824735

James T. Fyles
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George Stewart
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Dear George

The attached notes on the geology of the Mother Lode-Tam O'Shanter area are based on my mapping in this area from time to time in 1984 and 1985. My purpose was to become familiar with this highly mineralized area even though we have no claims there. I hope the map and notes will provide stimulation for our companies to continue exploration along the lines suggested in my conclusions. This might take us beyond the areas of current interest, although local parameters should be

1) the area of Smiths Ridge and southward toward Midway,
2) an appraisal of past work in the Copper Camp west of the Mother Lode, and
3) a conclusion to our work in the Thimble Mountain-Rathmullen Creek area.

I look forward to discussing these suggestions with you.

Sincerely

Jim

copies to George Stewart
John Keating
Vernon Office

# NOTES ON THE GEOLOGY
# OF THE
# MOTHER LODE - TAM O'SHANTER AREA

James T. Fyles

1984 - 1985

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# INTRODUCTION

The subject of this note is the fault-bounded area of mainly pre-Tertiary rocks around the former town of Deadwood about two km west of Greenwood. The Deadwood Ridge fault forms the western boundary and the Greyhound Creek fault the eastern boundary of the area. It includes the Mother Lode, Sunset and Greyhound copper skarn orebodies, the Buckhorn and nearby copper porphyry mineralization and a number of vein and replacement deposits on Crown-granted claims such as the Tam-O-Shanter, Golconda and Morrison. The area has been extensively prospected, explored, mapped and drilled, but in that work several aspects of the geology and controls of mineralization, particularly gold, have not been considered.

The purpose of this present study has been to:

a) review the stratigraphy and structure of the Brooklyn formation in the area which is the host for the copper skarn orebodies;

b) determine the major elements of the structure of the area;

c) review the controls of mineralization and assess the significance of the apparent widespread silicification.

Rocks in the area occur in a series of fault blocks the correlation of which, with formations elsewhere around Greenwood, is not always certain. Included are hornfelsic siltstones, sandstones and breccia , skarn and limestone of the Brooklyn formation; buff to white quartzite, metachert, chert breccia and conglomerate of various origins and uncertain correlation; granitic rocks related to the nearby Greenwood stock and/or Wallace Creek batholith; probably Triassic diorite, Tertiary arkose and sandstone and Tertiary dykes ranging in composition from syenite to diorite. The area is within an "eye" of intersecting and branching faults along the eastern margin of a major Tertiary graben referred to by Church (1985:16) as the Toroda Creek Graben.

## FAULTS

Although pre-Tertiary faults are probably present in the area, they have not been recognized. Tertiary faults occur in two sets; one dips steeply and trends northward, the other has a low dip to the northwest and north. Where exposed, the fault zones are marked by crushed zones up to several meters thick of breccia, gouge and slickensided fault surfaces. The faults offset Tertiary rocks and are locally followed by Tertiary dykes. Faulting thus appears to have taken place at various times within the Tertiary both during and after the deposition of the Kettle River sediments and overlying Marron formation (Middle Eocene) and related intrusions. It is part of a regional pattern of Tertiary extension which in this small area resulted in the dropping of fault blocks down on the west. In the following paragraphs the faults are named for ease of reference and their characteristics, derived from mapping and a review of drill records, are summarized.

Greyhound Creek Fault

This north trending fault forms the western margin of the main block of the Knob Hill-Attwood-Brooklyn rocks in the Greenwood-Phoenix-Hardy Mountain area. The fault, which was named and described by Little (1983: 31) abruptly terminates these rocks along a prominent topographic lineament formed by Deadwood Creek and the valley south of Deadwood. Along this valley, west and north of the Skomac Mine, the fault is not exposed but can be closely located. Cliffs along the western side of the valley are chert breccia and conglomerate which is crushed and rusty with disseminated pyrite and locally contains quartz lined cavities. Farther north the fault is exposed in new (1984) road cuts south of Deadwood where it consists of a rusty, locally copper stained, zone of sheared and crushed chert and felsite a few meters wide cut by steeply dipping fault planes trending north. In the covered area around Deadwood, drilling shows that the Greyhound orebody is terminated on the east against granitic rock (Greenwood stock) probably by the Greyhound Creek fault. Present exposures in the Greyhound pit are of highly crushed and slickensided hematitic skarn and feldspar porphyry. Farther north the fault is joined by (and offsets?) the low, north dipping Mother Lode, Sunset and Greyhound faults.

