Catface copper-molybdenum porphyry, west-central Vancouver Island, British Columbia: An update

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ABSTRACT

Catface is a calc-alkalic, Cu-Mo deposit situated on the rugged west coast of Vancouver Island. The claims covering the property are owned by Falconbridge Limited.

A partially defined resource known as the Cliff zone contains 124 million tonnes grading 0.46% Cu. To the north, a higher grade but smaller mineralized zone known as the Irishman Creek zone was discovered, but not delineated.

Mineralization is related to a small, mid-Eocene, porphyritic quartz diorite to granodiorite stock that intruded older quartz monzonite and Triassic Karmutsen Group basalt. Disseminated and fracture-controlled chalcopyrite, bornite and minor molybdenite are hosted by all these lithologies. The best copper grades are directly related to high fracture density, particularly within quartz monzonite and altered basalt. Potassic alteration, as secondary biotite, is associated with copper mineralization, but other features such as a quartz stockwork, phyllic alteration and a well defined pyrite halo are absent at Catface. Recent sampling of the Cliff zone showed low gold content in the order of 50 ppb.

Results from a recent airborne magnetometer survey, flown in 1989, show a direct response to the intrusion beneath the Cliff zone and also indicate the presence of a buried stock in the upper Irishman Creek basin. The I.P./resistivity survey responded directly to copper mineralization over the Cliff zone. A chargeability anomaly indicates a south extension of untested mineralization.

Metallurgical work completed to date shows that the best copper grades lie beneath partially oxidized low-grade material which causes variable copper recoveries. The environmental base-line studies at Catface showed that a mining operation is unlikely to generate acid mine water.

Introduction

The Catface Cu-Mo porphyry deposit is located on the west coast of Vancouver Island, about 13 km northwest of Tofino, British Columbia. Since the description of Catface by McDougall (1976) several exploration programs have been completed. They were conducted primarily in 1978 and 1989-1990 and include metallurgical testing, drilling, geophysical surveys, re-sampling of the adit, and environmental base-line studies.

The property consists of 145 contiguous two-post claims owned by Falconbridge Limited which cover all of the higher elevation between Morfee Island and Bawden Bay on the Catface Peninsula. A point near the centre of the property is at latitude 49° 15′20″N, longitude 125° 59′00″W. The deposit is covered by NTS map sheets 92E-1, 92E-8, 92F-4 and 92F-5.

Since 1976, the knowledge of regional geology in this part of the Insular tectonic belt has not progressed much beyond additional isotopic age determinations and the discovery of more small intrusive centres along the "Catface trend".

This paper presents additional geological observations not described by McDougall (1976) together with recent results from the 1989 program conducted by Falconbridge Limited.

Results from both recent and earlier metallurgical studies to improve copper recoveries are also presented. Economic considerations are discussed that reflect new and unpublished earlier results and evaluations.

History

The earliest evidence of exploration at Catface is a caved adit driven about 5 m into a highly fractured and oxidized shear; the main property was evidently not investigated between the turn of the century and 1960. In 1960, a local mine operator, John Jackson, and G. Davis, pilot prospector for Falconbridge Nickel Mines, made a brief visit to a cliff face displaying a conspicuous copper stain. Mineralized and highly oxidized samples prompted a more thorough examination by Falconbridge geologist J. McDougall and company helicopter pilot R. Hepworth who then staked the property.

Falconbridge, through Catface Copper Mines Ltd., conducted exploration between 1961 and 1979. This included driving an 857 m adit and drilling more than 19 000 m in 127 surface and underground holes. Numerous metallurgical tests were conducted, and a bulk sample was shipped to Falconbridge's Tasu mine on the west coast of the Queen Charlotte Islands for processing. The geology of the property was mapped; soil and silt geochemical surveys were completed. Limited geophysical test surveys including I.P./resistivity, self-potential and magnetic surveys were conducted in selected areas. The claims were also surveyed at this time.

In 1989 and 1990, Falconbridge Limited re-activated the project to increase the resource and to determine gold content of the copper mineralization. The program included detailed adit sampling for copper and gold, geological mapping of selected areas, a 19 line-km I.P./resistivity, VLF and magnetometer survey to cover accessible areas, 150 line-km of combined airborne magnetometer and VLF (EM) surveys covering most of the claim block (de Carle, 1989) and metallurgical tests. An environmental base-line survey was also carried out. Four holes (1628 m) were drilled to test chargeability anomalies.

