ited

sis

ed

n is

ed

[VER
Y

ano

ge are
uplift
rinite
m of
ast 2-

south
Well
in the
lbian
track
rocks
t -58
of the
ks to
Ma, at
ength

ses of
ne ar
ne ar

enced
de is
sulted
h.

determine age of basins, and adjacent continental geology, seismic surveys and shallow cores. Some of the resulting differences in interpretation were resolved but fundamental disagreement about ocean crust genesis remains.

The map provides data for modelling the evolution of the circum-Arctic region and guidance for resources evaluation. Ocean basin deposits contain information about past global climates and crustal plate motions.

This map was published in three months through cooperation among staff of the Geological Survey of Canada in Halifax, Calgary and Ottawa, and a contracted computer graphics firm in Montreal.

GEOCHEMISTRY OF IAPETAN VOLCANIC ROCKS: MODEL AGE FOR EARLY RIFTING OF PROTO-ATLANTIC BASIN

*Olive, Valérie, Hébert, Réjean., Département de géologie, Université Laval, Québec (Qc), G1K 7P4; Loubet, Michel., Laboratoire de Minéralogie et de Cristallographie, Université Paul Sabatier, 38,rue des Trente-Six Ponts, 31400 Toulouse, France.

In the structural external domain of the Quebec Appalachians, three groups of basalts (alkalic-transitional and MORB-type tholeiitic basalts) as well as trachyandesite and rhyolite were identified in the nappe de la Rivière Chaudière and in the Drummondville olistostrome. They are the well preserved testimonies remaining from the early stage of Iapetus ocean rifting. Isotopic geochemistry have been performed on the basaltic rocks using (Sm/Nd) and (Rb/Sr) radiogenic tracers. Preliminary results show that the alkalic and tholeiitic basalts are isotopically cogenitic. Transitional basalts and rhyolites appear to be contaminated by a continental crust component. A (Sm/Nd) model age is proposed for the Iapetus opening provided by an isochron obtained from analyses of the altered margin and core of single tholeiitic pillows. Occurrence of lustreous black material (anthraxolite), associated with calcite and quartz in veins of a breccied tholeiitic pillow facies lead us to investigate the possibility of fluid contaminating by percolation of fluids through surrounding sediments. There is no clear relations between the contamined fluid and the altered margin of the pillow but we present complementary isotopic analyses on separated plagioclase phenocrysts and core of tholeiitic basalt pillow. Those results allow us to better understand the importance of contamination phenomenon on the significance of Sm/Nd ages. New data on alkalic and tholeiitic basalts will constrain the contemporaneity of these two groups. Transitional basalts analyses will give us informations on the role of the continental crust during magma genesis. The data presented are critical for establishment of isotopic signatures and chronology of the various magmatic events associated with progressively continental breakup and oceanic rifting.

WRENCH FAULT TECTONICS AND GOLD MINERALIZATION: THE GOLDEN BEAR DEPOSIT; N.W. BRITISH COLUMBIA.

***Oliver, J. L. and Hodgson, C. J.** Department of Geological Sciences, Queen's University, Kingston, Ontario K7L 3N6.

The Golden Bear deposit, 625,390 tonnes diluted geological reserves grading 18.63 grams per tonne, is located 140 kilometres west of Dease Lake, British Columbia. The deposit is hosted by shears and splays of a crustal scale transcurrent fault, the Bear Fault. Several large scale tectonic features characterize this fault: 1. en echelon west-verging overturned folds; 2. northwest and southeast verging thrust faults, linked by transcurrent faults; and 3. remnant ophiolite assemblages. Lithologic discontinuities and the orientation of en echelon fold axial surfaces suggest that earliest movements on this fault were sinistral and reverse. Later movements are dextral.