Deadwood Ridge Fault

This is another fault named and described by Little (1983: 31). The surface trace trends generally north but is sinuous, partly because the fault has a low dip to the west, and partly because it is offset by other faults. The Deadwood Ridge fault forms the eastern margin of an extensive block of Tertiary volcanic rocks with a sliver of Kettle River arkose dipping west beneath them and above the fault zone. The fault is exposed in a big bulldozer stripping northwest of the upper part of Buckhorn Creek. In the stripping, shattered copper bearing diorite cut by several faults, is in fault contact on the west with Kettle River arkose and grey siltstone. Where exposed, this contact is marked by a meter of gouge and shattered diorite which dips 25-35 degrees to the west. North of the stripping the contact curves with the topography as it crosses the valleys of Mother Lode and Deadwood creeks probably reflecting a low west dip. It is marked at places by the wide zones of crushed and brecciated chert in the footwall. South of the stripping, the fault trace does not reflect this low west dip but follows the upper part of Buckhorn Creek into the head of Jolly Jack Creek. It may curve in strike or be offset by another fault in this area (Shear, 1984). Still farther south and east of the head of Jolly Jack Creek the contact with Tertiary volcanics has a steep dip and trends southeast. Though not exposed, it seems to be a tight contact without a significant crushed zone. It is offset to the right (south) by the Greyhound Creek fault in the area southwest of Skomac Mine.

Mother Lode Fault

The Mother Lode fault trends northeast, dips at low angles to the northwest and forms the base or southern contact of a block of Brooklyn strata containing the Mother Lode orebody. The fault zone is exposed beneath prominent bluffs of limestone at the western side of the valley of Greyhound Creek ( on the old Plutonia

Crown granted claim). The zone trends east and dips 30-40 degrees to the north and consists of several meters of crushed limestone cut by subsidiary slickensided faults lying above a finely brecciated aphanitic basaltic rock which is probably a Tertiary dyke. Breccia along the fault can be traced northward onto the Boundary Creek slope near the power line. To the west the fault is not exposed but at the Mother Lode Mine it is close to the mill and probably cuts off the orebody in the lower mine workings (see Sutherland Brown 1968: 230).[1] Many subsidiary faults are exposed in the pit.

Sunset Fault

The Sunset fault is named for the old copper skarn orebody on the Sunset claim east of the Mother Lode Mine. The Sunset orebody exposed in the pit is cut by many slickensided normal faults and several Tertiary dykes. The lowest fault exposed on the Mother Lode haul road trends northeast and dips 45 degrees to the northwest. Rocks beneath it, exposed below the road and in a low level adit, are highly fractured buff to white chert. The fault probably terminated the orebody in depth and was exposed in an adit the caved portal of which is below the haul road. Although not exposed elsewhere, the fault forms the upper contact of a prominent mass of crushed chert which outcrops east of the Sunset almost as far as Greyhound Creek.

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1 I have not seen any mine plans to check this and Seriphim (1956: 394) describes the structure at the mine as a north plunging syncline but I can find no evidence for this.

Greyhound Faults

At least two faults with the same trends as the Sunset and Mother Lode lie north of the Greyhound pit. Their presence is indicated by the strongly faulted character of the chert exposed in the old railroad cuts west of Greyhound Creek and by the distribution of the rock types exposed on surface and encountered in drilling (Shear, 1973-74). Skarn, microdiorite and serecitic feldspar porphyry exposed in the Greyhound pit are very strongly faulted and crushed. Slickensided surfaces coated with chlorite and hematite are very common. The orebody appears to be in a wedge between two or more faults closely bounded on the east by the Greyhound Creek fault and on the north and west by the Greyhound and other faults (see Fig. 1).