Geology of the Deposits

The geological description of the Catface deposits remains essentially as described by McDougall (1976), with minor additions. Mineralized zones at Catface, include the main deposit known as

monly associated with porphyry systems. The porphyry system contains an outer zone of pyrite-chlorite (propylitic) alteration and is more than 4 km long and 1 km to 2 km across. Two internal copper-molybdenum zones with associated potassic alteration (biotitic) are centred on granodiorite porphyry stocks that are in the west-central (Main zone) and east-central (East zone) parts of the system.

The highly pyritic system is well defined by a strong induced polarization-chargeability response. Exploration drilling was initially focussed on the Main zone because of its favourable geochemistry. However, subsequent geological mapping and geophysics served to outline the over-all system and indicated the additional potential of the East zone.

Acknowledgments

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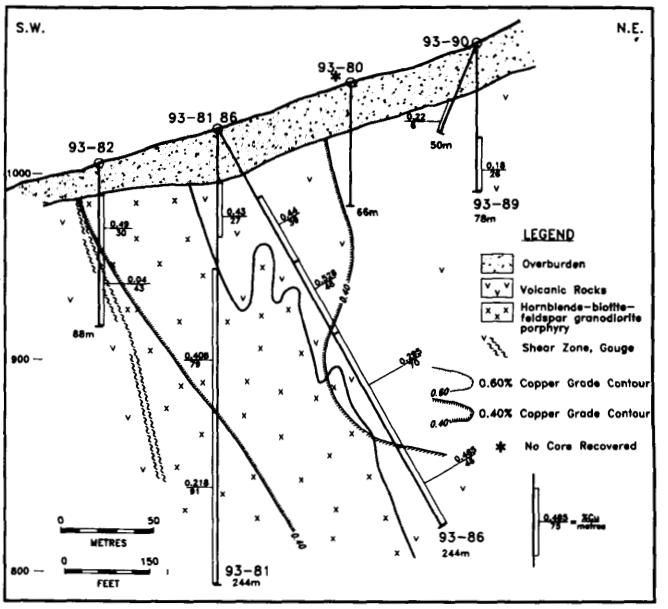

FIGURE 10c. Huckleberry project — East zone, cross section 1733 (looking northwest).

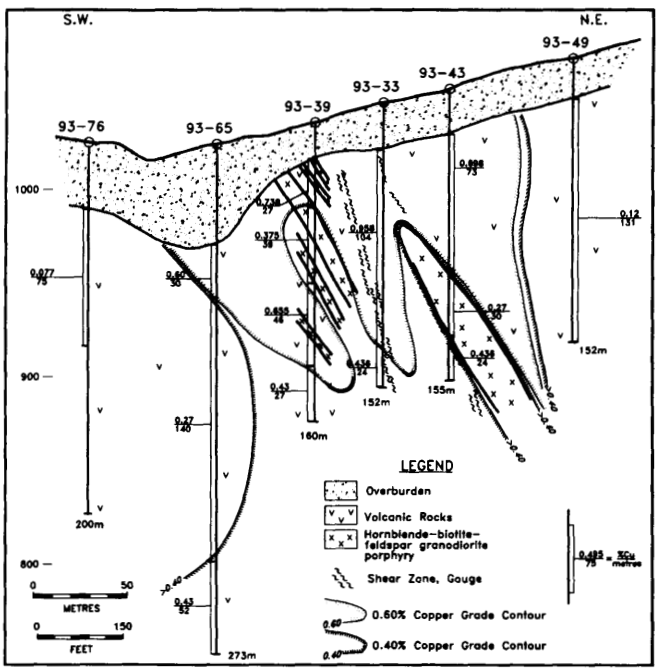

FIGURE 10d. Huckleberry project — East zone, cross section 2000 (looking northwest).

