CHH. Additional components of the sub-basin include sedimentary fragmentals, debris flows, thickened turbidites, slump sheets and ore.

The Sullivan hanging wall stratigraphic interval was recognized from 7826 to a fault at 8096.0 (Fig. 4) as follows:

7826.0 – 7916.0 carbonaceous wacke laminite including some turbidites, it is intensely silicified and difficult to recognize. A number of turbiditic beds are present below it.

7916.0 – 7942.9 HU PYRRHOTITE LAMINATED ZONE - Wacke, silicified, laminated with very fine pyrrhotite. Gabbro 7928.8 – 7939.0.

7942.9 – 7954.6 Medium to thin bedded interval.

7954.6 – 7996.6 HU GRADED BED – thickened turbidite graded from fine sand at base.

7996.6 – 8023.4 Three graded beds in LITTLE HU stratigraphic position. Normally only one such bed is recognized at this level.

8023.4 – 8030.0 H PYRRHOTITE LAMINATED ZONE – thin and very thin bedded and one well-laminated unit with pyrrhotite.

8030.0 – 8034.0 H CONGLOMERATE – Extensive fragmental and layer of disturbance related to the post-ore extrusion of the Southwest Breccia (mud volcano).

8034.0 – 8048.8 H GRADED BED – thickened turbidite.

8048.8 – 8095.9 I PYRRHOTITE LAMINATED ZONE – Photos 1 – 5, Fig 4. Sets of identical matching pyrrhotite laminations extend over two km at Sullivan. No definite match was made with core from DDH 6465, however some possibilities were considered. At 8061.3 the lams become overturned in a fold and are faulted at 8095.9. This fault is named the Hope fault, after the claim on which it was recognized.

At 8061.3, where the fold becomes overturned, is the lowest point stratigraphically in the I Lams. In the Sullivan sequence at this level there is one thickened turbidite, about 30 feet thick, above the topmost of the ore bands, the D Band (Figures 3 and 4).

The fold above the Hope fault has the appearance of a Laramide, cleavage age structure. That is, it has the appearance of a hanging wall overturn, similar to ones that formed by folding during regional contraction. Offset on the fault is however normal, not reverse as is characteristic of Laramide structures. The Kimberley fault is anomalous this way as well. When regional factors are considered the logical conclusion is that the Hope fault originally had normal offset(s) before undergoing the contraction that produced the hanging wall fold. As with the Kimberley fault, contraction only partially reversed the offset. Periods of extension affected this area during Helikian (Purcell), Hadrynian (Windermere) and Paleozoic (Cambrian, and Devonian periods) eras. Extension during the Eocene epoch may also have contributed to this picture.

The Hope fault has an Intermediate dip and is inferred to be parallel to and north of northwest dipping (38 – 60°) Ryot type faults known underground west of the orebody in 42176 XCW. These faults project into the northward continuation of the deposit and would be expected to be present at its east side up to 1 km north of the Kimberley fault. Because Lois Creek marker to base of middle Aldridge interval is not greatly shortened in DDH 6465 (850 feet compared to 800 feet in DDH 6464 and 950 feet at Sullivan), it is unlikely other significant fault of this type are north of the Hope Fault.

Below the Hope fault are sedimentary rocks characteristic of Sullivan footwall. One 10 cm zone of tourmalinite and two smaller, other possible tourmalinite occurrences, were noted. Strata over much of the interval are deformed, some tectonically, however syn-sedimentary deformation related to fragmental development is suspected.

From 8209 to 8557 gabbro and granofels were cored. These rocks are clearly the continuation of the gabbro arch north of the Kimberley fault.

A refined calculation of offset on the Kimberley fault is based on:

- presence of Sullivan mine stratigraphic sequence in DDH 6465,
- at least 100 feet of sediment above the footwall intrusion and intensely siliceous hanging wall alteration resembling albitite both indicate DDH 6465 could be about one quarter the distance across the deposit from the western side.

Net slip on Kimberley fault is about 4200 m toward azimuth 303°. The horizontal component is 3500 m, vertical 2300 m, and horizontal left lateral offset is 3000 m.

RESULTS – GEOCHEMISTRY

ICP, Hg by flameless AA and whole-rock analyses were done on samples collected, on average, at 80 foot intervals. The data are tabulated in Appendix 3. There are no plots however the positions of markers, gabbros and thrusts are indicated graphically in the table. Data for the I Lams represent continuous samples, the last ending at 8061.8.

Statistical parameters are shown at the bottom of each column. Comments by selected individual element or oxide follow:

Cu – Anomalous to elevated Cu is found in middle Aldridge gabbros but not in the footwall intrusion (only 2 samples there); Cu is somewhat elevated in uppermost lower Aldridge and in rare single samples elsewhere.

Pb and Zn –
- In gabbros Pb is particularly low, Zn is in some cases higher than adjacent rock, otherwise it is similar.
- In middle Aldridge sediments, Pb is anomalous near Meadowbrook (MD) and Moyie (MOY) markers, and at two points lower, two of these samples are elevated in Zn, no other elevated Zn. There is certainly no indication of a major basin metal event in these numbers.
- In lower Aldridge sediments only the I Lams are anomalous.

As – Values for As seem noisy and slightly higher values sometimes tend to cluster. The only place where one elevated and two anomalous values cluster is low in I Lams.

Co and Ni – Co is elevated in middle Aldridge gabbros, but not in the two samples from the footwall intrusion. Values seem a little higher in middle Aldridge sediments. Ni in gabbro below MD is similar to adjacent sediments. In the 3 repeats of the gabbro Ni is distinctly higher than in adjacent sediments; in the footwall intrusion Ni values are low. In general Ni values decrease down-hole.

Fe, Fe_2O_3 - Gabbros are much higher in Fe than adjacent sediments, reflecting ferromagnesian minerals present. Fe content of sediments generally is lower deeper in the Middle Aldridge, reflecting the dominance of quartzitic rocks at those levels as opposed to wacke and argillite that commonly have laminated and disseminated pyrrhotite at higher stratigraphic levels and in lower Aldridge strata.

Cr – The upper gabbro and the I Lams are especially low in Cr.

V – Gabbros have significantly higher V than the sediments, and the upper gabbro has significantly higher values than the other gabbros.

Sr – Gabbros have significantly higher Sr than the sedimentary rocks, however there are occasional single point highs in the sediments.

Mn – Upper gabbro has distinctly higher Mn than adjacent sediments. Faulted gabbro and the footwall intrusion has slightly higher Mn than nearby sediments. In the sediments are clusters of elevated Mn with values comparable to gabbro.

MnO – Upper gabbro MnO values are barely higher than adjacent sediments. Faulted gabbro and footwall intrusion MnO is several times higher than in nearby sediments.

Hg – The I Lams are anomalous in Hg. Only one other sample, well up in middle Aldridge, was above the 10 ppb detection limit.

There are no anomalies in the geochemistry of rocks above the I Laminations that stand out as obvious indicators of Sullivan and its faulted continuation below. Hg certainly is not taken up in solid rock, which the samples were all from, however it is possible that Hg could ltave dispersed along faults and fractures. It may be possible to discriminate between certain gabbros using vanadium. The inconsistent Mn vs MnO behavior may be attributed to analytical procedures because the analyses were done in two different jobs.

The I Laminations have anomalous Pb and Zn and to a lesser extent other elements may be elevated. Clearly Pb and Zn are the best indicators to use in the search of these metals. Alteration halos, discriminants and factor analysis have all been tried, they are very costly, time consumptive, a major diversion and results are at best equivocal.

RESULTS - GEOPHYSICS

Following completion of coring DDH 6465, a down-hole UTEM survey and a surface Conductivlty Depth Image Profiling (CDI) survey were completed. Off hole conductors, ± 20 m north westerly and ± 150 m easterly were recognized adjacent to the Hope Fault. Low resistivities associated with strata higher in middle Aldridge than normally explored using UTEM prevented any response from projected target depths. Background velocity/ density characteristics of Sullivan ore and Aldridge sedimentary and intrusive rocks were obtained to evaluate using seismic techniques to detect sulphide bodies. More details on these studies are in a report by Jules Lajoie in Appendix 4.

DEEP MINING EVALUATION

Relative to mining experience at Sullivan, new factors that are likely affect economics of mining the faulted continuation of Sullivan at a 2.5 km depth include the great depth, rock temperature and potential for rock bursts. Rock temperature is 76°C at the depth where sulphides are projected. The highest temperature, fairly deep, sulphide mining I am aware of is at Mt. Isa. There virgin rock temperatures are 60°C at a depth of 1800 m. In DDH 6465 the U Quartzites are silicified quartz arenites and some intervals develop buttons and close-spaced wavy fractures that indicate release of internal stresses. A memo by Barrie Hancock on aspects of deep mining is in Appendix 5.

EXPENDITURE SUMMARY

Drilling DDH 6465 – 6352' to 8557' only drilled in 1966		400,413	
Geophysics	DH UTEM, CDI survey, LC, Seismic study	96,768	
Analytical work		5,980	
Salaries	supervision	11,706	119612 'Other'
	Geology	113,632	
Tenure – staking		17,612	
Miscellaneous	Expense Accounts, office, transp.	15,823	
Admin		46,746	
Govt Grant re drilling of 6465 in 1995.		(40,290)	
		668,390	

(Note, 1996 drilling on Stemwinder of $87,126 is not in this total.)

CONCLUSIONS AND RECOMMENDATIONS

DDH 6465 intersected the unique hanging wall strata found above the east and north bedded ore at Sullivan. Only 30 feet above where the top-most ore band is projected the hole penetrated the Hope normal fault and passed into footwall rocks. Down hole UTEM identified two significant conductors adjacent to the hole at the level of the Hope fault, that on the east is the largest and is kilometres in area, less than 125 m thick and has a conductivity > 40 siemens. There is little doubt that the conductors represent the faulted continuation of Sullivan. That the sulphide mass may be enlarged above another vent is possible, however it is clear from the detailed stratigraphy that sulphides indicated by the conductor are in same 4th order sub-basin as Sullivan. Theoretically it should be possible to wedge from DDH 6465 to test the east and western conductive areas. The west conductor is likely thin, fringe mineralization, and the wedge would have to be set in U Quartzites, a technical risk where coring the wedge rather than adjacent rock is almost certain. The east conductor is so far from the hole that a continuous series of wedges would have to start between 4000 and 5000 feet, an expensive proposition that makes a hole from surface, a reasonable alternative. It is recommended that another hole be collared 800 metres east of DDH 6465, to test the large east conductive area.

Signed :________________________

P.W. Ransom, Project Geologist
June 1998

Copies:

Cranbrook
Vancouver UK
Admin

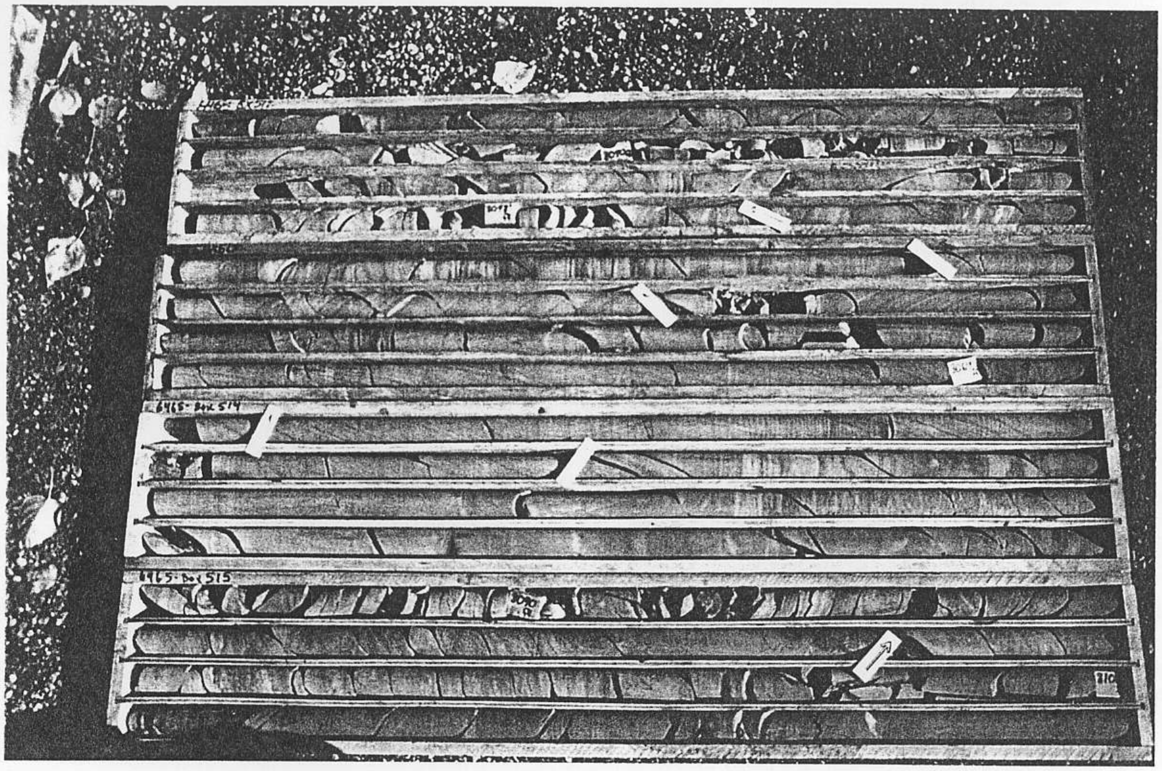


Photo 1. DDH 6465 I Laminated Zone. From 8050 to 8064 tops face up, from 8064 to 8095.5 tops face down, as indicated by the arrows. Thick black, red and thin black arrows are at matching laminations.

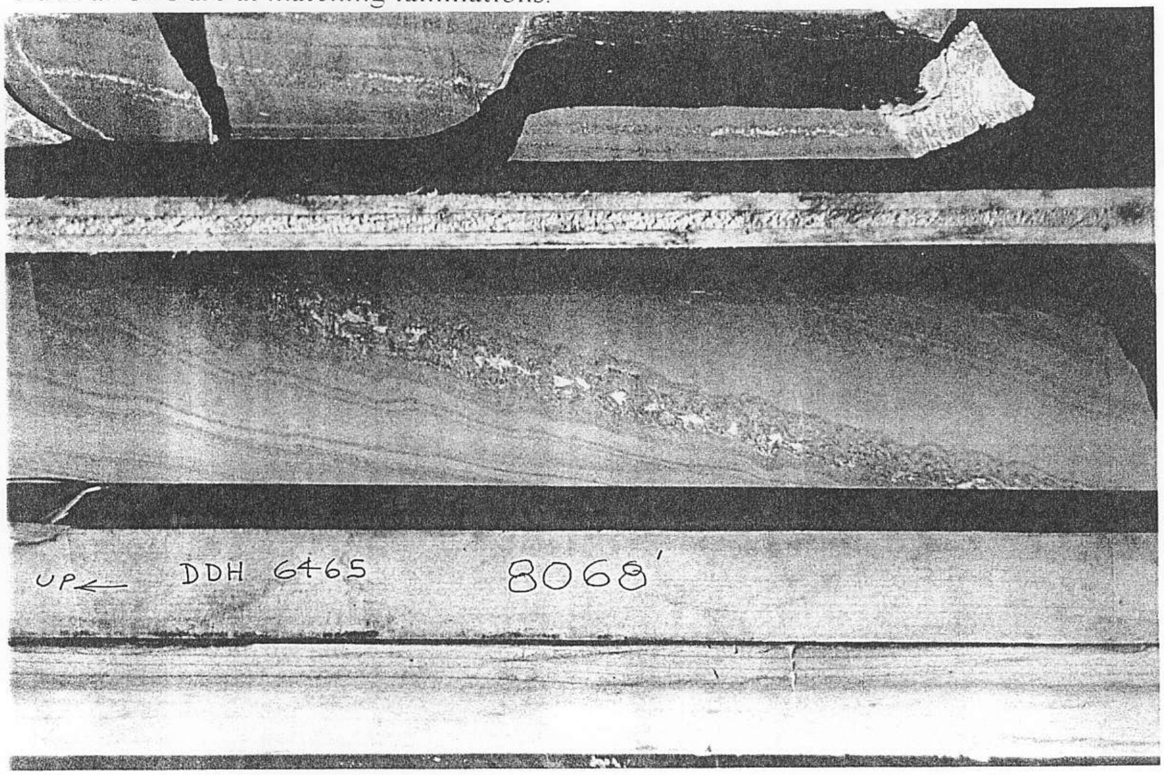
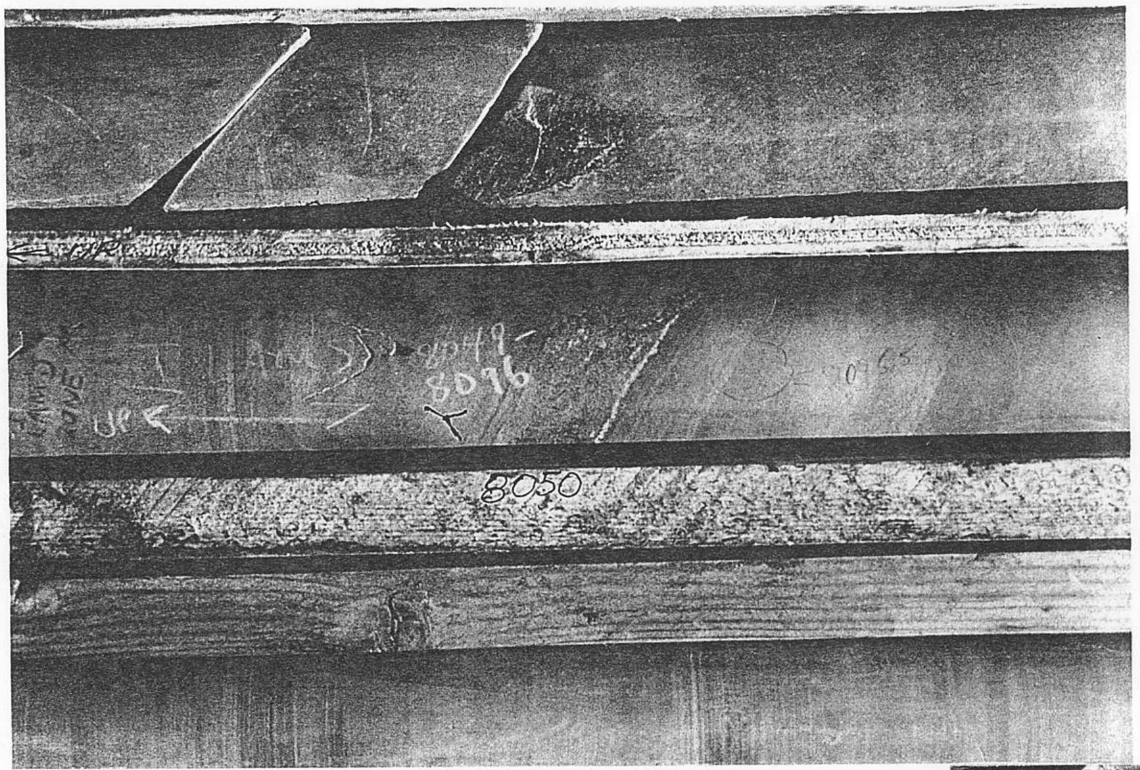
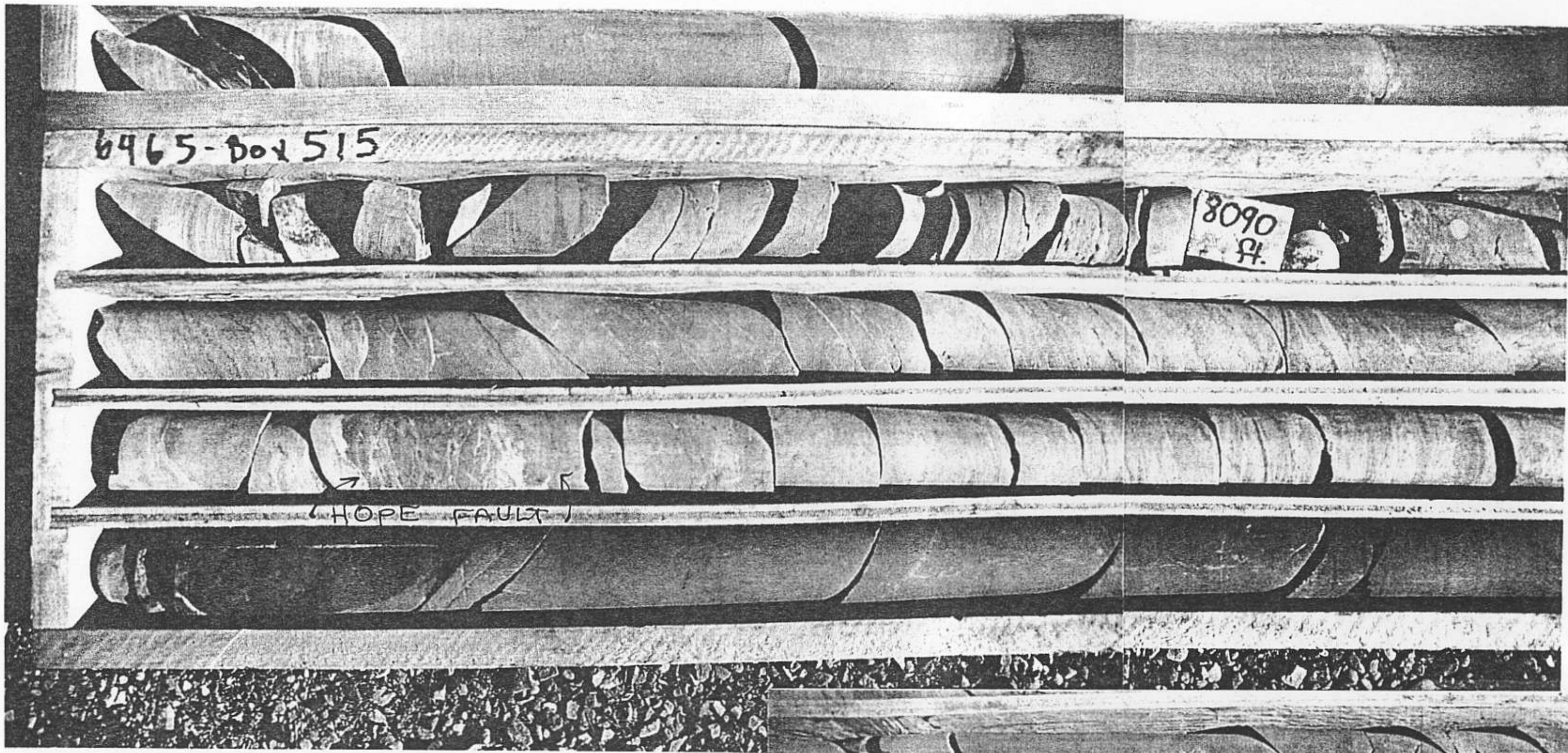


Photo 2. DDH 6465 I Laminated Zone. Distinct, very fine, dark grey carbonaceous laminations, some with pyrrhotite and coarse calcite, in light greenish grey argillite.



