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BLACKDOME MINE

Barry D. Devlin
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INTRODUCTION

The Blackdome gold and silver mine, 67km west-northwest of Clinton, B.C., is on the southwest side of Blackdome Mountain. Access to the mine is by road from either Clinton or Williams Lake via a suspension bridge used to cross the Fraser River near Gang Ranch. Most of the mine workings are above treeline at an elevation of 1,960m above sea level. The region lies within the interior dry belt so precipitation is relatively light; the area is generally snow-free from June to September.

Gold and silver mineralization at the Blackdome Mine occurs in quartz veins hosted by intermediate to felsic volcanic rocks of Tertiary age. These veins generally contain steeply plunging "bonanza type" shoots and are typical of epithermal precious metal-quartz vein deposits occurring in the western USA and Mexico (Skiber, 1962; Reeve and Rennie, 1985; Faulkner, 1986).

The initial claims staked on gold bearing quartz veins on Blackdome Mountain were recorded by Lawrence Frenier in 1948. From the early 1950's to the 1970's, exploration work was carried out in the area by Empire Valley Gold Mines Ltd., Vancouver, and Silver Standard Mines Ltd., Vancouver. In 1977, Barrier Reef Resources Ltd., Vancouver, staked the Dome claims and consolidated all the remaining claims under the ownership of Blackdome Exploration Ltd., Vancouver. Exploration since 1980 has concentrated on two persistent veins, the No. 1 and No. 2 Veins, part of it under an option agreement to Heath Steele Mines Ltd., Toronto.

A total of 185,000 tonnes of ore grading 27.23g gold per tonne and 128.9g silver per tonne have been defined (Faulkner, 1986). A production decision has been made with construction starting in 1985. First production from stockpiled ore is expected in mid-1986 at a rate of 185 tonnes per day. Mining plans are for trackless cut and fill mining with a planned dilution of 21%. Ore is dominantly free milling with the remainder of precious metals recovered by flotation.

REGIONAL GEOLOGY

The Blackdome property occurs in the Stikinia terrane of the Intermontane Belt (Fig. 1). This terrane has an island arc affinity which generally contains mafic to felsic volcanic and volcaniclastic units interspersed with shallow water carbonates.

The north-northwest trending Fraser Fault mapped by Tipper(1978) separates Triassic and older rocks . the east from Eocene and Cretaceous rocks on the west (Fig. 1). On the east side of the fault, metasedimentary and metavolcanic rocks are mapped as Triassic Pavilion Group. West of the Fraser Fault and south of the Blackdome Mine, outcrop sedimentary rocks of the Lower Cretaceous Jackass Mountain Group. The Jackass Mountain Group rocks are separated from Tertiary and Cretaceous rocks to the north by a branch of the Fraser Fault, mapped as the "d" fault (Trettin, 1961), and the Hungry Valley Fault. The oldest rocks exposed to the north of these two faults are volcanic rocks originally mapped as Upper Cretaceous Kingsvale Group (Tipper, 1978) but now included in the Upper Cretaceous Spences Bridge Group (D. J. Thorkelson, pers. comm.). Overlying the Spences Bridge Group rocks are Eocene volcanic rocks which host the precious metal-quartz veins of the Blackdome Mine. The Eocene strata are overlain by Oligocene and possibly Lower Miocene volcanic and sedimentary rocks which in turn are capped by basalt flows and sedimentary rocks of the Chilootin Group. These basalt flow rocks were originally thought to be Pliocene flood basalts (Tipper, 1978) but a K-Ar age of 24.0 Ma obtained by Church (1980) in the Blackdome Mine area indicates deposition during either Early Miocene or Late Oligocene. Pliocene plateau lavas, however, have been recognized and cover much of the map-area north and east of the Blackdome property. Unconsolidated Quaternary sediments also provide extensive cover throughout the region. Intrusive rocks, other than local dikes, are scarce in the Blackdome Mountain area. Several isolated intrusive bodies outcropping to the northwest and southeast of the Blackdome Mine, have been mapped by Tipper (1978) as Late Cretaceous quartz monzonite and granodiorite.

