MIDWAY SILVER-LEAD-ZINC MANTO DEPOSIT, NORTHERN BRITISH COLUMBIA*

(104O/16)

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INTRODUCTION

The Midway silver-lead-zinc deposit, in map area 104O/16, is 10 kilometres south of the British Columbia – Yukon border and about 80 kilometres west-southwest of Watson Lake, Yukon Territory. The deposit is centred at latitude 59°55′ north, longitude 130°20′ west. Mineralization consists of irregular, pipe-like, open-space filling and replacement massive sulphide bodies in mid-Devonian McDame Group carbonates beneath a major unconformity. Reserves are currently estimated at 1.185 million tonnes grading 410 grams per tonne silver, 9.6 per cent zinc and 7.0 per cent lead (Exploration in British Columbia, 1986; page A41). Regional mapping conducted during the 1986 field season showed that the deposit lies near the southern termination of a broad, north-trending extensional fault system (Tootsee River fault zone, Nelson and Bradford, 1987). This zone intersects a northwesterly trending belt of hydrothermal alteration 5 kilometres long just south of the deposit. Intense sericitic alteration and quartz veining in Devono-Mississipian Earn Group sediments, and geophysical anomalies, strongly indicate that a buried intrusive body cores the Midway hydrothermal system and underlies Brinco Hill, about 2 kilometres southeast of the Midway deposit (Figure 2-9-1). Deposit chemistry, sulphide mineralogy, isotopic signatures and preliminary temperature data indicate that Midway is an epigenetic manto deposit; potassium-argon dates and lead isotope model ages support a Late Cretaceous age of mineralization. The following highlights some of the results of ongoing studies of the Midway deposit and environs.

STRATIGRAPHY

Strata exposed east of Silvertip Creek, in the vicinity of Midway, range from Devonian to Mississippian in age (Figure 2-9-2). Miogeoclinal carbonates of Early to Middle Devonian age are unconformably overlain by Upper Devonian to Lower Mississippian (mid-Famennian to mid-Tournaisian, M. Orchard and Irwin, this volume) basinal shales and turbidites of the Earn Group. The Earn Group is structurally overlain by oceanic sediments and volcanic and intrusive rocks of the Sylvester allochthon.

McDAME GROUP

McDame Group carbonates of Middle Devonian age (Figure 2-9-2, Unit 2) paraconformably overlie Lower Devonian Tapioca sandstone (Unit 1), and outcrop on Silvertip Hill, on the south side of Silvertip Creek in the Midway portal area and on the north end of Tour Peak, south of Silvertip Hill (Figure 2-9-2). The base of the McDame grades upward from nonfetid dolostones and interbedded dolomitic quartz arenite of the upper Tapioca sandstone to alternating light and dark grey, well-laminated, locally fetid dolostones.

Total thickness of the McDame Group in the Midway area is about 350 metres. Dolomitic facies dominate the lower third of the section and consist of dark grey, fetid cryptalgal laminites and interbedded massive dolostone. The upper two thirds of the section consists of fossiliferous fetid rudstones, floatstones, wackestones and packstones, with interbedded micritic limestones. Faunal assemblages of low diversity consist primarily of stromatoporoids, with local concentrations of brachiopods, corals, crinoids, and bivalves (Mundy, 1984).

The upper McDame contact is a regional unconformity marked by topographic relief of over 100 metres. Erosional relief and widespread karsting, as manifested by spar-healed breccias, vugs and coarse spar-filled paleocaverns up to several metres across, testify to uplift and subaerial exposure of parts of the carbonate platform prior to subsidence and deposition of Earn Group basinal shales. Detailed biostratigraphic correlations suggest that uplift may have been accompanied by local block faulting (Mundy, 1984). Following regional extension and submergence of the carbonate platform in the Upper Devonian (middle Famennian), solution collapse within the karsted upper McDame accompanied deposition and diagenesis of the lower Earn. Mixed limestone and uncrenulated shale fragments in spar-healed and lime mud-filled cavities in the upper McDame are widespread. Absence of crenulation lineations developed during Jura-Cretaceous compressional deformation implies that these are premineral breccias (Nelson and Bradford, 1987). They are commonly well compacted and contain abundant stylolites both crosscutting and forming sutured clast boundaries. These stylolites probably developed by pressure solution during Earn diagenesis. Locally, well-bedded mudstones and siltstones occur within compacted shale and limestone breccias in cavities 30 metres or more below the top of the McDame, indicating that some cavities were open to the ocean floor during deposition of the Earn.