Photos 3 and 4. DDH 6465 I Laminated Zone. Two cm pyrrhotite band at 8050 (Photo 3) is repeated and overturned by folding (Photo 4.).



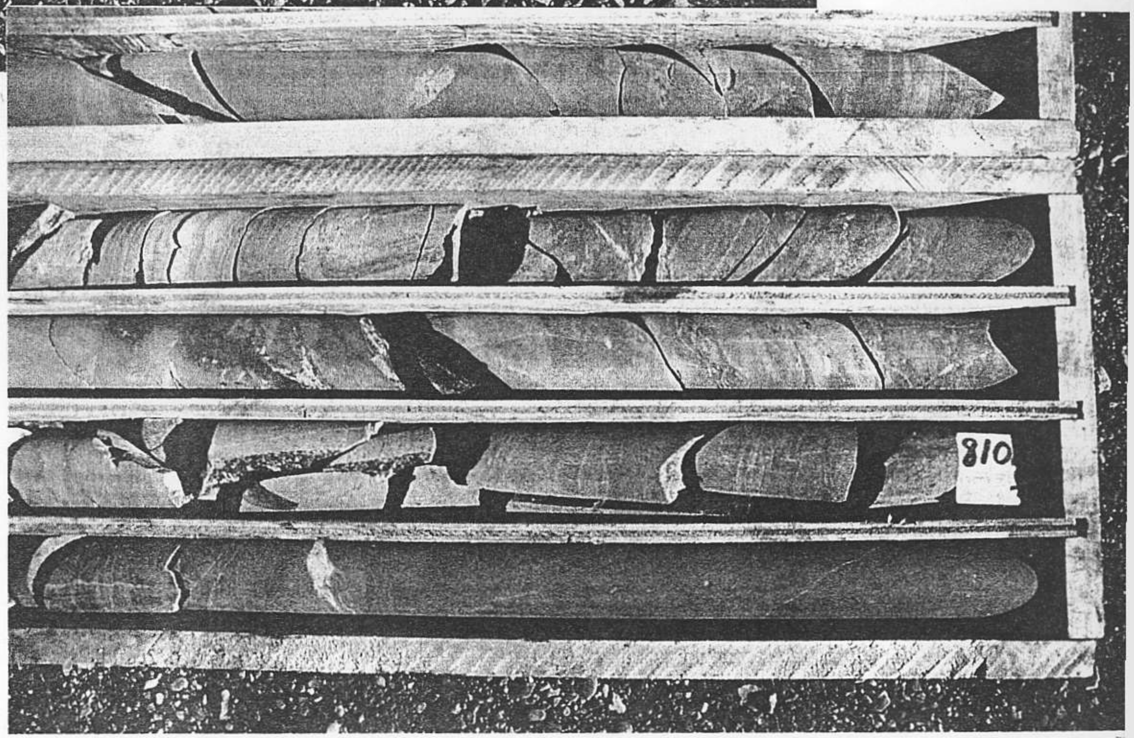


Photo 5. DDH 6465 Overturned top of I Laminated Zone 8095.5, Hope fault 8097.5 to 8098, lower Aldridge strata below.

APPENDIX 2

DEEP HOLE NORTH OF THE KIMBERLEY FAULT

DDH 6465 LOG

APPENDIX 1

DEEP HOLE NORTH OF THE KIMBERLEY FAULT

DRILL REPORT CONSULTANT

BY: W. B. GRIFFITH

W. Bruce Griffith

Cominco Ltd.
1051 Industrial Road #2
Cranbrook, BC V1C 4K7

September 30, 1996

Attention: Paul Ransom,
Kootenay Exploration

Dear Paul,

In the following pages I will endeavour to outline the main features of Connor's (New) H.H. 60 Diamond Drill and explain why I like it so much.

I am at a loss as to where to start. I would like to start with the most outstanding feature, however there are so many that I will start with the Power Unit.

1) The H.H. 60 drill is powered with a 275 H.P. 6 cylinder John Deere Industrial Diesel Motor.

2) The power is transferred through an all-hydraulic pump and motor system to the different components of the drill. The power for the water pressure pump is supplied by an independent 2 cylinder Lister Diesel Engine.

3) Drill and Tower: These are mounted on a steel base and are capable of drilling angle holes from -45 degrees to 90 degrees. The feed has a 11 foot stroke. The feed slide and rod hoisting slide are perfectly aligned and cannot go out of line when the angle of the hole being drilled is changed. The tower is capable of pulling a forty foot stand with a good safe rod rack, and helpers' platform, plus a good steel ladder. The tower is supported by four support legs and tied down with four guide cables.

4) Control Panel: The control panel is located on the left side of the drill and to the rear of the hydraulic oil reservoir. All handles and dials are easily seen and reached by the operator. With the electric over hydraulic control system, all phases of drilling operation are extremely smooth and efficient.

5) Drill Rotation Speed: The unit has a top rotation speed of 1100 R.P.M.. When I visited the site on September 1st and 2nd, the hole was 7400 feet in depth and they were rotating at 870 R.P.M..

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W. Bruce Griffith

6) Production: The drill had been in operation for two weeks when I visited and they had averaged approximately 100 feet per day. I would expect this to improve when the crew becomes more familiar with the rig, providing the ground remains the same.

7) Hoisting the Core Tube: The wireline hoist is fast and smooth and is equipped with a good manual operated cable guide which works well. At a depth of 7400 feet, it took 30-35 minutes for a complete trip up and down with the core tube.

8) Main Hoist: This hoist is well aligned with the tower and sheeve wheel and is powered with twin hydraulic motors which supply ample power for hoisting up to 10,000 feet of N.Q. or 76 M.M. drill rods. Recently they pulled 7500 feet of rods in 6 hours.

In closing this may not be the best core drill in the world; however, it is certainly the best one I have ever seen.

It is designed to drill holes to depth 0 - 10,000 feet in N.Q. of 76MM size, and is ideal for any hole from three thousand feet to ten thousand in depth.

If H.Q. size hole is preferred I would estimate it could handle holes from five to seven thousand feet without problems except for rod strength.

Thank you very much for giving me the opportunity to visit and see this rig operate.

Yours truly,

W. Bruce Griffith

P.S. I am sure R.W. Thompson would like a copy of this report.

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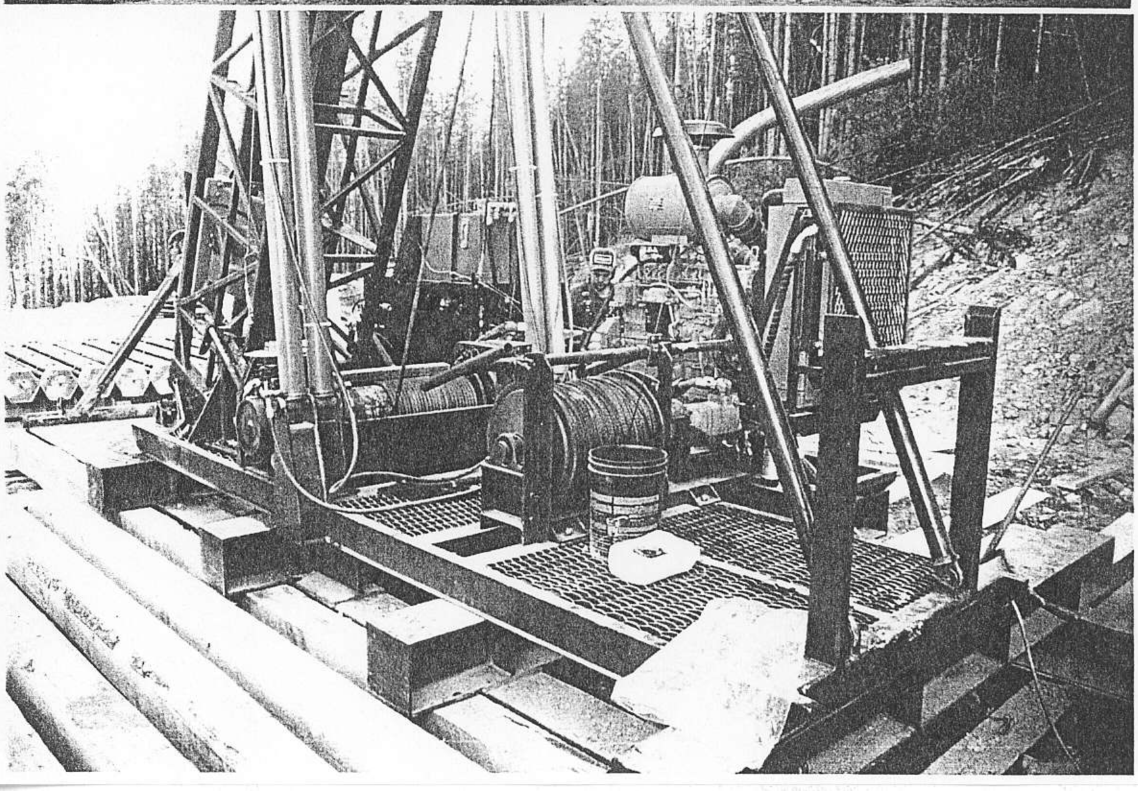
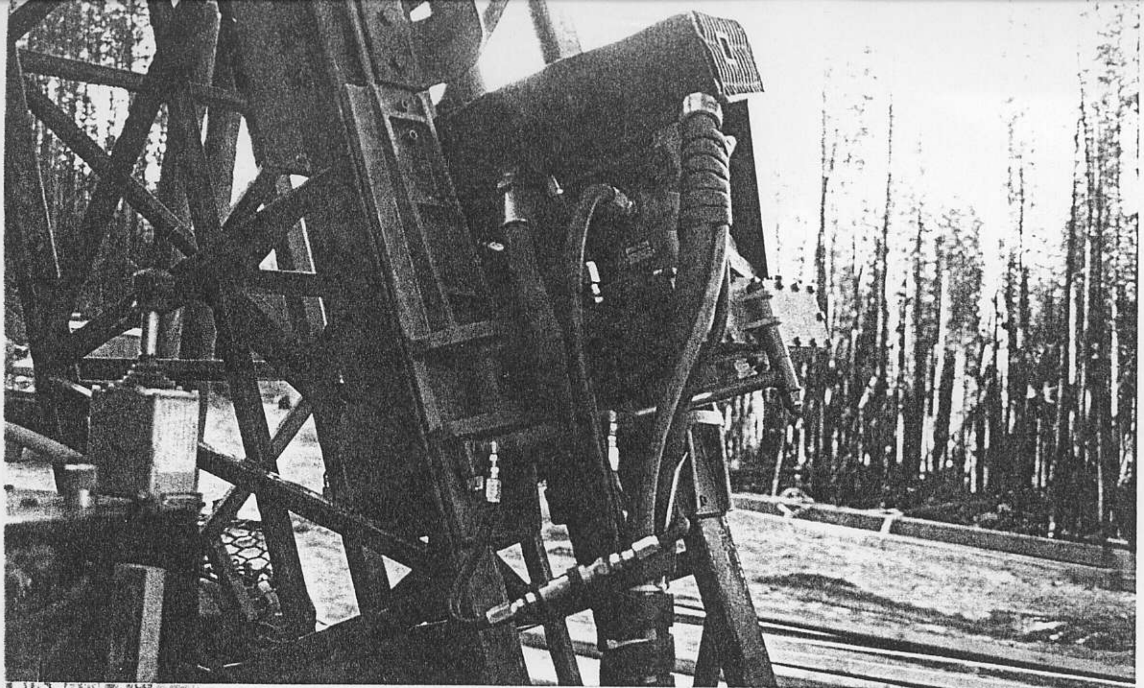
1. General View of drill site with Tower in raised position.

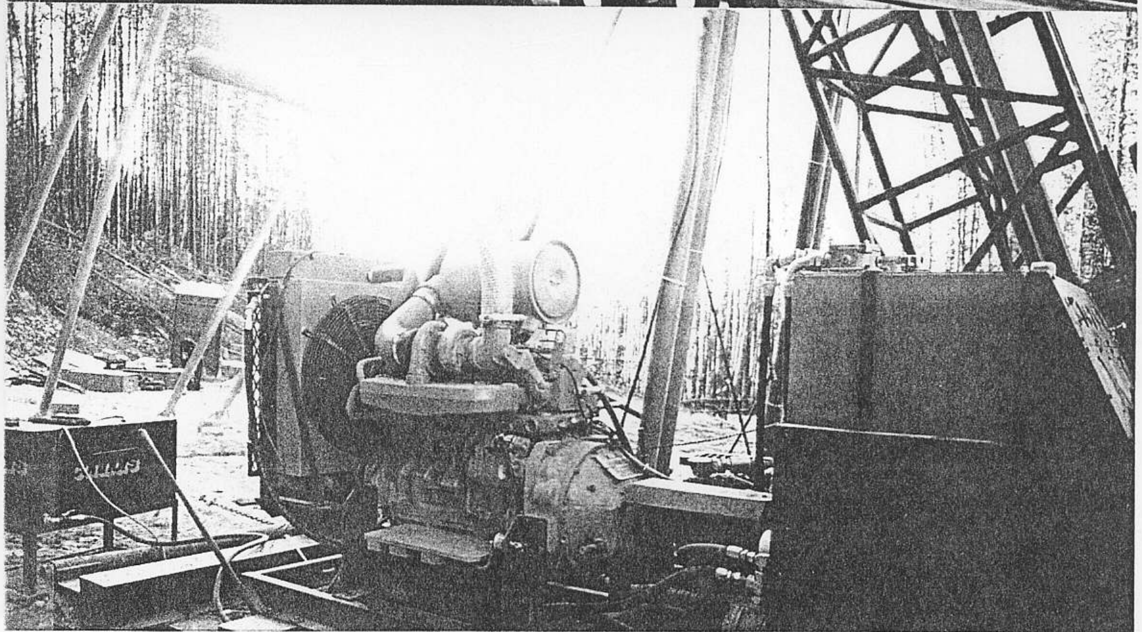
2. Closer view of drill. Rod storage visible on left.



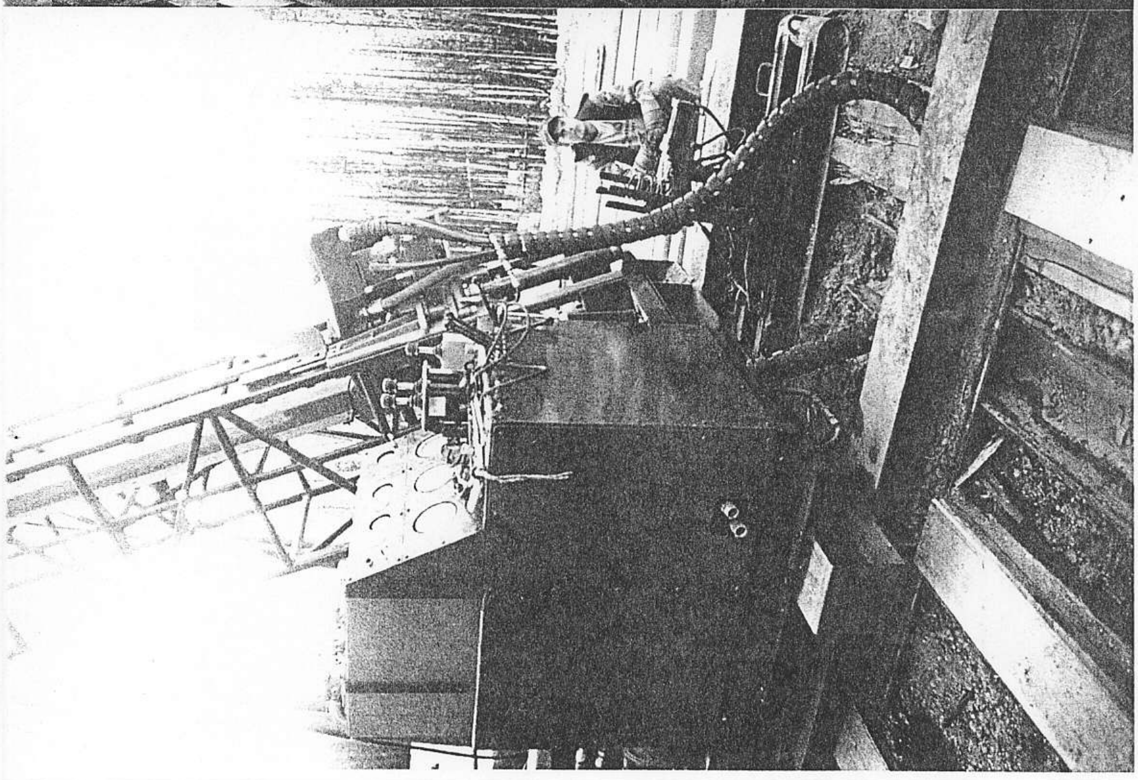
3. Drill base, Main hoist
Wireline hoist
Power Unit
Bottom Section of Tower.



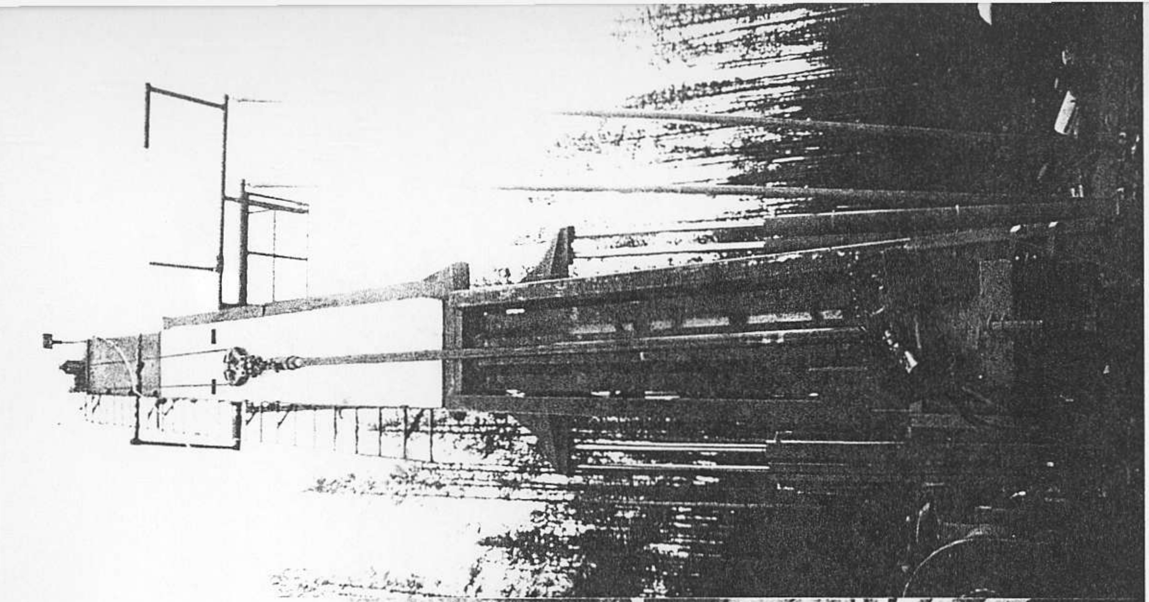
4. Drill Head
c/w Hydraulic Motor
Lower section of Tower.



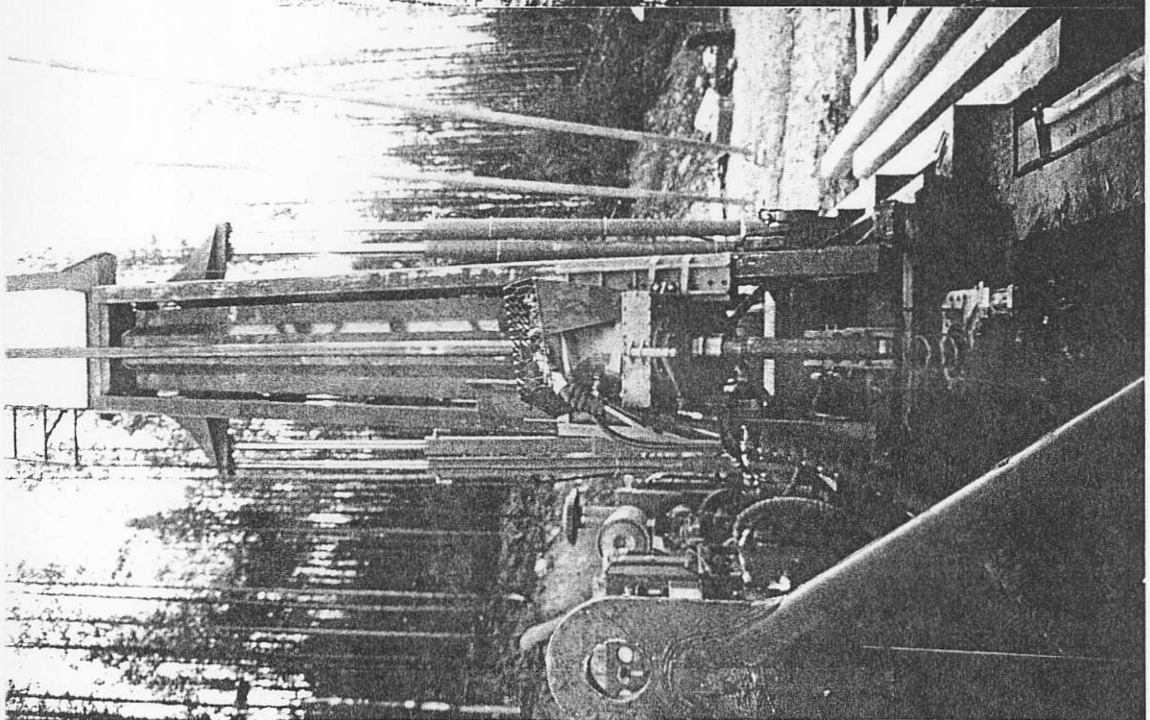
5. Power Unit275 H.P.
John Deere Diesel
Hydraulic oil reservoir
on right.



