TILLICUM MOUNTAIN GOLD PROSPECT
(82F/13)

By Y.T. John Kwong and George G. Addie

INTRODUCTION

The Tillicum Mountain gold property with latitude 49 degrees 59.2 minutes north and longtitude 117 degrees 42.7 minutes west is located 13 kilometres east of Burton in the Arrow Lakes region of the Kootenay District, south-central British Columbia. The general geologic setting of the property is shown on Figure 1. It is being developed under the joint venture between Welcome North Mines Ltd. and Esperanza Explorations Ltd. To the end of August 1981, trenching has revealed several high-grade gold occurrences within the property including the 16-metre-long Money pit, from which a 21.3-ton bulk sample yielded 3.887 ounces per ton gold, 2.30 ounces per ton silver, and 1.9 per cent zinc. Moreover, according to a recent report in the George Cross News Letter (No. 167, September 1, 1981), geochemical surveys have outlined two northwest-trending belts with anomalous gold values in soils varying from 100 to 3250 ppb over a strike length of 500 metres (see Figure 2).

GEOLOGY

Figure 2 presents a simplified geological map of the Tillicum gold property. In detail, the contact between the rocks of the Milford Group and the Kaslo Group is apparently marked by a band of argillite that is generally less than 5 metres in width. The argillite band, considered to be the youngest member of the Milford Group exposed in the area, consists of layers of different lithology. These include dark grey, relatively fissile argillite, whitish, highly siliceous cherty rock, and interbeds or rather massive, tuffaceous-looking rocks with streaks of sulphides. For clarity, these rocks are not shown on Figure 2. Similarly, small patches and dykes of garnet-bearing pegmatite, presumably derived from partial melting during the peak of regional metamorphism, and aplite and lamprophyre dykes are omitted from the figure.

With the exception of those occurring in and adjacent to the Money pit, rocks of the Milford Group near the contact zone with Kaslo Group rocks are silica-rich and resemble altered rhyolite in places. However, binocular microscope examination of collected specimens and thin sections indicate that these rocks are fine-grained muscovite-garnet schists with comparatively coarser grained quartzite lenses and interbeds. Relative proportions of quartz, muscovite, chlorite, K-feldspar, and plagioclase vary. Garnet is generally less than 5 per cent by volume. Opaque minerals rarely exceed 2 per cent. Schistosity in these rocks is generally marked by subaligned muscovite and chlorite. At least part of the latter mineral appears to be an alteration product of biotite.

