GEOLOGY OF THE SKIDDER PROSPECT BUCHANS, NEWFOUNDLAND

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by

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Abstract

The Skidder prospect is a volcanogenic massive sulfide deposit hosted by Ordovician mafic volcanic rocks. Three types of sulfide-bearing zones occur in the deposit: (1) a quartz-pyrite stockwork(?) zone that contains very minor amounts of chalcopyrite and sphalerite, (2) a semimassive to massive, medium to coarse grained pyrite zone with minor chalcopyrite and sphalerite, and (3) a laminated massive sulfide zone consisting of fine to medium grained pyrite with lesser amounts (10 to 15%) of chalcopyrite and sphalerite. Brecciated, quartz-veined, massive and rarely bedded jasper is associated with the massive sulfide-bearing zones. Changes in secondary mineral assemblages outline distinct zones of alteration that are evident in cross-section up to 100 m above and below the deposit. These changes involve a disappearance of epidote and hematite, considerable reduction in carbonate and a large increase in chlorite and quartz contents near the sulfide-bearing zones. The Skidder prospect has more features in common with deposits in ophiolite sequences than with the polymetallic, Kuroko-type massive sulfide deposits typical of the Buchans area.

Introduction

The Skidder prospect, located 12 km south-southwest of the town of Buchans, central Newfoundland (NTS 12A/10) (Figure 1), is a volcanogenic massive sulfide deposit hosted within mafic volcanic rocks. The prospect was discovered in 1971 by ASARCO Inc.. Between 1971 and 1975, ASARCO Inc. (and during 1976 and 1977 in joint venture with Abititi-Price Mineral Resources) drilled 38 holes yielding a total of 7795 m core. The total probable and possible resources indicated by this drilling are approximately 900,000 tonnes, grading about 2% Cu, 2% Zn and containing minor amounts of Pb and Ag (D.M. Barbour, 1977, unpublished Abitibi-Price Mineral Resources report).

During the summer of 1983, the principal author completed detailed and some regional geological mapping in the vicinity of the deposit and relogged approximately 50 percent of the drill core as part of a geological and lithogeochemical study of the deposit. The study will form the basis of a Master of Science thesis to be completed by him at Memorial University of Newfoundland. This report concentrates on field aspects of the study, describing macroscopic features of (1) the regional rock types, (2) the host rocks to the deposit and (3) the alteration and ore types.

Regional Geology

The Skidder area is underlain by submarine mafic volcanic rocks. These rocks have previously been included in the Footwall Basalt unit of the Lower Buchans Subgroup, a calc-alkaline volcanic and volcaniclastic suite of rocks of island arc affinity (Thurlow and Swanson, 1981). The Footwall Basalt unit was described by these authors as "the lowermost unit of the Buchans Group..." consisting of a "thick (approximately 3800 m), laterally continuous sequence composed mainly of basaltic pillow lava and pillow breccia interbedded with lesser pyroclastics and discontinuous lenses of multicolored, bedded chert."

Field examinations carried out during this study indicate differences between 'typical' rocks of the Footwall Basalt unit and the rocks that outcrop in the southern two-thirds of the area shown in Figure 1, including the host rocks of the prospect. Rocks in the vicinity of the prospect and in the previously mentioned area are

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generally greener in color and presumably more chloritic than the less altered dark green-black rocks typical of the Footwall Basalt unit. The flows contain fewer amygdules and the amygdules, where present, are smaller in size than those that occur within mafic flows exposed in other sections of the Footwall Basalt unit. This may indicate that these flows were deposited in a deeper water environment than those the flows typical of the Footwall Basalt unit (Jones, 1969). Pillows with variolitic rims are common in areas near the prospect but not in other areas of Footwall Basalt. Also, the rocks near the flows and lesser mafic pyroclastics. The rocks are generally medium green to medium gray and are fine to medium grained.