The Fraser Fault zone is the major structural feature in the region and is remarkable for its continuity, low sinuosity and steep, nearly vertical, dip (Mathews and Rouse, 1984). These features suggest a major transcurrent fault; a post mid-Cretaceous dextral shift of 70 to 80km has been reported (Misch, 1974; Monger, 1977 <u>in</u> Mathews and Rouse, 1984). In addition to this movement, a Cenozoic dip-slip displacement of at least 1.5km is possible based on the 1,500m of Eocene beds absent for many kilometres east of the Fraser Fault (Mathews and Rouse, 1984). The Hungry Valley Fault due south of the Blackdome Mine is a nearly east-west trending thrust fault that may be the extension of the northwesterly-striking "d" Fault (Trettin, 1961; Tipper, 1978).

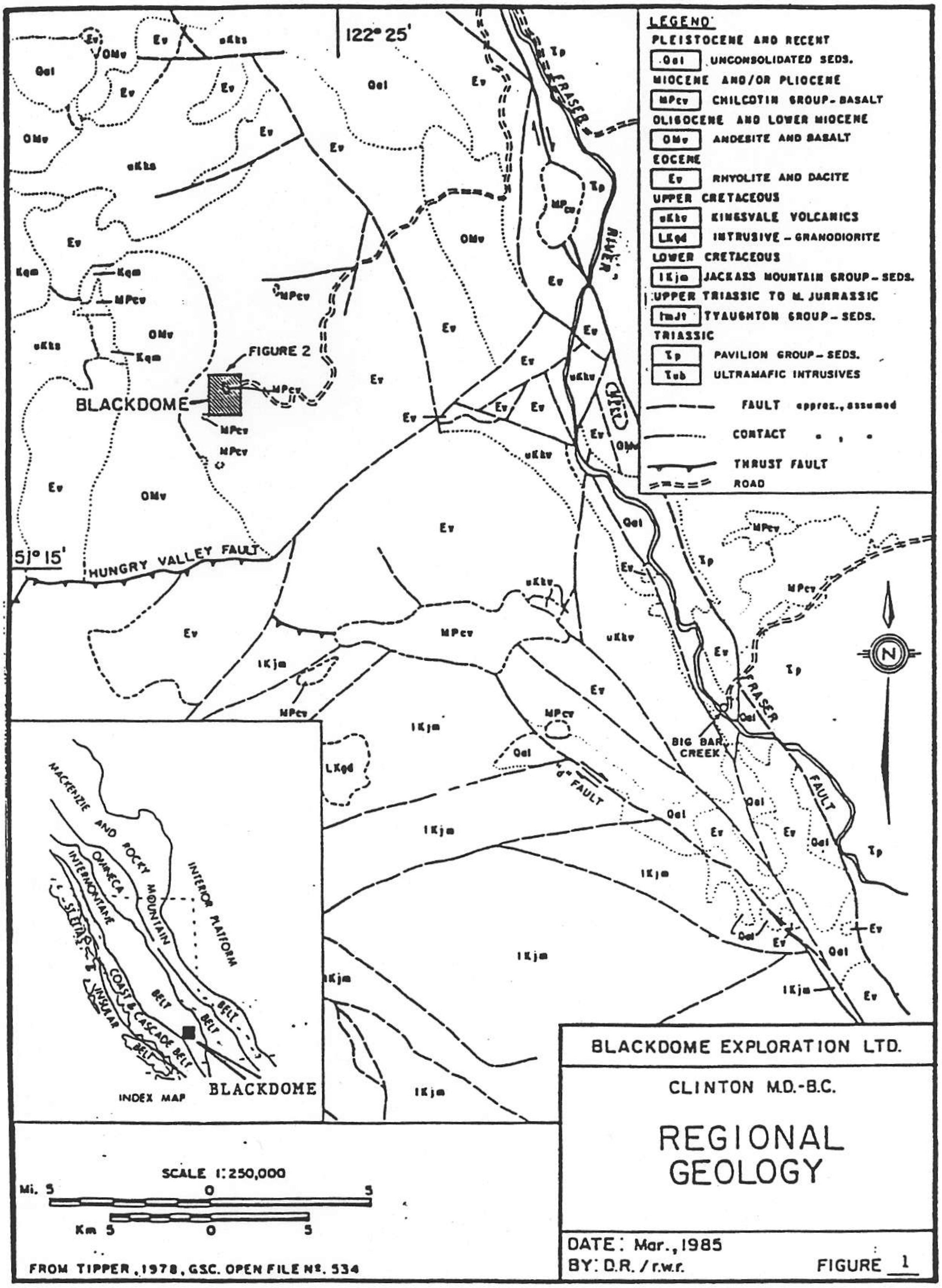

Figure 1 Regional geology (modified after Tipper, 1978 <u>in</u> Reeve and Rennie, 1985).

PROPERTY GEOLOGY

The Blackdome property is underlain by Cretaceous and Tertiary volcanic and volcaniclastic rocks with related feeder dykes (Figs. 2 and 3). Seven rock units have been mapped by Faulkner (1986), which from oldest to youngest include: greenstone, dacite, lower andesite, rhyolite, dacitic-andesite, dacitic domes, and basalt. Gold and silver mineralization occurs primarily in quartz veins cross-cutting the dacitic-andesite and rhyolite units.

The lowermost greenstone unit exposed on the west side of the map-area, has an indefinite thickness and consists of chloritized andesite flows, tuffs and agglomerates. Unconformably overlying the greenstone unit is a widespread but less than 70m thick dacite unit comprised of individual porphyritic dacite flows and minor discontinuous tuff horizons. Pyroclastic rocks of a lower andesite unit are rare and occur at the base of the rhyolite unit and in parts of the dacitic-andesite unit. The lower andesite unit is an irregular and patchy sequence of welded tuff, lapilli