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EARN GROUP

Lowermost Earn Group sediments consist of carbonaceous, locally calcareous or siliceous, black shales (Figure 2-9-2, Unit 3A) up to 40 metres thick. This euxinic basin facies contains a rich conodont fauna of mid-Famennian age (Orchard and Irwin, this volume). Thickness is variable over short distances, and in places the unit is missing entirely, perhaps due to depositional control by McDame paleotopography. Graphitic slickensides are common, indicating that the unit served as a detachment surface between the McDame and overlying thick, coarse siliciclastic sediments of the Earn Group (Unit 3B, below). Some thickening and thinning might therefore be structural in nature.

The black shale unit is overlain by a thick (up to 290 metres) succession of coarse sandstone, mudstone and pebble conglomerate characterized by ubiquitous normal and reverse graded bedding, load and flame structures, rip-ups, mud drapes and sole marks (Unit 3B). The sandstones are litharenites, consisting mainly of quartz, chert and shale grains. According to Gordey *et al.* (1986), the development of this turbidite succession above the euxinic basin facies occurred as a result of local uplift and erosion of miogeoclinal blocks during early Mississippian extension.

A thick succession (up to 640 metres) of argillite, siltstone, calcarenite and sandstone containing several exhalative horizons (Unit 3C) overlies the coarse turbidites of Unit 3B. Conodonts from Unit 3C give early to mid-Tournaisian ages (Orchard and Irwin, this volume). Exhalite horizons consist of orange-weathering laminated silica, barite, pyrite and, locally, sphalerite. They rarely attain thicknesses of over 1 metre in surface exposures. Discontinuous exhalites are exposed along a strike length of almost 10 kilometres southward from Midway. This probably represents a linear string of exhalative centres aligned along a basin-margin fault zone which also controlled later deposition of coarse turbidites.