In the Buckhorn area 1 to 3 km to the southwest of the Greyhound pit, a fault exposed in a new trench north of the Tam O'Shanter property, trends east and dips north separating copper stained chert from granodiorite and diorite with disseminated chalcopyrite. It is on trend from faults north of the Greyhound pit and is referred to as one of the Greyhound faults.

## ROCK UNITS

Quartzite and Chert

The area between the Greyhound Creek and Deadwood Ridge faults contains large amounts of buff to white quartzite and chert. These rocks form the open ridges south and east of the Mother Lode mine, scattered outcrops north of Buckhorn Creek and most of the northern slopes of the 4805-foot hill south of Buckhorn Creek, here refered to as Smiths Ridge. These rocks are commonly highly fractured, do not show bedding and are thought to be recrystallized chert. They probably belong to the Knob Hill group but do not show sedimentary characteristics typical of chert in the Knob Hill and at only two places are there thin layers of greenstone comparable to the greenstones in the Knob Hill.

Chert Breccia, Conglomerate, Sandstone and Grey Siltstone

The cherts and quartzites on the north and eastern slopes of Smiths Ridge grade into chert breccia and conglomerate which forms the upper part and south slopes of the ridge. These rocks are buff to brownish, fine grained, mainly massive breccia composed of angular to sub-rounded fragments up to 1 cm across of buff and grey chert. They show no bedding and along the Greyhound Creek fault are themselves fractured and brecciated. South of the head of Haas Creek the chert breccia grades into coarse grained buff chert sandstone with interbeds of grey to dark grey siltstones which strike east and dip at moderate angles to the north. On the uppermost part of Smiths Ridge and on the western slope, chert breccia is interbedded with buff to tan colored sandstone and siltstone dipping gently to the north and locally folded on north plunging axes.

Correlation of the chert breccia with other formations in the Greenwood area is uncertain. Similar breccias associated with conglomerate occur on the south and west slopes of Knob Hill which I consider to be part of the lower Knob Hill group. Church (1984), however, correlated the chert breccias on Smiths Ridge with the Attwood group and Little (1983: 14) includes them with sharpstone of the Brooklyn formation. The sandstone and siltstone on the top and western slope of Smiths Ridge resemble parts of the Tertiary Kettle River and I suggest the possibility that some, if not all, of the chert breccia and conglomerate is a Tertiary unit at places extensively silicified.

Brooklyn Formation

A fault block containing mainly rocks of the Brooklyn formation extends north and northeast of the Mother Lode and Sunset mines as far as the crest of Deadwood Ridge and the power line (see Fig.1). The rocks are extensively recrystallized to skarn, hornfels, metachert breccia and marble but primary structures are preserved and there is little or no cleavage and schistosity. Beds strike N25 to 45°E and dip 85 to 55°E. The gentler dips are at lower elevations and to the east near Greyhound Creek. Most of the rock types present in the Phoenix and Cyclops-BC basins are recognized in this fault block including chert breccia or sharpstone conglomerate, hornfelsic chert sandstone and siltstone, grey and white crystalline limestone and marble, dark grey argillite and irregular small bodies of microdiorite. The limestone forms two principal lenses, a lower one at the Mother Lode mine and an upper one on the hills northwest of the head of Greyhound Creek. The lower one is skarnified and is on the footwall of the Mother Lode orebody and appears to die out in the covered area north of the pit. The upper one consists of grey and white locally well bedded crystalline limestone which passes northward into calcareous garnet pyroxene skarn. The succession is described in Table 1.

Small, irregular bodies of microdiorite occur within this block of Brooklyn formation and at a few other places to the south.

