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Geological and Structural Setting of Gold Mineralization in the Goudreau-Lochalsh Area, Wawa Gold Camp

By

K.B. Heather and Z. Arias

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V.G. Milne, Director
Ontario Geological Survey

Foreword

This report describes in detail the geological and structural setting of gold mineralization in the Goudreau-Lochalsh area of the Michipicoten greenstone belt near Wawa. The observations made by the authors provide clues for future mineral exploration in the study area and Archean greenstone belt in general.

V.G.Milne
Director, Geoscience Branch
Ontario Geological Survey

GEOLOGICAL AND STRUCTURAL SETTING OF GOLD MINERALIZATION IN THE GOUDREAU-LOCHALSH DISTRICT, WAWA GOLD CAMP, WAWA, ONTARIO, DISTRICT OF ALGOMA

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ABSTRACT

This report describes the geological and structural setting of gold mineralization in the Goudreau-Lochalsh area of the Wawa Gold Camp, Wawa, Ontario. The study area is located about 40 km northeast of the town of Wawa and covers portions of Dunphy, Abotossaway, Finan, Aguonie, Jacobson and Bird townships.

Archean supracrustal rocks in the immediate Goudreau-Lochalsh area consist of felsic to intermediate, pyroclastic metavolcanics which are capped by pyrite-bearing iron formation. Immediately to the north are pillowed, massive and schistose mafic to intermediate metavolcanic rocks which are interpreted to be younger in age than the iron formation and felsic metavolcanic rocks. Several medium- to coarse-grained quartz dioritic to dioritic sills and/or dikes intrude all of the metavolcanic rocks. Several felsic intrusions ranging in composition from nepheline syenite to tonalite/trondhjemite occur within the study area. The metamorphic grade of the supracrustal rocks is greenschist, except for a narrow band of amphibolite grade rocks adjacent to the external tonalite-granodiorite granitoid rocks to the north. All of the rocks described above are cross-cut by northwest- and northeast-striking diabase dikes.

Two regionally extensive, subparallel zones of deformation, referred to as the Goudreau Lake Deformation Zone (GLDZ) and the Cradle Lakes Deformation Zone (CLDZ), have been defined using the deformation intensity (i.e., strain intensity) of the supracrustal rocks, the deformation style, and the distribution and density of discrete high-strain zones. The majority of the known gold deposits and occurrences are located within the GLDZ, a 4.5 km wide by over 30 km long, east-northeast- to east-striking arcuate zone which is subparallel to the major lithological and foliation trends. The CLDZ is located south of the GLDZ and is at least 5 to 10 km in length and approximately 1 to 2 km in width.

The GLDZ can be subdivided into four structural domains (northern, southern, western and eastern) based on style of deformation, lineation patterns, and the orientation and the sense of apparent shear displacement on sets of high-strain zones. Correspondingly, the style and geometry of the gold mineralized zones is different within each of the structural domains.

Gold mineralization occurs in all rock types (excluding diabase dikes) in the area associated with high-strain zone hosted quartz veins. There is a spatial association of gold mineralization with felsic porphyry dikes and stocks, the contacts of dikes being particularly favourable sites for shearing and gold deposition. The

alteration associated with the gold mineralization is of limited areal extent, being confined to the discrete high-strain zones. Mafic metavolcanic and metaintrusive rocks are typically intensely altered to an assemblage of biotite, Fe-carbonate, pyrite, pyrrhotite, quartz and minor potassium feldspar and, in other places, less intensely altered to an assemblage of chlorite, calcite, and minor pyrrhotite and/or pyrite. Felsic metavolcanic and metaintrusive rocks are typically intensely altered to an assemblage of quartz, sericite, pyrite, Fe-carbonate, albite, hematite, pyrite and/or pyrrhotite and, in other places, less altered to a similar assemblage except that chlorite replaces sericite as the dominant mineral.

ACKNOWLEDGEMENTS

The data summarized in this report are the result of one field season of work (1987) by Kevin B. Heather studying the metallogeny of gold. Much of the regional structural work in this report has been summarized from data collected by Zaira Arias. I would like to thank the staff of the Wawa Resident Geologist's office, Ministry of Northern Development and Mines, for their continued support over the course of this study, in particular, Ed Frey, Delio Tortosa and Barb Leschishin.

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GEOLOGICAL AND STRUCTURAL SETTING OF GOLD MINERALIZATION IN THE GOUDREAU-LOCHALSH AREA, WAWA GOLD CAMP, WAWA, ONTARIO, DISTRICT OF ALGOMA

by

Kevin B. Heather (1) and Zaira Arias (2)

1) Geologist, Precambrian Geoscience Section, Ontario Geological Survey Toronto
2) Graduate Student, Queen's University, Kingston, Ontario

Critical Readers: A.Fyon and B.Dressler, Precambrian Geoscience Section Ontario Geological Survey
Manuscript approved for publication by B.Dressler, Chief Geologist (A), Precambrian Geoscience Section, Ontario Geological Survey. This report is published with the permission of V.G.Milne, Director, Geoscience Branch, Ontario Geological Survey, Toronto

INTRODUCTION

LOCATION AND ACCESS

The Wawa gold camp is located 130 km southeast of the Hemlo gold camp and 225 km west of the Porcupine (Timmins) gold camp (Figure 1). The Goudreau-Lochalsh gold district (of the Wawa gold camp) is located about 40 km northeast of Wawa, Ontario and includes portions of Finan, Jacobson, Bird, Aguonie and Abotossaway townships (Figures 2 and 3). The Goudreau-Lochalsh gold district includes the north-central portion of the Michipicoten greenstone belt (Figure 2). Access into the area (from Wawa) is via Highway 17, northward to Highway 519, then eastward through the town of Dubreuilville, toward a network of gravel logging roads which lead southeast into Finan Township (Figure 2). At this point, an east-trending gravel road is encountered, which stretches from the town of Lochalsh in the east to the old Murphy Mine site in the west (Figure 3). Float-equipped fixed wing aircraft and helicopter, as well as the Algoma Central Railway (A.C.R.), provide access to the more isolated regions.

PURPOSE

This project consisted of field work from June to September 1987 and follow-up office studies from October 1987 to April 1988. The purpose of this project was:

(1) to document the geological and structural controls of the gold mineralization in the Goudreau-Lochalsh district, and

(2) to add to the understanding of regional gold metallogeny within the Wawa gold camp.

This report summarizes 1:50,000 and selected, detailed scale structural mapping conducted by Zaira Arias and regional mapping and detailed mapping on individual gold occurrences by Kevin B. Heather.

The first part of this report deals with background information, largely compiled from other sources, and summarizes the regional structural geology of the area. The second part deals with mineral deposit and occurrence descriptions. This is followed by a brief discussion outlining the regional and detailed geological and structural controls for gold mineralization.

PREVIOUS WORK

Bruce (1942) mapped the Precambrian geology of the Goudreau-Lochalsh area, encompassing the townships of Dunphy, Finan, Jacobson, Abotossaway, Aguonie, and Bird. Goodwin (1962, 1963) mapped and compiled the geology of the Michipicoten greenstone belt, with emphasis on stratigraphy and structure.

Various workers have described the mineral occurrences within the Goudreau-Lochalsh area (Burrows 1921a, 1921b, MacLeod and Cowie 1926, Collins *et al.* 1926, Frohberg 1937, Gledhill 1927, Moore 1931, Burwash 1937a, 1937b, Bruce 1948, and Moore 1948).

Extensive 1:15,840 scale geological mapping of the Goudreau-Lochalsh area has been completed by the Ontario Geological Survey (Sage 1979, 1980, 1981a, 1981b, 1982, 1983, 1984, 1985, 1986, 1987a-d, 1989 and 1990).

Recent exploration activity in the Goudreau-Lochalsh district is summarized by Heather and Arias (1987) and Tortosa *et al.* (1988, 1989, 1990, 1991). The increase in activity has been partially fueled by the recent discovery, development and production at the Kremzar gold mine by Canamax Resources Incorporated and the recommissioning of the Magino gold mine by Muscocho Explorations Limited and McNellan Resources Limited. Sage (in prep.) provides a comprehensive review of the past exploration and mining activities within the Goudreau-Lochalsh area.

TERMINOLOGY AND CONVENTION

Throughout this report an attempt has been made to define all technical terminology (e.g.'s, deformation intensity, deformation style, high-strain zone, etc.). In addition, definitions, as used in this report, are provided for terms that have loose usage in the geological community (e.g., deformation zone, brittle-ductile, etc.).

In the following descriptions the terminology "Fe-carbonate" is used as field term to describe any rusty weathering carbonate; whether it be siderite, ankerite or iron-rich dolomite. All grade, tonnage and other measurements quoted in this document are given in the units of measurement (i.e., metric or imperial) that they were originally reported in. Any data collected during this study will be reported in metric units.

All azimuthal data (e.g., high-strain zone orientations) is reported using the right-hand rule when dip information is known. When the dip is not known the azimuth is reported as a number between 0° and 180°. Where senses of displacement are reported for high-strain zones, fractures or faults, it is the apparent horizontal component of the displacement that is indicated. Where linear data (e.g.'s, mineral lineations, slickensides, etc.) are available the sense of displacement in both the horizontal and vertical directions will be indicated (e.g.'s, dextral oblique-slip, sinistral strike-slip, etc.).

REGIONAL GEOLOGY

MICHIPICOTEN GREENSTONE BELT

The supracrustal rocks of the Michipicoten greenstone belt can be subdivided into at least three mafic-felsic volcanic cycles (Sage *et al.* 1987; Sage and Heather 1991) based on whole rock geochemistry and U-Pb zircon age dates of approximately 2900 Ma (Turek *et al.* 1988), 2749 Ma (Turek *et al.* 1982), and 2700 Ma (Turek *et al.* 1982, 1984). The intermediate to mafic metavolcanic rocks of the oldest cycle are basaltic to peridotitic komatiite in composition, while the two younger mafic cycles are tholeiitic to high-iron tholeiitic in composition (Sage *et al.* 1987). The intermediate to felsic metavolcanic rocks of all three cycles are calc-alkalic rhyolites and dacites. Each of the volcanic cycles is capped by chemical metasedimentary rocks consisting of siderite-, pyrite-, or chert-magnetite-iron formations and/or clastic metasedimentary rocks consisting of argillites, siltstones, sandstones and conglomerates. Numerous sill- and dike-like intrusions of gabbroic to quartz dioritic composition intrude all three volcanic cycles. The Michipicoten supracrustal rocks have been intruded by granitoid intrusions of several ages (e.g., 2888±2 Ma, Turek *et al.* 1984; 2747±6 Ma, Turek *et al.* 1982; 2722±1 Ma and 2662±5 Ma, Turek *et al.* 1984) of widely varied composition. Sage and Heather (1991) provide a more detailed discussion of the regional geology.

GOUDREAU-LOCHALSH DISTRICT

Supracrustal rocks in the immediate Goudreau-Lochalsh district consist of Cycle 2 felsic to intermediate, pyroclastic metavolcanics (2729 ± 3 Ma, Turek *et al.* 1988) which are capped by pyrite-bearing ironstone (Figure 3). These ironstones were mined during World War I and are referred to as the Goudreau Iron Range. To the north are pillowed, massive and schistose, mafic to intermediate metavolcanics and minor intercalations of mafic pyroclastic rocks of Cycle 3 (Figure 3) which correlate with the base of the 2698 Ma metavolcanics near Wawa (Sage, personal communication, 1988).

Several medium- to coarse-grained quartz dioritic to dioritic sills and/or dikes intrude all of the metavolcanic rocks (Figure 3). Along the northern margin of the supracrustal sequence (Figure 3), separating Cycle 3 mafic metavolcanic rocks from the external granitoids, are thinly-bedded metasedimentary rocks with minor intercalations of chert-magnetite ironstone. These ironstones are referred to as the Dreany Iron Range. Several felsic intrusions occur within the Goudreau-Lochalsh district (Figure 3):

(a) the Herman Lake nepheline syenite complex (2671±5 Ma, Corfu 1991, unpublished; Map Unit 12, Figure 3)
(b) the Maskinonge Lake stock of granite (locally quartz deficient) to amphibole syenite composition (2672±2 Ma, Corfu 1991, unpublished; Map Unit 10, Figure 3),
(c) the Webb Lake stock of trondhjemite (Sage 1985) to granodiorite composition (Mine Geologists, Muscocho Explorations Limited, Magino Mine Site, personal communication, 1987) (Map Unit 7b; Figure 3),
(d) the Cradle Lakes quartz-feldspar porphyry (Map Unit 8a; Figure 3),
(e) the Gutcher Lake stock of trondhjemite composition ((2722 ± 1 Ma, Turek *et al.* 1984; Map Unit 7a, Figure 3)
(f) the Troupe Lake stock of granodiorite composition (2671 ± 2 Ma, Corfu, 1991, unpublished; Map Unit 11, Figure 3)
(g) numerous quartz-feldspar and feldspar porphyry dikes throughout the district.

Granitoid rocks, located to the north, external to the Michipicoten supracrustal rocks, consist of foliated to gneissic tonalite, which is intruded by more massive granodiorite. Turek *et al.* (1984, 1990), using U-Pb zircon geochronology, have dated the granodiorite phases at 2662±5 Ma and 2686±13 Ma.

The metamorphic grade of the supracrustal rocks is greenschist, except for a narrow band of amphibolite grade rocks adjacent to the external granitoids to the north. All of the rocks described above are cross-cut by northwest- and northeast-striking diabase dikes.

STRUCTURAL GEOLOGY

MICHIPICOTEN GREENSTONE BELT

The Michipicoten greenstone belt has been interpreted to be a monoclinal sequence of supracrustal rocks that have been thickened by regional folding (Sage *et al.* 1987). A more complex deformation history, involving early thrusting and multiple folding, was documented by McGill and Shrady (1986), Arias and Helmstaedt (1989, 1990a, 1990b) and Shrady (1988, 1991). Arias and Helmstaedt (1990a, 1990b) identified regional inverted folds and concluded that the present exposure level of the Michipicoten greenstone belt is the overturned limb of an early, belt-scale recumbent nappe fold (F_1), that was refolded and imbricated by south-verging thrusts (F_2) (Figure 4). The geometry of the southern portion of the Michipicoten greenstone belt is that of a thrust-faulted, inverted syncline (F_2), while the geometry of the northern portion of the belt (i.e., Goudreau-Lochalsh area) is that of an inverted anticline (F_2) (Figure 4). This inverted anticline is known as the Centre Anticline (Goodwin 1962) or Goudreau Anticline (Sage, in prep.; not the same as the Goudreau Cross Anticline of Goodwin (1962)).

The regional strike of the rock units is approximately parallel to the axial surfaces of the prominent F_2 folds and associated D_2 thrusts (Arias and Helmstaedt 1990a, 1990b). The present regional distribution of rock types reflects a D_2 map pattern (Arias and Helmstaedt 1990b). The D_2 event of Arias and Helmstaedt (1990b) correlates with the first major phase of deformation (D_1) of McGill and Shrady (1986), which involved folding and thrusting along faults that bound lithologic packages (Table 1). Arias and Helmstaedt (1990a, 1990b) deduced that the D_2 thrust imbrication produced structural repetition of at least the youngest supracrustal rocks that were formerly interpreted as a thick stratigraphic sequence of two volcanic cycles (Goodwin 1962; Attoh 1980; Sage *et al.* 1987).

Table 1 presents a correlation of some of the structural elements documented for parts of the Michipicoten greenstone belt. Although the interpretation of the structures differ, the sequence of structural elements associated with, and/or superimposed upon, the present geometry of the belt, is similarly described by McGill and Shrady (1986) and Arias and Helmstaedt (1989, 1990b). A consistently northeast-striking crenulation cleavage (S_4 of McGill and Shrady (1986); S_3 of Arias and Helmstaedt (1986)) overprints the early structures, but does not significantly alter the dominant map pattern (D_1 of McGill and Shrady (1986); D_2 of Arias and Helmstaedt (1989, 1990b).

In addition to the complex fold and cleavage patterns documented above, the Michipicoten greenstone belt is traversed by numerous northeast- and northwest-striking faults, which commonly host diabase dikes (Figures 3 and 5). The majority of the north- to northwest-striking faults exhibit kinematic features suggestive of a sinistral, steep southwest-side down sense of movement. Sage *et al.* (1987) state that the apparent displacement along many of these faults decreases significantly from south to north across the belt (Figure 5) due to a scissor-like motion. Most of the northeast-striking faults are manifested by the alignment of linear lakes. Goodwin (1962) indicated that the horizontal component of displacement for these faults was dominantly sinistral; however, there are a number that appear to be dextral.

GOUDREAU-LOCHALSH DISTRICT

The importance of structure in controlling gold mineralization has been established for many Archean gold deposits (Colvine *et al.* 1988; Robert 1990). The following discussion summarizes many of the regional structural patterns documented in the Goudreau-Lochalsh area by Z. Arias during the summer of 1987.

Foliations

In this report, the term foliation is used in accordance with the American Geological Institute's (1987) 'Glossary of Geology' and includes several planar fabric types, namely, schistosity, cleavage, fracture cleavage (i.e. spaced cleavage), fractures, joints and faults. Fracture cleavages, fractures, joints and faults are described in a separate section of this report. Foliations in the supracrustal rocks are defined by a preferred orientation of mineral grains (e.g., hornblende, chlorite, sericite) and deformed primary markers (e.g., flattened quartz eyes, varioles, pyroclastic fragments).

The regional foliation trends in the Goudreau-Lochalsh area are schematically shown in Figure 7. The predominant foliation trend is parallel (to subparallel) to the major rock type trends and essentially axial planar to the upright, doubly plunging Centre Anticline (F_2 of Arias and Helmstaedt 1990b). This steeply dipping, regional foliation is indicated as the "*1st foliation*" on Figure 7 and is equivalent to S_2 of Arias and Helmstaedt (1990b). This foliation is markedly sinuous on a regional scale, varying in trend from about 070° to 095° within the study area. Locally, there is an ESE-striking foliation (indicated as the "*2nd foliation*" on Figure 7) which overprints and crenulates the early foliation. This foliation has not been reported in the southern part of the belt, however, it has been recognized further to the east, in the

Renabie area (Heather 1989). A northeast-striking foliation can be distinguished locally in cross section, where a moderately north-dipping cleavage (indicated as the "*3rd foliation*" on Figure 7) crenulates the earlier cleavages. This northeast-striking cleavage, in the Goudreau-Lochalsh area, is correlated with the regionally extensive northeast-striking cleavage documented to the south (S_3 cleavage of Arias and Helmstaedt 1989, 1990b; and S_4 cleavage of Shrady 1988, 1991; Table 1).

Lineations

Various lineation types are observed upon the schistosity or cleavage planes (and upon the shear foliation planes): namely, mineral, striation, crenulation, intersection and elongation lineations. Mineral lineations are characterized by a parallel to subparallel orientation of acicular amphibole, chlorite, and rarely tourmaline crystals, tabular micas (i.e., biotite and sericite), and more rarely feldspar and quartz. Mineral lineations in the area are difficult to distinguish due to overprinting by strongly developed, micaceous crenulation lineations. Elongation lineations due to stretched and deformed pyroclastic fragments and stretched mineral aggregates, are also rarely observed. Intersection lineations are common and typically consist of two intersecting, steeply dipping foliations, or two intersecting high-strain zones, which define a moderate to steep plunging lineation. Crenulation lineations are expressed as the hinges of microfolds on foliation planes. Such lineations are particularly well developed in phyllitic, chlorite-rich mafic metavolcanic rocks. On foliation planes within felsic metavolcanic rocks, crenulation lineations are defined by the hinges of poorly developed microfolds. Crenulation lineations are usually strongly developed and hence tend to obliterate intersection lineations between two subparallel foliations, and often make identification of mineral lineations difficult.

Figure 7 shows a schematic representation of the distribution of lineations in the study area. The most prevalent lineation observed, in the central part of the study area (i.e., the Southern Domain of Figure 12b), is a crenulation lineation that plunges shallowly to the east-northeast or west-southwest. Mineral lineations, in this central area, appear to be steeply plunging, however they are typically obscured by a strongly developed crenulation. Mineral lineations plunge moderately to steeply east in the eastern portion of the study area (i.e., the Eastern Domain of Figure 12b) and moderately to steeply west in the western portion of the study area (i.e., the Western Domain of Figure 12b). Mineral lineations plunge moderately to steeply, northwest to northeast within the northern portion of the study area (i.e., the Northern Domain of Figure 12b). Mineral lineations within the supracrustal rocks adjacent to the external granitoids plunge moderately to the west (i.e., the Contact Domain of Figure 12b).

Lineations in this domain are related to a young, relatively massive granodiorite phase (2686 ± 13 Ma, Turek *et al.* 1990) that has intruded between the older external tonalite gneisses (to the north) and the supracrustal rocks (to the south).

Folds

The Goudreau-Lochalsh district is located on the northern limb of the Centre Anticline (Goodwin 1962), a regional, doubly plunging fold (Figures 4 and 5). Along the north limb of the Centre Anticline the Goudreau Iron Range (i.e., Michipicoten iron formation), which separates Cycle 2 rocks from Cycle 3 rocks, is highly folded (Figure 6). East of the McVeigh Creek fault the sulphide-rich iron formation is tightly folded with highly attenuated limbs which have locally been sheared out leaving isolated fold noses (e.g., the "D" and "E" pyrite deposits, Figure 6; Sage, in prep.). S-, U- and M-shaped folds have been documented; however, S-shaped folds dominate the regional map pattern (Figures 3 and 6). These tight to close folds are accompanied by an axial planar cleavage that is parallel to the regional foliation trend. These megascopic folds appear to be related to the larger Centre Anticline (Sage, in prep.).

The plunge of minor folds in the western part of the Goudreau-Lochalsh area is shallow to moderate (up to 35°) to the west, similiar to the plunges measured for lineations. In the vinicity of the Morrison No. 1 Iron Range (Figure 6), the iron formation is folded into a tight, shallow to moderate northeast plunging Z-fold. Hammer (1988) documents both S- and Z-shaped minor folds within the felsic (to intermediate) lapilli tuff rocks that underlie the iron formation. The S-folds may be an earlier generation while the Z-folds are interpreted to be shear folds (Hammer 1988). Rare small-scale folds, in the eastern part of the study area, plunge shallowly to moderately to the east, similiar to the plunges measured for lineations. Overall there are few outcrop-scale folds in the Goudreau-Lochalsh area. The paucity of small-scale folds may be due to a lack of well layered rocks (e.g.'s, metasedimentary rocks, bedded tuffaceous rocks).

Kink Folds and Kink Bands

Kink folds are observed primarily in the northeastern part of the Goudreau-Lochalsh area. Kink bands and folds are commonly found in the vicinity of large northwest- and northeast-striking faults (e.g., Maskinonge Lake fault in the vicinity of the Breccia gold occurrence) that transect the area Only one conjugate kink fold or box fold was observed, the geometry of which suggests an east-west direction of shortening (Ramsay and Huber 1983). At any given locality, both left-lateral (i.e., S-shaped) and right-lateral (i.e., Z-shaped) monoclinal kink folds can be observed. The S-shaped kinks generally are better developed than the Z-shaped kinks (i.e., Z-kinks are more open). The azimuths of kink fold axial planes range between 130°-165° for S-shaped kinks and 015°-050° for Z-shaped kinks.

Deformation Intensity

The deformation intensity (synonymous with strain intensity) of the rocks within the Goudreau-Lochalsh area has been systematically recorded in the field, in order to better delineate regional zones of high-strain. Deformation intensity is a subjective measurement of "how deformed (or strained)" rocks are at any given outcrop. The measurement is qualitative, subjective and used in a relative manner. While different rock types may not respond equally to a given amount of stress, deformation intensity has been assessed independent of rock type since the lithological differences themselves (or heterogeneities in the mechanical properties of rocks and minerals) can induce inhomogeneous strain.

Volcanic (e.g., pyroclastic breccia and lapilli tuff fragments, pillows, varioles, amygdules, etc.), plutonic (e.g., intrusive rock texture) and sedimentary (e.g., bedding, conglomerate clasts) features serve as excellent strain markers. These types of strain markers were used to determine deformation intensity, but only after the primary (i.e., original) shape of the feature was established in areas of low strain (Photos 1a, 1b, 1c, 2a, 2b and 2c). Where obvious strain markers are absent (e.g., massive metavolcanic flow rocks), the intensity of deformation was assessed based on the strength of planar fabric development. Foliations, for example, were observed to be weakly developed in some areas and strongly developed in others.

The following criteria were used for determining the deformation intensity and pertain only to the study area (modified from Arias and Heather 1987).

Faint Deformation

Faint deformation is characterized by:

(a) a *possible* faint alignment of minerals,
(b) no S (flattening) or L (extension) fabrics,
(c) an almost pristine primary rock texture of the original protolith (Photos 1a and 2a).

Weak Deformation

Weak deformation is characterized by:

(a) a weakly developed, non-penetrative foliation,
(b) a weak flattening of strain markers (S greater than L),
(c) an original protolith that is easily identified and primary rock textures that are only weakly modified,
(d) a spatial association with zones of moderate to strong deformation.

Moderate Deformation

Moderate deformation is characterized by:

(a) a moderately developed cleavage or schistosity,
(b) some flattening and/or elongation of strain markers (S approximately equal to L),
(c) an original protolith that is recognizable and primary rock textures that are only partially modified (Photos 1b and 2b),
(d) a spatial association (i.e., adjacent) to zones of intense or strong deformation,
(e) sigmoidal foliations, shear fabrics and kinematic indicators are generally absent.

Strong Deformation

Strong deformation is characterized by:

(a) a strongly developed cleavage or schistosity,
(b) strong flattening and/or elongation of strain markers (L greater than or equal to S),
(c) the partial obliteration of primary rock textures, such that an identification of the original protolith may be difficult (Photos 1c and 2b),
(d) locally developed shear fabrics and kinematic indicators.

Intense Deformation

Intense deformation is characterized by:

(a) an intensely developed cleavage or schistosity,
(b) highly deformed and elongated strain markers (L much greater than S),
(c) the almost total obliteration of any primary rock textures such that any identification of the original protolith is extremely difficult (Photos 1c and 2c),
(d) confined to discrete, narrow zones on the order of millimetres to tens of metres in width that may contain sigmoidal foliations, shear fabrics and kinematic indicators.

Figure 8 is a schematic representation of the deformation intensity data for the Goudreau-Lochalsh area. Symbols are oriented parallel to the dominant foliation (e.g., schistosity, cleavage) in the rocks at that particular locality.

Deformation Style

In this report, the terms "brittle", "ductile" and "brittle-ductile" (Ramsay 1980) have been used to describe deformation style in various domains within the study area (cf. High-strain Zones and Deformation Zones). Deformation style, as used in this study, is a visually subjective method of characterizing the structural appearance of high-strain zones.

Brittle deformation, in the Goudreau-Lochalsh area, is defined by the presence of:

(a) high-strain zones (see definition in following section) or fractures which show abrupt offsets of external markers such as quartz veins (Figure 9),
(b) quartz veins or dikes that infill pre-existing fractures or faults, and
(c) lozenge- or diamond-shaped fracture patterns, produced by the intersection of two pervasive fracture cleavages,
(d) the lack of a good penetrative schistosity.

Ductile deformation is defined by the presence of:

(a) development of a penetrative schistosity,

(b) sigmoidal foliations oblique to planes of shear, or sigmoidally folded shear veins within the boundaries,
(c) continuous offset or disruption of external markers (Figure 9) such as quartz veins, fractures and other cleavages.

It is apparent that the term brittle-ductile is used rather loosely among geologists, and should not necessarily imply that brittle deformation dominates over ductile deformation. Brittle-ductile deformation in the Goudreau-Lochalsh area is defined by the presence of features characteristic of both brittle and ductile deformation, typically superimposed on one another (Ramsay 1980).

High-strain Zones

In this report, the term "high-strain zone" is defined as any zone within which the rocks are strongly to intensely deformed, regardless of the deformation mechanism (e.g., simple shear versus flattening). The deformation style of these high-strain zones has been characterized as brittle, brittle-ductile or ductile according to Ramsay (1980) and the criteria listed earlier (cf. Deformation Style). Within the study area, high-strain zones vary from millimetres to tens of metres in width and are up to several hundreds of metres in length. Individual high-strain zones are typically of limited strike extent and of variable width. Centimetre wide high-strain zones that widen rapidily along strike to over 10 m in width, have been documented (e.g., Kremzar gold mine; see Figure 18 in the Economic Geology Section and Figure 19, back pocket). For this reason, even the most unassuming looking millimetre- and centimetre-scale high-strain zones were systematically documented.

Where they were present, shear fabrics (S, C and C'; Lister and Snoke 1984, Roberts 1987) were used in conjunction with lineation data to determine senses of displacement on individual high-strain zones. Other kinematic indicators used include: (a) "horsetails" at millimetre to centimetre-scale terminations, (b) brittle to brittle-ductile offsets of quartz veins, dikes, or lithological contacts, and (c) sigmoidal-shaped (i.e., deformed) objects such as lapilli fragments or pillow forms.

Regionally, the high-strain zones exhibit a systematic orientation pattern, similar to that of the fractures. Figure 10 illustrates the regional distribution and orientation of high-strain zones along with senses of displacement where determined. High-strain zones oriented parallel, or at low angles, to the regional foliation trend (less than 25°) generally exhibit a dextral, oblique-slip sense of displacement. High-strain zones oriented at a high angle to the regional foliation exhibit either dextral or sinistral, oblique-slip senses of displacement.

Fracture Cleavages, Fractures and Joints

Spaced fracture cleavages, fractures and joints are well developed in many of the rocks in the Goudreau-Lochalsh area, especially in the more competent rocks, such as felsic pyroclastic rocks, quartz-feldspar porphyry intrusive rocks and mafic metaintrusive rocks. Schematically illustrated in Figure 10 are the dominant fracture cleavage orientations, as well as high-strain zone orientations for the Goudreau-Lochalsh area. The number of measured fracture cleavages on this map is by no means representative of the overall *fracture* distribution within the area. Unfortunately, a systematic record of all observed fractures is unavailable. Qualitatively the density of fractures is greatest within each of the two regional deformation zones (i.e., the GLDZ and CLDZ) and decreases with distance away from these zones.

Locally, it is clear that some of the fractures are parallel to schistosities, cleavages, kink fold axial planes and local high-strain zones (Figures 7, 8 and 10). Quartz veins and quartz-feldspar porphyry dikes are typically fracture controlled. The fracture cleavages (Figure 10) and fractures (not all shown) exhibit various orientations, however they appear to cluster into six distinct groups:

a) 015°-035°	(fractures, rarely a spaced fracture cleavage, also kink fold axial planes)
b) 050°-075°	
c) 085°-095°	
d) 105°-120°	
e) 135°-150°	(fractures, rarely a spaced fracture cleavage, also kink fold axial planes)
f) 165°-180°	(fractures only, rarely a kink fold axial plane)

The orientation of the fracture cleavage or cleavage vary depending on rock type and the orientation of the regional schistosity. In all cases, the fracture cleavage is secondary to an earlier foliation. Usually two or three fracture cleavages and/or fractures are observed at any one outcrop. Where two dominant spaced fracture cleavages occur in outcrop together, one is oriented 5°-20° clockwise to the foliation and the other 5°-20° anticlockwise to foliation. This imparts a diamond-shaped or losenge-shaped fracture pattern to the rock. Relative crosscutting relationships between fracture cleavages/fractures are difficult to discern and offset of passive markers (e.g., quartz veins, dikes, etc.) is rarely observed.

In addition to fracture cleavages and fractures there are well developed joints that appear to be a relatively late structural feature. There are two prominent joint orientations recognized within the Goudreau-Lochalsh area: a northwest-striking (~340°) set and a northeast-striking (~035°) set. These joint sets are parallel to the orientation of the major diabase dikes and regional transverse faults in the area.

Deformation Zones

The systematic collection of regional deformation intensity data (Figure 8) and the locations of discrete high-strain zones (Figure 10) were used in conjunction to subjectively define the location and extent of two regionally extensive zones of deformation referred to as the Goudreau Lake Deformation Zone (GLDZ) and the Cradle Lakes Deformation Zone (CLDZ) (Figures 11a,11b and 11c).

These deformation zones are a composite of deformational features and are not nessarily the result of a single tectonic event. Figure 8 shows that outside of these deformation zones, the regional strain state, as preserved in the rocks, is relatively weak. However, it is important to emphasize that the deformation intensity varies widely within the zones of deformation themselves, as depicted in Figure 8. Therefore, a deformation zone can be described as:

> "an area or corridor within which there is a greater density of discrete high-strain zones and the rocks collectively exhibit a higher degree of deformation than rocks outside the zone. This is not to say that rocks exhibiting little or no deformation can not occur within that zone or that discrete high-strain zones can not occur outside that zone." (modified from Arias and Heather 1987; Heather and Buck 1988).

Goudreau Lake Deformation Zone (GLDZ)

The GLDZ is up to 4.5 km in width and strikes in a gentle sigmoid-form (from 090° in the west through 070° to about 095° in the east) for at least 30 km, subparallel to the stratigraphy and the regional foliation (Figures 3 and 11). In the immediate Goudreau-Lochalsh area the GLDZ is coincident with a major contact between Cycle 2 (2729 ± 3 Ma, Turek *et al.* 1988) felsic to intermediate pyroclastic metavolcanic rocks to the south and Cycle 3 (2700 Ma) massive and pillowed mafic metavolcanic rocks to the north (Figure 3). West of the McVeigh Creek fault this major lithological boundary curves southward with the GLDZ being located to north of it within Cycle 3 mafic metavolcanic rocks (Figure 3). To the east of the Goudreau-Lochalsh area the GLDZ is located within the mafic metavolcanic rocks to the north of the major litholgical boundary (Figure 3).

The GLDZ has been subdivided into four structural domains (i.e., southern, northern, eastern, and western; Figure 12) based on differences in (a) deformation style (Figure 12a), (b) lineation patterns (Figure 12b) and (c) the orientation of high-strain zones and fractures (Figure 12c). These domains are defined only to highlight the contrast in character within a single regional deformation zone. Recognition of these differences has important implications for exploration and will be addressed later in this report. These domains are described below in terms of their (a) extent, (b) style and intensity of deformation, (c) high-strain zone geometry and kinematics, and (d) regional alteration and mineralization patterns.

Southern Domain

The southern domain is composed of an 070°-striking, ductile-brittle zone of subparallel, dextral oblique-slip high-strain zones developed within strongly altered and deformed, felsic to intermediate metavolcanic rocks. The southern domain is approximately 8 km long by 2 km wide and occupies the south-central portion of the GLDZ (Figure 12). To the east, the possible extension of southern domain is covered by thick glacial overburden and hence there is little bedrock exposure. Whether the domain: (a) continues eastward, (b) pinches-out, or (c) is offset sinistrally along the Maskinonge Lake fault is not known (Figure 12). The "Goudreau Shear" is the dominant structural feature of the southern domain and hosts the Magino Mine, the Lochalsh Zone and the Island Zone (Figures 3 and 13a,b). Striations and crenulation lineations are horizontal to subhorizontal with local steeply plunging mineral lineations.

Northern Domain

The northern domain of the GLDZ is about 1 km wide and has been traced along strike for 4 km (Figure 12). This domain is located immediately south of the Maskinonge Lake stock and is composed of brittle to brittle-ductile high-strain zones oriented at high angles to the 070°-striking regional foliation (i.e., schistosity). These narrow brittle to ductile high-strain zones are up to tens of metres wide and may contain concordant quartz veins, and millimetre- to centimetre-scale brittle shears or fractures. The northeast-striking (030°) high-strain zones display sinistral, oblique-slip displacement, while the northwest-striking (140°) shears display dextral, oblique-slip displacement. Mineral lineations within the high-strain zones plunge moderately to steeply to the north-northwest in this domain, while lineations formed by the intersection of shear fabrics plunge slightly steeper to the northwest. High-strain zones, displaying dextral kinematic indicators, also occur at low angles to the regional foliation, but are weakly developed.

Mafic metavolcanic rocks immediately south of the Maskinonge Lake stock are strongly to intensely deformed. The southeastern portion of the Maskinonge Lake stock is characterized by weak mineral foliations and millimetre- to centimetre-scale, northeast-striking high-strain zones. The northern domain hosts the 120° to 140°-striking high-strain zone that hosts the Kremzar Mine (Figures 3, 13a,b, 16 and 18). Other occurrences in the northern domain of the GLDZ include: the No. 2, the No. 3, the No. 8, and the Rusty Zone (Figures 16 and).

Eastern Domain

The eastern domain of the GLDZ is 9 km long and 2 km wide and contains narrow, 085°- and 115°-striking brittle and brittle-ductile high-strain zones displaying dextral, oblique-slip displacement. Mineral lineations in the Cline Lake area have a consistent shallow plunge to the east, and become moderately to steeply (45°-70°) east plunging in the Godin Lake area (Figures 7 and 12b). Within the eastern domain, high-strain zones (as well as laminated quartz-tourmaline and/or quartz-Fe-carbonate veins, fractures, and felsic porphyry dikes) are dominantly parallel or at low angles (10°-25°) to the east-striking (090°-095°) regional foliation.

Brittle high-strain zones are characterized by distinct lozenge- or diamond-shaped fracture patterns best observed in quartz-feldspar porphyry dikes and sills. Brittle-ductile deformation is expressed as millimetre-scale high-strain zones (i.e., slip surfaces) along which discontinuous offset of centimetre-scale quartz vein is observed. Ductile high-strain zones displaying sigmoidal fabrics occur at contacts between felsic porphyry dikes and mafic metavolcanic rocks. In contrast to the strong deformation that affected the rocks of the southern domain, the eastern domain of the GLDZ is characterized by narrow zones (millimetre- to centimetre-scale) of intense strain immediately adjacent to rocks of weak to moderate deformation intensity.

The eastern domain of the GLDZ hosts several gold occurrences, namely: the Cline Lake gold mine, the Markes gold occurrence, the Edwards gold mine and others (Figures 3 and 13a,b).

Western Domain

The western domain of the GLDZ has been studied in less detail than the aforementioned domains. Preliminary work indicates that this domain is very similar to the eastern domain in terms of high-strain zone orientations and deformation style. The western domain is composed of 085°- and 115°-striking brittle and brittle-ductile high-strain zones displaying dextral oblique-slip displacement. Lineations plunge moderately to steeply to the west. The Murphy gold mine is located within the western domain (Figure 13a,b).

Cradle Lakes Deformation Zone (CLDZ)

The CLDZ is not as well delineated or characterized as the GLDZ. The CLDZ has been documented to be at least 5 km in length and roughly 1 to 2 km in width, but may be upwards of tens of kilometres in total length. The CLDZ is subparallel to stratigraphy and occurs largely within feldspar-crystal tuffs, which in many places are difficult to distinguish from the Cradle Lakes stock, a feldspar porphyry intrusion adjacent to and partially within the CLDZ.

The CLDZ contains a large, east-striking high-strain zone that is up to 40 m wide and has been traced for several hundred metres along strike. Rocks within this high-strain zone are fissile and kinematic indicators are difficult to find. The orientations of other high-strain zones observed are parallel, or at low angles (up to 20°), to stratigraphy and the regional foliation, similar to high-strain zone orientations described for the southern, eastern, and western domains of the Goudreau Lake Deformation Zone.

While the Cradle Lakes Deformation Zone (CLDZ) is characterized by a different style of deformation than that of the Goudreau Lake Deformation Zone (GLDZ), it bears many similarities to the GLDZ:

(a) The CLDZ occurs close to a major contact between Cycle 2 felsic metavolcanic rocks to the north and Cycle 3 mafic metavolcanic and metaintrusive rocks to the south (Figure 3),

(b) There is strong alteration, generally confined to the zones of high-strain, largely in the form of Fe-carbonatization and sericitization.
(c) The proximity of the Cradle Lakes porphyry stock to the CLDZ can be compared to the presence of the Gutcher Lake stock, the Webb Lake stock, and the Cline Lake felsic dike complex within the GLDZ (Figure 3).

The Contact Deformation Domain

Reconnaissance mapping within the granitoid rocks north of the northern margin of the Michipicoten greenstone belt, between Highway 17 and the eastern boundary of Jacobson Township (Figures 2 and 3) was also completed during the summer of 1987. On a preliminary basis, it is interpreted that a linear, granodiorite body intruded along the east-striking contact between the supracrustal rocks to the south and the deformed tonalite-granodiorite terrain to the north. The contact of this body with the older tonalitic rocks has not been mapped, and most of the available data pertains to the rocks adjacent to the greenstone belt.

Portions of the granodiorite body are massive to weakly foliated, while towards the margin of the greenstone belt it becomes strongly to intensely foliated. Foliations are defined by quartz ribbons (or quartz and quartz-feldspar crystal aggregates), or by alignment of hornblende or biotite crystals. The amphibolite grade supracrustal rocks at the margin of the greenstone belt are also strongly to intensely foliated. Flattening and stretching of sedimentary clasts in polymictic conglomerates, or of pillows in the mafic metavolcanic flows, is strong to intense.

Within the tonalite terrain north of the granodiorite body, lineations measured on the plane of the dominant east-striking foliation plunge moderately towards the east (Figures 7 and 12b). Lineations within the granodiorite body, defined by quartz or feldspar crystal aggregates, acicular hornblende, or biotite crystal clusters, plunge moderately to the west. Similarly, most lineations measured along the northernmost margin of the belt, within the supracrustal rocks, plunge moderately to the west (Figures 7 and 12b). From the limited data available, it is interpreted that the intrusion of the granodiorite body imposed a narrow contact strain aureole upon the supracrustal rocks along the northern margin of the greenstone belt, and may also have imparted a narrow amphibolite grade contact metamorphic aureole on those same rocks.

ECONOMIC GEOLOGY

INTRODUCTION

The Wawa gold camp consists of four distinct gold-bearing districts which are from west to east: the **Mishibishu Lake, Michipicoten, Goudreau-Lochalsh,** and **Missanabie-Renabie districts** (Figure 2). Gold mineralization in the **Goudreau-Lochalsh district** (Figures 2, 3 and 13a,b) is localized within the Goudreau Lake Deformation Zone (*GLDZ*) and the Cradle Lakes Deformation Zone (*CLDZ*) (Arias and Heather 1987; Heather and Arias 1987). The majority of the known gold occurrences are located within the *GLDZ*, a 4 km wide by 30 km long, east-northeast-trending arcuate zone coincident with a contact between mafic and felsic metavolcanic rocks. Additional gold occurrences are located within the subparallel *CLDZ* located 4 km south of the *GLDZ* broadly coincident with another felsic metavolcanic-mafic metavolcanic contact.

The majority of the gold occurrences within the Goudreau-Lochalsh district were examined during the current study (Tables 1 and 2). The surface exposures in the immediate area of past and presently producing mines, as well as other mechanically stripped outcrops were examined in greater detail. Only those occurrences that were visited are described here (Table 2). Sage (in prep.) provides a detailed discussion of the exploration history and property desriptions.

DETAILED DESCRIPTIONS OF GOLD DEPOSITS AND OCCURRENCES

Murphy Mine (1)

The Murphy gold mine is located 6 km southwest of Goudreau in central Abotassaway Township (Figures 3 and 13a,b). The mine has had several names; Goudreau Gold Mine (Gledhill 1927; Moore 1931), Algold Gold Mine (Keeler 1940; Bruce 1942), and Amherst Gold Mine (Bruce 1942), since gold was discovered at the site by Thomas Murphy in 1921 (Burrows 1921a, 1921b). The mine produced a total of 2,450 ounces of gold and 351 ounces of silver from 23,211 tons of ore for an average grade of 0.11 ounces of Au per ton (Unpublished Reports, Assessment Files Research Office, Ontario Geological Survey, Toronto) over the entire mine life. Gledhill (1927), Moore (1931), Keeler (1940), Bruce (1942) and Studemeister (1982, 1983, 1985a, 1985b) provide good descriptions of the general geology, mineralization and alteration found at the Murphy Mine, however structural data are lacking. The underground workings are presently (1987) flooded and much of the surface trenching sloughed-in and obscured by heavy vegetation.

General Geology

Massive, pillowed, and schistose mafic metavolcanic rocks, and quartz-feldspar porphyry dikes host the main quartz ± carbonate vein system. The vein system crosscuts both the mafic metavolcanic and felsic dike rocks; however, the vein is localized along the contact between these two rock types for much of its strike extent (Figure 14). The mafic metavolcanic rocks and the quartz-feldspar porphyry dikes are strongly deformed (i.e., schistose) in the vicinity of the vein system. The felsic porphyry dikes are apophyses of the Gutcher Lake stock (Gledhill 1927; Moore 1931; Bruce 1942) located immediately west of the Murphy gold mine (Figure 3). Locally, the felsic dikes have incorporated xenoliths of mafic metavolcanic rock and oxide facies ironstone. A large northwest-striking diabase dike crosscuts the vein system immediately east of the main No.1 shaft (Figure 14).

