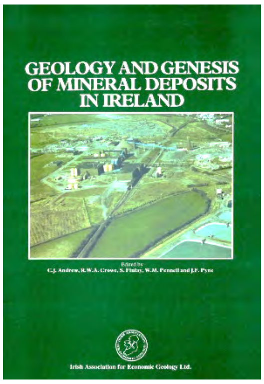

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Structural control of sulphide mineralization at Mace Head, Co. Galway.

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Abstract

The Galway Granite at Mace Head, Co. Galway hosts sulphide mineralization, chiefly molybdenite, that is associated with quartz veins, although subordinate amounts also occur disseminated in the granite. The mineralized veins are cut by faults, by joints and by barren quartz veins, indicating their early development with respect to structural and hydrothermal activity in the area. Two distinct phases of molybdenite mineralization can be distinguished, one in a steeply dipping set of veins, and the other in a shallowly dipping set; the two phases have different styles of mineralization. Evidence presented suggests that available figures on the amount of molybdenite present in the Mace Head area may not be representative due to the orientation of the diamond drill-holes.

Introduction

This paper briefly presents the inital results of a detailed investigation into the structural control of sulphide mineralization at Mace Head, Carna, Co. Galway (Fig. 1). As no detailed structural analysis of the Mace Head area exists, the author has instigated field mapping (Fig. 2) to lead to such an analysis. Geochemical investigations carried out by Anglo United and Canadian Johns-Mansville around Lough Bunnacliffa (Fig. 2), are reported by Talbot (1973) and more recently by Talbot and Max (1984). Between 1968 and 1970 Anglo United drilled 26 holes around Lough Bunnacliffa. Drill core assay results and some sludge sample results from these holes have been presented by Talbot (1973) and Talbot and Max (1984), who report that the mineralization at Mace Head is controlled by the strong NE structural trend observed in this region.

Geological setting

The Galway Granite is an end Silurian or early Devonian complex intrusion (Pidgeon, 1969) that shows reverse zoning (Max et al., 1975). The Granite was intruded into Dalradian gneisses and migmatites, and is considered to have been emplaced along a conduit formed by a major E-W splay of the Southern Uplands Fault which it now masks and anneals (Leake, 1979). The Galway Granite can be divided into four domes (Fig. 1). The oldest of these granite domes is the Carna Dome (Max et al., 1975) and it is this granite that hosts the sulphide mineralization at Mace Head.

Mineralization

General

Molybdenite, chalcopyrite, pyrite and galena occur at a number of widespread localities in the Galway Granite. Figure 3 shows some of the main localities. It is possible that the peripheral nature of these showings may be due to lack of detailed mapping, and to the lack of exposure in the central part of the Granite.

Mineralization most commonly occurs in late-stage quartz veins and joints, but it also occurs as disseminations in aplite veins and within the Granite. There does not appear to be any spatial relation between a particular granite type and sulphide mineralization. For example, at Mace Head (Figs. 2 and 3) the prominent molybdenite mineralization is hosted by the Carna Granite, whereas near Roundstone (Fig. 3) the Murvey Granite hosts the molybdenite.

Mace Head

The main economic minerals found at Mace Head are molybdenite and pyrite with minor chalcopyrite, magnetite and fluorite. The host rock, the Carna Granite, is a granodiorite.