TABLE 1

BROOKLYN FORMATION COMPOSITE SECTION MOTHERLODE-DEADWOOD RIDGE

| Thickness in meters | Rock types and relationships | Location |
|---|---|---|
| | ~~~ Greyhound Creek and Motherlode Faults ~~~ | |
| | Garnet pyroxene skarn | Head of Greyhound Creek and Boundary Creek slope |
| 0-500 | Grey to white massive and well-bedded crystalline limestone | |
| 700-1000 | Local copper skarn mineralization | Northeast of Motherlode and Deadwood Ridge |
| | Interbedded hornfelsic chert sandstone and breccia, siltstone, small lenses of silicated crystalline limestone | |
| 0-300 | Copper skarn mineralization | Motherlode Mine area |
| | Motherlode white crystalline limestone (0-100 m), hornfelsic siltstone, sandstone and chert breccia | |
| 700 | Black argillite (0-100 m) | Deadwood Creek and northwest of Motherlode Mine |
| | Grey white crystalline limestone (0-15 m) | |
| | Interbedded hornfelsic siltstone, sandstone and chert breccia grading downward into grey metachert breccia with angular are sub-rounded fragments up to 2 cm across of white quartz, grey chert, rare volcanic rocks, siltstone and jasper | |
| | ~~~ Unconformity and faults ~~~ | |
| | Knob Hill group - buff to white quartzite | |

These rocks are dark green to grey green, fine to very fine grained diorites and andesites more or less altered and mineralized. Fine pyrite coated fractures and disseminated pyrite causes rusty weathered surfaces. Magnetite is common along contact zones and copper stain from chalcopyrite in fractures occurs locally. One such locality is on the Birthday claim northwest of the head of Greyhound Creek just above the Mother Lode fault. Another of copper bearing microdiorite is on the south slope of Buckhorn Creek between elevations of 3500 and 4000 feet. Both these localities have been extensively explored for copper. The microdiorites are correlated with the Providence Lake microdiorite on the basis of lithology and are considered to be early Jurassic or Late Triassic subvolcanic intrusions (see Church 1985: 17).

Granodiorite and Quartz Diorite

These rocks are described in detail by LeRoy (1913), Little (1983: 23), Church (1985: 19) and others. They occur at various places throughout the map area as follows:

a) North of Deadwood Ridge along the power line is the southern edge of the Wallace Creek batholith. Although locally faulted this appearsto be a normal intrusive contact and the wide skarn zones in calcareous rocks and the extensive hornfelsing is probably related to this plutonic body. At least some of the granodiorites to the south may be offshoots or faulted pieces of this mass.

b) In the Mother Lode pit is an irregular dyke of granodiorite which is somewhat skarnified. Similar dykes were encountered underground.

c) Copper stained granodiorite is exposed in trenches beneath (south of) the Mother Lode fault at an elevation of 3300 feet on the northwest slopes at the head of Greyhound Creek. These rocks are highly fractured, presumably because of the faulting and the source of the copper stain is unclear.

d) Granodiorite outcrops about 300 m northeast of the Greyhound pit and was encountered in drilling north and west of the pit. These bodies are within or beneath the Greyhound fault zone and probably are part of the granodiorite exposed in the valley of Buckhorn Creek to the west.

e) The Greenwood stock lies east of the Greyhound Creek fault forming the eastern edge of the Greyhound orebody and in this area does not seem to be mineralized.

f) Copper bearing granodiorite and diorite occur in the valley of Buckhorn Creek, on the Buckhorn claim and westward to the Tam O'Shanter. The area is one of limited outcrop and contact relationships are not clear. The northern contact is a crushed zone, probably a gently north dipping Tertiary fault with copper stained quaatzite to the north. The western contact is the Deadwood Ridge fault. The southern contact is less well defined. Limited outcrops south of Buckhorn Creek suggest that the granodiorite intrudes the Brooklyn micro-diorite along an irregular contact which may be the upper surface of the pluton.

Tertiary Rocks

Within the block between the Greyhound Creek and Deadwood Ridge faults Tertiary rocks include a wedge of Kettle River sediments near Deadwood, possibly Tertiary sedimentary rocks on the top and western slopes of Smiths Ridge and many alkalic dykes.