Alteration

Intense Fe-carbonate alteration is characteristic of both the mafic metavolcanic rocks and felsic porphyry dikes found adjacent to the Murphy vein system. The Fe-carbonate alteration, localized in highly strained mafic metavolcanic rocks, decreases rapidly away from the main vein system to a chlorite ± calcite assemblage in the peripheral, less deformed rocks. Pyrrhotite, pyrite and trace chalcopyrite are associated with the Fe-carbonate wall rock alteration. The felsic dike rocks are strongly sericitized and typically have a fissile weathering character.

Mineralization

The main vein system has a strike length in excess of 500 m (>2,000 feet) and a width of up to 3 m (10 feet) (Bruce 1942; Studemeister 1982). The vein system has a variable strike from 090° to 115° and dips 70° to 80° to the south (Bruce 1942). The vein system consists of quartz and Fe-carbonate with minor pyrite, chalcopyrite and pyrrhotite. Traces of sphalerite, chlorite, muscovite, albite, tourmaline, galena, and arsenopyrite have also been reported (Studemeister 1982). The vein system is a composite made up of a massive quartz-(Fe-carbonate) portion and a Fe-carbonate-rich portion containing angular, brecciated fragments of quartz and quartz-(Fe-carbonate) vein material, sericitized porphyry dike and chloritized mafic metavolcanic wall rock material (Photo 3). The massive quartz vein assayed 0.17 ounces of Au per ton, while the Fe-carbonate-rich vein adjacent to it only assayed 480 ppb Au (Table 4). Immediately adjacent to the main vein system the felsic porphyry dike and mafic metavolcanic wall rocks commonly exhibit a stockwork of quartz-(Fe-carbonate) veins. In the vicinity of the Murphy No. 3 open pit (i.e., Westernmost Pit; Figure 14), late 010°-striking quartz veinlets crosscut both the main quartz-ankerite vein system and the mafic metavolcanic wall rocks to the north. These late veins assayed low in Au.

Structure

The Murphy vein system is hosted within a brittle-ductile high-strain zone which strikes from 085° to 115° and dips 80° to 90° to the southwest. Numerous other brittle-ductile high-strain zones, ranging in width from 1 cm up to 5 m, exist on the Murphy Mine property. Following is a list of the most common high-strain zone orientations found in the vicinity of the Murphy Mine, their structural style, and the apparent sense of horizontal displacement documented along each:

(a) 080°-085°, ductile, dextral (oblique-slip).
(b) 110°-115°, ductile, dextral (oblique-slip).
(c) 045°-065°, ductile, (?).
(d) 025°-030°, brittle, sinistral.
(e) 000°-010°, brittle, none.

Past workers (Gledhill 1927; Bruce 1942) have shown the Murphy vein system to have a variable strike between 085° and 115° which was attributed to local irregularities. However, the vein system may be localized within a series of *systematic* 085°- (group a above) and 115°- (group b above) striking high-strain zones. Inadequate surface exposures of the vein system precludes verification of this hypothesis. There is also insufficient assay data available to determine if one of the vein orientations is better mineralized then the other. In the immediate mine area, mineral and elongation lineations consistently plunge moderately to steeply (i.e., 40° to 70°) towards the west.

Magino Mine (2)

The Magino gold mine is located 6.5 km northeast of Goudreau on the north shore of Webb Lake in south-central Finan Township (Figures 3, 13a,b and 17). D.J. McCarthy and W.H. Webb discovered gold here in 1917 and staked 7 patented claims (#2048, #2049, #2050, #2051, #2052, #2053, and #2102) that cover the present mine site. The mine has been known by several names; McCarthy-Webb Gold Mines (Burrows 1921a, 1921b; Gledhill 1927), McCarthy-Webb Goudreau Gold Mines

(Moore 1931), Algoma Summit Gold Mines (Burwash 1935), and Magino Gold Mines (Bruce 1942). The Magino Mine produced 8,776 ounces of gold and 856 ounces of silver from 116,627 tons of ore, between 1934 and 1939 (Unpublished Reports, Assessment Files Research Office, Ontario Geological Survey, Toronto), for an average grade of 0.08 ounces of Au per ton. Presently operated by Muscocho Explorations Limited and McNellen Resources Limited, the Magino Mine was re-opened in 1986 at a production rate of ~650 tons per day. Current reserves in both the proven and probable categories are 1,240,000 tons at an average grade of 0.16 ounces of Au per ton (Staff, Wawa Resident Geologist Office, personal communication, 1991).

Geological and historical accounts of this mine can be found in Burrows (1921a, 1921b), MacLeod (1923), MacLeod and Cowie (1926), Gledhill (1927), Moore (1931), Burwash (1935), and Bruce (1942). The current study documents the regional setting of the Magino Mine and briefly describes some of detailed structural controls on the gold mineralization.

General Geology

The Magino Mine is hosted by the Webb Lake stock, an elliptical felsic intrusion measuring 1200 m long by 300 m wide (Figures 3 and 15a). Compositionally the stock has been called a quartz porphyry (Burrows 1921a, 1921b), a quartz-feldspar porphyry (MacLeod 1923; Macleod and Cowie 1926), a quartz diorite (Gledhill 1927), a granite-monzonite porphyry (Moore 1931; Burwash 1935), a granodiorite (Bruce 1942; Muscocho Explorations Limited Staff, personal communications, 1987) and a trondhjemite (Sage 1985). The intrusion has undergone intense deformation and metasomatic alteration such that any classification of the primary composition is suspect. The stock is surrounded by intermediate to mafic metavolcanic rocks (Figure 15a) which are locally cut by gold-bearing quartz veins.

Alteration

The Webb Lake stock has undergone variable metasomatic alteration during deformation and gold mineralization. Distinct haloes of sericite-quartz-(Fe-carbonate)-pyrite-hematite alteration are found adjacent to the quartz vein systems (Photo 4; Figure 15b). Outside the gold-bearing zones the alteration within the stock is manifested by chlorite-albite-quartz-tourmaline-calcite. Locally within the stock there are lensoidal chlorite-schist zones which represent either strongly foliated mafic metavolcanic xenoliths, or chlorite-altered felsic intrusion. The former seems more likely considering the discrete contact relationship between these chlorite-rich zones and the sericite-rich intrusive rocks, and their similarity to schistose mafic metavolcanic rocks immediately adjacent to the stock. One of the larger chlorite-schist zones hosts significant gold mineralization (S. Markell, Geologist, personal communication, 1987).

Mineralization

Gold mineralization occurs in several subparallel, 070°- to 080°-striking high-strain zones within the Webb Lake stock and within mafic metavolcanic rocks immediately along the northern margin of the stock. To-date no significant, continuous mineralization has been found along the southern margin of the Webb Lake stock (S. Markell, Geologist, Magino gold mine, personal communication, 1987). Native gold occurs in zones of pervasive silicification and in narrow (i.e., < 1 cm to 20 cm wide) quartz veins that form complex vein-systems 1 to 3 m in width (Figure 15b; Photos 4 and 5). Gold occurs within both the quartz veins and the foliated and altered wall rocks; however, the better gold grades are in the veins (T. Deevey, Mine Geologist, Magino gold mine, personal communication, 1987). Disseminated pyrite present in amounts up to several percent (i.e., 10%), is commonly found in the alteration haloes about the gold-bearing quartz veins.

Structure

There is a strong structural control of the gold-bearing quartz vein systems within each of the 070°-075°-striking high-strain zones. There are several, parallel 070°-075°-striking high-strain zones within the Webb Lake stock (Figure 15a). These zones are also parallel to the regional, 070°-striking schistosity in this area (Figures 7 and 15a). Individual quartz veins are localized within narrow, secondary, brittle-ductile shear-fractures (Figure 15b; Photos 4 and 5) with the following orientations and apparent senses of horizontal displacement documented along each:

(a) 080°-090° / 65°N, ductile, dextral (oblique-slip).
(b) 045°-055° / 70°N, ductile, (?).

A strongly developed foliation defined by elongated feldspars and sericite grains can be seen to wrap asymptotically into the narrow shear-fractures (Photo 6). These shear-fractures appear to splay off each other with the 085°-set being dominant (Figure 15b). On surface outcrops there are no obvious crosscutting relationships between these two sets of shear-fractures suggesting they developed synchronously. However, underground the 055°-set is reported to be part of a conjugate set of faults that are post-ore in age (T. Deevey, Mine Geologist, Magino gold mine, personal communication, 1991). Locally, the veins are better developed within the 085°-striking set of fractures than in the 055°-striking set (Figure 15b).

Underground at the Magino Mine, raise-mining on a single vein structure has shown that in a vertical distance of roughly 15 m the vein rolls from a dip of 80° to 60° and back to 80° (T. Deevey, Mine Geologist, Magino gold mine, personal communication, 1987). The best gold grades are found at the intersections of between shear-fracture-hosted quartz veins of different orienations (T. Deevey, Mine Geologist, Magino gold mine, personal communication, 1987). The Magino orebody plunges near-vertically, parallel to measured elongation lineations defined by stretched feldspar crystals.

The brittle-ductile shear-fractures and associated veins are consistently offset, by a few centimetres, along brittle fractures (Figure 15b; Photo 7) with the following orientations and apparent senses of horizontal displacement:

(c) 190° (010°) / 85°W, brittle, sinistral.
(d) 310° (130°) / 67°N, brittle, dextral.

Outside the ductile high-strain zones the Webb Lake stock is brittley deformed (Photo 8) with the following fracture orientations forming a regular pattern:

(e) 105° / 75°
(f) 035° / 74°
(g) 000° / 77°
(h) 065° / 55°

Fracture set (f) sinistrally offsets (e), while sets (g) and (h) are late with no offset relationships observed.

Late, north-striking tourmaline-quartz veins cut both the Webb Lake stock and the aforementioned gold-bearing quartz vein systems (Photo 9). Locally, within the Webb Lake stock, there are zones of intense tourmaline-quartz fracture-filling, flooding and brecciation (Photos 9 and 10), especially in the vicinity of the old glory hole (Figure 15a). This late tourmaline-quartz mineralization utilizes the network of pre-existing fractures in the rock (Photos 8 and 10). These late tourmaline-quartz fracture-fillings and veins can contain anomalous gold values, especially where they cut an earlier gold-bearing quartz vein (Photo 9).

Island and Lochalsh Zones (3)

The Island and Lochalsh Zones are located immediately east of the Magino gold mine beneath Goudreau Lake and Pine Lake (Figures 3, 13a,b and 17). Discovered in 1987 by Canamax Resources Incorporated, the Island and Lochalsh Zones appear to be the on-strike extention of a style of mineralization and alteration similar to that at the Magino Mine. Both zones are hosted by Cycle 2 felsic metavolcanic rocks, dominantly crystal metatuffs, and felsic dike rocks that are similar in composition and texture to the Webb Lake stock. Both the felsic metatuffs and the felsic dikes are strongly deformed and sericite-(Fe-carbonate) altered. This mineralization does not crop out at surface, thereby negating detailed structural mapping during the current study.

No. 3 Zone (4)

The No. 3 Zone is located in Finan Township approximately 1.2 km north of the Magino Mine (Figures 3, 13a,b and 16). The main portion of this 030°-striking zone occurs on Canamax Resources Incorporated's property while the southern portion occurs on Muscocho Explorations Limited's property.

Geology

Massive and pillowed mafic metavolcanic rocks and medium-grained mafic metaintrusive rocks occur in the vicinity of the No. 3 Zone. Burwash (1935) describes a 030°-striking, grey coloured, quartz porphyry dike that forms one of the walls to, and locally hosts, the gold-bearing vein system. This dike was not observed during the current study due to heavy vegetation cover over the old trenches. A large diabase dike crosscuts the vein system (Burwash 1935).

Alteration and Mineralization

The mafic metavolcanic and metaintrusive rocks near the gold-bearing zone are hydrothermally altered to a biotite ± calcite ± chlorite ± pyrite ± pyrrhotite ± Fe-carbonate assemblage. In the immediate vicinity of the gold-bearing zone there is an increase in quartz veining and pervasive wall rock silicification.

Gold mineralization occurs in a quartz vein that is localized along the contact between a felsic porphyry dike and mafic metavolcanic rocks. Locally, the mineralization is hosted by a quartz vein stockwork within the felsic porphyry dike

(Burwash 1935). MacGregor (1981) estimated the No. 3 zone to have a strike length of 600 feet (180 m) and a width of 7 feet (2 m).

Structure

The No. 3 Zone occurs within a 025°- to 035°-striking, 70° north-dipping, ductile high-strain zone. Steeply north-plunging mineral lineations (i.e., 50° to 70°) used in conjunction with S-C fabrics indicate a sinistral, oblique-slip sense of displacement. The sinistral displacement is consistent with the progressive rotation of the long-axes of elongated pillows from a 070° orientation 100 m east of the zone, through a 055° orientation 50 m east of the zone, to a 035° orientation adjacent to the zone. Within the brittle-ductile high-strain zone the stretched pillows are completely obliterated (Photo 1c). A strong brittle, to locally brittle-ductile, fracture pattern is present in the relatively undeformed (i.e., no ductile deformation) mafic metaintrusive rocks that flank the high-strain zone (Photo 11). Several fracture orientations were observed at the No. 3 Zone:

(a) 030°-035°, brittle-ductile, early(?), dominant.
(b) 105°-110°, brittle, offsets (a) dextrally.
(c) 150°, brittle, dextral.
(d) 070°-075°, brittle-ductile, offsets (a) and (b) dextrally.
(e) 000°, brittle, late.

Senses of displacement along individual fractures are given as the apparent horizontal component of the dispalcement.

<u>No. 2 Zone</u> (5)

The No. 2 Zone is located in southeastern Finan Township 600 m west of the Kremzar gold mine (Figures 3, 13a,b and 16). The zone has been mechanically stripped, sampled and diamond drilled by several companies since its discovery in the late 1920's. Poor bedrock exposure precluded any detailed geological mapping of this occurrence.

Geology

The No. 2 Zone is hosted by massive, mafic metavolcanic and coarse-grained, mafic metaintrusive rocks which become strongly schistose in the vicinity of the mineralization. Moore (1931) describes the host rocks as biotite-epidote-carbonate altered mafic metavolcanics on the east side of the vein, and as carbonatized and highly silicified "acid" rock with partially altered and replaced feldspars on the west side. The "acid" rock is likely a highly deformed and altered feldspar ± quartz porphyry dike, however poor exposure precluded its identification in the field during the current survey.

Alteration and Mineralization

The vein system has a 1 to 2 m wide halo of strongly biotitized, schistose mafic metavolcanic rocks with pyrrhotite, chlorite, and calcite. This grades outward into chlorite-calcite schists and then into relatively undeformed and unaltered mafic metavolcanic rocks. Mineralization consists of a quartz vein system containing pyrrhotite, pyrite, and chalcopyrite. The vein has a pinkish-grey colour on the weathered surface possibly due to to the high biotite content. The 035°-striking, 70°-northwest-dipping vein system can be traced for a minimum of 40 m along strike (MacGregor 1981). A grab sample of the main quartz vein assayed 0.21 ounces of Au per ton (Table 4).

Structure

The gold-bearing vein system is localized within a 030°-striking, ductile high-strain zone. Mineral lineations were difficult to recognize, however they appear to plunge steeply to the north, roughly orthogonal to a well developed, shallowly southwest-plunging chlorite crenulation lineation (cf. crinkle lineation). Poorly developed kinematic indicators suggest a sinistral, oblique-slip sense of displacement within the No. 2 Zone high-strain zone. Brittle fractures sets at (a) 120° / 83° and (b) 000° / 90° cut the 220° / 75° schistosity. Fracture set (b) is commonly infilled with hairline veinlets of calcite ± quartz. A brittlely deformed mafic metaintrusive rock, located approximately 40 m east of the No. 2 high-strain zone, exhibits two strongly developed fracture sets at (c) 250° / 75° and (d) 328° / 70°.

No. 8 Zone (6)

The No. 8 Zone is located in southeastern Finan Township south of the Kremzar Mine site (Figures 3, 13a,b and 16). Found in the early 1920's, this zone of mineralization was recently drilled by Canamax Resources Incorporated during which 100,000 tons of mineralization grading 0.20 ounces of Au per ton (Northern Miner, April 25, 1985, p. 1) were outlined.

Geology, Alteration, and Mineralization

Host rocks include strongly deformed mafic metaintrusive rocks, pillowed mafic metavolcanic rocks, and quartz-feldspar porphyry dikes. The mafic rocks are altered to Fe-carbonate, biotite, chlorite, calcite, pyrite and pyrrhotite. The felsic rocks are altered to Fe-carbonate, sericite, quartz and pyrite. Gold mineralization is hosted by quartz veins which occur in all of the host rocks above, but are preferentially localized at the sheared contacts between the felsic porphyry dikes and the mafic metavolcanic and metaintrusive rocks.

Structure

The No. 8 Zone is localized within a 080°-085°-striking high-strain zone which exhibits S-C fabrics that indicate a horizontal component of dextral displacement. The dominant foliation in the rocks surrounding the No. 8 Zone is oriented between 045° and 055° with an 80° north-dip. Brittle, brittle-ductile and ductile fractures are found in the immediate vicinity of the No. 8 Zone; the intensity of fracture development is intense, strong, moderate, or weak:

(a) 080°-085° / 60° S, ductile, dextral, intense.
(b) 035° / 60° S, brittle-ductile, strong.
(c) 110° / 70° S, brittle, weak.
(d) 005° / 90°, brittle, strong.

Rusty Zone (7)

The Rusty Zone is located approximately midway between the No. 8 Zone and the Kremzar Mine (Figures 3, 13a,b and 16). Canamax Resources Incorporated completed bedrock stripping at this occurrence followed by a channel sampling program that yielded erratic gold assay results (G. Yule, Geologist, Canamax Resources Incorporated, Timmins, personal communication, 1987).

Geology, Alteration, and Mineralization

The Rusty Zone is hosted by a strongly deformed and altered mafic metaintrusive rocks. In the less deformed areas the metaintrusive has a fine- to coarse-grained, gabbroic texture of intergrown amphibole and plagioclase. In the less deformed areas, the metaintrusive rocks contain several percent disseminated, euhedral magnetite crystals. In strongly deformed and altered areas disseminated pyrrhotite predominates. The metaintrusive rocks are altered to a biotite-chlorite-(Fe-carbonate) pyrrhotite schist in the vicinity of the mineralized zone.

Structure

Several orientations of narrow, ductile high-strain zones occur at the Rusty Zone (Photo 12). Following is a list of these high-strain zone orientations, the intensity of their development, and the apparent displacement (i.e., horizontal component only) along them:

(a) 060°, moderate, sinistral (?).
(b) 140°, strong, dextral.
(c) 080°, weak, dextral.
(d) 030°-035°, strong, sinistral.
(e) 115°, weak, dextral.

Outside of the ductile high-strain zones are brittley fractured, relatively undeformed mafic metaintrusive rocks. The brittle fracture orientations are very similar to the ductile shear zone orientations above. The following brittle fracture orientations are listed from youngest (1) to oldest (5) based on crosscutting relationships:

(1) 060° / 75° S, sinistral.
(2) 140° / 50° N, dextral.
(3) 350° / 90°, dextral.
(4) 080° / 40° N, dextral.
(5) 025°-035° / 65° S, sinistral (?).

There are pronounced glacial scour marks striking 035° on the bedrock at the Rusty Zone.

Kremzar Mine (8)

The Kremzar Mine, or the New Vein Zone as it is locally known, is located in Finan Township, 9 km northeast of Goudreau and immediately west of Maskinonge Lake (Figures 3, 13a,b, 16 and 17). The New Vein was discovered in the 1940's during the last major exploration boom in the area prior to the present activity (Sage in prep.). Canamax Resources Incorporated outlined reserves of 1.1 million tons grading 0.235 ounces of Au per ton at the Kremzar gold mine (Northern Miner Press, September 1, 1986). Production began in October 4, 1988 and ended in September of 1990 after which time the mine was flooded and put on a care-and-maintenance basis.

A large area of mechanically stripped bedrock, 100 m by 60 m referred to as the heritage outcrop, was mapped at 1:100 scale during the summer of 1987 (Figures 17 and 18; Figure 19, back pocket). Features referred to in the following text (denoted as "FEATURE") are keyed to Figure 18.

Geology

The Kremzar deposit is hosted by intensely deformed and altered mafic rocks (FEATURE A, Figure 18; Photo 13), which have been interpreted to be either, metavolcanic flow rocks (G. Yule, Geologist, Canamax Resources Incorporated, Timmins, personal communication, 1987), or metaintrusive rocks (R.P. Sage, Geologist, Ontario Geological Survey, Toronto, personal communication, 1987). Relatively undeformed mafic rocks, as seen at the heritage outcrop (FEATURE B, Figure 18; Photo 14), lack any internal features suggestive of an extrusive origin (e.g., pillows, flow tops, variolites, etc.). However, they are texturally similar to mafic meta-diorite and meta-quartz diorite intrusions seen elsewhere in the Goudreau-Lochalsh area (e.g., at the Cline Lake Mine). An intrusive origin for the mafic rocks at the Kremzar heritage outcrop is further supported by the presence of 5 to 20 cm sized, clot-shaped areas of coarser-grained amphibole and plagioclase crystals (FEATURE C, Figure 18; Photo 15). An irregular-shaped body of silicified rock (FEATURE Q, Figure 18; Photo 16) containing ghost outlines that resemble (relic) feldspar phenocrysts is texturally similar to the feldspar porphyry dikes in the region. A grab sample from this rock, referred to as a "cherty" quartz vein (at the mine), assayed 39 ppb Au (Table 4). The Kremzar orebody is crosscut by a four (4) metre wide, 155°- to 160°-striking diabase dike (FEATURE D, Figure 18).

Alteration

The least altered mafic rock consists of 47 percent sodium-rich amphibole, 40 percent saussurite (fine-grained epidote and albite), 6 percent ilmenite, and 7 percent quartz (Kwok 1986). Kwok (1986) subdivides the alteration associated with the gold mineralization into an outer zone dominated by chlorite-biotite-carbonate and an inner zone dominated by sericite-biotite-potassium feldspar. An extremely sharp boundary exists between the relatively unaltered rocks and the altered rocks (Figure 18 and Figure 19, back pocket; Photos 17 and 18). The mineralized high-strain zone weathers to a distinctive rusty-brown colour due to the abundant Fe-carbonate (Photos 13, 17 and 18).

Structure and Mineralization

The Kremzar Mine comprises two sub-parallel, high-strain-hosted, auriferous quartz vein systems (Figure 18) referred to as the R-Zone and the B-Zone (K. Tylee, Geologist, Canamax Resources Incorporated, Timmins, personal communication, 1987). These quartz vein systems show evidence of having undergone folding and/or shear-deformation (FEATURES H and I, Figure 18; Figure 19, back pocket; Photos 19 and 20). The R high-strain zone contains an obliquely oriented (relative to the high-strain zone boundaries), S-shaped schistosity which curves asymptotically into discrete, bounding shear zones (Photo 21). The 1.1 million ton Kremzar orebody, grading 0.235 ounces of Au per ton, is hosted exclusively within the R-Zone, a 110°- to 140°-striking ductile high-strain zone (FEATURE J, Figure 18). It dips steeply to the southwest and plunges at approximately 70° to the northwest (G. Yule, Geologist, Canamax Resources Incorporated, Timmins, personal communication, 1987). In plan view the mineralized zone is made up of right-stepping, en echelon ore-shoots. They are similar in orientation to the S-shaped sigmoidal schistosity (Photo 21) observed within the R high-strain zone at surface. A narrower, subparallel high-strain zone known as the B-Zone occurs immediately north of the R-Zone (FEATURE K, Figure 18). At the heritage outcrop the R and B zones merge together creating a complex structural pattern (FEATURE L, Figure 18). Both zones appear to rapidly narrow in width towards the southeastern corner of the heritage outcrop (FEATURE Q, Figure 18).

Mineralization consists of "cherty" blue-grey quartz veins containing potassium feldspar and sericite. Accessory minerals include pyrite, pyrrhotite, biotite, chlorite, Fe-carbonate and native gold (Yule 1987). Native gold occurs mainly as very fine-grained free gold ("gold dustings"), as fine individual specks and on the boundaries of fine-grained anhedral to subhedral pyrite grains.

Outside the ductile high-strain zone there is a systematic pattern of brittle and brittle-ductile fractures developed within the mafic metaintrusive host rock (Figure 18; Figure 19, back pocket; Photo 14). There are several orientations; the corresponding dips were not recorded:

(a) 080-090°
(b) 030-040°
(c) 140-150°

(d) 110°
(e) 175°

Fracture set (b) sinistrally displaces (d); however, late reactivation on 110° (d) surfaces dextrally displaces (b). These brittle and brittle-ductile fractures are locally infilled with quartz ± Fe-carbonate veins which are generally non-auriferous (Figure 18; Figure 19, back pocket). Inside the zone of ductile high-strain (i.e., R-mineralized zone, Figure 18) there are numerous, highly folded, boudinaged and disrupted veins (Photos 19 and 20). It would appear that the ductile high-strain zone may have been localized by a zone of strong brittle to brittle-ductile fractures. There is a noticeable increase in both the intensity and density of brittle fracturing (oriented subparallel to the R-Zone) in the rocks immediately adjacent to the R-Zone (Figure 19, back pocket). Property-scale map patterns and ground magnetic data indicate that the host mafic metaintrusive body is bulged or folded in the vicinity of the Kremzar Mine.

Michael Syndicate Shaft (9)

The Michael Syndicate Shaft is located in western Jacobson Township, 700 m east of Maskinonge Lake and 11.5 km northeast of Goudreau (Figures 3 and 13a,b).

A regional transverse fault, referred to as the Maskinonge Lake fault, hosts the Michael Syndicate Shaft occurrence and Canamax's Breccia Zone occurrence (10) immediately to the south. This regional, 145°-striking fault is one of many in the Michipicoten greenstone belt that sinistrally displaces the stratigraphy and the regional deformation zones (Figures 3, 11, 12 and 13a,b). In the vicinity of the Michael Syndicate Shaft area, the Maskinonge Lake fault juxtaposes strongly epidotized mafic metavolanic rocks to the west, against mafic metavolcanic rocks, felsic metavolcanic rocks and ironstones to the east. The Maskinonge Lake fault is locally occupied by diabase dike.

Gold mineralization is associated with disseminated and fracture controlled chalcopyrite and pyrite within an intensely silicified and quartz vein stockworked fault-breccia. Grab samples of the fracture controlled mineralization (i.e., psuedo-brecciated) and the more massive quartz vein material both returned low to anomalous gold values (Table 4). The breccia-texture is more of a stockwork-texture involving very little if any fragment rotation (Photo 22). At the Michael Sydicate Shaft, the mineralized zone is up to 7 m wide and of undetermined strike-length. Epidote and calcite alteration minerals are common, while typical, gold-associated alteration minerals such as sericite, biotite and Fe-carbonate were not observed.

Breccia Zone (10)

The Breccia Zone is located in western Jacobson Township immediately south of the Michael Syndicate Shaft occurrence (Figures 3 and 13a,b). The Breccia Zone is the southern strike extention of the Michael Syndicate Shaft mineralization (Figure 13a,b).

The geological setting and style of mineralization is identical to that described for the Michael Syndicate Shaft occurrence. A grab sample of chalcopyrite- and pyrite-bearing quartz stockwork material assayed 0.34 ounces Au per ton (Table 4). In addition to the stockwork-breccia style of mineralization there is a 0.75 m wide, massive quartz vein occuping the core of the fault (Photo 23). The mineralized portion of the Maskinonge Lake fault at the Breccia Zone is narrower than at the Michael Syndicate Shaft occurrence. The 130°- to 135°-striking, mineralized portion of the fault is only 1 to 2 m wide. The intensity of silicification and the number of quartz veins both decrease graditionally away from the fault to the east and abruptly to the west (G. Yule, Geologist, Canamax Resources Incorporated, Timmins, personal communication, 1987).

The calcite and epidote altered mafic metavolcanic host rocks are intensely silicified and quartz vein stockworked. East of the mineralized fault, the mafic metavolcanic rocks are intruded by a number of feldspar ± quartz porphyry dikes which are truncated by the structure. An ironstone unit to the east of the Breccia Zone occurrence abuts the Maskinonge Lake fault and hosts the Pine Zone occurrence (11).

Brittle fractures and sinistral kink-bands, both striking between 130° and 140°, become more abundant as the main Maskinonge Lake fault is approached. Quartz filled fractures and axial traces of kink bands both appear to splay off the main fault.

Pine Zone (11)

The Pine Zone occurrence is located in western Jacobson Township immediately east of the Breccia Zone occurrence (10) (Figures 3 and 13a,b). The Pine Zone mineralization is poorly exposed at surface thereby precluding any detailed descriptions. Rocks in the vicinity of the Pine Zone include mafic metavolcanics, felsic crystal tuffs, pyrite-bearing ironstone, and feldspar ± quartz porphyry dikes. All of these rocks are strongly schistose (schistosity = 250°/80N) and truncated to the west by the Maskinonge Lake fault that hosts the Breccia Zone (10) and Michael Syndicate

Shaft (9) occurrences. Gold mineralization occurs within a pyrite-bearing ironstone that abuts against the eastern side of the Maskinonge Lake fault. Significant gold values: (1) are localized in that portion of the ironstone immediately adjacent to the Maskinonge Lake fault, and (2) show a systematic decrease away from the fault (G. Yule, Geologist, Canamax Resources Incorporated, Timmins, personal communication, 1987). Both of these observations are consistent with a replacement-style of mineralization.

Morrison No. 1 Occurrence (12)

The Morrison No. 1 occurrence is located in southeastern Finan Township less than 1 km north of Goudreau Lake (Figures 3, 13a,b and 20). The Morrison No. 1 occurrence and the Pine Zone occurrence (11) are, to-date, the only significant gold mineralization known to occur within ironstone in the Goudreau-Lochalsh gold district. Descriptions of the Morrison No. 1 occurrence are based on observations made on two mechanically stripped outcrops (Figure 20) and from geological mapping by Hammar (1988).

Geology

The Morrison No. 1 occurrence is hosted by pyrite-bearing ironstone, of the Morrison No. 1 Iron Range, which occurs at the interface between Cycle 2, intermediate to felsic metavolcanic rocks to the south and Cycle 3, intermediate to mafic metavolcanic rocks to the north (Figures 3, 13a,b and 20). The footwall felsic metavolcanic rocks consist of tuff, feldspar crystal-tuff and lapilli-tuff (FEATURE A, Figure 20), while the hanging wall mafic metavolcanic rocks are massive to pillowed flows. The felsic metavolcanic rocks, and in particular the pyroclastic fragments, contain abundant chloritoid alteration (FEATURES B and L, Figure 20; Photo 24) typically associated with many of the Wawa Iron Ranges (Sage *et al.* 1987; Lockwood 1988). There are boudinaged pieces of competent, mafic dike rock "floating" within the less competent, siderite-bearing ironstones (FEATURE C, Figure 20).

The ironstone exposed at the Morrison No. 1 occurrence is part of the Goudreau Iron Range (Figures 1, 3, 5, 6 and 13a,b). The Goudreau Iron Range occurs at the same "lithostratigraphic" horizon as the huge Helen Iron Range in the Wawa area, and is interpreted by Sage and Heather (1991) to be a distal equivalent of the same. The Goudreau Iron Range is dominantly comprised of pyrite-bearing ironstones with subsidiary carbonate- and oxide-bearing ironstones. These "facies" of the ironstone are typically stacked in a specific stratigraphic sequence as described by

Sage and Heather (1991). The eastern outcrop of the Morrison No. 1 occurrence exposes part of this stratigraphic sequence; siderite-bearing ironstones at the base (south), overlain by massive pyrite, which, in turn, is overlain by chert ± pyrite ± magnetite at the top (north) (FEATURE J, Figure 20).

Alteration, Mineralization and Structure

The pyrite-bearing ironstone contains pervasive Fe-carbonate (FEATURE D, Figure 20), described as siderite by Collins *et al.* (1926), which may be of either; (a) primary, syn-pyrite ironstone origin or (b) secondary, hydrothermal origin. There may be more than one generation of Fe-carbonate present in this occurrence; however, this still remains to be fully documented. The tuffaceous rocks in the vicinity of the ironstone are strongly sideritized (FEATURE E, Figure 20). Gold mineralization appears to be controlled by microscopic, crosscutting fractures in the ironstone unit (G. Yule, Geologist, Canamax Resources Incorporated, Timmins, personal communication, 1987). Narrow quartz veinlets crosscut the ironstone (FEATURE K, Figure 20; Photo 25); however, gold assays (from channel sampling) do not appear to correlate with them (G. Yule, Geologist, Canamax Resources Incorporated, Timmins, personal communication, 1987).

The felsic metavolcanic tuffs are cut by numerous, narrow, discrete shears exhibiting dextral displacement and which are subparallel to the apparent bedding in the tuffs (FEATURE F, Figure 20; Photo 26). There are both S- and Z-symmetry folds of bedding and/or schistosity at the Morrison No. 1 occurrence (FEATURES G and H, Figure 20). The Z-symmetry folds (FEATURE G, Figure 20; Photo 27) have been interpreted as dextral shear folds related to late, dextral shearing which effects the area (Arias and Heather 1987). S-symmetry folds (FEATURE H, Figure 20) may be parasitic folds related to earlier regional folding (Arias and Heather 1987). Locally, there is a strong crenulation cleavage developed for which the orientation and kinematic indicators suggest an oblique, north-side-up sense of dextral displacement (FEATURE I, Figure 20).

Morrison Cabin Claims Occurrence (13)

The Morrison Cabin Claims occurrence (MacLeod 1923; Gledhill 1927) is located in the southeast corner of Finan Township, just east of the Magino Mine, on the north shore of Goudreau Lake (Figures 3, 13a,b and 17). Gold mineralization occurs in narrow, east-striking quartz veins that are localized along a strongly schistose, 070°-striking contact between a felsic porphyry dike and mafic metavolcanic rocks.

Descriptions of the Morrison Cabin Claim mineralization (Gledhill 1927) are similar to those of the mineralization found at the nearby Magino gold mine. Steeply plunging mineral lineations and dextral S-C fabric kinematic indicators suggest an oblique-slip, north-side-up sense of displacement along this zone of high-strain. There are numerous, non-auriferous, north-striking quartz-tourmaline veins, referred to by Gledhill (1927) as "transverse north-south veins", that crosscut the schistosity within the felsic porphyry dike. The high-strain zone is about one foot in width and strikes from 066° to 086° (Burrows 1921a, 1921b). The cross veins range in width from one inch to 14 inches and strike 006° (Burrows 1921a, 1921b). This occurrence may be the surface expression of the Magino-Island Zone-Lochalsh Zone gold mineralized system (Figure 13a,b and 17).

Edwards Mine (14)

The Edwards gold mine is located in central Jacobson Township approximately 8 km southwest of Lochalsh and immediately west of the Cline Lake gold mine (Figure 13a,b and 21). The Edwards Mine produced 485 ounces of gold and 37 ounces of silver from 1,573 tons of ore during 1937 (Unpublished Reports, Assessment Files Research Office, Ontario Geological Survey, Toronto) for an average gold grade of 0.31 ounces per ton, An additional 1,690 tons of stockpiled ore was milled but no grade figures were given (Unpublished Reports, Assessment Files Research Office, Ontario Geological Survey, Toronto).

The following descriptions and discussion of the geology in the vicinity of the Edwards gold mine are based on field work completed prior to a recent program of extensive mechanical stripping of bedrock and diamond drilling by Spirit Lake Resources Limited.

Geology and Structure

MacLeod and Cowie (1926), Gledhill (1927), Burwash (1935) and Bruce (1942) provide descriptions of the general geology. Host rocks include mafic metavolcanics, mafic metaintrusives, and quartz ± feldspar porphyry dikes. Two orientations of discrete, ductile high-strain zones cut all of the host rocks:

(a) 085° / 75° N, dextral (oblique-slip).
(b) 115° / 85° N, dextral (oblique-slip).

There are two dominant orientations of quartz-feldspar porphyry dikes; 085° and 115°. All of the rock types are folded and locally transposed.

A major high-strain zone, referred to as the "Cline-Edwards Shear", strikes at 070°-080° across the Edwards Mine property onto the Cline Lake property to the east. The Cline-Edwards high-strain zone is 1 to 15 m wide and several kilometres in length.

Alteration and Mineralization

Within the high-strain zones the mafic rocks are altered to chlorite-(biotite ?)-(Fe-carbonate)-pyrite schists, while the quartz-feldspar porphyry dikes are altered to sericite-quartz-(Fe-carbonate)-pyrite schists that carry low gold values (Table 4). There is a zonation in carbonate mineralogy from Fe-carbonate adjacent to the mineralized vein outward to a perpherial halo of calcite. The alteration is of limited extent and confined to individual high-strain zones. Gold mineralization occurs in quartz veins oriented subparallel to parallel to the high-strain zone boundaries. Several mineralized veins have been delineated in the Edwards Mine area (see Figure 3 in Burwash 1935). The Edwards No. 1 shaft, from which the bulk of the past production came, is located at the intersection of 085° and 115° vein structures. Burwash (1935) describes some of the richest mineralization as occurring 100 feet down the No. 1 shaft; "here a quartz vein intersects a mineralized band of rock, which resembles iron formation". The quartz from this locality contained abundant pyrite and considerable amounts of visible gold (Burwash 1935). The main mineralized zone is a 2.5 feet wide quartz vein that strikes 293° and dips 75°N and that has been extensively faulted (Bruce 1942). The geological setting and structural controls on mineralization at this occurrence are very similar to those at the Cline Lake gold mine (15) located immediately to the east (Figure 21).

The Cline-Edwards high-strain zone consists of schistose rocks that contain variable amounts of sericite, chlorite, Fe-carbonate and quartz. Mineralized zones have been delineated both north and south of the Cline-Edwards high-strain zone. The Cline-Edwards zone appears to crosscut, truncate and locally incorporate the gold-bearing veins and their altered host rocks. The Cline-Edwards zone is not mineralized with gold; except, where it has incorporated pieces of earlier mineralized quartz vein.

Cline Lake Mine (15)

The Cline Lake gold mine is located in central Jacobson Township approximately 7.5 km southwest of Lochalsh (Figures 3, 13a,b and 21). Discovered in 1918 by James Cline, the Cline Lake Mine produced 63,328 ounces of gold and 10,598 ounces of silver from 331,842 tons of ore, from 1938 to 1942 and 1947 to 1948, for average grades of 0.19 ounces of Au per ton and 0.03 ounces of Ag per ton (Unpublished Reports, Assessment Files Research Office, Ontario Geological Survey, Toronto). The mine is now inactive and flooded.

The No. 3 shaft and adit (Figure 21) provided access to exploration drifts along a number of parallel auriferous veins (No.'s 3, 4, 5, Q, R). A limited amount of production from the "Q" and "R" veins in this area was accomplished via a drift from the No. 4 shaft area (from P. Cooper *in* Sage and Heather 1991).

The following descriptions of the geology, alteration, mineralization and structure come from detailed 1:100 scale mapping (i.e., 1 cm = 1 m) of a large, mechanically stripped outcrop (Figure 22; Figure 23, back pocket; Photo 28) located in the No. 3 shaft and adit area, west of the main No. 4 production shaft (Figure 21). In addition, information on the Cline Lake gold mine was extracted from excellent descriptions by Bruce (1942, 1948) and Gledhill (1927). Features referred to in the following text (denoted as "FEATURE") are keyed to Figure 22. Several grab samples of quartz vein material and altered, schistose wall rock were assayed (Table 4) and are also keyed to Figure 23 (back pocket).

Geology

Host rocks in the immediate vicinity of the Cline Lake mineralization consist of mafic metavolcanics, mafic metaintrusives, felsic metavolcanics and felsic to intermediate dikes. Gold mineralization occurs in high-strain zone hosted quartz veins that crosscut all of the above rock types.

Mafic Metavolcanic Rocks

The mafic metavolcanic rocks are massive to pillowed flows belonging to volcanic Cycle 3 (R.P. Sage, Geologist, Ontario Geological Survey, Toronto, personal communication, 1988). In the vicinity of the No. 3 adit (Figures 21 and 22) the mafic metavolcanic rocks are massive to well foliated. No pillowed flows are recognized in this area (FEATURE A, Figure 22), but elsewhere pillowed flows are common.

There are narrow, lean chert-magnetite ironstones intercalated with the mafic metavolcanic rocks in a number of locations on the Cline Lake property. These ironstones are typically of limited strike extent due to dismemberment caused by folding and shearing (Photo 29).

Early Mafic Metaintrusive Rocks

There are several large synvolcanic mafic metaintrusive sills and/or dikes on the Cline Lake property. On the north side of the No. 3 adit stripping there is a large, medium- to coarse-grained mafic sill (FEATURE B, Figure 22), which has been mapped westward to Goudreau (Figures 3 and 13a,b) and eastward past the Markes occurrence (No. 16, Figure 13a,b) (R.P. Sage, Geologist, Ontario Geological Survey, Toronto, personal communication, 1988). Bruce (1942; 1948) describes this rock as a diorite with local evidence of intrusive relationships with the mafic metavolcanic rocks.

Narrow, bifurcating mafic dikes intrude the large mafic sill (FEATURE C, Figure 22; Figure 23, back pocket). These dikes are fine- to medium-grained and weather a greyish-green colour relative to the larger mafic sill. They strike between 085° and 110°, sub-parallel to the large mafic sill (Figure 22; Figure 23, back pocket). Similar dikes, though more deformed and altered, were recognized within the coarse-grained mafic rocks situated in southwest corner of the No. 3 adit stripped outcrop (Figure 22).

Felsic Metavolcanic Rocks

Bruce (1942, 1948) reports the presence of " bands of rhyolite interbedded with the basic types " in the immediate vicinity of the Cline Lake Mine workings. There are felsic metavolcanic rocks exposed in the No. 4 shaft area (Figure 21). The main mass of felsic metavolcanic rocks lies a few kilometres south of the mine workings (Figures 3 and 13a,b).

Exposures of other fine-grained, aphanitic felsic rocks (e.g., the southern portion of the No. 3 adit exposure; FEATURE D, Figure 22; Figure 23, back pocket) are interpreted to be intrusive because they are similar in composition and appearance to other intrusive rocks found in the Goudreau-Lochalsh area (R.P.Sage, Geologist, Ontario Geological Survey, Toronto, personal communication, 1987).

Felsic to Intermediate Metaintrusive Rocks

Bruce (1942, 1948) describes a near vertical, oval-shaped 'granodiorite' stock in the immediate Cline Lake Mine workings. In an isometric block diagram of the Cline Lake Mine (Bruce 1948) the 'granodiorite' stock plunges moderately to steeply to the east (Figure 24). The surface expression of this intrusion should occur within the fenced enclosure around old glory-hole (open stope indicated on Figure 21); however, this could not be confirmed for safety reasons.

Many felsic to intermediate dikes occur in the immediate area of the Cline Lake Mine (Figure 22; Figure 23, back pocket). These dikes were subdivided by Bruce (1942) on the basis of texture, mineralogy and crosscutting relationships into quartz porphyry, felsite and feldspar porphyry. During the current study, four distinct felsic to intermediate dike types were recognized in the No. 3 adit area. Standard Streckeisen (1976) classification of these dike rocks could not be done due to superimposed alteration and deformation, which have obliterated much of the original igneous mineralogy and textures. Crosscutting relationships between dike types are rare and are typically structurally modified and/or obliterated. The following rock types are field-based names that are consistent with Bruce (1942).

Intermediate Dikes

Several intermediate dikelets where mapped in the No. 3 adit stripped area (Figure 23, back pocket). They are typically narrow (1-2 cm) in width and appear to be older than all of the other felsic dike phases. The intermediate dikelets are fine-grained, greenish-grey in colour and have an aphanitic groundmass.

Aphanitic Felsic Dikes

Aphanitic felsic rocks are exposed at the southernmost portion of the No. 3 adit outcrop (FEATURE D, Figure 22; Figure 23, back pocket). They resemble felsic metavolcanic flow rocks; however, they are similar in appearance to intrusive rocks mapped by Sage (1987) in Abotossaway Township (R.P. Sage, Geologist, Ontario Geological Survey, Toronto, personal communication, 1989). They weather to a distinctive yellowish-white colour and are extensively fractured.

