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WHITEHORSE COPPER MINES
SUMMARY OF
REMAINING EXPLORATION TARGET AREAS

by
A. Hureau
May 1982

- Notes:
1. Attached sketches (Fig. 2 to 9) may be from earlier reports.
Please refer to for geological mapping only.
 2. Appendix 1: Evaluation of Exploration Targets in the Whitehorse Copper Belt, Yukon by G. Morrison, 1974.
 3. Appendix 2: References to Budget Proposals for 1980-1982
by A. Hureau.

Introduction

The following areas on the Copper Belt should be considered, if economic conditions improve and the development of small to medium sized copper deposits becomes attractive.

Target areas are listed from north to south and not in order of preference; North Star, Arctic Chief, and Cowley Park are considered to offer the best potential. Some areas, e.g. north of War Eagle, would only be considered if high prices allowed for the mining of much lower grade than is currently economic. Zones which have good grade, low tonnage potential, e.g. north of Arctic Chief west and Cowley Park south may be considered if production from these zones could supplement production from larger mines.

Results of the airborne Mag-E.M. survey '81 have not yet been studied in detail. No anomalies were plotted on preliminary sheets over the North Star and Arctic Chief pendants. An anomaly was detected near the east end of the Cowley Park main zone. Data from the survey should be reviewed when available, in conjunction with geological and ground geophysical information.

Areas of the Belt should be re-evaluated when any geophysical breakthrough or refinement of existing methods make heavily overburden covered areas or areas which may contain deeply buried blind deposits more amenable to exploration. Refinement of seismic methods may make these techniques applicable to help define stratigraphic contacts at depth.

The further development of stratigraphic models and recognition of different carbonate facies in areas where they have been recrystallized, near the intrusive, may help to more accurately predict targets at depth. The existence of limestone, skarn and mineralization under diorite and dioritized quartzite at North Star, Grafter, and the south end of Little Chief should caution against rash projections of intrusive contacts from surface which make zones appear too small to be attractive.

Geological controls for ore deposition are summarized by G. Morrison in the 1980 budget proposal. The paper is attached as appendix 1.

1. War Eagle Area

Ref. Exploration Budget Proposal 1980

- a) Two holes proposed for under the War Eagle pit in 1980 were not drilled. Funds were diverted to areas considered to be more attractive. In addition mineralization on the east side of the zone (53 E, sect 77 N elev 2600') has not been followed down dip and to the south.

b) North of Pit

Low grade mineralization on sect 103 N (386' @ 0.31% Cu) could be tested up and down dip.

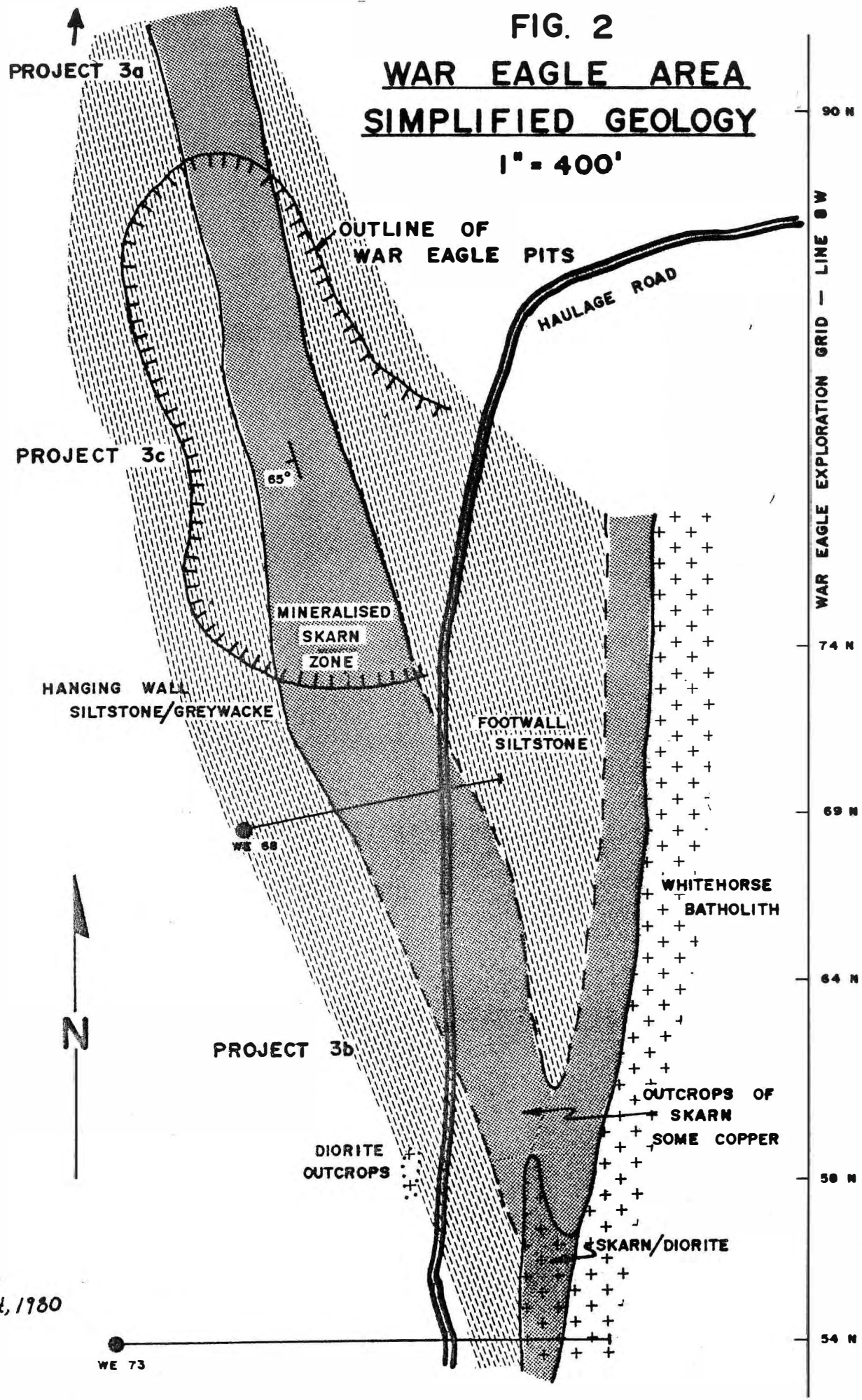
2. Rabbits Foot Canyon, Anaconda, Rabbits Foot, Ruby

Ref. 1981 Budget & Summary & Proposal G. Morrison & A. Hureau Sept. '80.

The area should be reassessed. A detailed mag survey around

FIG. 2 WAR EAGLE AREA SIMPLIFIED GEOLOGY

1" = 400'



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Sept, 1980

granodiorite plugs west of the highway, 1000-1500' north of the turnoff to the dump road, should help delineate the contact with limestone outcropping on the east side of the highway. Drilling should be considered to check the limestone-quartzite intrusive contact, near the highway, 1200' north of the Fish Lake turnoff. Hole RF2 drilled by HBED in 1973 was stopped only a few feet past skarn in diorite.

No anomalous IP or mag results were obtained over the sediments-intrusive contact east of the highway and north of McIntyre Creek. Drilling would appear to be the only way to test this contact at depth.

3. Copper King - Carlisle

This large pendant contained several small lenses of high grade ore. Only two deep holes have been drilled to test the zones under the workings. A third hole between the Copper King & Carlisle workings should be considered. Any new holes drilled in this area should be checked for tungsten.

IP using north-south lines (strike of zone is east) done in 1964 used only a 200' separation; check lines using wider spreads should be done on N-S lines.

4. Pueblo-Gulch

Ref 1981 Budget

A narrow (15.6') good grade (2.81% Cu) intersection in PB 16, in 1981, north of the Pueblo mine has not been followed up.

The sediments-intrusive contact west and north of the Pueblo pendant has NOT been tested. The area is heavily overburden covered and should be considered if a workable geophysical method for detection of deeply buried, poorly conductive, deposits evolves.

5. Pueblo to Bork Lake

Ref. 1980 Budget # 3&4

1981 Budget # 6a & 6b

1982 Budget # 10

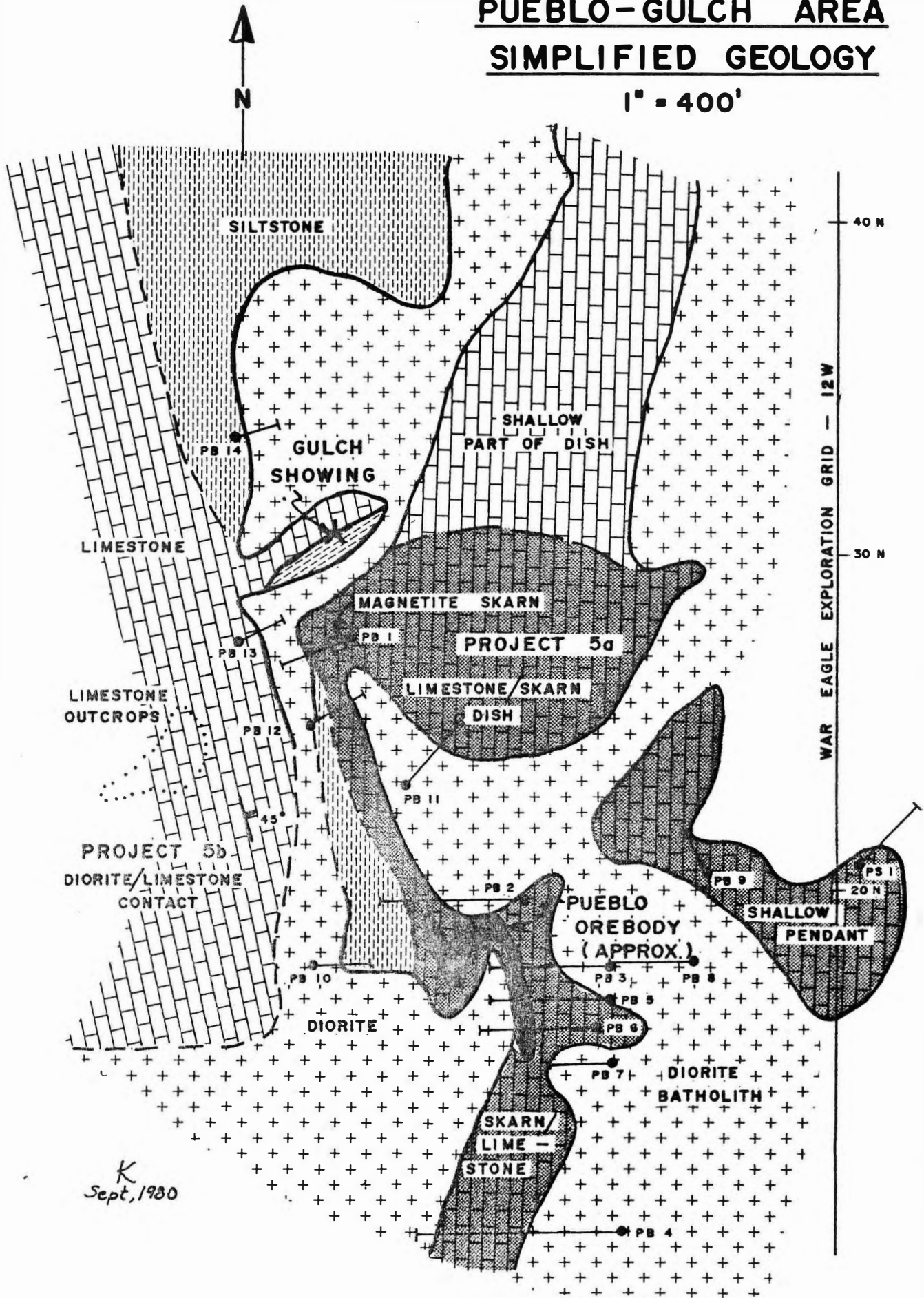
Results of the airborne survey, prospecting and extending the ground mag coverage to the west may help establish the intrusive-sediments contact. IP or possibly EM may detect mineralized zones near the contact.