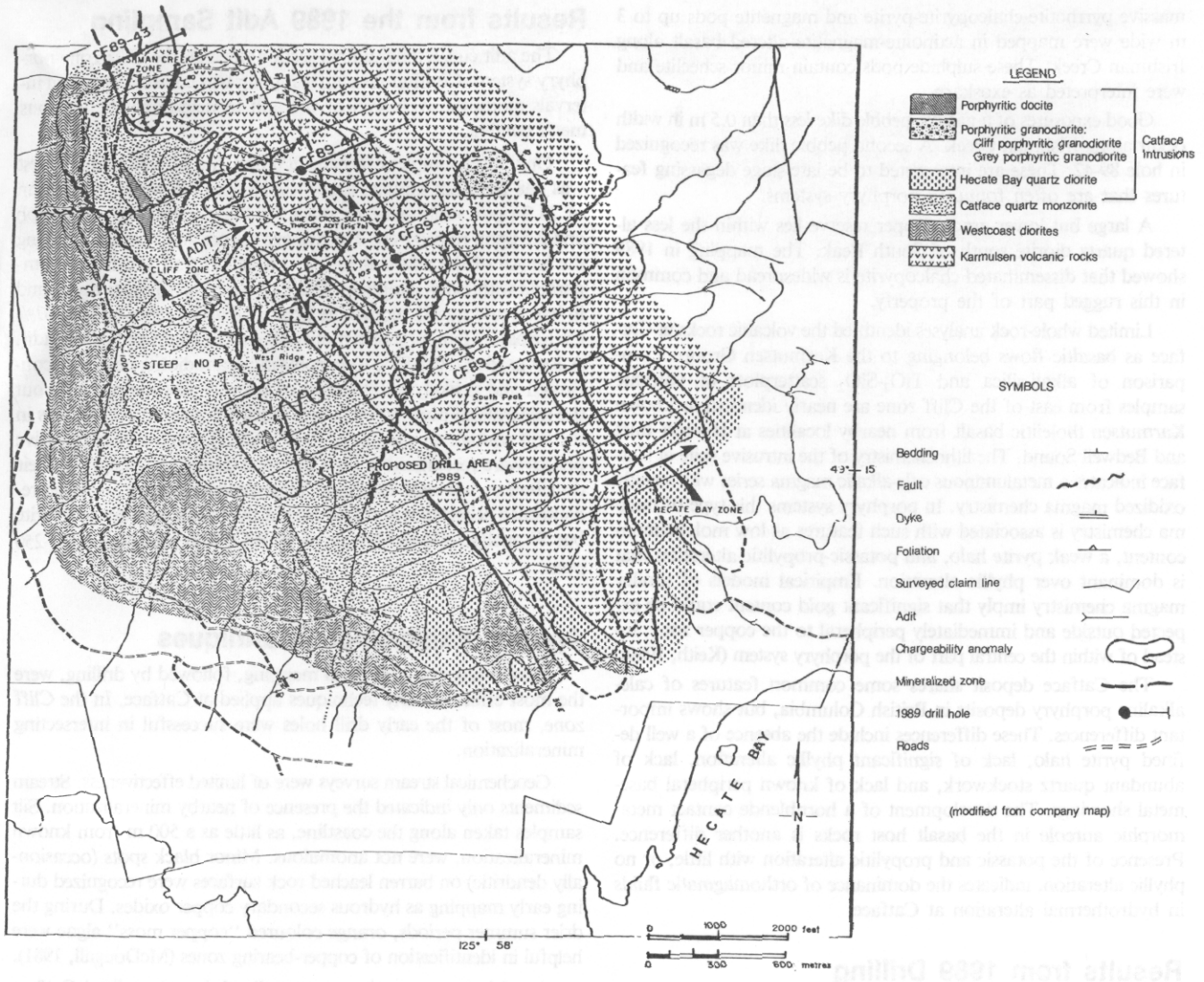

FIGURE 1. Geology map of Catface area.

the Cliff zone, the Irishman Creek zone to the north, and the Hecate Bay prospect which lies southeast of South Peak (Fig. 1).

The Cliff zone is a calc-alkalic Cu-Mo porphyry system genetically related to a small mid-Eocene porphyritic quartz diorite to granodiorite stock. This intrusion, known as Cliff porphyritic granodiorite (Fig. 1) belongs to an intrusive suite locally known as "Catface intrusions"; it cuts older quartz monzonite and basalt volcanic rocks of the Triassic Karmutsen Group. Mineralization consists of fracture-controlled chalcopyrite and bornite with minor molybdenite, with rare mineralized quartz veins. The higher grade copper mineralization (up to 0.6%), generally reflects higher bornite content and is found in quartz monzonite and basaltic volcanic rocks. Fracture density studies in the adit confirmed that highest copper grades are related to greatest fracture density (McDougall, 1981). Locally, some feldspar porphyry dikes also contain disseminated copper sulphides.