Quartz Porphyry Dikes

The quartz (± feldspar) porphyry is represented by a large, pink to buff weathering dike located on the northern side of the No. 3 adit outcrop (FEATURE E, Figure 22; Photo 28). Euhedral to anhedral quartz phenocrysts, up to 5 mm in diameter, are characteristic of this rock type (Photo 30). Feldspar phenocrysts are present, but rare. The distinctive pinkish weathering is due to finely disseminated hematite and Fe-carbonate. Less altered varieties of this rock type are similar to quartz porphyry dikes mapped elsewhere on the Cline Lake property and at the adjacent Markes occurrence to the east. No crosscutting relationships between these dikes and the other intermediate to felsic dikes were observed.

Feldspar Porphyry Dikes

The feldspar porphyry dikes can be subdivided into two types based on texture and crosscutting relationships. The first type, and the younger of the two, is a feldspar porphyritic variety with an aphanitic, siliceous groundmass (FEATURE F, Figure 22). The second type, which is crosscut by the first, is a feldspar porphyritic variety containing strong chlorite and sulphide alteration (FEATURE G, Figure 22). Bruce (1942) describes the former feldspar porphyry as containing plagioclase phenocrysts of oligoclase to andesine composition within a groundmass of intergrown quartz and plagioclase. Also present are accessory minerals such as zircon, apatite, and black iron oxide, as well as, secondary minerals like calcite, sericite, and chlorite. The chlorite- and sulphide-bearing feldspar porphyry dikes are not specifically described by Bruce (1942). Only one dike of this type was identified in the No. 3 adit area during the current mapping (Figures 22 and 23). The feldspar porphyry dikes crosscut both the intermediate and aphanitic felsic dikes.

Late Mafic Intrusive Rocks

Two late mafic dikes, striking 080°, crosscut all of the aforementioned rock types on the northern portion of the No. 3 adit stripped area (Figure 22; Figure 23, back pocket). The narrower dike, measuring 70 to 80 centimetres in width, is fine-grained and non-porphyritic (FEATURE H, Figure 22). The larger dike (FEATURE J, Figure 22), measuring 4 m in width, has a subophitic texture similar to the diabase dikes in the area. The narrow dike is cut at its northern end by an auriferous quartz vein within a high-strain zone (FEATURE I, Figure 22; Figure 23, back pocket). Adjacent to this 120°-striking structure, the dike contains large, rhombohedral-shaped porphyroblasts of Fe-carbonate. The same auriferous high-strain zone further along strike to the west does not appear to to crosscut the larger dike (FEATURE K, Figure 22). Therefore, the narrow dike pre-dates the gold mineralization, while the large dike post-dates gold mineralization. In addition, a 120°-striking fault dextrally displaces the narrow dike at its southernmost end while apparantly not affecting the larger dike (FEATURE L, Figure 22).

Structure

Structure at the Cline Lake Mine is extremely complex and the following discussion represents a compilation of underground work from Bruce (1942, 1948) and surface work conducted in the vicinity of the No.3 adit during the current survey (Figure 22; Figure 23, back pocket).

Folding

Bruce (1942, 1948) makes no direct reference to folding in the immediate area of the Cline Lake Mine. However, he does describe:

> "a large dike of quartz porphyry has a strike swinging from N.65°E. to east-west and dip from 50°S. at the surface to 85°S. on the third level."

Similar changes in orientation were documented on surface during the current mapping and can be attributed to folding. Although no large-scale fold structures were outlined during the current study there are a number of examples of outcrop-scale folding and transposition (Photos 29, 31, 32 and 33), especially in the vicinity of the brittle-ductile high-strain zones. Felsic dikes (FEATURES M, N, and O, Figure 22), chert-magnetite ironstones and quartz veins (FEATURES P and Q, Figure 22) are commonly folded within, and nearby, brittle-ductile high-strain zones. Fold axes and the long axes of quartz vein boudins typically plunge shallowly to moderately to the east (FEATURE Q, Figure 22; Photo 32). Britttle-ductile high-strain zones are locally axial planar to these fold structures (Photo 33). Bruce (1942, 1948) describes the tongue-like geometry of many of the felsic intrusion-volcanic rock contacts as a primary intrusive feature. Although there are examples of this in the Goudreau-Lochalsh district, there are a significant number that are the result of tectonic interleaving and transposition into parallelism with the dominant shear fabric (FEATURE N, Figure 22; Photos 31 and 33).

High-Strain Zones

A 15 m wide ductile high-strain zone, known as the quartz carbonate shear zone (Figure 24; Bruce 1948) or the Cline-Edwards high-strain zone, lies a short distance south of the No. 3 adit area and the main No. 4 production shaft (Figure 21). This 260°-striking, 70° to 80° north-dipping zone crosscuts both the mafic and the felsic rocks. There is abundant quartz, Fe-carbonate, sericite, and chlorite developed within this zone. Large, milky quartz veins are common within the Cline-Edwards high-strain zone, but they are generally non-auriferous. Surface exposures of this schistose zone locally contain anomalous quantities of pyrite, sphalerite and chalcopyrite. Bruce (1948) reports that 'no ore of any consequence' was found within this high-strain zone, a fact supported by the current exploration work (B. Calhoun, Geologist, Noranda Explorations Company Limited, Timmins, personal communication, 1987). Bruce (1948) indicates that this high-strain zone 'passes into the stock of granodiorite between the third and fourth levels' of the Cline Lake Mine underground workings (Figure 24). The productive portion of the Cline Lake Mine was in the hanging wall rocks of the Cline-Edwards high-strain zone (Figure 24). Bruce (1942) describes the presence of numerous subsidiary faults and zones of shearing within the hanging wall rocks which branch off the Cline-Edwards high-strainshear zone (Figure 24).

The most prominent subsidiary structure within the Cline Lake Mine workings is the 'A fault' (Bruce 1942), a 110°- to 115°-striking, near vertical brittle-ductile high-strain zone. Subsidiary structures branch off from the 'A fault' as well as the Cline-Edwards shear zone. The most important orebody was the 'A vein' which lies along the hanging wall side of the 'A fault' (Figure 24). Numerous subsidiary veins (e.g., the C and D veins; Figure 24) branch off the hanging wall side of the 'A vein', reportedly localized along the contacts of felsic dikes (Bruce 1948). No ore was found in the footwall of the Cline-Edwards high-strain zone (Figure 24); however, mineralization is known to occur in the footwall rocks (i.e., southside of the high-strain zone) on the adjoining Edwards property. Little mineralization was found below the fifth level of the mine workings (Bruce 1948). This appears to be because with increasing depth the north-dipping Cline-Edwards high-strain zone progressively encroaches on the near-vertical dipping, eastward plunging vein system and eventually truncates it (Figure 24). Bruce (1942, 1948) interprets the 'A fault/A vein' and the other faults and veins as being subsidiaries or splays off of the quartz-carbonate shear zone (i.e., the Cline-Edwards high-strain zone). An alternative explanation is that the Cline-Edwards high-strain zone is a related, or possibly even unrelated, but slightly younger structure that truncates the auriferous fault-vein system.

The structures and associated mineralization found at the No. 3 adit area are located a short distance along strike, to the northwest, from the main workings of the Cline Lake Mine (Figure 21). Figure 22 and Figure 23 (back pocket) show the distribution of the structures and mineralization in the No.3 adit area. There are five orientations of brittle-ductile high-strain zones that form a complex somewhat systematic pattern within the rocks of the No. 3 adit area. The most dominant of these are the 115°- and 085°-striking high-strain zones. These zones host the majority of auriferous quartz veins both within the No. 3 adit area (FEATURES R and S, Figure 22) and the main workings of the Cline Lake Mine (Figure 21). Unequivocal crosscutting relationships were not observed between the 080°- and 115°-striking high-strain zones suggesting that they may have developed synchronously. However, in the southern portion of the No. 3 adit area, a 080°-striking high-strain zone appears to dextrally displace a 115°-striking vein by approximately 6 m (FEATURE T, Figure 22). This may simply represent a later reactivation of the 085°-striking high-strain zone. More typically, where these high-strain zones intersect each other, the rocks are very friable and are cut by intersecting fractures that define a diamond-shaped pattern (FEATURE U, Figure 22; Photo 34). Intersection lineations in these areas typically plunge shallowly to moderately to the east (Figure 23, back pocket). The 'granodiorite' stock depicted in Bruce's (1948) isometric diagram (Figure 24) also plunges moderately to the east.

Figure 25c schematically depicts the major shear zone orientations recognized on the Cline Lake property during the current study. Most of the past production from the Cline Lake Mine appears to have come from the 115°-striking veins and to a lesser extent the 085°-striking veins. The intersection of vein/fault structures is where higher-grade shoots are developed (Bruce 1942).

Alteration

Alteration is confined to zones of shearing and does not effect large volumes of rock. Underground at the Cline Lake Mine, Bruce (1942) noted that the wall rocks had not undergone very extensive alteration. Alteration consists of variable amounts of Fe-carbonatization, sericitization, pyritization and minor silicification. Alteration of mafic rocks is dominated by chlorite, Fe-carbonate, calcite, and minor pyrite and quartz (FEATURE W, Figure 22). Alteration of felsic rocks is dominated by sericite, quartz, pyrite and Fe-carbonate (FEATURE X, Figure 22). Fe-carbonatization is by far the most abundant alteration type associated with the auriferous veins at the Cline Lake Mine. Mafic intrusive rocks in the immediate vicinity of the No. 3 adit area contain abundant disseminated, skeletal magnetite crystals (FEATURE Y, Figure 22), which may be of primary igneous origin, or alternatively may be due to hyrothermal replacement of chlorite (Bruce 1942).

Mineralization

Mineralization consists of auriferous quartz veins and schistose rocks hosted within brittle-ductile high-strain zones (FEATURES R and S, Figure 22; Photos 35 and 36). Gold mineralization can occur with, or without, quartz in thin (i.e., several millimetres in width) shears ("slips") accompanied by carbonate, pyrite (lesser pyrrhotite) and biotite or sericite (e.g., compare assay samples 87KBH-0037 and 87KBH-0039 in Table 4). Individual veins nearly always carry "anomalous" gold (>500 ppb), but gold values are generally highly erratic (i.e., nil to up to several ounces Au per ton; Table 4). Visible gold is common locally (FEATURE S, Figure 22). Quartz is the principal gangue mineral with subordinate amounts of sericite, chlorite, Fe-carbonate, calcite, and tourmaline. The quartz in the gold-bearing veins typically has a sugary texture, which is indicative of deformation and recrystallization. Opaque minerals, chiefly sulphides, usually comprise only 5-10 percent of the vein and include pyrite, minor arsenopyrite, minor chalcopyrite, pyrrhotite and native gold. In addition, Bruce (1942) recognized sphalerite, galena (?) and molybdenite displaying various textural relationships.

Quartz veins within the high-strain zones typically return anomalous to high gold values (i.e, multiple ounces of Au per ton; see Table 4; Figure 23, back pocket). These veins are typically highly strained and exhibit sheared contacts. Gold assays from individual quartz vein systems vary significantly along strike (e.g., compare assays 87KBH-0036, 0037, 0038 and 0039 from the southern, No. 3 adit vein, Table 4; FEATURE S, Figure 22) and likely down dip. Narrow sheeted vein systems (FEATURE Z, Figure 22; Photo 37) and other complex vein systems found within relatively unaltered and less deformed rocks perpherial to the brittle-ductile high-strain zones typically return low gold values (Table 4; Figure 23, back pocket). Late, north-striking quartz-tourmaline veins crosscut all other veins and appear to contain generally low and erratically distributed gold values. North-striking veins have a wavy (ptygmatic) form which is attributed to regional deformation. These veins are glassy as opposed to sugary, are very weakly pyritic and do not have sheared contacts.

Markes Occurrence (16)

The Markes occurrence is located in Jacobson Township immediately east of the Cline Lake Mine property (Figures 3, 13a,b and 21). The following descriptions of the geology, alteration, mineralization and structure come from detailed 1:100 scale mapping (i.e., 1 cm = 1 m) of a large, mechanically stripped area of bedrock (Figures 21 and 26; Figure 27, back pocket; Photo 38) and adjacent trenches (Figures 28 and 29). The main area of bedrock stripping was enlarged in the fall of 1987, subsequent to the mapping depicted in Figure 26.

Geology

Host rocks in the immediate vicinity of the mineralization consist of mafic metavolcanics, mafic metaintrusives, and felsic to intermediate dikes (Figures 26, 27, 28 and 29).

Mafic Metavolcanic Rocks

The mafic metavolcanic rocks are massive (FEATURE A, Figure 26) to pillowed (FEATURE B, Figure 26; Photo 39) flows belonging to volcanic Cycle 3 (R.P. Sage, Geologist, Ontario Geological Survey, Toronto, personal communication, 1988). Pillow shapes are north-facing (FEATURE B, Figure 26) within the steeply north-dipping mafic metavolcanic rocks in the vicinity of the Markes occurrence. The pillows are typically 30 to 100 cm in diameter and are locally vesicular and rarely variolitic (R. Hall, Geologist, Esso Minerals Canada, Toronto, personal communication, 1987).

Mafic to Intermediate Metaintrusive Rocks

Mafic to intermediate metaintrusive rocks are common throughout the area (Figure 3). The majority are sills, however dikes are also present. Mafic to intermediate metaintrusive sills and dikes occur immediately north of the main Markes occurrence (Hall 1987). They were also mapped in Trenches #3 and #4, southwest of the main Markes occurrence (Figures 28 and 29). These rocks exhibit a medium- to coarse-grained gabbroic-texture, locally are quartz-phyric and contain abundant coarse magnetite. These rocks have been mapped in the field as diorites and quartz diorites (Figures 28 and 29), however they may be gabbros (i.e., more mafic in composition). Some of the mafic to intermediate metaintrusive rocks have a crude layering, or zoning, with a finer-grained top to the south and coarser-grained, magnetite-bearing and quartz-phyric base (Hall 1987). Quartz phenocrysts are typically bluish-grey in colour and circular in shape (i.e., quartz eyes). Sage (1985) has interpreted similar mafic rocks in the Goudreau-Lochalsh area as being synvolcanic. These rocks tend to be weakly foliated to non-foliated; however, the margins of the intrusions are typically well-foliated and locally strongly schistose (Figure 29).

Felsic to Intermediate Metaintrusive Rocks

Felsic to intermediate dikes are common at the Markes occurrence (Figures 28 and 29) and are spatial associated with the main mineralized zone (Figure 26; Figure 27, back pocket). Three types of dike were identified within the immediate vicinity of the Markes occurrence during the current study. Hall (1987) also identified a number of felsic to intermediate dikes on the Markes property. The following descriptions are based on data collected from this study and that of Hall (1987).

A large intermediate (to felsic) dike makes up the northern half of the main stripped outcrop (Figure 26; Figure 27, back pocket; Photo 40) and clearly crosscuts and truncates mafic metavolcanic pillows (FEATURES C and G, Figure 26). This dike type has only been observed within the immediate vicinity of the main mineralized area (Hall 1987). The dike is not porphyritic, is weakly to strongly foliated, greenish-grey on the fresh surface and bleached-white on the weathered surface. The weakly deformed dike rocks consist of very fine-grained, moderately siliceous, quartz-sericite-chlorite schists. The more strongly deformed dike rocks consist of calcite-bearing sericite schists with little chlorite (Hall 1987).

Intruding the felsic to intermediate dike described above are quartz-phyric porphyry dikes (FEATURE D, Figure 26). These quartz porphyry dikes are encountered throughout the Markes property; however, in the area of the main mineralization they are confined to the eastern portion of mineralized zone (Figures 28 and 29). They are typically massive to foliated depending on the degree of superimposed deformation. Hall (1987) distinguishes between chlorite-bearing and non-chlorite-bearing varieties of this rock type and concludes they are distinct intrusive suites; one pre-gold and the other post-gold mineralization. This distinction is equivocal based on observations made during the current study.

Two narrow, northwest-striking felsic dikes crosscut the main stripped outcrop (FEATURES E and F, Figure 26; Photo 41). Primary textures in both dikes have been obliterated by strong alteration and/or deformation (Photos 40 and 41). The northernmost dike strikes from between 115°, in the west, to 090° in the east (FEATURE E, Figure 26) and is not structurally disrupted. This dike is non-porphyritic and weathers a pinkish colour due to moderate Fe-carbonate and hematite alteration. This contrasts with the southernmost dike which is structurally dismembered and intensely altered (FEATURE F, Figure 26; Photo 42). Despite having undergone strong deformation, boudinage and counterclockwise rotation (of the boudins), the southern dike still has a northwest-strike like the other dike (Figures 26 and 27). This pattern could be interpreted to be the result of an obliquely oriented dike that has buckled due to flattening or non-rotational strain (i.e., pure shear). Hall (1987) recognized several narrow feldspar and quartz-feldspar dikes throughout the Markes property which may be less altered and deformed versions of those described above.

Structure

The Markes occurrence is localized in the eastern domain of the GLDZ (Figure 13a,b) within a 090°-striking, near-vertical dipping, brittle-ductile high-strain zone (Figure 26; Figure 27, back pocket). This high-strain zone has been referred to as the Markes shear zone (Hall 1987) and here in this report as the Markes high-strain zone. A large mafic metaintrusive sill is reported to occur immediately north of the Markes high-strain zone (Hall 1987). This is the same mafic metaintrusive that is found north of the Cline Lake gold mine (Figure 3). The mafic sill has behaved more competently than the surrounding mafic metavolcanic flows and therefore has influenced the localization of the Markes high-strain zone. The large intermediate dike described earlier (FEATURE C, Figure 26) is localized within the Markes high-strain zone and has itself behaved more competently and served to focus subsequent, progressive deformation. The intermediate dike is folded and the Markes high-strain zone is roughly axial planar to these folds (FEATURE G, Figure 26; Photo 43).

The Markes high-strain zone is a 3 to 40 m wide composite zone comprised of numerous, discrete shears (Photos 40 and 44; Figure 26), which cut all the rock types described earlier. Relative differences in the structural compotency of rock types appears to have influenced the localization of the high-strain zones. In the immediate vicinity of the mineralization, the Markes high-strain zone is localized between a large intermediate dike and pillowed mafic metavolcanic rocks along the northern margin (FEATURE H, Figure 26; Photos 40 and 44) and between pillowed and massive mafic metavolcanic rocks along the southern margin (FEATURE I, Figure 26; Photo 45). Listed below are four of the most dominant orientations of subvertical, discrete high-strain zones recognized at the main stripped area of the Markes occurrence (Figure 25b).

(a) 045°-055°, variable
(b) 080°-090°, dextral (oblique-slip)

(c) 110°-120°, dextral (oblique-slip)
(d) 140°-150°, variable

These discrete shears are 1 to 2 cm wide and appear to splay off one another (FEATURES J and K, Figure 26) in a semi-regular to anastomosing pattern (Photos 40, 44 and 45). This phenomenon is particularily evident between groups (b) and (c) above (Figure 27, back pocket). All of the structures have influenced the localization of felsic dikes (e.g., Groups b and c), alteration (e.g., Groups a,b,c and d), higher-grade gold mineralization (e.g., Groups b and c) and later non-auriferous quartz veins (e.g., Group a). The sense of shear displacement listed above for each shear group has been determined from rotated shear fabrics and offset of lithological contacts, such as dike margins. For groups (a) and (d) the evidence was equivocal and both senses were observed.

Mineral lineations and minor shear fold axes both plunge shallowly from 10° to 40° to the east (Figures 7, 11c and 29; Figure 27, back pocket). Elongation lineations from within the Markes high-strain zone, the long axes of stretched pillows (Trench #1, Figure 29) and small-scale folds of ironstone (Trench #2, Figure 29) all consistently plunge shallowly to the east. This contrasts with the weakly deformed rocks north and south of the Markes high-strain zone which are weakly foliated and poorly lineated (Hall 1987).

Alteration and Mineralization

Alteration consists of varying degrees of Fe-carbonatization, silicification, sericitization and pyritization. The Markes high-strain zone has localized most of the alteration and associated gold mineralization. Fe-carbonatization and silicification are visually the most striking alteration types, especially within the mafic metavolcanic rocks (FEATURES L, M, N, and O, Figure 26).

Within the Markes high-strain zone the intensity of both the deformation and the alteration is variable (Figure 26; Figure 27, back pocket). The variation in alteration intensity is best exemplified by mafic pillowed metavolcanic rocks which are more reactive to the hydrothermal fluids than the felsic and intermediate dike rocks. Weakly to moderately altered pillows display Fe-carbonatized cores and chloritized rims (FEATURE L, Figure 26; Photo 46; Trench #1 and #3, Figure 29) and low gold values (Table 4). Strongly altered pillows have more Fe-carbonate within the core, selective silicification and chloritization of the rim (FEATURE M, Figure 26; Photo 47) and elevated gold values (Table 4). Intensely altered mafic metavolcanic rocks have a quartz and Fe-carbonate breccia/stockwork which almost totally obliterates any primary pillow textures (FEATURE N, Figure 26; Photo 48) and carries significant gold values (see Table 4). Spatially associated with this silicification and brecciation is 1 to 15 percent tourmaline. Within the strongly to intensely altered zones, 10 to 15 percent disseminated pyrite occurs about narrow quartz veinlets (FEATURE O, Figure 26). There is a spatial correlation between the intensely altered zones, pyrite content and the higher gold assays (Table 4; Figure 27, back pocket).

The felsic to intermediate dikes are strongly sericitized, Fe-carbonatized and locally silicified,(Photo 40) especially along the narrow dicrete shears (FEATURE P, Figure 26). Hematite is also common within the altered dikes; however, it is not known whether this is a hydrothermal alteration product or merely a late surface weathering phenomenon.

The northern and southern boundaries of the main mineralized high-strain zone are defined by narrow, 1 to 2 cm wide, crack and seal, quartz-tourmaline-filled shears (FEATURES Q and R, Figure 26; Photo 49), which carry some of the better gold assays (Table 4; R. Hall, Geologist, Esso Minerals Canada, Toronto, personal communication, 1987). Diamond drilling and surface stripping done by Esso Minerals Canada along strike to the east of the main zone indicates the Markes high-strain zone departs the mafic metavolcanic rocks and enters the intermediate and quartz porphyry dikes. Gold mineralization here is associated with intense sericitization, silicification and pyritization within narrow zones containing centimetre-wide crack and seal quartz veinlets typically with low erratic gold values (Hall 1987).

Laughlin and McColl Occurrences (17, 18)

The Laughlin (17) and McColl (18) occurrences are located in east-central Jacobson Township, approximately 0.5 km northwest of Godin Lake (Figures 3 and 13a,b). Surface exposures of these occurrences are poor and much of the old trenching is sloughed-in and heavily overgrown. Much of the alteration and rock type information discussed below was obtained from discarded boxes of diamond drill core found on the site. Much of this drilling is thought to have been completed by Vega Gold Explorations Incorporated during the mid 1980's.

The Laughlin occurrence consists of erratically-auriferous (J. Archibald, Geologist, personal communication, 1987), quartz-(Fe-carbonate) stringers within a 100°- to 110°-striking high-strain zone. The high-strain zone occurs at the contact between a quartz-feldspar porphyry dike and mafic metavolcanic rocks, which are altered to sericite-, chlorite-, Fe-carbonate-, and calcite-bearing schists. Gold mineralization is associated with pyrite-pyrrhotite-chalcopyrite-bearing quartz veins of unknown strike-length.

The McColl occurrence is hosted by strongly schistose and altered mafic metavolcanic and metaintrusive rocks. Erractic gold values are associated with quartz-(Fe-carbonate)-pyrite-pyrrhotite lenses within a 110°-striking high-strain zone containing chlorite-(Fe-carbonate)- and chlorite-calcite-altered mafic rocks. Deformed and altered felsic porphyry dikes occur in the vicinity of the mineralization.

Three-Mile Post Occurrence (19)

The Three-Mile Post occurrence is located northeast of Godin Lake, at the three mile post, on the township line between Jacobson and Riggs townships (Figures 3 and 13a,b). Strongly deformed (i.e., schistose) and altered, massive to pillowed mafic metavolcanic rocks, and a quartz-feldspar porphyry dike host lenticular quartz veins within a 30 m wide by 100 m long, 100°-striking, dextral high-strain zone. A peripheral zone of chlorite-calcite-pyrite alteration grades inward, toward the mineralized vein, to a (Fe-carbonate)-pyrite-sericite alteration. A grab sample of rusty weathering quartz vein material containing pyrrhotite and chlorite assayed 140 ppb Au (Table 4).

Archibald Occurrence (20)

The Archibald occurrence is located in east-central Jacobson Township, immediately southeast of Godin Lake (Figures 3 and 13a,b). Vega Gold Explorations Incorporated discovered this occurrence in 1981 (Unpublished Report 1981, Vega Gold Explorations Incorporated, Assessment Files Research Office, Ontario Geological Survey, Toronto) by diamond drilling a coincident electromagnetic-magnetic anomaly. This occurrence does not crop out at surface, but Vega Gold Explorations Incorporated drill logs describe the mineralization as "anomolous gold values associated with quartz, pyrite, pyrrhotite, chalcopyrite and sphalerite" (Unpublished Report 1981, Vega Gold Explorations Incorporated, Assessment Files Research Office, Ontario Geological Survey, Toronto).

Watson Lake Property (21)

The Watson Lake Property is located in Riggs Township, approximately 2 km south of Lochalsh (Figure 3). Massive to pillowed mafic metavolcanic rocks, interflow chert-magnetite ironstones, and mafic metaintrusive rocks are cut by narrow, 1 mm to 10 m wide, ductile and brittle-ductile high-strain zones with the following orientations and senses of shear displacement:

(a) 105°-110°/90°, dextral (oblique-slip).
(b) 135°-140°/85°, dextral (oblique-slip).
(c) 065°/80°, (?)

The timing relationship between (a) and (b) is equivocal; however, (c) appears to strongly crenulate both (a) and (b) and therefore is late. Weak to intense Fe-carbonatization, chloritization, pyritization, silicification (including quartz veining), and sericitization are associated with these high-strain zones. Each of these high-strain zones are associated with folding and attendant transposition of the host rocks, especially the ironstones. Anomalous gold values (Table 4) are associated with sulphidized (i.e., pyrrhotite-pyrite) chert-magnetite ironstones in the vicinity of high-strain zones. Gold mineralization is also associated with quartz-ankerite-pyrite veins hosted within chlorite-ankerite-sericite schists (Table 4).

Reid Occurrence (22)

The Reid occurrence is located in southeast Jacobson Township, 7 km southwest of Lochalsh (Figures 3 and 13a,b). Regional mapping (Sage 1985) indicates the host rocks are mafic metavolcanic rocks, metadiorite and metaquartz diorite intrusions, and intermediate to felsic metavolcanic rocks. Thirteen vein structures have been identified on the property (Unpublished Report 1939, Assessment Files Research Office, Ontario Geological Survey, Toronto). The No. 10 vein has recieved most of the previous exploration interest. The No. 10 vein occurs within a 2 m wide, 085°-090°-striking high-strain zone within mafic metaintrusive rocks (Figure 30). The metaintrusive rocks within the high-strain zone are altered to chlorite-(Fe-carbonate)-quartz-pyrite schists (Figure 30). An aphanitic felsic rock, likely a felsic dike, is folded, boudinaged and partially transposed into the high-strain zone (Figure 30; Photo 50). Grab samples of felsic dike rock, and also quartz vein material, returned low gold assays (Table 4). Outside the zone of ductile deformation the mafic metaintrusive rocks contain three strong sets of brittle fractures (Figure 30) with the following orientations and apparent senses of horizontal displacement:

(a) 080°, dextral.
(b) 040°, sinistral.
(c) 140°, dextral (?).

<u>MacLeod Occurrence</u> (23)

The MacLeod occurrence is located in Bird Township, 10 km due east of Goudreau, immediately northeast of Cradle Lakes (Figures 3 and 13a,b). Gold mineralization occurs in quartz veins associated with a 085°-striking high-strain zone developed within diorite to quartz diorite rocks. The vein is reported to be 75 feet long, average 22 inches in width and have a shallow 20° dip to the north. Assays as high as 1.34 ounces of Au per ton are reported (Unpublished Report 1938, Hollinger Consolidated Gold Mines Limited, Assessment Files Research Office, Ontario Geological Survey, Toronto). The vein strikes 065° / 40°N and averages 1 foot to 26 inches in width (Bruce 1942). The metaintrusive rocks immediately adjacent to the auriferous vein system are altered to chlorite-(Fe-carbonate)±green mica schists. The auriferous veins contain several percent chalcopyrite and are ribboned with chlorite and tourmaline. A grab sample, taken by the author, of chalcopyrite-rich quartz vein assayed 0.28 ounces Au per ton and 1.49% Cu (Table 4).

Two ductile high-strain zone orientations were observed to host alteration and quartz veins:

(a) 080°-085°, dextral (oblique-slip).
(b) 040°-045°, sinistral (oblique-slip).

The 040°-striking high-strain zone (b) crosscuts the 080°-striking high-strain zone (a). Outside these zones of ductile high-strain, the mafic metaintrusive rocks exhibit a strong brittle fracture pattern with the following orientations and apparent senses of horizontal displacement:

(c) 140° / 90°, dextral (?).
(d) 035° / 62°, sinistral (?).

<u>Bearpaw Portage Occurrence</u> (24)

The Bearpaw Portage occurrence is located in east-central Finan Township, along the creek between Bearpaw Lake and Pine Lake (Figures 3 and 13a,b). Gold mineralization is reported from schistose mafic metavolcanic rocks and felsic porphyry dikes (Gledhill 1927) and from deformed and sulphidized ironstones (Unpublished Report 1982, Algoma Steel Corporation Limited, Assessment Files Research Office, Ontario Geological Survey, Toronto). Shear-hosted white quartz containing minor pyrite and chalcopyrite, within the ironstone unit, assayed 0.322 ounces of Au per ton, 1.0 ounces of Ag per ton and 1.32 percent Cu (Unpublished Report 1982, Algoma Steel Corporation Limited, Assessment Files Research Office, Ontario Geological Survey, Toronto). Gledhill (1927) states that "fair" gold assays were obtained from a pyritized Keewatin (i.e., mafic) schist at this locality.

Adonis Occurrence (25)

The Adonis occurrence is located in southwestern Finan Township approximately 600 m (2,000 ft) southeast from the southeast corner of Herman Lake (Figures 3 and 13a,b). The occurrence is reported (Unpublished Report 1960, Adonis Mines Limited, Assessment Files Research Office, Ontario Geological Survey, Toronto) to have been found in 1918 by a Mr. Carl Knaupp. Gledhill (1927) describes the occurrence as a breccia zone filled with quartz veinlets and chalcopyrite that yielded "fair" gold assays. Adonis Mines Limited company diamond drill logs indicate values of up to 0.36 ounces Au per ton over 2 feet (Unpublished Report 1960, Adonis Mines Limited, Assessment Files Research Office, Ontario Geological Survey, Toronto).

Based on the brecciated style and the 140° to 145° orientation of the mineralization, the Adonis occurrence is very similar to the Michael Syndicate Shaft (9) and the Breccia Zone (10) type of transverse fault-hosted mineralization. In addition, a regional transverse structure, locally occupied by diabase, and known as the Herman Lake fault, occurs in the immediate vicinity of the Adonis occurrence (Figures 3 and 13a,b).

Leitch Occurrence (26)

The Leitch occurrence is located in northeast Bird Township on the south side of the north arm of Cawdron Lake (Figures 3 and 13a,b). Discovered in 1926 (Gledhill 1927), the Leitch occurrence is coincident with a strong airborne electromagnetic conductor (Ontario Geological Survey 1987) which is due to a pyrite-pyrrhotite-bearing interflow ironstone. The mafic metavolcanic rocks enclosing the occurrence are massive and pillowed, locally with variolites up to 1 cm in diameter (Sage in prep.). A grab sample of granular, glassy, iron-stained quartz, with 15 percent pyrrhotite, pyrite and minor magnetite, from a narrow band of deformed ironstone returned 0.11 ounces of Au per ton (Sage in prep.). In 1943, Leitch Gold Mines Limited completed 14 diamond drill holes on this occurrence, the results of which were discouraging (Unpublished Report 1944, Leitch Gold Mine Limited, Assessment Files Research Office, Ontario Geological Survey, Toronto).

OTHER OCCURRENCES

Gold

In addition to the 26 gold occurrences discussed above there are a number of other occurrences ranging in size from single, narrow veins (e.g., No. 31, Old Cabin occurrence) up to small past producers (e.g., No. 46, Kozak Mine). Sage (in prep.) provides brief geological summaries and detailed accounts of the previous exploration work for each of these occurrences. The location, orientation and structural characteristics of each of these gold occurrence is summarized in Table 2 and Figures 3 and 13a,b. Many of the occurrences are old historical discoveries which could not be located during the current study but are described as small, narrow veins by previous workers (Gledhill 1927; Moore 1931; Burwash 1935; Bruce 1942).

The Priest gold occurrence (Figures 3 and 13a,b, No. 52) appears to be similar in style to the Michael Syndicate Shaft (9), Canamax-Breccia Zone (10) and Adonis occurrence (25) all of which are silicified and brecciated zones hosted within northwest-striking transverse faults (Figures 3 and 13a,b). The other occurrences are quartz veins hosted within brittle-ductile high-strain zones which occur in a variety of rock types.

The Ego Mine (Figures 3 and 13a,b, No. 63) and the Kozak Mine (No. 46) are two of the more significant past producers that were not visited during the current study. Sage (in prep.) and Shriver (1989) provide detailed descriptions of the Ego Mine area.

Base Metals

To-date there are no significant base metal deposits have been discovered in the Goudreau-Lochalsh district; however, there are several small occurrences of copper and lead ± zinc (Table 2). The Ego Mine (63) contains appreciable amounts of chalcopyrite and accessory quantities of sphalerite, cobaltite, arsenopyrite and native gold (Studemeister 1982). There are no volcanic-associated massive sulphide (VMS) deposits or occurrences in the Goudreau-Lochalsh area. All of the known base metal occurrences in the Goudreau-Lochalsh area are either: (a) vein related, and/or (b) fracture or high-strain zone controlled. In the vicinity of the Gutcher Lake stock (Figures 3 and 13a,b) there are several lean oxide-type ironstones that are have been replaced by chalcopyrite, pyrite and pyrrhotite related to (a) or (b) above. Copper is the most common base metal; however, there are lead ± zinc vein systems (e.g., Kozak Mine (46)) and zinc veins (e.g., the OGS zinc occurrence (51), Sage (in prep.)). There are several small copper occurrences in the Goudreau-Lochalsh area (Figure 3, back pocket) which, although being spatially associated with the regional zones of deformation, may be related to volcanic-associated massive sulphide mineralization.

GEOLOGICAL CONTROLS ON GOLD MINERALIZATION

Introduction

Gold mineralization in the Goudreau-Lochalsh district is found in several geological settings which can be characterized in terms of host rock type, structure, alteration and mineralization style. The relative importance of host rock type, structure, alteration and mineralization style as an active or passive control on gold localization changes with the scale of evaluation. This is best examplified by discussing each of the categories in the context of regional (> 1:10 000) and detailed (< 1:10 000) scales.

Regional Controls

Host Rock

Gold mineralization is hosted by all rock types in the area except the diabase dikes and two granitoid intrusions, namely the Herman Lake nepheline syenite complex and the Maskinonge Lake granite stock. Host rocks at the regional scale have no direct control on gold mineralization; however, indirectly the competency contrast between the large felsic to intermediate metavolcanic sequence to the south and the mafic to intermediate metavolcanics to the north (Figures 3, 8, 10, 11 and 12) has focussed the strain responsible for creating the two regional scale deformation zones, which contain most of the gold occurrences (Figures 3 and 13a,b).

Regionally, most of the gold occurrences in the GLDZ appear to be spatially related to a large, regionally mappable mafic metaintrusive sheet (Figures 3 and 13a,b). This rigid mafic metaintrusive body deformed brittley relative to the enclosing mafic metavolcanic rocks, thus acting as a competency contrast and focusing the strain and associated mineralization.

Structure

The two regional scale deformation zones are referred to as the Goudreau Lake Deformation Zone (GLDZ) and the Cradle Lakes Deformation Zone (CLDZ). These deformation zones are comprised of systematically arranged, ductile, brittle-ductile and brittle shear zones, as defined by Ramsay (1980) and Arias and Heather (1987).

The GLDZ can be subdivided into four structurally distinct domains; northern, southern, western and eastern (Arias and Heather 1987). The southern domain of the GLDZ (Figure 12) is characterized as a 1 to 2 km wide, 070°-striking, zone of subparallel ductile and brittle-ductile high-strain zones. The Magino gold mine (2), Island and Lochalsh Zones (3), Morrison Cabin Claims occurrence (13), and Bearpaw Portage occurrence (24) all occur within the southern domain of the GLDZ (Figure 13a,b). The northern, western and eastern domains (Figure 12) are characterized by narrow, discrete brittle and brittle-ductile high-strain zones with the following orientations and senses of horizontal displacement:

(a) 020° - 035°, sinistral (oblique-slip).
(b) 130° - 140°, dextral (oblique-slip).
(c) 080° - 090°, dextral (oblique-slip).
(d) 110° - 115°, dextral (oblique-slip).
(e) 350° - 010°, variable (?).

Gold mineralization occurs in high-strain zone orientations (a), (b), (c) and (d), while (e) is generally poorly mineralized. Orientations (a) and (b) predominate in the northern domain of the GLDZ, immediately south of the Maskinonge Lake stock (Figures 9, 10, 12 and 13a,b). Orientations (c) and (d) predominate in the western domain (i.e., Gutcher Lake stock area) and the eastern domain (i.e., Cline Lake-Godin Lake area) of the GLDZ (Figures 8, 10, 11, 12 and 13a,b).

Subparallel to the GLDZ is the CLDZ which hosts the Reid gold occurrence (22), the Macleod gold occurrence (23), the Leitch gold occurrence (26) and several other small gold occurrences (Figure 13a,b).

Spatially coincident with both these regional deformation zones are felsic intrusive stocks and dikes (e.g., Gutcher Lake stock, Webb Lake stock, Cradle Lakes stock, and smaller plug and dike complexes in the Cline Lake area).

A structurally distinct type of gold mineralization is found at the Michael Syndicate Shaft (9), the Canamax-Breccia Zone (10), the Adonis Gold Occurrence (25) and the Priest gold occurrence (52). All of these occurrences lie within 135°- to 145°-striking, regional fault zones (Figure 13a,b). These fault zones are greater than10km in strike length and appear to offset the supracrustal stratigraphy as well as the regional deformation zones (Figures 3, 5, 11, 12 and 13a,b). Occurrences (9) and (10) are found within the Maskinonge Lake fault zone that also separates the northern-southern domains from the eastern domain (Figure 12). In addition, the Maskinonge Lake fault marks the easternmost outcrop expression of the Maskinonge Lake stock (Figure 3); however, interpretation of Landsat Thematic Mapper images and airborne total field magnetics indicates a possible extension of the stock east of the Maskinonge Lake fault (Mussakowski *et al.* 1991). The Adonis gold occurrence (25) is hosted within the Herman Lake fault, another of these northwset-striking fault zones, which forms the western boundary of the Herman Lake nepheline syenite complex (Figures 3 and 13a,b). The auriferous portions of both these brittle fault zones are where they are coincident (i.e., transect) with the GLDZ. In addition, the mineralized portions of these faults are spatially proximal to the Maskinonge Lake stock and the Herman Lake complex (Figure 3).

Alteration and Mineralization

At the regional scale there is not a readily discernible alteration pattern directly related to gold mineralization. However, rocks within both the GLDZ and the CLDZ are slightly more altered relative to the rest of the supracrustal rocks in the belt. This suggests that hydrothermal fluids were preferentially focussed into the regional zones of deformation.

Regionally, within the Goudreau-Lochalsh area, there are two types of gold mineralizaton recognized:

a) Brittle and brittle-ductile high-strain zone-hosted quartz veins
b) Brittle fault hosted, breccia-style mineralization

At the regional scale, structural controls strongly influence the location and style of mineralization, while host rock type does not.

Detailed Controls

Host Rocks

There are several host rock type controls on gold mineralization evident at the detailed scale. All of the past producing mines are spatially associated with, or hosted within felsic to intermediate intrusions, for example: (a) the Murphy Lake gold mine (1) and several smaller gold occurrences around the Gutcher Lake Stock, (b) the Magino gold mine (2) with the Webb Lake stock, and (c) the Cline Lake gold mine (15) and Edwards gold mine (14) with the Cline Lake felsic plug and dike complex (Figure 3). Numerous other gold occurrences are found: (a) in close proximity to felsic intrusions (e.g., Island and Lochalsh Zones (3)), (b) along the contact with felsic dikes (e.g., Markes gold occurrence (16)), or (c) hosted within felsic dikes (e.g., Morrison Cabin Claims (13)). In addition, the Kremzar gold mine (8) and several smaller occurrences cluster immediately south of the Maskinonge Lake stock (Figures 3, 13a,b and 16).

Gold mineralization is commonly hosted exclusively within a single rock type such as mafic intrusive rock (e.g., the Kremzar gold mine (8), Figures 3, 13a,b, 16, 18 and Figure 19, back pocket), felsic intrusive rock (e.g., Magino gold mine (2), Figures 3, 13a,b, 15 and 16), felsic metavolcanic rock (e.g., Bearpaw Portage occurrence (24), Figures 3 and 13a,b), or pyrite-siderite ironstone (e.g., Canamax-Pine Zone (11) and Canamax-Morrison No. 1 (12), Figures 3, 13a,b, and 20). However, gold mineralization can also be hosted by several rock types within a single deposit or occurrence (e.g., Cline Lake gold mine (15), Figures 3, 13a,b, 22 and Figure 23, back pocket).

Structure

The regional structural patterns are mimicked at the deposit and outcrop scales. Each of the gold occurrences in the Goudreau-Lochalsh district may contain several, systematically oriented brittle, brittle-ductile, or ductile high-strain zones ranging in width from a few millimetres to several metres. These high-strain zones can be classified into six groups based on their orientation (Table 3 and Figure 25a). For each gold occurrence, all the brittle (B), brittle-ductile (BD) and ductile (D) high-strain zone orientations were measured along with any apparent sense of displacement (i.e., sinistral (s), dextral (d), or not distinguishable (n.d.)). Several preliminary observations can be made from the data in Table 3:

(a) Up to six high-strain zone orientations may be present at an individual gold occurrence, but only one or two of those orientations typically will contain significant gold mineralization.

(b) Groups (1) through (5) do host gold mineralization, while group (6) does not.

(c) A consistent sense of displacement within some of the high-strain zone orientation groups does exist (e.g., Groups (1) and (2) are dextral), while a lack of consistency exists for others (e.g., Groups (3) and (6)).

(d) High-strain zones of identical orientation and apparent displacement sense may be brittle-ductile gold-bearing structures at one occurrence, while at another occurrence they are brittle and non-gold bearing, or vice versa (Figure 25).

(e) Geographically and structurally distinct areas can be defined within which certain high-strain zone orientation groups are dominant (Figures 11 and 12).

(f) Gold occurs in both brittle and brittle-ductile high-strain zones.

Generally, one high-strain zone orientation will be dominant and host significant gold mineralization within any individual deposit or occurrence (e.g., the 035° orientation at the Canamax-No. 2 Zone (5)). Locally, two high-strain zone orientations may host gold mineralization, but one is still more dominant (e.g., the 085° and especially the 115° orientations at the Cline Lake gold mine (15), Figures 3, 13a,b, 22, 23 (back pocket) and 25). Some of the auriferous high-strain zones are comprised of two or more, obliquely oriented, auriferous vein structures (e.g., the 070°-striking high-strain zone containing 085°- and 050-striking veins at the Magino gold mine (2), Figures 3, 13a,b, 16 and 25).

A close relationship between each group of high-strain zone (1 through 5) is indicated by the following field relationships:

(a) At any one of the gold occurrences, brittle-ductile high-strain zones of different orientations are seen splaying off one another with no apparent crosscutting relationship (e.g., the 085°- and 050°-striking veins at the Magino gold mine (Figure 15b), or the 090°- and 115°-striking high-strain zones at the Markes gold occurrence (Figure 26).

(b) A brittle high-strain zone of one orientation offsets a brittle-ductile high-strain zone of a different orientation at one occurrence, while at another occurrence the reverse relationship occurs. This seems to apply where both orientations are any of the high-strain zone orientation groups in Table 3 (for examples see Figure 25).

Intersections between high-strain zones of differing orientation appear to be favourable sites for higher grade shoots of gold mineralization at some occurrences (e.g., Cline Lake gold mine (15)).