Alteration associated with mineralization has been K/Ar dated at between 174 and 204 Ma. Along the Bear Fault, gold mineralization is associated with dilatent zones developed at the contacts of pyritized mafic tuffs and siliceous dolomites. An epithermal origin is suggested by the association of gold and silver tellurides, native mercury and mercury tellurides, with the main ore body. Metallic minerals are usually less than 5 microns in diameter and free gold is generally absent. A mesothermal origin is supported by the alteration style, carbonate-chlorite-sericite-pyrite, the limited development of clay rich alteration assemblages, and by the absence of well defined quartz veins exhibiting open space filling textures.

Canada. Six new zones are re
eight zones established earli
applicable, with two exceptic
separation. Conodont colour
extremely variable and genera
and attendant phenomena. Are
occur chiefly on NW Graham Is

The Sadler Limestone repre
carbonate platform with local
polygnathiformis Zone time.
rapid sea level rise beginnin
subsequent deposition in a sl
Norian. Carbonate sedimentat
Norian bidentata Zone time ar
sediments of the Sandilands F

**#Th/U DISEQUILIBRIA AND
SHELLS FROM RAISED MAR
METHODOLOGICAL PROBLEMS**

Ortlieb, Luc, Mission ORSTOM
Bassam, Pichet, Pierre and (
du Québec à Montréal,Montréal,

In the absence of more suitable m
mitigated success for geochrono
tectonically active coastal areas. In
and dry climatic conditions thro
diagenetic effects on biogenic carbo
mineralogical (aragonite/calcite) a
mollusk and barnacle fossil assem
high interglacial sea levels (from
allo/isoleucine (A/I) and Th/
chronostratigraphy of Pleistocene
each site, orderly values are c
unequivocal assignement of A/I r
Similarly, significant departures ar
corrected for the "detrical" Th-U
corresponding high Pleistocene se
however to decipher at most sites
7, 9 and 11. A few peculiarities we
studied biogenic carbonates. $^{234}U/^{2}$
samples to ~ 1 in the youngest or
fossil shell assemblages during th
continental sources progressivel
average 0.75 in the studied sample
relative closure of the ^{238}U-^{230}Th

KINETIC MODELS OF PETROLEUM
AND THE IMPORTANCE OF ENHAN

*Osadetz, K.G., Snowdo
Petroleum Geology, 3303-
Doligez, B. and Burrus, J
92506 Rueil-Malmaison Ce

Effective petroleum source r
Basin occur in the Yeoman
Devonian), Bakken (uppermos
Lodgepole (Mississippian) f
Type I source rock composed
prisca Zalessky 1917. Ot
marine organic matter. T
observed to be elevated to
heat flow and anomalous
Anticline coincident with t
of enhance hydrocarbon ge
prospectivity of Paleozoic
of these source rocks a
simulations, using time in
zone of enhanced hydrocarbo
higher than that characte
provides a stratigraphic, t
of hydrocarbon accumulatio
some source intervals are
flows characterize regions

that the hydrothermal fluids were low in salinity, 1 to 3% NaCl, and of low temperature , 180°C (J. O'Brient, B. Bodner, 1984).

The model for the GOLDEN BEAR mineralization requires the following features:

(1) Major fault
(2) Suitable structural trap
(3) Heat pump (Jurassic intrusions and/or porphyry copper deposit)
(4) Triassic volcanic rocks

These generalized features can now be made more specific for the GOLDEN BEAR mineralization. A major fault is required to channel the hydrothermal fluids both laterally and vertically. The Bear Fault and West Wall Fault are both major zones which have slivers of limestone, tuff, ultramafics and diorite along their length. The diversity of lithologies and the presence of fault slivers support the hypothesis that it is a major fault system and does tap deeper segments of the crust.

