GEOLOGY OF MAIN ZONE AT MT. SKUKUM, WHEATON RIVER AREA, SOUTHERN YUKON

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McDONALD, B.W.R. and GODWIN, C.I., 1986. Geology of Main Zone at Mt. Skukum, Wheaton River area, southern Yukon; in Yukon Geology, Vol. 1; Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 6-10.

INTRODUCTION

The Main Zone of the Mt. Skukum gold-silver deposit, 65 km southwest of Whitehorse, Yukon (60°12′ north and 135°28′ west; NTS map sheet 105 D; elevation 1,675 m), occurs in Main Cirque which forms the headwaters of Butte Creek in the southwestern part of the Mt. Skukum Volcanic Complex (Fig. 1). The deposit consists of low sulphide, gold-silver bearing quartz-calcite veins which crosscut a sequence of nearly flat-lying andesitic volcanic rocks.

The deposit was discovered in 1980 by Agip Canada Ltd. of Calgary, Alberta, during follow-up of geochemical anomalies found in stream sediment samples during regional exploration (Doherty et al., 1983). Diamond drilling, trenching and sampling, conducted from 1981 to 1984, led to the discovery of many zones of economic significance. Main Zone is presently perceived to be the most important. Erickson Gold Mines Ltd. of Vancouver, B.C., current operators on the property, completed a production adit to the Main Zone in late July, 1984. Proven reserves of the Main Zone (R. Somerville, 1985, pers. comm.) are 148,980 tonnes (164,222 tons) of ore with an average grade of 24.98 g/t gold and 20.5 g/t silver.

EXPLORATION HISTORY

Mt. Skukum occurs in Sloko volcanic rocks within the Coast Crystalline Belt (Fig. 1). Similar volcanics occur in the Bennett Lake Caldera Complex, and possibly at Montana Mountain. Both of these areas host precious metal occurrences (Doherty et al., 1983). Montana Mountain is perhaps the best known, nearby area of mineralization at which a number of gold-bearing quartz-sulphide veins have been mined at various times since early this century (Tempelman-Kluit, 1981). The Wheaton River district first became known in 1893 with the discovery of precious metal and antimony veins in the area. Since that time, a number of vein occurrences of galena, sphalerite and minor gold and silver have been found within the Berney Creek fracture which forms the southern boundary of the Mt. Skukum Volcanic Complex. Nevertheless, only limited metal production has come from deposits in the area. Since the beginning of this century, very little mineral exploration has taken place in the Mt. Skukum area. At nearby Chieftain Hill, 5.5 km east of Mt. Skukum, Yukon Antimony Corporation undertook a diamond drilling program for porphyry copper mineralization during 1967 and 1968. However, no recorded exploration or staking had occurred in the central area of the Mt. Skukum Volcanic Complex prior to the 1980 activities of Agip Canada Ltd. (Doherty et al., 1983).

GENERAL GEOLOGY

The Mt. Skukum deposits are hosted in andesitic rocks of the Mt. Skukum Volcanic Complex which unconformably overlie Precambrian schist and marble of the Yukon Group (Wheeler, 1961; Smith, 1983; Pride, 1985 — this volume), and granitic intrusive rocks of the Coast Crystalline Complex. An Early Eocene age of 51.6 ± 1.8 Ma for the andesitic volcanic rocks enclosing the deposit is indicated by the average of two K-Ar dates on whole rock (Table 1).

Mt. Skukum Volcanic Complex covers an area of about 140 square km, is fault-bounded, and has been intruded in places by felsic dykes and stocks. The complex is divided into two sections by a major north-trending fault. The western part includes a lower interlayered sedimentary-volcanic sequence and a thick upper sequence of andesitic volcanic rocks. The eastern part includes an 800 m thick sequence of felsic pyroclastic flows and brecciated, flow-layered and spherulitic felsic lava flows, felsic lapilli tuff and densely welded felsic tuffs (Pride, 1986 — this volume).