Alteration and Mineralization

There is a readily discernible alteration pattern related to gold mineralization at the deposit scale. All of the gold deposits and occurrences, with the possible exception of the brittle fault breccia hosted type, are characterized by variable amounts carbonatization (Fe-carbonate and/or calcite), silicification, sulphidization (pyrite and/or pyrrhotite), biotitization, sericitization, feldspathization (K-feldspar or albite) and chloritization. Original host rock composition is an obvious control on the alteration types that will be present at any single gold occurrence. Adjacent to the auriferous zones rocks of mafic composition are generally altered to biotite, Fe-carbonate, pyrrhotite and/or pyrite, quartz, and minor K-feldspar while chlorite, calcite, and minor pyrrhotite and/or pyrite are found peripherally. Within rocks of felsic composition the alteration proximal to the auriferous zones is manifested as quartz, sericite, pyrite and/or pyrrhotite, Fe-carbonate, hematite and locally albite. The alteration within the ironstones is cryptic due to the similarity between the original pyrite-siderite mineralogy and the superimposed, Fe-carbonate and sulphide-bearing hydrothermal alteration.

The brittle fault breccia type of mineralization is characterized by pervasive silicification, quartz vein stockworking, copper-rich sulphidation (i.e., chalcopyrite), chloritization, and minor calcite carbonatization.

Gold occurs in the following settings:

(a) Siliceous zones and quartz veins hosted by brittle-ductile high-strain zone (e.g., the Kremzar gold mine (8)).
(b) Quartz veins hosted by brittle high-strain zones (e.g., locally at the Cline Lake gold mine (15)).

(c) Brittle fault breccia (e.g., Michael Syndicate Shaft (9) and the Breccia Zone (10)).

(d) Brittle-ductile high-strain zones with disseminated sulphides (e.g., Pyrrhotite Zone (27)). (This type can be associated with (a) above).

(e) Hosted within ironstones spatially associated with, or cut by (a), (c) or (d) above (e.g., Pine Zone (11)).

DISCUSSION AND CONCLUSIONS

Work at the regional and detailed scales has identified a strong structural control of the gold mineralization in the Goudreau-Lochalsh district. High-strain zone orientations and senses of displacement documented at the regional scale are similar to those observed at the deposit and outcrop scales. The systematic orientation of high-strain zones; the consistent sense of displacement within high-strain zones of similar orientation; the angular relationship between individual high-strain zones; and the apparent synchronous development of each high-strain zone orientation all seem consistent with features found in Riedel fracture (shear) systems (Cloos 1928; Riedel 1929; Hills 1963 and Tchalenko 1970). Figure 25 depicts rose diagrams of theoretical Riedel shear orientations (25a), regional-scale auriferous high-strain zone orientations from the Goudreau-Lochalsh area (25b), and detailed-scale high-strain zone orientations from individual gold occurrences within the Goudreau-Lochalsh area (25c, d, e, and f). A comparison of the theoritical (ideal) Riedel fracture orientations (Figure 25a) and those hosting gold mineralization in the Goudreau-Lochalsh area (Figure 25b) reveals a close similarity. Likewise the high-strain zone orientations seen at the deposit scale (Figures 25c, d, e, and f) are consistent with the ideal Riedel fracture orientations.

Gold mineralization in the Goudreau-Lochalsh area has the following characteristics:

(1) Gold is found in a number of geological settings; however, significant gold mineralization is associated with quartz veins, siliceous zones, and sulphidized schists within discrete brittle-ductile high-strain zones in both the Goudreau Lake Deformation Zone (GLDZ) and the Cradle Lakes Deformation Zone (CLDZ).

(2) These discrete high-strain zones have systematic orientations at both the regional and detailed scales.

(3) The GLDZ can be subdivided into domains within which certain high-strain zone orientations appear more favourable for gold mineralization relative to others.

(4) There is a spatial relationship between felsic intrusions and gold mineralization.

(5) Locally, the authors have recognized that felsic dike contacts are particularly favourable sites for gold mineralization.

(6) Alteration associated with gold mineralization consists of variable amounts of biotite, sericite, Fe-carbonate, quartz, chlorite, K-feldspar, calcite, pyrite and pyrrhotite.

(7) Gold occurrences in Goudreau Lake Deformation Zone seem to be clustered along the margins of a regionally extensive mafic to intermediate sill/dike (Figure 3).

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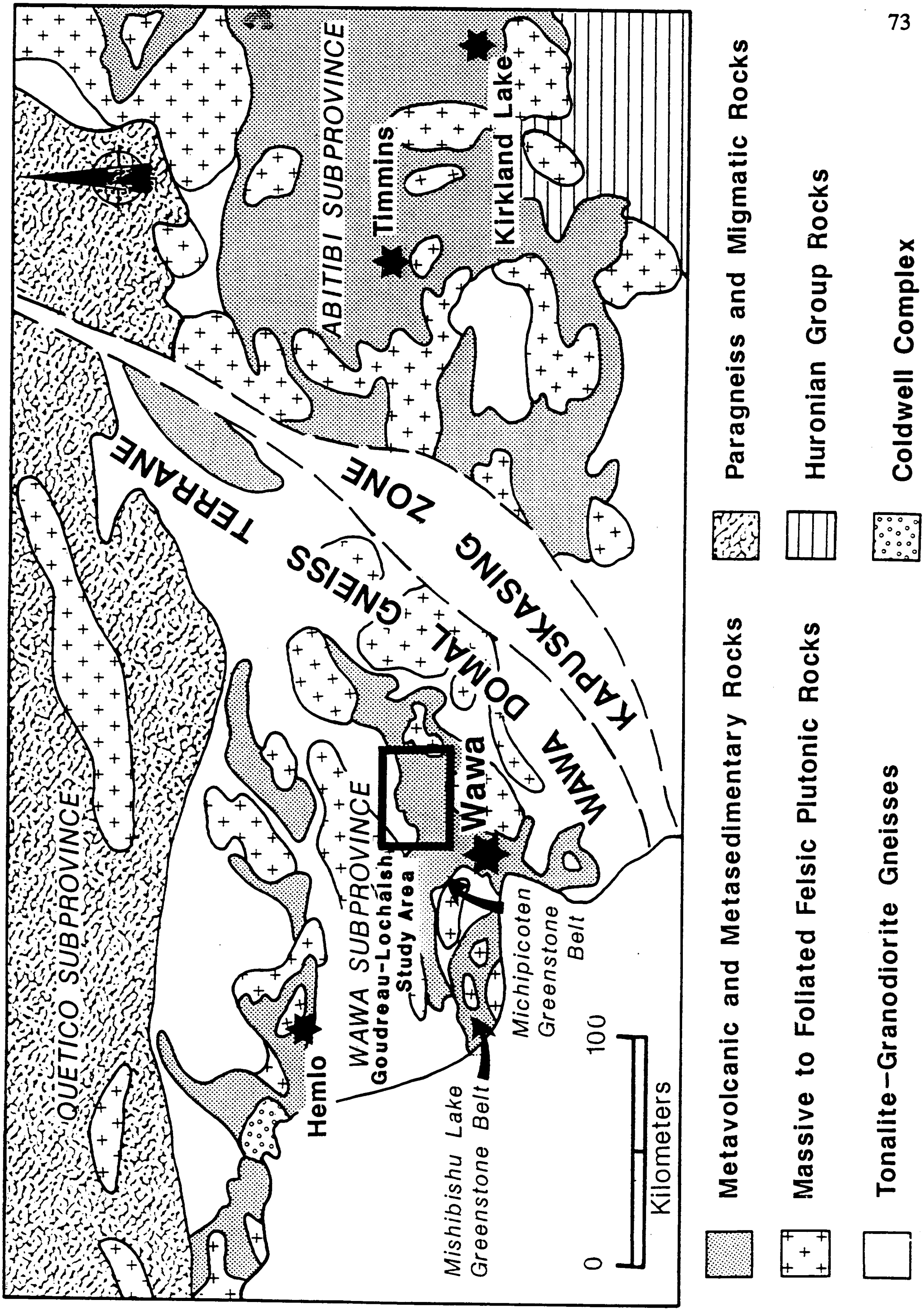


FIGURE 1: Regional geological setting of the Michipicoten greenstone belt and the Wawa Gold Camp.

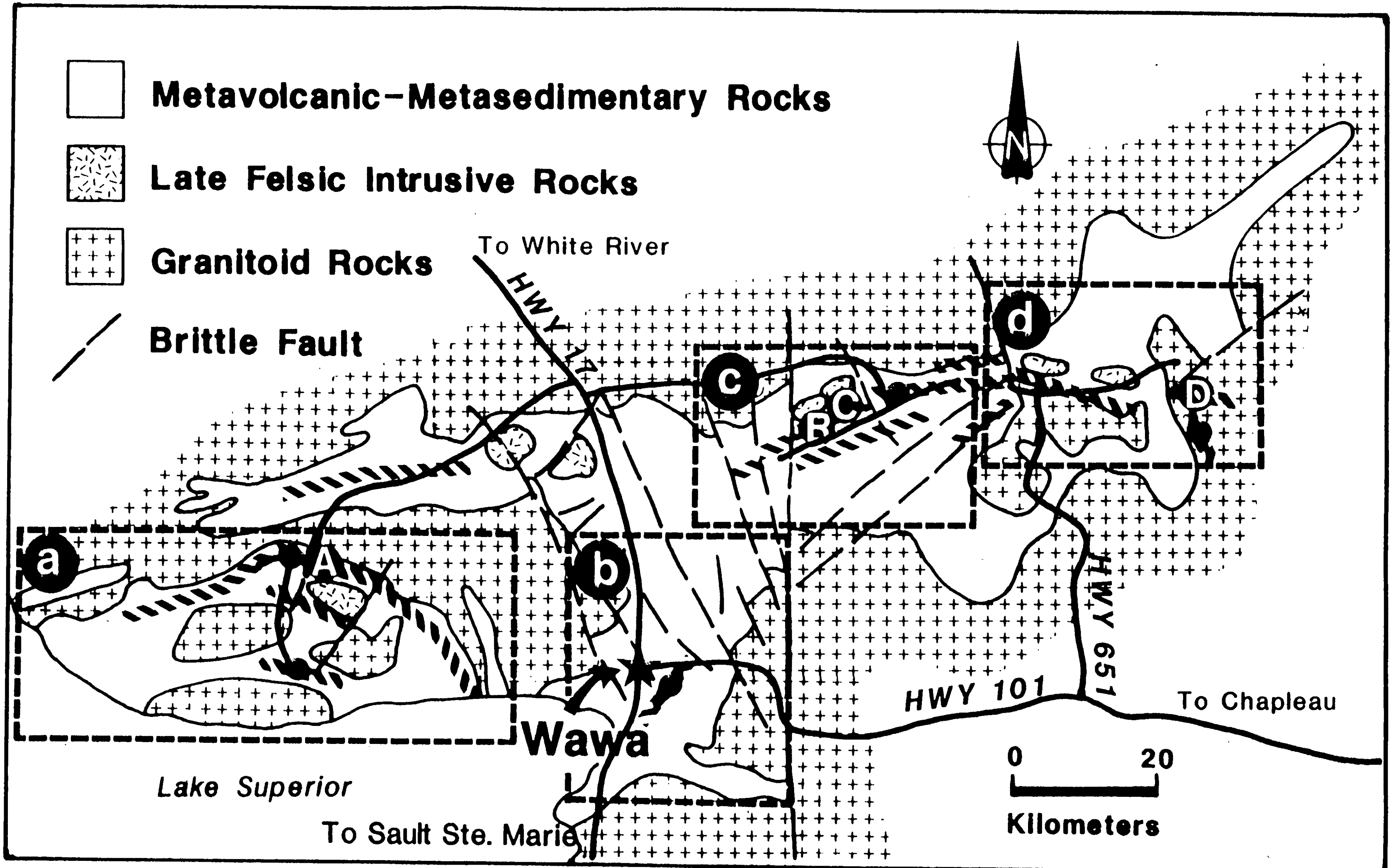


FIGURE 2: Regional location and access map for the Wawa area and location of the gold districts (outlined rectangles: *a*, Mishibishu Lake district; *b*, Michipicoten district; *c*, Goudreau-Lochalsh district; *d*, Missanabie-Renabie district), deformation zones (stripped lines), gold mines (capital letters: **A**=Magnacon, **B**=Magino, **C**=Kremzar, **D**=Renabie), and other significant gold occurrences (small black dots) of the Wawa Gold Camp.

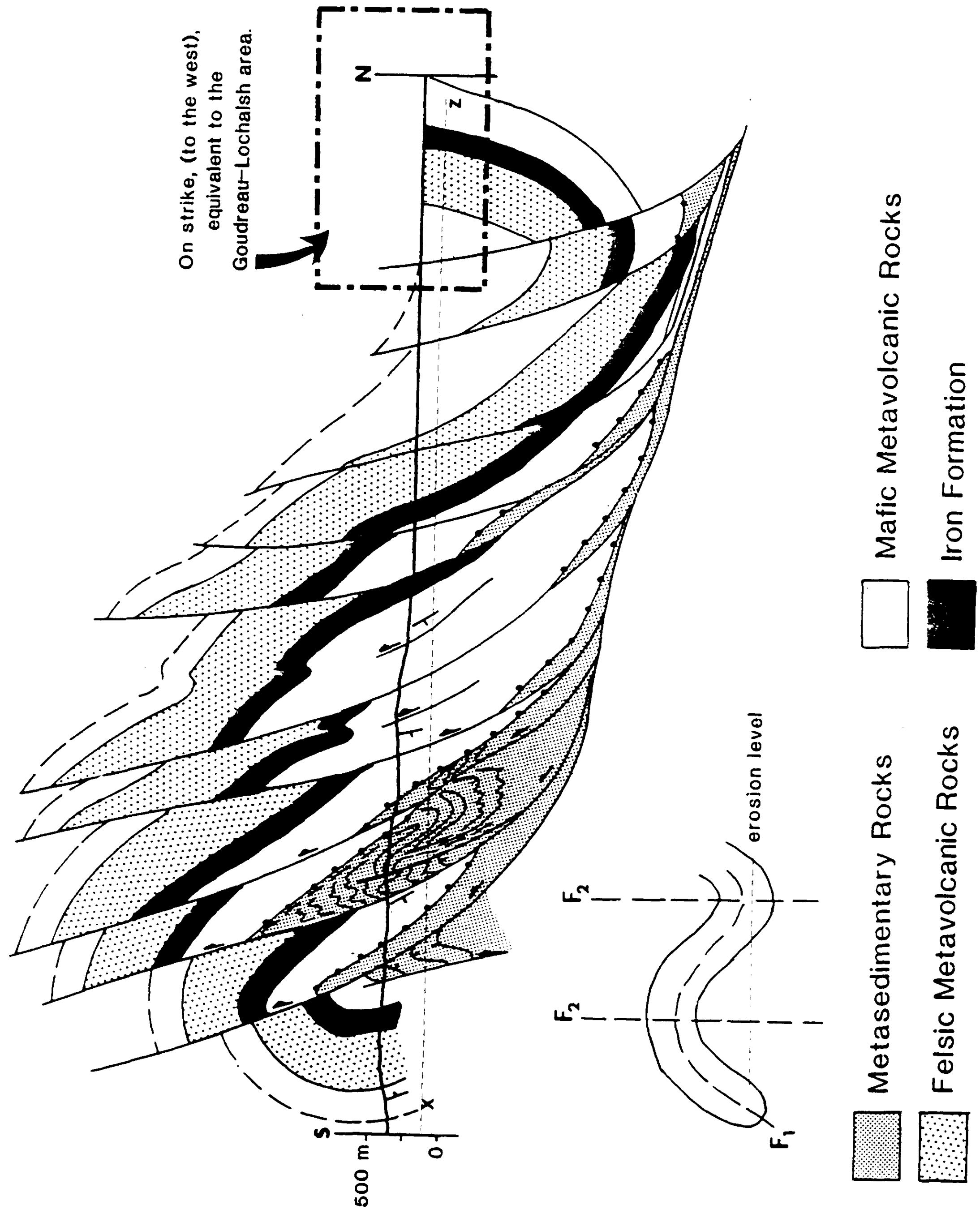


FIGURE 4: Composite structural section through the central part of the Michipicoten greenstone belt (section X-Y-Z indicated on Figure 5). See Figure 5 for legend. The sketch (lower left) explains the present configuration of the belt as a regional nappe fold (F_1) refolded about F_2 and imbricately thrusted (from Arias and Helmstaedt 1990).

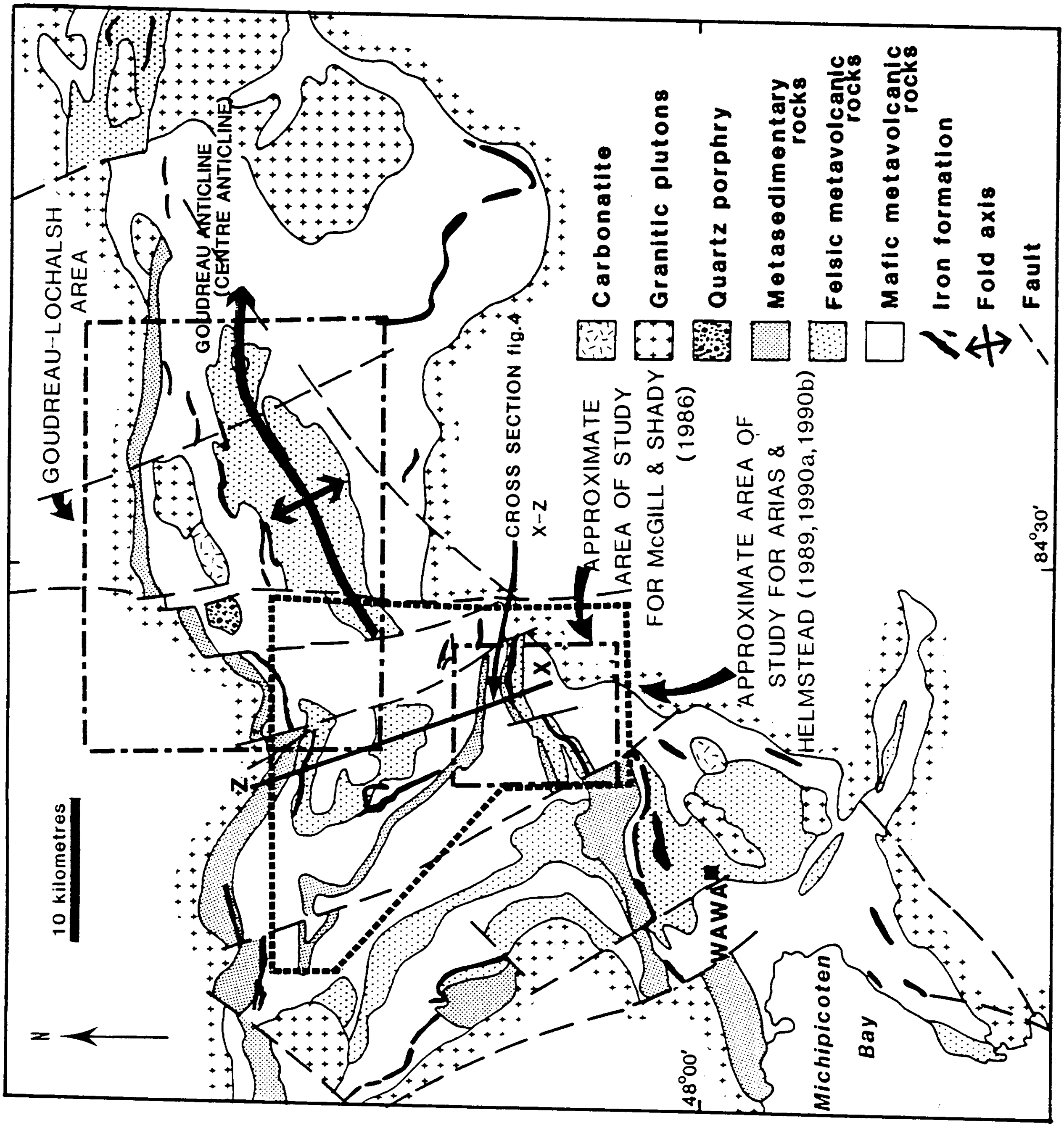


FIGURE 5: General geology and structure of the Michipicoten greenstone belt (modified from Arias and Helmstaedt 1990). The location of the cross-section (Figure 4) is indicated by the line labelled Z-X.

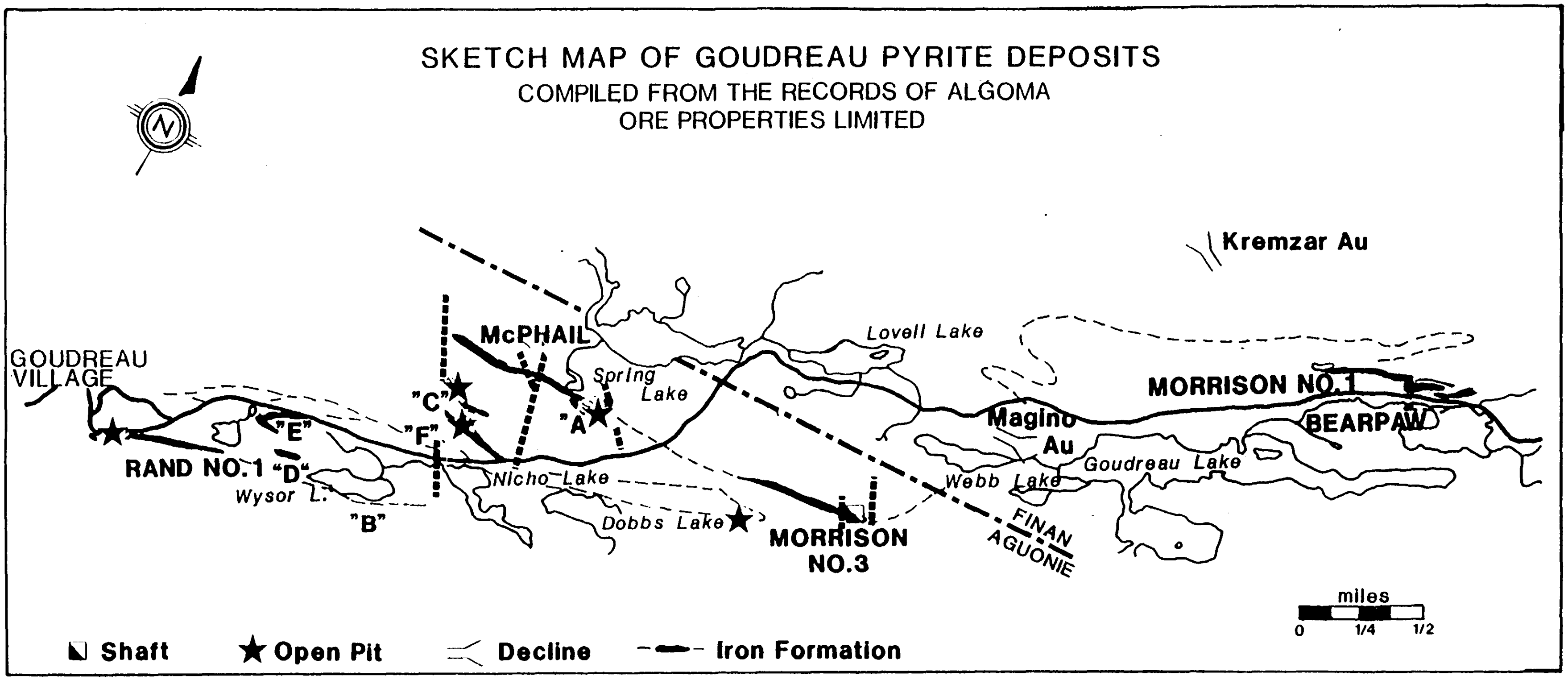


FIGURE 6: Regional-scale sketch showing the locations of the significant pyrite (Fe) deposits. Note the folding, attenuation and dismemberment of this once continuous horizon.

FIGURE 7: Schematic map showing the regional distribution of foliations and lineations in the Goudreau-Lochalsh area.

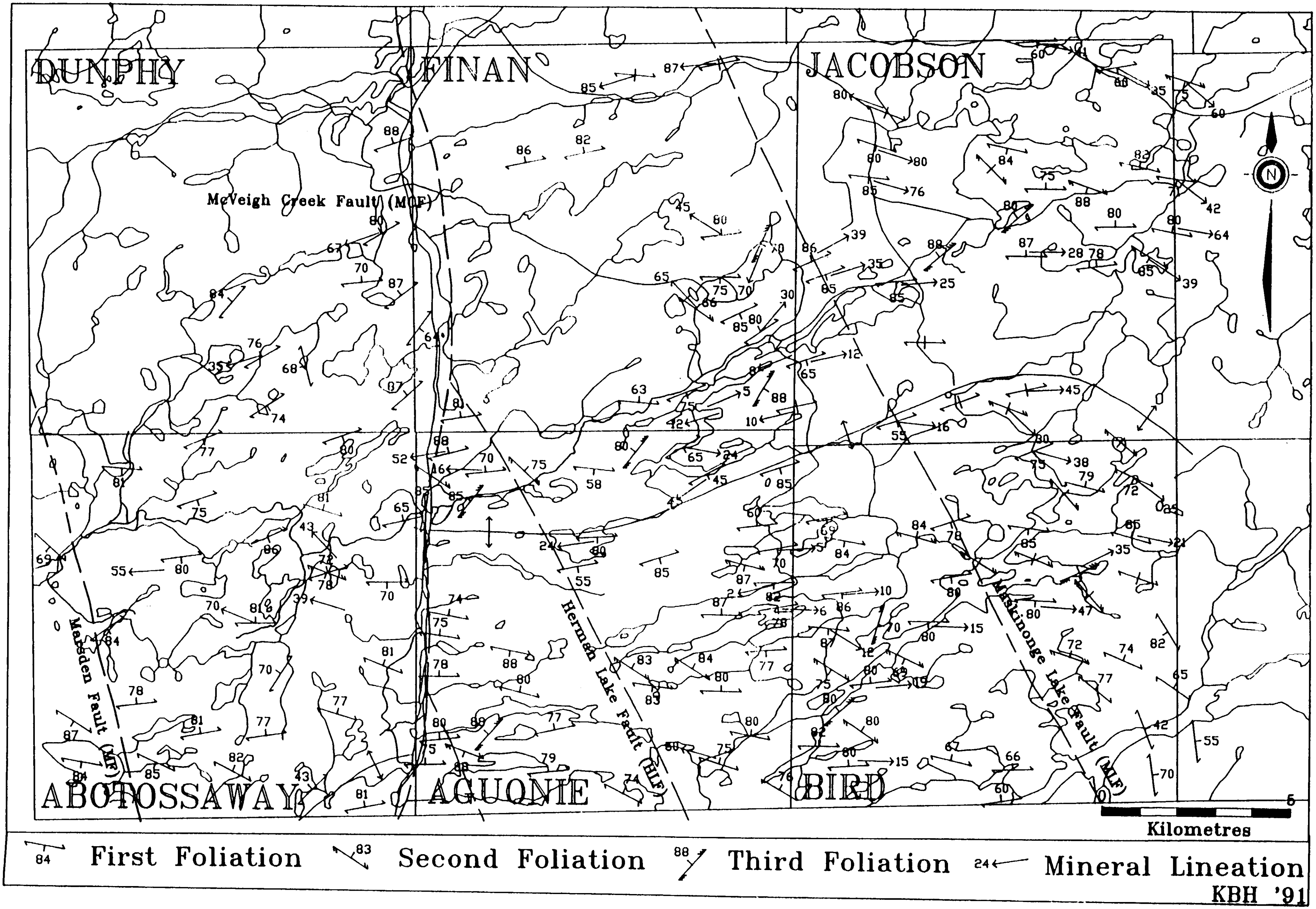
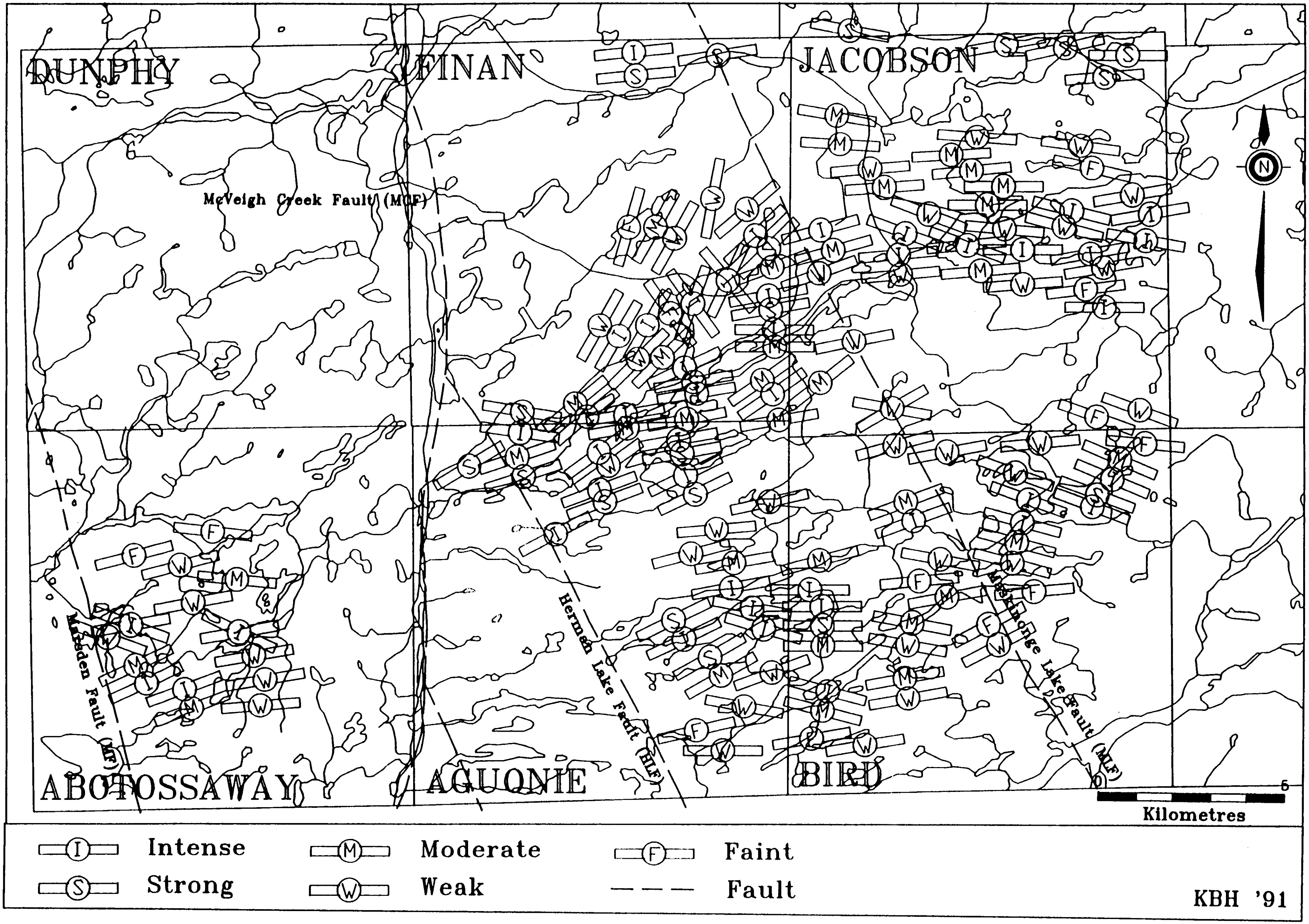


FIGURE 8: Schematic map showing the deformation intensity of rocks in the Goudreau-Lochalsh area.



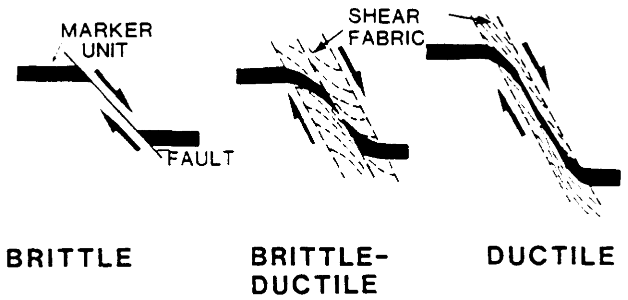


FIGURE 9: Characteristics of brittle, brittle-ductile and ductile deformation (from Ramsay 1980).

FIGURE 10: Schematic map showing the regional distribution of fracture cleavages and high-strain zones in the Goudreau-Lochalsh area. Note the orientation and sense of displacement of the discrete, high-strain zones.

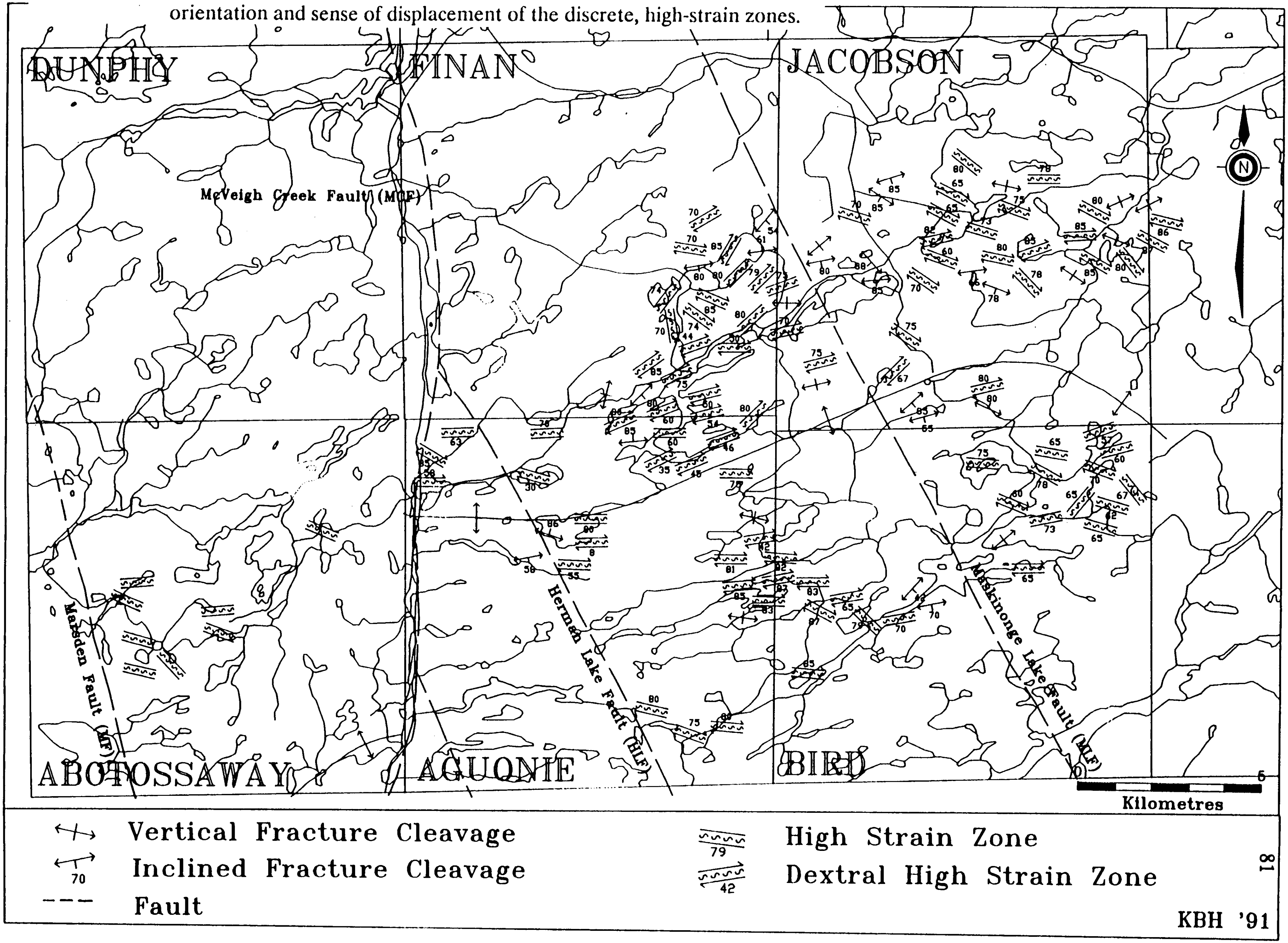


FIGURE 11: Relationship of deformation zones to (a) strain intensity, (b) high-strain zones and fracture cleavages, and (c) foliations and lineations in the Goudreau-Lochalsh district.

Figure 11a

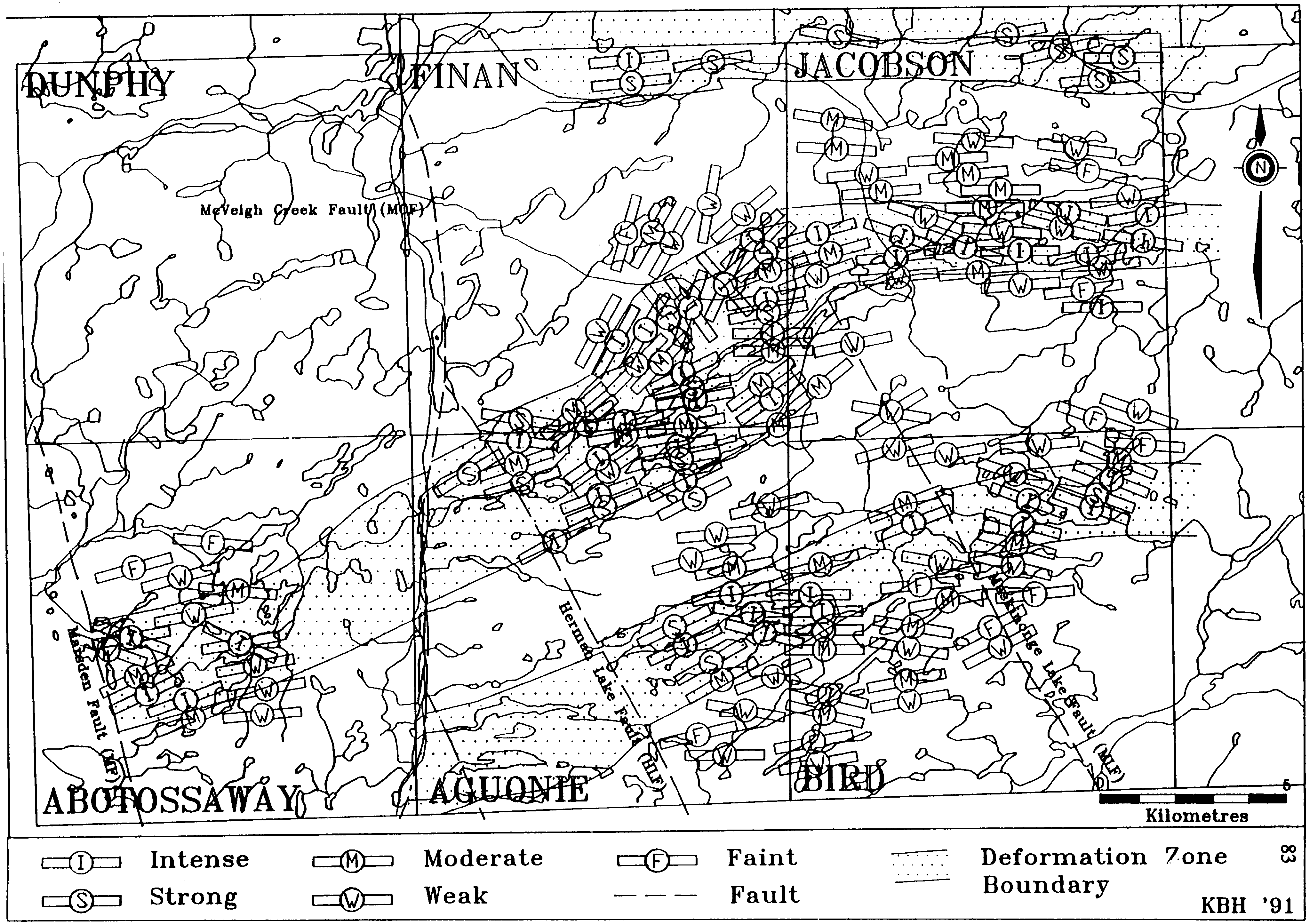

DUNPHY
FINAN
JACOBSON
ABOTOSSAWAY
AGUONIE
BIRD
McVeigh Creek Fault (MCF)
Marsden Fault (MF)
Herman Lake Fault (HLF)
Maskinonge Lake Fault (MLF)
N
0
5
Kilometres
Intense
Strong
Moderate
Weak
Faint
Fault
Deformation Zone
Boundary
KBH '91

Figure 11b

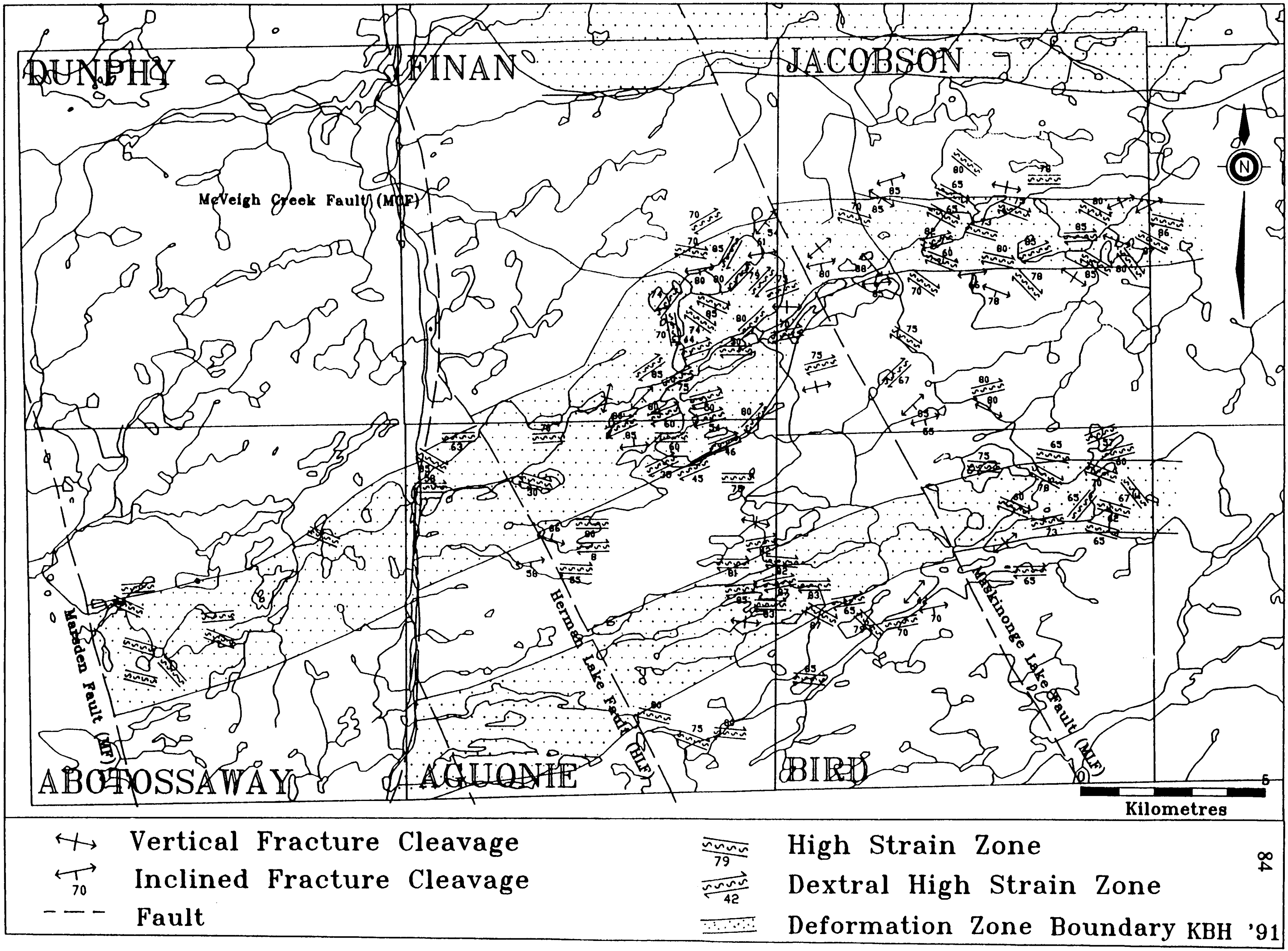
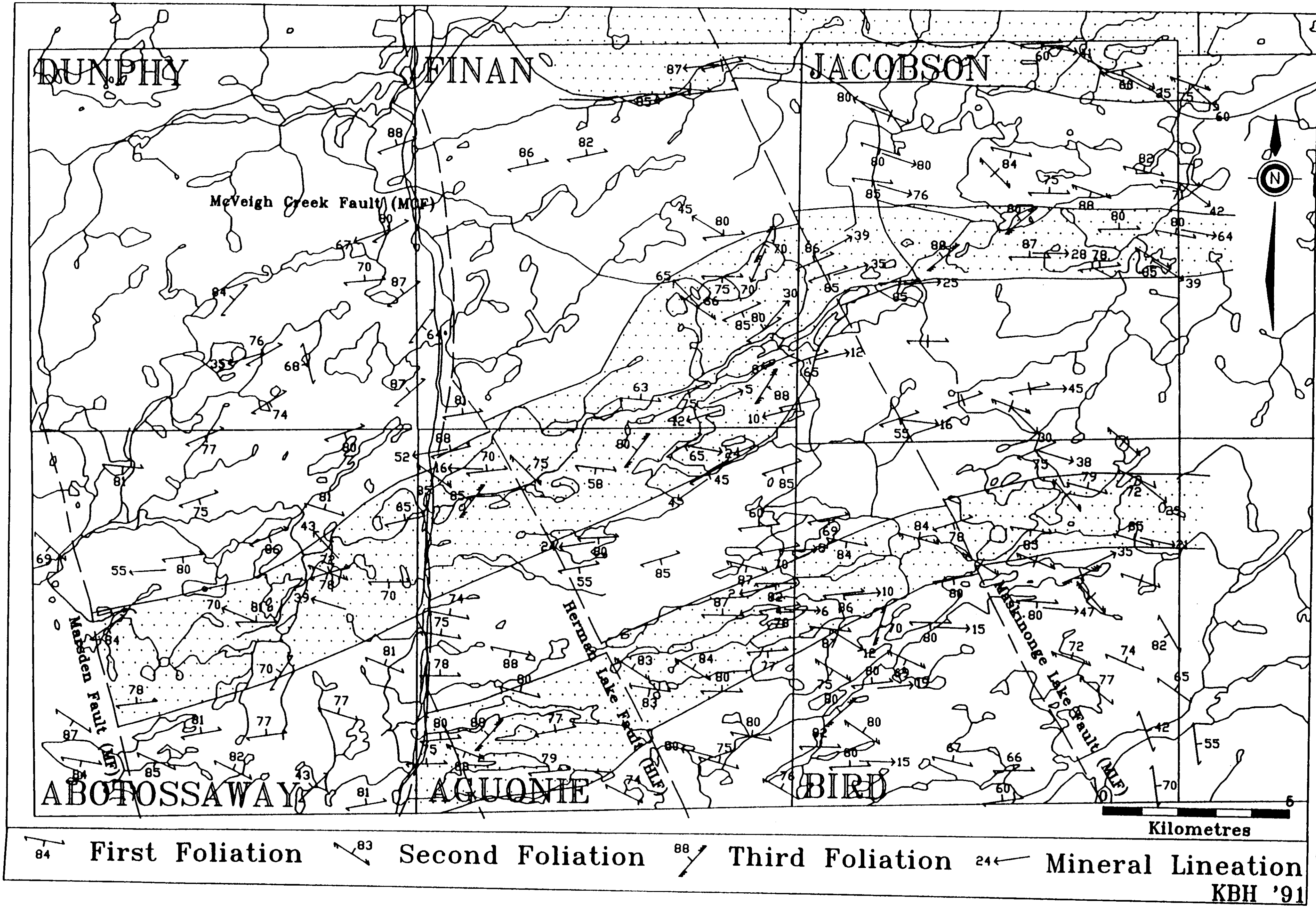

DUNPHY
FINAN
JACOBSON
ABOTOSSAWAY
AGUONIE
BIRD
McVeigh Creek Fault (MCF)
Marsden Fault (MF)
Herman Lake Fault (HLF)
Maskinonge Lake Fault (MLF)
N
5
Kilometres
Vertical Fracture Cleavage
Inclined Fracture Cleavage
70
Fault
High Strain Zone
79
Dextral High Strain Zone
42
Deformation Zone Boundary
KBH '91

Figure 11c



DUNPHY
FINAN
JACOBSON
ABOTOSSAWAY
AGUONIE
BIRD
McVeigh Creek Fault (MCF)
Herman Lake Fault (HLF)
Maskinonge Lake Fault (MLF)
Marsden Fault (MF)
N
0
5
Kilometres
First Foliation
Second Foliation
Third Foliation
Mineral Lineation
KBH '91

FIGURE 12: Deformation zones of the Goudreau-Lochalsh area subdivided into (a) structural domains and their associated structural style, based on distinct (b) lineation patterns within each structural domain, and specific (c) high-strain zone and fracture cleavage orientations within each structural domain.