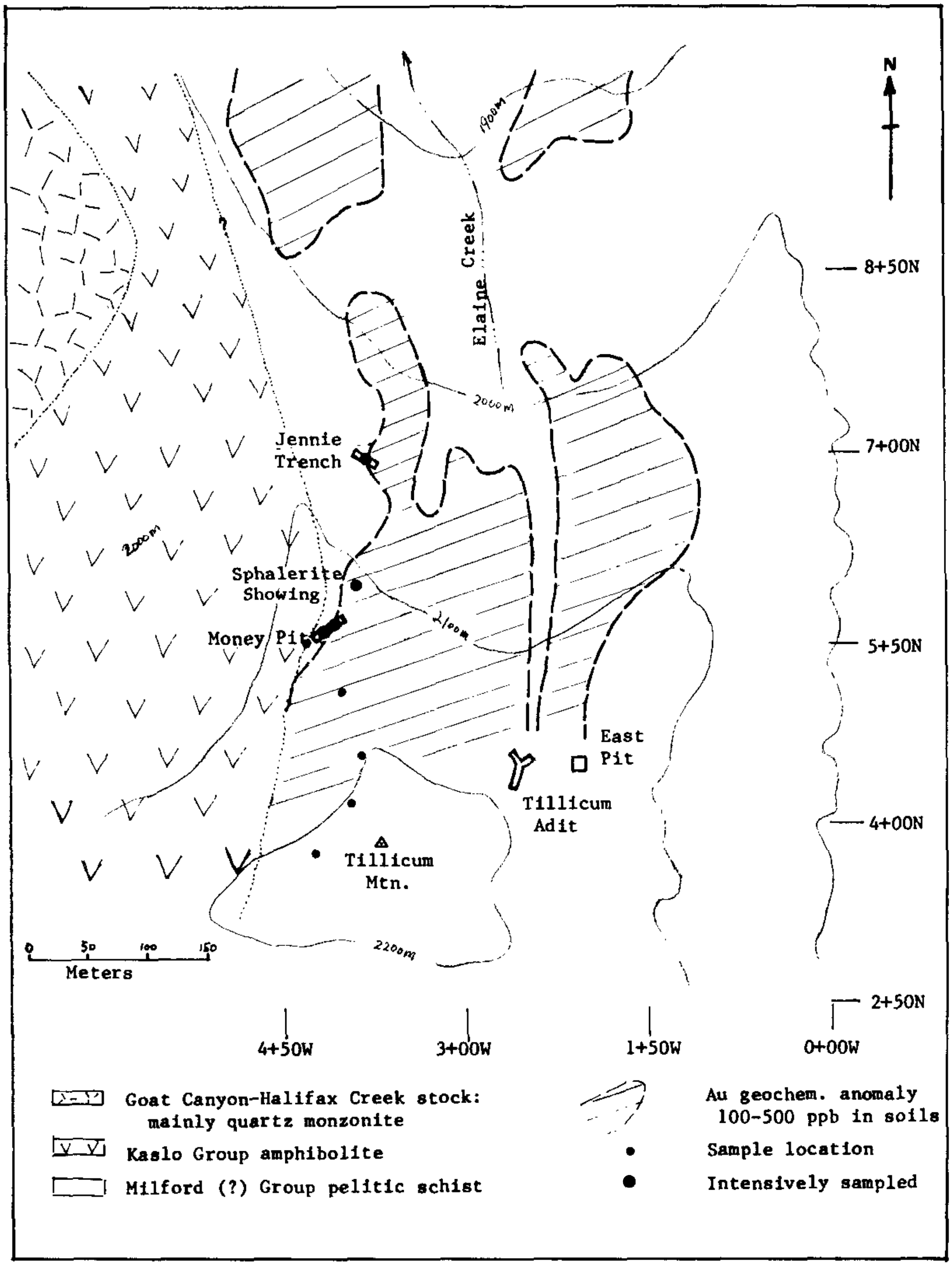

Figure 2. Local geology of the Tillicum gold property (partly after Crawford, pers. comm.). Soil geochemistry data are from George Cross News Letter, No. 167, September 1, 1981).

Metamorphosed, porphyritic, and locally amygdaloidal hornblende andesite and hornblende crystal tuff (?) are among the most common rock types of the Kaslo Group adjacent to the Milford contact. Intrusive rocks of the Goat Canyon-Halifax Creek stock to the northwest have not been examined in detail.

Figure 3 shows the geology in the vicinity of the Money pit and the location of samples collected for detailed petrographic and X-ray studies. Biotite-garnet-amphibole schists occurring around the perimeter of the Money pit are generally compact, fine-grained rocks. Common mineral constituents include K-feldspar, plagioclase, tremolite, biotite, and chlorite with lesser amounts of garnet (or its alteration product), quartz, opaque minerals, and rare calcite. Like the muscovite-garnet schists found away from the pit, schistosity in these rocks are defined by subaligned biotite and its alteration product, chlorite. Tremolite crystals are aligned either subparallel to the schistosity or at a small angle to it. Occasionally, tremolite also occurs with K-feldspar in patches and bands of varying dimensions. The proportion of these patches increases toward the Money pit and schistosity in the rock unit is locally destroyed. In four out of six thin sections cut from these rocks, garnet has been replaced by clusters of biotite and, less commonly, chlorite. Thus, a second episode of alteration featuring the stable appearance of tremolite, chlorite and possibly some K-feldspar and biotite was superimposed on regional metamorphism in which quartz-feldspar-mica-garnet±amphibole were stable. Prehnite and zoisite are locally associated with chlorite. Besides sulphides, a few samples also carry small amounts of amorphous carbon. Fold structures on a microscope scale occur in specimens from sampling stripes I and L.

Calc-silicate rocks in the Money pit consist, in order of decreasing abundance, of clinopyroxene (diopsidic augite ?), amphibole (tremolite-actinolite), quartz, K-feldspar, calcite, plagioclase, opaque minerals, and chlorite. Amphibole occurs either as fine-grained clusters or as elongated single crystals that cut across and include remnant fragments of clinopyroxene. Quartz, calcite, the feldspars, and opaque minerals commonly occupy interstitial spaces between the clinopyroxene and amphibole grains. All of these interstitial minerals appear to be in equilibrium with amphibole but most have a reaction contact with clinopyroxene. Less commonly, quartz occurs as scattered granular lenses or coarse fragments in locally brecciated clinopyroxene-dominated rocks.