6. Spring Creek

Hole B.C. 46 drilled under the Spring Creek workings intersected traces of copper at the limestone skarn contact. An 800' hole should be considered to test the contact deeper in the pendant. (see Spring Creek off section 577 E - NIM)

FIG. 3 PUEBLO-GULCH AREA SIMPLIFIED GEOLOGY

1" = 400'



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FIG. 4

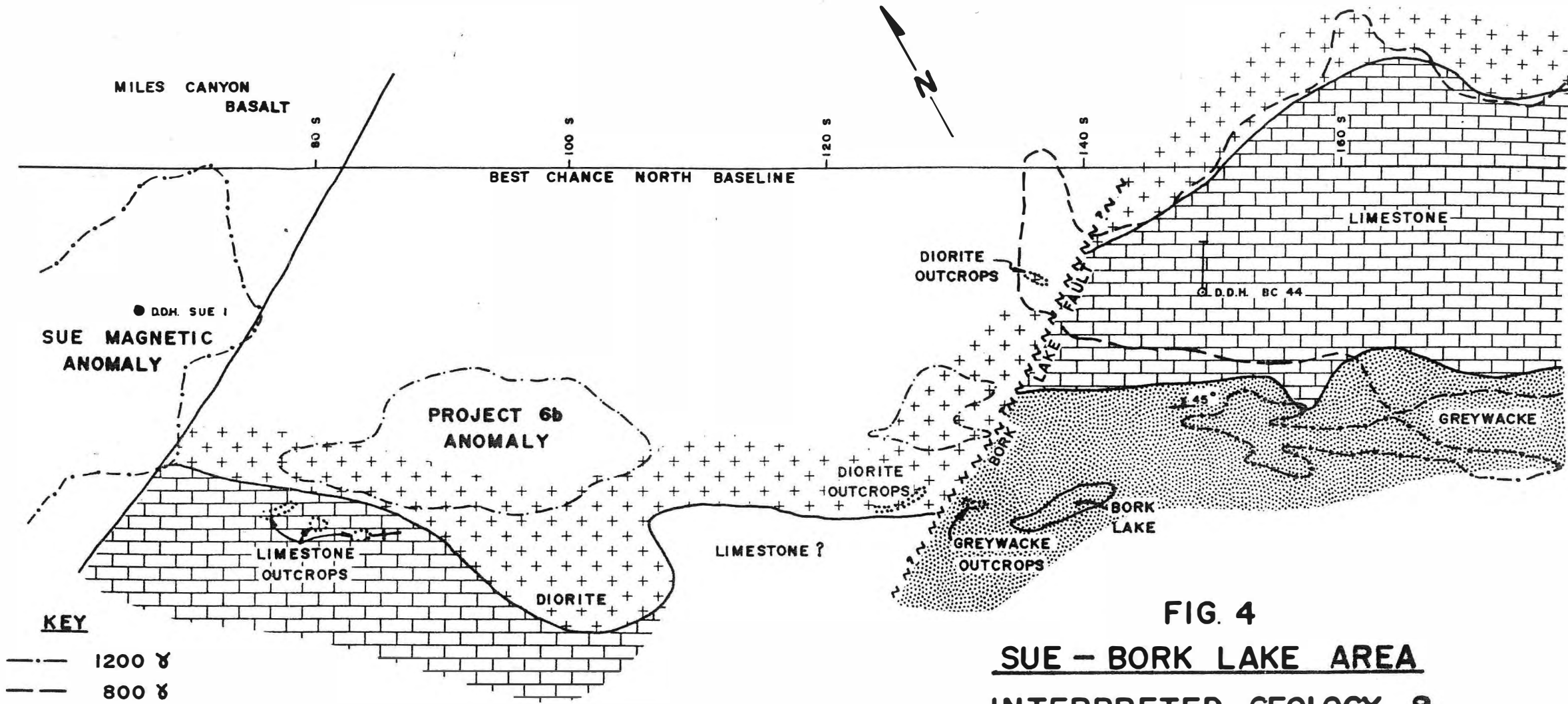


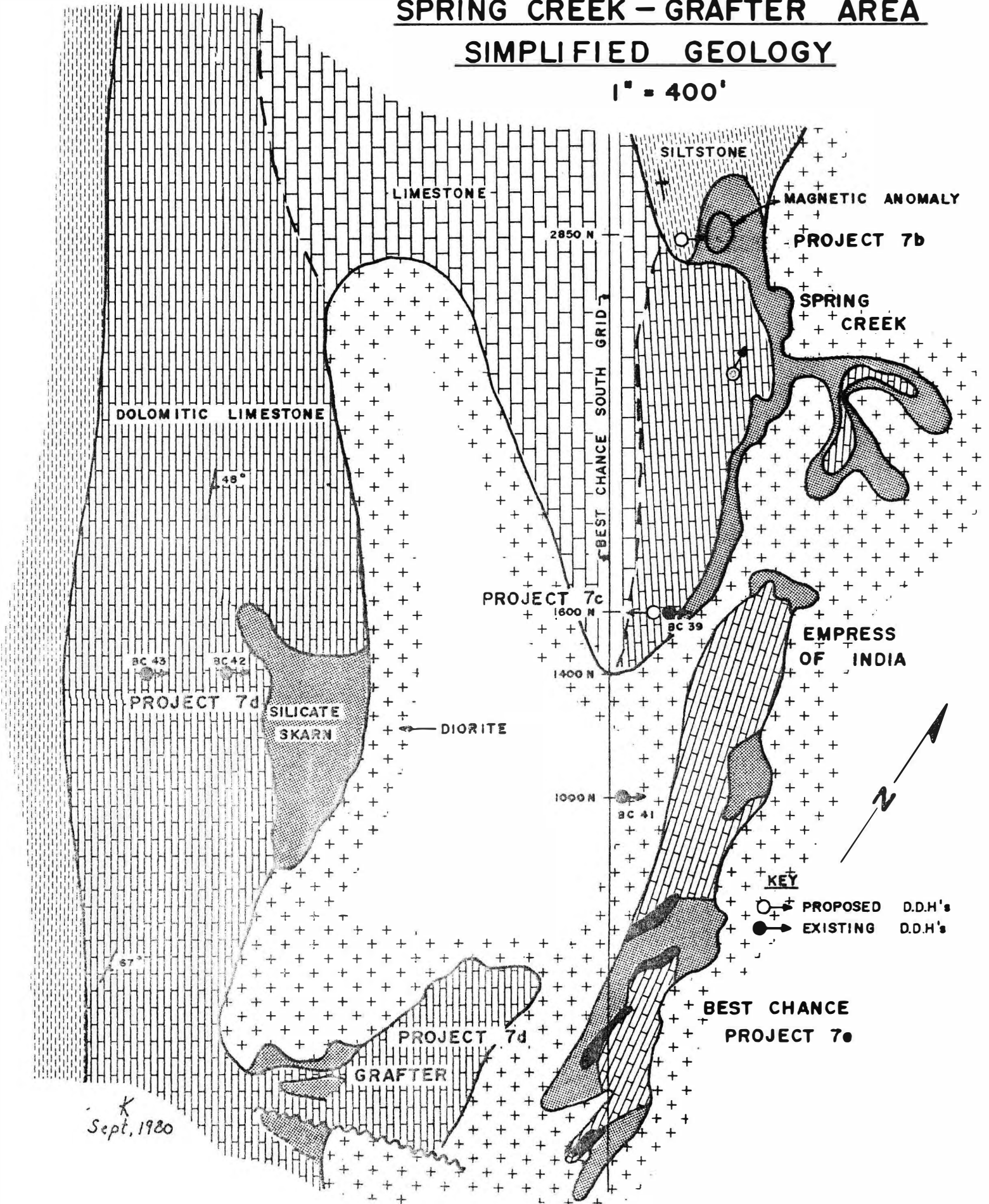
FIG. 4
SUE - BORK LAKE AREA
INTERPRETED GEOLOGY &
MAGNETIC ANOMALIES

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FIG. 5

SPRING CREEK - GRAFTER AREA
SIMPLIFIED GEOLOGY

1" = 400'



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Sept, 1980

7. Grafter-Best Chance

Short good grade intersections obtained by HBED in 1972 viz:
6W, 20' @ 1.48% Cu 900' below surface.
9W, 20' @ 3.95% Cu 520' below surface & 19.5' @ 2.32% Cu 540'
below surface, should be followed up. Much of the diorite and
dioritized clastic sediments outcropping or suboutcropping is
underlain by limestone and skarn. Drilling results at Grafter
may suggest drilling deep holes under Best Chance.