The Cliff porphyritic granodiorite is surrounded by an extensive biotite hornfels and widespread black hornblende hornfels is present in the basalt. By 1989, most of the drill core had been destroyed by the elements, but core from three surface holes was salvaged from near the centre of the Cliff zone (section 2S) and examined for hydrothermal alteration characteristics. The presence of potassic alteration was confirmed, and occurs as shreddy, fine-grained secondary biotite that is mainly fracture-controlled, but also locally pervasive (Enns, 1989a). Hydrothermal biotite overprints the earlier biotite hornfels. The highest copper grades on section 2S correlate closely with the zone of most intense potassic biotite alteration. Although present, sericite alteration is very local in its distribution and is largely controlled by structures such as faults. Scattered occurrences of white zeolite and gypsum in drill holes, and on surface, indicate the presence of a wide, outer alteration halo surrounding the Cliff zone.

The small Irishman Creek zone, north of the Cliff zone (Fig. 1) contains higher copper grades. Early drilling showed that the brecciated east margin of the Irishman Creek zone hosts significant copper mineralization. The best intercept came from hole 68-39 which assayed 0.63% Cu across 155.4 m and contained elevated silver up to 6.7 g/t. Old drill logs describe the breccia as "clasts and blocks of basalt and quartz monzonite with a chloritic matrix", but the logs are not sufficiently detailed to classify this breccia. Well-exposed breccia along nearby Irishman Creek was mapped in 1989 and has the appearance of an intrusion breccia related to the irregular contact between quartz monzonite, the Karmutsen basalt and Westcoast intrusive complex (diorite and gabbro migmatite).

A patchy garnet-epidote alteration zone was mapped in basalt and quartz monzonite along Irishman Creek and was interpreted as local exoskarn and endoskarn alteration. Garnet-epidote altered quartz monzonite intervals were also intersected by hole 89-43. Thin sections of core from the altered quartz monzonite show replacement of Ca-plagioclase by K-feldspar and albite as well as primary biotite that is altered to hydrobiotite. The hydrobiotite overprints the garnet-epidote (skarn) alteration. Exposures of local, banded

massive pyrrhotite-chalcopyrite-pyrite and magnetite pods up to 3 m wide were mapped in actinolite-magnetite altered basalt along Irishman Creek. These sulphide pods contain minor scheelite and were interpreted as exoskarn.

Good exposures of a narrow pebble dike less than 0.5 m in width occur along Irishman Creek. A second pebble dike was recognized in hole 89-42. These are interpreted to be late-stage degassing features that are often found in porphyry systems.

A large but lower grade copper reserve lies within the less altered quartz diorite south of South Peak. The mapping in 1989 showed that disseminated chalcopyrite is widespread and common in this rugged part of the property.

Limited whole-rock analyses identified the volcanic rocks at Catface as basaltic flows belonging to the Karmutsen Group. Comparison of alkali-silica and TiO_2-SiO_2 scatterplots of volcanic samples from east of the Cliff zone are nearly identical to known Karmutsen tholeiitic basalt from nearby localities at Herbert Inlet and Bedwell Sound. The lithochemistry of the intrusive suite at Catface indicates a metaluminous calc-alkalic magma series with weakly oxidized magma chemistry. In porphyry systems this type of magma chemistry is associated with such features as low molybdenum content, a weak pyrite halo, and potassic-propylitic alteration that is dominant over phyllic alteration. Empirical models of similar magma chemistry imply that significant gold content could be expected outside and immediately peripheral to the copper zone, instead of within the central part of the porphyry system (Keith, 1989).

The Catface deposit shares some common features of calc-alkaline porphyry deposits in British Columbia, but shows important differences. These differences include the absence of a well defined pyrite halo, lack of significant phyllic alteration, lack of abundant quartz stockwork, and lack of known peripheral base-metal showings. The development of a hornblende contact metamorphic aureole in the basalt host rocks is another difference. Presence of the potassic and propylitic alteration with little, or no phyllic alteration, indicates the dominance of orthomagmatic fluids in hydrothermal alteration at Catface.

Results from 1989 Drilling

In 1989, four holes (1628 m) were drilled to test chargeability anomalies (Fig. 1). One hole (89-43) tested the anomaly extending north of the Irishman Creek zone, in which earlier drilling (hole 68-39) had intersected high copper grades. Two holes (89-44 and 89-45), 487 m apart and due east of the Cliff zone, tested two chargeability anomalies in the upper basin of Irishman Creek. The fourth hole (89-42) tested the north fringe of a large chargeability anomaly that extends more than 600 m south of South Peak.