The mineralized veins described in this paper outcrop along the shoreline south of Mace Head (Fig. 2). The shoreline mineralization was not observed NW of a large NE-trending fault (Fig. 2), while the SE limit of the mineralized veins has yet to be delineated with certainty. The bulk of the mineralized veins strike NE and dip to the NW (Fig. 4), being controlled by the strong NE structural trend of this area. The molybdenite occurs predominantly in association with quartz veining, but is also observed on joint planes and disseminated in the granite. The relation between disseminated molybdenite and vein or joint molybdenite is not yet clear. The vein mineralization is of two types. The first is "in vein" molybdenite, where the vein quartz hosts the molybdenite which can occur as rosettes, fine disseminations, or massive pods of both rosette form and finely disseminated molybdenite. The second type features a molybdenite coating between the vein quartz and the wall rock, and also on some joint surfaces. In both of the latter cases the molybdenite occurs as flattened rosettes and as smears. (See also Talbot, 1973). Some vein and joint rosettes can be up to 3cm in diameter. In the larger mineralized veins the molybdenite can occur in "pods" or "beads" extending up to 40cm along strike and 10cm wide. These beads are separated from each other along strike by thin barren vein quartz, 1-3cm thick.

The molybdenite veins are cut by later barren, and sometimes quite thick (10-15cm), quartz veins and by NW-trending faults. Molybdenite is also found associated with a major NE-trending fault; here the sulphide occurs in a large (c. 20cm) multiphase quartz vein, of which at least one phase involved hydraulic fracturing. The style of miner-