Figure 12a

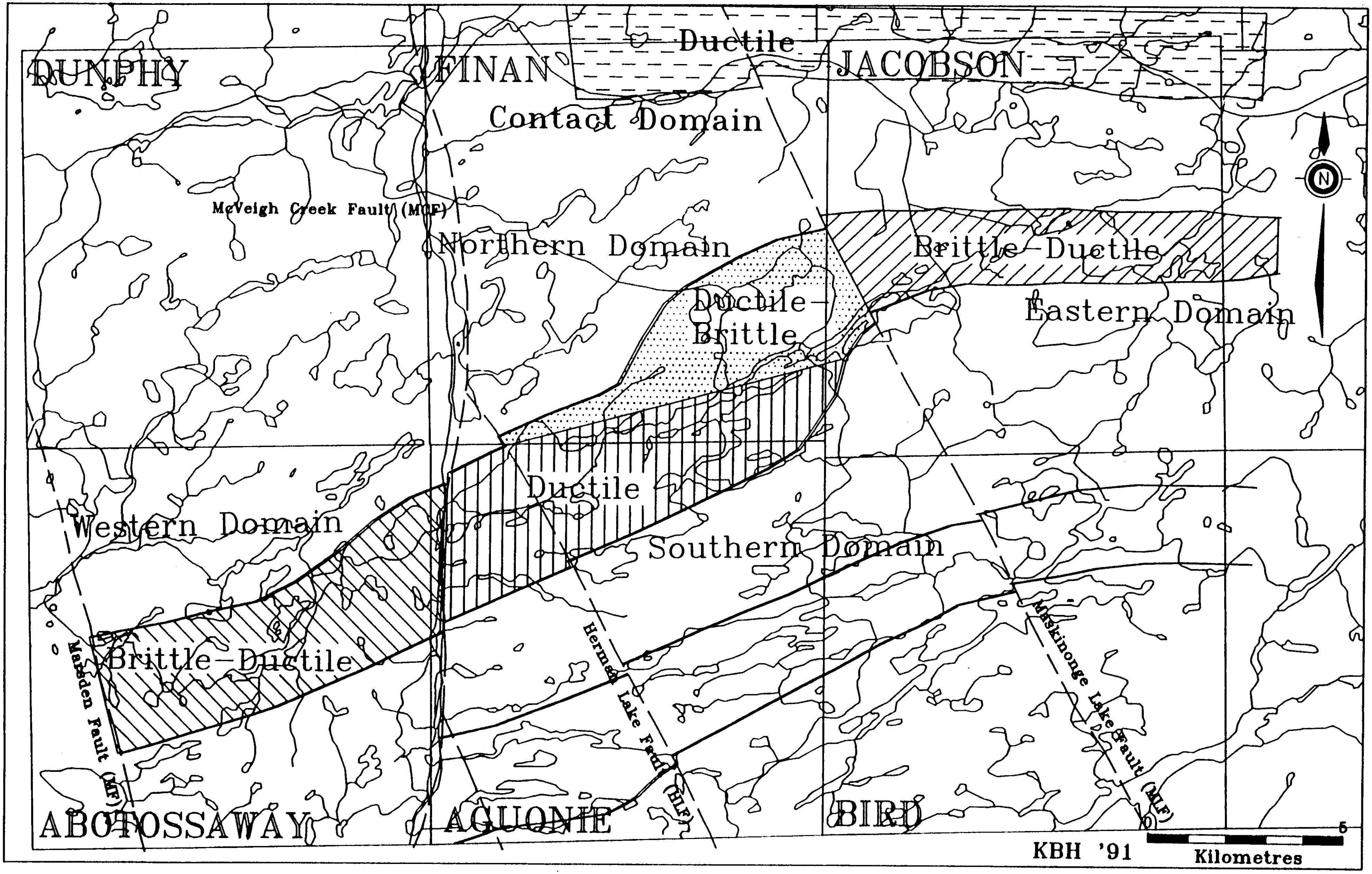
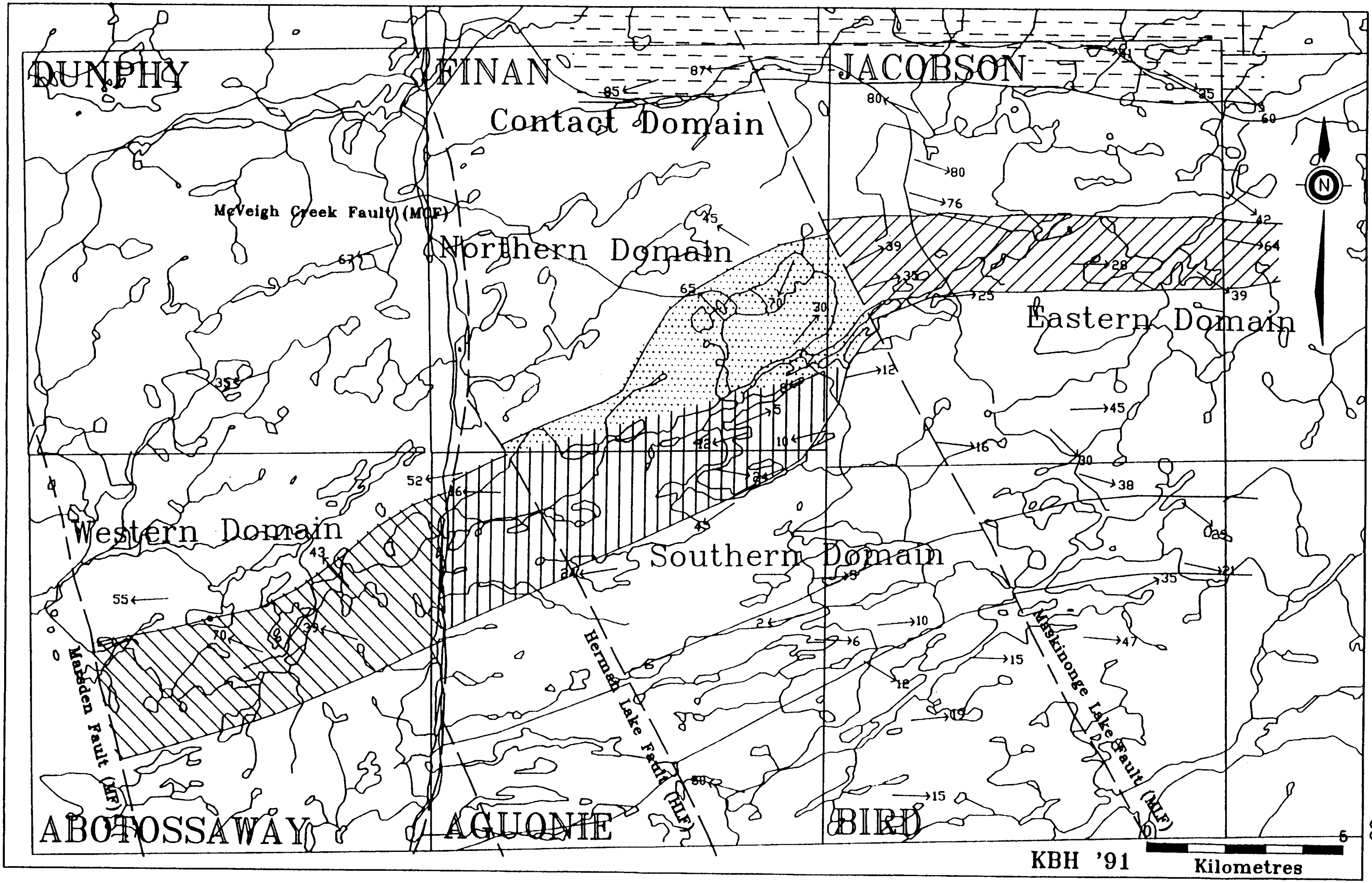
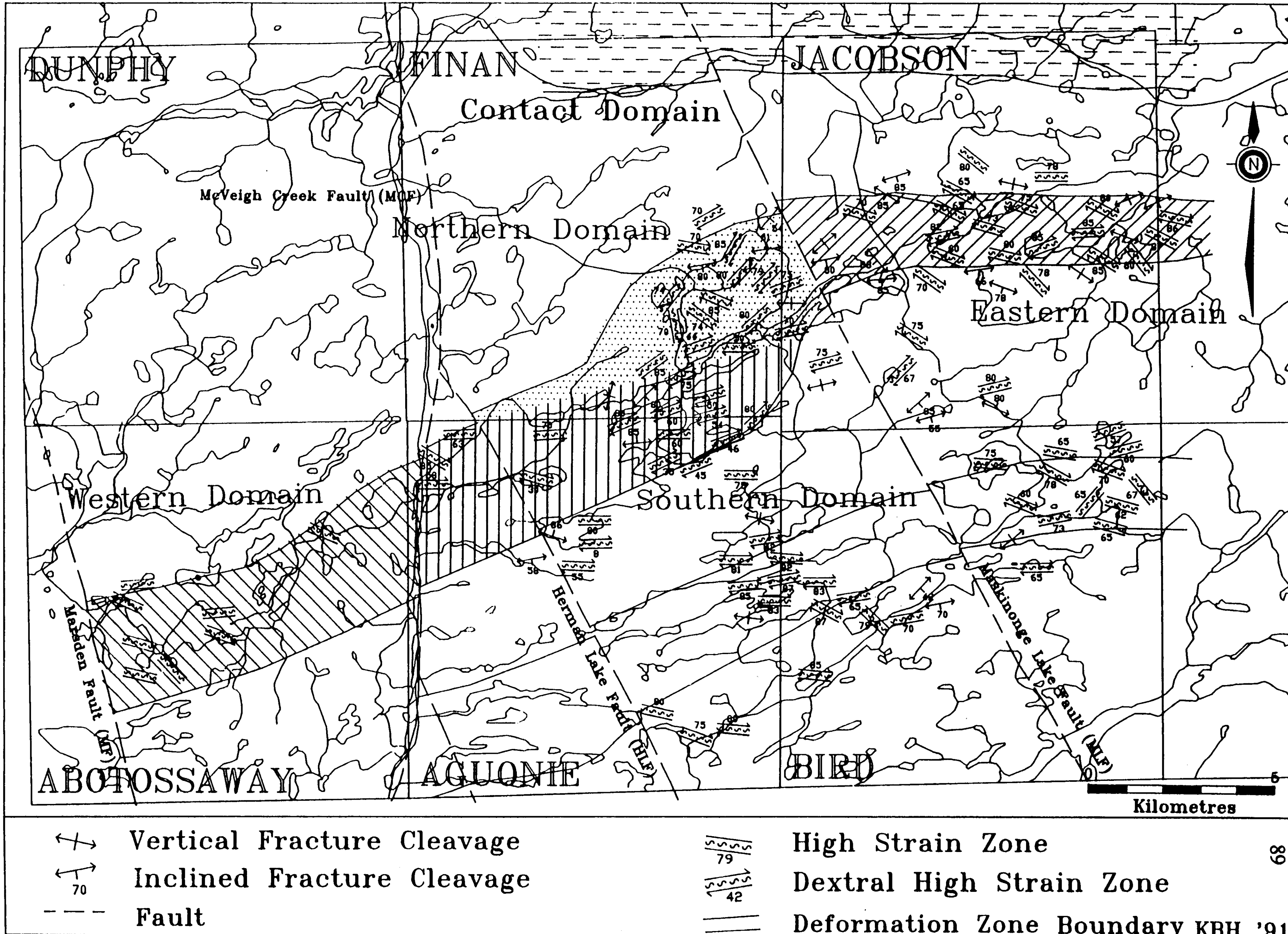

Ductile
DUNPHY
FINAN
JACOBSON
Contact Domain
McVeigh Creek Fault (MCF)
Northern Domain
Brittle-Ductile
Ductile-
Brittle
Eastern Domain
Ductile
Western Domain
Southern Domain
Brittle-Ductile
Marsden Fault (MF)
Herman Lake Fault (HLF)
Maskinonge Lake Fault (MLF)
ABOTOSSAWAY
AGUONIE
BIRD
0
5
KBH '91
Kilometres

Figure 12b


DUNPHY
FINAN
JACOBSON
ABOTOSSAWAY
AGUONIE
BIRD
Contact Domain
Northern Domain
Eastern Domain
Western Domain
Southern Domain
McVeigh Creek Fault (MCF)
Marsden Fault (MF)
Herman Lake Fault (HLF)
Maskinonge Lake Fault (MLF)
N
KBH '91
0
5
Kilometres

F ure


DUNPHY
FINAN
JACOBSON
ABOTOSSAWAY
AGUONIE
BIRD
Contact Domain
Northern Domain
Eastern Domain
Western Domain
Southern Domain
McVeigh Creek Fault (MCF)
Marsden Fault (MF)
Herman Lake Fault (HLF)
Maskinonge Lake Fault (MLF)
N
0
5
Kilometres
Vertical Fracture Cleavage
Inclined Fracture Cleavage
Fault
High Strain Zone
Dextral High Strain Zone
Deformation Zone Boundary
KBH '91

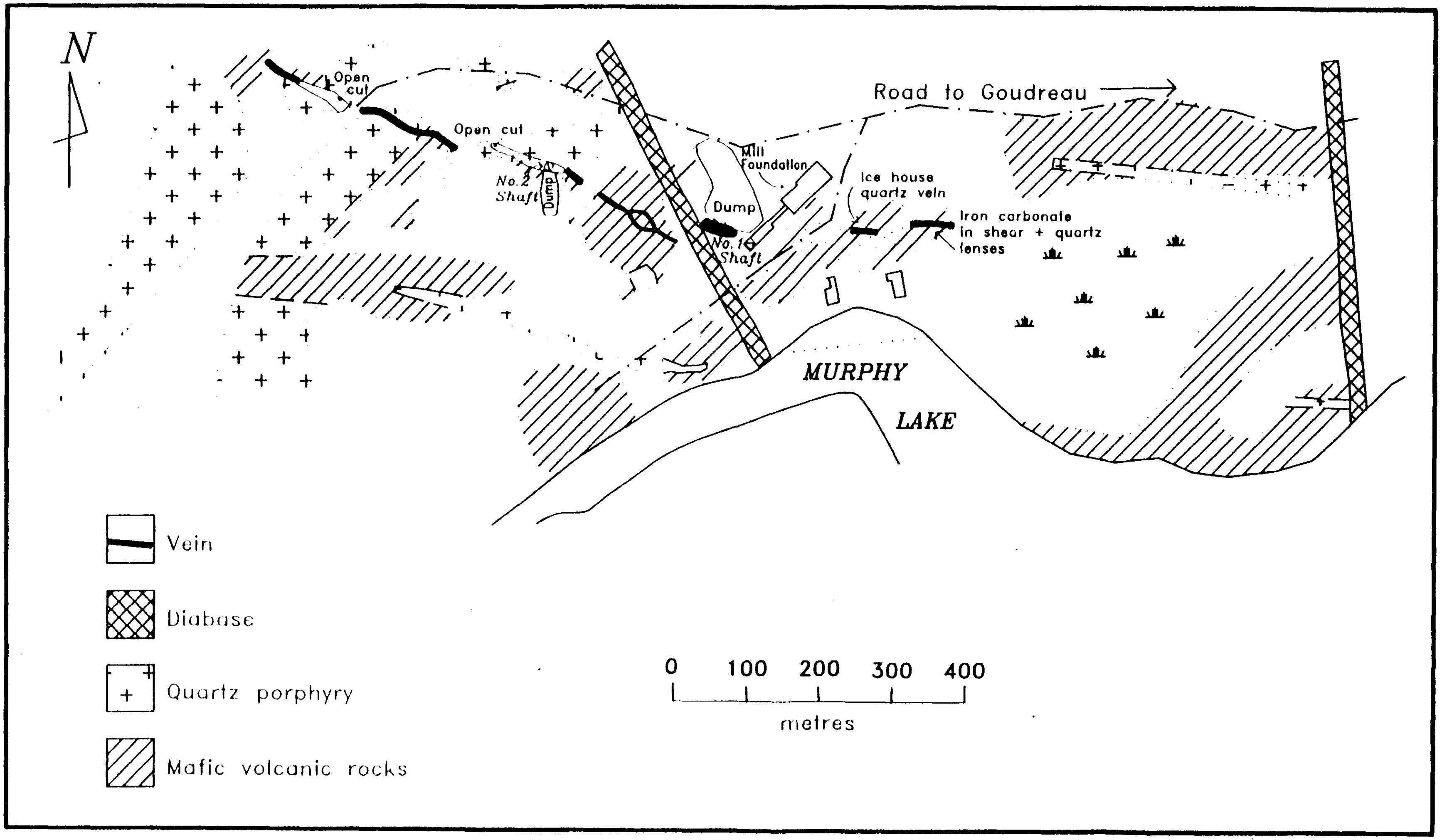


FIGURE 14: General geology of the Murphy gold mine area. The geology has been compiled from Bruce (1942), Gledhill (1927), Moore (1931) and assessment file data.

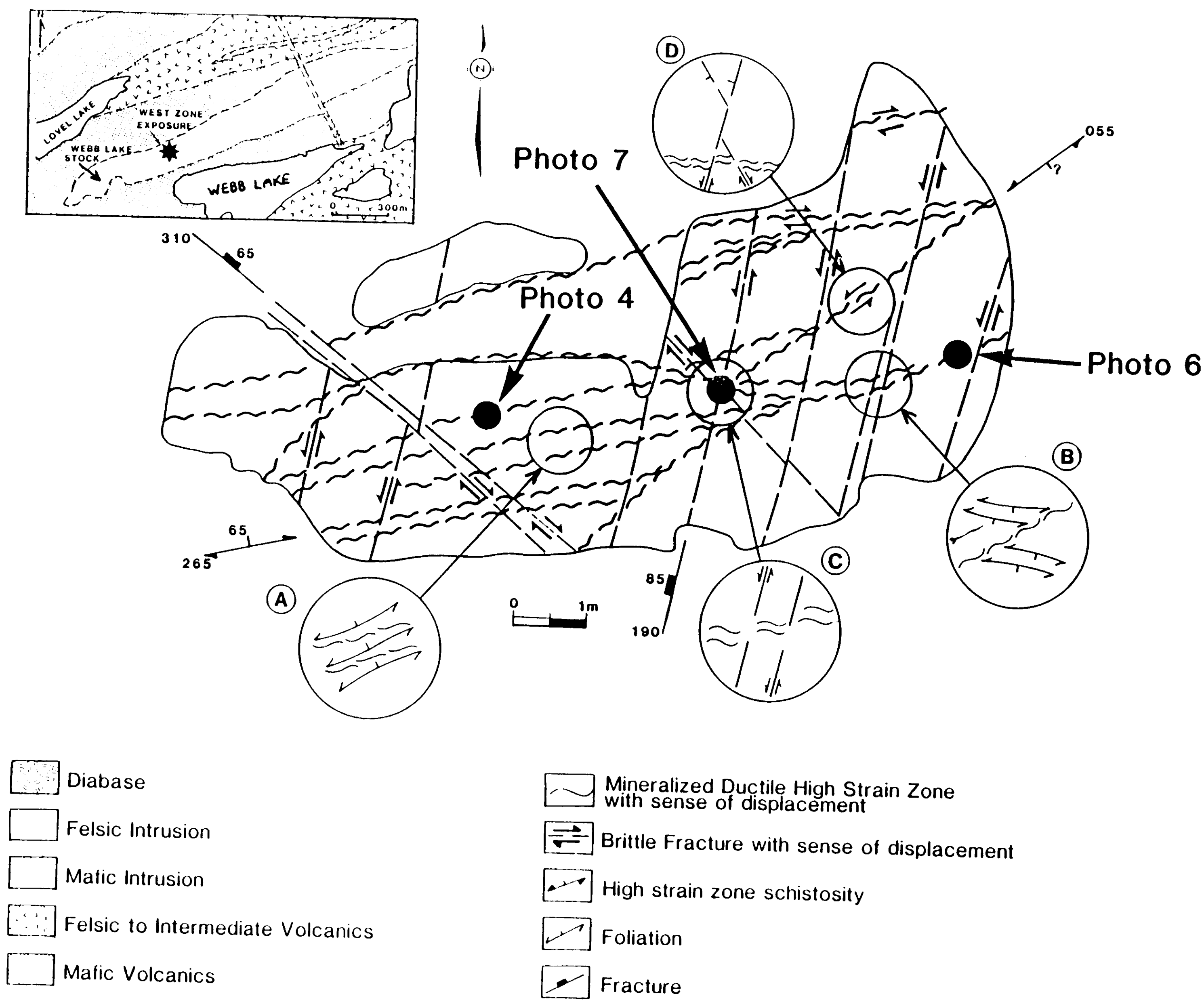


FIGURE 15: Simplified geology of the Magino gold mine area (small inset) compiled from Bruce (1942), Gledhill (1927), Moore (1931) and assessment file data. Detailed geology and structure of the West Zone, Magino gold mine as mapped by K.B. Heather in 1987.

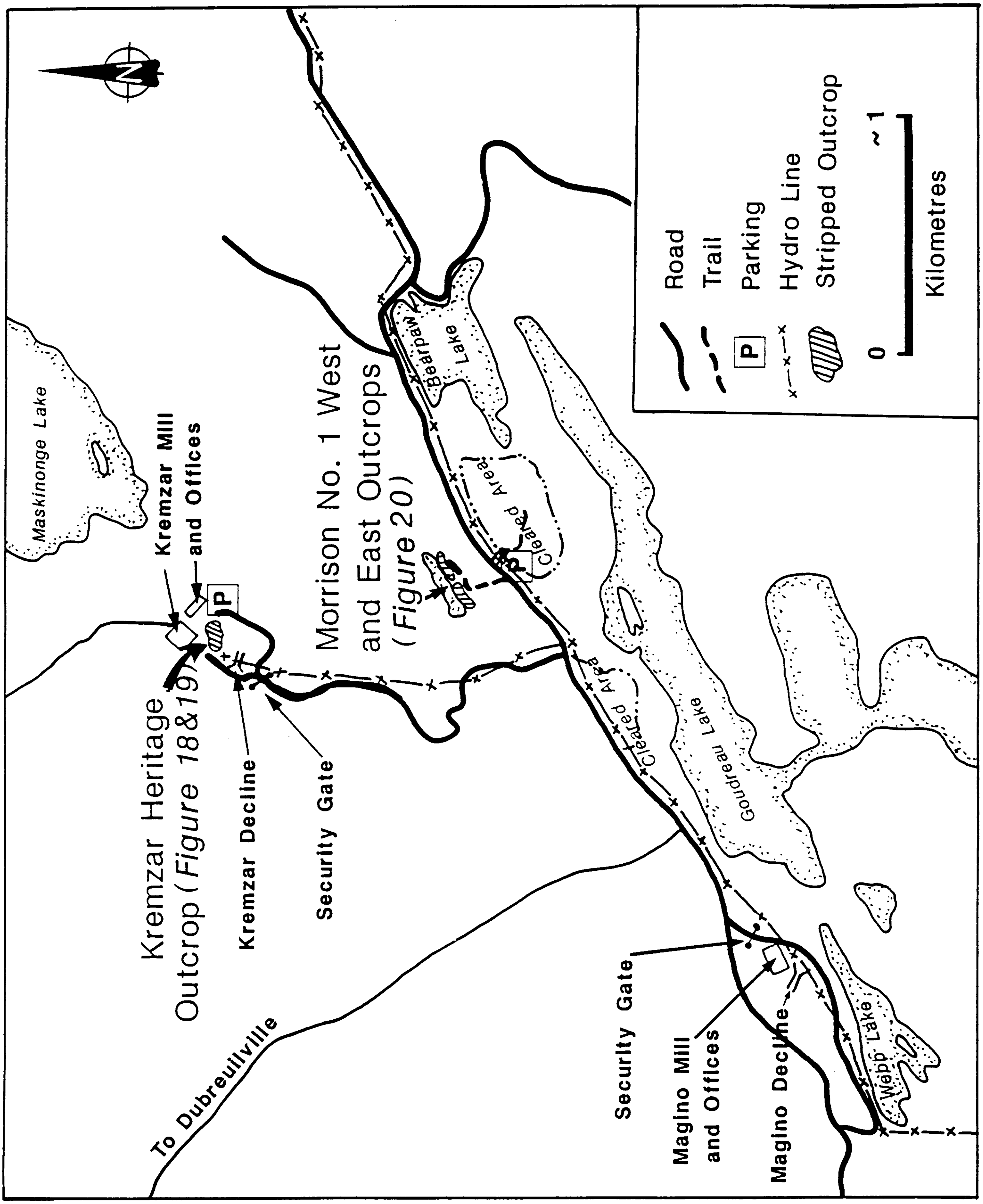


FIGURE 17: Location map for the Kremzar gold mine, Morrison No.1 occurrence, Magino gold mine and the Island-Lochalsh Zones.

FIGURE 18: Detailed geology, structure and FEATURE locations for the Heritage outcrop, Kremzar gold mine.

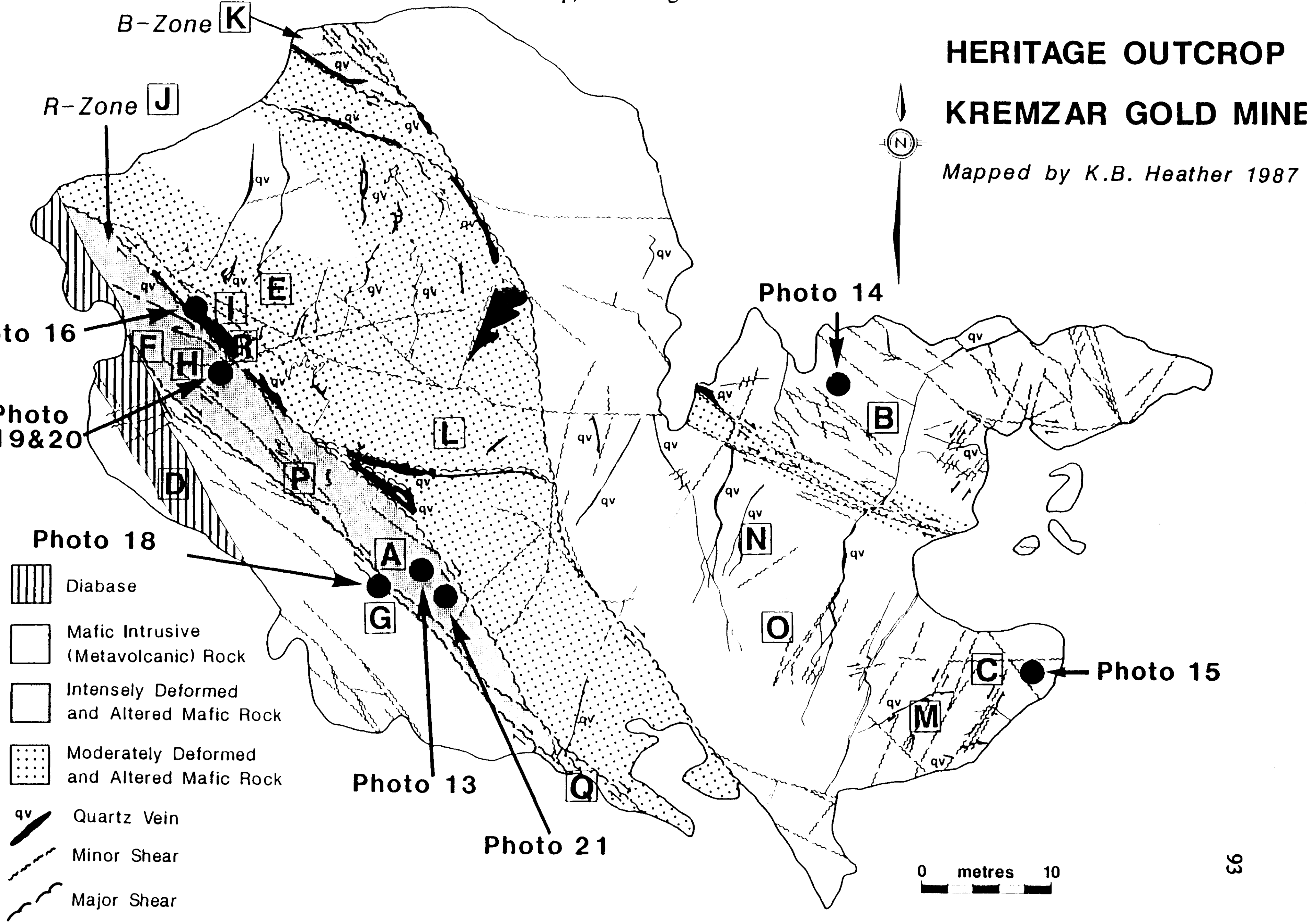
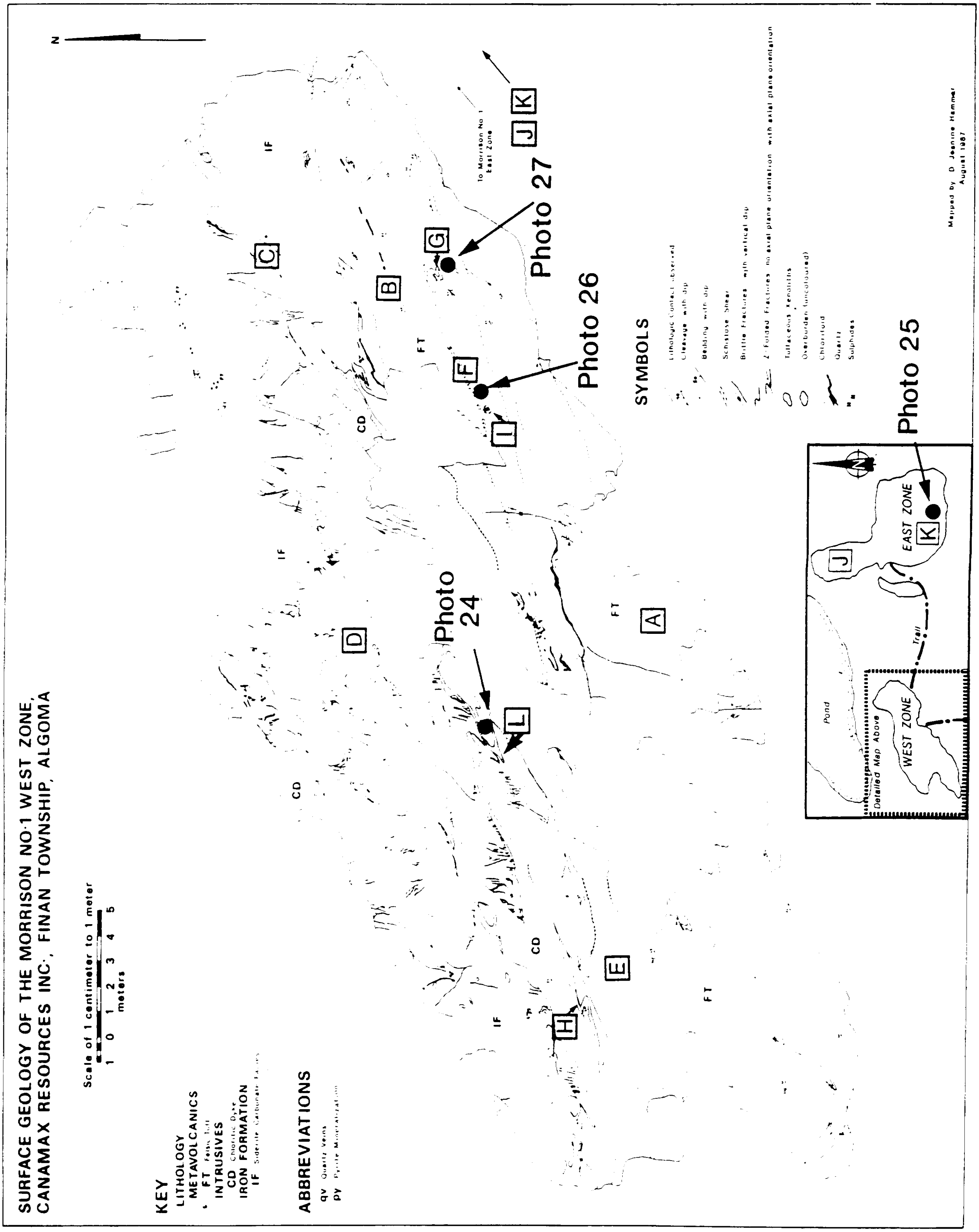


FIGURE 20: Detailed geology map of the Morrison No.1 gold occurrence (from Hammer 1988) and FEATURE locations.



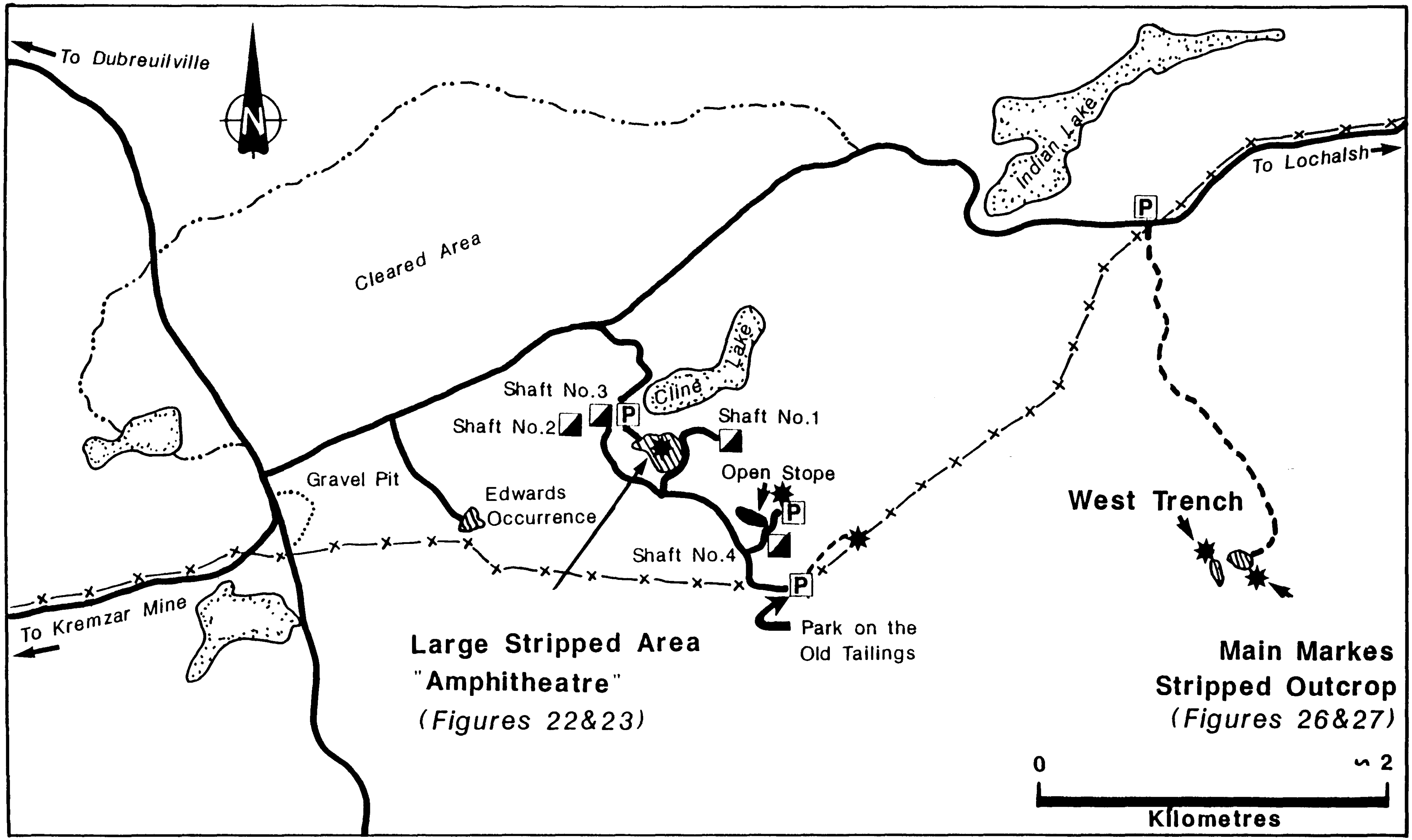


FIGURE 21: Location map for the Edwards gold mine, Cline Lake gold mine, and the Markes gold occurrence.

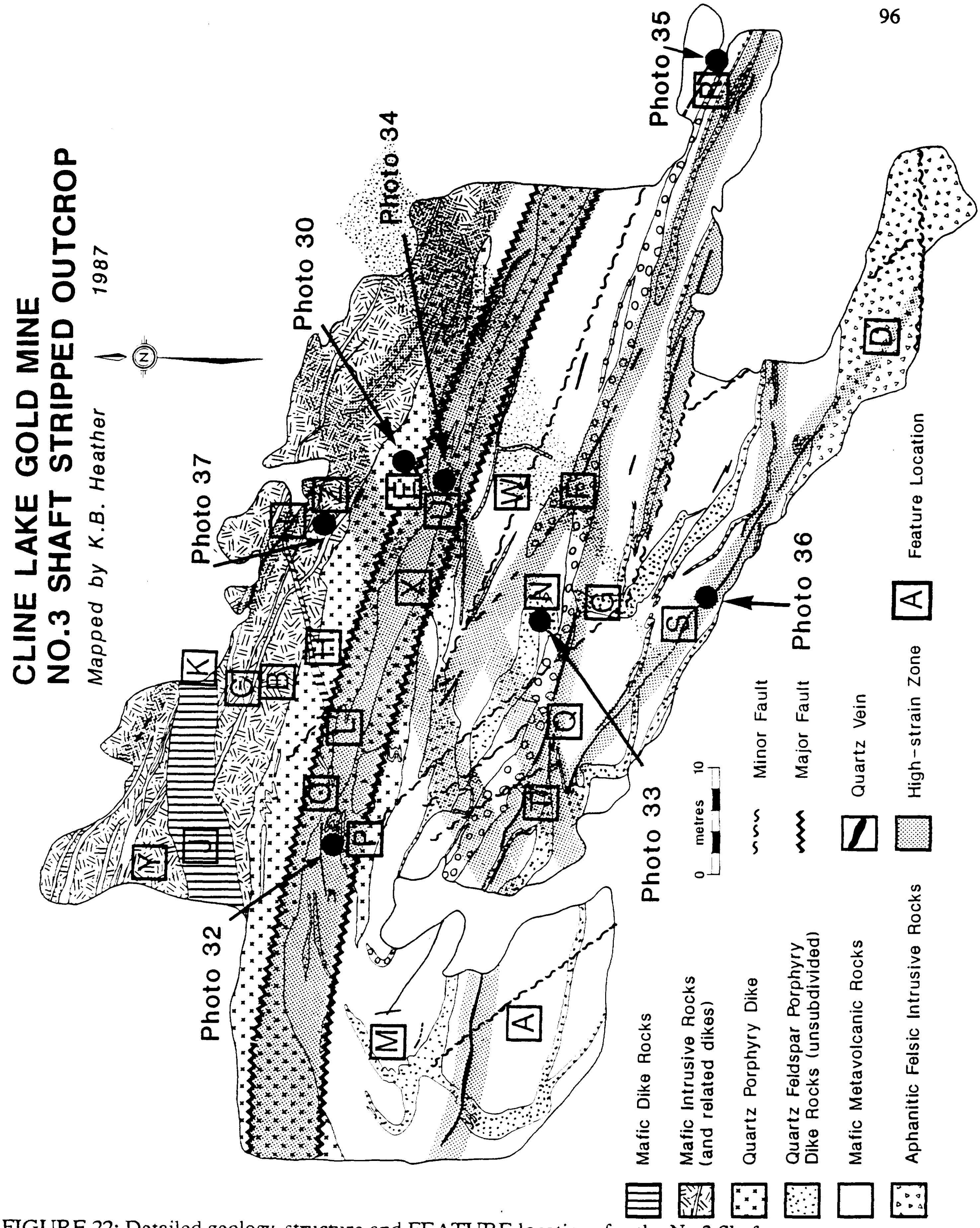


FIGURE 22: Detailed geology, structure and FEATURE locations for the No.3 Shaft mechanically stripped outcrop (The Amphitheatre), Cline Lake gold mine.