At the Irishman Creek zone, drilling intersected mixed breccia, hornfels altered and mineralized basalt, and patches of skarn alteration. The best interval was 12.2 m of 0.51% Cu with a narrow intersection of 0.22 g/t Au and 21.4 g/t Ag. It demonstrated that copper mineralization in this zone contains significant, though variable precious metal content. It also showed the erratic nature of the copper grades and lack of continuity of mineralization. Steep terrain discouraged additional planned drilling for this area.

The two holes east of the Cliff zone encountered weak, fracture-controlled copper mineralization related to feldspar porphyry dikes that cut biotite-altered basalt. Near the bottom of hole 89-45, disseminated chalcopyrite mineralization was intersected (0.36% Cu across 15.2 m) in a mineralized quartz diorite dike. Molybdenite content in these two holes showed an increase to the south as well as with depth, indicating that a mineralized stock underlies the extreme upper Irishman Creek drainage.

Hole 89-42 intersected very weak copper mineralization in biotite-altered basalt. Copper mineralization increased slightly near the bottom of the hole where 46 m of 0.11% Cu were intersected in altered basalt. At 487 m this hole did not reach the quartz monzonite contact.

Results from the 1989 Adit Sampling

The adit cuts a longitudinal section through the Cliff zone porphyry system. Continuous chip sampling was conducted at 3 m intervals along the west wall of the adit to determine the precious metal content.

Only three samples exceeded 200 ppb Au, of which the highest was 338 ppb. Six samples exceeded 10 ppm Ag with a maximum of 25.2 ppm. Arithmetic averages for the Au and Ag are 50 ppb and 2.5 ppm, respectively. The average copper grade calculated along the length of the adit is 0.36% Cu over 827.5 m which was comparable with early sampling. The highest copper grades are found in basalt and quartz monzonite host rock with grades up to 0.67% Cu across 39.6 m in quartz monzonite at the south end of the adit. A low-grade (<0.2 % Cu) porphyritic granodiorite core was confirmed and is likely an intrusion of late- to post-mineral age, but the mineralized porphyritic quartz diorite to granodiorite phases in the adit contain an average of 0.44% Cu. Several distinct intrusive phases were recognized in the Cliff zone during sampling, but their distribution was not mapped. Widespread tungsten as fracture-controlled scheelite was discovered in the basalt and quartz diorite but W analysis showed low levels of WO_3 with a maximum of 250 ppm.

Applied Exploration Techniques

Prospecting and geological mapping, followed by drilling, were the most effective early techniques applied at Catface. In the Cliff zone, most of the early drill holes were successful in intersecting mineralization.

Geochemical stream surveys were of limited effectiveness. Stream sediments only indicated the presence of nearby mineralization. Silt samples taken along the coastline, as little as a 500 m from known mineralization, were not anomalous. Minor black spots (occasionally dendritic) on barren leached rock surfaces were recognized during early mapping as hydrous secondary copper oxides. During the drier summer periods, orange coloured "copper moss" algae were helpful in identification of copper-bearing zones (McDougall, 1981).

An airborne magnetic survey outlined the mineralized Catface intrusions as low magnetic features. VLF (air and ground) surveys indicated a response to possible faults and contacts. Resistivity features from the airborne and ground surveys lacked definition, but together with magnetic data, they outlined several geophysical targets (Hendrickson, 1989).

The chargeability readings from the I.P./resistivity survey showed a direct response to known chalcopyrite and minor bornite because copper mineralization lacks pyrite. The 22 msec chargeability contour generally corresponds to the 0.4% Cu contour in the Cliff zone. Grid costs are high at Catface; lines were cut over the accessible part of the Cliff zone at a cost of $1160 per line-km.

Soil geochemistry integrated with chargeability anomalies and known geology was effective in establishing drill targets in regions of poor outcrop at the south end of the property.

Economics

The drill indicated resource figures recently calculated for the Cliff zone vary from 188 million tonnes to 308 million tonnes, depending on copper cutoff. Table 1 lists the figures. Mineable, "optimal reserves" using pit optimization-block modelling calculations based on $0.89/lb Cu and $1.10/lb Cu yielded 124 million tonnes and 203 million tonnes, respectively (Charbonneau, 1990). A combined resource was first calculated by Wade (1972); later, for comparison, Charbonneau (1990) using a similar low strip ratio, calculated an even larger geological resource.