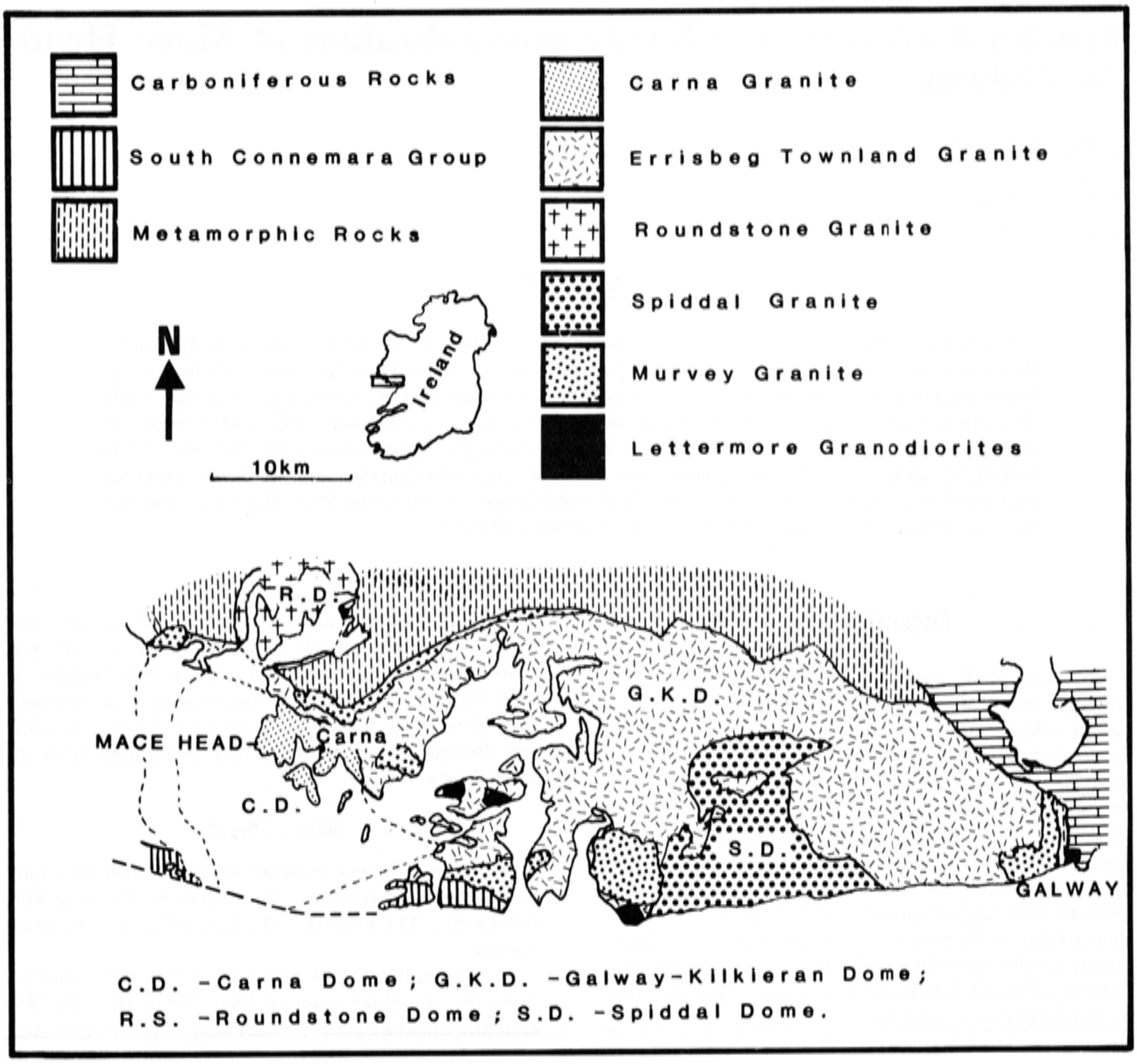

Figure 1. A map showing the distribution of the main granite facies and structural units within the Main Galway Granite, (adapted from Max et al., 1975).

alization includes both rosette form and finely disseminated molybdenite. It would therefore seem that there was remobilization of molybdenite in this fault zone during post-mineralization tectonism. Talbot's (1973) observations of strained vein molybdenite confirms this.

The mineralized veins plot on a stereogram as two sets of poles (Fig. 4). One set represents veins with "in vein" molybdenite, the other set the molybdenite-coated veins. Although both sets of veins strike approximately NE and dip NW, the stereoplot shows that, in general, the veins with "in vein" molybdenite have a steeper dip than the veins with a molybdenite coating. The Kolmogorov-Smirnov two-sample statistical test carried out on vein orientation data (Fig. 5), shows a 0.1% chance of these two sets of mineralized veins being drawn from the same population. This suggests that there were two phases of molybdenite mineralization, associated with different tectonic phases.

The spherical mean of the mineralized veins was calculated using only the main cluster of poles, and then plotted (Fig. 6). If one were intending to drill this area in search of mineralization, then the best approach, i.e. to obtain the most representative core for minimum cost, would be obtained by drilling parallel to, and at the same plunge as, the spherical mean, i.e. perpendicular to the mineralized veins. It is interesting to note that the 26 drill hole orientations at Lough Bunnacliffa are approximately at right angles to this mean (Fig. 6) and were therefore drilled parallel to the veins. The mineralized veins studied in this work occur 1000m SW along strike from Lough Bunnacliffa, and there do not appear to be any major structures between the shoreline traverse and the lake. Talbot (1973) and Talbot and Max (1984) do not cite any dip directions for the mineralized veins; they state merely that the veins are controlled by the dominant NE structural trend of this area. If the bulk of the mineralized veins around Lough Bunnacliffa have similar strike and dip to the shoreline veins (and recent investigations near the lake by the author suggest that this is so), it would appear that the diamond drilling was carried out in an uninformative orientation. So the assay and sludge sample results mentioned by Talbot (1973) and Talbot and Max (1984) are unlikely to provide a correct estimate of the grade of mineralization. Figures 7a and 7b demonstrate simply the effects of this type of drilling, given that the mean dip of molybdenite veins along the shore is 50°NW and the average dip of the 26 drill holes is 50°NW.