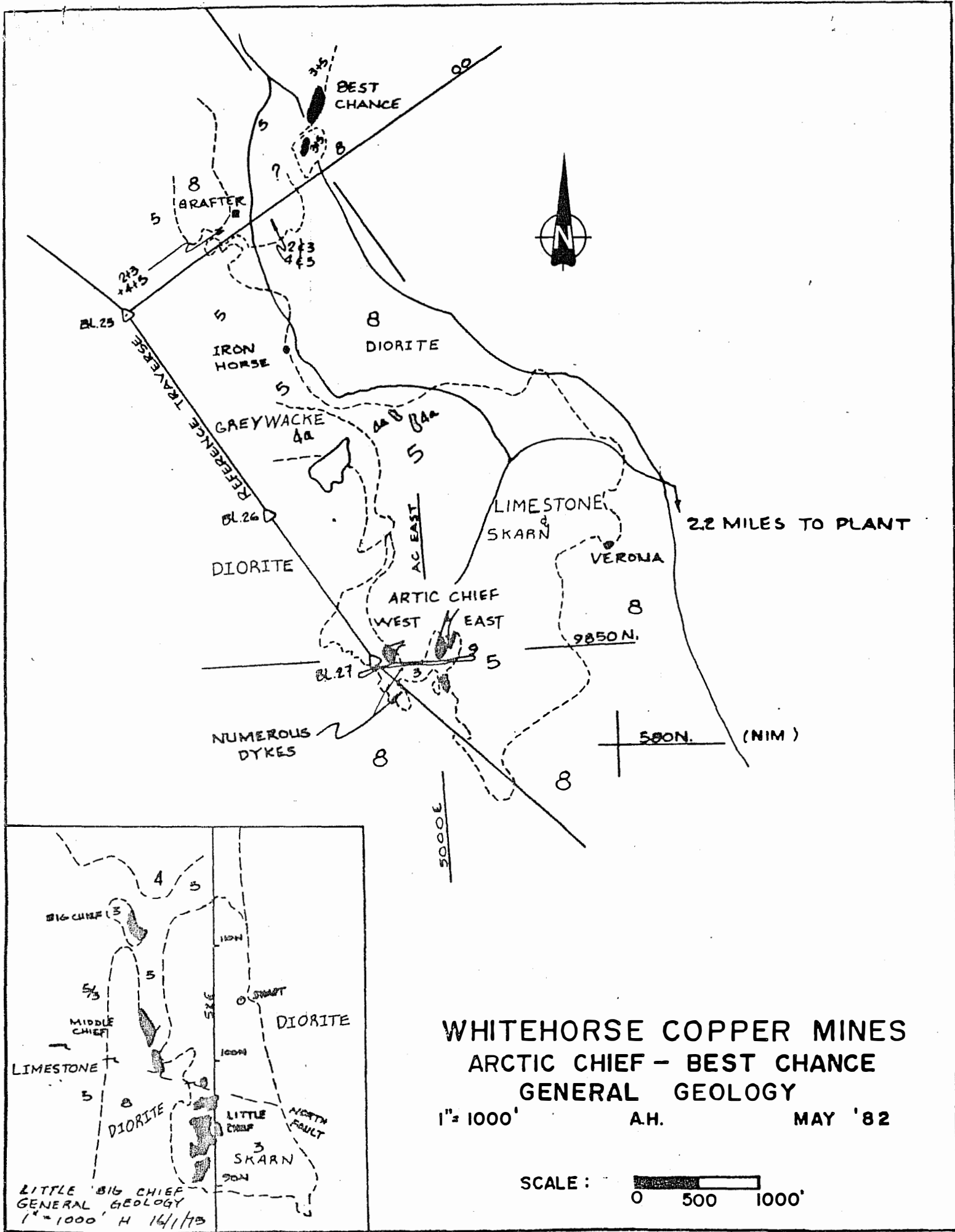
8. Arctic Chief-Verona

The Arctic Chief pendant has approximately twice the dimensions
of the Little Chief pendant (Fig. 6). Work to date has been
concentrated on mining of and exploring the small good grade
zones near the west contact of the pendant. Some potential
still exists for establishing small tonnage reserves north and
south of the pits. Hole AC 49 on sect. 102N could possibly be
deepened by reducing to AQ core, to determine whether mineralized
magnetite skarn continues below the intersections in AC 47 &
AC 48. Drilling to the south was hampered by the existence of
numerous irregular dykes which strike perpendicular to the
sections and were intersected in critical areas at very low angles
to the core. Any drilling program in the area should include
provision for directional wedging if dykes are intersected in
critical areas.

Four holes have been drilled to test the east contact of the
pendant. Results indicate that: (1) the intrusive contact is
steep and may be dipping to the east; (2) the footwall
quartzite steepens and may parallel the intrusive contact; (3)
dolomitic limestone and skarn extend to depths in excess of 2300'
below surface.

A comparison with Little Chief geology (Fig. 7) suggests that the
depth at which the limestone quartzite contact is sufficiently
near the intrusive to be skarnified may, unfortunately, be in the
order of 2000'. However, the available strike and dip distances
of the contact, the nature of the Arctic Chief mineralization
(similar to Little Chief & with good gold content) and the
location, two miles from the plant could still make exploration
of this contact attractive.

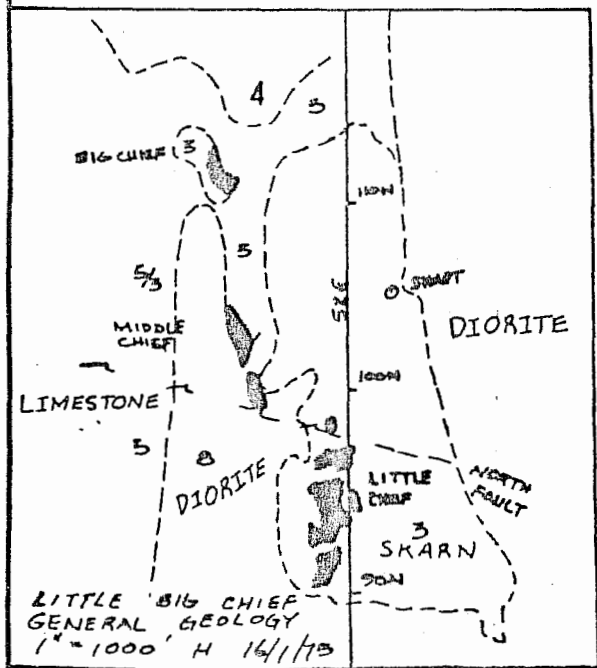
Drilling to establish at depth the dip of the F.W. quartzite on
sect. 9850 N or 108 N is recommended as the first step in
evaluating the east side of the pendant. One of the two holes
suggested on sect. 9850 N should establish both the dip of the
quartzite limestone contact and that of the diorite to the east.
Hole AC 58 sect. 108 N, is open to 2040' and could probably be
deepened by: (1) reaming the hole to 900' past bad ground and
water courses from 750' to 850', (2) putting down N casing to
900', (3) putting in a bypass wedge at 2040' and continuing to
drill NQ. The hole could be reduced to BQ if further difficulty
is encountered. Wedging the hole to flatten it should be
considered if the quartzite is not reached after several
hundred feet.



**WHITEHORSE COPPER MINES
ARCTIC CHIEF - BEST CHANCE
GENERAL GEOLOGY**

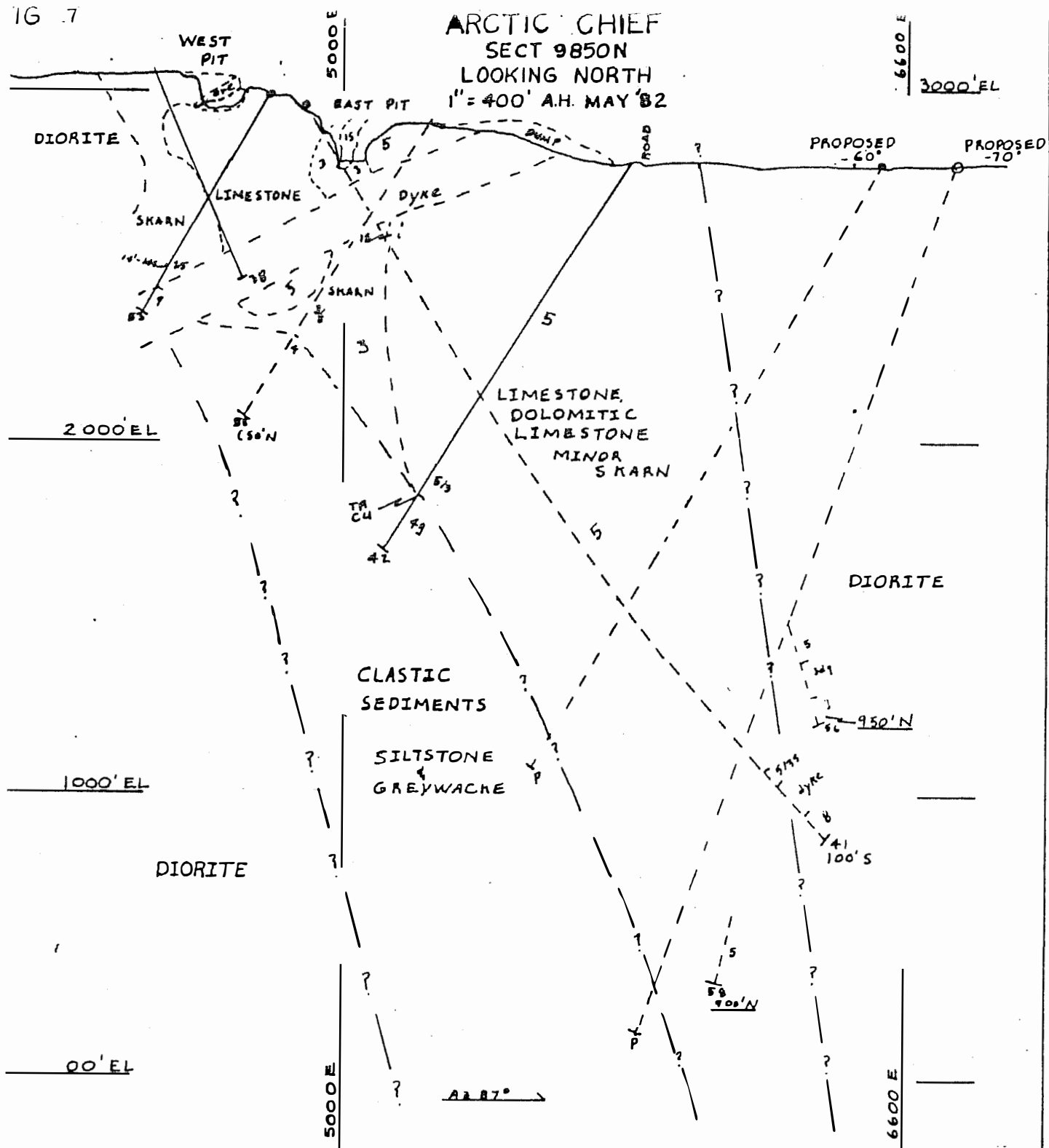
1" = 1000' A.H. MAY '82

SCALE: 0 500 1000'