Hydrothermal fluids, either from intrusions or from local hot spots, will be able to move up and along these fault zones. The association between gold deposits and porphyry copper mineralization can be clearly documented. For example, in Chile, the Silica gold deposit is found 1000 meters vertically above the large porphyry copper deposit, El Salvador. This type of setting can be applied to the GOLDEN BEAR where there are numerous low grade porphyry copper deposits nearby. The hydrothermal system which created the porphyry copper deposits could also have caused the gold deposit at GOLDEN BEAR. In the Tatsamenie area, the Jurassic intrusions contained abundant volatiles as they were crystallizing. In the case of the RAM-TUT claims, the Jurassic diorite was albitized. The albitization process takes place in the weaning stages of magmatic crystallization when the volatiles alter the crystallized portion of the intrusion. The date of this albitization event is 171 ± 5 Ma (Hewgill, 1985), close to the sericite dated from the BEAR mineralization (177 Ma).

The host rocks are important both stratigraphically and structurally. Stratigraphically, the Triassic volcanics appear to be significant when considering gold deposits on a provincial scale as they may be the source for the gold. Structurally, the host rock, if it is not originally porous or permeable, will require some modification by brittle deformation. There are certain aspects that would make one set of fault systems more amenable to creating a more favourable host. They include rocks of varying competence, favourable geochemistry and porosity. Regionally, there may have been a number of feeder zones which have brought fluids up through the brittle limestone. In some cases, faults such as the West Wall Fault and Bear Fault have broken the contact between the Siltstone and Limestone Units. In other cases the contact has not been broken and the silica rich fluids have replaced the upper layers of the Limestone Unit to form a manto style deposit (e.g. RAM TUT).

After completion of the underground work at GOLDEN BEAR, it is clear that the hydrothermal fluids have travelled along the Bear Fault (a major fault system) and deposited the BEAR Main Zone at a change in strike and dip (structural trap) of the fault zone. The change in strike and dip is extremely well illustrated when structural contours are made of the fault plane (Hulstein, pers. comm. 1987). It is interesting to note that the bulk of the consistent high grade mineralization in the BEAR Main Zone is directly associated with this change in strike and dip and occurs just above the roll in the fault (Fig. 5). Once the fault becomes more regular in strike and dip, the grade is less predictable. The style of mineralization becomes more

GOLDEN BEAR MAIN ZONE
IDEALIZED CROSS-SECTION SHOWING MINERALIZATION
(LOOKING NORTH)