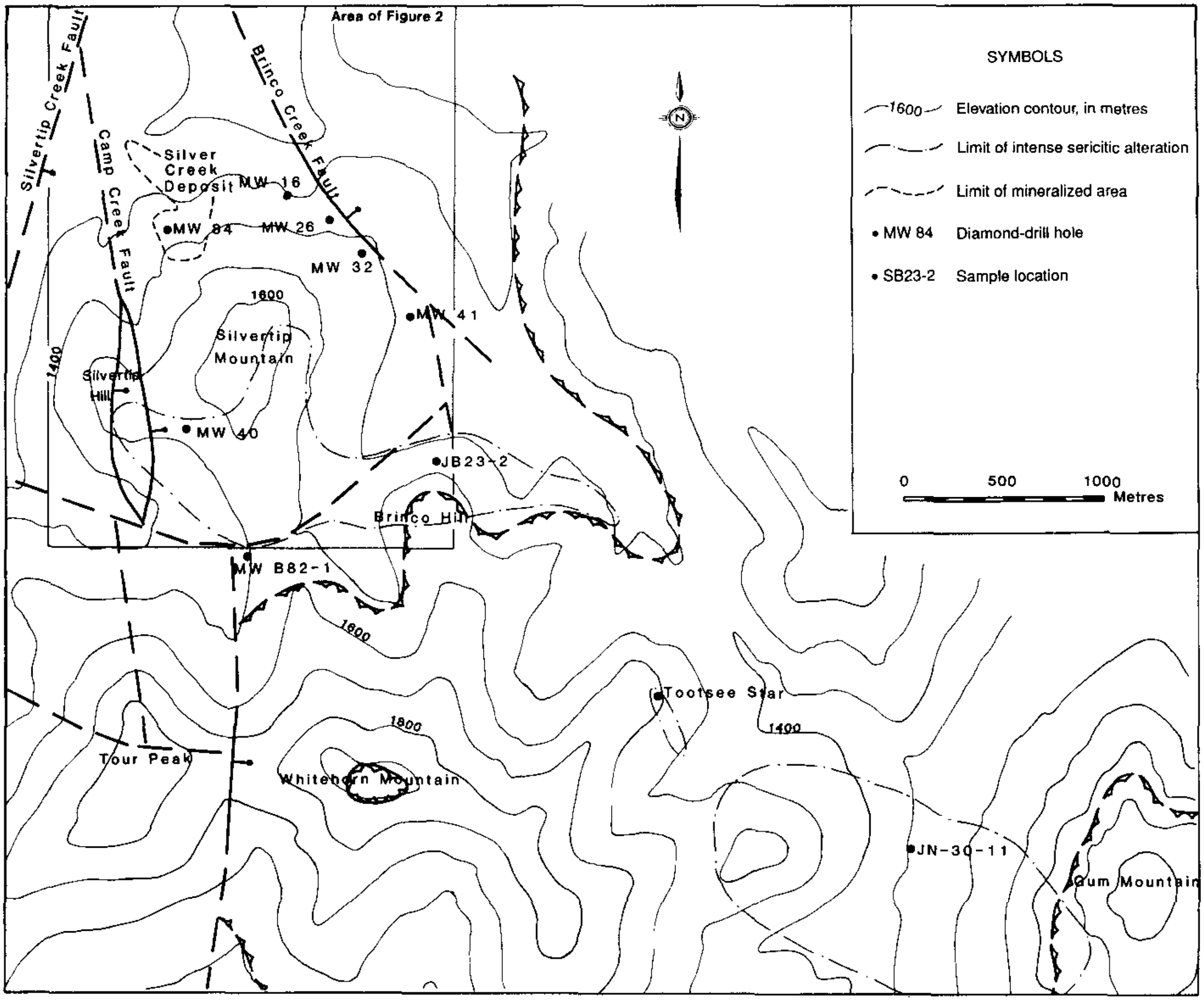

Figure 2-9-1. Midway area alteration and faulting.

A sequence of pebble to boulder conglomerate and lesser sandstone with a thickness of 150 to 200 metres (Unit 3D) overlies exhalite-bearing fine clastics on Silvertip Mountain and Tour Peak. On Tour Peak, a section of well-rounded boulder conglomerate contains clasts of McDame limestone, Tapioca sandstone, quartzite and dolostone, possibly Lower Cambrian Boya Formation quartzite, and black massive chert of undetermined origin.

The transition from fine clastics of Unit 3C to conglomerates of Unit 3D might represent a turbidite feeder channel prograding over its distal lower fan. The channel deposits are confined to the Silvertip Mountain – Tour Peak areas, with no thick conglomerate beds occurring to the south or west. Instead, thinner lensoid conglomerates are interbedded with, and overlain by, fine clastics in the Caribou Ridge area south of Tour Peak, suggesting a lateral facies change.

SYLVESTER ALLOCHTHON

A thick sequence of black argillite, limestone with black chert and green thin-bedded chert and cherty phyllite (Unit 4), assigned to Division I of the Sylvester allochthon (Nelson *et al.*, 1988), abruptly overlies Unit 3D.

STRUCTURE

The cluster of sulphide bodies at Midway which comprises the Silver Creek deposit lies mainly on the west limb of an open anticline plunging gently to the southeast (Figure 2-9-3). The east limb dips to the east at about 25 degrees, while the west limb is folded and cut by a strand of the Tootsee River fault zone. The anticlinal fold axis parallels southeasterly regional structural trends generated during Jurassic compression and emplacement of the Sylvester allochthon. Locally, a later easterly trending phase of folding deforms southeasterly trending structures. This phase is characterized by chevron and kink folds that are often accompanied by *en échelon* quartz-filled extension gashes.

Thrust faulting can be inferred from diamond drilling in the Silver Creek and Silvertip areas. In the southern part of the Silver Creek deposit (Figure 2-9-1, DDH MW 84, 86), a