tuff and volcanic breccia of andesitic composition with local, closely spaced blocks and bombs suggesting proximity to a volcanic vent. The 100m thick overlying rhyolite unit, found in the southernmost part of the map-area, consists of flow banded rhyolite and lapilli tuff with minor lahar. Porphyritic flow rocks of dacitic-andesite composition comprise the 200m thick dacitic-andesite unit which underlies much of Blackdome Mountain. Dacitio-andesite dykes, recognized in the southwestern part of the map-area, possibly feed the flows of the dacitic-andesite unit. Dome-shaped occurrences of dacitic-andesite composition disconformably overly the dacitic-andesite unit in the southern part of the map-area. These dacitic domes, generally less than 30m thick, are believed to be comagmatic with the dacitic-andesite flow rocks. A K-Ar age of 51.5 ± 1.9 Ma for the dacitic domes indicates emplacement during Tertiary, Eocene time (Church, B.N., pers. comm., *in* Faulkner, 1986). Basalt flow rocks of a basalt unit outcrop in the northwest part of the map-area and form the peak of Blackdome Mountain. This unit is approximately 60m thick; thin, brick red agglomerate occurs at the base of the basalt where exposed. A basalt from Blackdome Mountain yielded a K-Ar age of 24.0 ± 0.8 Ma indicating deposition during Tertiary, Miocene time (Church, 1982). All rock units are summarized in the generalized stratigraphic column in Figure 4.

Volcanic and volcaniclastic beds in the Blackdome Mine area are antiformal with a shallow northeasterly plunge (Faulkner, 1986). The beds strike northeast with gentle dips to the northwest and southeast seldom exceeding 20^{o}. Northeasterly trending normal block faults cut the area and dominate the structure of both feeder dykes and precious metal-quartz veins. These faults are probably related to movement along the Fraser Fault system during Eocene time (Skiber, 1962; Faulkner, 1986).