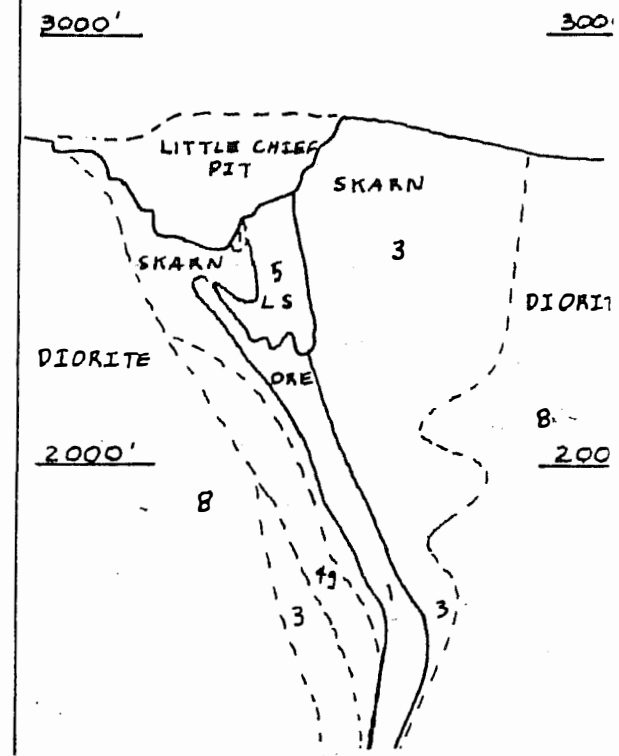


16 7

ARCTIC CHIEF SECT 9850N LOOKING NORTH 1" = 400' A.H. MAY '82



LITTLE CHIEF SECT. 9250 LOOKING NORTH 1" = 400' A.H. MAY 82



8. Arctic Chief-Verona (continued)

Hole AC 58 passed through 50' of dioritized clastic sediments from bedrock before entering limestone. Much of the dioritized clastic sediments mapped in the Verona area may be underlain by limestone and skarn. A magnetic anomaly 250' long and 100' wide exists around the Verona trenches. The mag survey was done on lines near parallel to the zone. The survey should be redone using north-south lines. Banding in quartzite 400' SW of Verona strikes NE & dips 70° SE. A hole drilled to the north from approximately 105 N, 6575 E, is suggested to check the Verona mineralization which may extend to the southwest, under the clastic sediments. Drilling in this area may be helpful in establishing the dip of the intrusive contact on sect. 108 N.

9. North of Middle Chief

Consideration should be given to checking more thoroughly the Middle Chief contact north of the underground workings. Unfortunately, part of this contact is under the mill complex but some room does exist north and south of it.

A 1000' hole drilled at -55°W from 5615 E on section 110 N or 10950 N is recommended.

10. North Star-Valerie

(see Summary Report & Recommendations A.H. May '82).

11. Copper Cliff

Ref. 1981 budget proposal.

The Copper Cliff pendant has not been tested by drilling. A detailed mag survey and mapping, possibly to be followed by an IP survey and drilling, should be considered.

12. Gem-Brown Cub-Cowley

There appears to be little chance of improving reserves of known zones in this area. If Gem should become economic the smaller zones (Black Cub North-Kodiak Cub) should be reassessed.

The limestone-quartzite intrusive contact east of Black Cub south in the Brown Cub area is weakly mineralized. No geophysical targets are known along this buried contact which extends for two miles east to Cowley Creek. IP has delineated the limestone (graphitic) - intrusive contact and small weakly mineralized skarn zones have been drilled 4000' south of the Cowley Park main zone. Copper bearing skarn zones whose IP response has been masked by that of graphitic limestone could exist along this contact. If a geophysical method evolves which could distinguish these deposits, its application should be considered in this area.

13. Cowley Park Main Zone

Additional drilling on this zone would be for pit definition if the zone became economic with possible small increases in reserves.

FIG. 8

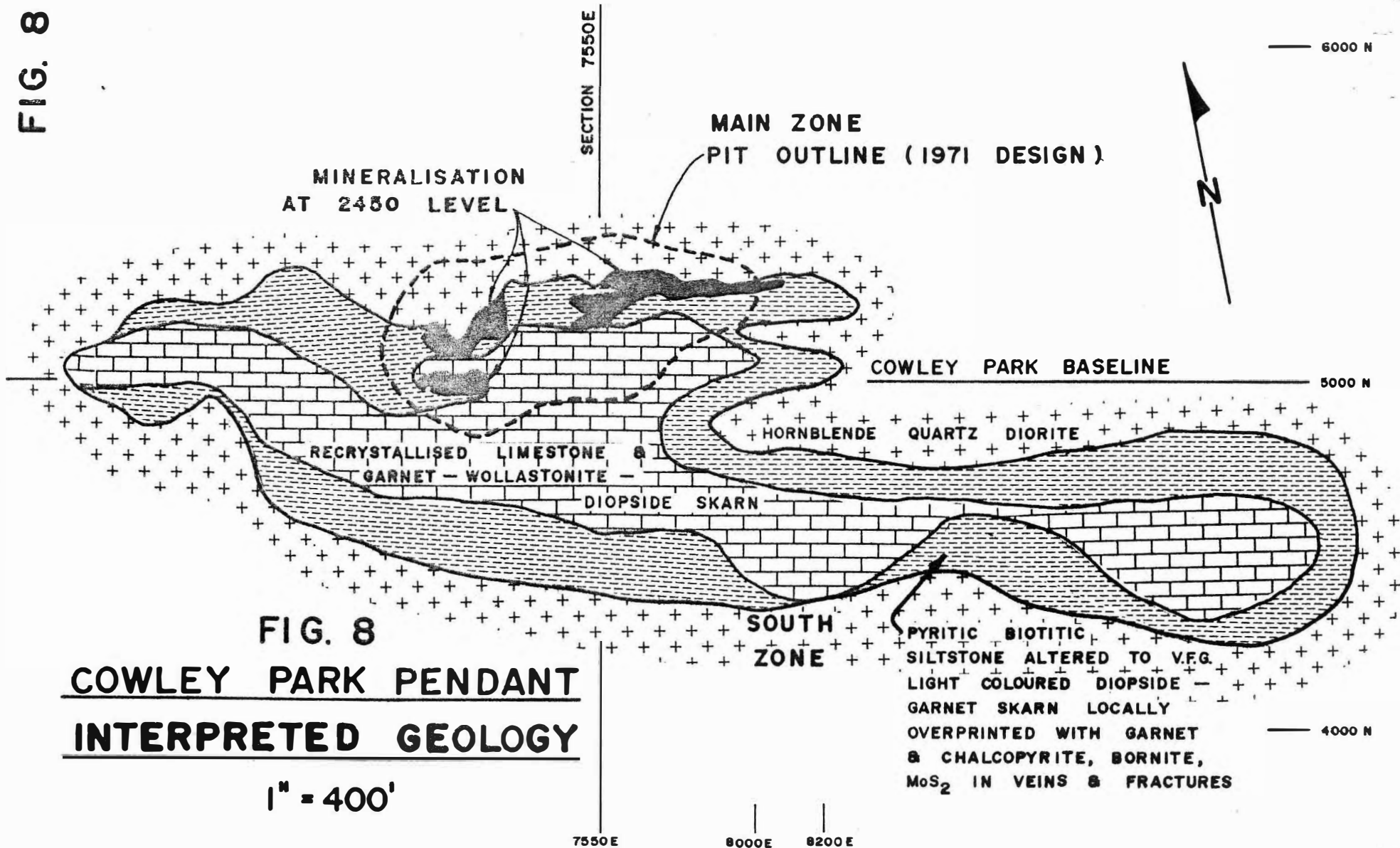


FIG. 8
COWLEY PARK PENDANT
INTERPRETED GEOLOGY

1" = 400'