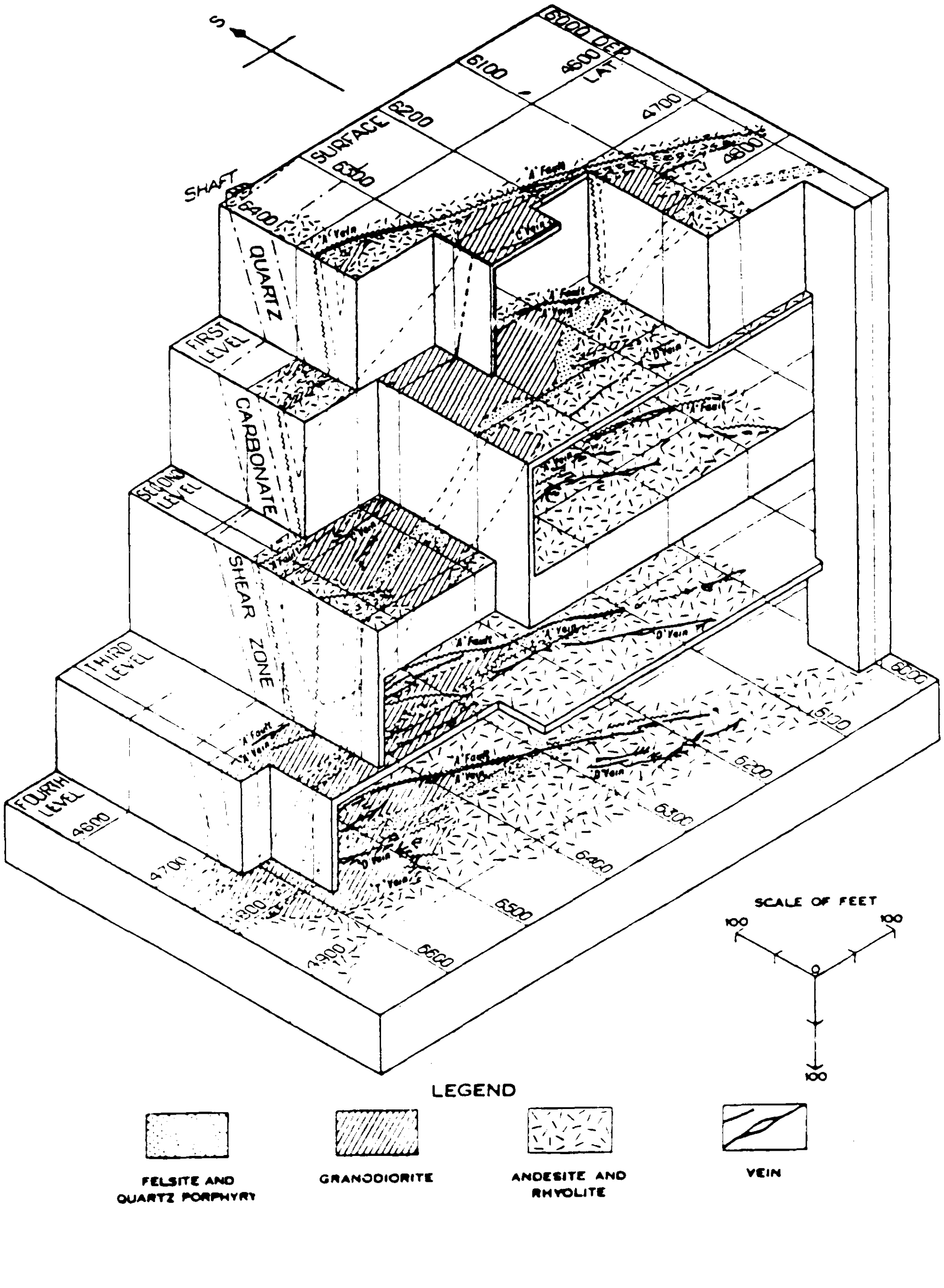


FIGURE 24: Isometric block diagram of the Cline Lake gold mine (from Bruce 1948). Note the arrow points south.

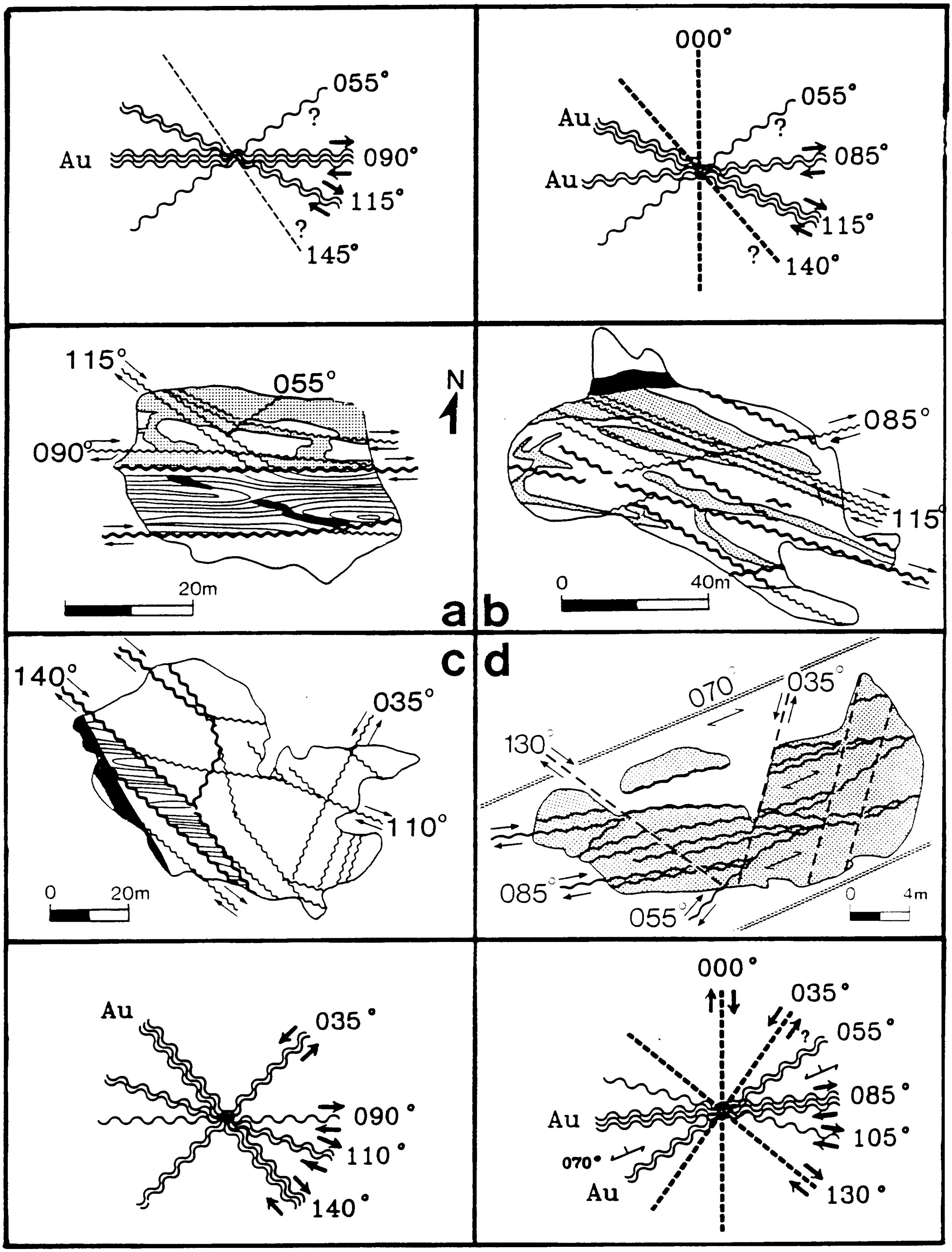


FIGURE 25: Rose diagrams of high-strain zone orientations and senses of displacement for: (a) the regional groups of gold-bearing high-strain zones from the Goudreau-Lochalsh area; (b) the Markes gold occurrence; (c) the Cline Lake gold mine; (d) the Kremzar gold mine; and (e) the Magino gold mine.

LEGEND: The intensity (and size) of the brittle-ductile high-strain zones are denoted by three styles of sinuous lines: (i) strong (triple line); (ii) moderate (double line); (iii) weak (single line). Brittle faults are denoted by a straight dashed line.

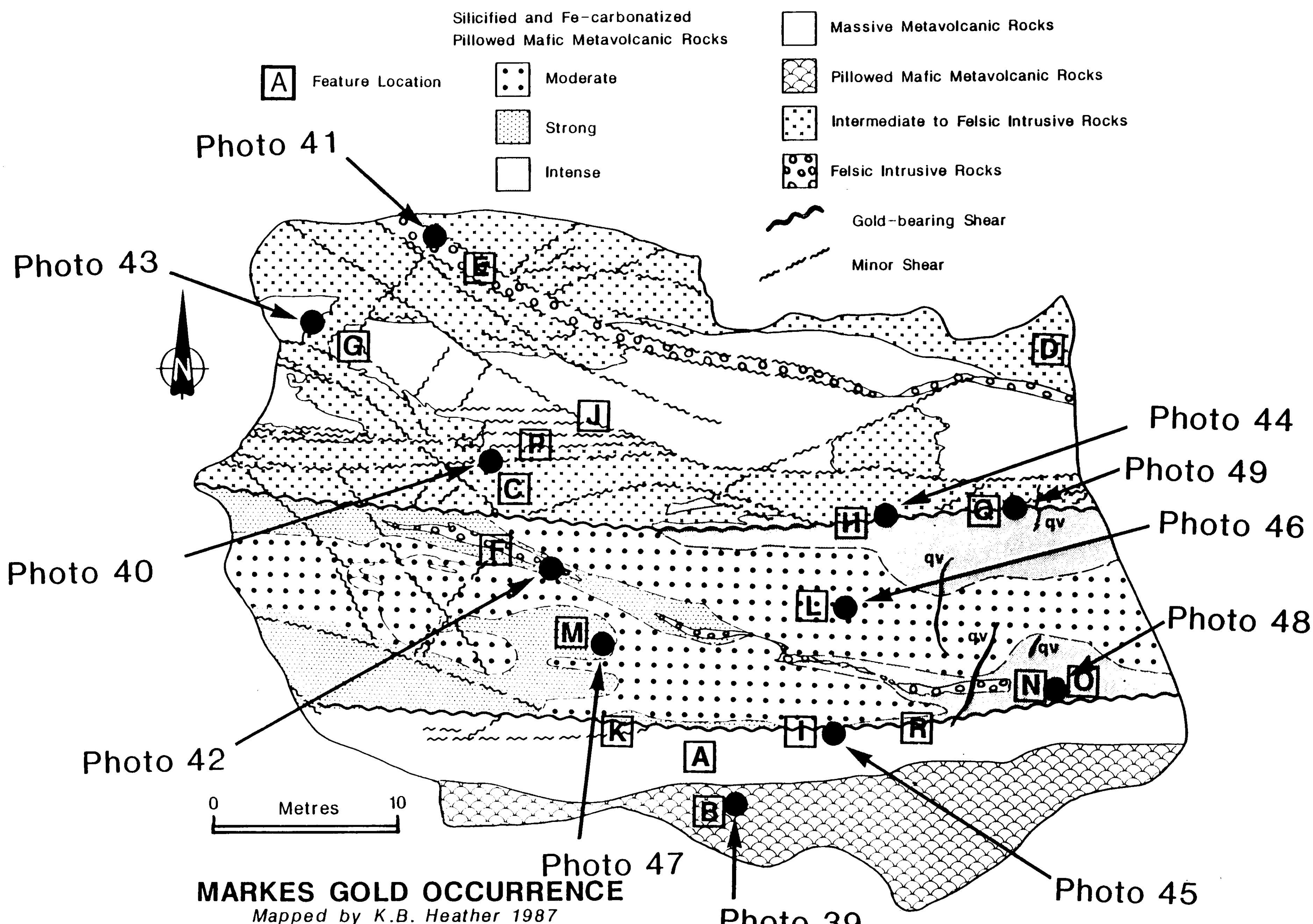
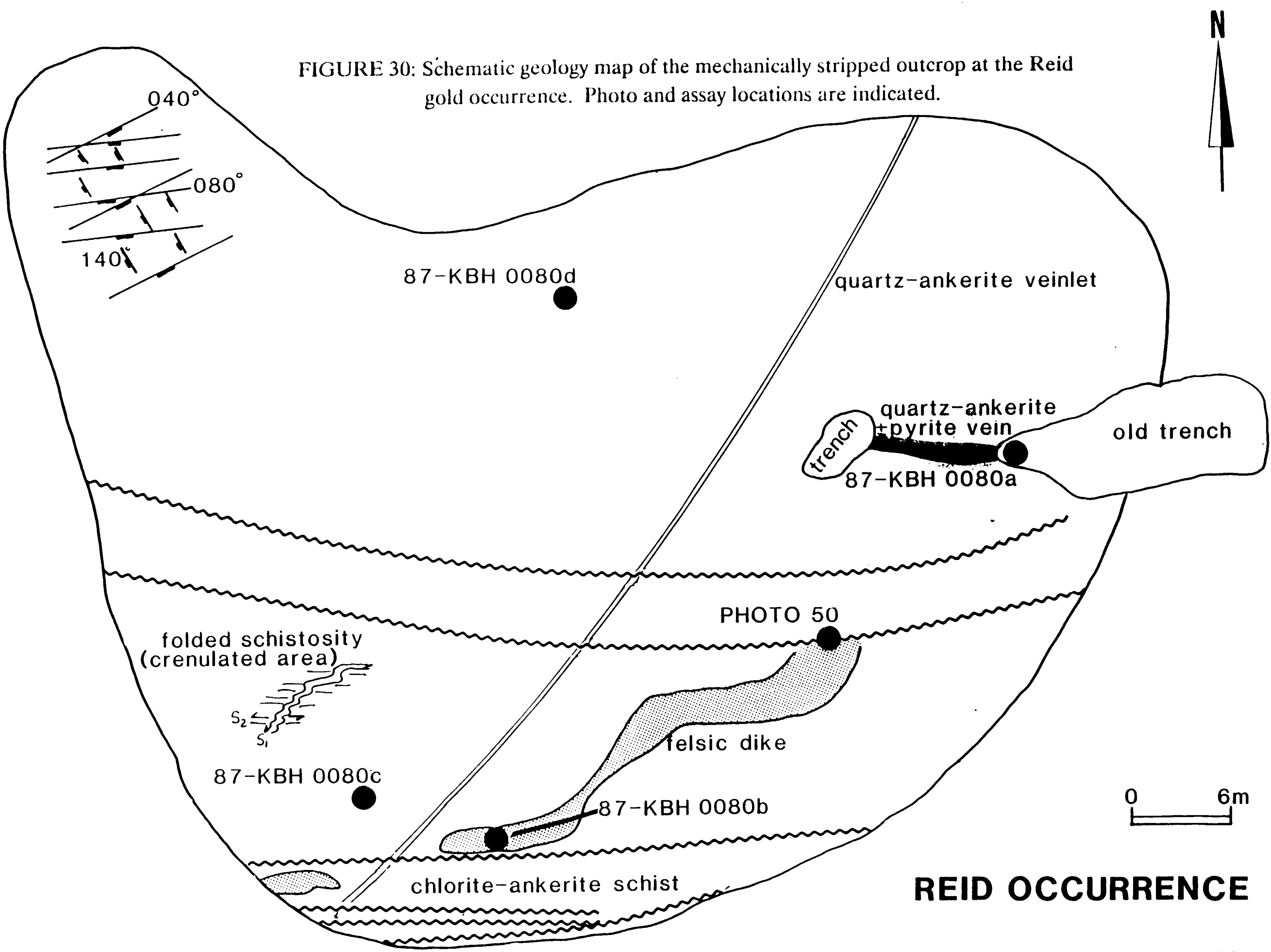


FIGURE 26: Detailed geology, structure and FEATURE locations for the Markes gold occurrence.

FIGURE 30: Schematic geology map of the mechanically stripped outcrop at the Reid gold occurrence. Photo and assay locations are indicated.



PHOTOS

PHOTO 1: (a) Relatively undeformed (i.e., faint to weak deformation intensity), pillowed, mafic metavolcanic rock. Tops can still be determined. Hammer for scale. From the Godin Lake area.
(b) Moderately deformed (i.e., moderate deformation intensity), pillowed, mafic metavolcanic rock. Pillows are elongated, tops cannot be determined. Scale card indicates north. From the vicinity of the Canamax No.3 Zone gold occurrence.
(c) Strongly to intensely deformed (i.e., strong to intense deformation intensity), pillowed, mafic metavolcanic rock. Pillows are completely obliterated within the high-strain zone (right side of photo) and highly attenuated immediately outside the high-strain zone (left side of the photo). Scale card indicates north. From adjacent to the Canamax No.3 Zone gold occurrence.

Photo 1a

Photo 1b

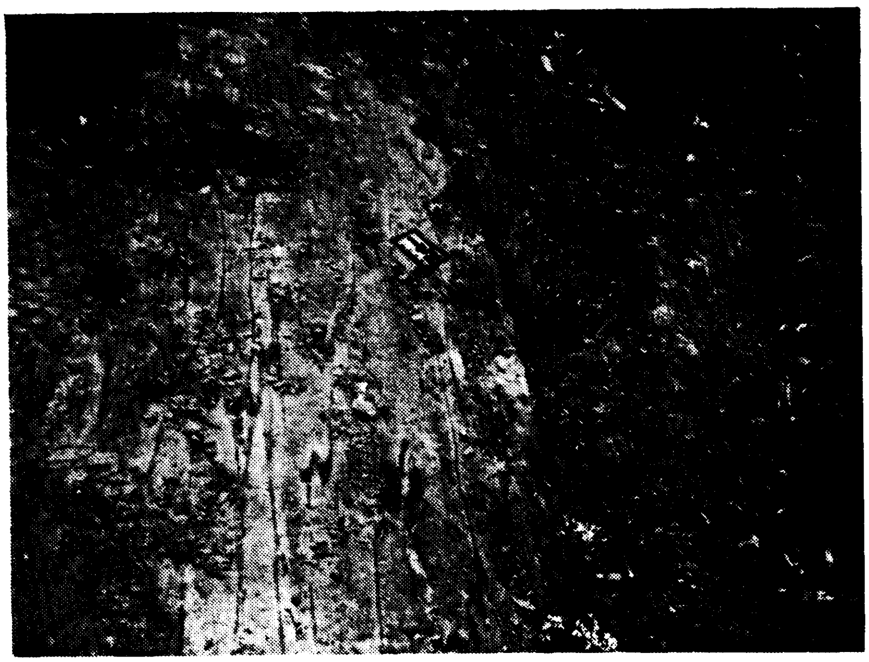


Photo 1c

PHOTO 2: (a) Relatively undeformed (i.e., faint to weak deformation intensity), intermediate tuff breccia rock. Primary fragmental textures can still be seen. Hammer handle indicates north. From the Morrison Lake area.
(b) Moderately to strongly deformed (i.e., moderate to strong deformation intensity), intermediate tuff breccia rock. The fragments are slightly attenuated and alined parallel to the dominant schistosity. Note the second fracture cleavage (indicated by the double arrowhead) cutting the dominant schistosity (indicated by the single arrowhead). Hammer handle indicates north. From the Cradle Lakes area.
(c) Intensely deformed (i.e., intense deformation intensity), intermediate tuff breccia rock. The fragments are highly attenuated (some have been highlighted in the photo). Hammer for scale. From near the Bearpaw Portage gold occurrence.

Photo 2a

Photo 2b

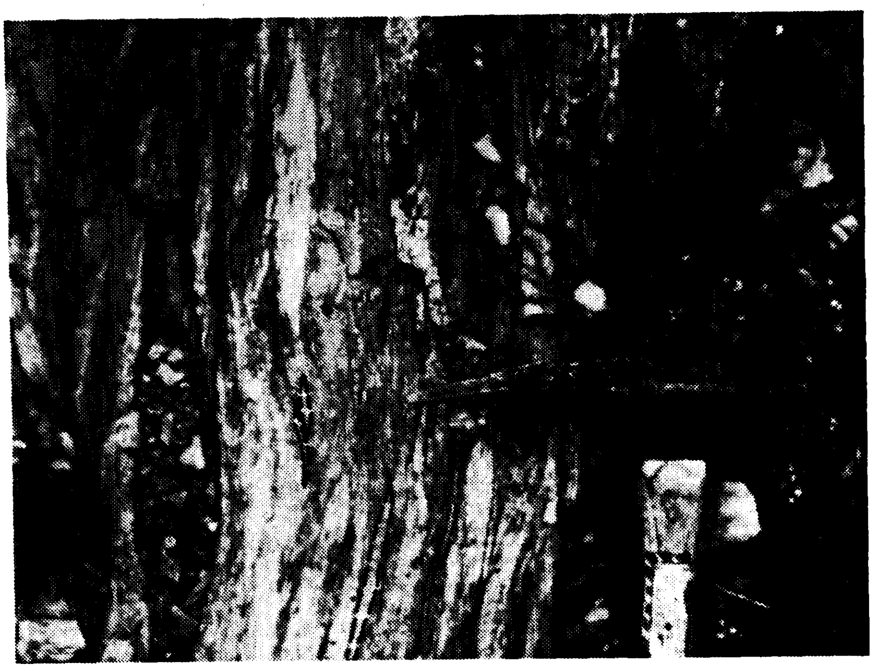


Photo 2c

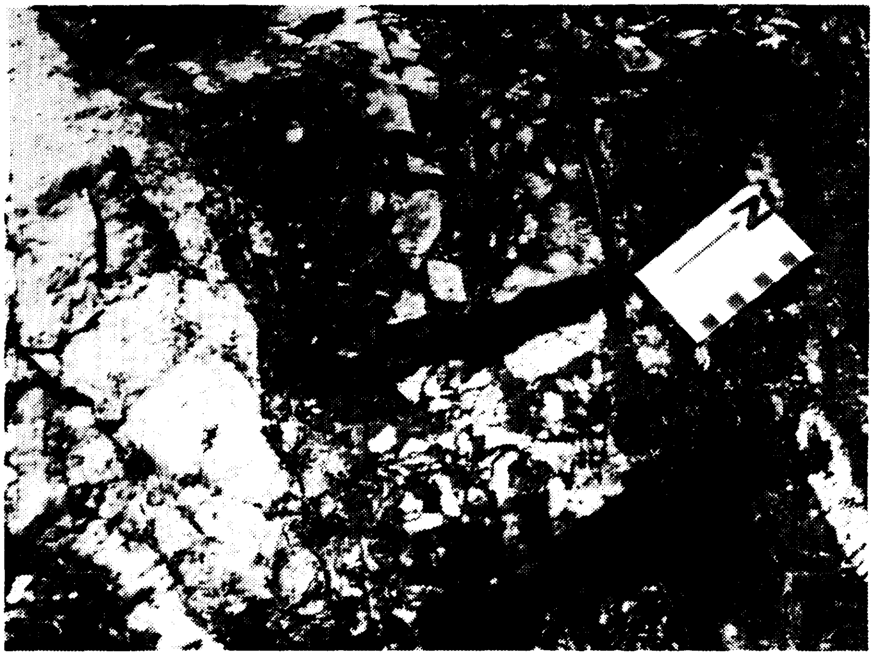
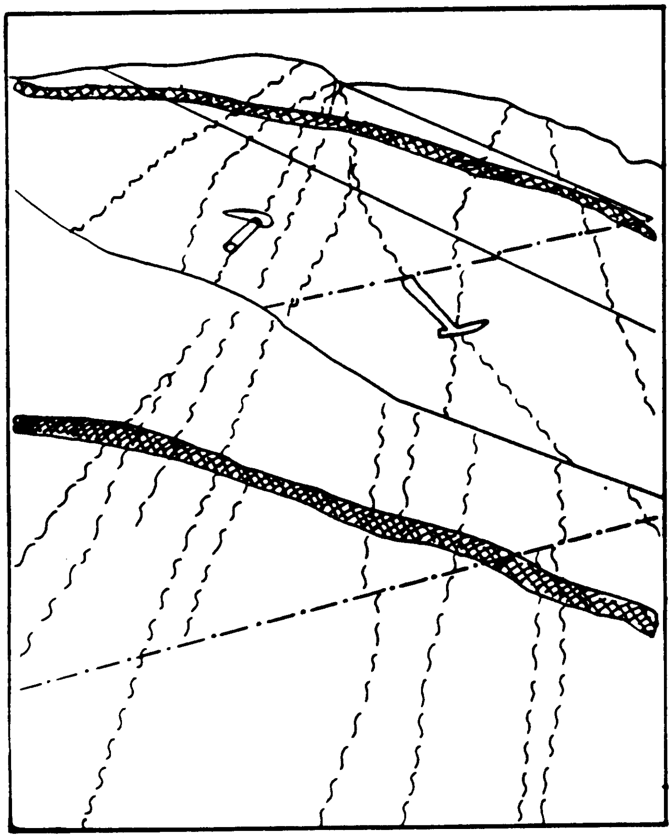


PHOTO 3: Quartz ± ankerite vein (left of the dashed line) and an ankerite vein with quartz and sericitized felsic dike fragments (right of the dashed line). View is to the west towards a vertical trench wall. Scale card indicates north. This is thought to be the Icehouse vein, Murphy gold mine, described by Bruce (1942; Figure 4) and shown in Figure 14 of this report.

PHOTO 4: Close-up of a narrow, auriferous quartz vein (highlighted by dashed lines) with an alteration halo of sericite, Fe-carbonate, hematite, pyrite and quartz (dotted areas). Vein is hosted by a high-strain zone developed within the Webb Lake stock. Note the distinct colour change from the strongly altered zone (lighter colour) outward to the less altered rock (darker colour). Scale card indicates north. West Zone, Magino gold mine.



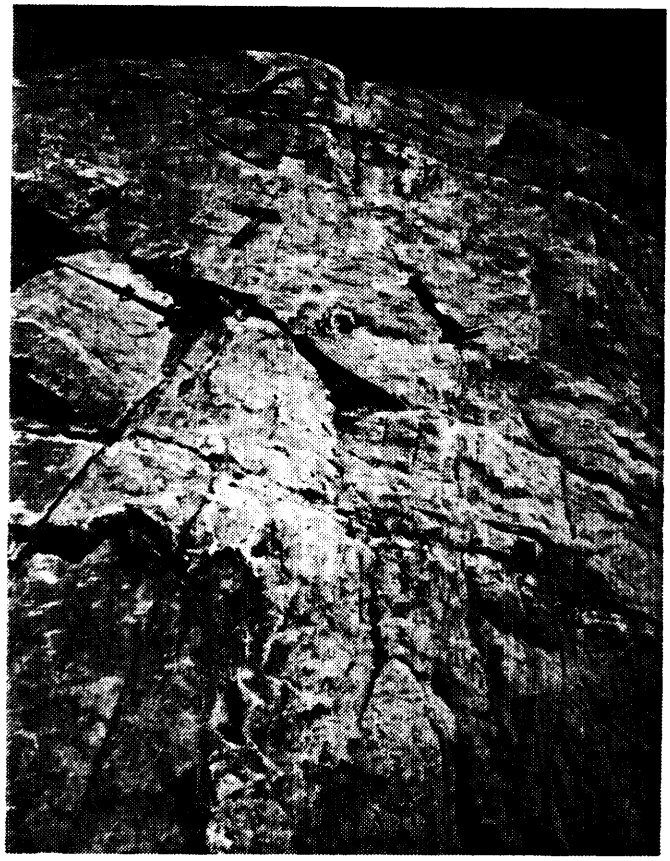


PHOTO 5: Photograph and corresponding sketch of the surface exposure of the West Zone, Magino gold mine. Mineralization here consists of two gold-bearing vein sets (indicated by the wavy lines in the sketch) which are oriented at a low, oblique angle to the dominant 070°-striking schistosity within the high-strain zone. The veins appear to splay and branch off one another. Note the late brittle fractures (solid and dot-solid lines) and the old channel sample cuts (hatched areas). Hammer for scale.

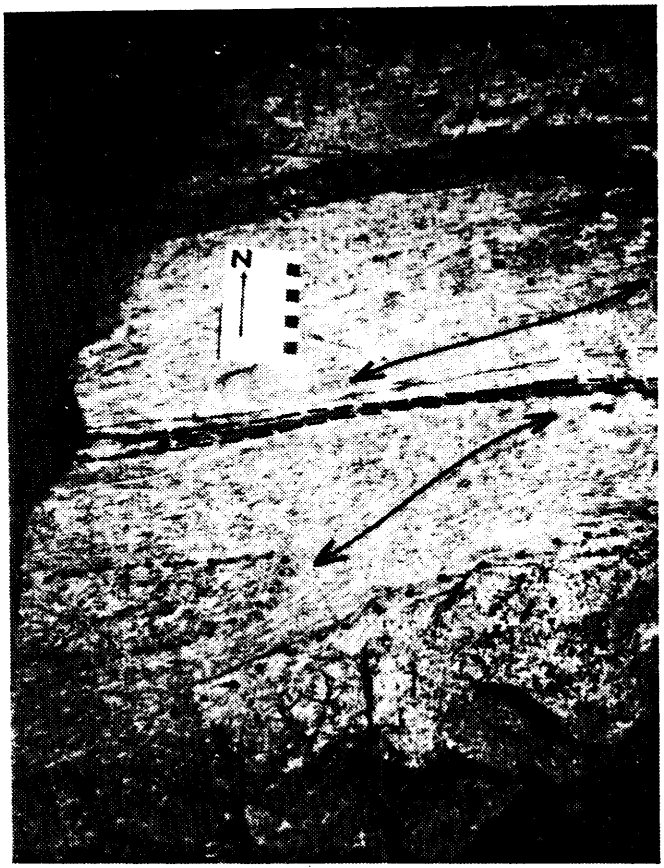
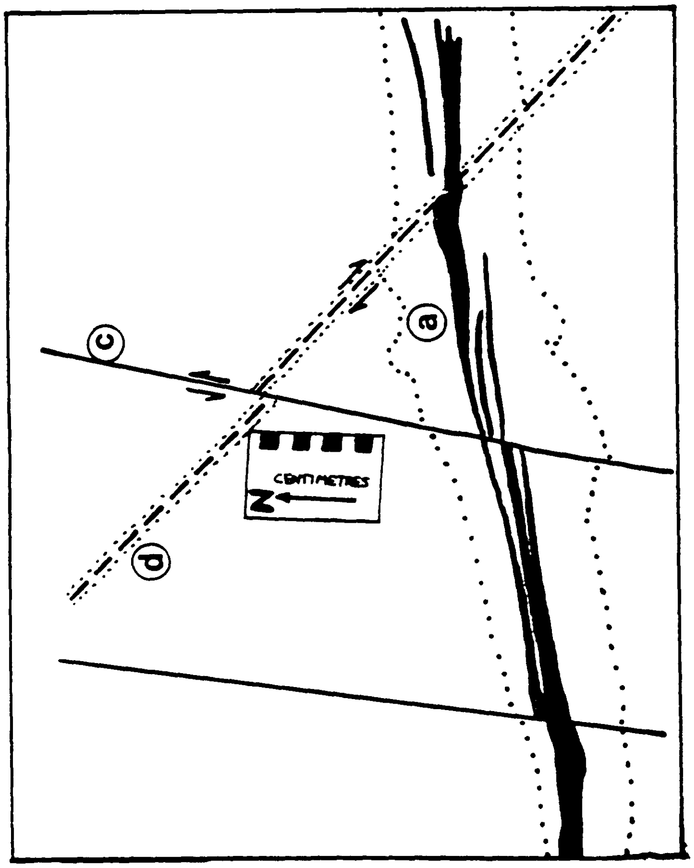


PHOTO 6: Narrow auriferous quartz vein (dark) hosted within a ductile high-strain zone. Compare the relatively undeformed intrusive rock (bottom of photo) versus the strongly foliated, equivalent intrusive rock adjacent to the vein. Note the rotation of the schistosity into the vein structure. Scale card indicates north. West Zone, Magino gold mine.



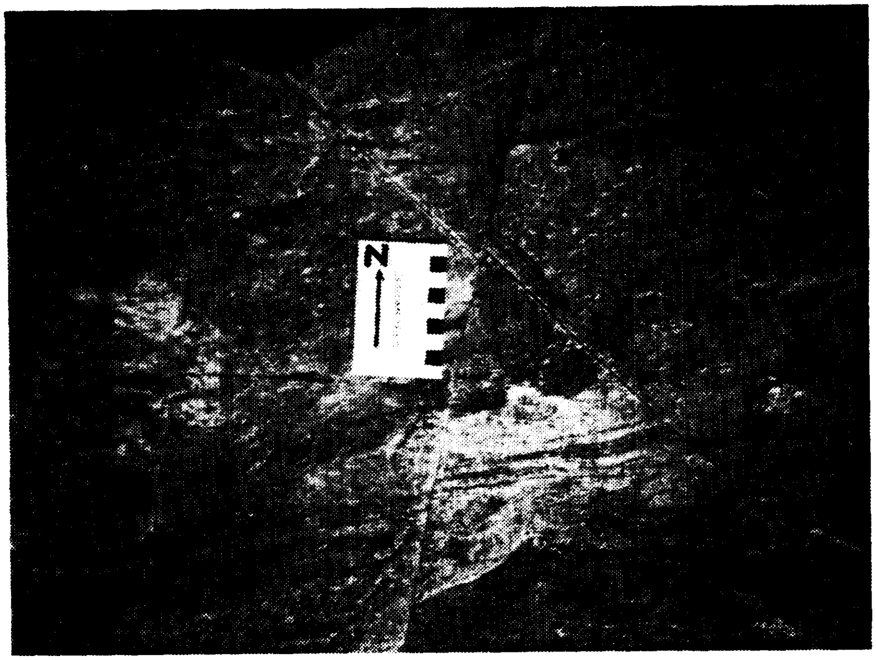


PHOTO 7: Close-up of an 085°-striking auriferous quartz vein (black) and associated alteration halo (dotted outline) being offset dextrally by a brittle, 130°-striking fracture. Both the vein and the fracture are in turn offset sinistrally by a 035°-striking brittle fracture. Note the narrow alteration halo (similar colouration to the one associated with the vein) confined to the 130°-striking fracture. Letters correspond to high-strain zones and fracture sets discussed in the text. Scale card indicates north. West Zone, Magino gold mine.

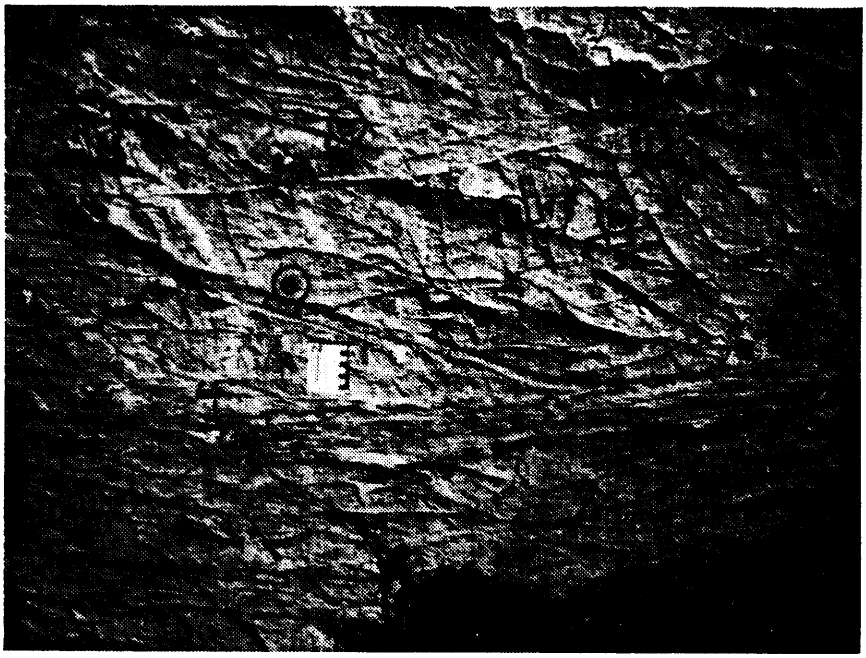


PHOTO 8: Unmineralized brittle and brittle-ductile fractures (e,f,g,h) typically found within the Webb Lake stock outside of the ductile high-strain zones. Note the narrow 085°-striking high-strain zone (a). Letters correspond to those discussed in the text. Scale card indicates north. Magino gold mine area.

PHOTO 9: Late north-striking tourmaline ± quartz vein (black) crosscu*ting the dominant schistosity and gold-bearing veins. Scale card indicates north. Magino gold mine area.

PHOTO 10: Webb Lake stock exhibiting late brittle fractures (e,f,g,h) infilled with tourmaline ± quartz. Note the psuedo-brecciation texture. Scale card for north. Old glory hole area, Magino gold mine.

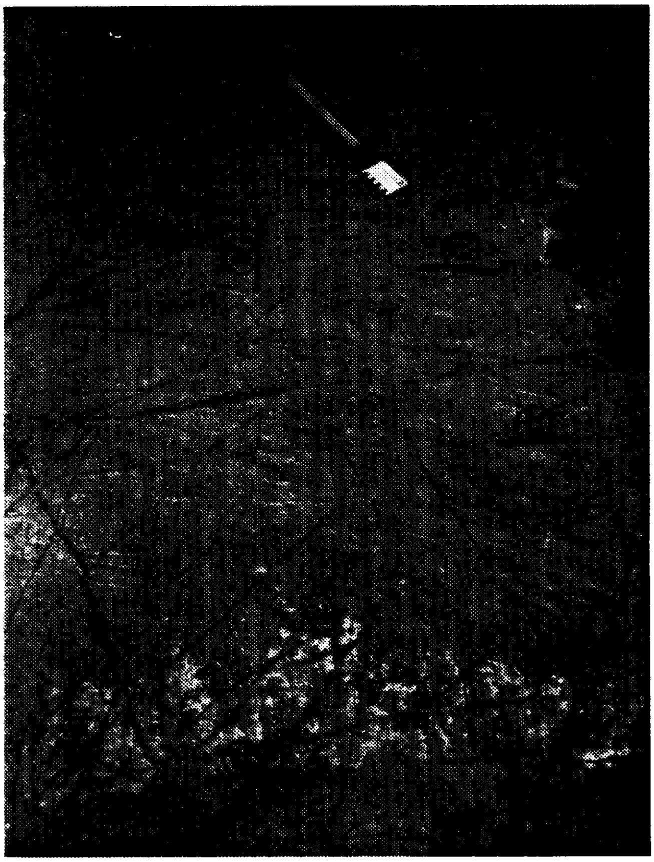


PHOTO 11: Brittlely deformed (i.e., fractured), mafic metaintrusion found adjacent to the main high-strain zone at the Canamax No.3 Zone gold occurrence. Hammer handle indicates north. Letters correspond to those discussed in the text.

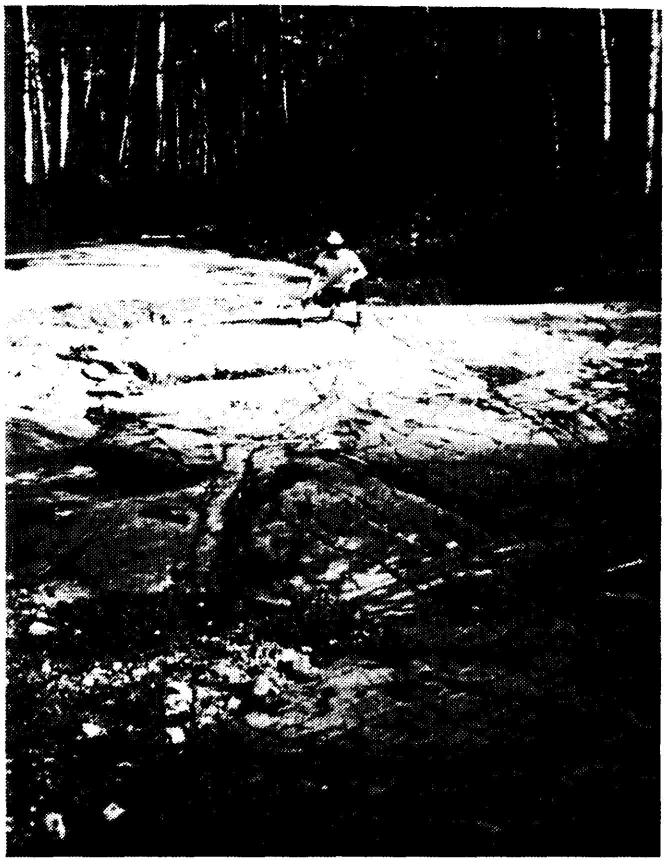


PHOTO 12: Several orientations of discrete high-strain zones and quartz veins seen at the Canamax Rusty Zone gold occurrence. Person for scale.

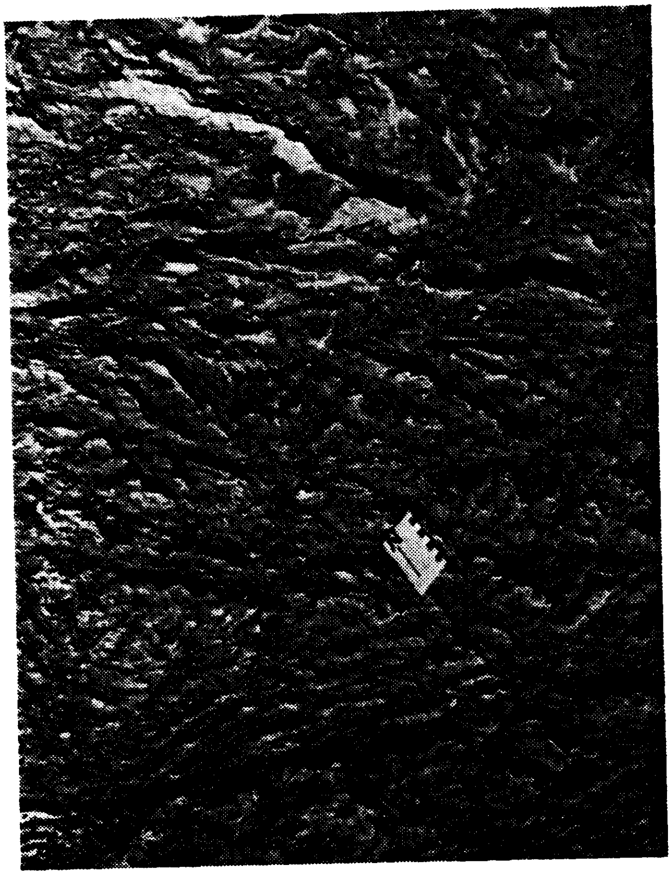
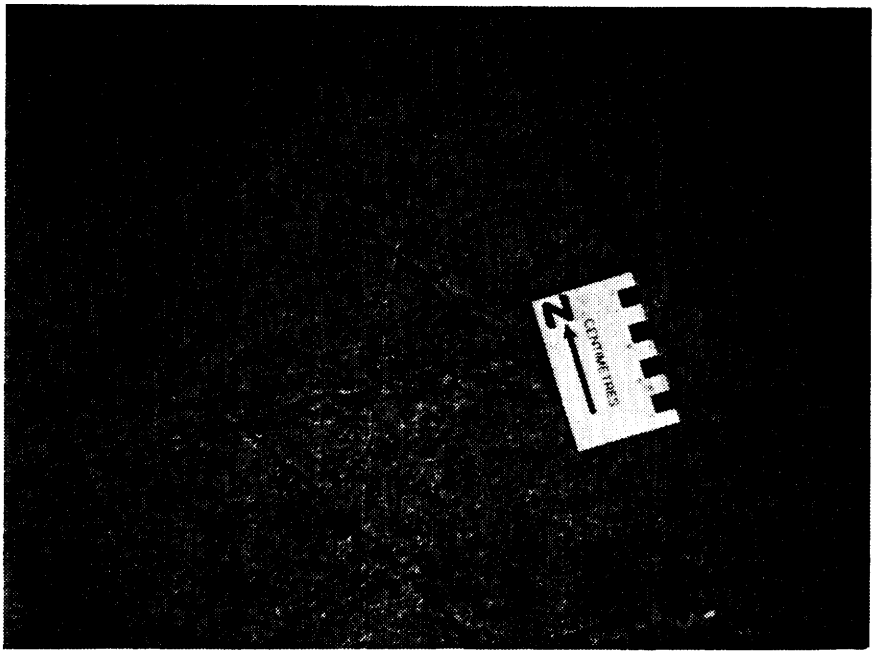


PHOTO 13: Chlorite-biotite-ankerite-quartz schist interpreted to be intensely deformed and altered mafic metaintrusive rock (FEATURE A, Figure 18). This rock type hosts the Kremzar R-Zone mineralization. Note the abundant dismembered quartz veinlets. Scale card indicates north. Heritage outcrop, Kremzar gold mine.