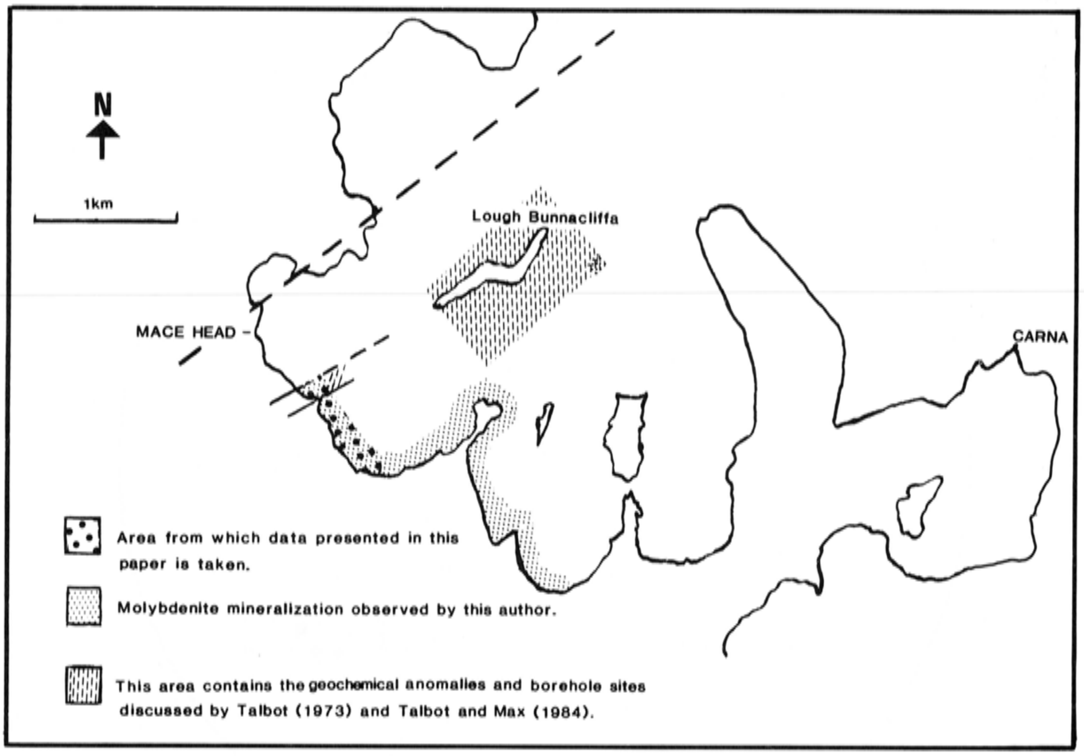

Figure 2. The Mace Head area showing the various sub-areas discussed in this paper.

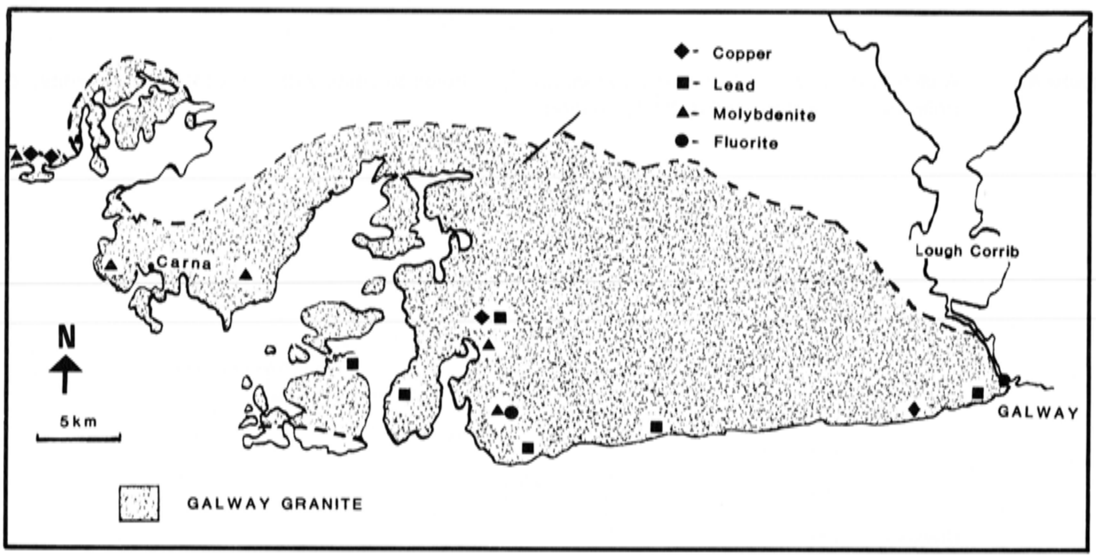

Figure 3. Locations of principal mineral showings in the Galway Granite, based on Geological Survey of Ireland Memoirs and unpublished Canadian Johns-Manville data.