The Mt. Skukum deposits occur in the southwestern portion of the volcanic complex where they are enclosed in the upper sequence of andesites estimated at 500 m thick (Fig. 2) are extensively dissected by north-trending faults and many late rhyolitic, dacitic and andesitic dykes which have a similar orientation. Several late

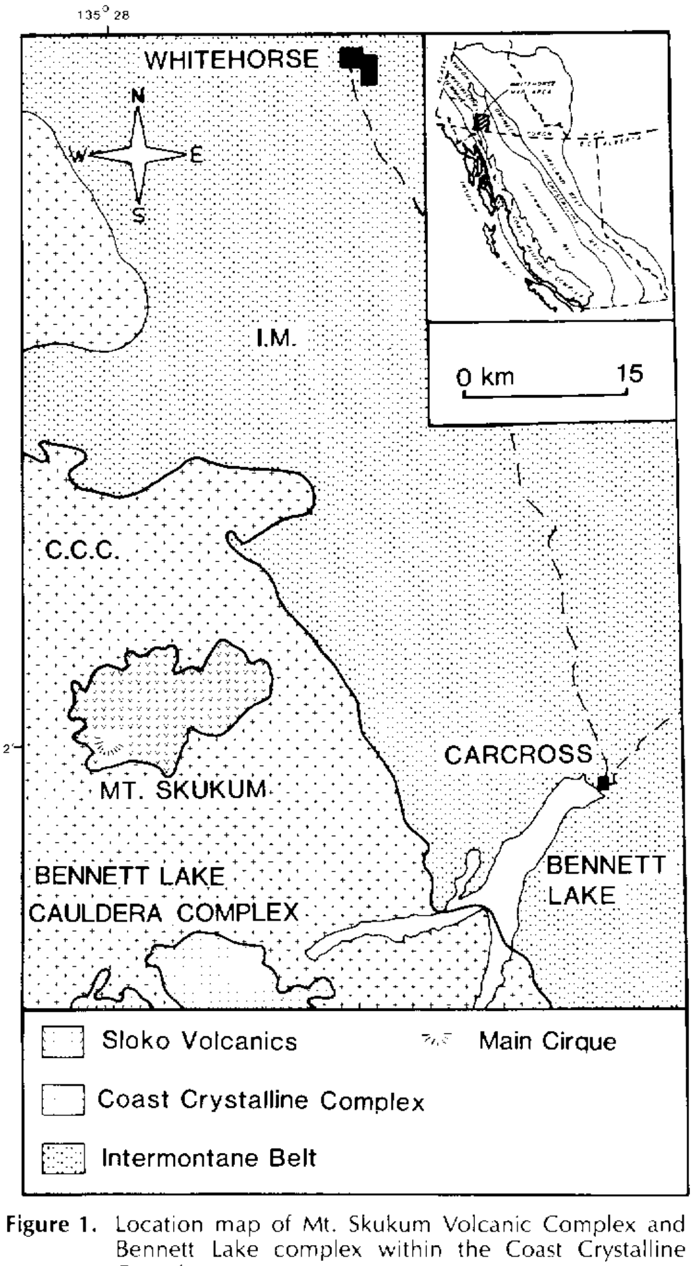

Figure 1. Location map of Mt. Skukum Volcanic Complex and Bennett Lake complex within the Coast Crystalline Complex.