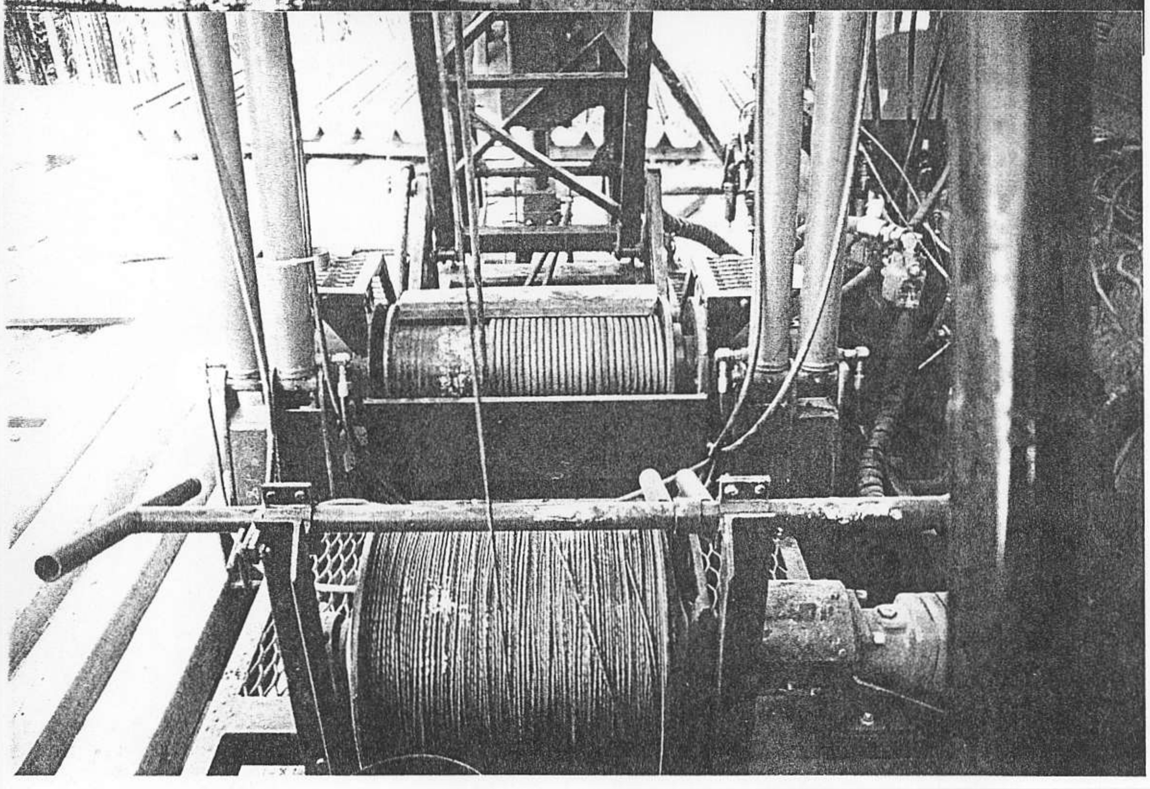
6. Hydraulic oil reservo
c/w hose coil leading t
drill head.



7. Tower with drill rod ir partly pulled position. Rod rack and helpe platform. Ladder on left

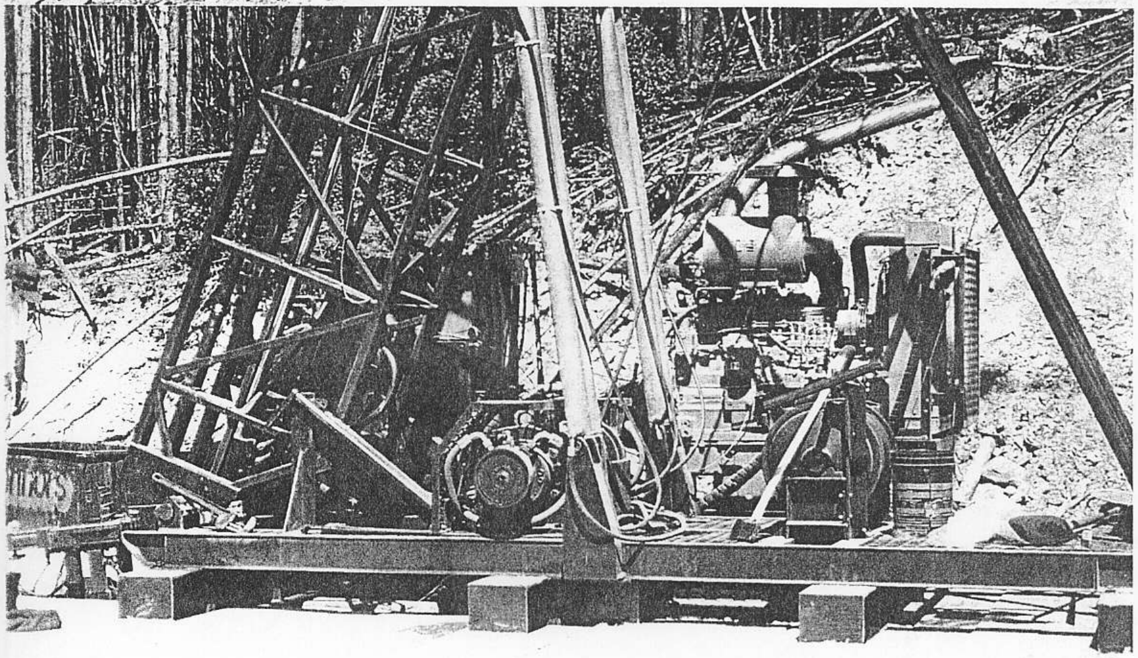


8. Lower section of towe drill head, feed slide ar 11 fast feed cylinder.

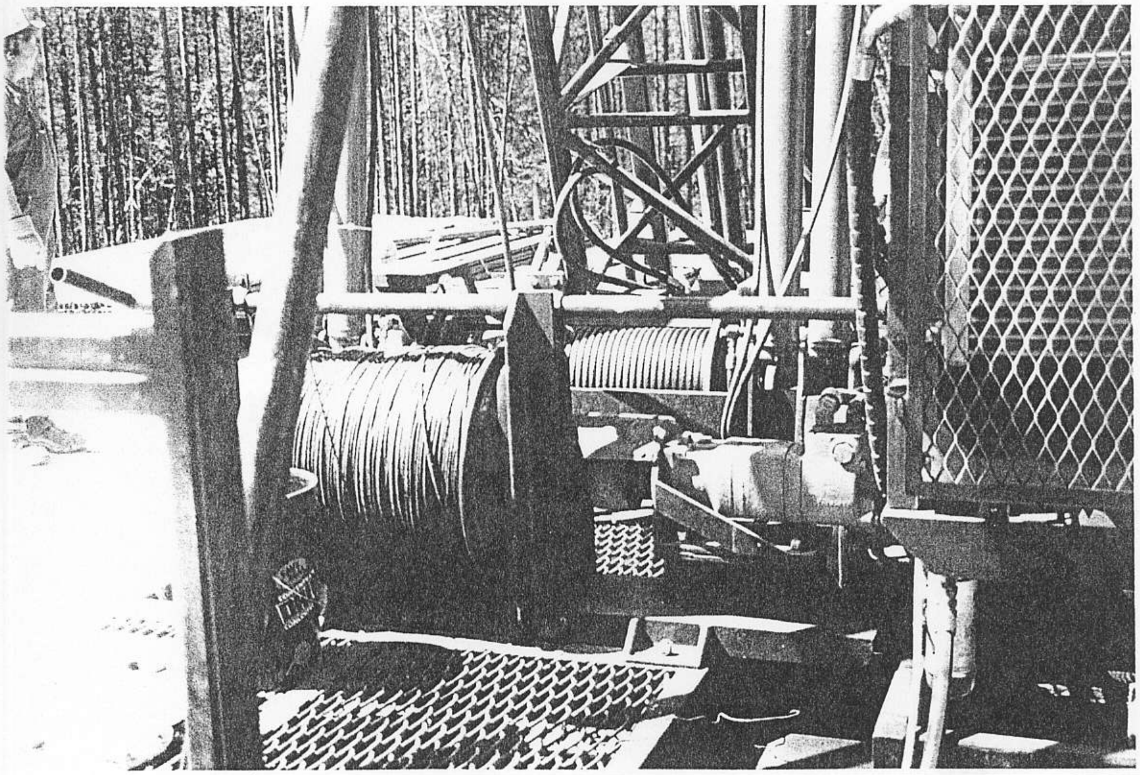


9. Main Hoist i background. Wireline Hoist i foreground.

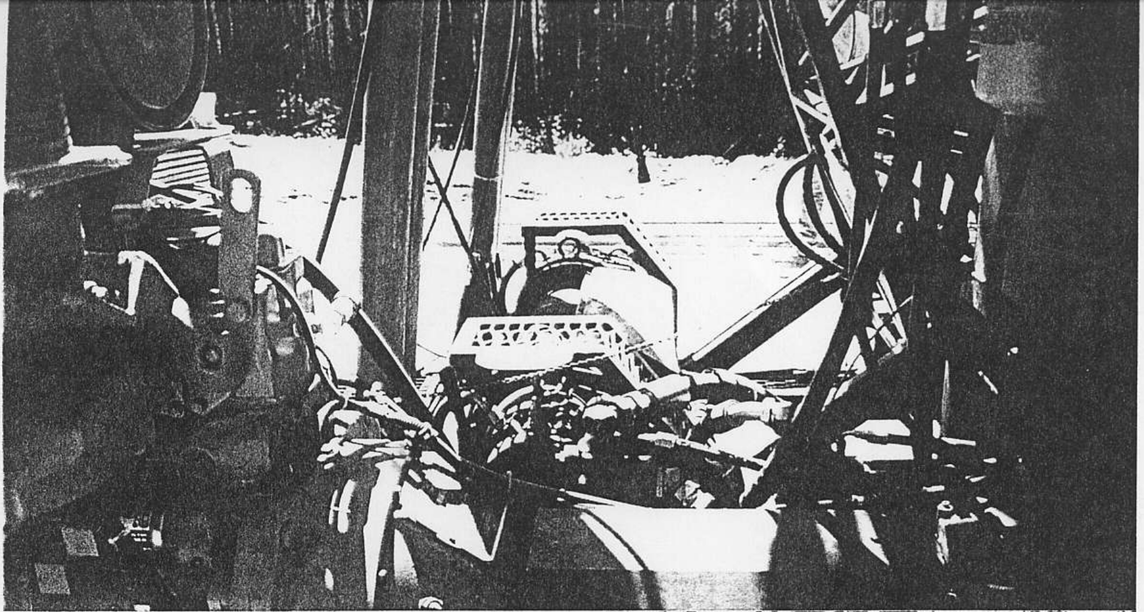
10. Tower raised support leg and guide cables in place.



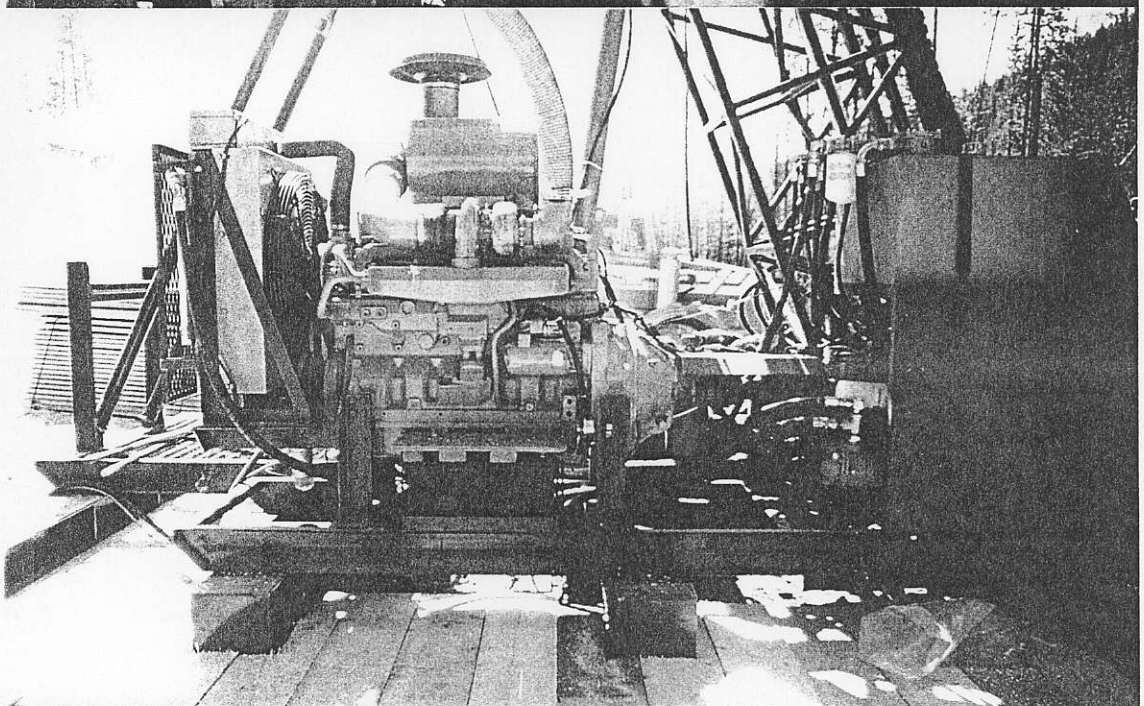
11. Left side view of Base, lower Tower, both Hoists, Power Unit.



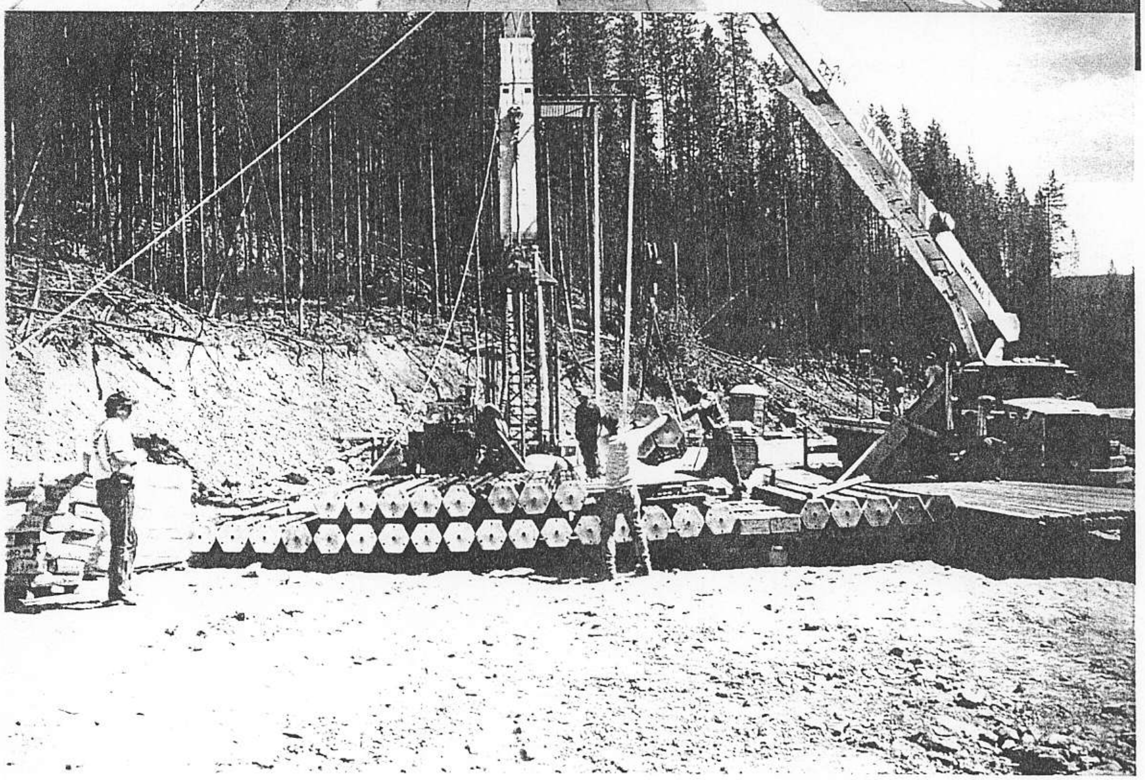
12. Angle view of botl Hoist Radiator Grill an Hydraulic oil cooler o right.



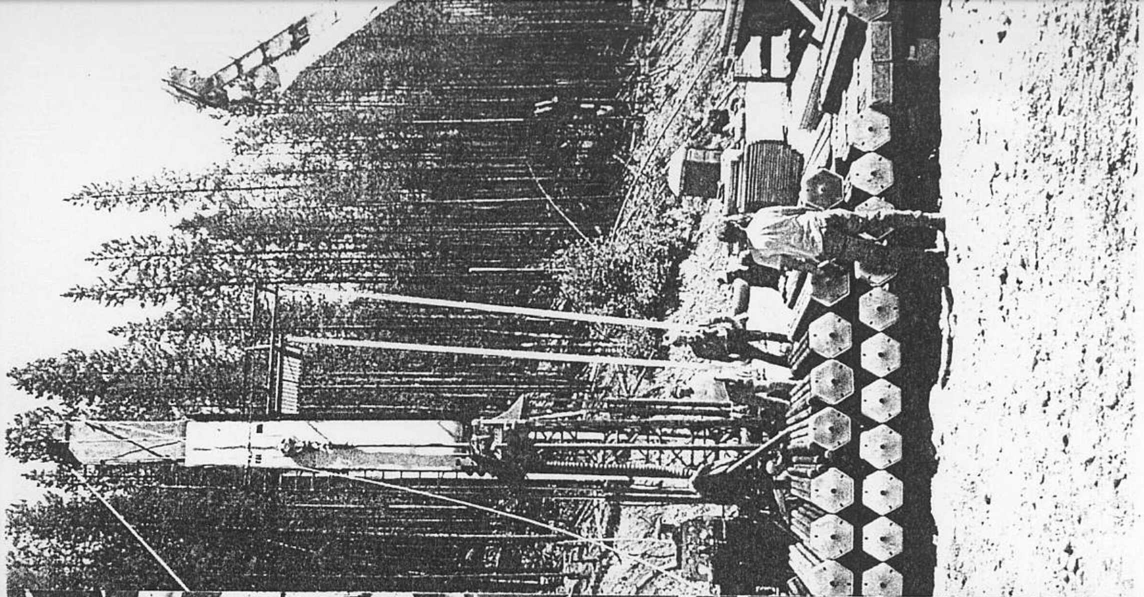
13. Foreground main Hydraulic pumps, rear end of power unit.



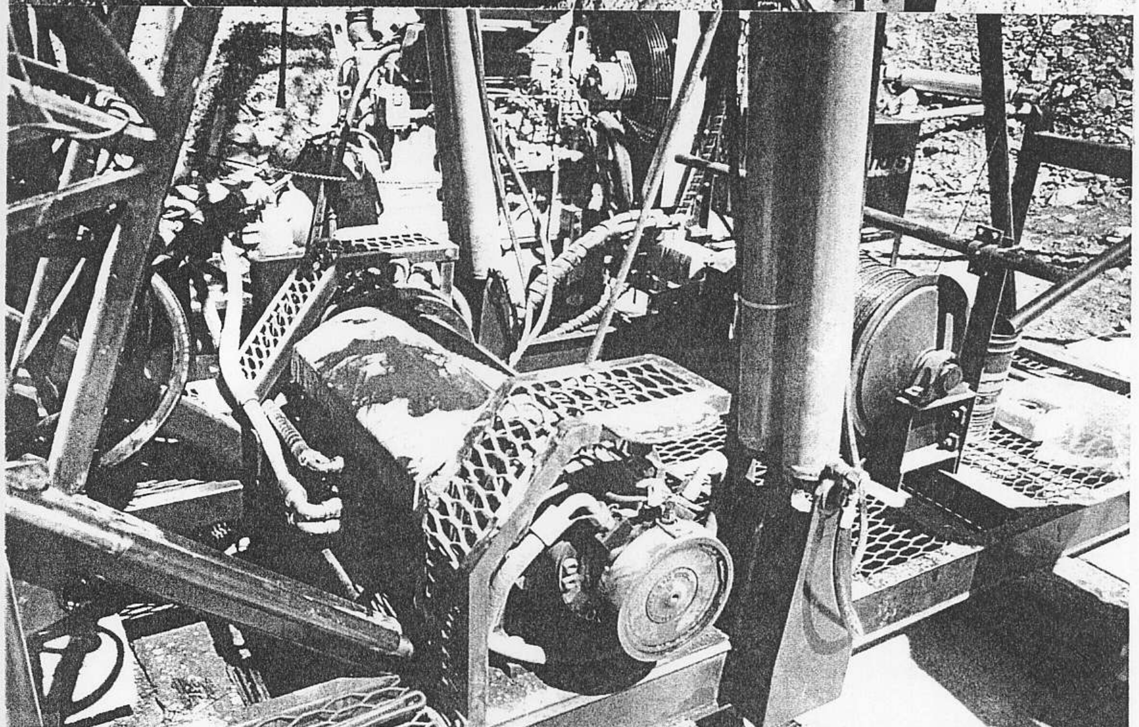
14. Closer view of Pow Unit.



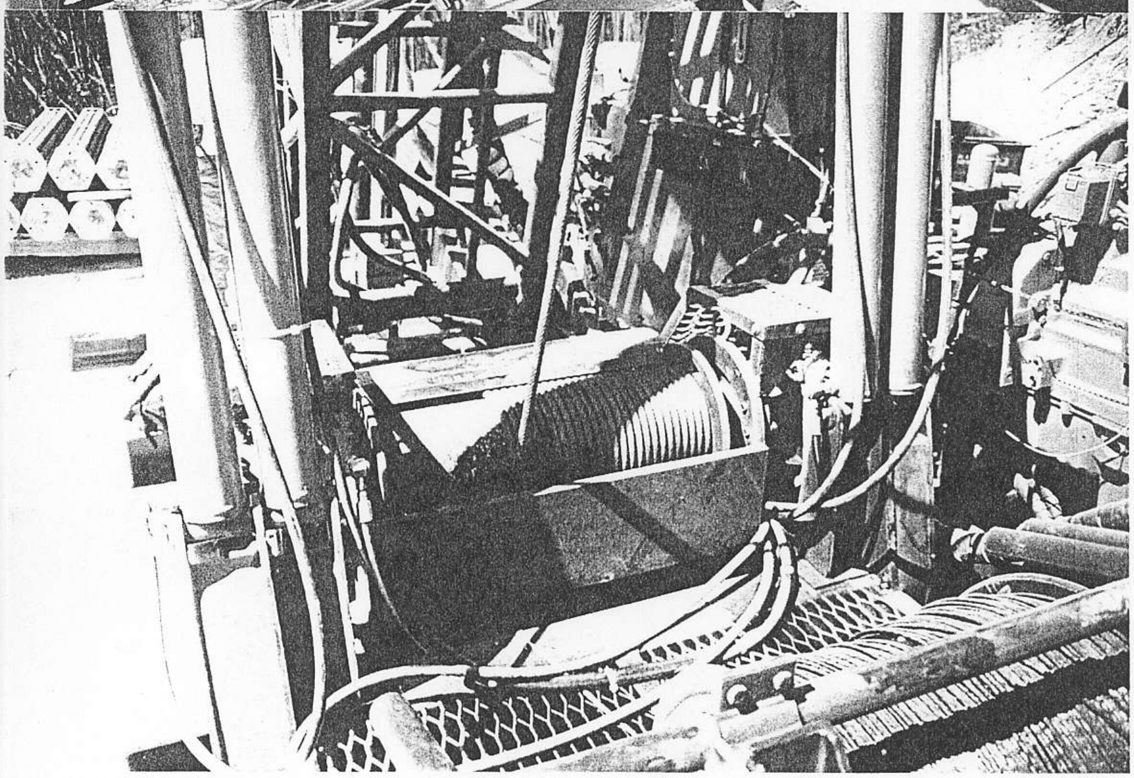
15. Drill Rod supply i foreground. Lowe section of drill with hea in raised position.