Structure

Faults

There are two main fault trends (Fig. 8a), the prominent NE trend and a less strongly developed NW trend. The NE trend contains both major and minor faults. The major NE-trending faults define the boundaries of deformation zones across which the intensity of jointing and minor faulting changes abruptly, and from this the area can be divided into deformation "packages".

The sense of fault movement is determined, where possible, by dyke and vein offsets, and from slickensides. The direction and amount of movement of the major NE faults is difficult to determine. The majority of the abundant NE-trending minor faults show sinistral offsets (Fig. 8c), never greater than 3m, and commonly less than 1m. This small amount of movement nevertheless is often associated with

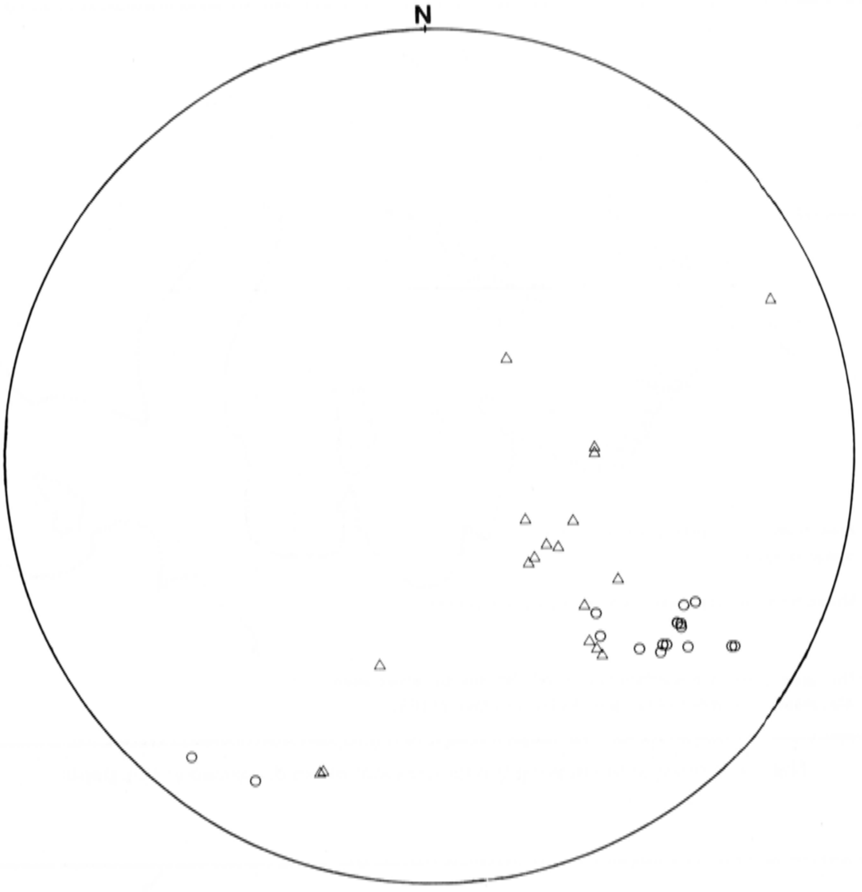

Figure 4. A stereoplot of poles to mineralized veins. ○ = Poles to veins with "in vein" molybdenite; △ = poles to veins with a molybdenite coating.