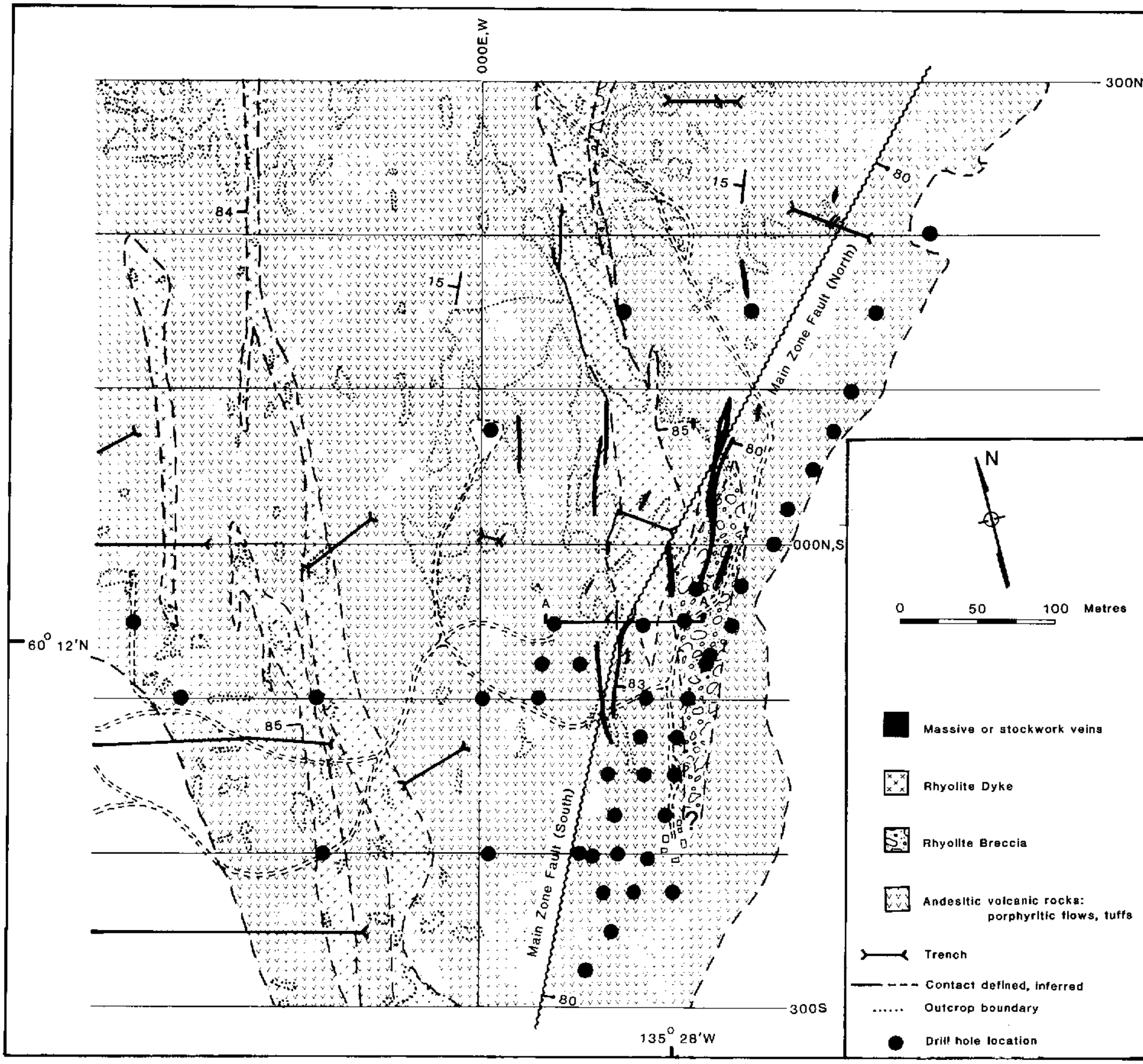

Figure 2. Geology of the Main Zone, Mt. Skukum gold vein deposit (cross-section A-A' is in Fig. 3).

quartz-feldspar porphyry bodies outcrop near the deposit, the closest being a small plug located on cliffs immediately northeast of the Main Cirque (Doherty et al., 1982).

GEOLOGY OF THE MAIN ZONE

The Main Zone occurs in Main Cirque at the northeastern foot of Mt. Skukum, at an elevation of 1675 m. It is one of three major quartz-carbonate vein systems within the Main Cirque which trend NNE and bisect the enclosing volcanic rocks at high angles. Each of these vein systems (Main Zone, Brandy Zone, and Lake Zone), all within 300 m of each other, host gold and silver mineralization with only trace amounts of sulphide minerals. Enclosing volcanic rocks (Fig. 2) dip gently to the southwest and consist of porphyritic andesite flows with vesiculated flow tops and brecciated flow bottoms as well as andesitic lapilli tuffs with minor bedded tuff layers. In the vicinity of the deposit, these rocks have undergone magnetite and plagioclase destructive alteration and characteristically display abundant chlorite, calcite and epidote. Alteration occurs in alternating layers of fresh or propylitized andesites which are clearly visible as bands of pale-altered or dark-fresh rock in cliff exposures. Altered layers tend to encompass the interfaces between individual flow units which, through their higher permeability, may have been preferentially altered relative to the more massive flow centres (Fig. 4).

A major fault zone (the Main Fault Zone) bisects the Main Cirque and may have acted as a conduit for hydrothermal fluids during formation of the Main Zone vein. The fault zone ranges from 20 to 30 m across, and consists of two or three major faults and associated heavy fracturing. The Main Fault Zone can be divided into two parts according to its orientation (Fig. 2): the southern part which trends 030° and dips 80° east. Faults are poorly expressed on surface, but occur in drill core as gouge ranging from 10 cm to 3 m or more in width. The Main Fault Zone is the easternmost of several subparallel vein fault systems which are current exploration targets on the property. The others lie immediately to the west of the map area. The operator has indicated that mineable ore exists in the Brandy Zone whereas the others have yet to be defined (R. Somerville, 1985, pers. comm.).