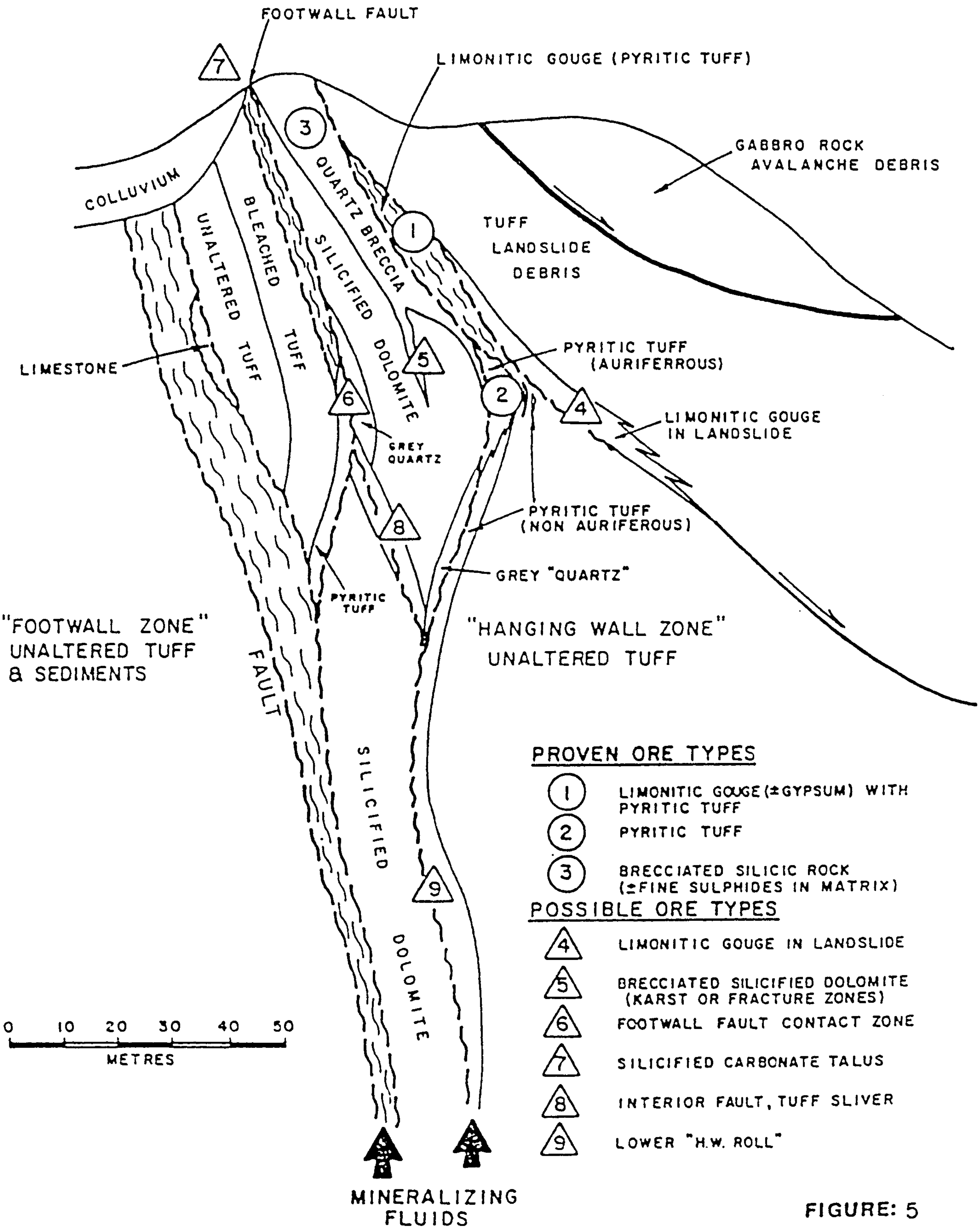

FIGURE: 5

typical of other gold deposits with respect to the difficulty in connecting drill hole intersections to make ore shoots. The ability to predict changes in strike and dip will be essential in finding another large deposit in the area.

PROPERTY GEOLOGY AND MINERALIZATION

The geology of each property will be discussed based upon the information from the 1987 drill core and surface mapping from 1981 to 1987.

MISTY-NIE

The MISTY-NIE claims are underlain by the Pre-Upper Triassic assemblage as shown on Figure 3. Detailed geological maps (Fig. 6ab, 7) covers the MISTY-NIE claims and includes the 1987 drill holes.

Pre-Upper Triassic

The stratigraphic column (Fig. 4) of the Stikine Assemblage is represented on the claims. The basal Limestone Unit occurs only as fault slivers along the West Wall Fault. These fault bounded slivers are predominantly unaltered. The limestone is generally equigranular and appears to have recrystallized. The limestone was intersected by hole N-38 and it was not possible to identify where in the stratigraphic column it came from.

The Siltstone Unit was intersected in the majority of the holes. It is represented by well bedded, graphitic mudstones to siltstones that exhibit soft sediment deformation. Soft sediment breccias were also observed in many of the holes. The fragments appear to have been silicified and the matrix is primarily composed of graphite. The silicification in the intraformational breccia and in parts of the siltstone is both pervasive and along banding.

Structurally, most of the slip has been taken up by this unit. In the siltstone, slickensides are visible on graphitic surfaces and in some gouge zones. Most of the fragments in the intraformational breccia have been elongated, probably during faulting.