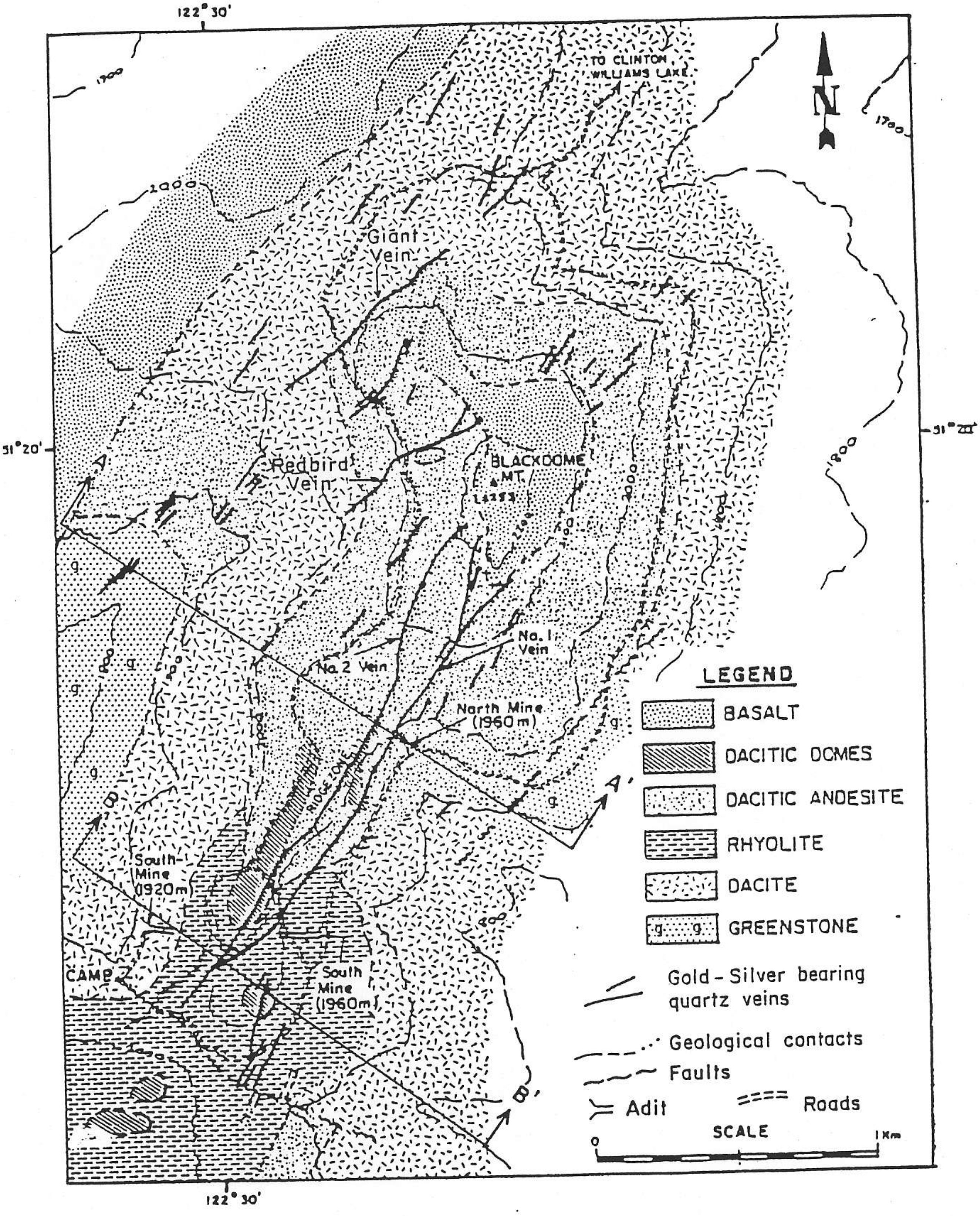

Figure 2 Geological setting of the Blackdome gold deposit (from Faulkner, 1986).