Pillows in the Skidder Basalt are dominantly small (15 to 30 cm in diameter) but in certain areas are up to 1 m in diameter and are rounded but irregular in cross-section. Interpillow material is generally more chloritic than that making up the pillows themselves, and in some areas small irregular jasper bodies fill pillow interstices. Some pillows have

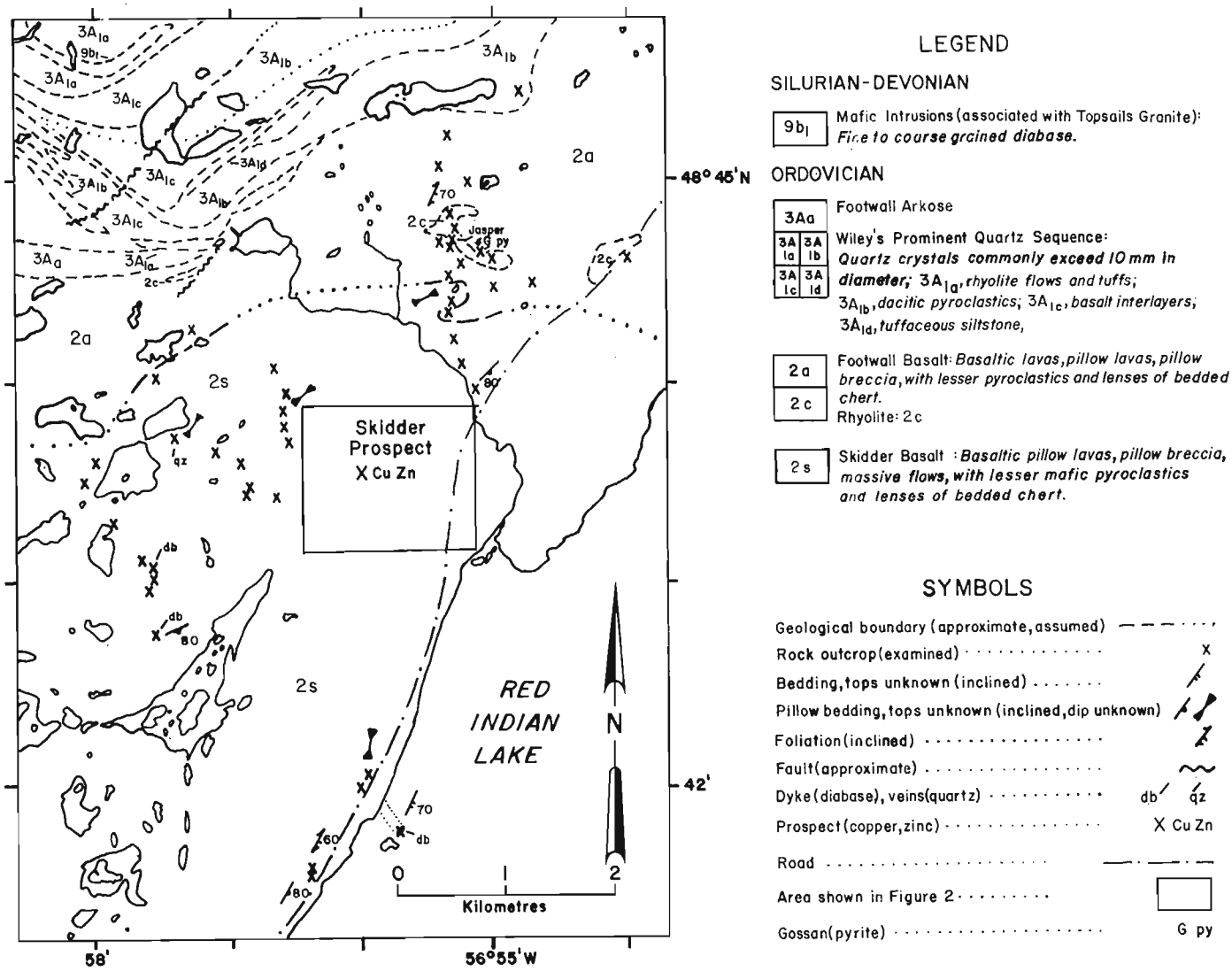

Figure 1: *Regional geology of the Skidder area.*

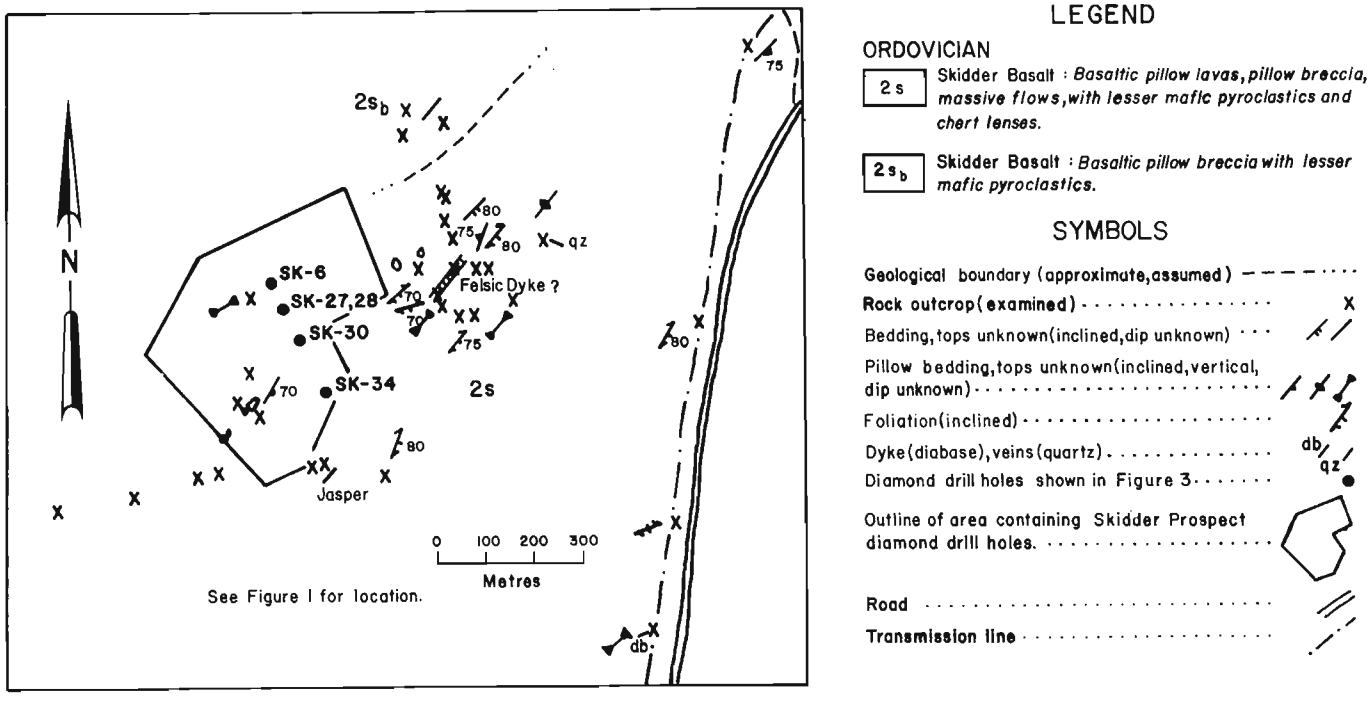

Figure 2: *Local geology of the Skidder prospect.*

variolitic rims characterized by light gray variolites, 3 to 6 mm in diameter, within a of the Skidder basalts and those of the Footwall Basalt unit will be undertaken later in this study.

Individual flow units plus pyroclastic and sedimentary beds examined within both the Skidder Basalt and Footwall Basalt units generally strike northeasterly and dip steeply to the southeast (Figure 1). Pillows predominantly indicate a northwest facing, but most pillows are not suitable for determining stratigraphic tops.