The total reserves at Catface are yet to be established because the south limit of the Cliff zone is not known. High copper grades

were encountered at the end of the adit indicating that the south limit of mineralization has not been defined beyond section 14S. In addition, a small resource of 20 million tonnes of mineralized rock with unknown grade was estimated by Wade (1972) for the Irishman Creek zone. The Hecate Bay zone lies southeast of the Cliff zone, and it represents a large untested future copper resource.

The gold levels within the Cliff zone were shown to be low. In the most gold-enriched portion, the average is about 160 ppb. Silver values are up to 6 g/t. Rhenium may be present as a credit in the molybdenite concentrate, but the amount of recoverable by-product (Mo, Re or Ag) at Catface has not been established.

In a pre-feasibility study, Pringle (1969) calculated that an "acceptable" rate of return could be achieved by using economy of scale (40 000 to 80 000 TPD), if the copper recoveries in the higher grade sections could be improved. The presence of copper oxides in the partially leached upper portions of the Cliff zone apparently hinder consistent copper recovery in that region.

Metallurgical Tests

Since 1976, Falconbridge Limited completed a number of metallurgical tests on material from Catface. Most of their work was conducted on material from the Cliff zone, but some of the early work also tested material from the higher grade Irishman Creek zone.

Tasu Bulk Sample Mill Test

In 1979, approximately 3000 tonnes of material from the Cliff zone with copper grades exceeding 0.2% were processed at the company's Cu-Fe concentrator at Tasu. This material, which had been stockpiled at Catface as individual "volcanic" and "granitic" piles since 1971, showed only slight signs of oxidation eight years later despite the high rainfall climate at Catface.

The Catface material processed at the Tasu mill had an average head grade of 0.39% Cu; with average recovery of 82% a rougher copper concentrate up to 16% was produced. Low copper concentrates probably were due to the coarse grind and the untuned scrubber system at Tasu. The use of saline sea water was found to improve the copper recoveries in some circuits. A large amount of visible molybdenite was liberated in the milling process at Tasu in a mill which was not designed to recover molybdenite. The head assay averaged 0.01% MoS_2. Silver recoveries were variable, either due to the variable nature of the metal (such as native silver), or due to losses.

The copper concentrates contained an average of 124 g/t Ag and 2.34 g/t Au from average silver head grade of 10.3 g/t "uncut" and 3.80 g/t "cut" materials.

Recent Metallurgical Study of Adit Samples

New bench tests were conducted in 1989 by Lakefield Laboratories (Salter, 1989), using modern flotation technology and better agents (high xanthate) to improve copper recovery. Representative mineralized samples of two clearly defined lithologies were chosen, and collected from deep sites near the south end of the adit to minimize the effects of copper oxidation. For the study, a sample of mineralized porphyritic quartz diorite with 0.40% Cu was collected across an interval of 67.1 m and a basalt sample with 0.48% Cu was collected across 48.8 m (Enns, 1989b). The combined sample weight was 136 kg. A composite sample of equal amounts of each lithology was also tested (Table 2). Results showed a 5% to 10% improvement in the copper recovery over the earlier tests conducted at Tasu. Rougher copper concentrates of 15% to 18% were within the acceptable range, and "cleaned up" concentrate was produced containing 26.6% Cu with by-product content of 4.39 g/t Au and 181.0 g/t Ag. Significant Cu-oxide is present even in these deep samples from the adit. A molybdenite concentrate was not attempted.

TABLE 1. Catface resource summary

Million tonnes	Cu%	MoS_2%	Cu% cutoff	Strip ratio	Remarks
188	0.42	0.014	0.30	1.1:1	Falconbridge, 1990
308	0.37	0.012	0.25	0.5:1	Falconbridge, 1990
124	0.46		0.31	0.7:1	Block Model $0.89 Cu
203	0.40		0.25	0.5:1	Block Model $1.01 Cu
325	0.31	0.01	0	0.068:1	Wade, 1972
607	0.21		0		Charbonneau, 1990

TABLE 2. 1989 Lakefield flotation test

	Quartz diorite	Basalt	Composite
Total Cu %	0.40	0.48	
Oxide Cu %	0.12	0.14	
S %	0.24	0.39	
MoS_2 %	0.008	0.003	
Au g/t	0.09	0.08	
Ag g/t	2.0	3.4	
Rougher Con. Cu %	14.8	14.8	17.8
Recovery % (Rougher + Scav.)	87.0	92.0	88.0
Rougher Tail Cu %	0.058	0.038	0.052
3rd Clean Con. Cu %	30.1	28.5	26.6
Con. Au g/t	5.89	3.34	4.39
Con. Ag g/t	158.0	227.0	181.0

Irishman Creek Zone Metallurgical Tests

In 1981, a 52 kg sample from hole 68-39 was submitted to Lakefield Laboratories for micro bench tests. This hole, drilled in the Irishman Creek zone ended in 0.8% Cu in the breccia.