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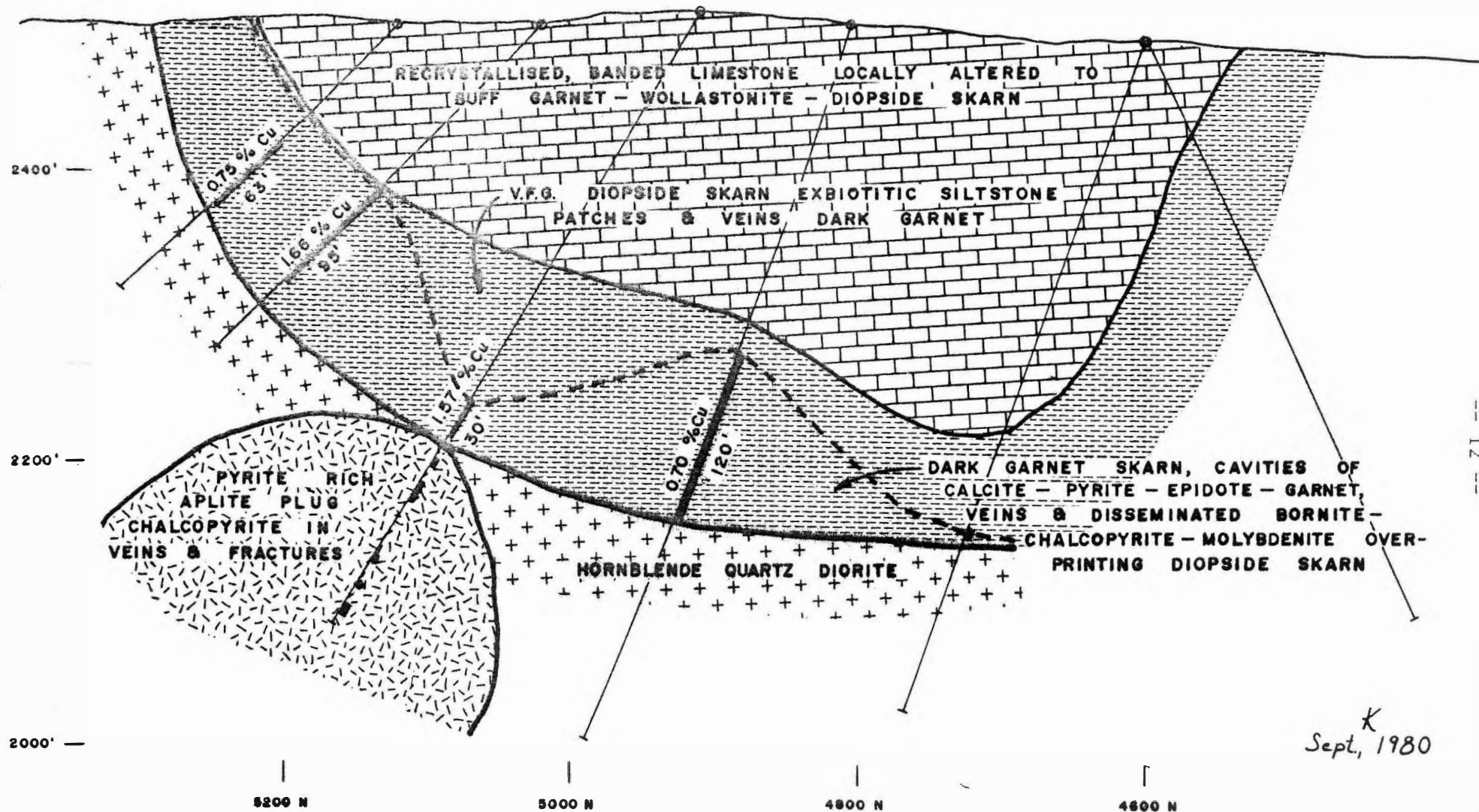
FIG. 9

FIG. 9

COWLEY PARK SECTION 7550 E

Az. 10°54'24"

1" = 100'



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Sept, 1980^K

14. Cowley Park South
Ref. 1982 Budget Proposal

Reserves on this zone could probably be improved by drilling along strike to the east and west. Orientation EM surveys should be done and if correlation with known zones is present, the surveys should be extended to the east to help delimit the mineralization.

EVALUATION OF EXPLORATION TARGETS

IN THE WHITEHORSE COPPER BELT, YUKON

Gregg Morrison
University of Western Ontario
London, Ontario
August 16, 1979

COPPER BELT PROJECT

Objective: Evaluation of ore potential in the Copper Belt in the light of structural, stratigraphic and skarn petrologic concepts.

Long term comprehensive project of Copper Belt exploration potential based largely on diamond drilling of geological targets below depth of geophysical surveys.

Background: Majority of exploration to date has been based on shallow drilling of geophysical anomalies (particularly I.P.) commonly resulting in shallow termination of drill holes on explanation of the anomalies. The majority of known geophysical anomalies have been tested. Discovery of major orebodies (eg. on the scale of the Little Chief deposit) requires deeper drilling and where there is no immediate surface expression of such bodies, geologic concepts are required to guide drilling.

Approach: The method used here to define drilling targets requires the definition of general ore control parameters, then for specific target areas development of a model of the ore environment by comparison with known occurrences with similar ore control parameters. The major ore control parameters fall into three groups 1) Structure 2) Stratigraphic 3) Skarn petrology.

Ore Control Parameters:

1) STRUCTURAL:

The single most important characteristic of the mines and occurrences along the Copper Belt is location of mineralized skarn in pendants of upper Triassic Lewes River group carbonate and clastic rocks within the margins of the mid-Cre taceous Whitehorse Batholith.

The batholith is homogeneous in composition and consists approximately 80% of hornblende quartz diorite, locally with a margin of hornblende diorite containing partly digested inclusions of country rocks and with local quartz monzonite. There is no mappable zonation of intrusive phases within the batholith and apart from pervasive saussuritisation and chloritisation there is a notable absence of hydrothermal alteration and mineralization that would indicate the passage of large volumes of ore forming fluid through the batholith. There is local development of endoskarn within the batholith near the margins of some pendants and at the base of some pendants sheeted quartz veins carry mineralization (eg. reservoir lake). Dike swarms of tertiary age are responsible for the "porphyry-type" mineralization at the Keewenaw Pit.

The distribution of skarn assemblages within the pendants and isotope work suggest the pendant shape provides a restricted zone of circulation of fluids with results in more intensive skarnification and mineralization.

In general, massive skarn development appears restricted to a zone within three hundred feet of the batholith contact and consequently pendants that are narrow (say less than 800 ft. wide) elongated and deep hold the best ore potential (Little Chief pendant). Shallow "U-shaped" pendants have restricted volume and hence more limited ore potential (Cowley Park main zone).

The margin of the intrusion in the absence of pendants may also have some skarn and ore potential. For example "V-shaped" "semi-pendants" bound on one side by the batholith and on the other by clastic sedimentary host-rocks should be investigated at least on a reconnaissance basis (see Grafter-Best Change exploration targets). There is also a pendant formed by the convergence at depth of the Whitehorse batholith and the Mt. McIntyre batholith in the vicinity of the Pass Lake showing. Two mines (War Eagle and Black Cub South) do not appear to be associated with pendants, consequently an open mind should be kept about the nature of sediment/intrusive contacts.

2) Stratigraphic

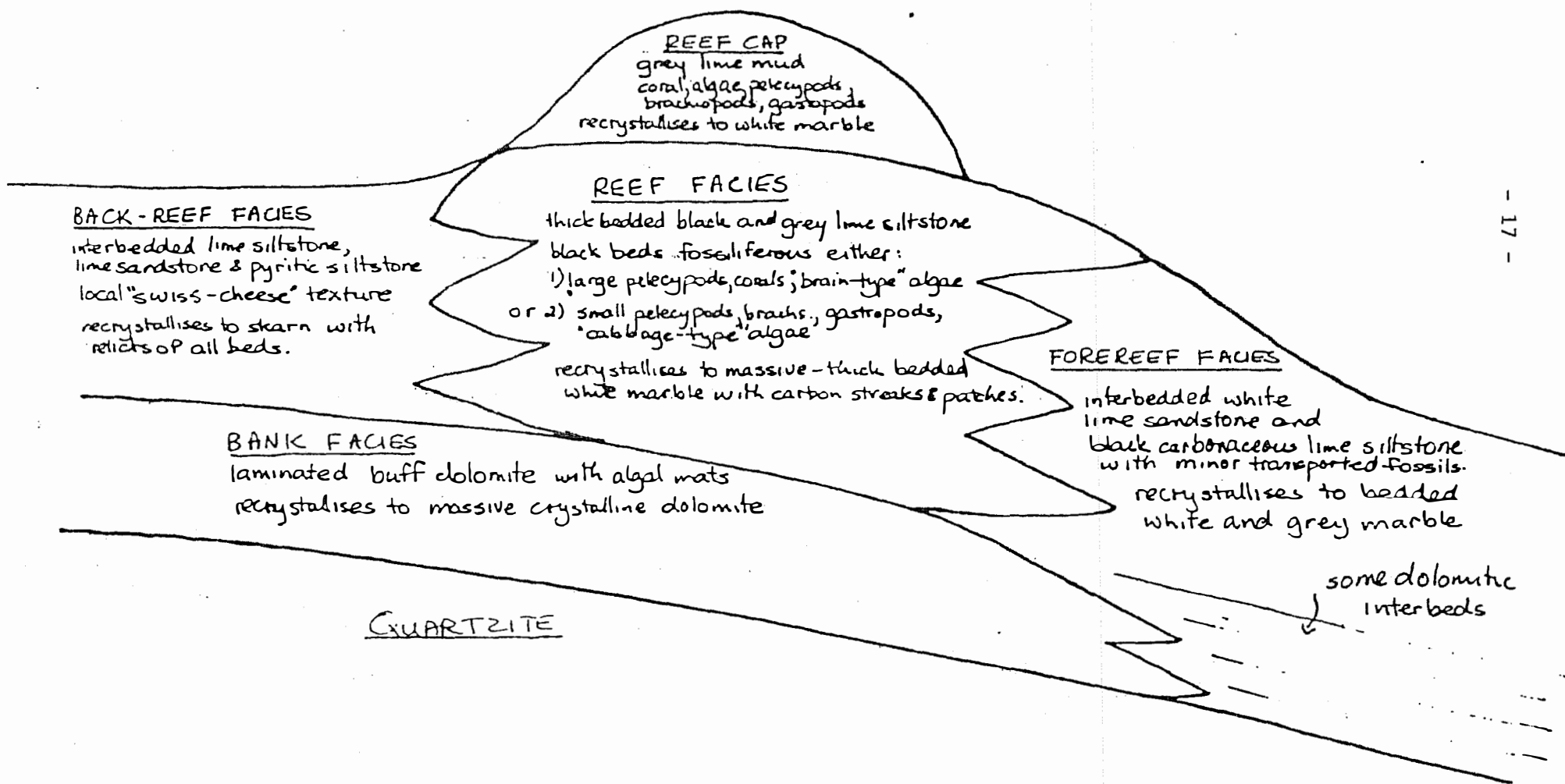
The skarn that hosts the ore in the Little Chief deposit is developed in carbonate rocks adjacent to the contact with the clastic unit generally referred to as "quartzite". A similar relationship also exists at several other deposits and showings in the Copper Belt. Recent regional mappings of the Lewes River carbonate rocks and comparison with those exposed in the Copper Belt also suggests that specific lithologies within carbonate reef complexes develop different kinds of skarn assemblages and different types of orebodies. See appendix 1. The carbonate reef complexes in the Whitehorse Copper Belt rests upon the quartzite unit and consists of four main facies. The back-reef facies, typified by exposures north of the CNT road on Mt. McIntyre and the west wall of the War Eagle pit consists of interbedded pyritic siltstone, lime sandstone and/or dolomitic siltstone and either overlies the bank or reef facies or lies directly on the quartzite unit. The bank facies, typified by exposures on the base of the cliffs west of the Little Chief deposit, consists of laminated algal, dolomite locally interbedded with algal, laminated, black carbonaceous limestone and oyster beds, as occurs below the back reef and reef facies. The reef facies, typified by the upper part of the cliffs west of the Little Chief mine and by exposures west of the gate on the War Eagle haulage road consists of thick-bedded, black, carbonaceous limestone containing either large pelecypods with minor interstitial pelecypod debris, gastropods, brachiopods, solitary corals, sponges and algae; or above the faunal assemblage without the pelecypods. This lithology is interbedded with non-fossiferous grey dolomitic limestone and capped by light grey lime mudstone containing algae corals and pelecypods. The fore-reef facies, typified by the cliffs one mile north of the Grafter showing on the War Eagle haulage road consists of interbedded flow-textured white laminated limy dolomite and black carbonaceous locally fossiliferous lime, mudstone and sandstone.