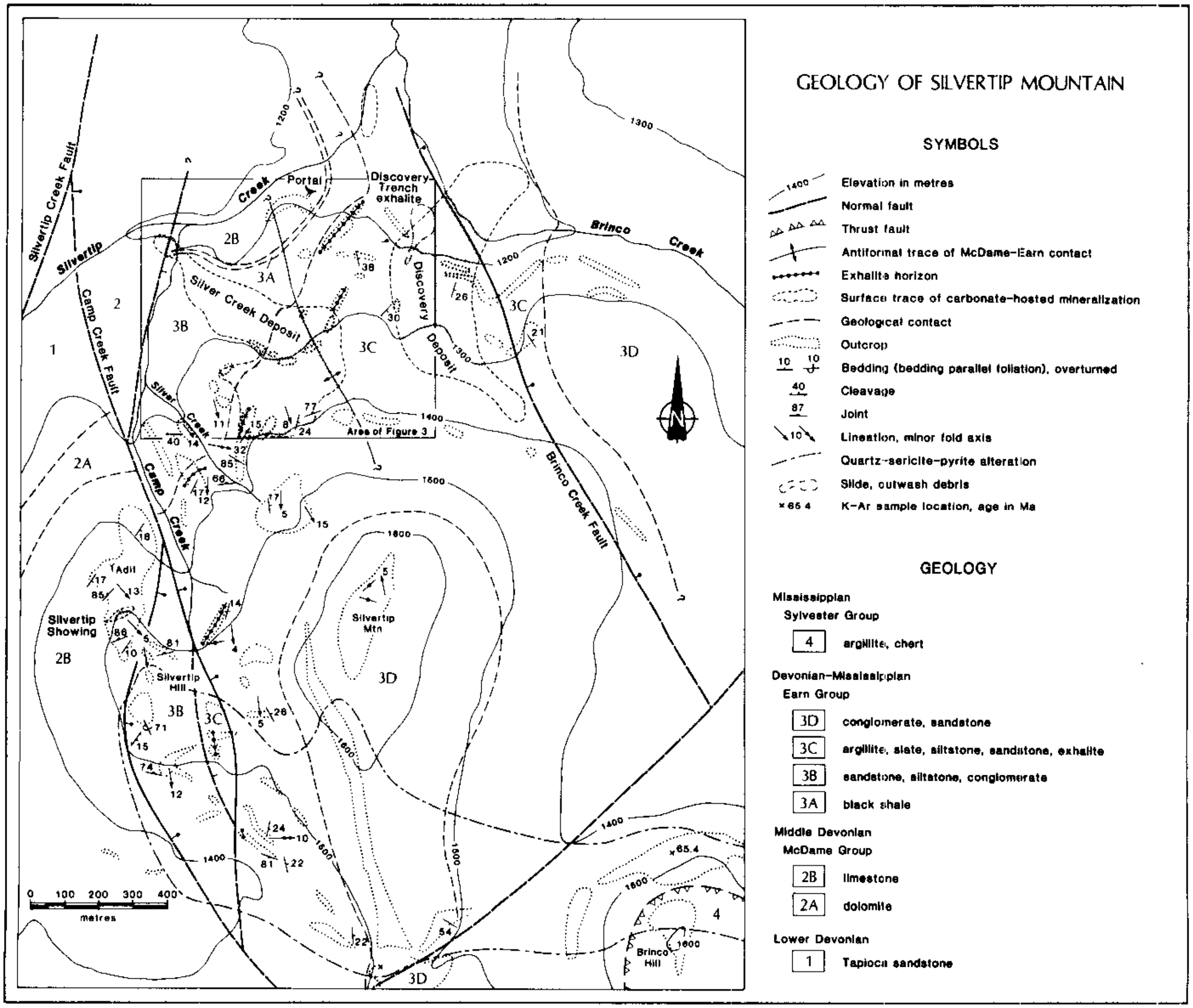

Figure 2-9-2. Silvertip Mountain area, geology.

wedge of Unit 3B is imbricated with Unit 3C above the lowermost exhalite horizon. On Silvertip Hill (DDH MW 40) McDame limestone is imbricated with Unit 3A, which has also undergone structural thickening.

The Silvertip area is cut by several strands of the Tootsee River fault zone, a northerly trending system of anastomosing high-angle faults extending from about 7 kilometres south of Midway to about 17 kilometres north of the British Columbia – Yukon Territory border (Lowey and Lowey, 1987). These include the Silvertip Creek, Camp Creek and Brinco Creek faults (Figure 2-9-1).

The Silvertip Creek fault separates Silvertip Hill and Tricorn Mountain to the west. Rotation of large blocks juxtaposed a southerly dipping panel on Tricorn Mountain with easterly dipping strata on Silvertip Hill. Because of the discordant dips and convergence of several fault strands north of Midway, stratigraphic throw increases from 50 metres west of Silvertip Hill to over 1 kilometre (Lower Cambrian Rosella Formation against Sylvester) in a narrow zone in the Silvertip Creek valley, 3 kilometres to the north.

The Camp Creek fault juxtaposes the McDame Group against Earn Group on Silvertip Hill, where it diverges into two main strands with offsets of about 50 metres, east side down. Between fault strands, Earn Group strata are disrupted and locally overturned. The Silver Creek deposit and the Silvertip showing are both adjacent to this fault zone, which may have been a channelway for hydrothermal fluids.

The Brinco Creek fault offsets strata east of the Discovery deposit, with a displacement of about 100 metres, east side down. Other faults with smaller offsets may occur west of the Brinco Creek fault. The latter appears to die out to the southeast, as the base of the Sylvester allochthon east of Brinco Hill is not offset.

Late Cretaceous (Midway) and Eocene (Butler Mountain) intrusions, as well as numerous silver-lead-zinc showings in the Rancheria district (Abbott, 1984), lie close to the Tootsee River fault zone. Overprinting of Early Mississippian exhalative and Cretaceous to Eocene intrusion-related mineralization within the zone suggests that it might represent a long-lived, periodically remobilized zone of structural weak-