A second major fault occurs along the eastern wall of the

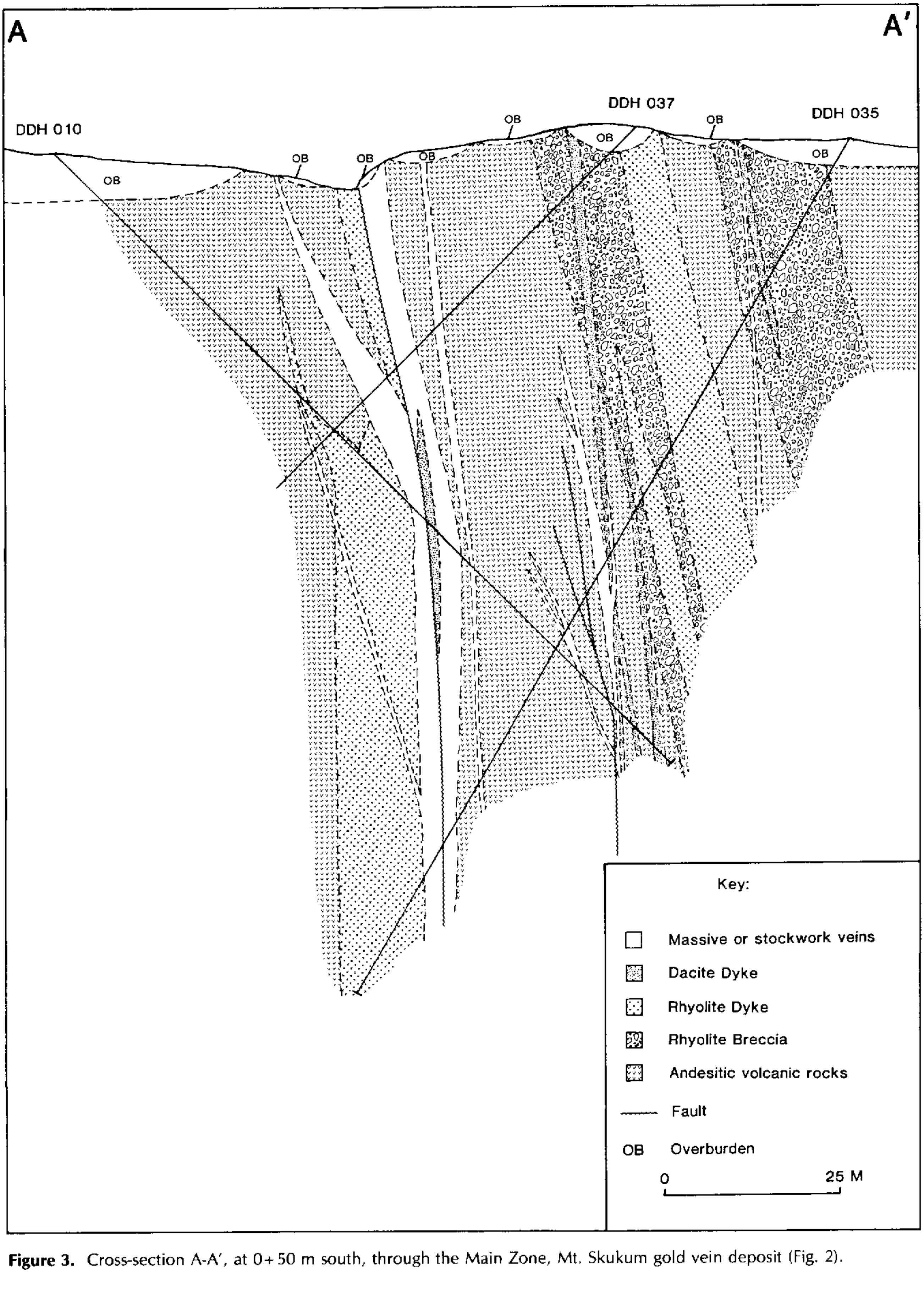

Figure 3. Cross-section A-A', at 0+ 50 m south, through the Main Zone, Mt. Skukum gold vein deposit (Fig. 2).