16. Drill rod storage i foreground. Drill witl head in raised 11 foo feed position.

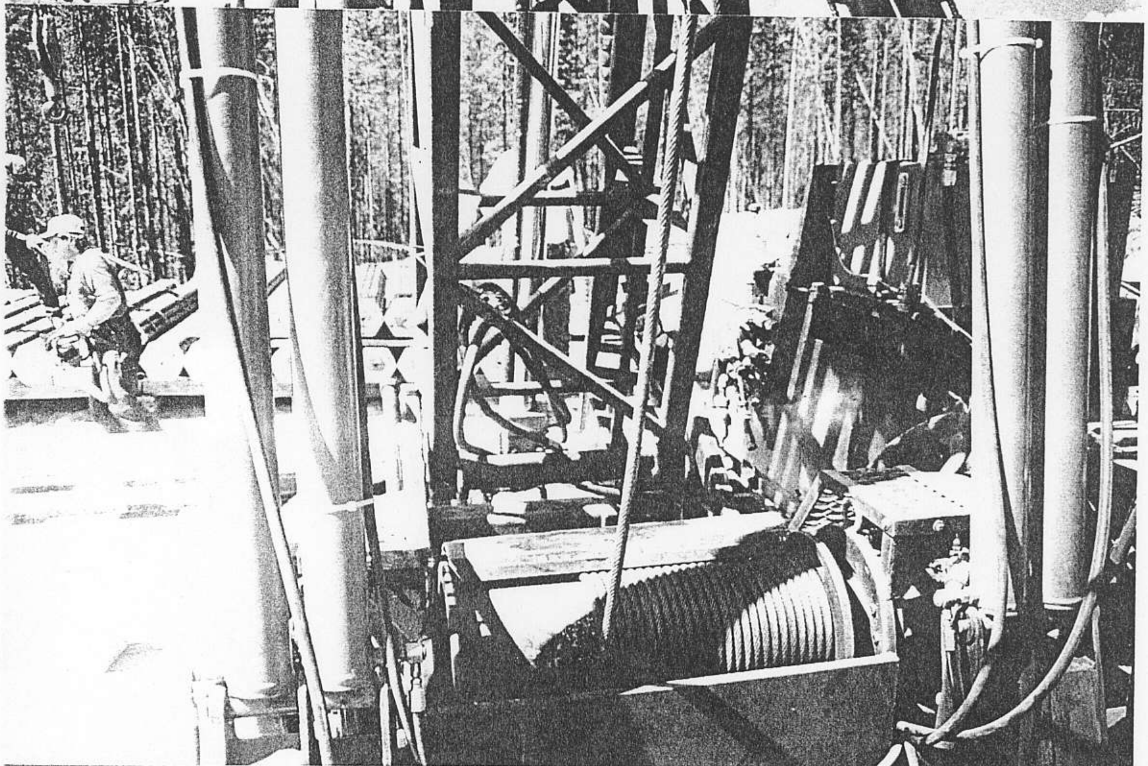


17. Left side view of hoists showing one of twir drive hydraulic motors on main hoist.

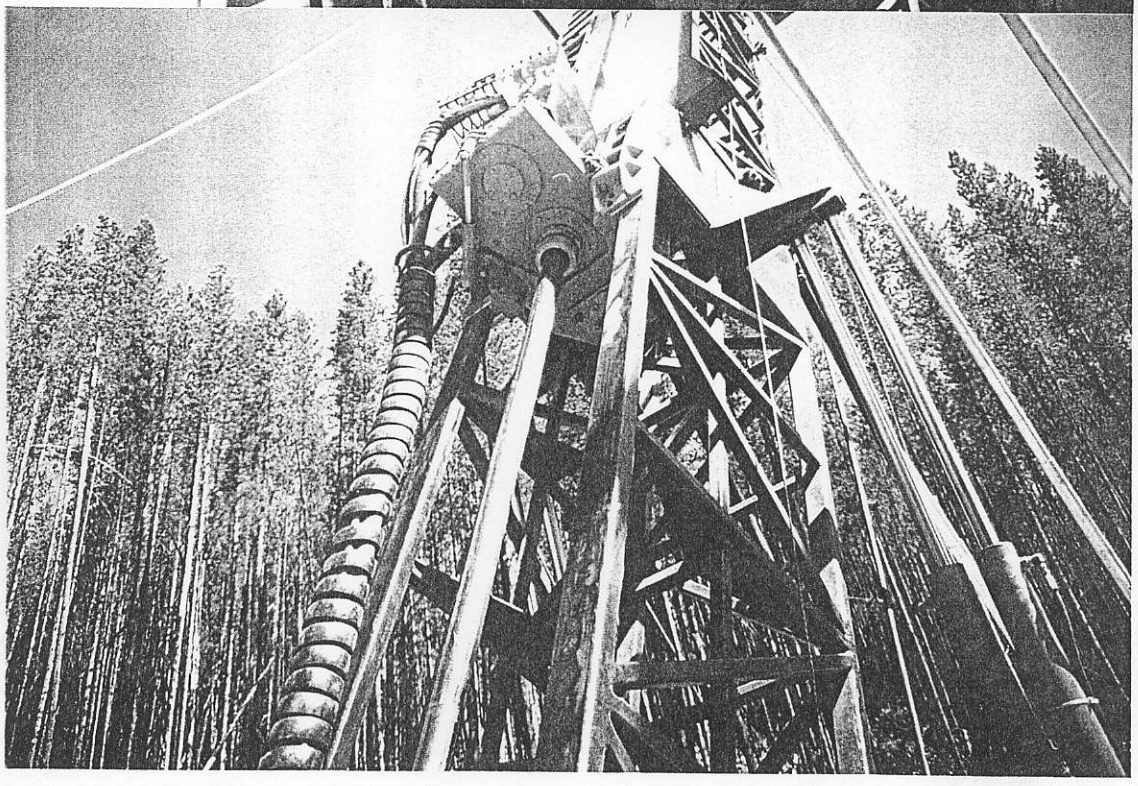


18. Front view of Mair Hoist.

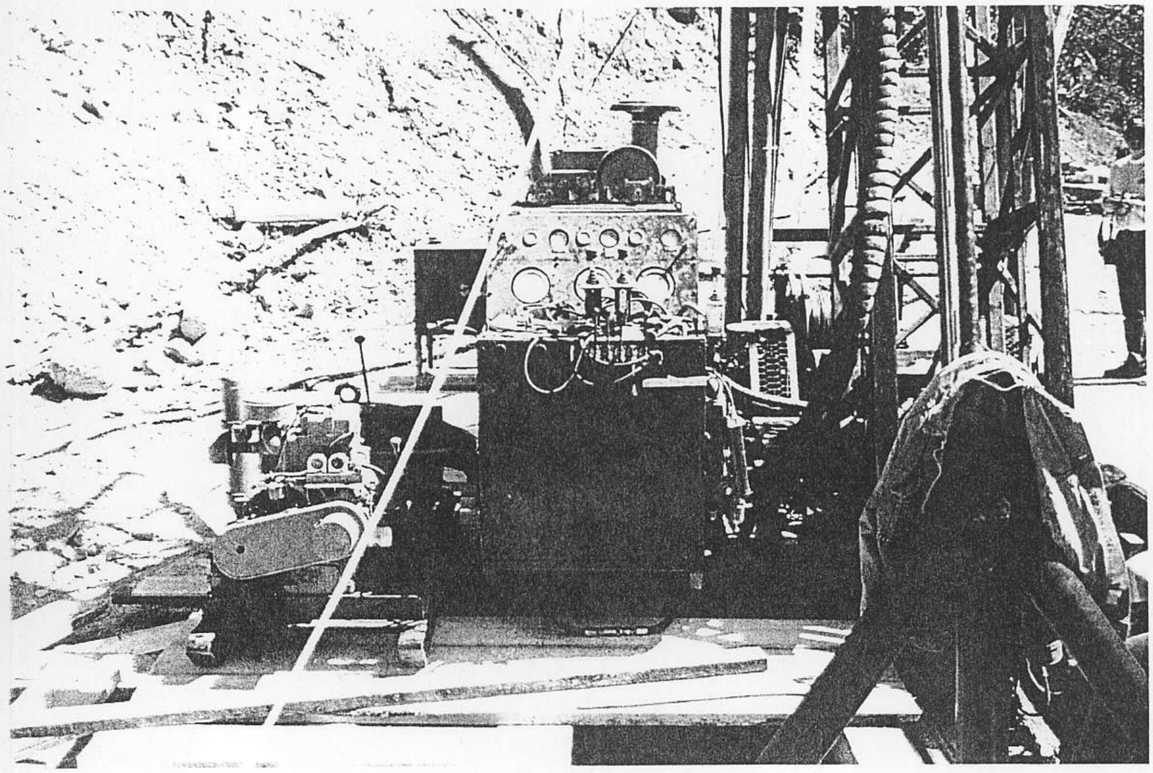
19. Lower section of tow
showing four raising an
lowering hydrauli
cylinders-upper portion



20. Lower section of tow
showing four raising an
lowering hydrauli
cylinders.



21. Lower section of tower
with drill head in raised
position.



22. Main drill Control Panel Center.
Water pressure pump on left.

23. Complete setup with drill shack, spare parts storage and tool shed in position.

From ft.	To ft.	Geology
6019.1	6047.3	WACKE, SUBWACKE ARGILLITE, MINOR QUARTZ WACKE Wacke, subwacke and argillite, minor quartz wacke, medium to thin bedded and laminated, a few thick beds. Contacts sharp and flat, a few rxlams and possible starved ripples noted. Silicification gives thick quartz wacke a marbled appearance. Bedding to core 62° at 6023.7', 86° at 6042.7', BCAD 66°, 50°, 180° at 6041.8' a few narrow seams parallel bedding of chlorite alteration.
6047.3	6066.4	QUARTZ ARENITE WITH MINOR QUARTZ WACKE AND WACKE, SUBWACKE AND ARGILLITE Quartz arenite with minor quartz wacke and wacke, subwacke and argillite. Quartz arenite is thick to very thick bedded, wavy contacts, coarse sand. Wecke, subwacke near start is thinly leminated with some rxlams highlighted by calcite and chlorite. Thickest bed is from 6052.3 to 6063.4. Bouma a and bed dominant, internal flame-like feature noted.
6066.4	6076.5	WACKE, SUBWACKE AND ARGILLITE Wacke, subwacke and argillite, thin bedded and laminated with a few medium and thick beds. Contacts sharp and flat. Ripple cross-laminations present in a couple of places, may be bouma ° without lower units, highlighted by siliceous alteration. 40 cm above base is 5 cm calcareous zone. Bedding to core 58° at 6068'.
6076.5	6112.3	WACKE, SUBWACKE ARGILLITE, QUARTZ WACKE AND QUARTZ ARENITE Wacke, subwacke and argillite, quartz wacke and quartz arenite. From very thick bedded to laminated, contacts sharp and flat. Thick beds are quartz wacke - quartz arenite, from 6082.4 to 6086.4 bouma bed base, 6086.4 to 6091.0 bouma bed base, 6091.0 to 6094.2, 6098.5 to 6101.5, 6102.4 to 6112.3 almost entire bed is bouma a, most have medium sand bases, all are graded. Pyrrhotite wisps and flecks is somw wacke portions of soma beds appear to be transported. Pyrrhotite also disd aleng a few laminations ih wacke, subwacke. Marbled caleite alteration over 40 cm at 6077.8.
6112.3	6212.0	WACKE, SUBWACKE AND ARGILLITE WITH QUARTZ WACKE AND RARE QUARTZ ARENITE Wacke, subwacke and argillite with quartz wacke and rere quartz arenite, thin bedded and laminated with medium and occasional thick beds, contacts sharp and flat. Ripple cross-lamination noted in some of the thicker beds and in some laminated units. Beds at 6125.4, 6198.2 and 6212.0 are only ones with sand grains. A few mm wide bedding parallel calcite - chlorite features have tension gash characterize. Argillite with discontinuous pyrrhotite laminations at 6113.9 (10 cm) and 6120.5 to 6121.5. Bedding to core 56° at 6118.8', 60° at 6143.4', 59° at 6156.6', 55° at 6165.7', 50° at 6143.4'. ✓ 6164.4 6309.4 H1 and H2 (HIAWATHA) markers. H1: first diagnostic match is 6164.0 (1878.9 to 78.95 m) H1/3 of v-78-1 standard. Bands likely at top of H1 at 6159.5 (1877.4 m). From 6182.5 to 6183.66 (1884.42 to 84.78 m) segments match H1/13 (std. With incorrect up arrow). Excellent but unmatched 6228.5 to 6229.3 (1898.45 to 1898.70 m), fair 6288.7 to 6289.0 (1916.8 to 1916.9 m), 6289.6 6289.8 (1917.06 to 1917.13 m) probable match to H1/22-23. H2 : from 6228.3 to 6228.90 (1898.4 to 1898.57) ia good match to H2 in ddh 6434 at 2864, so there is overlap of H1 and H2. From 6288.4 to 6288.7 (1916.7 to 1916.8 m) is good match to H2 in 6414 at 125.5 (h1/22-23? is just below). Last bit of marker type laminations at 6292.7 (1918.0 to 1918.02 m) and two poor laminites 5 and 8 cm between 6308.1 and 6309.7 (1922.7 and 1923.2 m). Several other marker type laminations segments throughout this interval. 6308.2 (1922.75 to 1922.8 m) fair match to bese of Hiawatha2 and twe short faint marker type laminations segments between 6308.7 to 6309.6 (1922.9 to 1923.17.
6212.0	6226.8	QUARTZ WACKE Quartz wacke verging on quartz arenite, single bed, contact sharp and flat. Is quartz wacke below 6214.0, fairly homogeneous, some bouma bed laminations over less than 10 cm just above base.
6226.8	6264.5	QUARTZ WACKE WACKE, SOME QUARTZ ARENITE AND WACKE, SUBWACKE AND ARGILLITE Quartz wacke, wacke, some quartz arenite and wacke, subwacke and argillite, thiok bedded with a few thin beds and rare laminations. Contacts sharp to flat and wavy. Beds graded, general homogeneous probably bouma a for 80% of most beds, a few thin intervals of ripple cross-lamination noted. Bedding to core 60° at 6227.1', 65° at 6251.7'.
6264.5	6287.4	WACKE, SUBWACKE AND ARGILLITE Wacke, subwacke and argillite, thin to medium bedded and laminated, contacts sharp and flat, rare cm scale beds of quartz wacke fine sand. Convoluted bedding involving some sand at 6280.5. Bedding to core 60° at 6270.7' 59° at 6286.4'.

From ft.	To ft.	Geology
6287.4	6289.7	QUARTZ ARENITE Quartz arenite, single thick bed, contacts sharp and flat, medium sand. Bouma a for 70% with minor bed and carbonate.
6289.7	6295.0	SUBWACKE AND ARGILLITE Subwacke and argillite, thin bedded and laminated, contacts sharp and flat, bedding to core 58° at 6292.4'.
6295.0	6320.2	QUARTZ WACKE Quartz wacke with minor subwacke and argillite, thick and very thick bedded with rare thin beds and laminations. Contacts sharp and flat, some amalgamated. Thin argillite tops with chlorite flakes, fine sand. Dark grey argillite clasts in subwacke top at 6295.0. Bedding to core 60° at 6307.4', 57° at 6311.7'. Small fault zone of cohesive quartz breccia fragments in gouge, 6305.8 to 6306.5.
6320.2	6342.0	SUBWACKE AND ARGILLITE AND QUARTZ ARENITE QUARTZ WACKE Subwacke and argillite and quartz arenite quartz wacke, medium and thin bedded with rare laminations and 30% quartz arenite and quartz wacke in thick beds. Gouge of clay and fine gritty fragments define fault zone 6328.4 to 6329.4. Core above fault zone is shattered, about 50 cm of core loss. Slickensides in plane parallel core at 72° to core.
6342.0	6360.0	QUARTZ ARENITE QUARTZ WACKE Quartz wacke quartz arenite, first beds weakly calcareous, thick bedded, contacts distinct, some vague, bedding to core 70° at 6350'.
6360.0	6391.5	WACKE, SUBWACKE AND ARGILLITE Wacke, subwacke and argillite, minor quartz arenite, short intervals weakly calcaraous, thin to medium bedded with a few thick beds and laminated sections (both even parallel-laminated and ripple cross-lamination) that are calcareous. Disrupted bedding over 20 to 40 cm in two intervals. One cm of laminations of granular pyrrhotite at 6389. Bedding to core 65° at 6390.5'.
6391.5	6451.0	QUARTZ ARENITE QUARTZ WACKE Quartz arenite, quartz wacke, minor wacke, subwacke and argillite, thick bedded with some very thick amalgamated beds and a few thin beds. Both bouma bed, hemipelagite and ripple cross-laminations present, latter are calcareous. Contacts sharp to vague. A few grain of pyrrhotite noted in wacke parts of some beds. Bedding to core 65° at 6433'.
6451.0	6471.5	WACKE, SUBWACKE AND ARGILLITE Wacke, subwacke and argillite, thin bedded and laminated with two thick beds to quartz wacke, contacts sharp and flat, a few thin dark grey hemipelagite intervals, wacke commonly thinly laminated wacke grains of pyrrhotite scattered along some laminations. Both types of laminite are weakly calcareous. Calcareous ripple cross-lamination ? at 6463. Bedding to core 70° at 6469'.
6471.5	6503.5	QUARTZ WACKE, QUARTZ ARENITE MINOR WACKE, SUBWACKE AND ARGILLITE Quartz wacke, quartz arenite, some weakly calcareous, thick bedded with less than 30 cm intervals of wacke, subwacke and argillite thin beds between some of the lower beds. Fine and medium sand size grains and in one bed are lithic clasts to 4 by 25 mm. Contacts sharp and flat on most beds, amalgamated and possibly wavy with some of the thick beds. Several h beds from 0.1 to 20.0 mm. Pyrrhotite scattered along some silty laminations. Platy chlorite noted in thick argillite intervals. Bedding to core 73° at 6498'.
6503.5	6529.0	QUARTZ WACKE, WACKE, SUBWACKE AND ARGILLITE Qwall, wacke and quartz wacke weakly calcareous, laminated to thick bedded, contacts sharp and flat, wacke, quartz wacke commonly internally laminated, one ripple cross-lamination noted. Bedding to core 74° at 6523'.
6529.0	6573.0	A SUBWACKE QUARTZ WACKE A, subwacke and quartz wacke, very thick intervals of both wacke, subwacke and quartz wacke in single sedimentation units, some with thin quartz wacke bases, thin argillite tops or both parts thick. Slight disruption of vague argillite and subwacke layering from 6534 to 6538. Pale pink garnets noted in the quartz arenite, and platy chlorite in the subwacke and argillite. Bedding to core 80° at 6573'.
6573.0	6722.0	QUARTZ ARENITE, QUARTZ WACKE, WACKE, SUBWACKE AND ARGILLITE

Quartz arenite, quartz wacke, wacke, subwacke and argillite, virtually no sharp bedding contacts normal laminations throughout this interval. Long very thick sections of single lithotype, usually quartz arenite, quartz wacke or argillite, however many contacts are vague to distinct based on hardness. Only internal features are rare isolated clasts and a few remnants of disrupted bedding. A 5 to 10 mm thick clast ? of folded massive laminated pyrrhotite noted at 6720. Laminations at 77° at 6707'. This interval is interpreted to be a slump unit with intercalated very thick beds. From 6590 to 6695 sections of the coro ane as thin as one inch, caused by the bit and core-barrell whipping out the hole in particularly long argillaceous intervals. This was noted to occur even after the bit and core-barrell were changed as it was assumed they may have been bent. Cause may have just been vibration and the long runs of argillite, though some quartz arenite was affected (less severe) as well.

6722.0 6756.0 WACKE, SUBWACKE
Wacke, subwacke, some verging on quartz wacke, minor argillite. Much of interval is faintly laminated to 6751, some pyrrhotite disseminated along laminations 6735 to 6741. Minor calcite noted. Ripple cross-lamination noted but rare. Calcite filling thin sub parallel froms between 6746 and 6747 that may be a small fault. Bedding to core 77° at 6722', 78° at 6740' and 84° at 6756'.

6756.0 6764.0 QUARTZ ARENITE
Quartz arenite, three beds with argillite tops, two thick, one medium. Top bed is 50% argillite, others have normal 5 to 10 cm tops. Grain size probably silt.

6764.0 6769.0 WACKE, SUBWACKE AND ARGILLITE
Wacke, subwacke and argillite, laminated to medium bedded, bedding to core 74° at 6764' and 37° at 6769'.

6769.0 6772.0 FAULT ZONE
Fault zone, quartz wacke, wacke, subwacke and argillite, cohesive breccia from 6769 to 6770. Below bedding is little disrupted but some slips with slickensides are present. A vague breccia in quartz wacke base.

6772.0 6867.0 QUARTZ ARENITE AND QUARTZ WACKE
Quartz arenite and quartz wacke, some beds slightly calcareous particularly laminite and short portions near base of many of the thickest beds, thick and very thick bedded with 1 to 2 metre intervals of thin beds and laminite, tops and rare interbeds of wacke, subwacke and argillite, contacts distinct to sharp, wavy to cuspate in both thick and thin beds. Calcareous wacke laminite from 6809 to 6811 has flat parallel laminations and one ripple cross-lamination. Bedding to core 74° at 6788', 80° at 6810', 78° at 6830' and 82° at 6858'.

6867.0 6881.0 WACKE, SUBWACKE AND ARGILLITE AND QUARTZ ARENITE
LOIS MARKER 6880.2 to 6880.5.
Wacke, subwacke and argillite and quartz arenite, calcareous, medium bedded to laminated with some thick beds, contacts sharp and flat with a few disrupted, pyrrhotite present as clasts in one interval, shredded argillite indicative of penecontemporaneous movement. Cleavage chlorites common. LOIS Marker 6880.2 to 6880.5, a portion of the marker is missing. Bedding to core 76° at 6880.4'.

6881.0 6921.0 QUARTZ ARENITE QUARTZ WACKE
Quartz arenite and quartz wacke, tops graded to wacke, subwacke and argillite, rare bouma bed laminations are calcareous, thick and very thick bedded, contacts sharp and flat to wavy, some that are diffuse are probably amalgamated. Rip-up clast noted at 6912. Bedding to core 77° at 6905'.

6921.0 6939.0 WACKE, SUBWACKE AND ARGILLITE
Wacke, subwacke and argillite, a few quartz arenite beds, calcareous sections, thick bedded with medium and thin beds and some laminated intervals. Contacts sharp and wavy tp flat, flame noted. Bedding to core 73° at 6935'.

6939.0 6950.2 QUARTZ ARENITE
Quartz arenite, calcareous, thick bedded with thin and laminated interbeds of wacke, subwacke and argillite, contacts sharp and wavy to flat, some ripple cross-laminations, fine to medium sand. Platy pyrrhotite defines oleavage in opposite sense to bedding.