The Siltstone represents a restricted anoxic basin where the mud and silt collected. This unit represents the transition from a reefal limestone to a major volcanic cycle. Within the layered siltstone, there is abundant fine yellow pyrite which is probably syngenetic. Much of the black component in the siltstone is graphite, although in some instances it does resemble the fine black sulphides observed in the BEAR deposit.

The Tuff Unit is very common on the MISTY-NIE. It is represented by intermediate to mafic, fine to medium grained tuffs and possibly flows. They range in colour from medium green to dark green to greenish gray. The tuffs are predominantly fine grained with rare lapilli fragments and are typically bleached when altered. The bleaching is caused by an introduction of dolomite and pyrite. Quartz and carbonate veining is also more common in the bleached zones. This type of alteration is typical of that on the GOLDEN BEAR property, peripheral fo the mineralization.

On surface, ultramafic rocks have been mapped, although none were intersected in the core. These rocks are described by Souther (1971) as part of the Stikine terrane. On the claims they are typically serpentinized amphibolite. A small sliver of ultramafic occurs on the NIE plateau adjacent to the West Wall Fault. The rocks are interpreted as alpine ultramafics rafted into their current structural position by major faulting. The largest of these ultramafic bodies is within what is now called the Ultramafic Fault on the east side of the NIE group.

Foliated Diorite

The foliated diorite is classified as Triassic by Souther (1971). It is generally medium grained, equigranular and has a weak to strong foliation. In most cases on the NIE claims, it is in fault contact with the Tuff Unit; however, on the GOLDEN BEAR property to the south, it has an intrusive contact with the Tuff Unit.

Non-Foliated Diorite

Souther (1971) has classified the non-foliated diorite as Jurassic. On the NIE group it is represented by a series of feldspar porphyry dykes, which have come up along the West Wall Fault. These dykes are probably related to the large body of Jurassic diorite that outcrops on Misty Mountain, just to the west of the NIE Claims.

In many of the drill holes, the intersected dykes were generally dark gray when least altered. The dykes are usually porphyritic with 80 - 90% feldspar, 5 - 10% mafics and 5 - 10% quartz. In the most intensely altered sections, the feldspar was totally clay altered with a green to white colour and the mafic content decreased to less than 5%. Away from the fault, the dykes are pinkish in colour and were originally thought to be syenitic. However, thin sections have shown the composition to be dioritic. The dykes have preferentially intruded the siltstones along the West Wall Fault.

From the best showing on the NIE Claims, a sample of the dyke was dated by Schroeter (1987) yielding an age of 156 $\bar{M}a$. These dykes are presumed to be part of the later phase of the Jurassic diorite intrusion (Schroeter, 1987). If the Jurassic intrusions are the heat pump which created the hydrothermal system to form the mineralization in this area (GOLDEN BEAR), then that system survived for approximately 50 $\bar{M}a$ (from 154 to 205 $\bar{M}a$). These dates, based on K-Ar dating of sericite in the diorites, were obtained from samples collected by Chevron and Schroeter (1987).

Level Mountain Basalts

These basalts are located on the upper plateau of the NIE Claims and are remnants of flows from the Hearts Peak and Level Mountain volcano. Originally a large portion of the area was probably covered by these basalt flows. Surface mapping located a few outcrops of columnar-jointed, vesicular basalts. Today a number of the cinder cones are still visible on Hearts Peak.

Mineralization

The gold mineralization discovered to date is associated with sulphides (primarily pyrite) along the West Wall Fault. In most cases, the surface grab samples assayed from 10 grams/tonne to 61 grams/tonne gold. The highest value was then trenched with resultant assays of 10 grams/tonne gold over 0.6 meters and 20 grams/tonne gold over 0.3 meters. This zone was intersected at depth in holes N-1 and N-3 and along strike in holes N-4 and N-6. Drill holes placed below the trench and below all of the showings produced no highly anomalous gold values.

A second fault, the Ultramafic Fault, is the locus of a series of grab samples from various locations along strike ranging in value from 3.4 to 8.6 grams/tonne gold. These samples are also rich in sulphides.