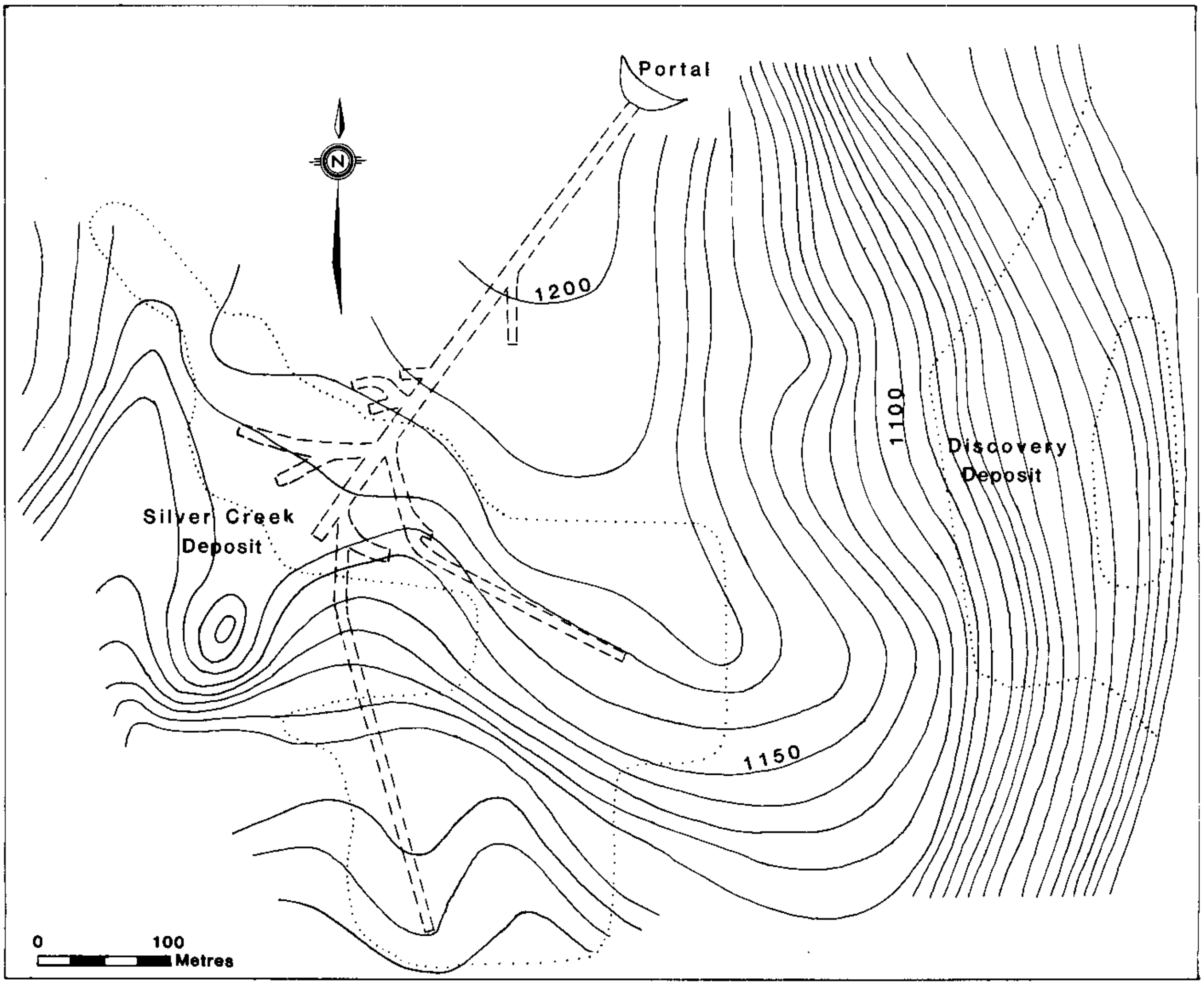

Figure 2-9-3. Elevation contours of McDame Group - Earn Group contact in Midway area.

ness and anomalous heat flow that was initiated in the Late Devonian during extension along the continental margin. Remobilization of old structures during Late Cretaceous to Eocene dextral wrench faulting could have contributed to localization of intrusions postdating the Cassiar batholith.

ALTERATION AND EVIDENCE FOR INTRUSIONS

Intense sericitization of Earn Group and Sylvester sediments occurs in a northwesterly trending zone extending from Silvertip Hill southeast for about 5 kilometres to Gum Mountain (Figure 2-9-1). Strong alteration is also evident at deeper levels in diamond-drill holes in the southeasterly part of the Midway drill grid (near DDH MW 16, 32 and 41), and south of Silvertip Mountain (near DDH B82-1). Its strongest expression is on the north side of Brinco Hill, which coincides with geophysical anomalies interpreted as consistent with a buried intrusion (J. Hylands, personal communication, 1986). At Brinco Hill, Earn Group sandstones and conglomerates are altered to sericite, quartz, pyrite, rutile and rare carbonate, with both matrix and nonsilica clasts being completely replaced. The altered sediments are cut by numerous vuggy, locally comb-textured quartz veins 1 to 10 centimetres thick containing pyrite, chalcopyrite and rare galena blebs. Isotopic analyses of galena from the alteration zone support a genetic relationship between the alteration zone and carbonate-hosted deposits at Midway.