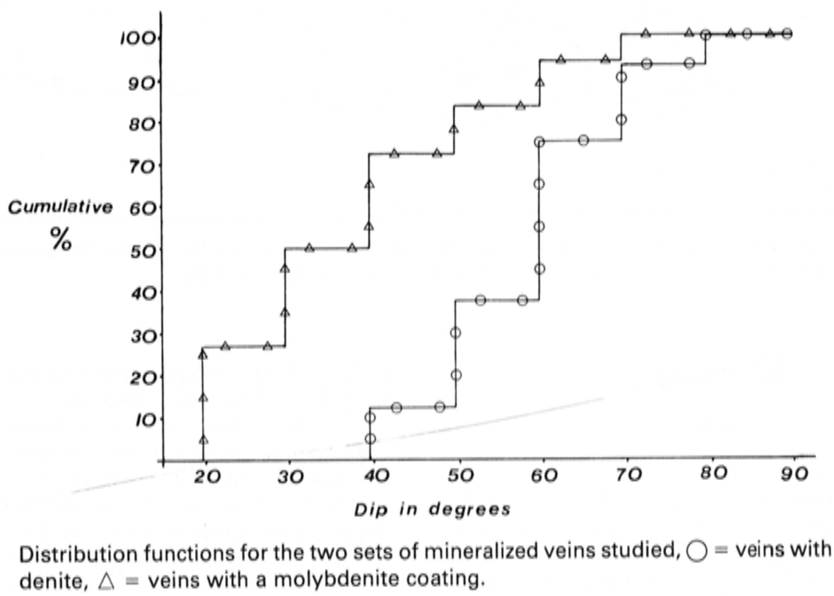

Figure 5. Distribution functions for the two sets of mineralized veins studied, ○ = veins with "in vein" molybdenite, △ = veins with a molybdenite coating.

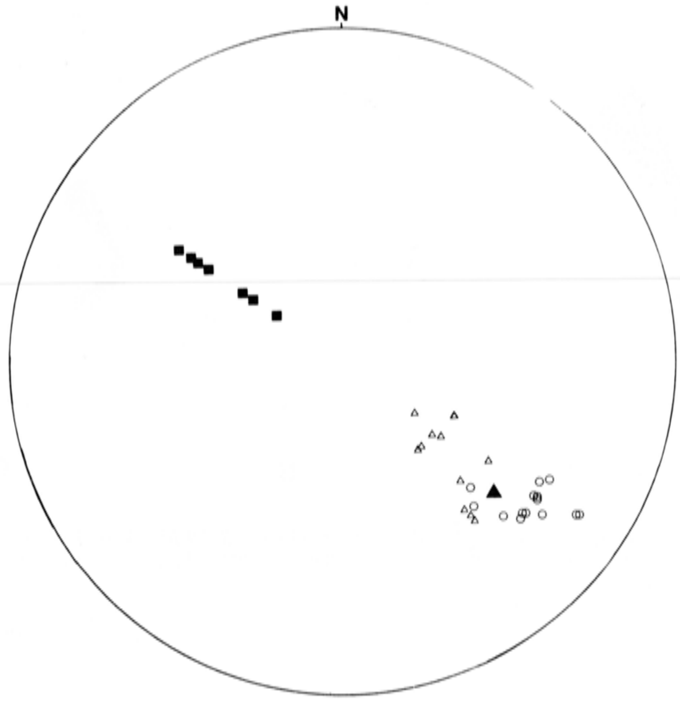

Figure 6. Stereographic projection of poles to mineralized veins, (○ and △), using only the main cluster of veins. From these the spherical mean was calculated (▲). Also plotted are the 7 diamond drillhole orientations used by Anglo United, (■).