Dean (1977) suggested a Late Ordovician to Middle Silurian age for the Buchans Group based on general stratigraphic relationships. Subsequently, Bell and Blenkinsop (1981) reported a 447 ± 18 Ma whole rock Rb/Sr date for the Buchans Group, which supports a Middle Ordovician to Early Silurian age. However, conodonts recovered from carbonate clasts within Buchans Group breccia units suggest a slightly older, early Middle Ordovician Llanvirnian age for the carbonate clasts (Nowlan and Thurlow, *in preparation)*. The clasts are considered by these authors to be of local origin and, thus, their age to be representative of the age of the Buchans Group. The Skidder Basalt appears to be conformably overlain by the Footwall Basalt unit of the Buchans Group; both are presumed to be of similar age.

Local Geology

Skidder Basalt

The Skidder Basalt (unit 2s, Figures 1 and 2) comprises a sequence of basaltic pillow lavas, pillow breccias, massive green chloritic matrix. These variolite-rimmed pillows have been noted in drill core structurally beneath the massive sulfide deposit, as well as in outcrop to the south of and presumably stratigraphically below the deposit.

Pillow breccias in the area include angular basaltic fragments within a chloritic and, in many instances, epidote-rich matrix. Other pillow breccias, particularly those noted in drill core, are more characteristic of isolated pillow breccia (Carlisle, 1963). These breccias consist of rounded 'mini-pillows' that are 5 to 20 cm in diameter and are located, in most places, within a greener presumably more chloritic matrix. The chloritic matrix generally makes up 30 to 60 per cent of the rock. In many cases, these 'mini-pillows' have variolitic rims similar to the variolitic pillow rims described previously.