Metallurgical results showed head grades of 0.62% Cu, 0.02% Cu-oxide, between 0.03 and 0.10 g/t Au, and between 5.7 and 6.7 g/t Ag. Copper recovery exceeded 90% and produced a concentrate grade of 20% Cu, with an average of 2.47 g/t Au, 253 g/t Ag, 0.0075% MoS_2 and 0.65% Zn.

Biological Leach Tests

In 1989, biological leaching studies were conducted on Catface material to determine the viability of recovering copper from low-grade material. Results showed that the rocks are too acid-consuming to economically extract oxide copper from low-grade material. Large volumes of sulphuric acid must be continually applied to sustain the biological leaching activity because the rocks contain insufficient sulphide to generate free acid.

Environmental Base-line Study

In 1989, Falconbridge Limited began an environmental base-line survey. Water tests showed that apart from expected elevated copper and molybdenum levels (respectively 130 ppb and 70 ppb), the water quality, including that from the adit, is pristine. Adit waters are slightly alkaline with a pH of 7.16 and an alkalinity content of 27.3 mg/l Ca CO_3 equivalent. Tests on three representative batches of different mineralized lithologies showed pH paste lithologies of 8.5 for basalt, 8.5 for quartz diorite and 7.5 for quartz monzonite (Hallam, 1989). All sulphide-bearing lithologies are weak net acid consumers, and as such, are incapable of acid generation.

Discussion and Conclusions

A geological resource exceeding 1 billion kg of copper with possible recoverable by-product silver, molybdenum and minor gold has been identified at Catface. The location is favourable near tidewater and infrastructure on the west coast of Vancouver Island, where production costs would be competitive with those for most porphyry deposits in Western Canada. Strip ratios are low and the mineralized rock is not acid generating. Recent tests using more advanced metallurgical technology have improved the copper recov-

ery and showed that production of a saleable copper concentrate is feasible.

Additional untested I.P. anomalies in areas of favourable geology offer the potential for expanding the resource at Catface. These targets include the following:

1. A large untested chargeability anomaly south of the South Peak is underlain by volcanic rocks and scattered Hecate Bay quartz diorite outcrops known to contain widespread weak copper mineralization.
2. The chargeability anomaly over the Cliff zone shows a large extension of mineralization beyond section 14S to the south. This is corroborated by the fact that the adit ended in copper mineralization (exceeding 0.6% Cu). The south limit of the Cliff zone has not been defined, nor has its tenor been tested.
3. A small reserve of higher grade copper mineralization exists at the Irishman Creek zone where limited drilling indicates localized, high-grade copper intercepts with associated precious metals. Terrain in this area is challenging.

With escalating capital costs, the challenges at Catface include a marginal improvement of copper grade and establishing a sufficient inventory of mineable reserves to support a viable long-term operation. Possibly even more challenging at present is the difficulty of being granted a mining permit within the highly sensitive Clayoquot Sound region, so close to Tofino.

Current Status

Between 1960 and 1990, total expenditures by Falconbridge Limited on the Catface project amounted to nearly $10 million (constant $1990). The mineral claims have been held since 1960 and core claims are in the process of being taken to mining lease status. In 1990, Falconbridge Limited planned a drilling program to test the large IP anomalies south of South Peak from two helicopter-serviced sites in steep terrain. Granting of required work permits was delayed by the Clayoquot Land Use dispute; consequently, the Catface project was abruptly cancelled and exploration funding was transferred to other projects. Catface lies within a General Integrated Management Zone designation (multiple use). At present, Falconbridge Limited has no plans to reactivate this project.

Acknowledgments

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May 8/06
Don Barker stated that Alan Savage (Doublestar) says that there is RHENIUM at Catface. (from: Falconbridge data?) VGS

CATFACE Feb. 1/06
Alan Savage "very close" to deal with local First Nations
→ $350k expl'n exp. targeted for 2006 VGS