These fragments and lenses are especially obvious in the southeastern corner of the pit where abundant sulphide minerals occur. Geological contacts of the calc-silicate rocks with the biotite-garnet-amphibole rock are sharp but the calc-silicates pinch out abruptly in a short distance. Consequently the limit of the calc-silicate unit depicted in the figure is very approximate.

Argillite adjacent to the Money pit are very similar to argillite bands described above except for the ubiquitous presence of tremolite. In most cases, the amphibole occurs in K-feldspar-rich bands that cut foliation defined by aligned mica and/or chlorite at a small angle. In a bulk sample, however, plagioclase is more abundant than K-feldspar.

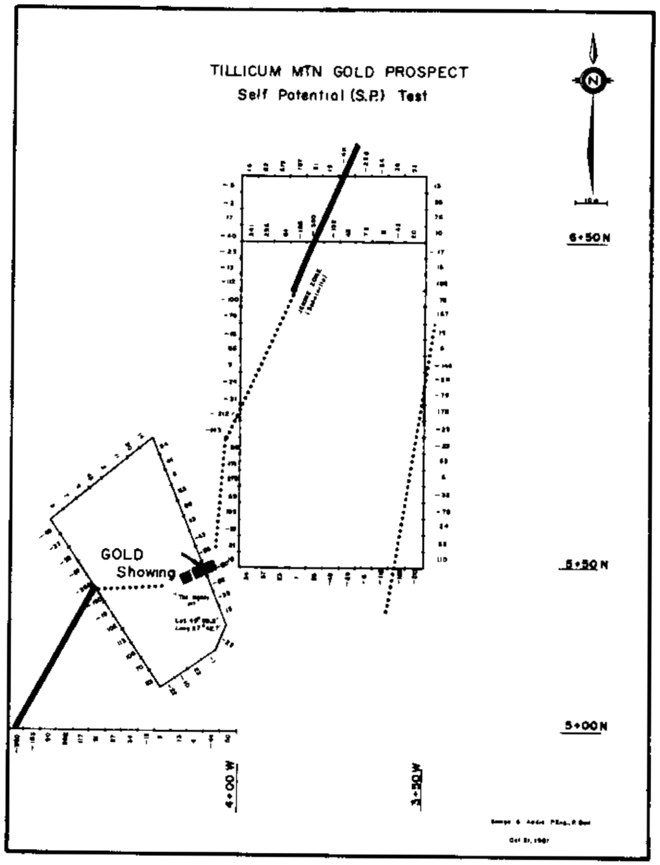

Figure 3. Lithology and location of samples at the Money pit and its immediate vicinities. The plan of the pit was kindly provided by Welcome North Mines.

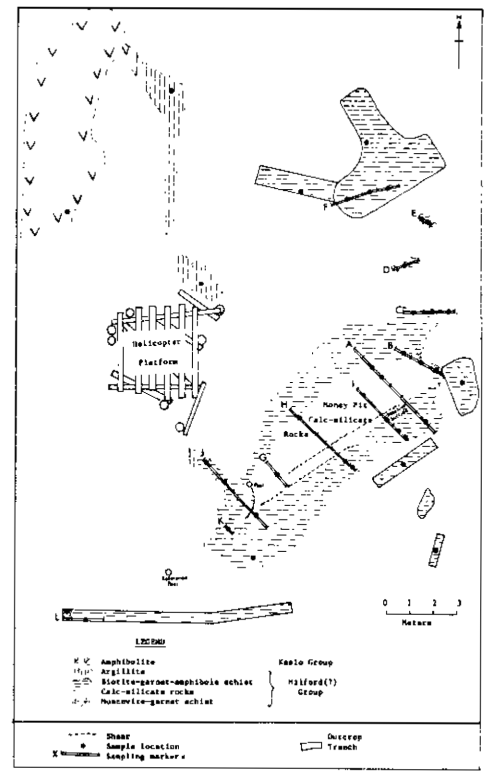

Figure 4. Self-potential test, Tillicum gold property.

Amphibolite west of the argillite unit was probably a porphyritic andesite prior to metamorphism. Subaligned hornblende phenocrysts, which define the foliation, are replaced by clusters of tremolite, biotite, and chlorite. Less abundant plagioclase phenocrysts and fine-grained clinopyroxene in the matrix, however, remain intact. Deformed lenses of quartz aggregates frequently enclose a carbonate core; they may have been amygdules originally.