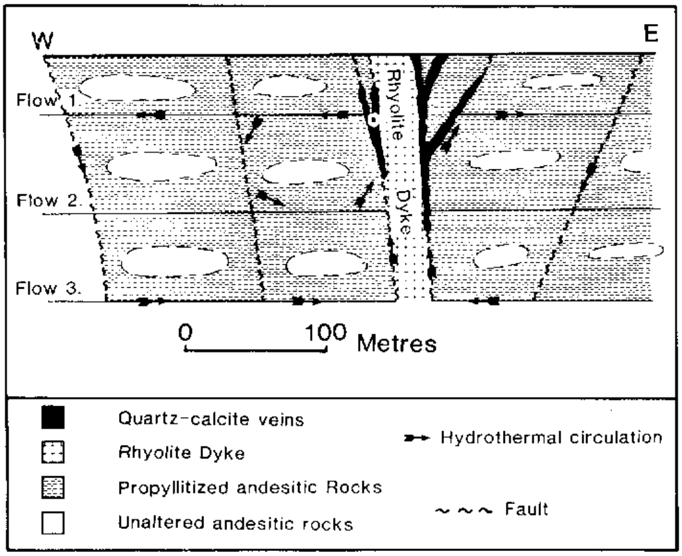

Figure 4. Schematic cross-section of hydrothermal system causing regional propylitic alteration of source area for precious metals, and deposition of gold-silver bearing, quartz-calcite vein zones at Mt. Skukum. Vertical scale is diagrammatic.

Main Cirque and also has a northeasterly trend. This fault forms the eastern contact between the andesites of the Main Cirque and the stratigraphically overlying felsic extrusives (Pride, 1986 — this volume). In these felsic extrusive rocks, 1100 m south of the Main Zone, a localized zone of pale, recessive and locally limonitic, intensely altered rock is apparent in a cliff exposure. X-ray diffraction analysis of a specimen taken from higher elevations of this altered zone showed it to contain abundant alunite and pyrophyllite.

Numerous felsic to intermediate dykes parallel the Main Zone Fault and are most abundant in its immediate vicinity (Figs. 2 and 3). A prominent felsic dyke, up to 30 m thick, occurs immediately adjacent to mineralized vein material in the southern end of the Main Zone structure. This dyke is one of three which are crosscut by narrower, but equally extensive andesitic and dacitic dykes. All dykes have subsequently been crosscut by the veins.

Several extensive tabular breccia bodies crosscut the volcanic strata at high angles throughout the Main Cirque and are parallel to dominant local fractures. The largest, immediately east of the Main Zone structure, consists exclusively of a highly siliceous matrix enclosing angular rhyolitic and/or andesitic fragments that range up to 10 cm in diameter. This body is at most about 10 m thick and closely parallels the eastern rhyolitic dyke along most of its length (Fig. 3). Several small breccia bodies, rarely over 1 m across, are scattered throughout the area surrounding the Main Cirque. Unlike their larger counterpart, these bodies are composed of a range of clastic components including granitic, rhyolitic, andesitic, schist, and marble fragments. All fragments are angular to subrounded and are enclosed in a siliceous matrix.

Two stages of vein formation occur in rocks of the Main Zone. The first is marked by blue-grey chalcedonic veinlets rarely more than 2 mm thick. These veinlets usually display pyritic selvages and envelopes, and are associated with extensive wallrock alteration ranging from pervasive silicification to phyllic alteration characterized by abundant muscovite, quartz and pyrite. Locally, these first stage veinlets form dense stockworks (up to 60 veinlets/m in drill core) associated with intense alteration and pyritization. Throughout the Main Cirque area, these stockworks are marked by heavily iron-stained gossans which bear no relation to the economic veins. First stage veinlets have not been found with significant gold or silver mineralization.

The second stage of veins, in contrast to the first, contains most known gold mineralization and contains no sulphides. These veins, found throughout the Main Cirque area, are concentrated in and around the Main Fault Zone structure. Megascopically, second stage veins are white and consist exclusively of a quartz-calcite assemblage. Characteristic textures range from a sugary massive appearance to a vuggy texture with abundant wallrock breccia fragments and well developed cockade structures. Calcite commonly appears as coarse, bladed crystals up to 1.5 cm intergrown with quartz.

An "ore" shoot has been defined in the Main Zone occurring over a section of the second stage veins south of the flexure in the Main Fault Zone. This "ore" shoot, as defined by drill holes, is 200 m long with an average width of 5 m and a vertical extent of about 80 m (Doherty et al., 1983). The ore zone vein which is up to 10 m thick branches at shallow depths into smaller, closely spaced, discontinuous veins that parallel the Main Fault Zone. A 1983 petrographic study by Bacon, Donaldson and Associates Ltd., Vancouver, B.C., of a limited number of specimens of vein material showed that gold (more correctly electrum) occurs as fine flakes between 15 and 20 microns in diameter. Within the vein, electrum is contained only in quartz, although assay values are highest in veins with at least equal amounts of quartz and calcite. The 1.2:1 ratio between gold and silver assay values (R. Somerville, 1985, pers. comm.) shows no systematic variation with vertical position in the deposit. The ratio between gold and silver combined with the lack of observed native silver or possible silver-bearing phases indicates that both gold and silver occur as electrum. Values for gold and silver drop abruptly in wallrock adjacent to the veins. Precious metal content also appears to be low in veins distant from the rhyolite dyke.