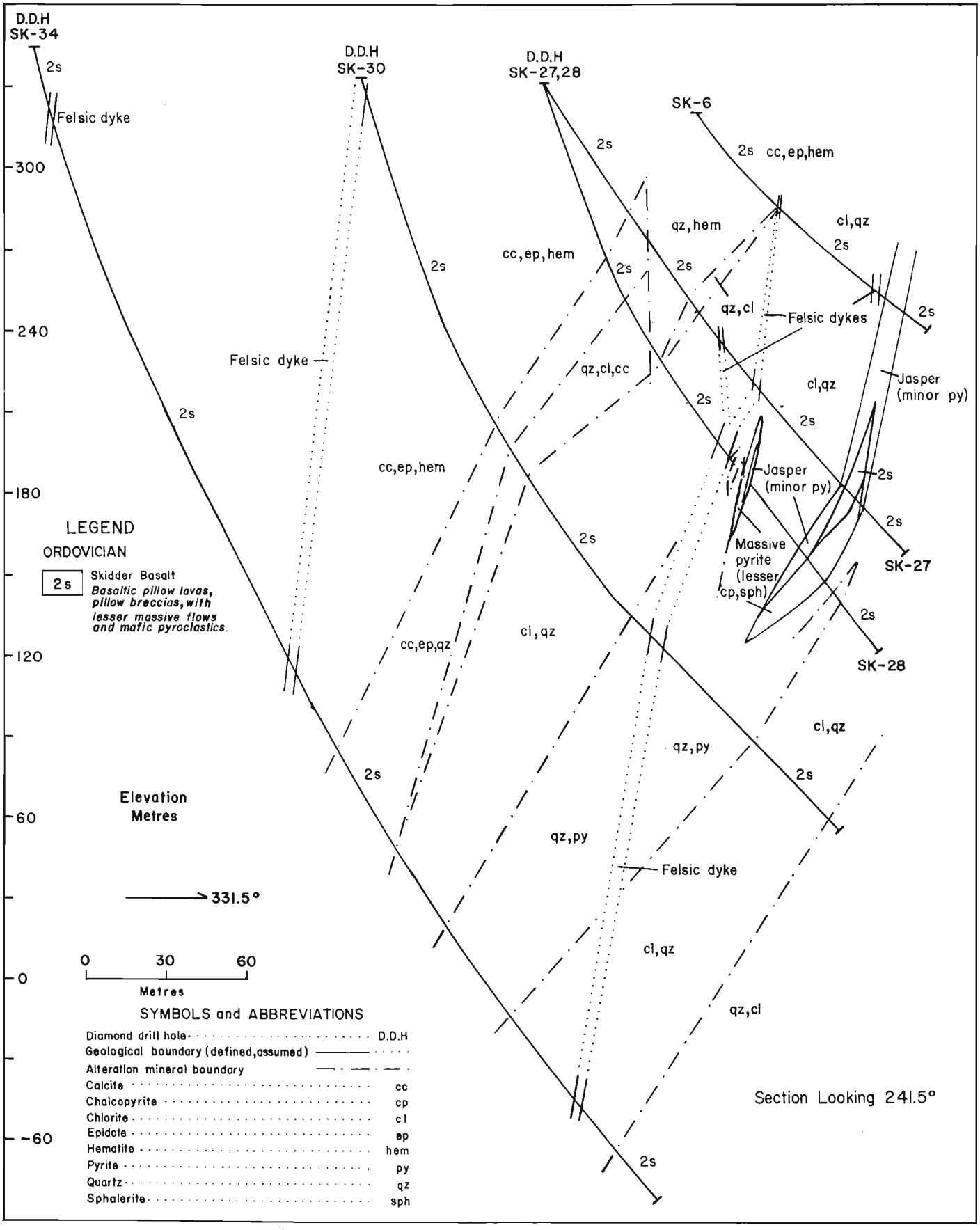

Figure 3. *Cross-section through the Skidder prospect showing the alteration zones that flank the sulphide-bearing units. See Figure 77.2 for location of diamond drillholes.*

Massive flows are also medium gray to medium green and fine to medium grained. Locally, the flows have been autoclastically brecciated.

An estimated 30 per cent of the massive and pillowed flows are amygdaloidal. These amygdules, dominantly calcite and to a lesser extent epidote and chlorite, are generally 2 to 4 mm in diameter and, where present, make up less than 10 per cent of the rock.

Mafic pyroclastics consist dominantly of medium green-gray ash-crystal tuffs. These tuffs have an overall massive appearance and are poorly bedded. Bedding planes are visible only on the weathered surface thus making them difficult to distinguish from massive flows in drill core. Other mafic pyroclastics include aquagene tuffs (?) that were noted only in core, generally close to the massive sulfide zone. The tuffs consist of olive green, very fine grained, discontinuous, anastomosing layers (locally 1 to 5 cm in maximum dimension) that occur within a very dark green, fine grained, highly chloritic matrix. One outcrop of matrix-supported lapilli tuff is exposed 400 m northeast of the prospect. The lapilli are angular, 2 to 8 cm in length and make up approximately 10 per cent of the unit. The matrix to the lapilli is chloritic to cherty.

Jasper and red cherty siltstone occur as interpillow material and as discontinuous massive, in rare instances, bedded units (Figures 1, 2 and 3).

Mafic intrusive rocks exposed in the area include fine to medium grained diabase dikes and coarser grained gabbroic bodies (dikes?). The latter occur in two outcrops west of the Skidder prospect. In hand specimen, these rocks contain visible ophitic intergrowths of plagioclase and pyroxene.

Light gray-green, fine grained felsic dikes were noted in core (Figure 3) and also in two outcrops east of the prospect (Figure 2). The dikes strike approximately parallel to the local stratigraphy and dip steeply to the southeast (Figure 3). In some sections, they contain approximately 5 percent quartz and feldspar phenocrysts, 1 to 3 mm in diameter, that occur in very fine grained matrix. In many instances, layering is present in these dikes within 30 cm of their contact with adjacent mafic units. This layering is defined by alternating light and dark gray-green to buff colored 0.5 to 1 cm wide zones that parallel the dike contact.