Quartz-feldspar-biotite porphyry dykes crop out west of Gum Mountain, where they intrude intensely sericitized and pyritized argillites and cherts of the Sylvester allochthon. The dykes are commonly altered to sericite, carbonate, quartz and pyrite. Similar dykes observed during the 1987 field season in the Blue Dome map area (104P/12; Nelson *et al.*, this volume), occur as subparallel swarms associated with quartz veins in Sylvester basalts and argillites.

Alteration is associated with anomalous fluorine values. Grab samples indicate that the porphyry dykes near Gum Mountain contain up to 1200 ppm fluorine, while sericitized conglomerates at Brinco Hill ran 790 ppm fluorine. Microprobe analyses of sericites from surface and drill core show averaged values for several probe sites per sample ranging from 2900 to 21 900 ppm fluorine (W.D. Sinclair, written communication, 1986). Substitution of fluorine for hydroxyl groups in micas from the alteration zone probably reflects the contribution of magmatic volatiles to the hydrothermal system centred on Brinco Hill.

Subvolcanic felsic intrusives, elevated fluorine in alteration minerals, and a geological setting within an extensional fault system adjacent to an older, voluminous intrusion (Cassiar batholith) are all features typical of A-type (anorogenic) granites (W.D. Sinclair, 1986; Collins *et al.*, 1982). The presence of tin mineralization (for example, stannite and franckeite) at Midway is also consistent with this interpretation, although tin is also associated with S-type granites. Intrusions within the Cassiar platform and coeval with the Midway system include the Troutline, Kuhn and Windy stocks in the Cassiar area. Numerous silver-zinc-lead and tungsten skarns and veins, fluorine anomalies, fluorite veins and molybdenum showings are associated with the young Cassiar granites (Panteleyev, 1980). Chemistry of this intrusive suite is more typical of S-type granites, or I-type granites strongly contaminated with upper crustal material (Cooke and Godwin, 1984). In any case, volatile-rich felsic intrusives, whether of the A or S-type, are apparently fundamental to generating hydrothermal systems associated with silver-zinc-lead ± tin mineralization.

POTASSIUM-ARGON DATING

Potassium-argon dating of samples collected during mapping of map sheet 104O/16 (Nelson and Bradford, 1987)

TABLE 2-9-1
NEW POTASSIUM-ARGON DATES FROM THE MIDWAY AREA, NORTH-CENTRAL BRITISH COLUMBIA
(104D/16)

Sample No	Latitude (N) Longitude (W)	Location (Minfile Number)	Mineral	%K	^{40}Ar rad. 10^{-6} cc/g	%^{40}Ar rad / ^{40}Ar tot	Age (Ma)
JN30-11	59°53′N 130°16′W	Gum Mtn.	Sericite	5.40 ± 0.09 n = 2	14.353	92.1	67.1 ± 2.3
JB23-2	59°54′N 130°16′W	Brinco Hill	Sericite	5.57 ± 0.01 n = 2	14.420	92.0	65.4 ± 2.3
KG28-7	59°59′N 130°28′W	Lucky showing (MI 104-033)	Muscovite	8.67 ± 0.04 n = 2	36.411	92.6	105 ± 4
JB26-12	59°56′N 130°29′W	Amy showing (MI 104-004)	Muscovite	7.38	28.662	93.3	97.3 ± 3.4

K analyses by D. Runkle, The University of British Columbia.
Ar analyses by J. E. Harakal, The University of British Columbia.
Decay constants (Steiger and Jager, 1977):
$=4.96 \times 10^{-10}$ yr^{-1}
$=0.581 \times 10^{-10}$ yr^{-1}.
^{40}K/K = 0.01167 atomic per cent.
Errors are one standard deviation.

focused on intrusions and alteration associated with silver-lead-zinc mineralization (Table 2-9-1). Two samples from the alteration zone southeast of Midway were dated (Figure 2-9-1, JN30-11 and JB23-2), as well as one from a late intrusion less than 100 metres from surface exposures of sulphide bodies at the Amy property (JB26-12), and one from sericite envelopes around galena-rich quartz veins at the Lucky showing, hosted in the Cassiar batholith (KG28-7).

The Midway samples include sericitized Earn Group sediments from Brinco Hill (Table 2-9-1, Sample JB23-2), and a sericitized quartz feldspar porphyry dyke near Gum Mountain (Sample JN30-11). These both give a Late Cretaceous age, interpreted as the age of alteration. The alteration is apparently due to emplacement of a buried comagmatic stock.

The intrusion sampled at the Amy property, a silver-lead-zinc replacement deposit in Cambro-Ordovician Kechika Group marbles and calc-silicates, is a tourmaline-bearing equigranular muscovite granite with coarse quartz-muscovite-tourmaline greisen zones. The Middle Cretaceous date of 97.3 Ma (Table 2-9-1) suggests that this may represent a late-stage apophysis of the Cassiar batholith.