6950.2 6960.0 WACKE, SUBWACKE AND ARGILLITE

From ft.	To ft.	Geology
		Wacke, subwacke and argillite with calcareous laminated units, thin bedded and laminated, contacts sharp and flat, some wavy, internal current laminations noted with ripple cross-lamination. Some hemipelagite laminite. Pyrrhotite disseminated in narrow zones, some pyrrhotite in cleavage.
6960.0	6969.0	QUARTZ ARENITE Quartz arenite, thick bedded, contacts sharp to flat and wavy, flame noted. A few medium and thin beds. Pale greenish bleaching silicification noted.
6969.0	6976.5	WACKE, SUBWACKE AND ARGILLITE Wacke, subwacke and argillite, medium and thin bedded with a few minor laminites. Contacts sharp and flat. Bedding to core 79° at 6974' very fine equant pyrrhotite grains disseminated, especially in laminite. Pyrrhotite is assoc with quartz or feldspar and minor calcite all clustered as fine grains.
6976.5	7004.0	QUARTZ ARENITE Quartz arenite, thick and very thick bedded, contacts sharp and flat to wavy, flames noted, fine sand, patches of mottled silicification are calcareous.
7004.0	7022.0	WACKE, SUBWACKE AND ARGILLITE Wacke, subwacke and argillite, thick bedded to faintly laminated, many contacts are vague, some sections are broken, bedding to core 57° at 7022'.
7022.0	7051.0	QUARTZ ARENITE, QUARTZ WACKE, WACKE, SUBWACKE AND ARGILLITE Quartz arenite, quartz wacke, wacke, subwacke and argillite, primarily quartz arenite, thick bedded a few medium and thin beds and rare laminations, contacts sharp and flat to wavy and disaggregated. Clasts noted, especially argillite tops, indicate slumping of much of this interval. Bedding to core 62° at 7033'.
7051.0	7075.5	WACKE, SUBWACKE AND ARGILLITE Wacke, subwacke and argillite, thin bedded and laminated, a few medium beds of quartz wacke, contacts sharp and flat, some wavy near end may be related to folding. Bedding to core 62° at 7053'.
7075.5	7086.0	QUARTZ ARENITE Quartz arenite, thick and medium bedded, contacts sharp and folded with cleavage chlorite present.
7086.0	7091.0	SUBWACKE AND ARGILLITE Subwacke and argillite, thin bedded, contacts sharp and tightly folded. Cleavage symmetric to folds and cleavage fans in hinges and near lithological discontinuities show that these folds are tectonic.
7091.0	7289.0	QUARTZ ARENITE Quartz arenite graded beds with tops to argillite, and a few short intervals of wacke, subwacke and argillite thin beds, contacts sharp and wavy, a few rip-up clasts noted. A few tension froms with quartz 7100 to 7120. Pyrrhotite noted in a number of irregular veinlets, especially 7130 to 7147, including a speck of sphalerite at 7147. 15 mm micro fault breccia noted at 7275 bedding to core 54° at 7105', 73° at 7141', 69° at 7204', 64° at 7254.5' and 59° at 7288'.
7289.0	7298.3	GABBRO Gabbro, medium greined, biotite altered, sill, intrudes laminite that starts at 7287, top contact sharp, bottom contact distinct, somewhat irregular.
7298.3	7316.0	WACKE Wacke, laminite to 7305 then quartz wacke to argillite, thin, medium bedded and laminated. Laminite has granular texture that probable is biotite develop next to sill. Convoluted bedding 7310 to 7311. Five mm chlorite matrix micro fault breccia parallel bedding at 7311.5.

From ft.	To ft.	Geology
7316.0	7353.5	QUARTZ ARENITE Quartz arenite with thin tops of wacke, subwacke and argillite, thick bedded, contacts sharp and flat, mottled alteration patches are slightly calcareous. Bedding to core 69° at 7322'.
7353.5	7423.0	WACKE, SUBWACKE AND ARGILLITE Wacke, subwacke and argillite, minor quartz wacke and quartz arenite, medium bedded, occasional thick and thin beds, laminite 7413.5 to 7117 and rare elsewhere, contacts sharp and flat to occasionally wavy, a few narrow zones have disrupted bedding caused by slumping. Cleavage chlorites common above 7380. Very fine pyrrhotitic laminations noted scattered near 7358 and near 7420. Bedding to core 72° at 7358', 65° at 7392' and 57° at 7420' coarse chloritized amphiboles (?) develop in calcite rich bands in laminite 7373 to 7374.
7423.0	7450.9	QUARTZ ARENITE Quartz arenite, weakly calcareous where altered, thick bedded, contacts sharp to distinct and flat, tops and interbeds argillaceous. Slightly curved froms near perpendicular to core causes a series of distinctive buttons from 7430 to 7431.5 bedding to core 63° at 7438'.
7450.9	7461.0	WACKE QUARTZ ARENITE Wacke quartz arenite, medium to thin bedded, some weakly laminated. Biotite common.
7461.0	7474.5	QUARTZ ARENITE Quartz arenite with tops graded to argillite, a few medium beds then single bed 7464 to 7474.5 with an amalgamated contact at 7471.
7474.5	7483.0	WACKE, QUARTZ WACKE Wacke, quartz wacke, laminite, biotitic and one quartz arenite thick bed, fine sand. Bedding to core 59° at 7483'.
7483.0	7567.0	QUARTZ ARENITE ALBITITE Quartz arenite, albitic, initially some quartz wacke and wacke, thick to very thick bedded, rare argillaceous section 0.5 to 2.0 feet, contact sharp to broken, flat to irregular. Intense alteration below 7512, pale to medium brown when wet, very dense with clusters of fine calcareous snowflake patches occasionally noted, possibly albitite. Fracturing common and core tended to break during drilling resulting in poor bit life. Slightly curving parallel close spaced fractures almost result in button core from 7540 to 7541. Below 7556 note white coating, calcite and possibly zoisite, on mny fractures, calcite cemented breccia over 5 cm at 7556. Occasional thin beds almost completely altered except argillite top in some cases. Bedding to core 63° at 7514' and 55° at 7562'. Runs and shorts. 7474.2 7486.2 2. 7486.2 7502.3 1.0. 4502.3 7511.8 1.5. 7511.8 7513.6 1.0. 7513.6 7522.6 5.0. 7522.6 7528.1 1.5. 7528.1 7532.2 0.7. 7532.2 7543.0 1.0. 7543.0 7546.2 0. 7546.2 7554.5 0.5. 7554.5 7561.5 0.7. 7561.5 7566.3 1.0. 7566.3 7573.5 1.7.
7567.0	7569.7	METASEDIMENTS GABBRO Metasediments ?, gabbro ? biotite quartz rock, near base has appearance of altered gabbro body.
7569.7	7577.0	QUARTZ ARENITE ALBITITE Quartz arenite highly altered and silicified, albitite?, much like 7483 to 7567, broken. Gabbro at 7575.8 is probably cave picked up after bit change.

7577.0 7588.5 GABBRO
Gabbro, highly biotite, chlorite and calcite altered. Probably dike as basal contact is at about 18° to core. Most of calcite is in fine fractures.

7588.5 7622.0 QUARTZ ARENITE
Quartz arenite, albitic appearance, mottled grey and brown, badly broken, intensely altered, virtually no bedding recognized. Biotitic patch 7600.0 to 7600.7, possibly intrusion related. Gabbro at 7613.4 is cave from bit change. Laminations in few cm above base from 40° to 60° to core. Runs and shorts:.
7573.5 7575.8 2.0.
7575.8 7579.2 2.2.
7579.2 7592.4 2.0.
7592.4 7600.7 2.0.
7600.7 7603.7 1.5.
7603.7 7607.6 2.0.
7606.7 7609.5 1.0.
7609.5 7611.6 1.6.
7611.6 7613.4 1.5.
7613.4 7614.8 0.6.
7614.8 7617.1 1.5.
7617.1 7618.4 0.4.
7618.4 7626.8 1.8.

7622.0 7627.0 GABBRO
Gabbro, highly biotite and chlorite altered, some calcite alteration. Gabbroic texture noted at 7625. 5 cm of incohesive gouge just above 7625. Synsedimentary develop in planes sub parallel to core, slicks within 20° to core.

7627.0 7633.5 FAULT ZONE
Fault zone, intensely bxb, altered and calcite cemented rock. Recognizably quartz arenite at end. One foot of core loss in run 7626.8 to 7637.1 is in the fault.

7633.5 7646.0 QUARTZ ARENITE ALBITITE
Quartz arenite, broken, intensely altered, albitic, minor small patches with snowflake texture bedding to core 47° at 7642'.

7646.0 7655.0 GABBRO
Gabbro ?, initially equigranular calcareous quartz feldsp ? biotite rock, darker than above, one short section has altered gabbro appearance, but not compelling as gabbro. Fine calcite from, common. 20 cm near base has bleached fractures cutting more siliceous rock with very fine biotite, typical of altered wacke quartz wacke elsewhere. Contact at very base is sharp, conformable and offset on a fracture parallel to the core. Similarity to interval at 7664.5, however, indicates this rock is extremely altered gabbro. Good core.

7655.0 7664.5 METASEDIMENTS ALBITITE
Metasediments, albitite, probably initially quartz wacke, some fine laminations, bedding to core 52° at 7659'. Good core.

7664.5 7672.5 GABBRO
Gabbro, intensely biotite altered rock but with less altered sections that are clearly gabbro. Transitions between these textures indicates the biotite rich rock was originally gabbro. Contacts between gabbro and biotite alteration vary from sharp to diffuse. The same textures are present in the interval 7646 to 7655, indicating it is intrusive. Only calcite noted is on thin flat planar fractures. Good core.

7672.5 7679.6 QUARTZ ARENITE METASEDIMENTS ALBITITE
Quartz arenite, highly altered, albitic, mottlod medium brown. Remnant laminations 58° at 7676.5'. Number fine fractures throughout, minor quartz veinlets. Good core.

From ft.	To ft.	Geology
7679.6	7681.8	GABBRO Gabbro, mainly biotite altered rock, a patch in centre has gabbroic appearance, probably a sill. Top contact sharp, slightly wavy at 55° to core, lower contact also at 55° to core has a tight wave over 1 cm. Good core.
7681.8	7686.1	QUARTZ ARENITE METASEDIMENTS ALBITITE Quartz arenite, creamy to medium brown mottled, albitic, with abundant fine calcite dispersed down to 7683. Good core.
7686.1	7688.7	GABBRO Gabbro, highly altered, very chloritic and biotitic, quartzose patches near top indicate included sedimentary rock. Very fine grained chill zone with coarse biotite at base. Contact at top is irregular, contact at base is sharp and flat at 61° to core.
7688.7	7690.5	QUARTZ ARENITE ALBITITE Quartz arenite, dark brown, albitic with abundant fine calcite.
7690.5	7697.3	GABBRO Gabbro, good medium grained igneous texture, 25% of intervai is moderately biotitic where core is green. Abeut 75% bf interval is extremely biotitic, where core is brown. Both contacts sharp and flat, top at 55° to core, bottom at 63° to core.
7697.3	7713.0	QUARTZ ARENITE ALBITITE Quartz arenite, medium brown, thick bedded, contacts distinct to vague, medium to fine sand, altered, albitic with only a few fine snowflake grains of calcite. Possible minor shear alteration zone 7 cm wide at 55° to 35° to core at 7705. Bedding to core 56° at 7709', 59° at 7712'.
7713.0	7714.5	GABBRO Gabbro ?, biotite quartz feldspar rock, presumed altored gabbro, no primery characteristics preserved.
7714.5	7717.0	QUARTZ ARENITE ALBITITE Quartz arenite albitite, mottled creamy over dark brown, minor calcite snowflakes and on fractures.
7717.0	7723.6	GABBRO Gabbro, mainly biotitic with a few greenish patches with original igneous texture. Only slightly calcareous in patches. Contacts, top at 35° to core, bottom at 45° to core.
7723.6	7738.2	QUARTZ ARENITE ALBITITE Quartz arenite, parts albitite, thick bedded, fine sand, a number of lithic clasts present - abundant over first 20 cm, scatt below, some argillaceeus. Granule size clasts in albitized zone at 7736.6, spec for thin sectien and whole rock. Argillite top about 25 cm true at 7728.6$ bedding to core 50° at 7728.6'.
7738.2	7739.1	DIABASE Diabase, dark green, dense aphenitic matrix with fine plag grains and resettes. Sharp contacts, both at 39° to core and parallel.
7739.1	7741.0	QUARTZ ARENITE ALBITITE Quartz arenite albitite, brown, fine sand.
7741.0	7742.5	DIABASE Diabase, similar to 7738.2 to 7739.1, but a bit coarser, more gabbroic looking, but with distinct aphanitic, light green chill zones about 1 cm wide and containing fine dark green phenocrysts. There is a 10 cm inclusion of metasediments with much more extensive chill effects in adjacent diabase, but margin is quite irregular. Top contact at 30° to core, bottom at 38° to core.
7742.5	7747.2	METASEDIMENTS GABBRO

From ft. | To ft. | Geology | Geology

Metasediments ? or gabbro. Dark brownish biotite quartz feldsp rock, probably intrusive related, possibly altered gabbro and suspect relict igneous texture. Darkest most biotitic zones flank foliation parallel silica veining, away from these narrow features rock is paler and calcareous. Bottom contact at 70° to core.

7747.2 7823.6 QUARTZ ARENITE ALBITITE
Quartz arenite albitite, mottled creamy grey to brn. Some of the more homogeneous grey sections are argillaceous and judging by that, interval is thick bedded. There are no primary sedimentary features preserved, other than fine sand. Buttoning of core noted 7756 to 7758 and 7763 to 7764.

7823.6 7916.0 METASEDIMENTS WACKE QUARTZ WACKE QUARTZ ARENITE SUBWACKE AND ARGILLITE
Metasediments, top of Lower Aldridge Fm. This interval is highly altered by silicification and some calcite development along certain laminated intervals. Laminites are recog on and off throughout this interval, but are not a dominant lithotype. There are some very th (guess this is thin, check) beds with and without laminations and some alteration has destroyed primary features. Detailed subdivisions follow: 7823.6 7826.0 wacke laminite, silicified with minor calcite, one thin bed. Bedding to core 45°.

7826.0 7828.5 Metasediments, quartz veining with chlorite cores, biotite throughout.

7828.5 7830.5 Wacke, dark grey, very fine bleached fractures.

7830.5 7833.5 Metasediments, wacke with quartz veining and biotitic margins. A few laminations near bottom with bedding to core 31° at 7833.5'. Contact sharp and flat but altered.

7833.5 7837.3 Argillite and subwacke with a 5 cm quartz wacke base. Believe next unit is not part of this sedimentation unit. Basal contact is sharp and flat at 50° to core.

7837.3 7845.0 Wacke, portions silicified and calcite develop along restricted sets of laminations. Much of interval was laminite not totally destroyed by the alteration. Two coarse garnets noted. Bedding to core 45° at 7842.5'.

7845.0 7854.0 Single thick bed, pale grey argillite and subwacke to 7851.5 then abruptly to mottled light brown quartz arenite, silicified with calcite present on a few laminations. Injected turb?.

7854.0 7856.0 Wacke, laminated, somewhat silicified and some laminations with extensive calcite development. Pyrrhotite and traces of sphalerite noted. Bedding to core 46° at 7856'.

7856.0 7884.0 A series of beds of increasing thickness downwards, bases at 7856.3, 7856.8, 7858.7, 7860.9, 7863.7, 7867.5, 7871.7, and 7884.0 most beds are not unusual, hard dark patches are probably polished quartz wacke rather than tourmalinite. Contacts are diffuse, so somewhat subjective. Bottom two-thirds of last bed is a laminite, presumably bouma bed but is a candidate for top of lower aldridge type, it has considerable calcite development along laminations and along cleavage, BCAD 45°, 42°, 206° at 7878'. Fine biotite throughout, occasional coarse chlorite with the calcite. Some fine pyrrhotite and traces of sphalerite noted.

7884.0 7892.0 Subwacke and argillite or very fine wacke, as is rather hard to 7888.6 then quartz arenite or silicified wacke, biotitic and silicified with secondary calcite in nomerous small silicified patches that have cores of pyrrhotite intergrown around quartz grains with occasional chlorite. Calcite also along laminations below 7891.

7892.0 7894.7 Quartz arenite, quartz wacke, wacke, subwacke and argillite, good distinct darker grey laminations in wacke, subwacke and argillite to 7893.2 at 55° to core. The quartz arenite ? or silicified wacke below is dark brown (fine biotite) and has a few laminations with secondary calcite.

7894.7 7897.9 Quartz arenite ? and quartz wacke ? or silicified wacke, patch of wacke. Largely laminite, fairly dark with sections that have secondary calcite and fine cross fractures from which biotite destructive alteration eminates. Laminations at 56° to core

7897.9 7903.2 Single bed from a fairly hard argillite to 7900.3 then an abrupt change to qa? or silicified wacke below. Possible amalgamated contact at 7902.1. Three patches less than 10 cm of secondary calcite.

7903.2 7912.3 Wacke, subwacke and argillite, silicified so much is hard as quartz arenite. Two patches of secondary calcite in upper section. Below 7909.5 much of interval is laminite at 60° to core. Very fine pyrrhotite dispersed in parts of the lower interval.

7912.3 7915.2 Bed subwacke and argillite changes abruptly at 7913.3 tc quartz arenite and silicified wacke, central portion of silicified section is altered with fine brown biotite and cm wide pale calcite rich lenses and spots with some associated fine pyrrhotite

7915.2 7916.0 Quartz arenite with a short subwacke top, much very finely laminated at 59° to core may be continuous into following, but a thin argillite at 7916.0.

7916.0 7918.5 WACKE

From ft.	To ft.	Geology
		HU PYRRHOTITE LAMINATED ZONE. Wacke, silicified, dark grey, thinly laminated below 7917.0, with abundant very fine pyrrhotite below 7917.5. Dense and very hard. Possibly top of HU pyrrhotite Laminated Zone.
7918.5	7921.5	SUBWACKE Subwacke, light grey, homogeneous, fine granular appearance. Faint laminite over first 1.0 foot with faint slightly darker spots to 5mm long, flattened in plane of bedding, bedding at 54° to core.
7921.5	7928.8	METASEDIMENTS WACKE Altered wacke, silicified with several zones with secondary calcite developed parallel bedding, a few coerse grains of pyrrhotite accompany some of the calcite.
7928.8	7939.0	GABBRO Gabbro, extensive coarse biotite throughout, a few fine calcareous veinlets.
7939.0	7942.9	WACKE Wacke laminite, silicified and very hard to 7942.3, then soft. Laminations at 25° to core.
7942.9	7954.6	SUBWACKE WACKE QUARTZ WACKE QUARTZ ARENITE METASEDIMENTS Several medium to thin beds, some intensely silicified and very hard, some probably quartz arenite originally, contacts vague to distinct and flat with small scale irregularities.
7954.6	7996.6	QUARTZ ARENITE, QUARTZ WACKE, WACKE, SUBWACKE AND ARGILLITE HU GRADED BED. Quartz arenite, quartz wacke, wacke, subwacke and argillite. Distinct mm laminations at 35° to 48° to core from 7954.6 to 7955.7' otherwise core is homogeneous in appearance and changes to wacke at 7971, where there is a small amount of silicification, then to quartz wacke at about 7980 and to quartz arenite at 7990. At base grain size is fine sand.
7996.6	8004.8	QUARTZ WACKE WACKE, SUBWACKE AND ARGILLITE LITTLE HU GRADED BED. Quartz wacke wacke, subwacke and argillite, sections appear silicified could be quartz arenite. Single very thick bed. Thinly laminated subwacke to 7999 at whioh point is a 2 mm quartz veinlet parallel to cleavage that is evident below as defined by number thin streaky pyrrhotitic wisps. Below the veinlet colour changes from normal greys to a more creamy shade that persists to 8001.5. Below 8003.2 rock consists of zones that vary from wacke to quartz wacke to qa? with a few fine grains of pyrrhotite, some reoriented in cleavage. BCAD 60°, 50°, 180° at 7999'.
8004.8	8007.3	SUBWACKE AND ARGILLITE Subwacke and argillite, first 30 cm even parallel-laminated with one small faint starved ripple. Below is dark grey argillite, very uniform. Bedding to core 67°.
8007.3	8009.3	WACKE Wacke, brownish, altered, by coarse sericite and probably by fine biotite.
8009.3	8012.2	QUARTZ WACKE Quartz wacke, single bed, faintly laminated throughout, argillaceous over first few cm.
8012.2	8023.4	QUARTZ WACKE Quartz wacke, single bed graded from wacke from start through to 8020, then quartz wacke with aome hard patches that might be quartz arenite but are probably too dirty. Contact with bed above is sharp based on hardness and loss of laminite character, however no colour change. Bouma bed type current laminations from 8020 to 8022, a portion of which is calcareous to fine calcareous fractures define a cleavage, BCAD 60°, 34°, 180° at 8021'. Very basal 10 cm is a mix of wacke an coarse quartz grains with coarse pyrrhotite in wisps to 3 by 15 mm. Basal contact is irregular with cm size load structures.
8023.4	8030.0	WACKE, SUBWACKE AND ARGILLITE

H LAMINATED UNIT. Wacke, subwacke and argillite. Thin and very thin bedded with short well laminated units and one unit of very finely laminated pyrrhotite in wacke in basal 30 cm. Many basal contacts of beds with silty bases are irregular with wavy, flames or features suggestion of ripples. All contacts are distinct. Pyrrhotite and calcite developed along several of the silty layers. Bedding to core 56° at 8026'.

8030.0 8034.0 WACKE PEBBLE FRAGMENTAL
H CONGLOMERATE. Wacke, dark grey, top half is homogeneous, dense, very fine with rare pale grey grains that are probably argillite remnants, bottom half consists of similar material as matrix with discontinuous and convoluted silty and pyrrhotitic laminations. Pyrrhotite in masses with lithic material and calcite up to 5 by 10 mm. Very fine sphalerite noted but rare.

8034.0 8048.8 QUARTZ ARENITE
H GRADED BED, quartz arenite. Here just about all quartzite. Medium to light grey with faint fine mottled appearance throughout. Recognizable laminations from start to 8038 have bedding to core 36°, indicating possible reorientation during devt of H Conglomerate. Coarse sericite present throughout. BCAD 35°, 45°, 193° at 8038'. Patches of softer material present in lower 30 cm. Fine pyrrhotite grains scattered in basal one cm. Basal contact sharp and flat and parallel to laminations below.

8048.8 8095.9 SUBWACKE AND ARGILLITE
I LAMINATED UNIT. Subwacke and argillite, probably medium grey argillite with 10 to 10 % of interval characterized by subwacke in which distinct paper thin dark grey carbonaceous laminations occur in bands from a single lamination up to 10 cm thick. These laminations are pyrrhotitic, contain traces of sphalerite and a few have scatt to continuous calcite. Within the argillite are a few wisps of silty material with pyrrhotite and calcite that appears to have been resedimented. The I Laminated Zone is folded. The fold starts at the top of the zone, the lowest stratigraphic point in the I Laminated Zone is at 8061.3 where laminations parallel the core. Below this strata are overturned to 8096. Laminations at 8049.2, 8055, 8056.4, 8058 and 8059.4 precisely match those at 8095.3, 8076.5, 8073.5, 8069.6 and 8067.4 respectively. Description continued below.