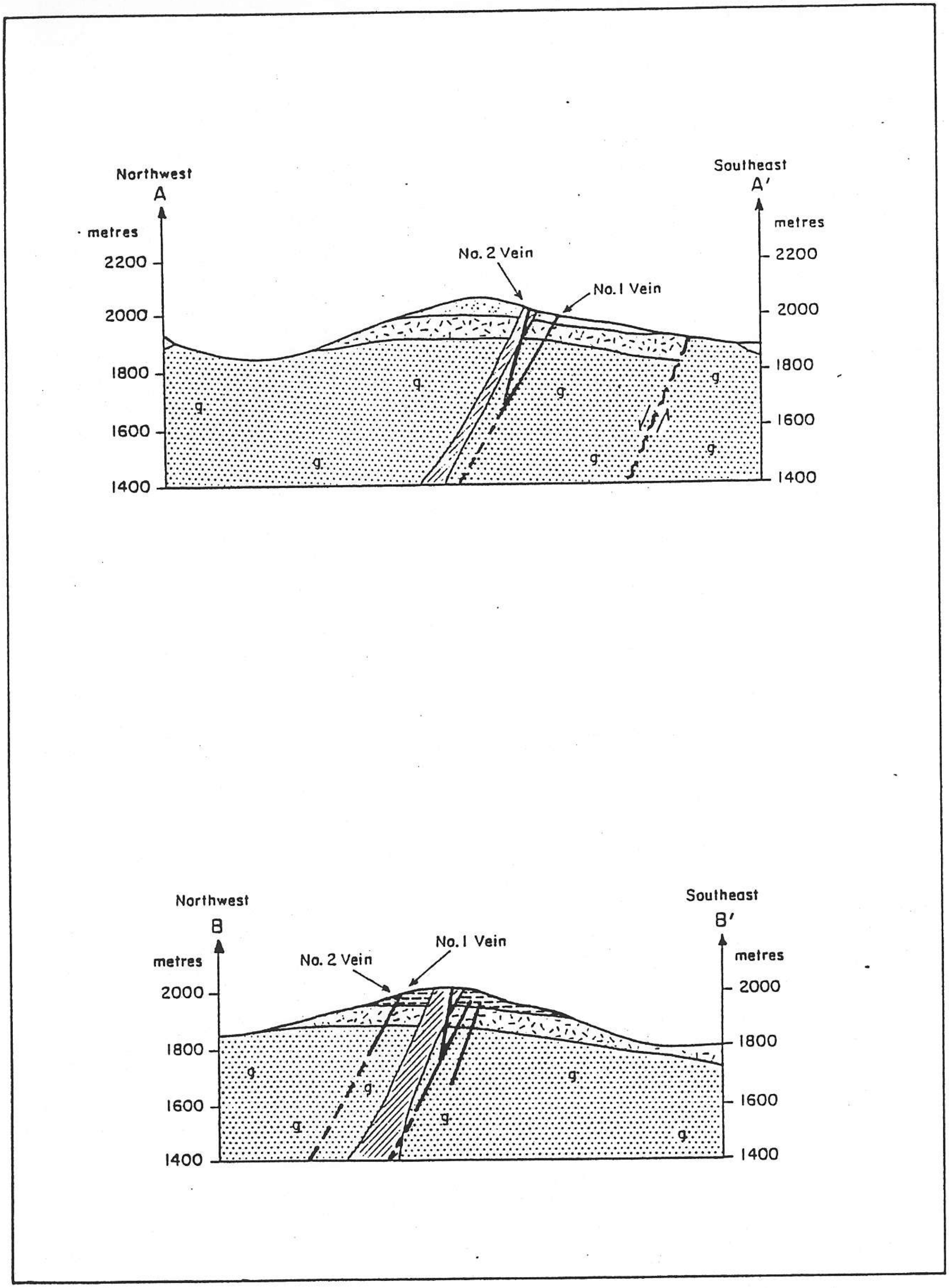

Figure 3 Geological cross-sections, looking northeast of the Blackdome Mine area (for location and legend, see Fig. 2).