MINERALIZATION AND ALTERATION

Native gold and sulphide minerals occur in the Money pit. Sulphides include sphalerite, pyrrhotite, galena, pyrite and rarely arsenopyrite, chalcopyrite, and marcasite. Polished sections indicate that native gold, sphalerite, pyrrhotite, and galena were precipitated in equilibrium. Sphalerite commonly includes discontinuous trains of exsolved blebs of chalcopyrite and pyrrhotite along cleavages indicating that it was originally deposited at a relatively high temperature. Many large pyrrhotite grains are replaced by marcasite and possibly some pyrite. Weathering products occurring in the Money pit have been confirmed by X-ray diffractometry to include colourless gypsum, white hydrozincite, and hemimorphite, black and dark brown goethite, reddish clayey hematite, and yellowish brown limonite.

As the intensity of mineralization decreases away from the Money pit, the sulphide mineralogy also changes. Whereas small amounts of sphalerite and locally galena are present in rocks of the Milford Group throughout the property, little or no pyrrhotite persists beyond the occurrence of biotite-garnet-amphibole schists. In the place of pyrrhotite, pyrite and locally arsenopyrite become the predominant sulphide minerals in the muscovite-garnet schists. Most of these sulphides are conformable with the schistosity, and hence with the original bedding because the two are parallel. Some sulphides, particularly sphalerite and galena, also occur along fractures at an angle to the schistosity or in association with silicate bands and patches at variable angles to the schistosity. Hydrous iron oxides are the predominant weathering products observed but locally, for example at the Jennie trench, arsenopyrite alters to abundant greenish yellow scorodite ($FeAsO_4 \cdot 2H_2O$). In the sphalerite showing lying northeast of the Money pit (see Figure 2 for location), an alteration mineral assemblage similar to that observed at the Money pit is present. However, neither visible gold nor extensive calc-silicate rocks were noted.

SP SURVEY

SP loops by both long and short wire methods got anomalous results at both the Money pit and the Jennie trench (Figure 4).

DISCUSSION

Pennsylvanian to Triassic sediments of the Milford Group deposited in the vicinity of Tillicum Mountain were probably made up of pelite with highly siliceous interbeds and localized pockets and lenses of impure carbonate which were precursors of a Money pit. These sediments might or might not contain small amounts of syngenetic sulphides. Undergoing progressive metamorphism up to the lower almandine-amphibolite facies, the carbonate was gradually converted into a clinopyroxene-dominating rock. The conversion process required a continual supply of silica from the neighboring rocks which accounts for the paucity of quartz in the biotite-garnet-amphibole rocks in comparison with the muscovite-garnet schist. A net transfer of FeO toward the nucleating calc-silicate zone was also likely so that diopsidic augite rather than diopside was stabilized and that biotite instead of muscovite preferentially occurred in the vicinity. The conversion of carbonate to a calc-silicate assemblage also involved a significant decrease in total volume that might induce incipient porosity and permeability in the resultant rock in the form of microfractures and pore space. Such inherited defects would be accentuated by structural deformation during or subsequent to regional metamorphism resulting in the formation of a highly permeable zone. In this way the Money pit was chemically and structurally prepared as a suitable site for the introduction of ore which probably took place during the intrusion of the Goat Canyon-Halifax Creek stock. Besides deposition of the ore minerals, the intrusive event also initiated an episode of recrystallization in the host rocks. Details of chemical changes and reactions involved in the formation and modification of the rocks in the Money pit and its vicinity will be dealt with in a later paper. It should be pointed out here that the ore reserve generated in the model would depend on the size of the original carbonate pocket, and consequently the extent of occurrences of deformed calc-silicate rocks.

Regarding the ultimate source of the ore elements, three alternatives are possible and each carries its own implications on further exploration targets in the region. First, the metals were derived from the intrusive stock and transferred to the Money pit by enriched magmatic hydrothermal fluid. In this case, the entire contact zone of the stock with the country rocks would be of interest. Besides Au-Zn-Pb, other types of mineralizatin like Cu-Mo would also be expected to occur closer to the stock. Second, Au+Zn$\pm$Pb was scavenged from the Kaslo Group amphibolite by hydrothermal fluid emanating from the stock. Under such a situation, the area around Mineral Creek (northwest of the centre of Figure 1) where a similar lithologic assemblage crops out should be investigated for similar deposits. Third, the mineralization at the Money pit represents a concentration of remobilized ore elements from the Milford Group rocks themselves. In view of the overall poor permeability of the fine-grained schists, which would readily hinder the formation of an extensive convection system, this alternative seems unlikely. Nevertheless, if it were true, then permeable zones in the Milford Group rocks occurring close to the intrusive stock should be examined for possible mineralization.