Quartz-galena veins in the Cassiar batholith at the Lucky showing are also Middle Cretaceous in age (Table 2-9-1, 105 Ma). This contradicts the suggestion of Abbott (1984), that galena-rich veins in the Midway-Rancheria district are Tertiary in age.

Cretaceous to Tertiary mineralization in the Rancheria district occurred in three separate episodes. Middle Cretaceous showings include silver-lead-zinc replacement deposits (Amy), intrusion-hosted veins (Lucky) and molybdenum-tungsten showings at the margins of the Cassiar batholith (Nancy and Root, Nelson and Bradford, 1987). Carbonate-hosted silver-lead-zinc-tin mineralization at Midway as well as nearby quartz veins (Brinco Hill, Tootsee Star) are related to Lake Cretaceous intrusions. Eocene mineralization includes silver-lead-zinc showings (Butler Mountain) and tin-tungsten veins and greisens (Fiddler). The three intrusive and associated mineralizing episodes correspond to a similar set of intrusive ages in the Cassiar area (Panteleyev, 1985; Christopher *et al.*, 1972; Sinclair, 1986).

SULPHIDE PARAGENESIS AND MORPHOLOGY

Sulphide bodies at Midway are characterized by a complex mineralogy with at least 16 ore and gangue minerals identified (Archambault, 1984). Microscopic and mesoscopic paragenetic relationships indicate four main mineralizing episodes: (1) early silica rich, (2) main stage sulphide-silica, (3) late sulphide-sulphosalt and (4) late carbonate. In addition, postmineral supergene effects have caused some alteration of the sulphide and gangue assemblages. Mesoscopic textures suggest that conditions of sulphide deposition fluctuated cyclically, resulting, for example, in repeated layers of the sequence pyrite-galena-sphalerite. During evolution of the hydrothermal system, local variability of depositional conditions resulted in a great variety of paragenetic relationships.

Sulphide bodies are massive and irregular in form, with abrupt wallrock contacts which are locally bleached or silicified. Both subhorizontal, pipe-like bodies and vertical, keel-shaped chimneys occur, but these do not have predictable compositional differences, as in some manto deposits (J. Hylands, 1986, personal communication; Lovering *et al.*, 1978). Although wallrock contacts are abrupt, gradational transitions occur outward from massive sulphides, to sulphide-matrix breccias with angular "stoped" wallrock clasts, to carbonate-matrix solution breccias, to unbrecciated limestone. This suggests that sulphide deposition was partly controlled by pre-existing porosity as defined by carbonate-healed breccia haloes around premineralization open channels and vuggy breccias, now filled and partly replaced by sulphide.

Stylolite-sutured limestone and shale clasts in breccias with fine-grained nonsparry carbonate matrix occur within and at the base of some sulphide bodies. These could represent relict premineral solution-collapse breccias in a lithified lime silt (calcarenite) karst filling. Internally, massive sulphide bodies contain angular wallrock clasts from pebble to boulder size, occurring as single fragments, mosaics of clasts of diverse sizes, or jumbles of rotated clasts of mixed lithologies. Shale-clast breccia zones within massive sulphide bodies occur well below (100 metres) the Late Devonian unconformity. Mixing of shale and limestone clasts at such depths indicates that solution collapse occurred over great vertical distances within the McDame. In some cases shale fragments exhibit a strong crenulation lineation, showing that collapse occurred after Jurassic compressional deformation, probably during mineralization.

Massive sulphide bodies most commonly occur near the McDame-Earn contact, but also exist up to 100 metres below it. The relatively impermeable black shales of the lowermost Earn constituted a barrier to mineralizing solutions and thus behaved as a fluid flow guide. The shales are commonly brecciated and veined by sulphides (especially pyrite) above major sulphide bodies. Concentration of sulphide bodies near the unconformity indicates that pre-existing carbonate porosity was probably greatest in the upper part of the McDame, producing favorable conditions for sulphide deposition along this horizon. Mixing of shale clasts into sulphide bodies adjacent to the unconformity is suggestive of hydrothermal stoping along the contact.

A further set of breccias, internal to massive sulphide bodies, contains sulphide and quartz fragments from earlier phases of mineralization. Hydrothermal brecciation caused mixing of earlier sulphide fragments (most commonly pyrite, but in some cases including pyrrhotite, arsenopyrite, sphalerite and galena) and shale clasts, sulphides and limestone clasts, or mixed sulphide, shale and limestone clasts in a later sulphide matrix. Mixed clast breccias in a carbonate matrix are also common; these postdate sulphide deposition and involve the latest phase of the hydrothermal system.

Breccias at Midway are multi-episodic and contain diverse combinations of clast lithologies, including sulphide and gangue minerals. Brecciation preceding, postdating and contemporaneous with mineralization can be documented. Premineral brecciation and clast mixing occurred during Earn diagenesis and support a model in which early karsting of the upper McDame provided enhanced permeability for fluid flow and sulphide deposition.