Footwall Basalt

Rocks of the Footwall Basalt unit (unit 2a, Figure 1) examined in the study area are generally basaltic pillow lavas and flow breccias. These rocks are green-black, fine grained, and generally amygdaloidal; the amygdules are usually slightly flattened, 0.5 to 1.5 cm in diameter and calcite-filled, and comprise up to 20 per cent of the rock. Pillows are slightly flattened, 0.5 to 1 m in diameter, and in some areas contain amygdules arranged in a roughly concentric pattern. The breccia units consist of angular gray-black basalt fragments from 0.5 to several centimetres across that occur within a fine grained, green-black, presumably more chloritic matrix.

Rhyolite(?)

A small body of rhyolite(?) (possibly silicified mafic volcanic rock(?)) outcrops approximately 2 km northeast of the Skidder prospect (unit 2c, Figure 1). The rhyolite(?) is gray, fine grained and massive. A one metre thick unit of jasper separates the gray rhyolite(?) from the Footwall Basalt in an exposed contact of these units (Figure 1).

Sulfide-bearing Zones

The massive and disseminated sulfides are hosted within basaltic pillow lavas, pillow breccias and aquagene tuffs of the Skidder Basalt unit. The sulfide-bearing units are of three types:

(1) The first consists of essentially massive silicified volcanics with quartz veins that contain 30 to 70 percent pyrite plus rare chalcopyrite and sphalerite (see qz, py zone, Figure 3). Quartz and pyrite make up approximately 80 percent of this unit with the remaining 20 percent consisting of scattered, discontinuous chlorite-rich masses, some of which contain variolites. These masses are presumably altered remnants of the original rock unit. The pyrite is generally medium to coarse grained and occurs as veins, massive bodies and disseminated cubes within the quartz. The chalcopyrite and sphalerite occur typically along the margins of quartz veins.

(2) The second type consists of semimassive to massive, nonbedded, medium to coarse grained pyrite with 5 to 15 percent quartz and lesser calcite

gangue. Rare fine grained chalcopyrite- and sphalerite-rich zones occur within the massive pyrite.

(3) Laminated, fine to medium grained pyrite with 10 to 15 percent interlaminated chalcopyrite and sphalerite constitute the third type.

The massive sulfides (types 2 and 3) occur as two main lens-shaped bodies. The first plunges 37° westward with a known length of 380 m along the plunge and has a maximum width of 90 m, a maximum known thickness of 11 m and an average thickness of 4.1 m. The second lens plunges 57° westward with a defined length of 243 m, has a maximum width of 68 m, a maximum known thickness of 6.7 m and an average thickness of 3.4 m (D.M. Barbour, 1977, unpublished Abitibi-Price Mineral Resources report).

In some sections, jasper occurs at the contact of the massive sulfide lenses with adjacent units (Figure 3). It occurs generally as massive units that are in many areas brecciated and veined by quartz. The jasper units, which in very rare instances show bedding, range from 0.3 to 8 m in thickness.

Regional Alteration

Rocks of the Skidder Basalt examined in outcrop generally contain epidote, calcite and, in places, chlorite as veins and amygdule fillings. In addition, alteration of mafic minerals to chlorite is ubiquitous. Alteration to epidote, particularly in the matrix to pillow breccia fragments, is also pervasive in some areas. Quartz veins are limited in extent and, where observed in outcrops away from the massive-sulfide-bearing zones, are present as 1 to 3 cm wide, subparallel veins that are probably related to mobilization of silica during regional metamorphism. Basalts exposed in the Halfway Mountain area, approximately 2 km southwest of the prospect, contain fibrous actinolite rossettes as vein fillings in addition to lesser amounts of epidote and carbonate.