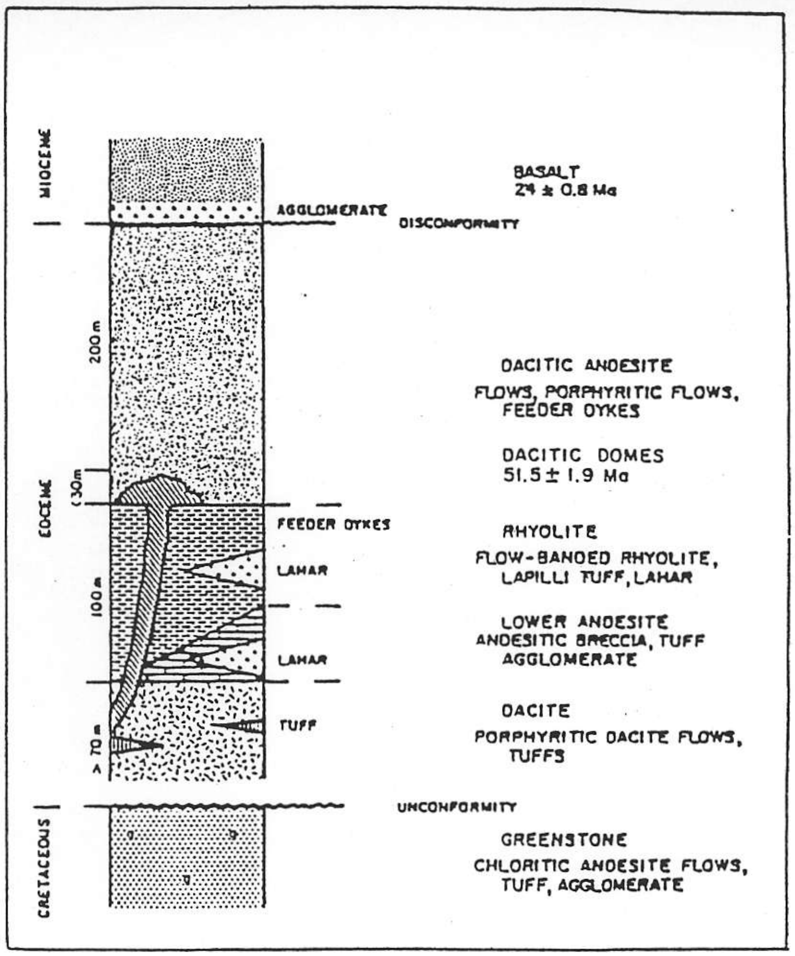

Figure 4 Generalized stratigraphic column for rocks in the vicinity of the Blackdome gold deposit (modified after Reeve and Rennie, 1985; Faulkner, 1986).

MINERALIZATION

At least 12 quartz veins or vein systems, striking at 30 to 40 degrees with moderate to steep northwesterly dips, occur within the Blackdome Mine area. Most of the exploration work, however, has been concentrated on the No. 1 and No. 2 Veins, which extend up the southwest ridge of Blackdome Mountain (Figs. 2 and 3). Gold and silver mineralization in these two veins is hosted by splayed quartz stringers and lenses, shear zones filled with gouge, and silicified breccia situated along two subparallel faults. Vein width varies from 2cm to 1.5m in thickness and ore grades occur in "bonanza-type" shoots with a strike length rarely exceeding 30m. Movement along the veins has been normal with displacement in excess of 20m and in places as much as 50m. The No.1 Vein has a shallower dip than the No.2 Vein (60^{o} *versus* 75^{o}), so they converge at depth and to the southwest, with the No.1 Vein appearing to branch from the No.2 Vein (Faulkner, 1986).

Ore and metallic minerals represented are generally less than 2% of the total vein material. They occur as fine grained disseminations of native gold and silver, electrum, acanthite (argentite), friebergite and silver sulphosalts associated with minor amounts of pyrite, pyrrhotite, chalcopyrite, sphalerite, galena and other accessory sulphide minerals. The gold to silver ratio averages 0.21:1. High selenium contents of sulphides have been reported (R. Morton, 1985, pers. comm. to C. Godwin).