The wedge of Kettle River near Deadwood was encountered in drilling for extensions of the Greyhound orebody and is exposed in a trench on the Buckhorn property and in poor outcrops to the northeast. In the trench, yellow brown sandstone and light buff arkose dips at moderate angles to the east and unconformably (?) overlies copper bearing diorite. Drilling outlines an area of Kettle River sediments as shown on Figure 1 which probably is bounded on the north by a north dipping fault and on the east by the Greyhound Creek fault.

Flaggy brown sandstone and grey brown siltstone on the top of Smiths Ridge closely resemble rocks of the Kettle River formation. If this correlation is correct, chert sandstones and fine chert conglomerate on the southwest slope of Smiths Ridge with which they are interbedded, are also Tertiary as may be also some of the buff to white quartzites formerly considered to be Knob Hill. This possibility is significant as it implies widespread Tertiary silicification in this area.

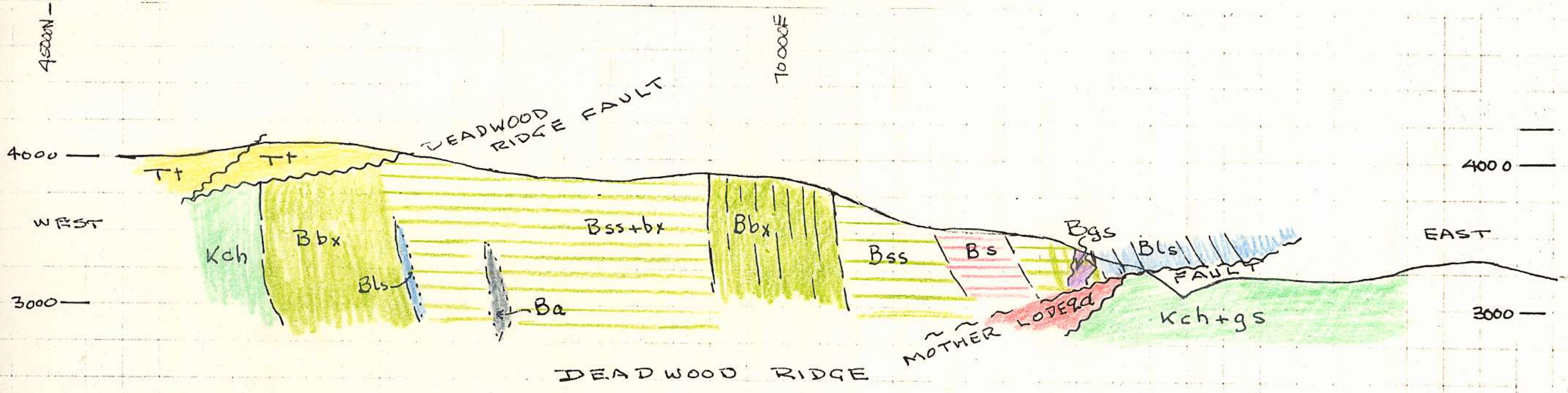
Tertiary dykes are of three principal types - pink to buff weathering feldspar porphyry or pulaskite, blocky grey green diorite and dark green to black aphanitic basalt. The pulaskites are most conspicuous in the block of Brooklyn north of the Sunset and Greyhound faults and are abundant in the Sunset pit. Commonly they have faulted margins and some are highly crushed and sericitized. The basalts which typically have a fine brecciated structure are found in the same area and are conspicuous along the Mother Lode fault near the head of Greyhound Creek. The diorites occur as a swarm of steeply dipping dykes trending about 340 degrees across the eastern slopes of Smiths Ridge and the head of Haas Creek. They follow a zone of fractures and subsidiary faults one strand of which contains the gold showing on the Golconda claim.