Local Alteration

A zoned sequence of alteration minerals is present for approximately 100 m structurally above and below the sulfide-bearing zones. Calcite, epidote and lesser amounts of hematite make up the first alteration assemblage, furthest from the sulfide-bearing zones (Figure 3). The calcite and epidote occur as veinlets and amygdule fillings. 'Blotches' of epidote, generally 5 to 15 cm in diameter, are also widely distributed in some areas. Hematite is less abundant than epidote and calcite, and is more prevalent in pillow breccia zones. Hematite occurs as veins, and in some areas is disseminated throughout the unit. The remainder of the assemblages are arranged below in order of increasing proximity to the sulfide-bearing zones.

The absence of hematite and the occurrence of quartz along or with calcite as veinlets and amygdule fillings define the second alteration assemblage (Figure 3).

An increase in the amount of chlorite, the lack of epidote and the presence of fine grained, gray siliceous areas mark the third alteration assemblage (Figure 3). The siliceous sections characteristically have quartz veinlets throughout and range from 5 to 20 cm in length in drill core.

The fourth alteration assemblage is characterized by a marked increase in chlorite and a decrease in calcite relative to the first two zones (Figure 3). In some areas, chlorite makes up an estimated 50 to 60 percent of the rock. Pervasively silicified areas and quartz veinlets are present, similar to those in the previous zone.

The fifth assemblage, the quartz-pyrite zone (qz, py zone, Figure 3), is the most extensively altered of the zones, with an estimated 80 percent of the rock replaced by quartz and pyrite.

Discussion of Alteration Assemblages

Mottl (1983) summarized results of experimental studies of basalt-seawater interaction and the relationship of these results to the alteration minerals in metabasalts and metadiabase dredged from the Mid-Atlantic Ridge. In this summary, Mottl suggested the following sequences of mineral assemblages to be characteristic of increasing seawater/rock ratios within the temperature range 250°C to 450°C: (1) chlorite(chl)-albite(ab)-epidote(ep)-actinolite(act), (2) chl-ab-ep-act-quartz (qtz), (3) chl-ab-qtz, and (4) chl-qtz. The secondary mineral assemblages that define the alteration zone structurally above and below the sulfide units of the Skidder prospect match reasonably well the assemblages described by Mottl (1983), and possibly indicate that more hydrothermal fluid passed through the rocks closer to the sulfide-bearing unit.

General Discussion

The Skidder prospect has more similarities to massive sulfide deposits in ophiolite sequences (Franklin et al., 1981; Constantinou and Govett, 1973; Constantinou, 1980) than have other deposits in the Buchans area, which are considered

similar to the Kuroko ore deposits of Japan (Thurlow, 1973, 1981; Thurlow et al., 1975). The similarity to ophiolite-associated massive sulfide deposits is indicated by the following: (1) the sulfides are hosted by mafic pillow lavas and related pillow breccias; (2) pyrite, chalcopyrite and sphalerite are the dominant sulfides with only very minor galena; (3) in some areas, jasper occurs at contacts of the massive sulfide zones with adjacent units; and (4) felsic rocks and high barite content characteristic of other Buchans sulfide deposits are lacking.

Summary

The Skidder prospect is a massive sulfide deposit that occurs in pillowed basalts, associated pillow breccias and lesser mafic pyroclastics. The deposit consists of three types of sulfide-bearing units, (1) a quartz-pyrite stockwork(?) zone that contains rare chalcopyrite and sphalerite, (2) a semimassive to massive nonbedded pyrite zone with minor chalcopyrite and sphalerite, and (3) a laminated massive sulfide zone consisting of fine to medium grained pyrite with lesser amounts of chalcopyrite and sphalerite. Brecciated, quartz-veined, massive and rarely bedded jasper is associated with the massive sulfides. Distinct alteration zones characterized by secondary mineral assemblages occur within 100 m of the sulfide-bearing unit.

The mafic rocks surrounding the Skidder prospect, including those that host it, are different from "typical" rocks of the Buchans Footwall Basalt unit. On the basis of these differences, the rocks surrounding and including the Skidder prospect have been assigned to a new unit called the Skidder Basalt.

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