8095.9 8096.0 SUBWACKE AND ARGILLITE
Description of unit too long for program the 8049.2 8095.3 correlation contains the thickest most pyrrhotitic interval. It is 2 cm wide and there is considerable remobilization of pyrrhotite in the lower folded intersection. A broad open fold between 8070.5 and 8073.0 probably reflects the larger structure. A small extensional fault offsets laminations in the upper part of this fold, this fault appear penecontemporaneous as it is in a solid piece of core without any indications of post lithification movement. Below 8088 is a strong foliation and parting is common, synsedimentary are present on many of the parting surfaces. Microfolds are common in the overturned strata. Bedding to core 60° at 8049.2', 40° at 8057', 22° at 8060', 0° at 8061', 30° at 8069.5', 0° at 8071.1', 19° at 8071.6', 0° at 8072.0', 21° at 8072.8', 26° at 8076.5', 60° at 8091' parallel to cleavage, BCAD 20°, 55°, 0° at 8095', small scale folds in last few feet.

8096.0 8102.0 FAULT ZONE
Fault zone, subwacke and argillite. Cleaved throughout, only a few remnant wisps of bedded lithons with a few specks of pyrrhotite. Deformation transitional from overlying interval. This is a rather inoccuous zone for a fault with such a substantial offset. Zone is cohesive with some parting on the cleavage shear planes. Synsedimentary present on these planes that cross the core at 78° to core. 10 cm zone 8097.0 to 8097.3 has a few calcite veinlets and is probably the fault plane.

8102.0 8105.7 METASEDIMENTS TOURMALINITE
Metasediments including 10 cm of black tourmalinite.

8105.7 8109.0 GABBRO
Gabbro, very fine grained, diabasic. Contacts sharp and flat at 50° to core to core, bottom contact has small offset.

8109.0 8190.0 QUARTZ WACKE, WACKE, SUBWACKE AND ARGILLITE TOURMALINITE
Quartz wacke, wacke, subwacke and argillite, core is subparallel to bedding. Occasional bed contact and a few sets of fine laminations but none are I type and none resemble laminations from higher in the section. A few of the laminations are silty and contain minor pyrrhotite. Probably tourmalinized zones 8109 to 8111 dark grey, 8130 to 8140 medium with two dark grey sections, 8146 to 8155.5 light grey with dark zones in middle and base. Bedding to core 20° at 8118.5', 12° at 1855', 20° at 8175', 25° at 8183', 32° at 8185', 20° at 8191'. BCAD 20°,

From ft.	To ft.	Geology
		55°, 49° at 8184', therefore overturned.
8190.0	8209.0	METASEDIMENTS Metasediments, contact hornfels, includes albitite, and chlorite, biotite, calcite marbled beef textured alteration from 8197.0 to 8199.5. Laminations at 17° to core to 0° to core at start of interval. BCAD 15°, 65°, 224° at 8203.5' bedding to core 42° at 8204.0'. Based on these relationships bedding is returning to normal at this point. From 8202 to 8205 pyrrhotite grains define bedding but the grains are oriented along cleavage and there are several pyrrhotite veinlets in this interval.
8209.0	8365.0	GABBRO
8365.0	8496.0	GRANOFELS
8496.0	8515.0	GABBRO
8515.0	8524.0	GRANOFELS
8524.0	8529.0	GABBRO
8529.0	8538.0	GRANOFELS
8538.0	8540.0	METASEDIMENTS
8540.0	8557.0	GABBRO

APPENDIX 3

DEEP HOLE NORTH OF THE KIMBERLEY FAULT

GEOCHEMICAL DATA DDH 6465

ERL JOBS: 960592R, 970081R, 970110R

MEMO TO: Project Geologist, Kootenay Exploration (PW Ransom)

FROM: E.R.L. Manager, Tech. Support (JA McLeod) 18 October1996

SUBJECT: SULLIVAN DDH 6465 **JOB:** V96-592R

A piece of core from 7561 feet was submitted for thin sectioning.

In transmitted light, a fragment 0.5 x 6.0 mm has very fine grained tourmaline overprinting a microcrystalline siliceous material. Other areas in the rock up to 5 mm in diameter are comprised of calcite and fresh sieve textured muscovite intergrown with quartzo-feldspathic material.

The matrix is comprised of sutured, very fine (0.05 - 0.2 mm) grained quartz and albite. Quartz veinlets cross-cut the rock. These veinlets are 0.5 - 1.0 mm wide.

The rock is a quartzo-feldspathic material which hosts two different fragment types. One is an elongate, tourmaline rich (brown coloured in hand sample) type while the other is a calcite-muscovite type (white in hand sample).

Some sort of disruption and fragmentation process has gone on during the formation of the quartz-albite unit.

J.A. McLeod.

JAM/skw

MEMO TO: Project Geologist, Kootenay Exploration (PW Ransom)

FROM: E.R.L. Manager, Tech. Support (JA McLeod) 20 Oct. 1995

SUBJECT: SULLIVAN THIN SECTION JOB V95-629R

SAMPLE DD6465, 4385' (R95:23425) was submitted for thin sectioning. Following is a brief microscopic description.

The mode is approximately as follows:

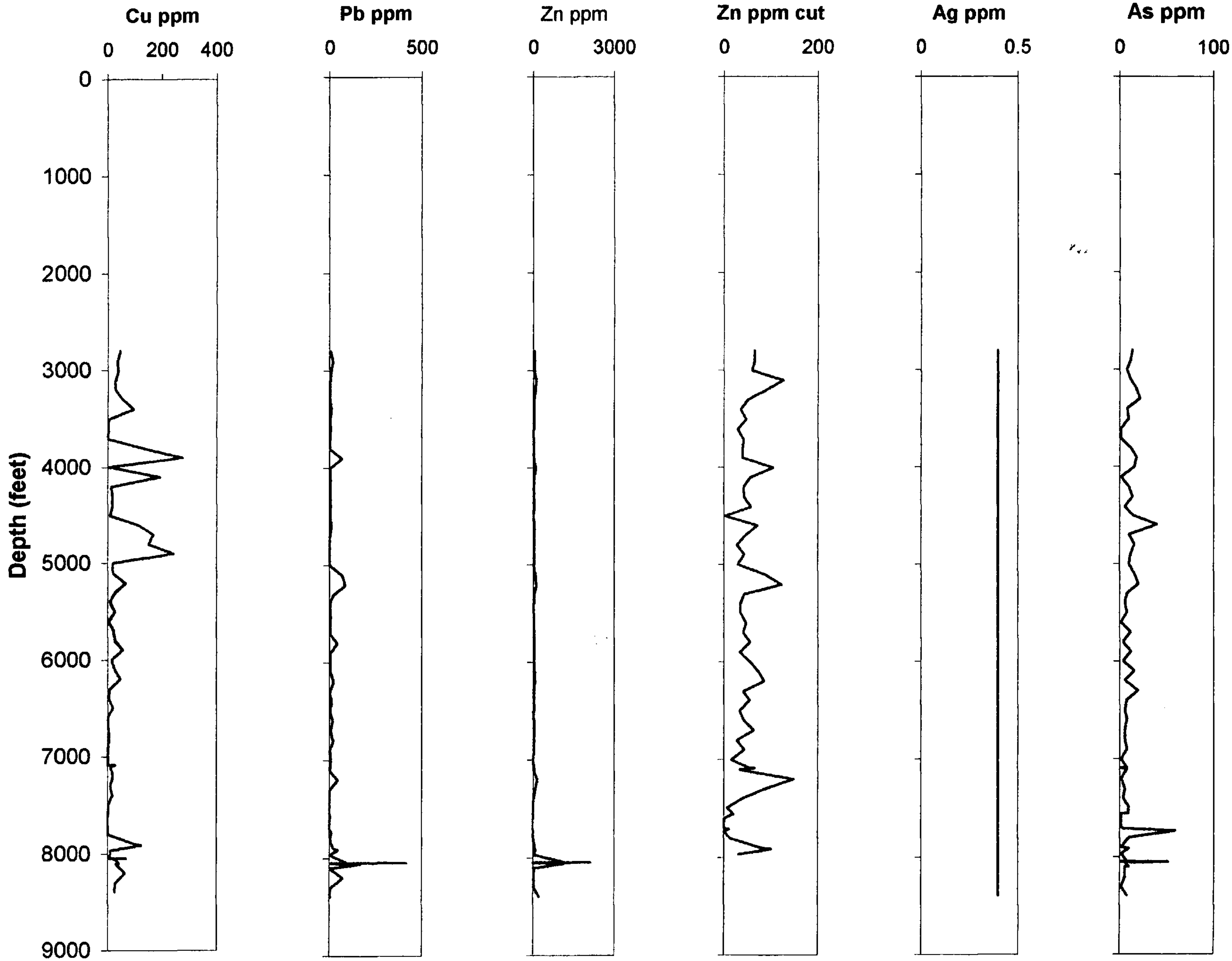
Quartz:	95%
Calcite:	3-4%
Opaques:	1%
Zircon:	Tr.
Apatite:	Tr.
Tourmaline:	Tr.

Grains of quartz to 0.5 mm in length tend to be highly elongate and are cemented by much finer grained quartz and albite. The cementing grains are 0.1 mm and finer. Grain boundaries are highly sutured. Some interstitial calcite grains occur as highly irregular shaped grains. Opaque grains tend to be ragged in outline and in the 0.1 mm size range. Very small, euhedral to equigranular grains of zircon, tourmaline and apatite are noted.

The rock is a recrystallized, foliated quartzo-feldspathic wacke.

J.A. McLeod.

JAM/skw



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Zn ppm
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3000
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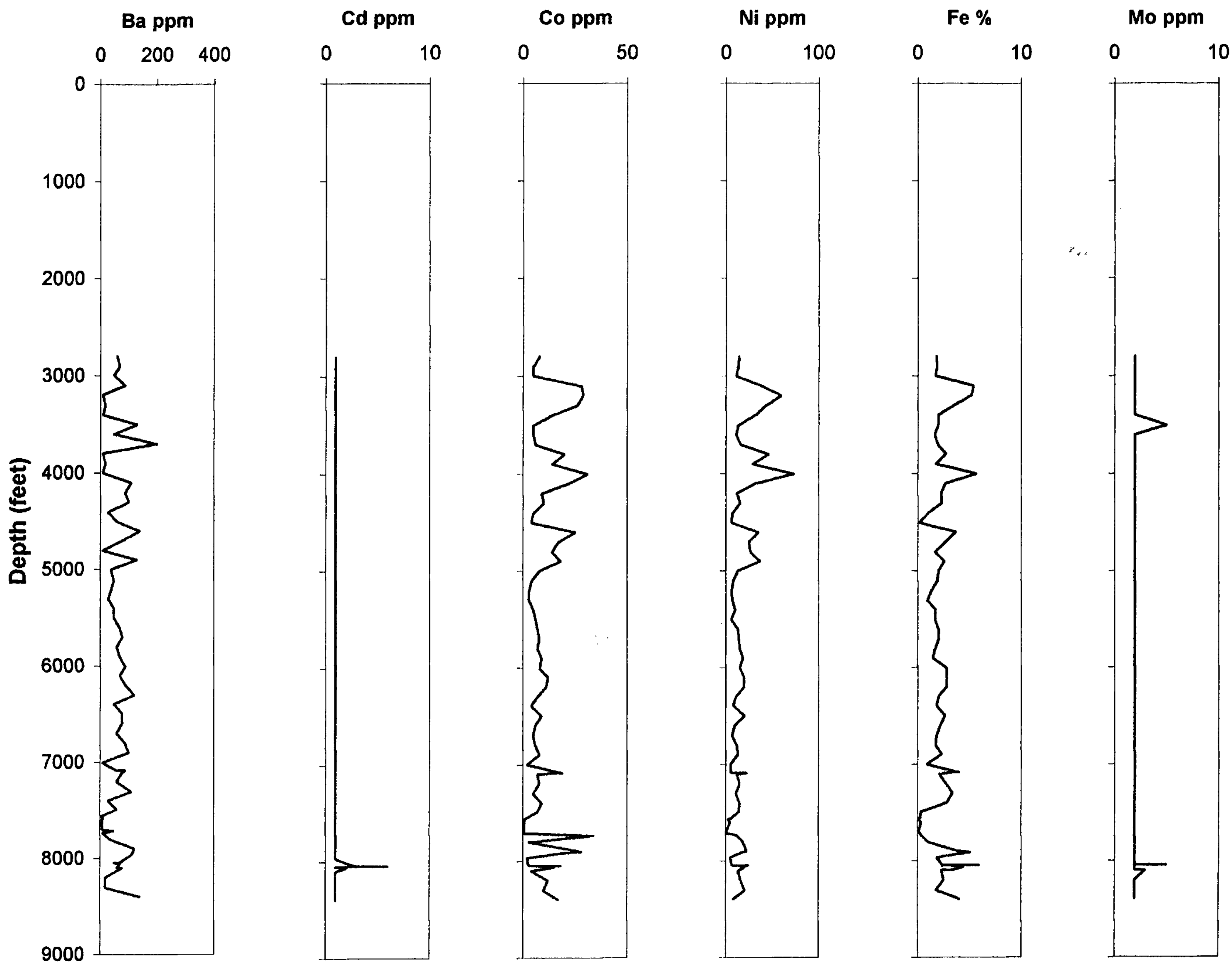
5000
6000
7000
8000
9000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Co ppm
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Depth (feet)
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7000
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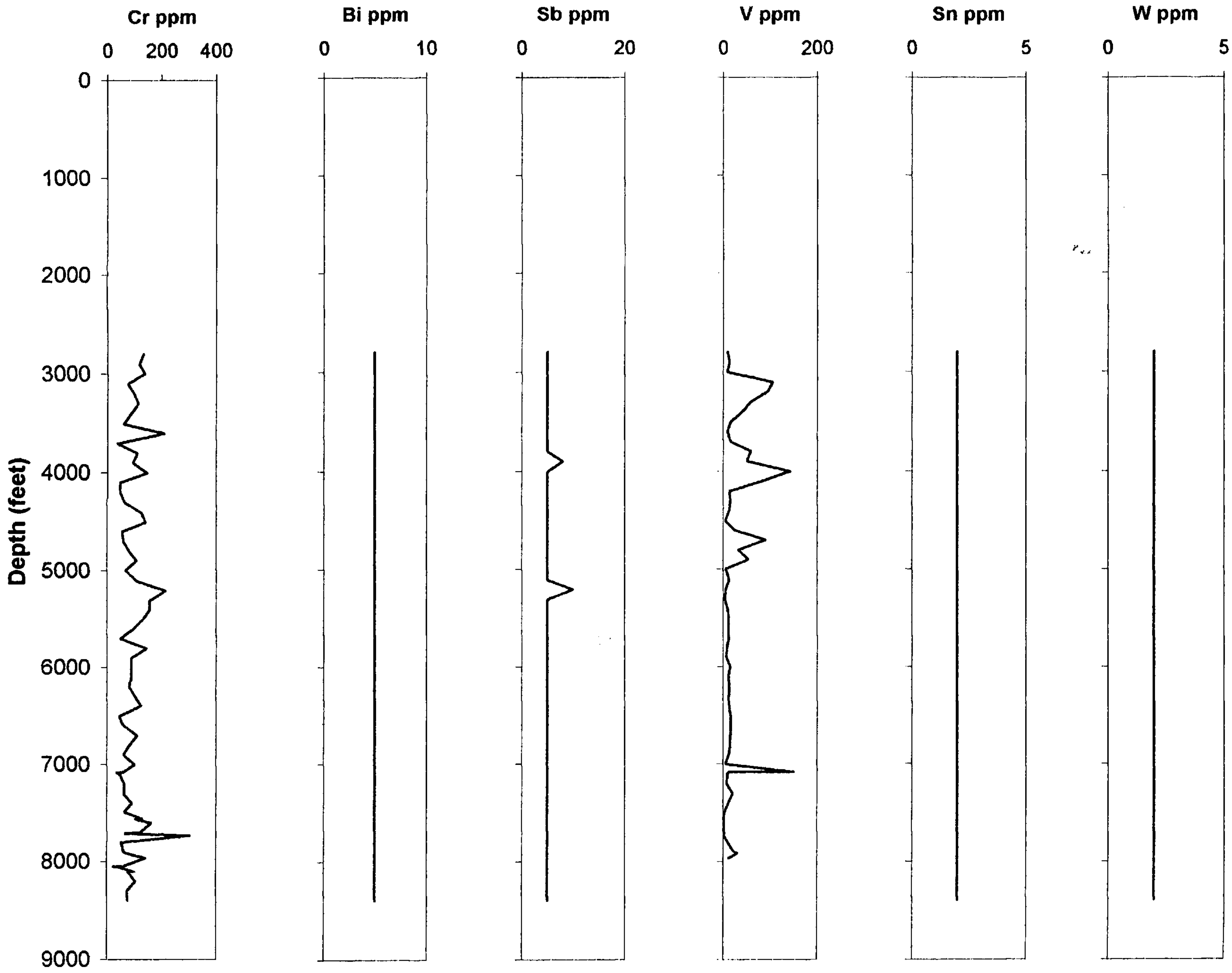

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V ppm
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7000
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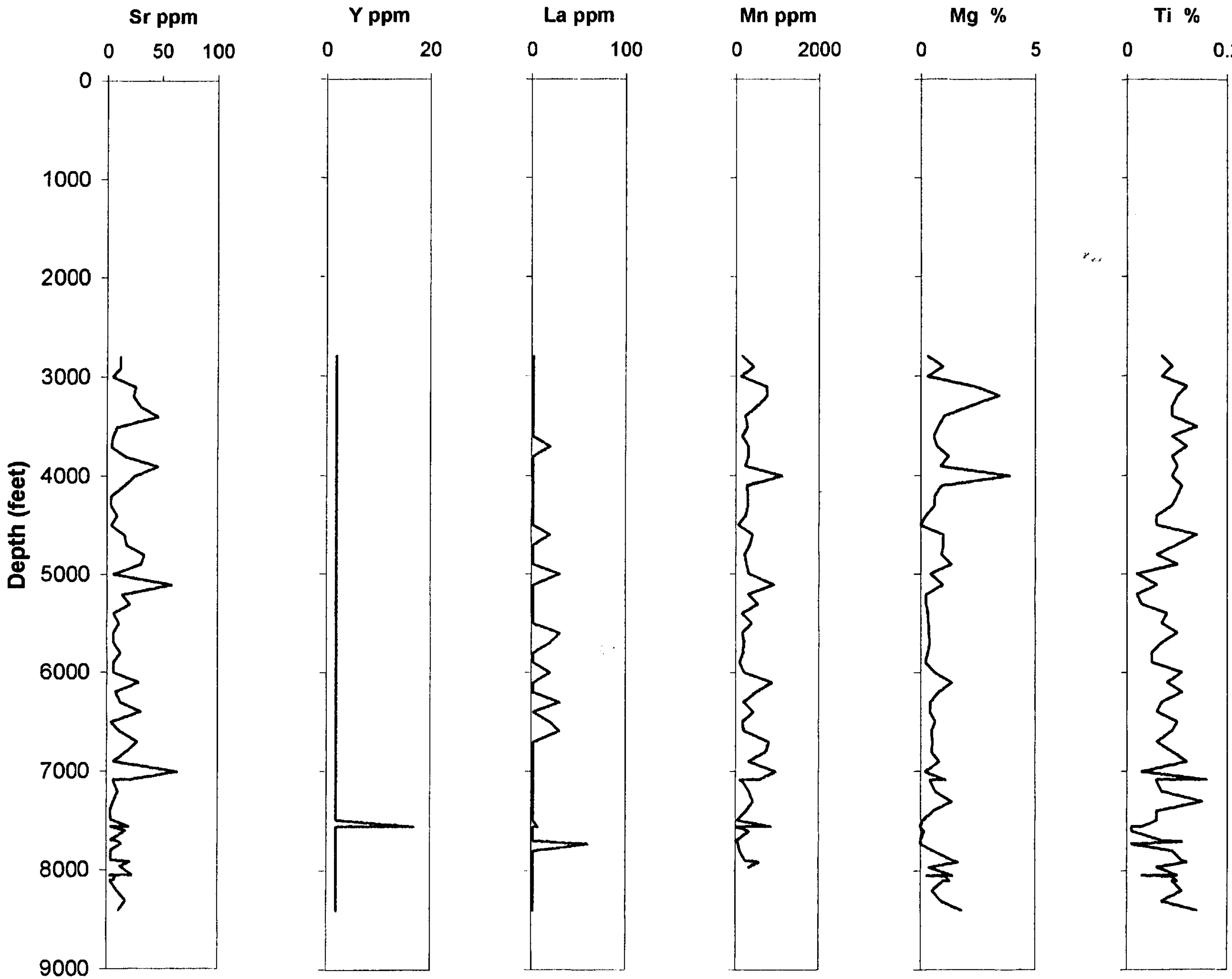
9000