## DISCUSSION

### Mother Lode - Greyhound Area

This review of the geology of the Mother Lode-Greyhound area has clarified the stratigraphy and structure of the Brooklyn formation. Some relationships are obscured by the widespread thermal metamorphism which has produced biotite, epidote and other silicates in non-calcareous rocks, recrystallized the cherts, chert sandstones and breccias, marblized the limestones and led to the development of medium and coarse grained garnet-epidote-pyroxene skarns in other calcareous rocks. Other relationships are confused by the difficulty of distinguishing between Tertiary basalts and greenstones or hornfelses of the Brooklyn formation and between hornfelsic cherty rocks of the Brooklyn and cherts of the Knob Hill. In spite of these difficulties, it seems clear that the Brooklyn in the Mother Lode-Deadwood Ridge area is a steeply dipping fault block trending north and northeast, stratigraphic top toward

FIGURE 2



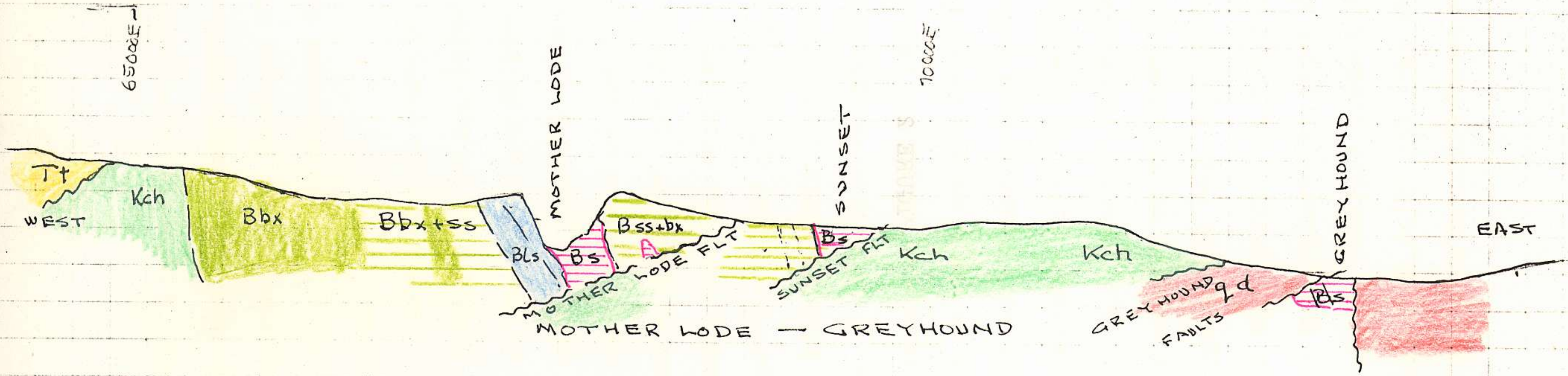



FIGURE 2

DIAGRAMMATIC CROSS SECTIONS NORTH OF DEADWOOD SCALE 1:12000 the east and base poorly exposed about a kilometer west of the Mother Lode mine (Fig. 2). The basal sharpstone conglomerate is similar (though possibly finer grained with more rounded fragments) to that in the Phoenix-Sylvester K area. The Sylvester K-Canbec transition zone (unit 2 of our 1985 work in that area; see Fyles 1985) in the Mother Lode area begins with a thin limestone and contains a variety of siltstone, sandstones and a lens of black argillite. The Brooklyn limestone (unit 3) is exposed only in the footwall (western side) of the Mother Lode pit apparently lensing out rapidly in a covered area north of the pit. The Mother Lode orebody is in skarn on the hanging wall side of the limestone probably developed in impure oalcareous sedimentary rocks above the limestone. I am convinced that the orebody is cut off by a gently northwest dipping fault (the Mother Lode fault) which was alluded to by Sutherland Brown (1967) but not by other workers. To the north it must lens out with facies changes in the stratigraphy as is the case at Phoenix. The Sunset and Greyhound orebodies are probably the extensions of the Mother Lode beneath the Sunset and Greyhound faults. Although structures exposed in the pits are very complex and dominated by faults and crushed zones, the orebodies (controlled by strtigraphy) should trend somewhat east of north, dip steeply and be complicated by subsidiary faults and Tertiary dykes.