Alteration associated with second stage veins is poorly developed. Veins 1 and 2 m in width can have phyllic alteration envelopes which extend up to 2 cm into the wallrock; more commonly, alteration envelopes are absent.

CONCLUSIONS

Gold mineralization at the Mt. Skukum deposit occurs in nearly vertical quartz-carbonate veins which crosscut flat-lying andesites with a NNE trend. The mineralized veins represent the second stage of a two stage hydrothermal system, the first of which resulted in emplacement of thin chalcedonic veinlets. These two stages of veins are probably indicative of an evolving hydrothermal fluid rather than being representative of two separate events, although consistent crosscutting relationships clearly show that the first stage predates the second. Vein emplacement is one of the latest of a series of events which began with volcanism, producing felsic and andesitic volcanic rocks which overlie basement in this area. Subsequent periods of tectonism related to extrusion of the most recent rhyolitic rocks and possibly to depletion of magma chambers at depth, produced large faults along which rhyolitic dykes were emplaced. Continued tectonism resulted in reactivation of old faults along which andesitic and dacitic dykes were injected, crosscutting rhyolite dykes in many cases. As volcanic activity waned, the faults remained active, leaving zones of high permeability which acted as conduits for the still active hydrothermal circulation. The area of intense alteration south of the Main Zone contains alunite-pyrophyllite and cryptocrystalline silica which may represent a near-surface expression of a hydrothermal vent that possibly was active during formation of the Main Zone.

Veins appear to have been emplaced at low temperature in a circulating hydrothermal system driven by a heat source at depth associated with dykes present in the area (Fig. 4). Circulating hydrothermal fluids may have leached gold from the surrounding andesitic volcanics during propylitization (Roslyakova and Rozlyakov, 1975). Permeability may have been controlled by faulting, brecciated flow tops and bottoms, and lapilli tuff horizons. Gold was precipitated in highly permeable conduits, such as the Main Fault Zone and breccia bodies.

ACKNOWLEDGEMENTS

This project has been funded by the Exploration and Geological Services Division of the Department of Indian Affairs and Northern Development. Many thanks go to J. Morin who initiated this study and arranged funding for most of the presented research. Thanks also are extended to Agip Canada Ltd., R.A. Doherty, M. Balog, R. Robertson, E. Stewart and the Mt. Skukum field crew who made their field facilities available and gave a great deal of guidance to this project. We also acknowledge the cooperation and support from Erickson Gold Mines Ltd., particularly R. Somerville and R. Basnett.

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TABLE 1

POTASSIUM-ARGON DATA FROM WHOLE ROCK ANALYSES OF ANDESITE FROM THE MT. SKUKUM PROPERTY, MAIN ZONE AREA, YUKON

Sample number	Location lat(°N)	long(°W)	Rock description	% K (±)	$^{40}Ar^{*}$ / $^{40}Ar_{total}$ [2]	$^{40}Ar^{*}$ [2] 10^{-5} cm³ STP/g	Apparent age (Ma)[3]	Time[4]
ASTN-13WR DDH83-63: 57.61M	60°20′	135°47′	Fine grained andesite with pervasive propylytic alteration	2.71 0.01	0.674	0.5416	50.7 ± 1.8	Tertiary Early Eocene
ASTN-14WR DDH83-63: 59.19M	60°20′	135°47′	Fine grained, fresh andesite	2.18 0.04	0.938	0.4574	53.2 ± 1.8	Tertiary Early Eocene

1. Argon analyses are by J. Harakal and potassium analyses are by K. Scott; all analyses were done at the Geochronology Laboratory, The University of British Columbia
2. Ar* indicates radiogenic argon
3. Constants used are from Steiger and Jager (1977): $\lambda_e = 0.581 \times 10^{-10}$ yr^{-1}; $\lambda_\beta = 4.962 \times 10^{-10}$yr^{-1}; $^{40}K/K = 1.167 \times 10^{-4}$
4. Time designation is from Harland et al. (1982).