ZONING

Skarn-manto systems often show a district scale compositional or mineralogical zonation, reflecting temperature and chemical gradients surrounding the source of heat and volatiles, and pressure gradients related to depth of burial, for example, Darwin, California (Hall and MacKevett, 1962) and Zimapan, Mexico (Simons and Mapes, 1956). Exploration at Midway has been sufficient to indicate analogous zoning patterns. Within the Silver Creek deposit, a north-south transect shows an apparent mineralogical shift which may be a function of distance from heat source and depth. In the northern part of the deposit, sulphide bodies have high lead-antimony sulphosalt contents, commonly up to 15 per cent and locally as high as 40 per cent, while 300 metres to the south, and at deeper levels, mineralization contains relatively minor sulphosalts. In addition to indicating a possible zonation with respect to heat source and depth, such transitions may also be a function of pre-existing permeability, with high lead:zinc and high silver:lead ratios representing zones of high permeability (Birnie and Petersen, 1977).

The southern part of the Silver Creek deposit contains sulphide bodies with abundant pyrrhotite. Pyrrhotitic assemblages with chalcopyrite and negligible galena also predominate in sulphide intersections in the southern part of the Discovery deposit (Figure 2-9-1, DDH MW 16 and MW 26), and west of Brinco Hill (DDH B82-1). The change from galena-sulphosalt to pyrrhotite-chalcopyrite apparently defines a deposit-scale zonation pattern (Cordilleran Engineering Ltd., 1982). This provides evidence for relating the alteration zone centred on Brinco Hill to the sulphide pipes at Midway. Similar mineralogical transitions in better explored skarn-manto systems correlate with distance from the source intrusion, having an inner zone of iron and copper-rich sulphides and an outer zone of lead-arsenic-antimony-rich mineralization. In addition, deep drill-hole intersections closest to Brinco Hill contain calc-silicates (tremolite and epidote) intimately intermixed with pyrrhotite; skarn mineralogy has not been found elsewhere in the Midway area.

Zonation is also reflected in tin mineralogy. Tin is high (>1000 ppm) in two areas, one in the northern part of the Silver Creek deposit, and the other 300 metres to the south. The two areas differ in that tin-lead-antimony sulphosalts (franckeite) are the primary tin-bearing minerals in the former case, whereas stannite is the only tin mineral in the latter, where it accompanies pyrrhotitic mineralization (Archambault, 1984).

In manto-skarn systems elsewhere, distal, shallower sulphosalt-rich zones are commonly silver rich, while proximal, deeper, iron-rich sulphide zones are commonly gold rich and silver poor. In view of the limited exploration done in areas closer to Brinco Hill (due to the depth of cover rocks), gold-bearing mantos and veins represent an interesting exploration possibility south of currently explored mineralization, although depth of cover rocks is an inhibiting factor.

SUMMARY

Studies of the Midway deposit to date have suggested several exploration guides and controls on mineralization. Regionally, localization of intrusive and associated hydrothermal systems along large-scale, high-angle fault systems is important. The bulk of skarn-manto-vein systems in carbonates in the Cassiar platform are associated with young felsic intrusives (post-Cassiar batholith), which are commonly reclusive in outcrop, but generate large alteration haloes in noncarbonate cover rocks and are associated with fluorine, base metal and lithophile element anomalies. Strongly fractionated late phases of older intrusions may also be mineralizers.

At the deposit scale, fault control of fluid pathways may be significant in areas with coeval or overlapping intrusion and faulting. At Midway, known sulphides are largely distributed between the Camp Creek and Brinco Creek faults, while no mineralization has been found west of the Silvertip Creek fault. These faults converge north of Midway, and the convergent zone may have focused fluid migration. The coincidence of this fault convergence with an antiformal structure below a shale cap of low permeability probably contributed to concentrating hydrothermal fluid flow in the vicinity of the Silver Creek deposit. The southeasterly plunge of this antiform might have controlled upward and outward migration of fluids from the intrusive centre to the trapping structure.

Stratigraphically, both a strongly brecciated, karsted carbonate sequence with enhanced permeability and less permeable capping sequences are significant controls on sulphide deposition.

Deposit-scale mineral zoning may be useful in defining intrusive centres and their spatial relationship to orebodies. At Midway, sporadic sulphides are found throughout the area bounded by the Camp Creek and Brinco Creek faults, in veins in cover rocks as well as in limestone. By comparison with skarn-manto systems elsewhere, major sulphide bodies are probably not limited to the relatively distal unskarned environment of the Silver Creek deposit, and mineralization of different tenor may be expected closer to the intrusive core of the system.

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