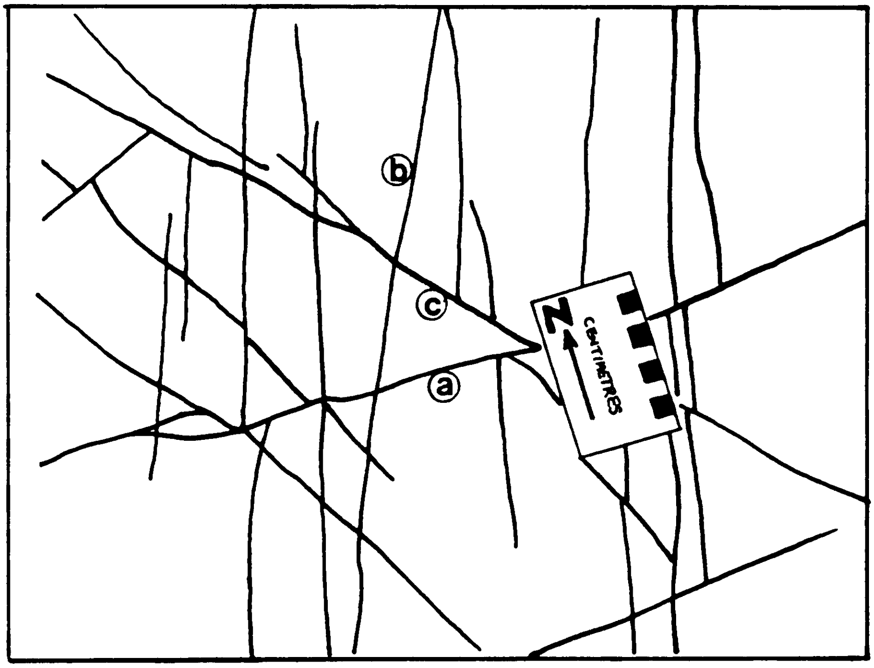


PHOTO 14: Relatively undeformed and unaltered, medium-grained mafic metaintrusive rock found adjacent to the Kremzar high-strain zone and its associated alteration and mineralization (FEATURE B, Figure 18). Note the well developed brittle fracture sets at (a) 090°, (b) 030° and (c) 145°. Scale card indicates north. Heritage outcrop, Kremzar gold mine.

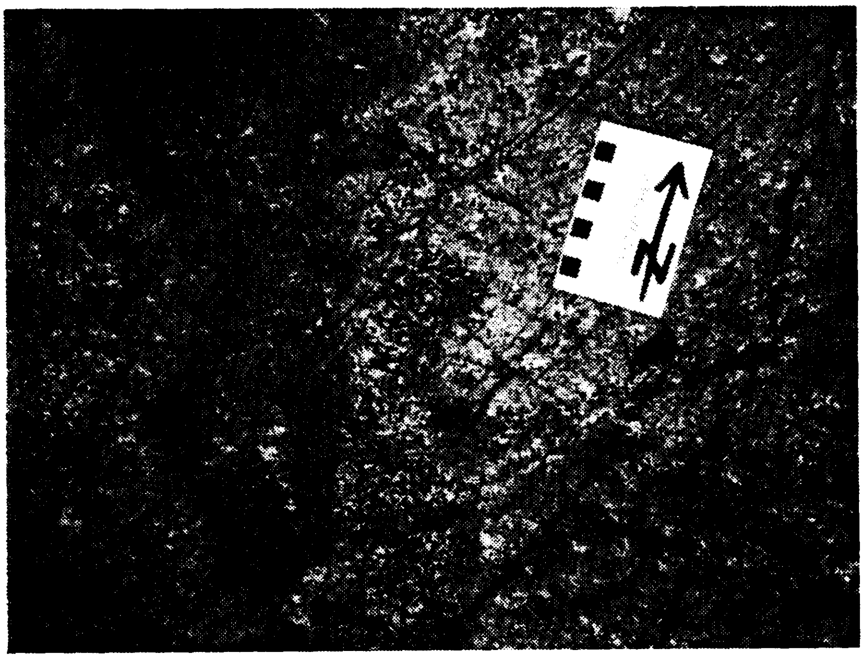


PHOTO 15: Close-up of a clot of coarse-grained (almost pegmatitic) amphibole and plagioclase from within the host mafic rock (FEATURE C, Figure 18). These pockets of coarser grained minerals are suggestive of an intrusive origin for the host mafic rocks at the Kremzar gold mine. Note the brittle fractures (similar orientations to those in Photo 14) superimposed on these clots. Scale card indicates north. Heritage outcrop, Kremzar gold mine.

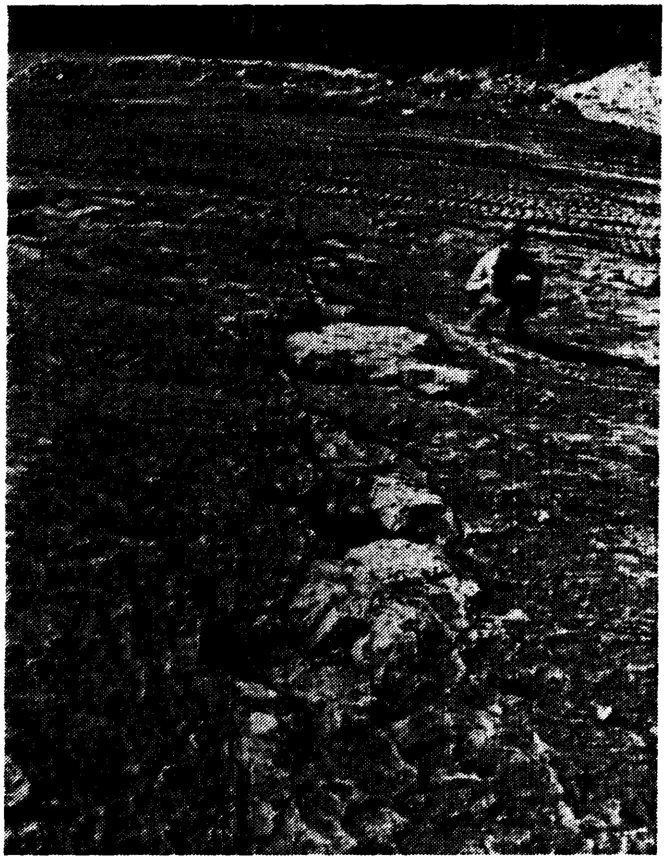


PHOTO 16: View to the northwest along the strike of an irregular, dike/vein-like body of silicified and auriferous rock (highlighted in black) that bounds the Kremzar R-Zone on its footwall side (i.e., north side)(FEATURE R, Figure 18). The body strikes approximately 140° and is highly deformed, hence the lensoidal (boudinaged ?) shapes. This body has been interpreted as a "cherty" quartz vein (G. Yule, personal communication, 1987), however it contains ghost outlines that resemble feldspar phenocrysts suggesting it may be an intensely altered and deformed feldspar porphyry dike. D. Finlay for scale. Heritage outcrop, Kremzar gold mine.

PHOTO 17: View (to the west) of the Heritage outcrop, Kremzar gold mine. Note the distinct colour difference between the strongly altered and deformed, gold-bearing zone (light) and the relatively unaltered and undeformed mafic metaintrusive rock (dark) that bounds the high-strain zone.

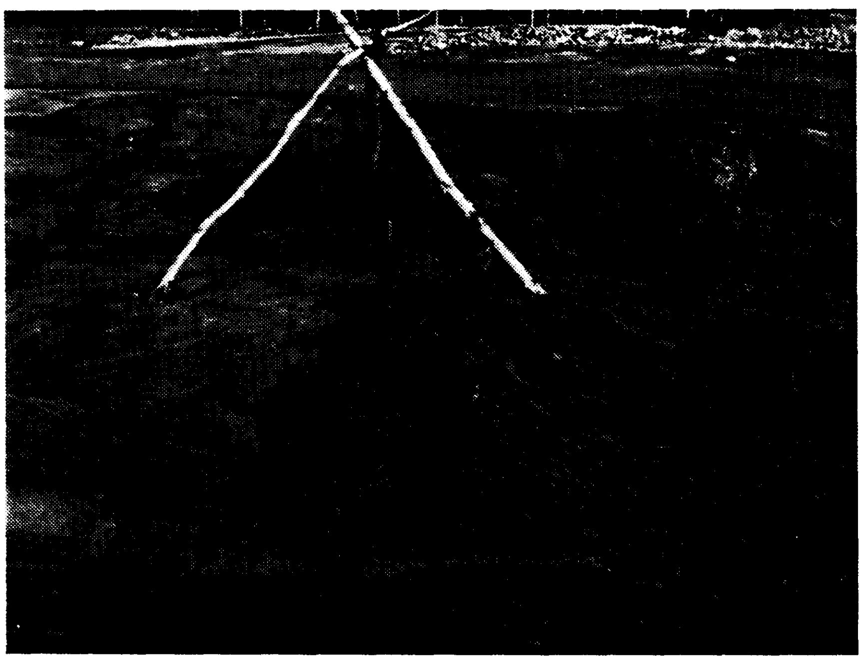
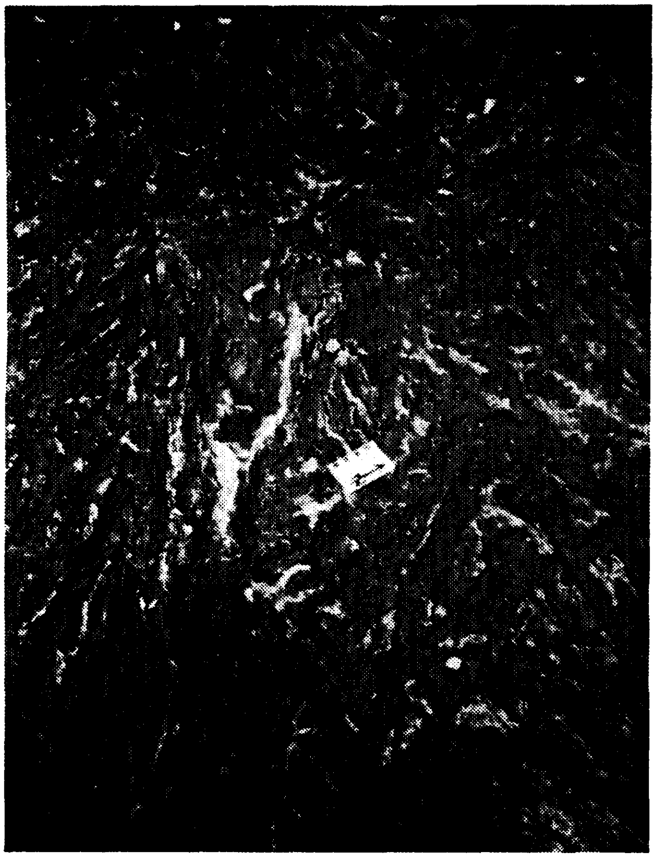


PHOTO 18: Close-up of the hanging wall contact between relatively undeformed mafic metaintrusive rock (left) and the strongly Fe-carbonatized and deformed zone that hosts the Kremzar R-Zone mineralization (right). Note the discrete shear (wavy line) that defines the sharp contact between these rock types (FEATURE G, Figure 18). Also note the sigmoidal fabric (indicated) developed within the high-strain zone. Heritage outcrop, Kremzar gold mine.

PHOTO 19: Close-up of folded, boudinaged and dismembered quartz-Fe-carbonate veinlets within the high-strain zone hosting the R-Zone mineralization (FEATURE H and I, Figure 18). Scale card indicates north. Heritage outcrop, Kremzar gold mine.



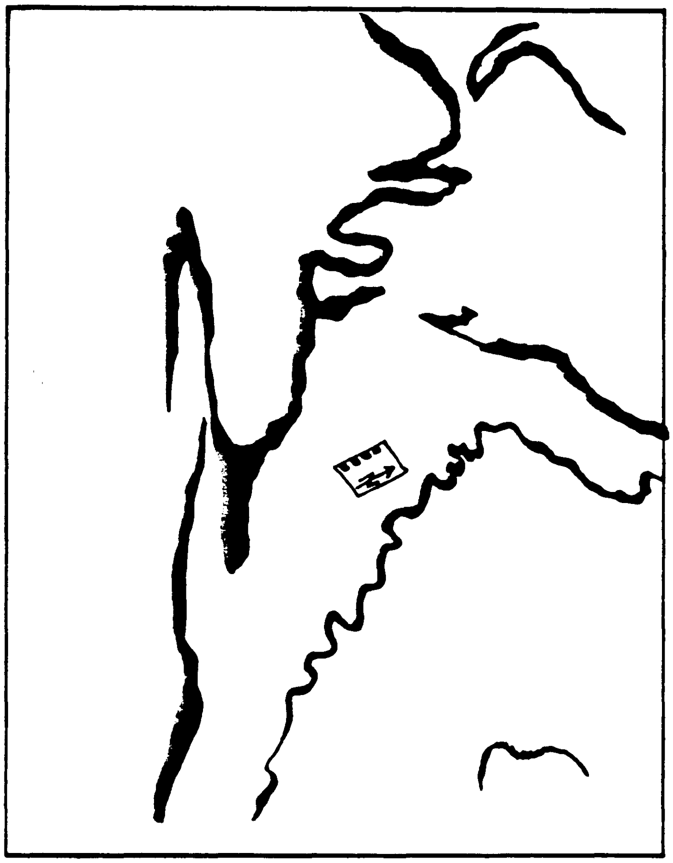


PHOTO 20: Close-up of folded, boudinaged and dismembered quartz-Fe-carbonate veinlets (highlighted in black) within the high-strain zone hosting the R-Zone mineralization (FEATURE H and I, Figure 18). Scale card indicates north. Heritage outcrop, Kremzar gold mine.

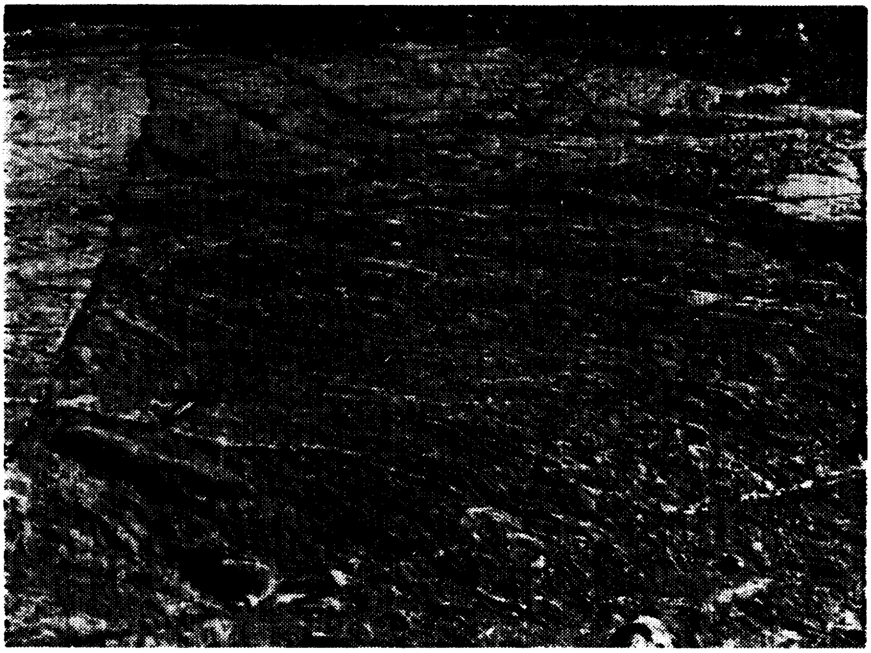


PHOTO 21: Overall view of S-shaped sigmoidal schistosity within the high-strain zone. This schistosity wraps into discrete shear zones (wavy lines) that bound the main high-strain zone (Photo 18; FEATURE G, Figure 18). Hammer handle indicates north. Heritage outcrop, Kremzar gold mine.

Photo 22

Photo 23

PHOTO 22: Massive, banded quartz vein occupying the central portion of the Maskinonge Lake fault. Vertical rock face. Scale card indicates north. Canamax's Breccia Zone gold occurrence.

PHOTO 23: Silicified and quartz stockworked zone within the Maskinonge Lake fault. The rock takes on a psuedo-brecciated texture. Scale card indicates north. Canamax's Breccia Zone gold occurrence.

PHOTO 24: Coarse-grained chloritoid crystals developed as an alteration rim within a fragment of sideritized and chloritized mafic dike rock (FEATURE L, Figure 20). Scale card indicates north. West Zone of the Morrison No.1 gold occurrence.

PHOTO 25: Stockwork of narrow quartz veins developed within the siderite ironstone (FEATURE K, Figure 20). These veins are spatially associated with the zone of gold mineralization, however, they do not contain anomalous gold values. Note the fragment of sideritized and chloritoid-bearing intermediate tuff (top of photo). Hammer handle indicates north. East Zone of the Morrison No.1 gold occurrence.

PHOTO 26: Schistose high-strain zone (left of the wavy line) developed within intermediate tuffaceous rocks in the footwall to the ironstone (FEATURE F, Figure 20). The deformed tuffaceous rocks (left) are very fissile compared to less deformed ones immediately to the south (right). Note the numerous discrete, subparallel shears within the less deformed tuffaceous rocks. Hammer handle indicates north. West Zone of the Morrison No.1 gold occurrence.

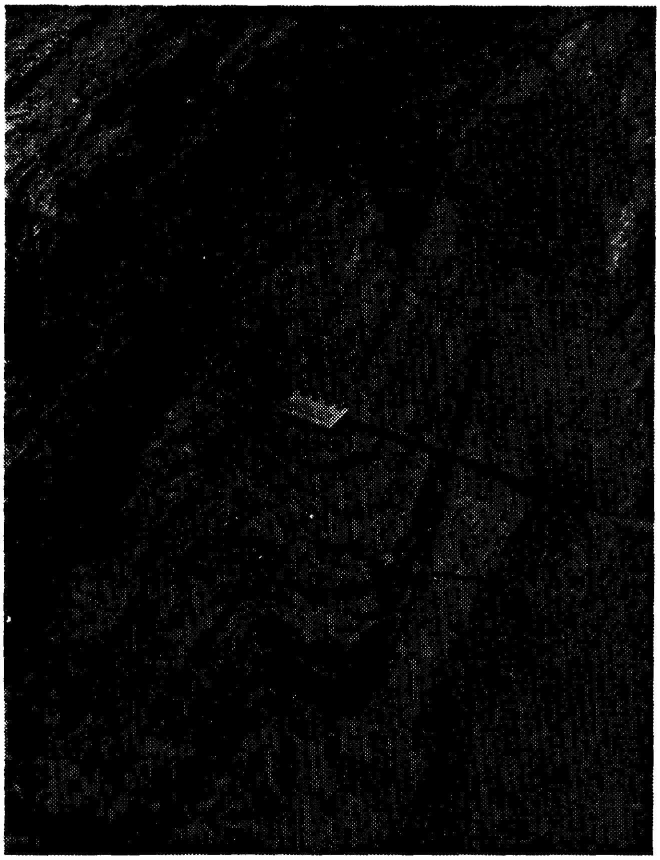


PHOTO 27: Z-shaped folds developed within highly strained intermediate tuffaceous rocks (FEATURE G, Figure 20). Both the bedding and a parallel schistosity (single arrowhead) appear to be folded and locally crenulated by an axial planar cleavage (double arrowhead). Scale card indicates north. West Zone of the Morrison No.1 gold occurrence.

PHOTO 28: Panoramic view (to the east) of the No.3 adit "amphitheatre" surface exposure at the Cline Lake gold mine (Figure 21; Figure 23, back pocket). Note the extensive system of felsic dikes (light) cutting the mafic metavolcanic and metaintrusive rocks (dark).

PHOTO 29: Dismembered portion of a lean chert-magnetite ironstone, illustrating the style of deformation (i.e., folding and transposition) within the host rocks in the Cline Lake Mine area. Scale card indicates north. Cline Lake property, east of the Cline Lake No.4 shaft.

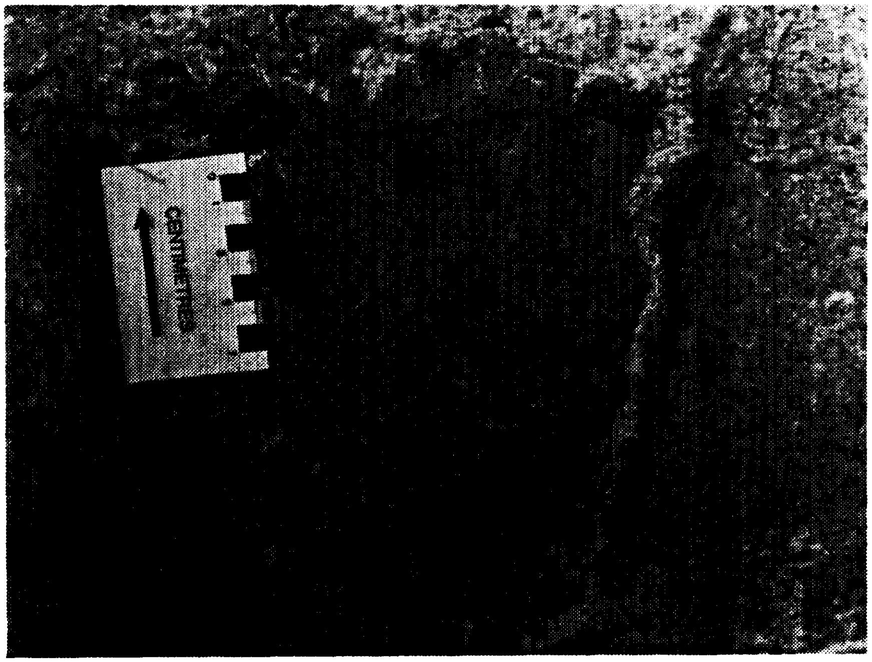


PHOTO 30: Large quartz eyes within a quartz porphyry dike (FEATURE E, Figure 22). Scale card for scale. No.3 adit "amphitheatre outcrop", Cline Lake gold mine.

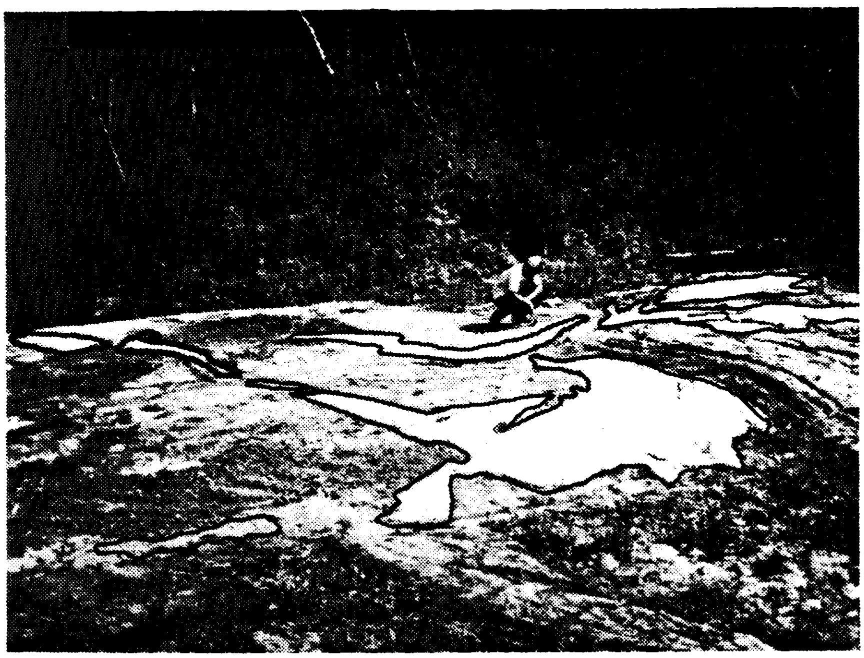


PHOTO 31: Folded and dismembered quartz feldspar porphyry (QFP) dikes (outlined in black). Note the schistose zones and strong rusty alteration along the margins of the dikes. D. Finlay for scale. From surface trenches located east of the No.4 shaft, Cline Lake gold mine.

PHOTO 32: Near vertical face with down-plunge view to the east. A narrow, gold-bearing quartz vein is boudinaged (left), while a felsic porphyry dike is S-folded in the down-plunge direction (right). Both the long axes of the quartz vein boudins and the fold noses of the dike plunge moderately to the east (FEATURES O and P, Figure 22). Hammer for scale. No.3 adit "amphitheatre outcrop", Cline Lake gold mine.

PHOTO 33: View to the west of an irregular contact between a felsic dike (light) and mafic metavolcanic rocks (dark). The seriated or digitated contact is due to folding and transposition of the felsic dike (FEATURE N, Figure 22). Hammer for scale. No.3 adit "amphitheatre outcrop", Cline Lake gold mine.

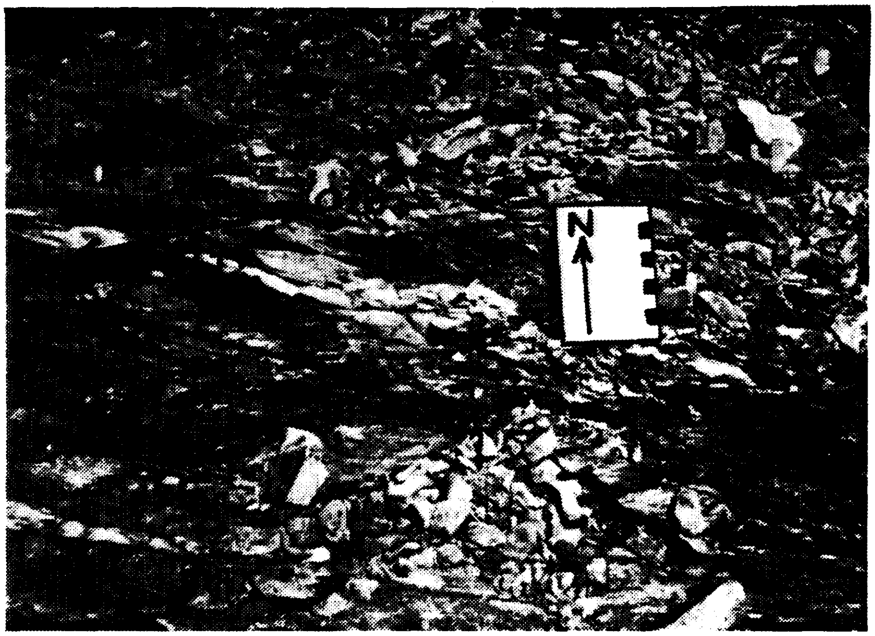


PHOTO 34: Strong brittle to brittle-ductile fracturing within a felsic dike (FEATURE U, Figure 22). The intersection of 080°- and 110°-striking high-strain zones creates a distinctive diamond fracture pattern and a strong, moderately east-plunging intersection lineation. Hammer for scale. No.3 adit "amphitheatre outcrop", Cline Lake gold mine.

PHOTO 35: View to the west along a narrow, gold-bearing quartz vein (black) within a brittle-ductile high-strain zone which is localized along a mafic metavolcanic (Mv) - felsic porphyry dike (Fp) contact. Note the brittle fractures developed within the porphyry dikes on either side of the strongly foliated mafic metavolcanic. Hammer for scale. No.3 adit "amphitheatre outcrop", Cline Lake gold mine.

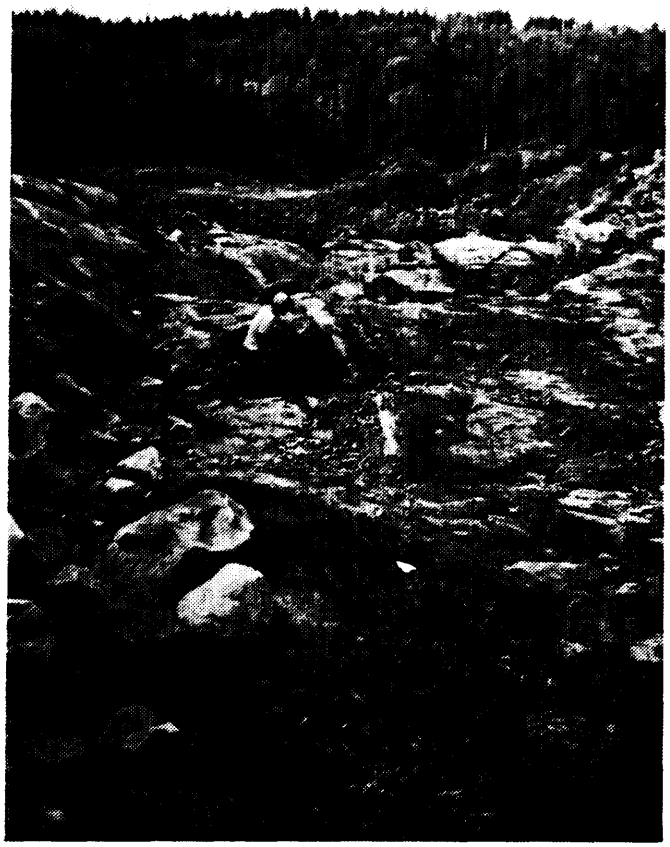


PHOTO 36: View to the west of a narrow, high grade, gold-bearing vein (FEATURE S, Figure 22) typical of the mineralization found at the Cline Lake gold mine. D. Finlay for scale. No.3 adit "amphitheatre outcrop", Cline Lake gold mine.

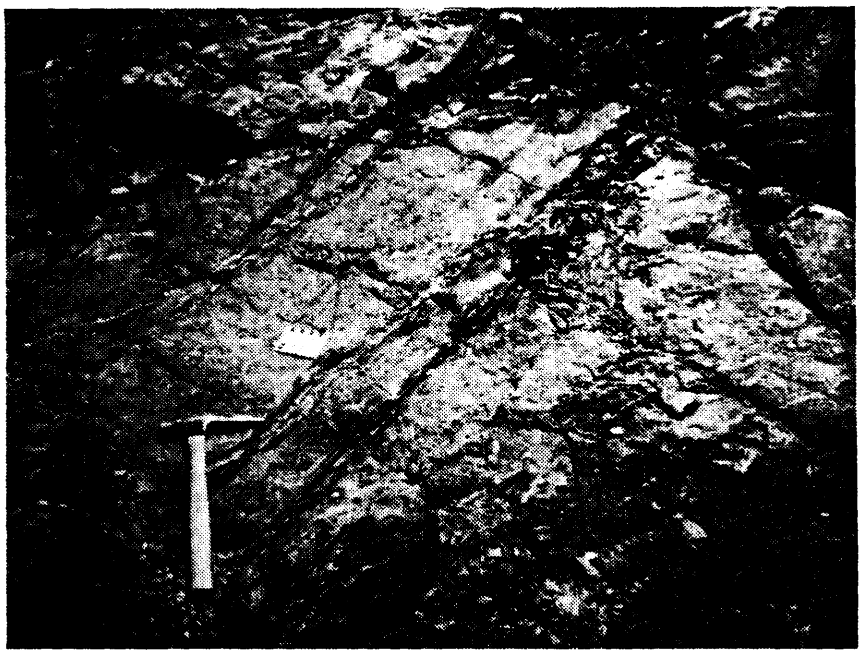


PHOTO 37: Non-auriferous, sheeted quartz-Fe-carbonate veins (FEATURE Z, Figure 22) hosted by less deformed and relatively unaltered mafic rocks peripherial to the gold-bearing, brittle-ductile, high-strain zones. Scale card for north and hammer for scale. No.3 adit "amphitheatre outcrop", Cline Lake gold mine.

PHOTO 38: Overall view (to the northwest) of the mechanically stripped outcrop at the Markes gold occurrence (Figure 26; Figure 27, back pocket). D. Finlay for scale. Main stripped outcrop, Markes gold occurrence.

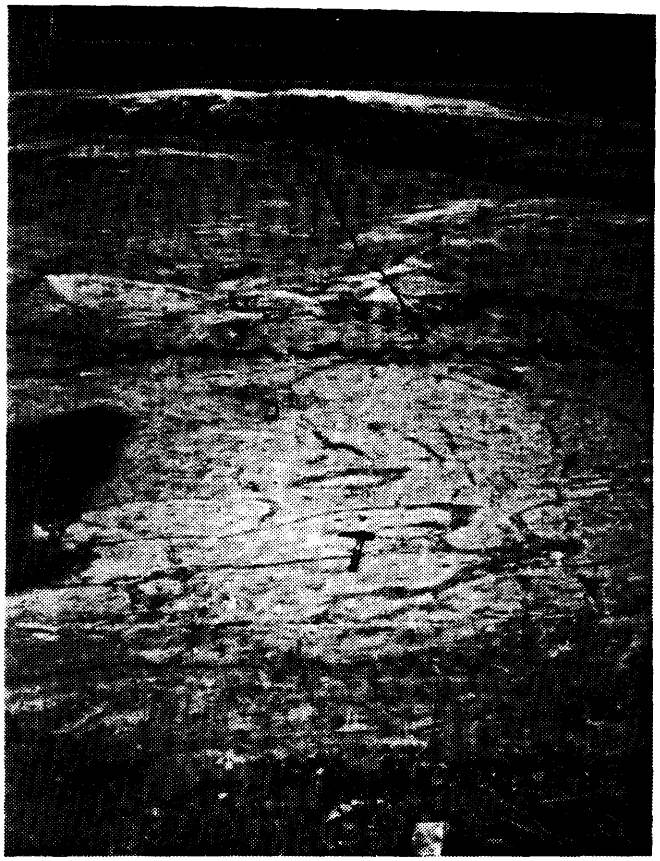
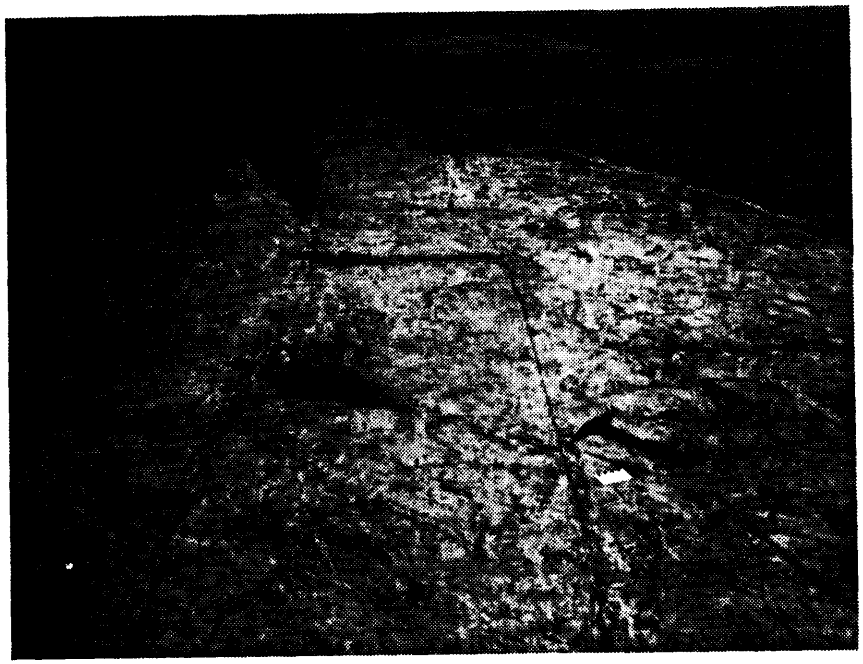


PHOTO 39: View to the north of the undeformed and weakly altered pillowed mafic metavolcanic rocks (foreground) in contact (wavy line) with strongly altered and deformed mafic rocks (background)(FEATURES A, B and M, Figure 26). Hammer for scale. Main stripped outcrop, Markes gold occurrence.

PHOTO 40: View (to the west) of the intermediate to felsic dike bounding the Markes high-strain zone to the north (FEATURE C, Figure 26). Note the discrete, narrow shears developed subparallel to the strike of the dike (FEATURE P, Figure 26). Hammer for scale. Main stripped outcrop, Markes gold occurrence.



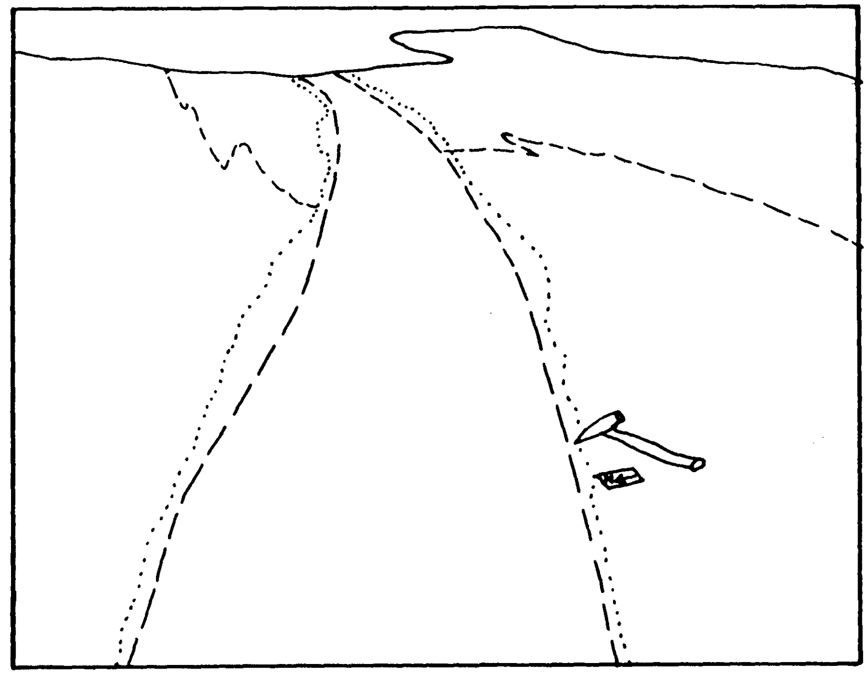


PHOTO 41: View (to the southeast) of a felsic dike (centre of photo) crosscutting an earlier intermediate to felsic dike (FEATURE E, Figure 26). Note the discrete, narrow shears (dashed lines) that bound the late dike and appear to control Fe-carbonate and hematite alteration (highlighted by dotted lines). Hammer for scale. From the main stripped outcrop, Markes gold occurrence.

PHOTO 42: View (to the northwest) of a boudinaged and partially back-rotated felsic dike (highlighted in black) within the main Markes high-strain zone (FEATURE F, Figure 26). This dike is of a similar type and orientation to that in Photo 41 (FEATURE E, Figure 26). Hammer for scale. From the main stripped outcrop, Markes gold occurrence.

PHOTO 43: View (to the north) of a folded intermediate to felsic dike (FEATURE G, Figure 26) located immediately north of the Markes high-strain zone. Hammer for scale. From the main stripped outcrop, Markes gold occurrence.

PHOTO 44: View (to the west) of the northern margin of the Markes high-strain zone (FEATURE H, Figure 26) and an auriferous, quartz ± tourmaline filled shear (FEATURE Q, Figure 26) localized at the contact between altered and deformed, pillowed mafic metavolcanic rocks (left) and an intermediate to felsic dike (centre). To the north (right) are less deformed and altered pillowed mafic metavolcanic rocks. Hammer for scale. From the main stripped outcrop, Markes gold occurrence.

PHOTO 45: View (to the east) of the southern margin of the Markes high-strain zone (FEATURE I, Figure 26). The boundary is defined by a discrete, narrow shear separating altered and deformed pillowed mafic metavolcanic rocks (left) from relatively undeformed and unaltered massive, mafic metavolcanic rocks. Hammer for scale. From the main stripped outcrop, Markes gold occurrence.

PHOTO 46: View (to the south) of weakly to moderately Fe-carbonate altered pillowed, mafic metavolcanic rocks within the Markes high-strain zone (FEATURE L, Figure 26). Note the deformed, elongated shapes of many of the pillows. Hammer for scale. From the main stripped outcrop, Markes gold occurrence.

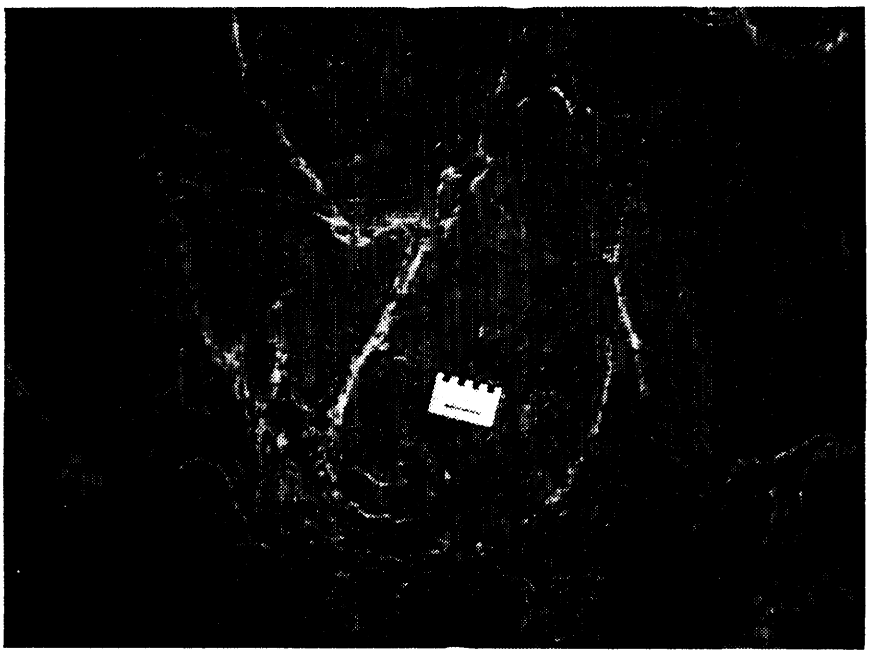


PHOTO 47: Close-up view of strongly altered, pillowed mafic metavolcanic rocks from within the Markes high-strain zone (FEATURE M, Figure 26). Alteration consists of the selective Fe-carbonatization of the pillow cores and the chloritization and silicification of the pillow selvages. Note the relatively undeformed state of the pillows. Scale card for scale. From the main stripped outcrop, Markes gold occurrence.

PHOTO 48: Close-up view of intensely altered, pillowed mafic metavolcanic rocks within the Markes high-strain zone (FEATURE N, Figure 26). Note that the intense silicification and Fe-carbonatization take on a stockwork or psuedo-brecciated texture, which almost completely obliterates the primary pillow shapes. Scale card for scale. From the main stripped outcrop, Markes gold occurrence.

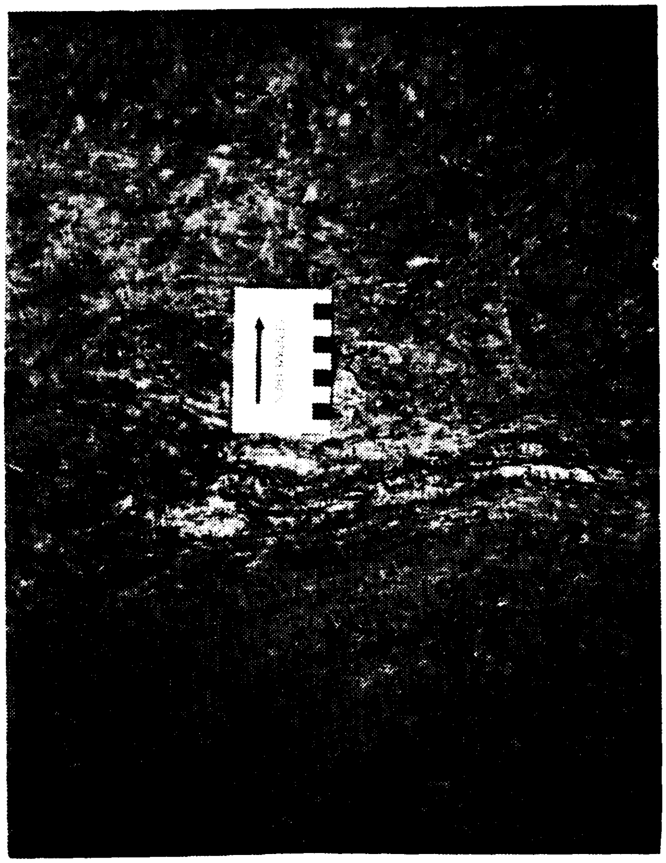


PHOTO 49: Close-up of the main auriferous, quartz ± tourmaline filled shear (FEATURE Q, Figure 26) that bounds the Markes high-strain zone to the north. See Photo 44 for overall view of this feature. Scalecard indicates north. From the main stripped outcrop, Markes gold occurrence.