The style of mineralization expected on the MISTY-NIE Claims is similar to that on the GOLDEN BEAR property and is described earlier in this report. The mineralization on the MISTY-NIE has been interpreted as an indication that the fault is still fertile and has allowed mineralization to leak from depth. Although much of the area is covered by glacial moraines and ice, extensive sampling has ascertained that the deposit does not outcrop at surface. Regional alteration and the strong hydrothermal system at GOLDEN

BEAR are indicative of a very large system or several smaller systems. The size or extent of the system is conveyed by the widespread alteration (silicification) of the upper layers of the limestone. One key to finding the ore grade mineralization is to locate the feeder zone of the fluid. On the MISTY-NIE Claims, the West Wall Fault has been clearly identified as the feeder zone. Now it is essential to locate a structural trap similar to GOLDEN BEAR where the gold has been deposited.

OUTLAW

The OUTLAW Claims, illustrated in Figure 3, are underlain by Pre-Upper Triassic rocks, Stuhini volcanics, a Jurassic diorite and the Sloko Group volcanics. The geological map for the OUTLAW claim block (Figure 7) contains the following units:

Pre-Upper Triassic Unit
Stuhini Group
Takwahoni Formation
Biotite-hornblende Diorite
Sloko Group

"Pre-Upper Triassic" (?)

Although this unit is mapped by Souther (1971) as Pre-Upper Triassic, it could be interpreted as a hornfelsed portion of the Takwahoni Formation. Regional traverses by the author have located other areas of clearly Takwahoni Formation which have been contact metamorphosed by the Jurassic volcanic rocks. In some places the sediments can be traced from areas of low metamorphism through contact metamorphism and into the intrusion. The outcrops on the OUTLAW Claims are not the same as any of the stratigraphic sections that occur in the Pre-Upper Triassic. This section would have to be a completely different unit that has not been seen before. The relatively thinner layering is more indicative of the younger rock sequences.

This unit is well layered and gray to green to black with abundant chlorite-epidote alteration. It outcrops on the southern side of the diorite near the central portion of the claims. The rocks are well silicified on a broad scale and have been referred to in the field as the "Flintstone Unit". Locally the rock is cut by quartz veins which are up to one meter in width. A marker bed, traceable over one kilometer, was found in the sediments near the diorite contact. This marker bed consists of subrounded to subangular clasts of gray, black and white chert in a fine grained sericite matrix.

In drill core, these rocks are represented by a series of shales, siltstones, sandstones and occasionally conglomerates, which have been contact metamorphosed to hornfels. Subsequently the hornfels has been subjected to intense hydrothermal alteration and locally altered to clay. The clay altered hornfels tends to be bleached, crumbly, and locally limonitic. Montmorillonite and sericite were seen in the intensely altered areas, while pyrophyllite and possible talc occurred as fracture coatings and veinlets. Some gouge zones near the top of the holes contained more competent rock fragments.

Disseminated pyrite (0.5 to 2%) was common in the hornfels with local areas of fine, gray sulphides (1%). Trace amounts of chalcopyrite, pyrrhotite, arsenopyrite and stibnite were also found. Some extremely high values of antimony were obtained from drill core analysis.

Stuhini Group

This group is identified as Triassic by Souther (1971) and consists of a sequence of volcanic flows, flow breccias and subordinate volcaniclastic rocks. Dark green and maroon feldspar porphyry and augite-feldspar porphyry dominate the exposures. The volcanic breccia is polymictic and contains rounded limestone clasts. The rocks are generally fresh with minor chlorite-epidote alteration and veins of calcite.

Takwahoni Formation

Souther (1971) places this formation in the Lower to Mid-Jurassic. On the OUTLAW Claims it is represented by a series of shales, mudstones and siltstones. This formation is generally recessive and underlies the eastern portion of the property. The hornfels just south of the diorite is interpreted as part of the Takwahoni, although Souther (1971) identifies it as the Pre-Upper Triassic sequence.