Two other veins, called the Giant Vein and Redbird Vein, are situated northwest of Blackdome Mountain and have been explored in the past (Fig. 2). Quartz stringers, quartz and carbonate lenses, and breccia with minor pyrite are typical features of the Giant Vein, that is exposed over a length of 800m with widths generally less than 1m. The Redbird Vein has a strike length of a few hundred metres and is characterized by jasper accompanying milky quartz and carbonate infillings with local visible gold. Both the Giant and Redbird veins are considered uneconomical.

Wallrock alteration associated with the veins is characterized by the introduction of silioa, potassium feldspar, sericite and clay minerals (Reeve and Rennie, 1985). The altered wallrock has a typical bleached appearance and in places is intensely kaolinitized, with complete conversion of wallrock to clay. Alteration zones are usually confined to about 1m on either side of the veins but may extend as much as 15m into the wallrocks.

Silica alteration occurs as tiny veinlets, pore fillings and replacements of phenocrysts. Potassium feldspar most commonly replaces plagioclase in the groundmass of the volcanics as well as occurring as minor fracture fillings (G. Vivian, pers. comm., in Reeve and Rennie, 1985). Sericite occurs in veinlets and as irregular masses, probably replacing plagioclase. Argillic alteration comprised of sericite, clay minerals and possibly chlorite is pervasive and widespread in the rhyolite unit. Weak to moderate propylitic alteration characterized by fine to medium grained epidote, chlorite, carbonate and pyrite fracture fillings is observed mostly in the dacitic-andesite units and locally in the rhyolite unit.

GENETIC MODEL

Mineralization at the Blackdome Mine is typical of an epithermal deposit formed in a relatively isolated intermediate to felsic volcanic pile of Tertiary age, similar to those found in Mexico and the southwest USA. The term epithermal being used here was first introduced by Lindgren (1933) as a genetic classification of ore deposits formed at shallow depths under moderate pressures and temperatures ranging from 50 to 200° C (since extended to include an upper limit of at least 300° C). Buchanan (1981) studied many western USA epithermal deposits and proposed a model of formation that involves shallow circulating, meteoric water being heated by cooling volcanics or shallow plutons, the upward movement of the ore forming fluids in fault or phreatic breccias, and the deposition of ore and gangue phases in response to cooling and boiling of the hydrothermal fluids (Fig. 5). This genetic model for epithermal mineralization bears similar geological and geochemical characteristics to the Blackdome gold-silver deposit and other epithermal occurrences in the Canadian Cordillera (Panteleyev, in preparation; Nesbitt et al., in preparation). Many typical epithermal features are recognized at the Blackdome Mine. Native gold and silver, electrum and low-temperature sulphides and sulphosalts occur as dissem....tions in quartz vein stockworks related to fault zones and phreatic breccias. The gold to silver ratio is low (0.21 to 1), and ore shoots are small, high grade bonanza lodes. Alteration in the vein systems is represented by a typical low pH assemblage represented by intense kaolinization and silicification adjacent to the veins, and widespread weak to moderate propylitic and argillic alteration. Neither a silica cap nor a boiling level as defined by a transition from precious metal to base metal mineralization, as proposed by Buchanan (1981), have been observed at the Blackdome Mine.

Fluid inclusion studies of the precious metal-quartz veins show temperatures of homogenization between 200 and 300° C, salinities equal to one equivalent weight percent NaCl or less, and low values for CO_2 (G. Vivian, pers. comm., _in_ Nesbitt _et al_, in preparation). Stable isotope analysis of vein quartz indicated a mean $\delta^{18}O$ value of -8.0°/oo (parts per thousand) for the ore forming fluids suggesting only minor isotopic evolution and favouring a meteoric origin for the fluids involved in the formation of the Blackdome deposit (Nesbitt _et al_, in preparation).