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Y ppm
La ppm
Mn ppm
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Ti %
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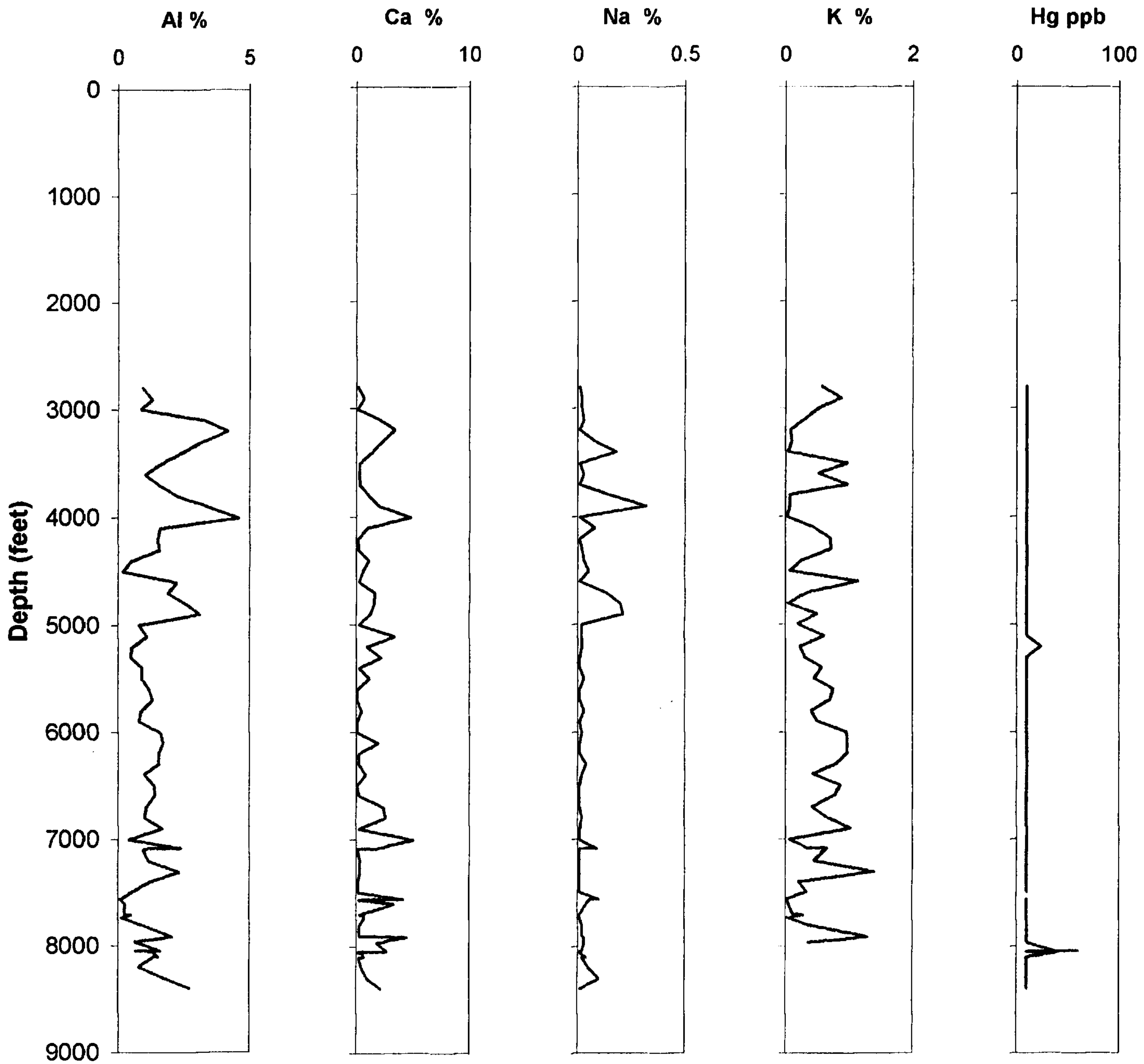
Depth (feet)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8000
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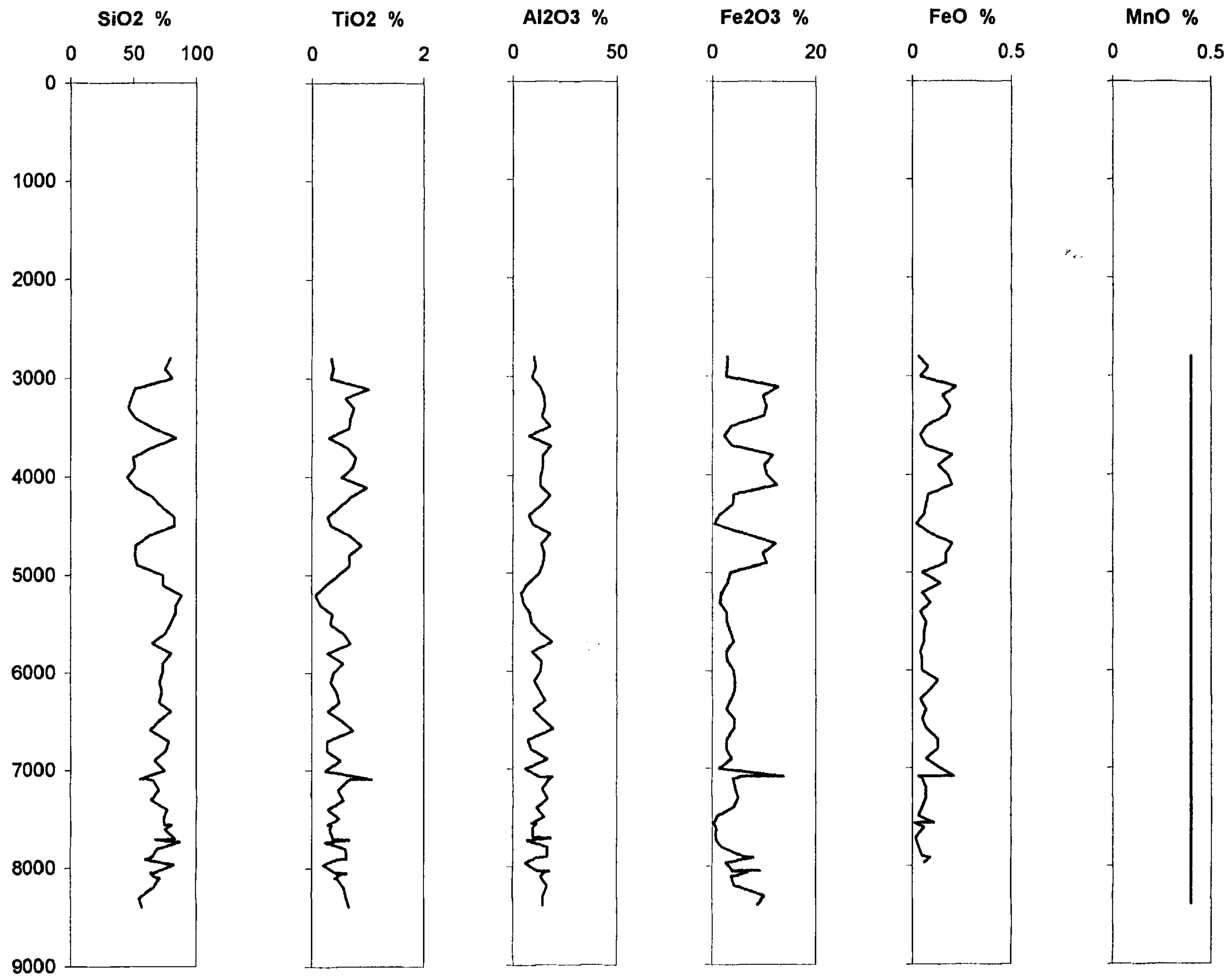
Depth (feet)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Al2O3 %
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Fe2O3 %
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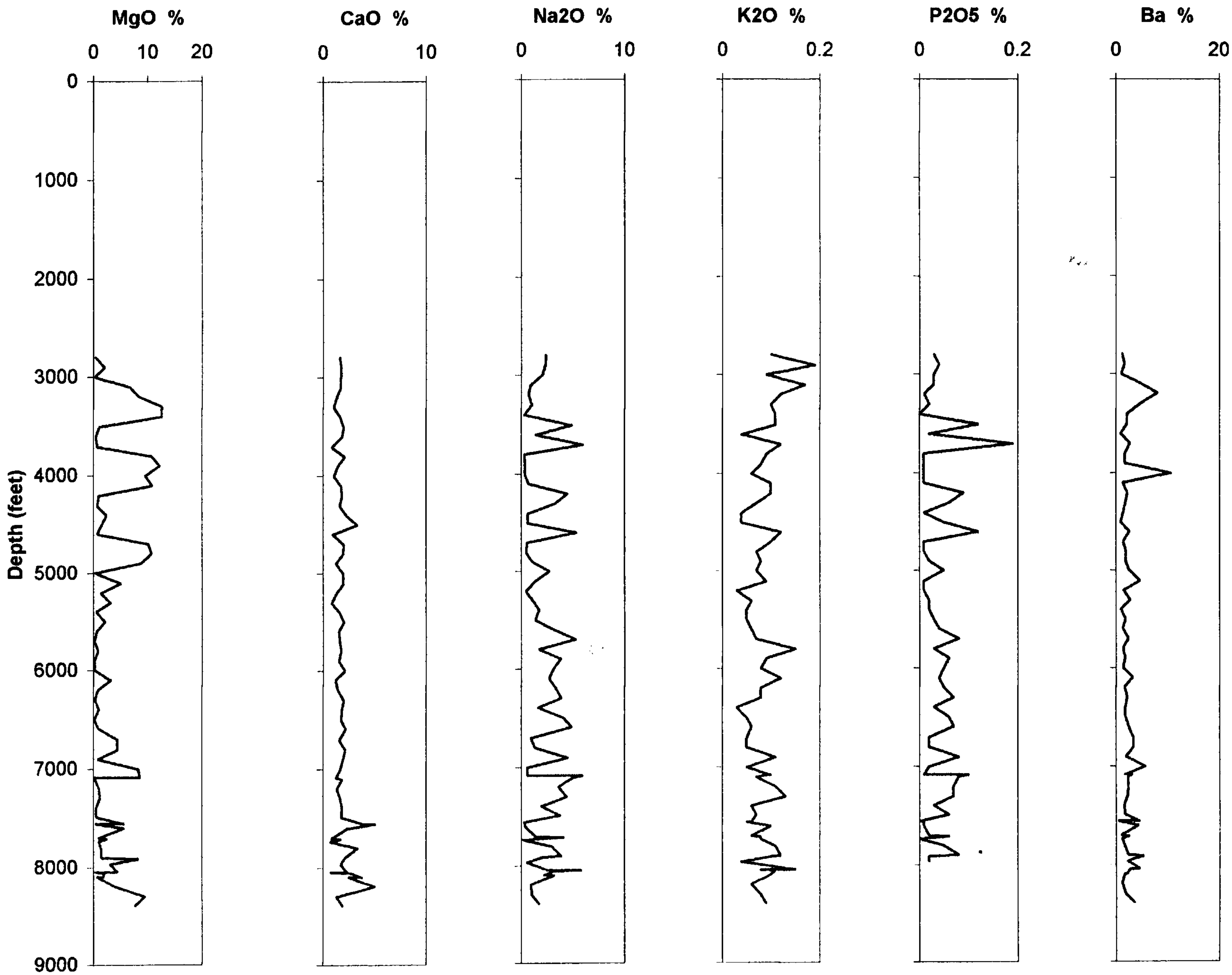
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K2O %
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P2O5 %
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0.2
Ba %
0
20
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
Depth (feet)

APPENDIX 4

DEEP HOLE NORTH OF THE KIMBERLEY FAULT

GEOPHYSICS:

FILE NOTE BY J. LAJOIE ON:

1. **DH UTEM – DDH 6465**
2. **COMPUTER DEPTH IMAGE PROFILING**
3. **SEISMIC FEASIBILITY**

STATUS OF GEOPHYSICAL METHODS FOR EXPLORATION NORTH OF THE KIMBERLEY FAULT - JJL FEB 1997

INTRODUCTION

Electromagnetic and reflection seismic methods are the two geophysical methods that have potential application in the search for an extension of the Sullivan deposit north of the Kimberley fault. The deposit is known to be a good conductor with a conductance value measured at about 200 Siemens, providing a strong contrast with local host rocks. As for seismic properties, there is a seismic impedance (velocity x density) contrast approaching 1.5 between ore rocks and host rocks.

During the fall of 1996, downhole electromagnetio surveying was done in DH 6465 as well as a deep probing surface electromagnetic survey called Conductivity Depth Image Profiling, (CDI), using the UTEM system. Also, testing of a suite of rock samples was done to determine their seismic properties with the goal of being able to do computer modeling assessment of the reflection seismic method.

ELECTROMAGNETICS

During Sept. & Oct. '96, a combined downhole and surface CDI survey was performed jointly by Cominco and Lamontagne Geophysics staff.

CDI SURVEY:

A CDI survey is similar to a standard Utem survey with the main difference being that the line is surveyed using at least 3 different transmitter loops. The multi-fold data is processed using principles akin to seismic data analysis. The result is a conductivity vs depth profile under the survey line. The CDI profile obtained for this survey is attached. The survey was done with a transmitter base frequency of 30 Hz with data from one loop acquired at 7 Hz as a test. Unfortunately, the resistivities encountered in the first 1500M were much lower than anticipated. The maximum penetration depth of the survey is estimated to be only about 1400M. Computer modeling studies by LGL using their Multiloop modeling program, suggests that a 3 km size target at a depth of 2500M in this environment would be at the fringe of detection with the CDI method using a much lower operating base frequency of 2 Hz. Such a survey would require very long reading times due to the low base frequency as well as heavier gauge transmitter wire to maximize transmitter power.

DOWNHOLE SURVEY:

The downhole survey system consisted of a single axial component receiver in the hole, measuring from 4 transmitter loops on surface. One loop was centered over the hole, one was displaced 2 km to the west and another was displaced two km to the east. These provide an E-W component to any anomalous responses. At the end of the survey, it was decided to install a fourth loop displaced about 1 km to the south of the hole to provide some N-S control.

Aside from the low resistivity material found in the top half of the hole, three conductors were identified near the bottom of the hole:

a) A large conductive zone within about 150M of the hole at a depth of about 2500M. It has a large extent to the east of the order of 2 to 4 km, this being required to explain the strong response amplitude with the eastern loop. Conductance is estimated to be at least 40 Siemens. All that can be said about thickness is that it can be no more than about 125M.

b) A conductor very close to the hole at a depth of 2450M. This could be the top sulphide band in the nose of a fold.
c) Another conductor very close to the hole at a depth of 2560M which puts it well within the gabbro intersected in the hole and therefore difficult to explain.

This interpretation was arrived at by LGL using their Multiloop modelling program which attempts to model the electromagnetic response of the earth with a series of plates. More advanced modeling software recently delivered to Cominco is still in the Beta stage of development and requires more time to be useful for this particular application.

Conductor a) above is the target of interest which could well represent the Sullivan deposit on the north side of the Kimberley fault. The 40 Siemen conductance value is a minimum; it could be much higher. To get a better estimate would require a downhole survey at a lower base frequency of at least 7 Hz or even preferably lower. Additionally, LGL's new 3 component probe should be used which would provide much better 3 dimensional interpretation information. The first of these probes was commissioned by Inco Ltd. and is currently being used in Sudbury on production surveys. Informal reports from their geophysicists are that it is working very well. Another probe is being constructed at this time.

REFLECTION SEISMICS.

A study of the velocity/density characteristics of a suite of Sullivan ore and host rocks has been completed. The results suggest that the ore rocks and gabbro sills have sufficient impedance contrast to provide seismic reflections. Computer modeling has not yet been done. The big question is whether or not a sufficiently strong reflection can be obtained from a sulphide horizon to distinguish it from reflections due to sills and the myriad of other reflections usually seen in a typical reflection seismic survey. In the view of this writer, albeit with modest experience with reflection seismics, I think it is doubtful; yet I remain open to other views if computer modeling or other sources can provide evidence to the contrary.

CONCLUSIONS:

1. The CDI survey was not successful at probing down to the target depth of 2500M. The achieved depth was only about 1400m due to resistivities much lower than anticipated in the first 1500M. Repeating the CDI survey with a much lower operating base frequency of 2 Hz would put our target at the fringe of detection capability. Such a survey would cost of the order $40,000. Computer modeling attempts are ongoing to test the viability of such a survey.
2. Single axial component downhole Utem survey of DH 6465 suggests a large conductive horizon extending east of the hole for some 3 - 4 km. It is interpreted to be about 150M away from the hole at a hole depth of 2500M. Conductance is estimated to be at least 40 Siemens. The interpretation could be confirmed and refined by repeating the downhole survey using a lower operating frequency of 7 Hz or lower and using a new 3 component probe. The geophysical cost for such work should be of the order of $30,000. Other costs would involve reopening the hole.
3. As for the potential of reflection seismics, rock measurements suggest sufficient impedance contrast for reflection, but the question remains whether or not a sulphide reflection would be sufficiently appreciable over that of the sills and other reflection events. Computer modeling remains to be done. The cost of a field trial is roughly estimated to be of the order of $250,000. An intermediate step may be a velocity log borehole survey at a cost of some $20,000.00 (??).

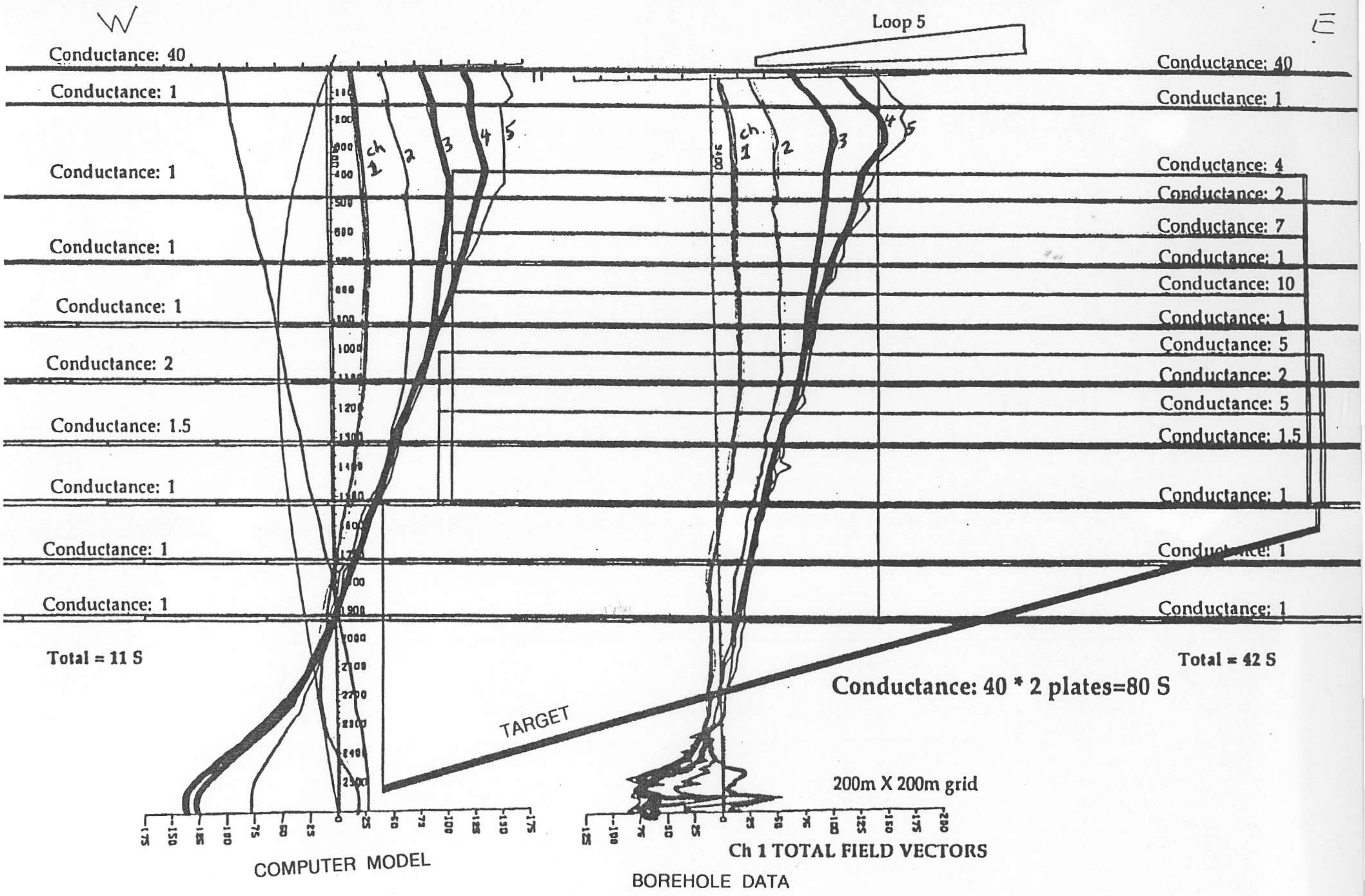
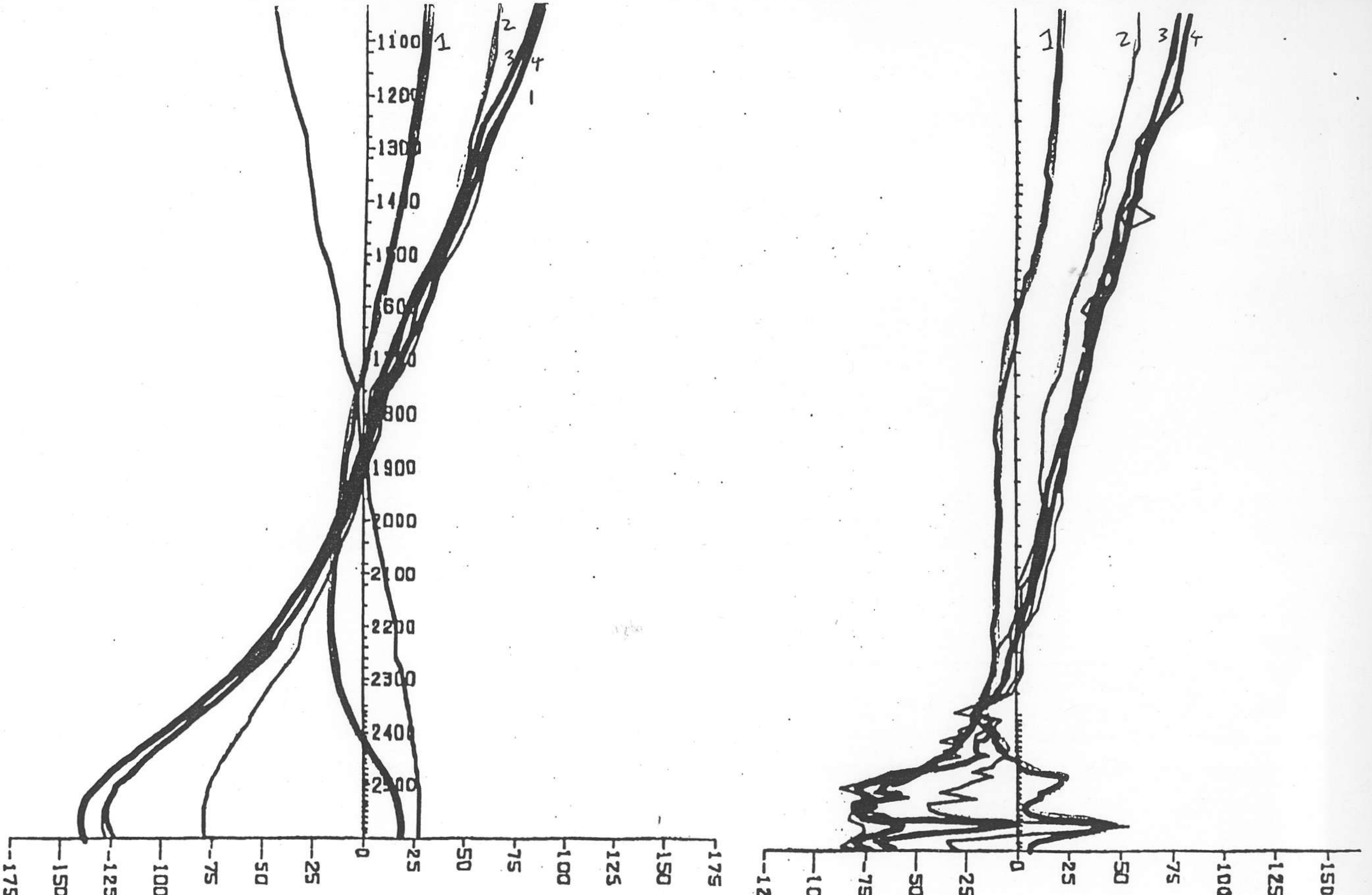


FIG. 8 – Response of loop 5 compared with upward dipping plate model. This dip is needed to duplicate the amplitudes, but current channelling would cause a similar effect. I used two 40 S plates slightly separated to make things stand out. Two plates with less than 20 S each produce diminishing amplitudes.