Projection of these facies into mineralized pendants suggest that most of the known silicate skarns are developed within the forereef facies and most magnetite serpentine skarns within the dolomitic bank facies of the carbonate reef complexes. The association of magnetite skarn with dolomitic host rocks is a common feature of skarns world wide and is explained by the precipitation of iron as magnetite rather than silicates in Mg-rich host rocks. Location of dolomitic host rock facies within the contact aureole of pendants is an important guide to magnetite-serpentine skarns.

3) Skarn Petrology

Typical garnet-diopside skarns in the Copper Belt contain locally small amounts of sometimes spectacular mineralization (eg Copper King) or virtually no mineralization at all (Little Chief hangingwall). More important silicate skarns have either unusual mineral assemblage (wollastonite at War Eagle) or have mineralization associated with vein and patch alteration cross cutting the silicate skarn (actinolite alteration in diopside skarn at Arctic Chief mine). Work by Grabher (1974) and observations at the Arctic Chief pit suggest that early formed diopside-rich skarn is barren and this assemblage is replaced locally in the vicinity of irregularities in the diorite contact by garnet-epidote skarn that may have a halo of magnetite-chalcopyrite and generate the actinolite-cp veins mentioned previously. Consequently, diopside skarns that are extensively replaced by garnet-epidote may be at the silicate skarn-carbonate contact.

APPENDIX I: CARBONATE FACIES COMPOSITION AND DISTRIBUTION.



REFERENCES OF BUDGET PROPOSALS

FROM

1980 - 1981 - 1982

By A. Hureau

From: 1980

2. War Eagle .

a. War Eagle 128N 24W

Holes HS 1 & HS 2 drilled in 1972 to test a strong IP anomaly intersected patchy copper mineralization in silicate skarn. The best intersection in HS 1 was 19.8' at 2.38% Cu. Two holes are proposed up dip and on strike to check for the extentions of mineralization which may be mined by a small open pit.

Allow 2 holes, 600' \$12,000

b. Hole HS 7 (112N 1W) drilled in 1977, intersected over three hundred feet of skarn including 16.5' at 1.78% copper. The hole was drilled into an area of a chargeability high 3000' north east of the War Eagle pit. A detailed magnetometer survey is proposed to delineate the skarn intrusive contact. Further drilling is planned to check for economic mineralization.

Allow 2 holes, 800' \$16,000

3. War Eagle

The War Eagle zone is the largest mineralized skarn zone on the Copper Belt with a strike length of 3000' and width of up to 300'.

3. War Eagle (continued)

Deep drilling by HBED in 1972 intersected sub economic narrow good grade lenses. Potential still exists below the limit of present drilling where proximity to enclosing diorite may have resulted in more pervasive skarnification and mineralization. A magnetic survey north and west of the pit will be done to attempt to delineate the intrusive on the hanging wall side of the orebody. Three holes at 1000' intervals along strike are proposed to intersect mineralization 300' - 500' below present drilling.

Allow 3 holes, 3000' \$60,000

* 4. Rabbit's Foot Canyon (See Morrison #1)

Remapping of area. Quartzite at base of limestone at junction of Fish Lake road is well mineralized with malachite. Consider hole from east side of canyon toward intrusive west of canyon.

Allow 1 hole, 500' \$10,000

* 5. West of War Eagle to Gulch (see Morrison #2)

Allow 1 hole, 1000' \$20,000

* 6. South of Pueblo to Bork Lake (See Morrison #3)

Hole BC 40 drilled in 1979 intersected 235' of overburden, the last one hundred feet of which was clay and the probable source of the IP anomaly. The hole continued through 100' of Miles Canyon basalt and on to 442' in partially consolidated conglomeratic overburden. This is the only hole drilled from north of Best Chance to Pueblo except for Sue 1 which was stopped in Miles Canyon basalt. Results of all IP surveys done in the valley are suspect because of the probable depth of overburden and the presence of conductive clay. A test survey using a portable seismic instrument is being considered to help define areas of minimum overburden thickness for drilling.

Allow 3 holes, 1500' \$30,000

5. Gulch Pueblo (Fig. 3)

A detailed magnetometer survey (lines at 100' intervals) will be completed to try to delineate the intrusive-sediments contact north and west of Pueblo.

Low grade mineralization intersected in PB 1 (Hudbay 1972) will be checked at depth. Two holes are proposed to check the contact on the east side of the pendant.

Allow 3 holes 1,800' = \$37,800.00

4. RABBITS FOOT CANYON

The thick limestone unit exposed in Rabbits Foot Canyon is a north dipping lens underlain to the west and south by siltstone and overlain to the northeast by interbedded siltstone

and limestone. These strata are correlated with those in the War Eagle Pit. Although quartz diorite outcrops on three sides of the lens, only near the Anaconda showing does it appear to enclose a siltstone-limestone pendant. The pendant is 1200' x 500', plunges east and includes numerous small copper showings. It is probably terminated to the east by the fault in Rabbits Foot Canyon.

Drill hole RF-2 of H.B.E.D. suggests the limestone is a thin skin over siltstone in the west part of the pendant. Further field checks and interpretation may justify drilling the east part of this pendant.

6. Pueblo - Bork Lakea) Pueblo - Sue

A sediments-intrusive contact probably exists on the west side of the Best Chance North base line from '0' south to 5600 south. No outcrop has been found in this area and the I.P. surveys done may not have gone sufficiently far west to cover the contact. An I.P. survey with detailed magnetic surveys and prospecting is proposed. Drilling is contingent on results.

Allow: I.P.	6 mi.	\$ 6,000.00
Mag	10 mi.	
Linecutting	5 mi.	1,750.00
2 holes	1,000 '	<u>\$21,000.00</u>
TOTAL		\$28,750.00

b) Sue to Bork Lake (Fig. 4)

The west contact of the Whitehorse batholith is not exposed from south of the Sue anomaly (Miles Canyon Basalt) at line 7200 S to Bork Lake (line 13200 S). Previous I.P. surveys may not have been extended sufficiently far west to cover the contact. An I.P. survey, detailed magnetic surveys and prospecting are proposed to establish the location of the contact. Drilling is contingent on results.

Allow: I.P.	5 mi.	\$5,000.00
Linecutting	5 mi.	1,750.00
Magnetic Surveys	10 mi.	
Drilling, 2 holes	1,000'	<u>\$21,000.00</u>
TOTAL		\$27,750.00

10. Copper Cliff

From: 1981

A reconnaissance I.P. survey on a line 600' south of the small Copper Cliff showing gave a moderately high chargeability response on the second separation ($n = 2$, $a = 400$). The high is on the east contact of a limestone pendant which is approximately 600 - 1,000' wide in this area and may extend 800' to the south. North of the Copper Cliff showing, it is partially covered by basalt flows. A detailed magnetometer survey, an I.P. survey, mapping and one drill hole are proposed to test the area.

Allow Line Cutting	3 mi.	\$ 1,050.00
I.P.	5 days	5,000.00
1 hole	700'	<u>\$14,700.00</u>
TOTAL		\$20,750.00

2. Cowley Park South

From 1982

- 24 -

An increase in reserve tonnage of 100,000 tons could possibly make this deposit economic. Development of this zone would have to commence in the spring of 1982 in order for production to coincide with the mining of Cowley Park Main zone. Drilling is proposed to test the zone on strike - east and west of current reserves.

Allow 10 holes	5,000'	\$ 100,000
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10. Pueblo to Bork Lake (1981 Budget 6 a) and 6 b))

Work in this area would be contingent on results of the airborne survey. If the survey is not flown ground geophysics would be done as proposed for 1981.

Allow	Ground Geophysics	
	& Linecutting	\$ 15,000
	4 holes 2,000'	\$ 44,000

WHITEHORSE COPPER MINES

NORTH STAR AREA

SUMMARY REPORT & RECOMMENDATIONS

A. HUREAU

MAY 1982

Summary

A buried limestone reef, found one mile south of the Little Chief Mine (Fig. 1) contains copper mineralization similar to that of the Little Chief - Middle Chief Zones, in skarn zones near the intrusive contact. The best mineralization was found near the base of the limestone reef where it is in contact with siltstone and greywacke at depths from 1400 to 1800'. Gold-silver content in the mineralization is comparable to that of the Little - Middle Chief zones.