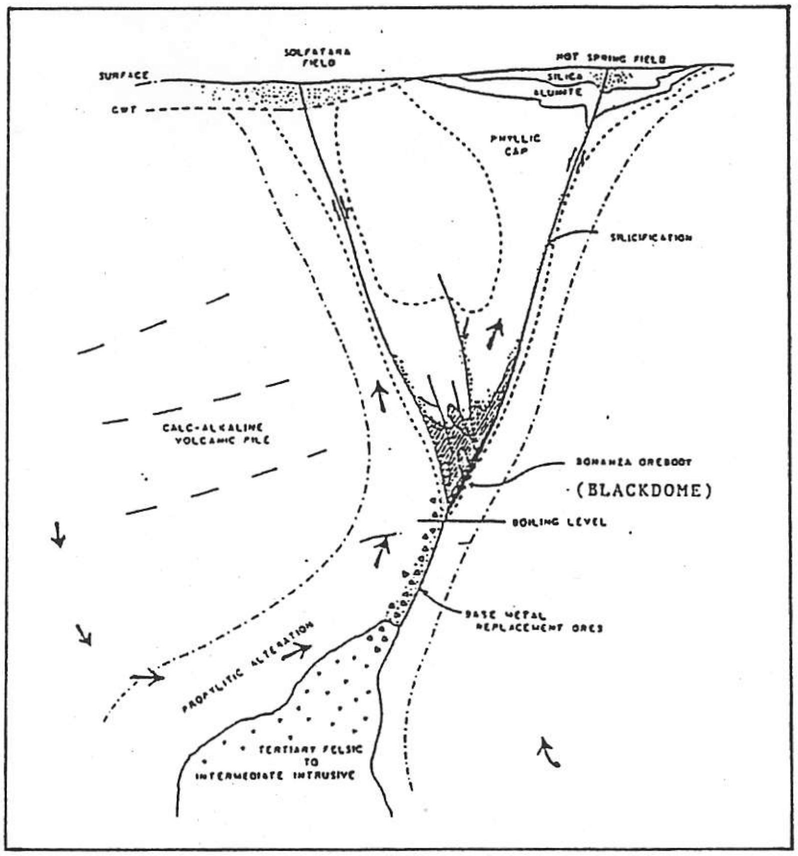

Figure 5 A schematic cross-section for "bonanza-type" epithermal deposits (modified after Buchanan, 1981).

EXPLORATION MODEL

Epithermal precious metal-quartz vein deposits, such as the Blackdome Mine, are attractive exploration targets because of the high unit values of precious metals with generally low or no base metal content (Panteleyev, in preparation). The deposits, however, tend to be small (less than one million tonnes) but typically have very good grades with many high grade shoots. They are found in extensional tectonic settings with volcanic terranes comprised of pyroclastic rocks and small subvolcanic intrusions. Deposits form near the surface to a maximum depth of 1,000m and the precious metal mineralization is associated with pronounced hydrothermal alteration.

In the Blackdome Mountain area, the most significant precious metal values are hosted by veins with a high percentage of quartz (Faulkner, 1986). Abundant quartz, however, does not guarantee precious metal values. Overburden in the area is not deep but prospecting for precious metal-quartz veins can be difficult because outcrops are scarce and limited to the higher slopes. Above treeline, quartz veins either stand above the surface or occur beneath areas of abundant quartz float. Below treeline, veins have been discovered by trenching precious metal soil geochemical anomalies. Panned surface material has also yielded a few tiny colours, in the vicinity of some veins (Sargent, 1948). Stream sediment geochemical surveys in the Blackdome Mine area have successfully detected anomalous values of Au, Ag and As in creeks draining known mineralized areas. Soil geochemistry was also found to be a useful tool for delineating anomalous areas for more detailed surface work (Dawson, 1979). Soil samples analyzed for Ag, however, were found to contain uniformly low Ag values; Au and Hg values, however, pinpointed the location of mineralized quartz veins. A ground magnetic survey picked up a number of north-northeasterly trends which coincided with mineralized quartz veins as well as barren fault structures.

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