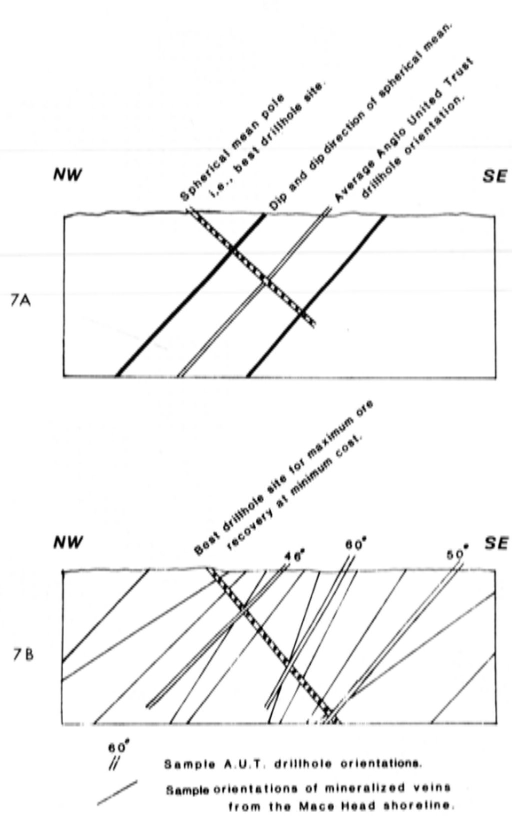

Figure 7. These two diagrams show how incorrect drillhole orientations can produce inaccurate assay and sludge sample results. Figure 7a involves statistical results from orientation data, and Figure 7b involves representative readings of field orientations.

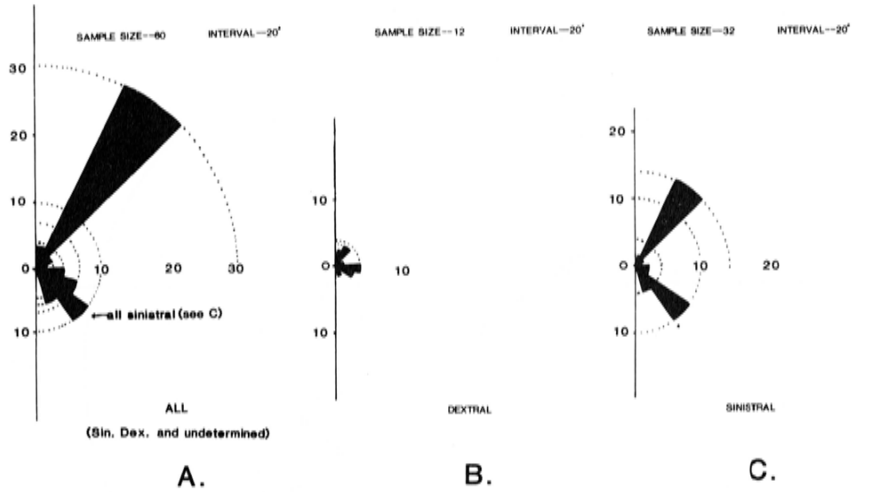

Figure 8. Rose diagrams of fault orientations, with 8a showing the prominent NE structural trend of this area. Figures 8b and 8c, respectively, are extracted from 8a and show the number of faults with a determined sense of slip.