The mineralization is erratic, being partly controlled by proximity to the intrusive contact which is irregular and variably gradational. Twenty diamond drill holes with an aggregate footage of 33,000' have been drilled on the property. No mineable reserves have been established in the area which should be considered as an exploration target. A figure of 800,000 tons at 1.5% copper is indicated for the footwall zone from drilling on sections 32 S and 36 S. High grade mineralization (48' @ 5% Cu) in silicate skarn, two hundred feet above the footwall contact may follow the contact of a diorite apophysis intersected 400' west.

A pulse E.M. survey using a Geonics E.M. 37 unit indicated a conductive zone along the north contact of the pendant for a distance of 3600'. Five holes drilled to test the indicated conductive zone have failed to intersect any mineralized zones or explain the survey results adequately.

Approximately \$1 million has been spent on the property to April 1982, when the 1982 program was cancelled due to economic restrictions and the planned early shutdown of the mine.

The area is considered by the writer to offer excellent potential for the existence of ore zones which could be accessible from the Little Chief underground workings. Mineralization has been intersected over a distance of 2000' and a favourable contact may exist at depth for a distance of 10,000' around the pendant.

Recommendations

The following exploration approach is suggested for the North Star area:

1. a) An orientation survey using borehole pulse E.M. should be done to determine whether zones known to exist could be detected by the survey of barren holes in the area (e.g. a survey of NS 18 to detect zones intersected in NS 15). If the orientation survey is successful, it should be extended to other areas, and followed up by drilling.
- b) Drilling should be continued:
 1. to determine the limit of the pendant and mineralization to the south east. A preliminary hole at 2E drilled west @ -70° , 1800' is suggested on section 38+50 S, 40S or 42S.
 2. to follow the high grade mineralization in NS 15 to the north and west. A vertical hole at 6W on 32S or 34S is suggested to a depth of 1600'.

- b) 3. to follow the north contact of the pendant west from the BL @ 28S which has not been adequately explored. The dip of the intrusive is unknown and low grade mineralization intersected in NS 11 can be expected to improve toward the intrusive contact (compare section 36). A hole drilled on section 71 400 E from 45 675 N at -75° S is suggested. This contact should be followed west and north towards Valerie. If the reef grades out to the north, the zone of facies change from carbonate to clastic sediment facies, near the intrusive is an attractive target. Such a zone probably exists along the Valerie contact. Check mapping, detailed ground mag and short drill holes are recommended to establish the attitude of the top of the limestone reef before deep drilling is attempted. Similar work is suggested west and southwest of NS 19 where a similar environment may occur.
- c) Dr. Greg Morrison (P.H.D. Whitehorse Copper Belt) whose work contributed a great deal to the understanding of the setting of the deposits, will be working in Alaska during the summer and will be visiting Whitehorse. His services should be solicited to review all data and to suggest a model for the reef topography north and south of the pendant.
- d) Remnants of the carbonate and clastic sediment sequence may exist in the diorite between the south end of Little Chief and the North Star pendant. If difficulties with correlation of pulse EM response with the location of known conductive zones can be resolved, it is recommended that this area be covered by a Deep E.M. survey.

Introduction

Reinterpretation of geological and geophysical data in the North Star area in 1975, remapping (R. Reid), magnetic survey and drilling of a broad low intensity I.P. anomaly led to the discovery of a large, nearly completely buried, flat lying limestone reef. This carbonate unit was extensively skarnified, near its contact with diorite of the Whitehorse Batholith, at the upper contact with overlying dioritized clastic sediments at the foot wall contact with underlying metasediments. Copper mineralization has been found in each of these skarn zones, with that near the shallow dipping footwall contact near the intrusive, at depth from 1400' to 1800', being most attractive.

The area was considered attractive because of, the similarity of the skarn zones to those of Little Chief, the size of the pendant and its proximity to the Little Chief workings and the W.C.M. plant. Only five holes were drilled in the area from 175 to 1980 due to budget restrictions. In 1980, in hole NS 8, forty feet of massive magnetite with traces of copper mineralization was intersected at a depth of 1400'. followed by 113' of silicate skarn with graded 0.52% copper.

A pulse E.M. survey using a Geonics E.M. 37 unit was completed by Geophysicon Ltd. (Calgary) in 1981 using both a standard loop configuration and mise a la masse system in which an electrode was located in the conductive magnetite intersected in NS 8. Five holes drilled to test an indicated conductive zone, extending for 3600' along the north contact of the pendant, failed to explain the results adequately.

Drilling southeast of NS 8 in late 1981 intersected good to high grade copper mineralization in intersection lengths of up to 48' and indicated true widths of up to 40'. Mineralization has been intersected over a horizontal distance of 2000' and has not been cut off along strike. The drilling program was cancelled in March 1982 due to economic restrictions and a planned early shutdown for the mine.

Work in the area has been hampered by the depth of the most favourable contact (+ 1500'), the irregularity of the intrusive contact and the restriction of "ore" grade-widths, to within a few hundred feet of the intrusive.

Evaluation of Results

1. High Grade Zone

The high grade silicate skarn zone (48' - 5% Cu) intersected in NS 15 in section 3600 S, two hundred feet above the footwall contact, has not been extended by the wedged hole NS 15 W₂ (120' E, 16' - 1.05% Cu) or NS 5, 250' south (0.8' - 8.4% Cu). NS 18,400' west of NS 15 was in a diorite apophysis below 600'. The high grade zone may follow along the contact of this diorite to the north and west. A 10' intersection at 3.34% Cu on section 32 S in NS 14 probably correlates with that in NS 15. Borehole pulse E.M. may be of some assistance in delineating this zone.

2. Footwall Zone

The footwall zone intersected on 32 S and 36 S is located at the base of the limestone at the contact with underlying clastic sediments. This zone only exists where this contact is within three or four hundred feet of the intrusive contact. Mineralization in this flat to shallow dipping zone is identical to that of Little Chief consisting of chalcopyrite, bornite and valleriite in a magnetite serpentine phlogopite skarn. The grade and thickness of this zone can change very quickly grading from a barren weakly skarnified contact towards the intrusive. On section 36 S the zone changes from 10' @ 0.98% to 47' at 1.53% in a distance of 160' with the grade of the mineralization in the latter intersection being 2%, but including an 11' dyke.

This zone can not be considered to be cut off by drilling on sections 70,600 E and 71,400 E. Holes 19 and 20 probably intersected the footwall contact too far from the intrusive while hole NS 11 on section 71,400 E did intersect weakly mineralized magnetite skarn which may improve in thickness and grade towards the intrusive contact. A hole layed out to intersect the zone a few hundred feet closer to the contact would determine whether ore grade mineralization does extend to this area. While the zone may generally be in the order of 1000 - 2000 tons/horizontal foot, the potential strike length and the likely existence of irregularities in the intrusive contact which could be expected to yield better mineralized zones, make it attractive.

The footwall zone may also extend to the southeast of section

38+50 S. Generally the grade of mineralization has improved in this direction. The southeast limb of the North Star pendant is interpreted to be 600' wide on 38+50 S and could reasonably be expected to extend several hundred feet southeast. There is a suggestion of steepening of the upper contact from banding in the core and good grade mineralization intersected in NS 5 near the upper limestone contact. If the attitude of the footwall were to steepen or the limestone reef grade out in this direction conditions would exist for more pervasive skarnification and ore deposition.

Hangingwall Zones

Narrow, widespread, erratic mineralization has been intersected at or near the upper skarn contact with the dioritized clastic sediments. These intersections were generally in the order of a few feet but do suggest that where the upper and lower contacts converge near the intrusive contact would be an attractive locus for ore deposition.

Other Considerations

The Craigmont model of G. Morrison (P.H.D. Thesis 1981) located the Craigmont underground ore zone at the facies change from reef limestone to clastic sediments. The North Star reef is shown to be grading out to the East on section 32 S and 28 S changing from 1500' thickness (NS 19 - 20) to 900' (NS 9 & 11). However, it was still 900' thick where intruded by the Whitehorse Batholith.

If no major fault exists between the North Star pendant and V 17 the North Star reef must grade out completely to the North. No limestone equivalent to that at North Star was intersected in V 17 drilled to a depth of 3,555'. The area where the limestone grades out along the Valerie contact would be an attractive target area and may be in the order of 2,000' from the Little Chief underground workings. The south contact of the pendant and the possible extension at depth of the reef to the southwest along the contact should also be considered as areas which could contain favourable contacts at depth.