Biotite-Hornblende Diorite

This stock has been identified as Jurassic by Souther (1971). Generally, it is coarse grained, equigranular and unaltered diorite on the surface with mafic content varying from hornblende rich in the center to biotite rich near the margins. In the drill holes, a highly altered version of the diorite was intersected making it difficult to differentiate between the hornfelsed sediments and the diorite. The contact zone was extremely pyritic (up to 10% coarse yellow pyrite) with high values of arsenic and antimony. In outcrop, however, there is no obvious increase in the pyrite mineralization of the diorite near the contact.

In core, minor veins of calcite and hematite were observed in the diorite. Where the diorite is recognizable, it is usually medium to coarse grained and locally porphyritic.

Sloko Group

The youngest rock type on this claim block, and to the north, is the Cretaceous to Tertiary Sloko Group. It is represented by rocks ranging from subvolcanic (high level intrusions) to extrusive flows and tuffs. The composition of the volcanic sequence is acidic with rock types varying from rhyodacite to rhyolite. The center of the volcanic complex is five to six kilometers north of the claims.

In the vicinity of the drilling, the Sloko is represented by a number of feldspar porphyry dykes. Their strike is parallel to the fracture system that appears to control the alteration and mineralization on the claims. These dykes have up to 2% coarse, euhedral yellow pyrite. In the rhyolite dykes, quartz eyes are visible.

Mineralization

The mineralization on the OUTLAW Claims is related to an area of intense clay alteration and a series of east-west fractures that are visible on the airphotographs and Landsat imagery.

Just west of the area drilled in 1987, a quartz vein system was trenched in 1983. These trenches produced no anomalous gold values although two samples assayed 15 and 16 grams/tonne silver. Surrounding the vein system is a narrow clay alteration zone. This vein system strikes east and appears to be the same system that was encountered in the area drilled. The only major difference between the two areas is in the intensity and extent of the alteration around the vein system. The highest values of arsenic and antimony are in soil samples found in the drill area.

Fluids could move along this east-west striking fracture system. The flow of fluids would have been greater in areas of higher porosity and permeability, as well as areas near the center of the hydrothermal system. As the fluids rose to the surface, they would have been able to percolate into the fractured sediments, altering them to clay. Some silica would have leaked along the fracture system and formed a vein system. The fluids carried arsenic, antimony, barium, gold and silver.

The alteration and mineralization of the OUTLAW Claims (Fig. 9) are characteristic of a classic epithermal style gold deposit: extensive acid clay alteration and gold-silver values in veins with arsenic, antimony and barium geochemistry. The system is almost certainly Cretaceous to Tertiary age (related to Sloko) because (1) it appears to occupy a fracture system also occupied by the Sloko dykes, and (2) it has altered the Jurassic diorite after the hornfels was formed.

A second less favoured interpretation is that the alteration in the diorite and the hornfels is associated with the diorite. The alteration in the diorite is termed an endoskarn while the alteration in the hornfels is termed an exoskarn. If the alteration and mineralization is related to the Jurassic diorites, then there is significant potential for a bulk deposit in the area. The geochemistry of the soils indicates a large gold, arsenic and antimony anomaly which correlates well with the hornfels sediments. The large aerial extent of the anomaly would tend to support the hypothesis that the mineralization is related to the Jurassic stock.

RAM-TUT-TOT

The geological map for this claim block (Fig. 10) displays the following units:

Pre-Upper Triassic Unit
Diorite
Sloko Group

Pre-Upper Triassic

The RAM-TUT-TOT Claims have the best exposure of Pre-Upper Triassic rocks in the area. From the top of the hill to the first bench, the Tuff Unit occurs in outcrop, followed by an exceptionally large section of sediments (the Siltstone Unit) and then the Limestone Unit.