Calculated secondary field

Observed secondary field

FIG. 9 – Expanded bottom part of Figure 8 at 100 m/cm and 25%/cm.

APPENDIX 5

DEEP HOLE NORTH OF THE KIMBERLEY FAULT

DEEP MINING EVALUATION

FILE NOTE BY J. HANCOCK

FILE NOTE

DATE: November 26, 1996

FROM: J. B. Hancock, Evaluations Manager, Exploration Division

SUBJECT: **Sullivan Mine Deep Hole**

The deep hole at Sullivan was drilled to a depth of 8557 feet and a temperature reading of 80°C was taken. The hole did not intersect the targeted mineralization, but it is understood the geophysics data obtained from the hole indicates the mineralization is there. While a good width intersection would have provided a stronger case for continuation, the obvious questions concern the future actions which should be carried out. Doing nothing is, of course, one option.

On the mining front, people will wonder about the practicality of mining at this depth and temperature. The two major factors which limit the depth to which mining can take place economically, are high rock pressures and high temperatures. The South African gold mining industry have had to deal with both problems, and as a result, are very knowledgeable. A lot of papers have been written on the heat aspect of South African mines. The relative importance of the various sources of heat may change quite significantly from mine to mine, dependent on a number of variables such as depth, mining method and amount and type of equipment used. The writer has commenced a brief study into the heat aspect and this note presents a summary to date.

1. Comparison of the readings of the deep hole at Sullivan with other areas where mining is being conducted in deep and hot conditions gives some perspective of the potential heat problem at Sullivan. One of the factors causing the amount of heat liberated to the ventilating stream depends upon the temperature of the rock when rock is first exposed by mining operations. This is called the virgin rock temperature (VRT). The attached graph from a paper by Malcolm J. McPherson at I.M.M. meeting in London in 1976 has been adapted by the writer. The writer has added a line on the graph for the Mindola Mine on the Zambian Copperbelt from the writer's personal experience and a plot of in hole readings for Sullivan. The Sullivan figures are the down-the-hole readings and the writer is not sure of the relationship of these figures with the VRT figures. The accuracy of the Sullivan figures was questioned by the writer and he was assured that they were reliable figures.

2. Maximum working temperatures should not exceed 30°C. The highest VRT temperatures in South Africa have passed 54°C. The average VRT for South Africa has risen from 37.4°C to 38.6° in the period 1974 to 1988. The deepest workings in South Africa exceed 3.5 kilometers (11, 500 feet).

   The writer is continuing to try and obtain some more data on South Africa mines and deeper North American operations, so this note will have some form of addendum.

3. What does this mean for the Sullivan deep "ore"? The writer does not underestimate the problems and there are many associated with the heat, but it is said that the limitation on the heat loads which can be handled is essentially one of economics. A very large cooling plant would be required in the capital cost with the operating cost being influenced by the cost of power.

   The depth would require a mining method providing good support/pillars etc. The mining plan for extraction of deep Sullivan reserves would be designed to limit certain equipment because of their heat generation. But the plan must also strictly limit the number of people. People who work in such warm temperatures would have to receive special conditioning for these conditions. One immediately thinks of air conditioned cabs for all equipment including jeeps, etc.

There are various routes Cominco can now follow that need to be discussed at a senior level within the company. Among alternatives are the following:

(a) Do nothing and continue with closure plan;
(b) Wedge off the hole to get an intersection of full mineralization
(c) After (b), plan other deep holes with a strategy for the longer term definition of reserves. Sometime in the future a feasibility study would be required.

Technically, the writer is of the opinion that there is a good chance that ore at this depth could be mined with special planning, etc. There is little doubt that the Sullivan Mine reserves will be depleted prior to any completed feasibility. When the writer last looked at this project, a few suggestions were made, such as bringing in a partner or forming a separate company, once the mineralization has been confirmed by a couple of intersections. The idea of bringing in a partner or diluting Cominco's interest in a small company would be to spread the risk, but it would be necessary to show the potential rewards as well. A copy of this proposal from the earlier note is attached.

J. Barrie Hancock/krv

Attachments

cc: GDT
WPA
WJW
DWM
PWR

FINANCING OF SULLIVAN

MINE NORTH OF KIMBERLEY FAULT

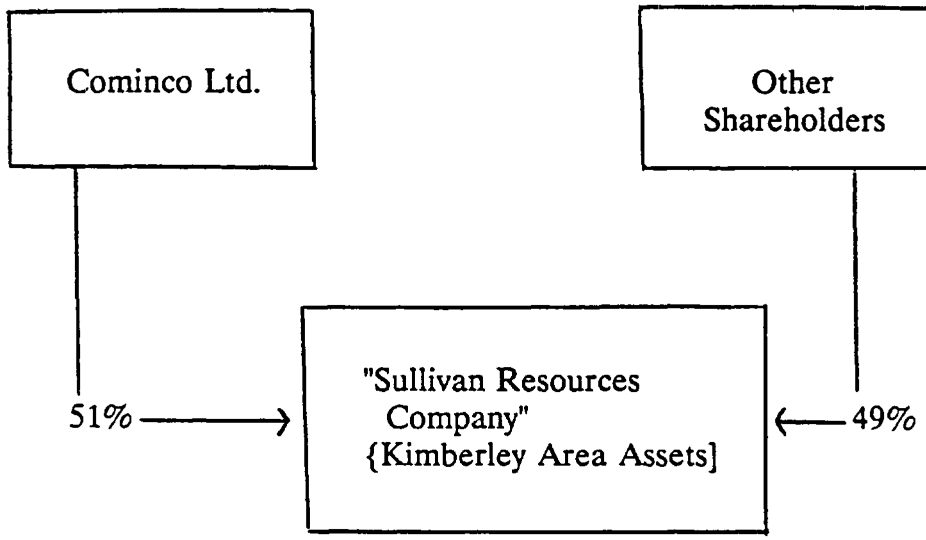
It may be a little premature to be considering financing the delineation and development of the deposit not yet confirmed. However, in the same context that the writer considers the deep ore technically and economically mineable, and the fact that previous decisions within Cominco have shied away of proceeding with this exploration, it should be pointed out that it is possible that funds can be raised from outside investors for this project.

Apart from the high interest in the Mining Community that such a discovery would generate, it is considered that a farm-out of an interest could go at least two routes:

1. A J/V with another major who would pay a significant farm-in fee.

2. Form a separate company such as the "Sullivan Resources". Cominco would place all the Kimberley area assets into the company. A 40% to 49% equity interest would be sold to the public with the funds from shares remaining in the company. Some of the funds could be designated or bonded for future environmental work, but a major portion would be designated for the deep development.

EQUITY OF NEW COMPANY



The advantage for Cominco is that a major feed for Trail would continue at minimal cost. Even if someone wanted to purchase the remainder of Cominco's equity, the likelihood is that Trail would still get as much concentrates as it needs.

From File Note dated Dec 15, 1994.

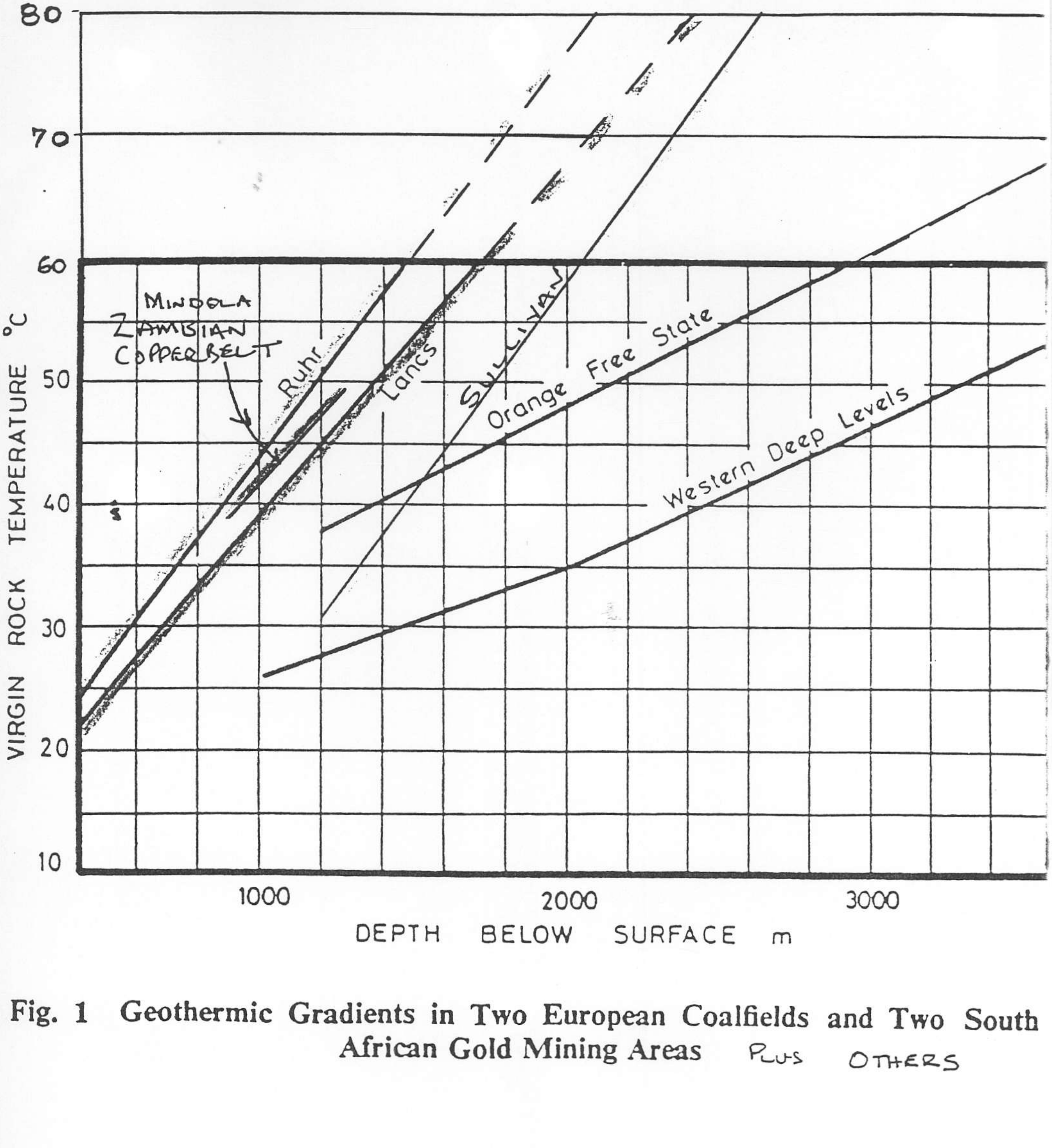
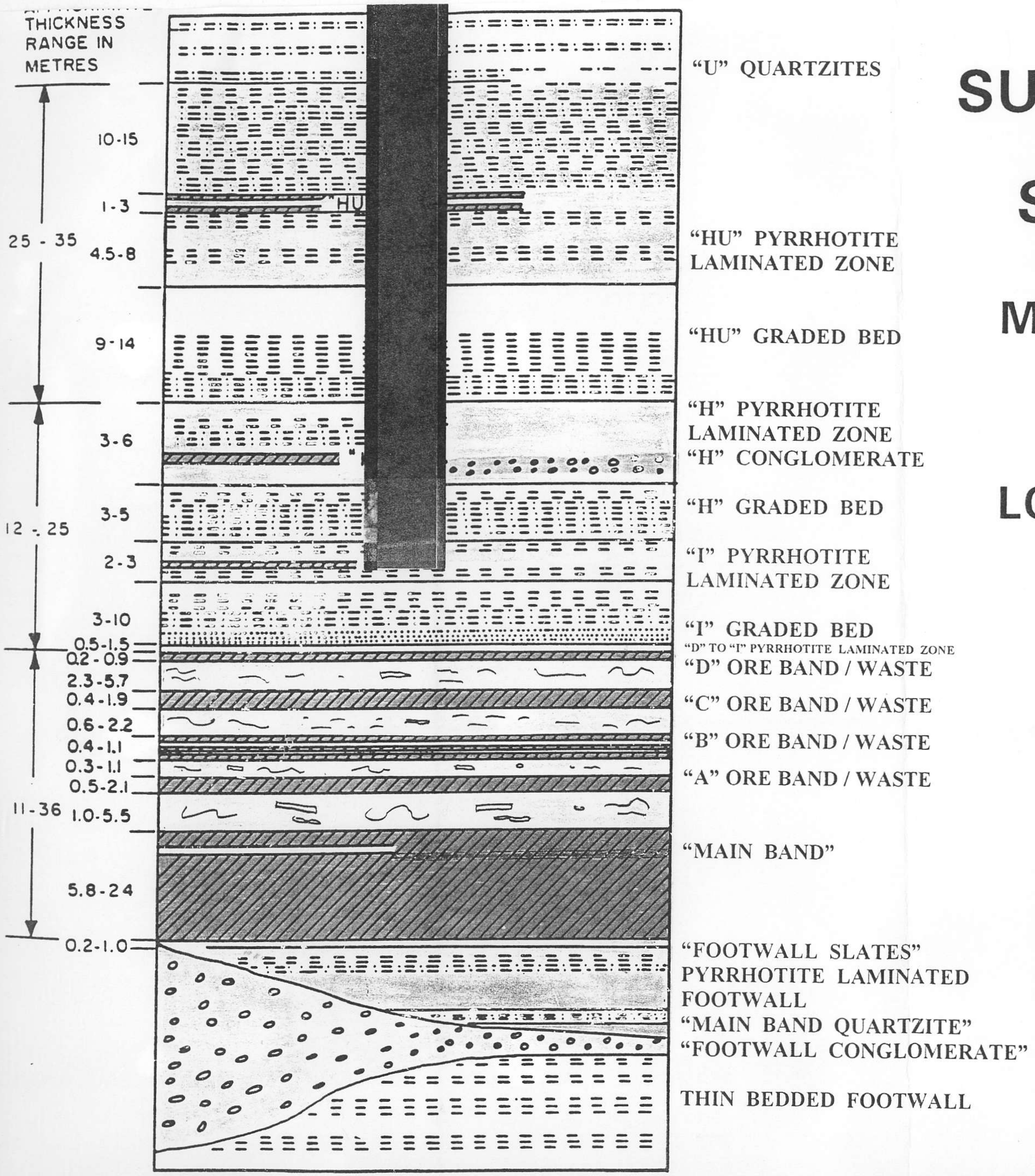


Fig. 1 Geothermic Gradients in Two European Coalfields and Two South African Gold Mining Areas PLUS OTHERS



SULLIVAN SUB-BASIN STRATIGRAPHY

MIDDLE ALDRIDGE FM.

QUARTZ ARENITE TURBIDITES

LOWER ALDRIDGE FM.

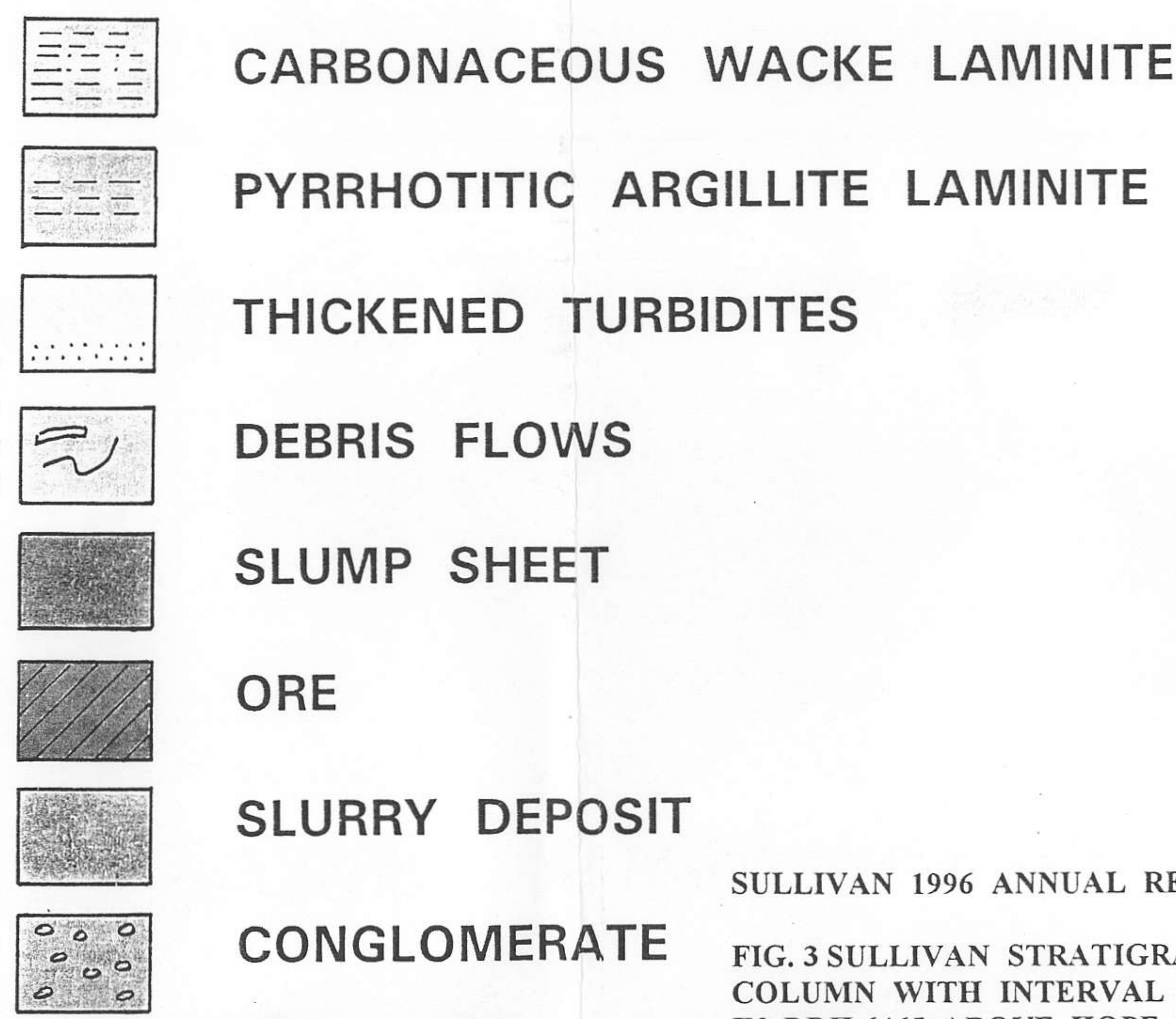


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FIG. 3 SULLIVAN STRATIGRAPHIC COLUMN WITH INTERVAL CORED IN DDH 6465 ABOVE HOPE FAULT SHOWN IN GREEN

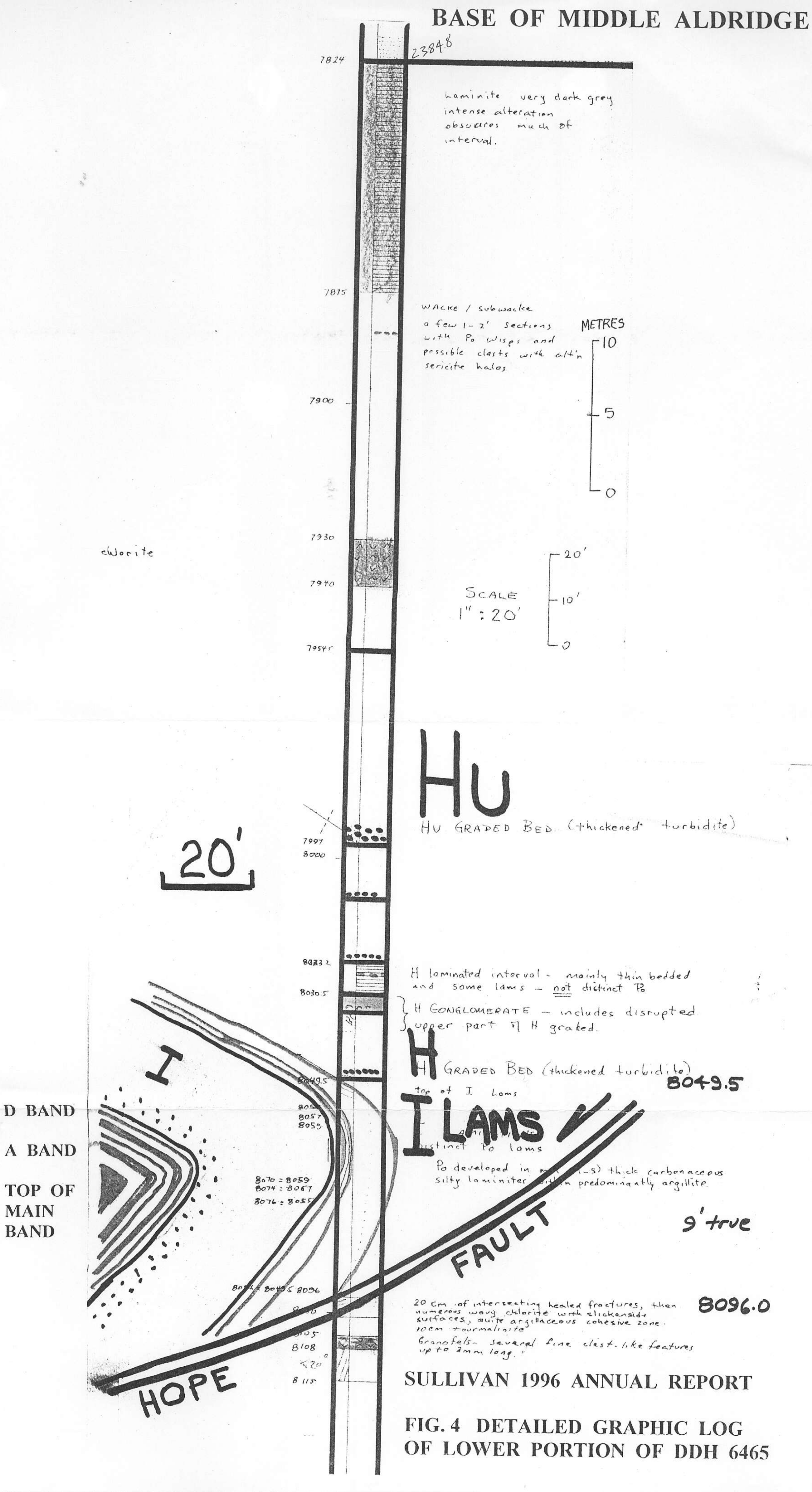

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FIG. 4 DETAILED GRAPHIC LOG OF LOWER PORTION OF DDH 6465