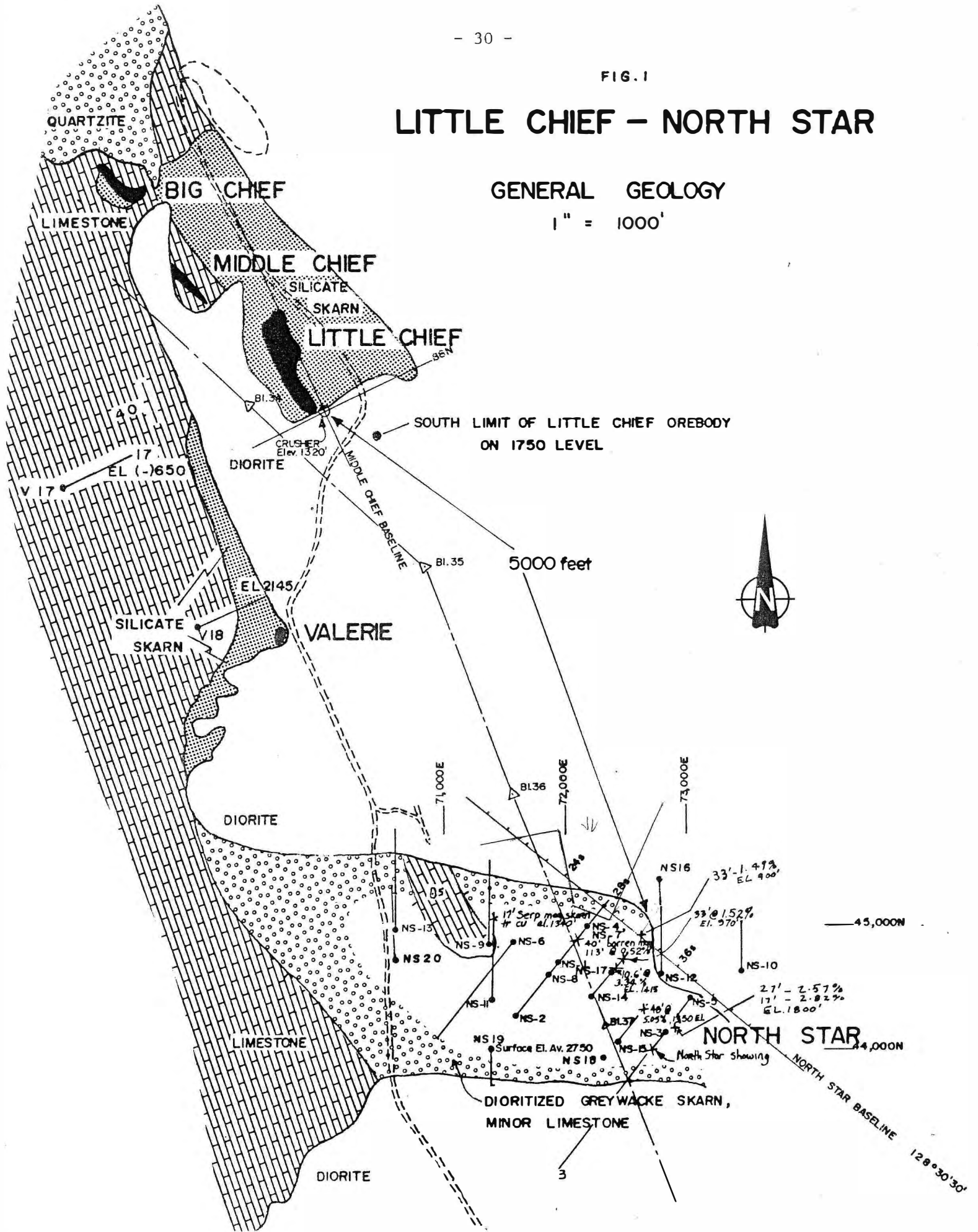
The diorite between the North Star Pendant and Little Chief may contain remnants of limestone and clastic sediments at depth. Some of the "diorite" in this area may be equivalent to the "dioritized" clastic sediments overlying the limestone reef. If confidence in interpretation and correlation of "Deep E.M." response to location of known conductive zones can be established, this area along with the contact north and south of the pendant should be surveyed.

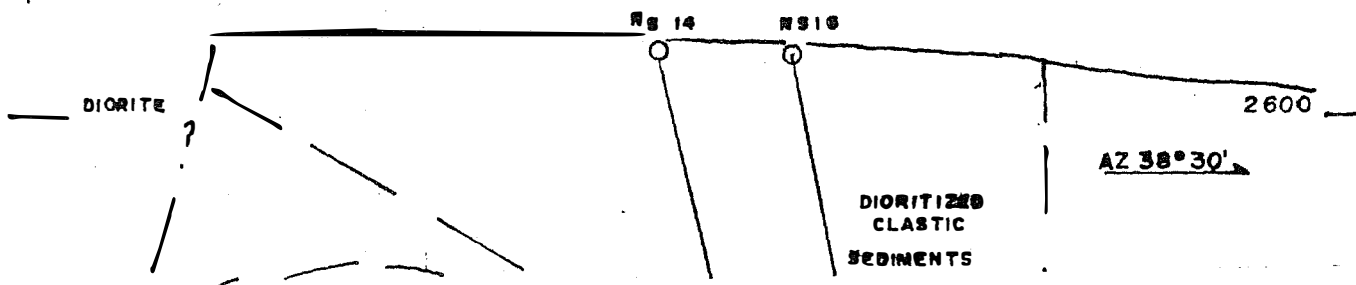
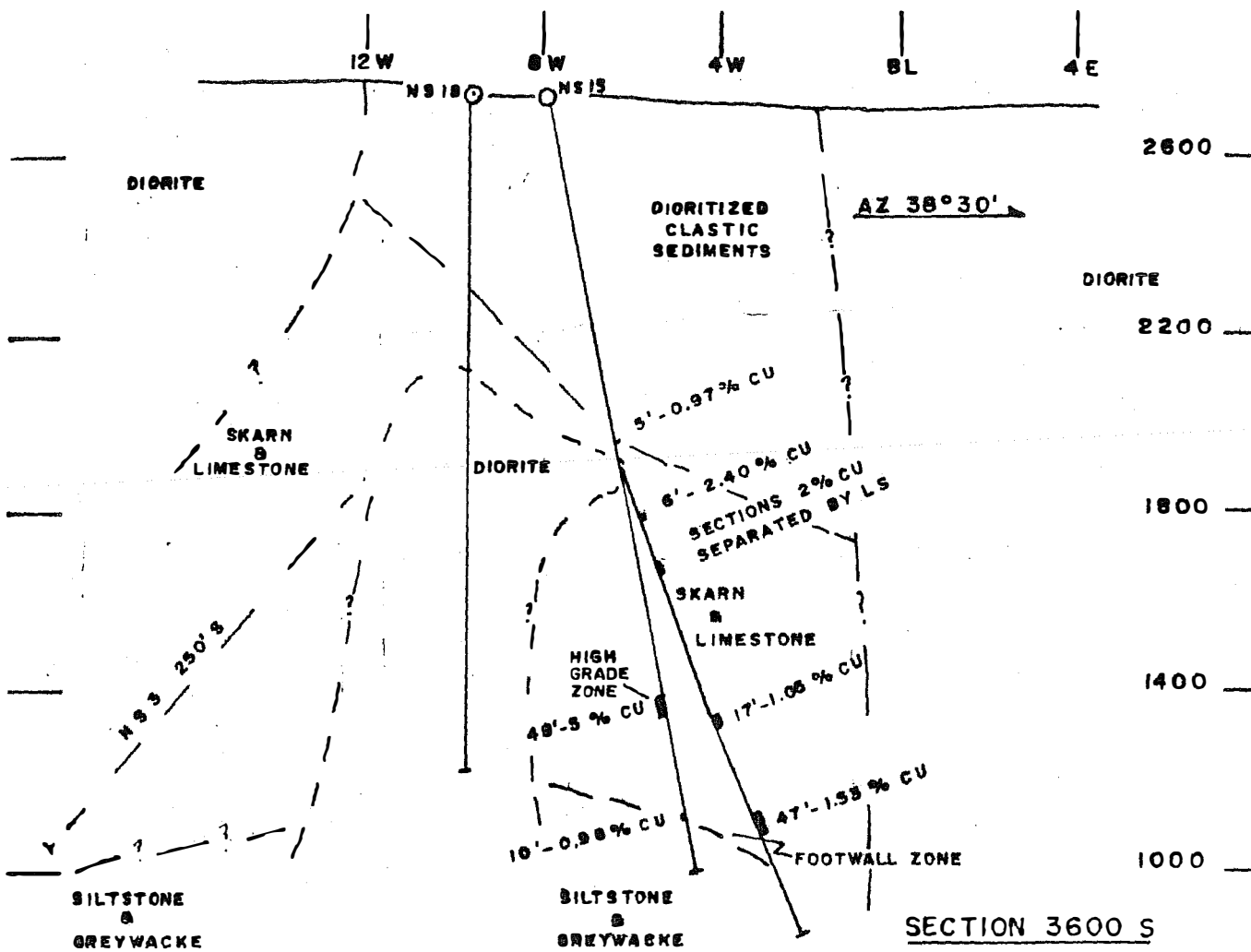
FIG. 1

LITTLE CHIEF - NORTH STAR

GENERAL GEOLOGY

1" = 1000'





WHITEHORSE COPPER BELT PRODUCTION 1967 - 1982

YEAR	TONS MILLED	HEADS % Cu	RECOVERY % Cu	PRODUCTION			DEPOSIT
				Cu (lbs)	Au (oz.)	Ag (oz.)	
1967	453,046	1.16	69.76	7,322,180	8,752	89,786	Little Chief
1968	732,095	1.03	80.38	12,153,016	16,595	148,188	L. Chief, Arctic Chief
1969	805,519	1.09	86.84	15,192,201	14,560	196,469	Arctic Chief, War Eagle
1970	852,461	1.03	91.97	16,113,635	5,579	211,614	War Eagle
1971	337,758	1.02	75.90	5,236,738	3,646	53,273	B. Cub South, Keewenaw
	3,180,879	1.06	82.95	56,017,770	49,132	699,330	TOTAL OPEN PITS
1973	700,053	1.83	84.33	21,563,064	13,888	250,627	Little Chief
1974	626,541	1.86	90.22	21,035,329	17,731	209,512	Little Chief
1975	738,062	1.52	89.36	20,062,121	18,630	217,397	Little Chief
1976	800,836	1.69	89.74	24,364,262	18,550	241,159	Little Chief
1977	901,459	1.65	88.35	26,340,602	24,058	249,672	Little Chief
1978	863,092	1.40	86.34	20,923,048	19,443	195,765	Little Chief
1979	914,060	1.12	85.66	17,494,036	15,868	168,972	Little Chief
1980	854,306	1.58	87.61	23,651,040	22,102	240,273	Little Chief
1981	800,378	1.42	87.97	19,994,225	15,727	194,363	Little Chief
1982	897,624	1.39	84.16	20,989,608			Little Chief
	8,096,412	1.53	87.40	216,417,410	(165,997)	(1,967,740)	TOTAL UNDERGROUND
	11,277,291	1.40	86.45	272,435,180	(215,129)	(2,667,970)	TOTAL PRODUCTION

Recovery Grades = 1.21% Cu, 0.021 oz./ton Au, 0.25% oz/ton Ag

WHITEHORSE COPPER BELT PRODUCTION 1967 - 1982

YEAR	TONS MILLED	HEADS % Cu	RECOVERY % Cu	PRODUCTION			DEPOSIT
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1982	897,624	1.39	84.16	20,989,608			Little Chief
	8,096,412	1.53	87.40	216,417,410			TOTAL UNDERGROUND
	11,277,291	1.40	86.45	272,435,180	(177,300)	(2,232,434)	TOTAL PRODUCTION

Recovery Grades = 1.21% Cu, 0.020 oz./ton Au, 0.256 oz/ton Ag