Gayfer (1974) analysed gold assays in this area and tried to substantiate a model in which relatively high gold occured in these mines near the Brooklyn-Knob Hill contact which he related to pre-Brooklyn paleoplacers. With my present understanding of the geology, the higher than average gold values defined by Gayfer are on both sidesof the Tertiary faults to which they may be genetically related. In my view, the best metallogenic model for the Mother Lode-Greyhound area recognizes a primary source of metals in the Brooklyn sedimentation and vulcanism, modified (and enhanced?) by intrusions of Nelson plutonic rocks with remobilization and introduction of gold during the Tertiary extension and vulcanism.

There are strong similarities between the Tertiary faulting in this area and at Phoenix. Gently dipping faults with the upper side dropped down toward the west are present in both areas. Horizontal displacements of 100 to 1000 meters are indicated in both areas by the apparent offset of recognizeable markers. In the Mother Lode area these faults are clearly a subsidiary set within a zone forming the eastern side of the Toroda Creek graben. The economic implications based on the geometry of the faulting of such regional dimensions are still to be assessed.

Buckhorn-Tam O'Shanter-Golconda Area

The new features of the geology of this area are the following:

a) A significant, low north dipping fault forms the northern (upper) contact of the Buckhorn quartz diorite copper porphyry. The western end of the fault is exposed in a new trench on the 3800-foot hill north of the Tam O'Shanter, in which a crushed zone more than 10 m wide resembles other Tertiary faults in the area. Though not exposed to the east, scattered outcrops of shattered chert and granodiorite define a linear contact on strike between this and other faults encountered by drilling north of the Greyhound orebody. It is significant that both the chert and the granodiorite along this zone are mineralized with fine pyrite and chalcopyrite.

b) Diorite and microdiorite below elevations of about 4000 feet on the southeast side of Buckhorn Creek very closely resemble the Brooklyn microdiorite and are correlated with similar rocks on the south side of Providence Lake near the Sylvester K. In the Buckhorn locality, these rocks contain chalcopyrite and pyrite over large areas. Diorite and andesite on the Buckhorn claim may also be correlated with the Brooklyn microdiorite. Between these locations quartz diorite which carries molybdenite as well as chalcopyrite, is probably a Nelson intrusion, locally with fault contacts but also intrusive into the microdiorite. This interpretation, together with the recognition of Tertiary faults through the deposit might change the evaluations made in the past. Gold and copper values recorded, however, are sub-economic.

c) This study has confirmed and extended data and evidence for widespread silicification around the head of Buckhorn and Jolly Jack creeks and on Smiths Ridge which was originally recognized by GOMStewart and is described in reports by Rayner (1982) and Shear (1984). My observations on Smiths Ridge are that sandstone, siltstone and chert pebble conglomerate which resemble Tertiary rocks, grade into and interfinger with massive buff to white chert. These relationships are shown by Shear (Fig. 4) in a drill section in the Bengal shaft area where a discrete northerly trending zone of epithermal quartz is exposed. The extent of silicification is uncertain because the completely silicified rocks resemble cherts mapped as Knob Hill. Gold-silver showings on the Golconda claim and pyritic, vuggy quartz breccias along the cliffs west of the Greyhound Creek fault on the east slope of Smiths Ridge are local areas of mineralization which should be prospected more thoroughly.

## CONCLUSIONS

1) This study of the Brooklyn rocks confirms the original metallogenic model. The stratigraphy and structure of the Brooklyn is all important in defining exploration targets and is obscure enough that such targets have almost certainly gone unrecognized in the past. The lower part of the Brooklyn contains the copper iron mineralization as well as Sylvester K type lenses of massive sulphides. Distribution of gold within these deposits is erratic and probably depends on the superimposed metamorphism and Tertiary metallogenic events. We should take advantage of our detailed knowledge of these rocks to evaluate other areas in the Boundary Camp.

2) There is sufficient evidence for Tertiary mineralization along the eastern side (and within?) the Toroda Creek graben to justify prospecting of this belt for gold and silver. This search is for subtle, structurally controlled zones of silicification, brecciation and open space filling with or without sulphides. In my view, prospecting and sampling is called for.

JANUARY 20, 1986
James T. Fyles

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