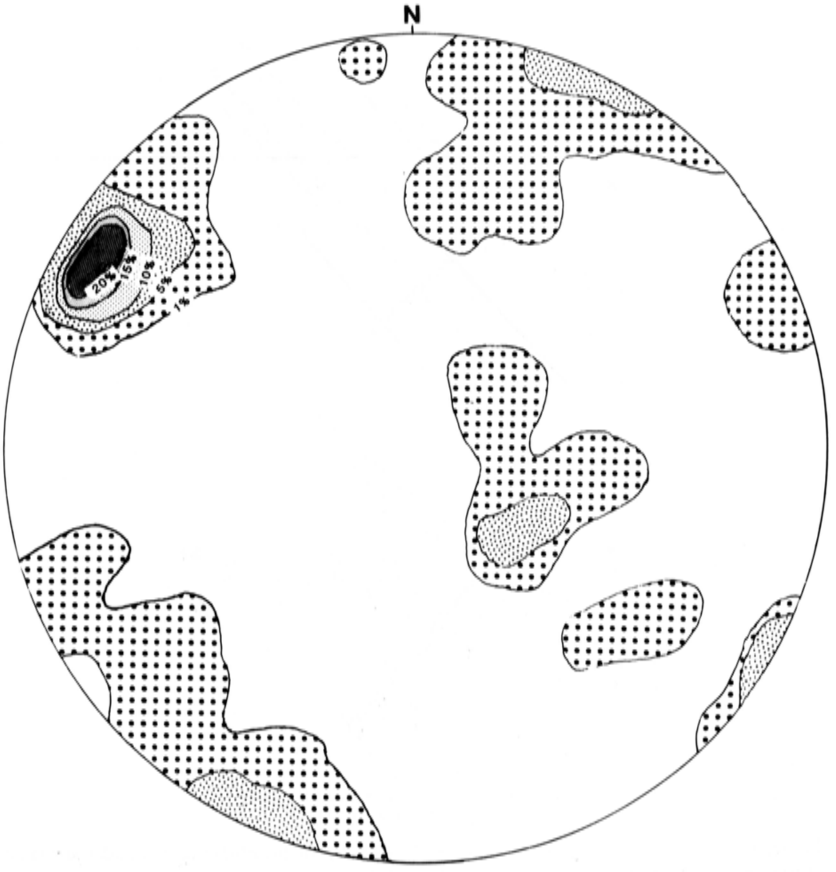

Figure 9. Contoured stereographic projection of poles to joints.

a zone of cataclasis, locally up to 30cm wide. The vertical component of the faults is difficult to determine, but observed slickensides are generally sub-horizontal. The only well-exposed major NE-trending fault dips steeply NW, and, as previously mentioned, has associated molybdenite mineralization. The dips of the minor NE-trending faults vary between 80° SE and vertical.

The steep northeasterly dipping NW-trending faults effect predominantly sinistral offsets (Fig. 8c), with the amount of movement usually less than 1m. These faults cut the minor NE-trending faults but their relation to the major NE-trending faults is less clear.

Joints

The main trends of jointing coincide with the fault trends (Fig. 9). The dominant joint sets are the NE and ESE sets, the former being the better developed, and clearly more dominant (Fig. 9). A set of low-angled sheet joints occupies a distinct zone in the region of 036°/25°NW on the stereonet (Fig. 9). Faults appear to have taken advantage of the NE-trending master joints. The jointing, as in the case of the faulting, is compartmentalized. Some areas show a greater abundance and intensity of joints in one orientation, due to enhancement of pre-existing joints in the region of the major faults. In some areas jointing becomes quite intense along narrow zones up to 5m wide. These zones resemble minor shear zones with each "joint" surface in the zone producing a small offset, usually less than 3cm. These planes are preferably called joints and not faults, because they are laterally discontinuous, offsets on them are minor, and they occur as parallel equi-spaced fractures both in and out of these "shear" zones, although more intense within the zones.

A comparison between Figure 4 and Figure 9 demonstrates that the mineralized veins did not develop in association with the dominant joint trend, but are related to other, less well-developed joint sets.

Conclusions

(1) The mineralization is controlled by early structures in the granite.
(2) The molybdenite mineralization is not associated with the main phase of jointing.
(3) The main molybdenite mineralization is associated with quartz veining.
(4) There are two distinct types and phases of vein-associated molybdenite mineralization at Mace Head, veins with "in vein" molybdenite, and veins with a molybdenite coating between the wall rock and the vein quartz.
(5) Structural analysis indicates that the 26 NW-plunging drill holes at Mace Head were drilled approximately parallel to the NE-striking, NW-dipping mineralized veins, implying that their drill core assay results do not accurately reflect the mineralization in the area.

Acknowledgements

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