ACKNOWLEDGMENTS

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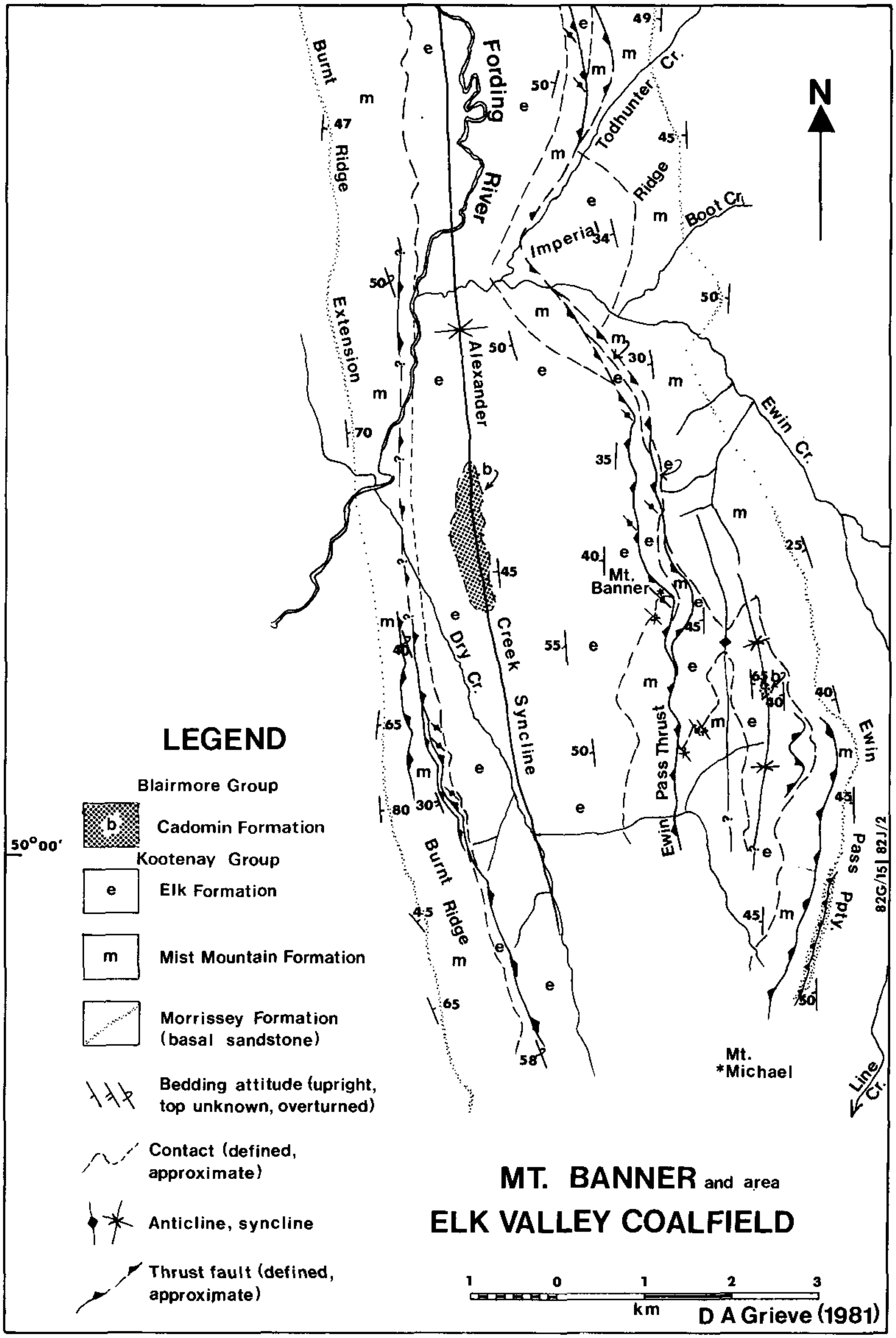

Figure 1. Geology of the Mount Banner area, Elk Valley Coalfield.