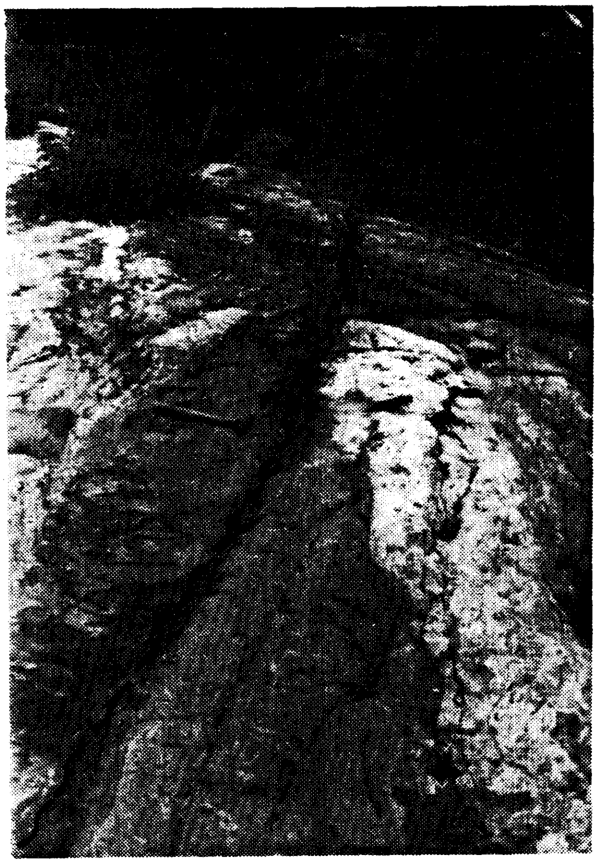


PHOTO 50: Overall view of a folded felsic dike which is truncated by a discrete shear zone (see Figure 30). Hammer handle indicates north. From a mechanically stripped outcrop at the Reid gold occurrence.

TABLE 1: Correlation between regional structural elements reported for parts of the Michipicoten greenstone belt and those documented for the Goudreau-Lochalsh area.

McGill and Shrady (1986)	Arias and Helmstaedt (1989, 1990b)	
Southwestern Belt	West-central Belt	East-central Belt (Goudreau-Lochalsh)

D1 - dominant map pattern, strike of rock units

- thrust imbrication, recumbent F1?

- F1 syncline, thrust-faulted

D2 - F2, S2, NW-strike

D3 - F3, S3, ENE-NE-strike

D4 - S4, NE-strike

Late NW-, NE- and N-striking brittle faults

D1 - recumbent regional F1; local S1 and small-scale F1

D2 - dominant map pattern, strike of rock units

- thrust imbrication producing repetition of, at least the youngest supracrustal units

- F2 inverted syncline, thrust-faulted

- F2 inverted anticline (Centre Anticline), thrust-faulted

- F2, S2, NW-strike

- F2, S2, ENE-NE-strike

D3 - local F3, S3, NE-strike

D1 - local S1

D2 - dominant map pattern, strike of rock units

- F2 anticline (Goudreau Anticline)

- F2, S2, E-ENE-strike

D3 - S3, NE-strike

TABLE 2: Gold (Au), base-metal (Cu, Zn, Pb) and iron deposits/occurrences of the Goudreau-Lochalsh district. Numbers correspond to those shown in Figures 3 and 13. All the Iron Ranges indicated with an * are part of the more regionally extensive Goudreau Iron Range.

1 Murphy mine (Au)
2 Magino mine (Au)
3 Island-Lochalsh Zones (Au)
4 Canamax-No.3 Zone (Au)
5 Canamax-No.2 Zone (Au)
6 Canamax-No.8 Zone (Au)
7 Canamax-Rusty Zone (Au)
8 Kremzar mine (Au)
9 Michael Syndicate Shaft (Au)
10 Canamax-Breccia Zone (Au)
11 Canamax-Pine Zone (Au)
12 Canamax-Morrison No.1 Zone
13 Morrison Cabin Claims (Au)
14 Edwards mine (Au)
15 Cline Lake mine (Au)
16 Markes occurrence (Au)
17 Laughlin occurrence (Au)

18 McColl occurrence (Au)
19 3-mile Post occurrence (Au)
20 Archibald occurrence (Au)
21 Watson Lake occurrence (Au)
22 Reid occurrence (Au)
23 MacLeod occurrence (Au)
24 Bearpaw Portage occurrence (Au)
25 Adonis occurrence (Au)
26 Leitch occurrence (Au)
27 Canamax-Pyrrhotite Zone (Au)
28 Canamax-No.6 Zone (Au)
29 Canamax-No.1 Zone (Au)
30 Canamax-No.9 Zone (Au)
31 Old Cabin occurrences (Au)
32 Archer-Crawford occurrence (Au)
33 McCormick-Indian Lake occurrence (Au)
34 Farquhar Vein occurrence (Au)
35 Brighton occurrence (Au)
36 Cline Claim A.C. 452 (Au)
37 Barnes occurrence (Cu)

53 Slate Lake occurrence (Au)
54 Smith Highgrade occurrence (Au)
55 Blowout occurrence (Au)
56 Blackout occurrence (Au)
57 Sawmill occurrence (Au)
58 Aitkins Pyrite occurrence (Fe)
59 Bearpaw Lake occurrence (Au)
60 Brandt-Lovell Lake occurrence (Au)
61 Racicot occurrence (Cu)
62 Texron occurrence (Cu)
63 Ego mine (Au, Cu, Co)
64 Maskinonge occurrence (Au)
65 Canamax-No.4 Zone (Au)
66 Canamax-No.5 Zone (Au)
67 Canamax-No.10 Zone (Au)
68 Canamax-Tent Vein (Au)
69 Canamax-No.7 Zone (Au)

70 Canamax-Wiggly Vein (Au)
71
72 Eccles Lake Iron Formation (Fe)
73 Morrison No.2 Iron Range* (Fe)
74 Rutledge Iron Range (Fe)
75 Candela Development Property occurrence (Au)
76 Garbe Lake West occurrence (Au)
77 Rand No.1 and Morrison No.4 Iron Ranges* (Fe)
78 "E" Iron Range* (Fe)
79 "D" Iron Range* (Fe)
80 "B" Iron Range* (Fe)
81 "F" Iron Range* (Fe)
82 "C" Iron Range* (Fe)
83 McPhail Iron Range* (Fe)
84 "A" Iron Range* (Fe)
85 Bear Iron Range* (Fe)
86 Morrison No.3 Iron Range* (Fe)
87 Goodman-Whalen occurrence (Au)
88 Chitty occurrence (Au)
89 Herman Lake Nepheline Cancrinite Syenite

38 McCauley occurrence (Au)
39 Paquette occurrence (Au)
40 Porter-Premier occurrence (Au)
41 McMahon occurrence (Au)
42 Brandt occurrence (Au)
43 Doherty Lake occurrence (Au)
44 Gutcher occurrence (Au)
45 Banville-Page occurrence (Au)
46 Kozak mine (Au, Pb, Zn)
47 Canorama occurrence (Cu)(Au)
48 Chuck Lake occurrence (Cu)
49 Lajoie occurrence (Au)
50 Noranda anomaly 1-81 (Au)
51 OGS zinc occurrence (Zn)
52 Priest occurrence (Au)

90 Dreany Iron Range (Fe)
91 Quartzite occurrence (Au)
92 Bearpaw Lake Iron Range* (Fe)
93 Huronian Belt occurrence (Au)
94 Cymbal Exploration Claim (Au)
95 Old Cabin Lake Iron Formation (Fe)
96 Jackfish Lake occurrence (Au)
97 Little Grace occurrence (Au)
98 Leitch Gold Mines Iron Formation (Fe)
99 Swanson Lake occurrence (Au)
100 Manitowik Lake occurrence (Au)
101 Mespi Mines anomaly #49 (Au)
102 Mespi Mines anomaly #50 (Au)
103 Locke Lake occurrence (Au)

TABLE 3: Structural characteristics and host rocks for selected go
Goudreau-Lochalsh district during the current study. Lis
deformation styles and sense of displacements.

No.	Gold Mine/Occurrence Name			Hig
		080°-090°	105°-120°	045
1	Murphy Mine	*,BD,d	*,BD,d	B
2	Magino Mine	*,BD,d	?	*,B
3	Island-Lochalsh Zones		(NOT EXPOSED AT	
4	Canamax-No. 3 Zone	BD,d	B,d	-
5	Canamax-No. 2 Zone	B,n.d.	B,n.d.	B
6	Canamax-No. 8 Zone	*,BD,d	B,n.d.	B
7	Canamax-Rusty Zone	BD,d	BD,d	*,B
8	Canamax-Kremzar Mine	B,n.d.	BD,d	
9	Michael Syndicate Shaft	-	-	
10	Canamax-Breccia Zone	-	-	
11	Canamax-Pine Zone	*,BD,n.d.	-	
12	Canamax-Morrison No. 1		(IRONSTONE HOSTE	
13	Morrison Cabin Claims	*,BD,n.d.	-	
14	Edwards Mine	*,BD,d	*,BD,d	
15	Cline Lake Mine	*,BD,d	*,BD,d	B
16	Markes	*,BD,d	BD,d	B
17	Laughlin	-	*,BD,d	B
18	McColl	-	*,BD,d	
19	3-Mile Post	-	*,BD,d	
20	Archibald		(NOT EXPOSED AT	
21	Watson Lake Property	BD,d	*,BD,d	B
22	Reid	*,BD,d	-	B
23	MacLeod	*,BD,d	-	B
24	Bearpaw Portage	*,BD,d	-	
25	Adonis	-	-	
26	Leitch	*,BD,n.d.	-	

BD = Brittle-ductile high strain zone *
B = Brittle high strain zone n.d.= sense of
d = dextral, oblique-slip displacement ?
s = sinistral, oblique-slip displacement -

TABLE 4: Assay data for selected grab samples.

SAMPLE No.	OCCURRENCE	Au (ppb)	Au (oz./ton)	Ag (ppm)	As (ppm)	Co (ppm)	Ni (ppm)	Mo (ppm)	W (ppm)	Cr (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	SAMPLE DESCRIPTION
87-KBH-0001	Markes (16)	2	-	ND	1.5	34	6	<10	<50	11	63	<10	183	Relatively unaltered and undeformed mafic pillowed metavolcanic rock; from south of high strain zone.
0002	Markes (16)	275	-	ND	30	25	5	<10	<50	10	43	<10	195	moderate silicification and Fe-carbonatization of pillowed mafic metavolcanic; from old trench in the high strain zone.
0003	Markes (16)	(17.0 ppm)	0.50	ND	280	17	<5	<10	<50	<10	24	<10	51	Intensely deformed and altered (silicified and Fe-carbonatizied) mafic pillowed metavolcanics; from south margin of the high strain zone.
0004	Markes (16)	8400	0.24	2	310	40	15	17	<50	11	71	<10	100	Quartz-Fe-carbonate-tourmaline bearing shear; from shear bounding the northern margin of the high strain zone.
0005	Markes (16)	575	0.02	<2	13.5	5	<5	<10	<50	<10	26	<10	66	Late, flat-dipping, north-striking quartz-tourmaline vein crosscutting the high strain zone.
0007	Markes (16)	2	-	ND	<1	<5	<5	<10	<50	<10	6	<10	116	Large intermediate dike north of the Markes high strain zone; weakly deformed, moderately altered.
0008	Markes (16)	(13.75 ppm)	0.40	2	240	22	<5	<10	<50	<10	23	<10	200	Strongly silicified and Fe-carbonatized mafic pillowed metavolcanic rock; from within the high strain zone near the north margin.
0009	Markes (16)	9	-	ND	4	6	<5	<10	<50	<10	8	<10	35	Crosscutting NW-striking felsic dike; from outside the high strain zone (to the north).
031A	Cline Lake (15)	(39.3 ppm)	1.15	<2	400	<5	<5	<10	<50	<10	35	14	13	No.3 adit vein; sugary quartz vein along the southern part of of the vein structure; 87-KBH-031B is of the northern vein.
031B	Cline Lake (15)	(46.0 ppm)	1.34	<2	90	<5	<5	<10	<50	<10	24	12	13	No.3 adit vein; grey coloured quartz vein along the northern part of the vein structure; 87-KBH-031A is of the southern vein.
032A	Cline Lake (15)	(58.7 ppm)	1.71	<2	120	9	<5	<10	<50	<10	36	<10	50	Northern portion of No.3 adit outcrop; 115°-striking quartz vein in a narrow high strain zone within coarse-grained mafic metaintrusive rocks.

SAMPLE No.	OCCURRENCE	Au (ppb)	Au (oz./ton)	Ag (ppm)	As (ppm)	Co (ppm)	Ni (ppm)	Mo (ppm)	W (ppm)	Cr (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	SAMPLE DESCRIPTION
032B	Cline Lake (15)	2470	0.07	2	540	37	9	<10	95	<10	114	<10	71	Strongly deformed and altered mafic metaintrusive wall rock to the quartz vein sampled in 87-KBH-032A; abundant calcite and up to 25% pyrite.
0033	Cline Lake (15)	1000	0.03	<2	200	11	<5	<10	<50	<10	33	<10	11	Rusty, fissile, highly deformed and altered felsic (?) dike rock at the intersection zone between an 080°- and 110°-striking high strain zones.
0034	Cline Lake (15)	1760	0.05	<2	50	29	42	<10	<50	62	165	<10	67	Narrow, 3-4 cm wide vuggy quartz vein, locally glassy; confined to a 110°-striking high strain zone on the eastern side of the No.3 outcrop.
0035	Cline Lake (15)	(318.0 ppm)	9.27	4	330	<5	<5	<10	65	<10	21	37	31	Sugary quartz vein, 10-12 cm wide; localized in a 110°-striking high strain zone; minor tourmaline, chlorite; trace pyrite.
0036	Cline Lake (15)	2530	0.07	<2	63	5	<5	<10	<50	<10	14	<10	<10	115°-striking southern vein on the No.3 outcrop; sugary texture, 8-10 cm wide; sample taken where the vein transects a rusty-grey, silicified felsic dike.
0037	Cline Lake (15)	(122.6 ppm)	3.57	<2	58	<5	<5	<10	<50	<10	16	<10	20	Same 115°-striking vein as 87-KBH-0036 except 10 m southeast along strike; sugary texture; chlorite with 1-2% pyrite; schistose mafic metavolcanic host rock.
0038	Cline Lake (15)	2450	0.07	2	68	15	8	<10	445	18	64	<10	77	Same vein as 87-KBH-0036 and 0037, except 17 m southeast of 87-KBH-0037; located near contact with aphanitic felsic rock.
0039	Cline Lake (15)	6950	0.20	<2	40	<5	<5	<10	<515	<10	36	11	58	Same structure as 87-KBH-0036, 0037 and 0038, except now within the aphanitic felsic rock; no quartz vein, only a rusty, narrow fault/fracture.
0041	Cline Lake (15)	560	0.02	2	31	24	<5	45	<50	17	122	<10	25	080°-striking rusty high strain zone containing a narrow, rusty pyrite-chlorite-bearing quartz vein.
0042	Cline Lake (15)	100	-	17	49	29	9	<10	<50	<10	102	<10	91	Sheeted quartz-Fe-carbonate veinlet zone; hosted by weakly to moderately altered mafic rocks; from north of a majorfissile high strain zone.
052C	No.2 Zone (5)	7360	0.21	<2	4	<5	<5	<10	<50	<10	13	<10	52	025°-035° striking No.2 zone vein; abundant pinkish-coloured biotite and disseminated pyrrhotite.

SAMPLE No.	OCCURRENCE	Au (ppb)	Au (oz./ton)	Ag (ppm)	As (ppm)	Co (ppm)	Ni (ppm)	Mo (ppm)	W (ppm)	Cr (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	SAMPLE DESCRIPTION
067B	3-Mile Post (19)	140	-	<2	16.5	14	21	<10	<50	12	270	<10	2000	Rusty quartz vein containing pyrrhotite and chlorite; localized along the northern margin of sericite- and Fe-carbonate-altered quartz-feldspar porphyry dike.
074A	MacLeod (23)	9570	0.28	ND	1	27	17	<10	<50	<10	1.49%	<10	74	Large, pod-shaped quartz vein containing abundant chalcopyrite and ribbons of chlorite±tourmaline (?).
080A	Reid (22)	1240	0.04	ND	<1	<5	10	<10	<50	22	40	<10	15	Quartz vein from within a 080°-striking high strain zone.
080B	Reid (22)	3	-	ND	4.5	5	<5	<10	<50	<10	11	<10	16	Felsic dike.
082B	Edwards (14)	50	-	ND	310	5	<5	<10	<50	<10	12	<10	18	Felsic quartz eye porphyry dike; sericitized; abundant disseminated pyrite (up to 15%); from a small trench immediately west of the No.1 shaft.
092B	Breccia Zone (10)	(11.9 ppm)	0.34	ND	1	9	<5	<10	335	<10	7500	<10	9100	Chalcopyrite-pyrite as disseminations and veinlet fillings within a silicified and psuedo-brecciated zone within the the Maskinonge Lake fault.
093A	Michael Shaft (9)	90	-	ND	3	26	21	<10	<50	37	26	<10	71	Quartz vein stockwork; psuedo-brecciated rock; from immediately north of the old shaft.
093B	Michael Shaft (9)	180	-	ND	2	5	<5	<10	<50	<10	11	24	25	Massive quartz vein adjacent to the psuedo-brecciated rock; from immediately south of the old shaft.
098A	Murphy (1)	5830	0.17	8	12	<5	<5	<10	<50	<10	193	86	880	Quartz±ankerite vein; from the north side of the trench; in contact with a QFP dike; Icehouse veins of Bruce (1942).
098B	Murphy (1)	480	-	<1	54	<5	<5	<10	<50	<10	19	<10	48	Ankerite vein with brecciated and incorporated fragments of quartz and wall rock altered QFP; adjacent to 87-KBH-093A.
108A	Murphy (1)	185	-	ND	1	25	46	<10	<50	130	44	<10	220	010°-striking ankerite±quartz veinlets; from hanging wall (north) mafic metavolcanic rocks; Murphy Mine open pit #3 (West Pit).
108B	Murphy (1)	26	-	ND	1	<5	<5	<10	<50	<10	9	<10	56	Main ankerite-quartz vein; from western end of the open pit between 87-KBH-108A and 108B; Murphy Mine open pit #3 (West Pit).

SAMPLE No.	OCCURRENCE	Au (ppb)	Au (oz./ton)	Ag (ppm)	As (ppm)	Co (ppm)	Ni (ppm)	Mo (ppm)	W (ppm)	Cr (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	SAMPLE DESCRIPTION
108C	Murphy (1)	27	-	ND	1	<5	<5	<10	<50	<10	36	<10	18	Schistose, sericitized felsic quartz eye porphyry dike; footwall (south) to the main vein (87-KBH-108B); Murphy Mine open pit #3.
0121	Kremzar (8)	39	-	ND	1.5	10	9	<10	<50	22	12	<10	36	Silicified and Fe-carbonatized "cherty" vein material from the R-Zone mineralized area; possibly an altered and deformed dike.
135A	Watson Lake (21)	675	0.02	ND	<1	<5	<5	<10	150	<10	35	<10	29	Sulphidized (pyrite-pyrrhotite) chert-magnetite banded ironstone; folded and deformed.
135B	Watson Lake (21)	19	-	ND	1	11	8	<10	<50	15	31	<10	61	Fe-carbonitized (ankerite ?) mafic metavolcanic rock with quartz veins; adjacent to the ironstone sampled in 87-KBH-135A.
0136	Watson Lake (21)	10	-	ND	4	26	32	<10	<50	61	57	<10	61	2 m wide zone of sericite-chlorite-pyrite-Fe-carbonate bearing schist with quartz-carbonate veinlets; crenulated.
137B	Watson Lake (21)	2930	0.09	ND	31	50	106	<10	<50	33	102	<10	98	Quartz-ankerite-pyrite veining within a chlorite-ankerite-sericite schist; strongly altered and deformed; kinked.

CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS.

Conversion from SI to Imperial			Conversion from Imperial to SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
		LENGTH			
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
		AREA			
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
		VOLUME			
1 cm^3	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.308 0	cubic yards	1 cubic yard	0.764 555	m^3
		CAPACITY			
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
		MASS			
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
		CONCENTRATION			
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

	Multiplied by	
1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

Note: Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in co-operation with the Coal Association of Canada.

Telephone (416) 965-4534
Facsimile (416) 963-1489

June 16, 1992

MEMORANDUM TO: All Recipients of OFR 5832

FROM: Andrea Perego

RE: Replacement Tables and Photo

Please find enclosed new versions of Tables 1, 2 and 3, and Photo 7, made necessary by errors in the printing of Open File Report 5832, *Geological and Structural Setting of Gold Mineralization in the Goudreau-Lochalsh Area, Wawa Gold Camp.*

The new versions of Tables 1 and 2 should clarify the content of those tables. The original version of Table 3 was missing the second half of the table, and is included here. Photo 7, on page 110, included a sketch which was inadvertently placed sideways over the photograph.

Please use these new pages to replace those in error in the original. We apologize for any inconvenience this may have caused. Please call if you have any further questions.

Sincerely,

Andrea Perego
Geoscience Reviewer
Publication and Cartographic Services
718-77 Grenville St.
Toronto, Ontario
M7A 1W4

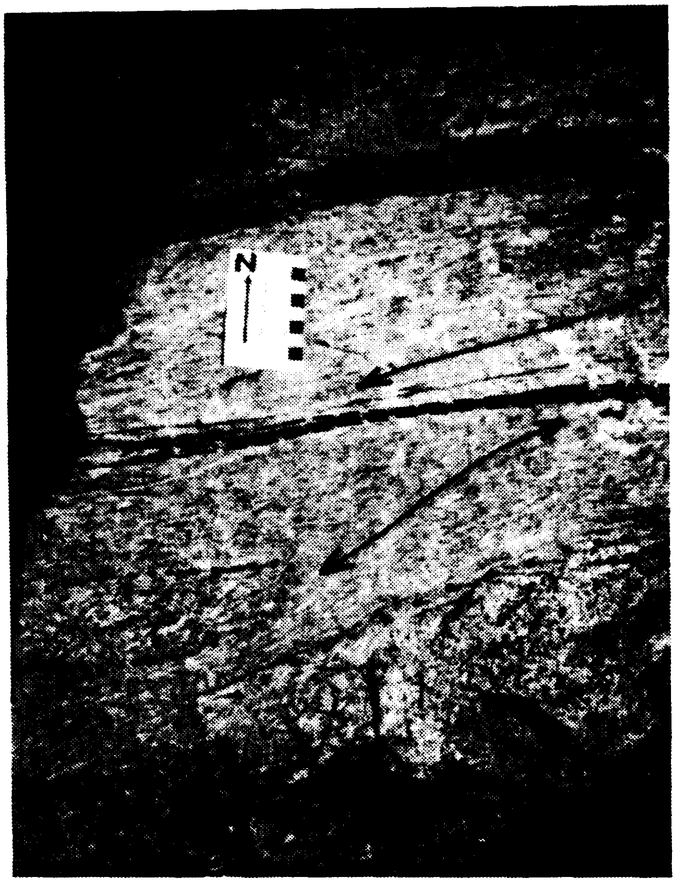
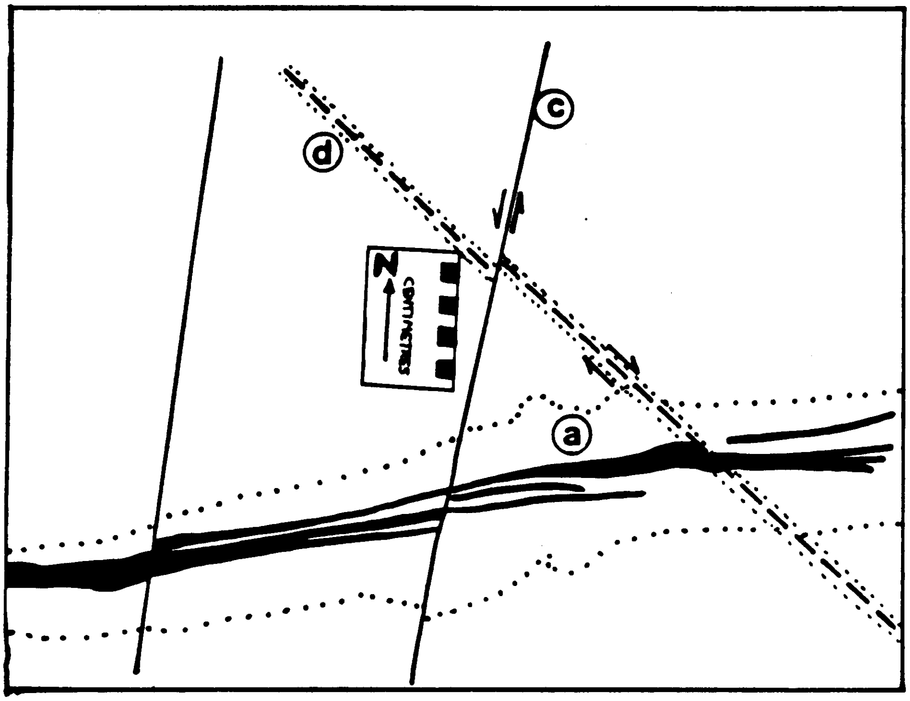


PHOTO 6: Narrow auriferous quartz vein (dark) hosted within a ductile high-strain zone. Compare the relatively undeformed intrusive rock (bottom of photo) versus the strongly foliated, equivalent intrusive rock adjacent to the vein. Note the rotation of the schistosity into the vein structure. Scale card indicates north. West Zone, Magino gold mine.



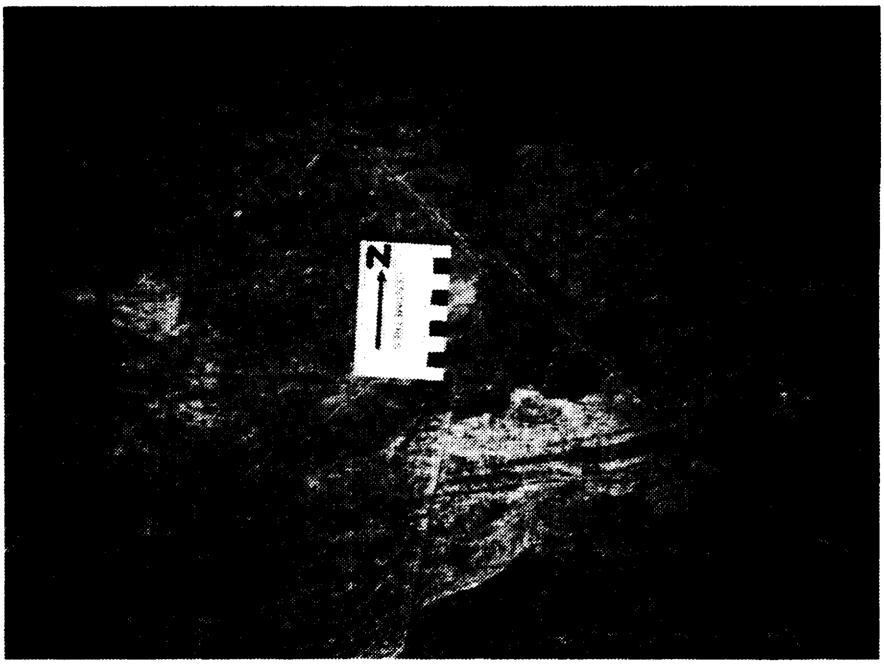


PHOTO 7: Close-up of an 085°-striking auriferous quartz vein (black) and associated alteration halo (dotted outline) being offset dextrally by a brittle, 130°-striking fracture. Both the vein and the fracture are in turn offset sinistrally by a 035°-striking brittle fracture. Note the narrow alteration halo (similar colouration to the one associated with the vein) confined to the 130°-striking fracture. Letters correspond to high-strain zones and fracture sets discussed in the text. Scale card indicates north. West Zone, Magino gold mine.

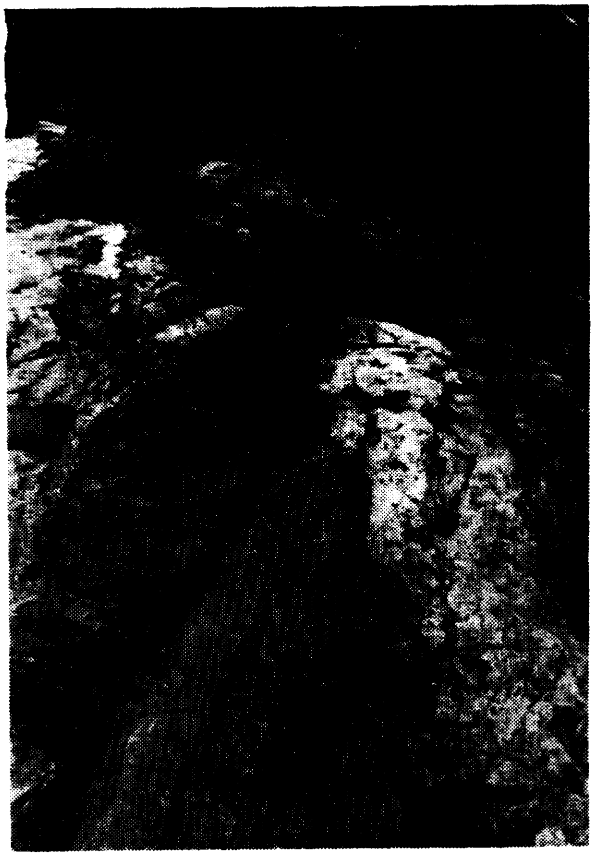


PHOTO 50: Overall view of a folded felsic dike which is truncated by a discrete shear zone (see Figure 30). Hammer handle indicates north. From a mechanically stripped outcrop at the Reid gold occurrence.

Table 1: Correlation between regional structural elements reported for parts of the Michipicoten greenstone belt and those documented for the Goudreau-Lochalsh area.

Table 1

McGill and Shrady (1986)
Southwestern Michipicoten Belt

D1 - dominant map pattern, strike of rock units

- thrust imbrication, recumbent F1?

- F1 syncline, thrust-faulted

D2 - F2, S2, NW-strike

D3 - F3, S3, ENE-NE-strike

D4 - S4, NE-strike

Late NW-, NE- and N-striking brittle faults

Arias and Helmstaedt (1989, 1990b)
West-Central Michipicoten Belt

D1 - recumbent regional F1; local S1 and small-scale F1

D2 - dominant map pattern, strike of rock units

- thrust imbrication producing repetition of, at least the youngest supracrustal units

- F2 inverted syncline, thrust-faulted

- F2 inverted anticline (Centre Anticline), thrust-faulted

- F2, S2, NW-strike

- F2, S2, ENE-NE-strike

D3 - local F3, S3, NE-strike

Heather and Arias (1992, this study)
East-Central Michipicoten Belt (Goudreau-Lochalsh area)

D1 - local S1

D2 - dominant map pattern, strike of rock units

- F2 anticline (Goudreau Anticline)

- F2, S2, E-ENE-strike

D3 - S3, NE-strike

TABLE 2: Gold (Au), base-metal (Cu, Zn, Pb) and iron deposits/occurrences of the Goudreau-Lochalsh district. Numbers correspond to those shown in Figures 3 and 13. All the Iron Ranges indicated with an * are part of the more regionally extensive Goudreau Iron Range.

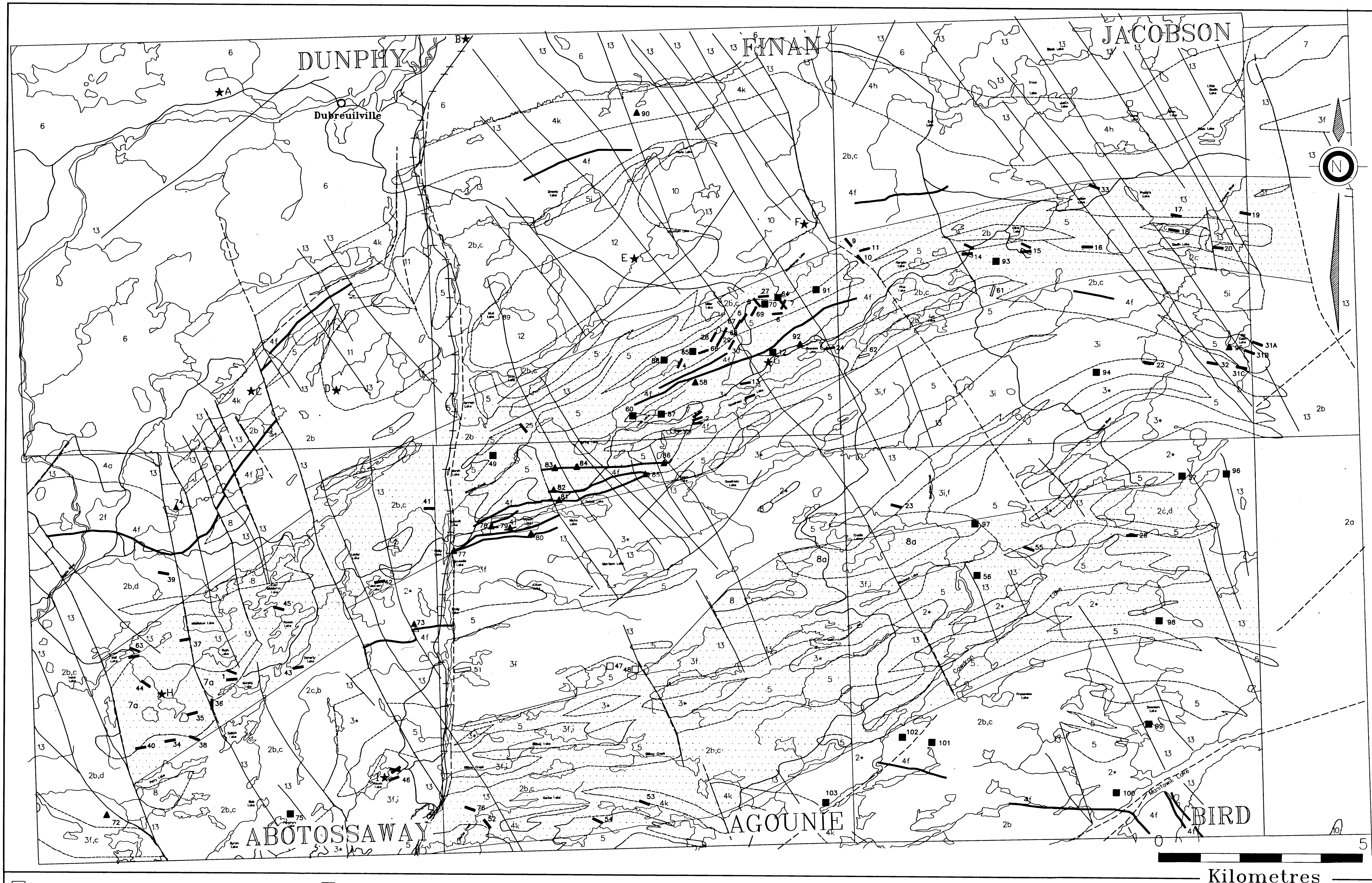
1	Murphy mine (Au)	53	Slate Lake occurrence (Au)
2	Magino mine (Au)	54	Smith Highgrade occurrence (Au)
3	Island-Lochalsh Zones (Au)	55	Blowout occurrence (Au)
4	Canamax-No.3 Zone (Au)	56	Blackout occurrence (Au)
5	Canamax-No.2 Zone (Au)	57	Sawmill occurrence (Au)
6	Canamax-No.8 Zone (Au)	58	Aitkins Pyrite occurrence (Fe)
7	Canamax-Rusty Zone (Au)	59	Bearpaw Lake occurrence (Au)
8	Kremzar mine (Au)	60	Brandt-Lovell Lake occurrence (Au)
9	Michael Syndicate Shaft (Au)	61	Racicot occurrence (Cu)
10	Canamax-Breccia Zone (Au)	62	Texron occurrence (Cu)
11	Canamax-Pine Zone (Au)	63	Ego mine (Au, Cu, Co)
12	Canamax-Morrison No.1 Zone	64	Maskinonge occurrence (Au)
13	Morrison Cabin Claims (Au)	65	Canamax-No.4 Zone (Au)
14	Edwards mine (Au)	66	Canamax-No.5 Zone (Au)
15	Cline Lake mine (Au)	67	Canamax-No.10 Zone (Au)
16	Markes occurrence (Au)	68	Canamax-Tent Vein (Au)
17	Laughlin occurrence (Au)	69	Canamax-No.7 Zone (Au)
18	McColl occurrence (Au)	70	Canamax-Wiggly Vein (Au)
19	3-mile Post occurrence (Au)	71	
20	Archibald occurrence (Au)	72	Eccles Lake Iron Formation (Fe)
21	Watson Lake occurrence (Au)	73	Morrison No.2 Iron Range* (Fe)
22	Reid occurrence (Au)	74	Rutledge Iron Range (Fe)
23	MacLeod occurrence (Au)	75	Candela Development Property occurrence (Au)
24	Bearpaw Portage occurrence (Au)	76	Garbe Lake West occurrence (Au)
25	Adonis occurrence (Au)	77	Rand No.1 and Morrison No.4 Iron Ranges* (Fe)
26	Leitch occurrence (Au)	78	"E" Iron Range* (Fe)
27	Canamax-Pyrrhotite Zone (Au)	79	"D" Iron Range* (Fe)
28	Canamax-No.6 Zone (Au)	80	"B" Iron Range* (Fe)
29	Canamax-No.1 Zone (Au)	81	"F" Iron Range* (Fe)
30	Canamax-No.9 Zone (Au)	82	"C" Iron Range* (Fe)
31	Old Cabin occurrences (Au)	83	McPhail Iron Range* (Fe)
32	Archer-Crawford occurrence (Au)	84	"A" Iron Range* (Fe)
33	McCormick-Indian Lake occurrence (Au)	85	Bear Iron Range* (Fe)
34	Farquhar Vein occurrence (Au)	86	Morrison No.3 Iron Range* (Fe)
35	Brighton occurrence (Au)	87	Goodman-Whalen occurrence (Au)
36	Cline Claim A.C. 452 (Au)	88	Chitty occurrence (Au)
37	Barnes occurrence (Cu)	89	Herman Lake Nepheline Cancrinite Syenite
38	McCauley occurrence (Au)	90	Dreany Iron Range (Fe)
39	Paquette occurrence (Au)	91	Quartzite occurrence (Au)
40	Porter-Premier occurrence (Au)	92	Bearpaw Lake Iron Range* (Fe)
41	McMahon occurrence (Au)	93	Huronian Belt occurrence (Au)
42	Brandt occurrence (Au)	94	Cymbal Exploration Claim (Au)
43	Doherty Lake occurrence (Au)	95	Old Cabin Lake Iron Formation (Fe)
44	Gutcher occurrence (Au)	96	Jackfish Lake occurrence (Au)
45	Banville-Page occurrence (Au)	97	Little Grace occurrence (Au)
46	Kozak mine (Au, Pb, Zn)	98	Leitch Gold Mines Iron Formation (Fe)
47	Canorama occurrence (Cu)(Au)	99	Swanson Lake occurrence (Au)
48	Chuck Lake occurrence (Cu)	100	Manitowik Lake occurrence (Au)
49	Lajoie occurrence (Au)	101	Mespi Mines anomaly #49 (Au)
50	Noranda anomaly 1-81 (Au)	102	Mespi Mines anomaly #50 (Au)
51	OGS zinc occurrence (Zn)	103	Locke Lake occurrence (Au)
52	Priest occurrence (Au)		

TABLE 3: Structural characteristics and host rocks for selected gold mines and occurrences visited in the Goudreau-Lochalsh district during the current study. Listed are the high strain zone orientations, deformation styles and sense of displacements.

No.	Gold Mine/Occurrence Name	High Strain Zone Orientation Groups					
		080^0-090^0	105^0-120^0	045^0-065^0	025^0-035^0	130^0-150^0	350^0-010^0
1	Murphy Mine	*, BD, d	*, BD, d	BD, d?	B, s	B, n. d.	-
2	Magino Mine	*, BD, d	?	*, BD, d?	-	B, d	B, s
3	Island-Lochalsh Zones		(NOT EXPOSED AT SURFACE)				
4	Canamax-No. 3 Zone	BD, d	B, d	-	*, BD, s	B, n. d.	B, n. d.
5	Canamax-No. 2 Zone	B, n. d.	B, n. d.	BD, n. d.	*, BD, s	B, n. d.	-
6	Canamax-No. 8 Zone	*, BD, d	B, n. d.	BD, n. d.	BD, n. d.	-	B, n. d.
7	Canamax-Rusty Zone	BD, d	BD, d	*, BD, s?	BD, s	*, BD, d	B, d
8	Canamax-Kremzar Mine	B, n. d.	BD, d	-	BD, s	*, BD, d	B, n. d.
9	Michael Syndicate Shaft	-	-	-	-	*, B, n. d.	-
10	Canamax-Breccia Zone	-	-	-	-	*, B, n. d.	-
11	Canamax-Pine Zone	*, BD, n. d.	-	-	-	-	-
12	Canamax-Morrison No. 1		(IRONSTONE HOSTED)				
13	Morrison Cabin Claims	*, BD, n. d.	-	-	-	-	B, n. d.
14	Edwards Mine	*, BD, d	*, BD, d	-	-	-	-
15	Cline Lake Mine	*, BD, d	*, BD, d	BD, n. d.	-	B, n. d.	B, d
16	Markes	*, BD, d	BD, d	BD, n. d.	-	-	B, n. d.
17	Laughlin	-	*, BD, d	BD, s?	-	-	-
18	McColl	-	*, BD, d	-	-	-	-
19	3-Mile Post	-	*, BD, d	B, n. d.	B, n. d.	B, n. d.	B, n. d.
20	Archibald		(NOT EXPOSED AT SURFACE)				
21	Watson Lake Property	BD, d	*, BD, d	BD, n. d.	-	*, BD, d?	-
22	Reic	*, BD, d	-	BD, s	BD, s	BD, d?	
23	MacLeod	*, BD, d	-	BD, s	B, s?	B, d?	-
24	Bearpaw Portage	*, BD, d	-	-	-	-	-
25	Adonis	-	-	-	-	B, n. d.	-
26	Leitch	*, BD, n. d.	-	-	-	-	-

BD = Brittle-ductile high strain zone
B = Brittle high strain zone
d = dextral, oblique-slip displacement
s = sinistral, oblique-slip displacement

* = hosts significant gold
n. d. = sense of displacement; not determined
? = sense of displacement; equivocal
\- = sense of displacement; not recorded



2 Mafic to Intermediate Metavolcanic Rocks
- * Unsubdivided
- b Massive Flows
- c Pillowed Flows
- d Volcaniclastic Rocks
- f Amphibolite, Mafic Gneiss

3 Felsic to Intermediate Metavolcanic Rocks
- * Unsubdivided
- c Massive Flows
- f Tuff and/or Lapilli Tuff
- i Volcanic Breccia

4 Clastic and Chemical Metasedimentary Rocks
- a Unsubdivided
- f Iron Formation
- h Polymictic Conglomerate
- k Mixed Conglomerate and Wacke

5 Mafic Intrusive Rocks

6 External Felsic Intrusive Rocks

7 Internal Felsic Intrusive Rocks
- a Gutcher Lake Trondhjemite Stock
- b Webb Lake Trondhjemite Stock

8 Subvolcanic Felsic to Intermediate Intrusive Rocks
- a Cradle Lakes Quartz–Feldspar Porphyry

10 Maskinonge Lake Granodiorite Stock

11 Troupe Lake Granodiorite Stock

12 Herman Lake Nepheline–Syenite Intrusive Complex

13 Diabase

Road

Railway

Deformation Zone

Fault

Lineament

Geological Contact

NOTE: Unit 1 (Ultramafic metavolcanic rocks) and Unit 2 (Timiskaming-type rocks) do not occur within this map area and therefore have been omitted from the legend.

★ U-Pb Zircon Geochronological Sample Site
- A Biotite Tonalite (2662 ± 5 Ma)
- B Dubreuilville Granodiorite (2686 ± 13 Ma)
- C Dore (equivalent) Wacke (2680 ± 5 Ma)
- D Troupe Lake Stock (2671 ± 2 Ma)
- E Herman Lake Nepheline Syenite (2671 ± 5 Ma)
- F Maskinonge Lake Stock (2672 ± 2 Ma)
- G Morrison Felsic Metavolcanic (2729 ± 3 Ma)
- H Gutcher Lake Stock (2722 ± 1 Ma)
- I Alden Felsic Metavolcanic Tuff (2746 ± 15 Ma)

Occurrence Orientation Not Known
- ■ Gold (Au)
- ▲ Iron (Fe)
- □ Base Metals (Cu, Pb, Zn)

Occurrence Orientation Known
- Gold (Au)
- Base Metals (Cu, Pb, Zn)

FIGURE 3: Regional geology (from Sage 1985) of the Goudreau-Lochalsh district. Major access roads are highlighted (dark lines), U-Pb geochronological sample sites identified (black triangles) and mineral occurrences indicated (numbers correspond to those in Table 2).

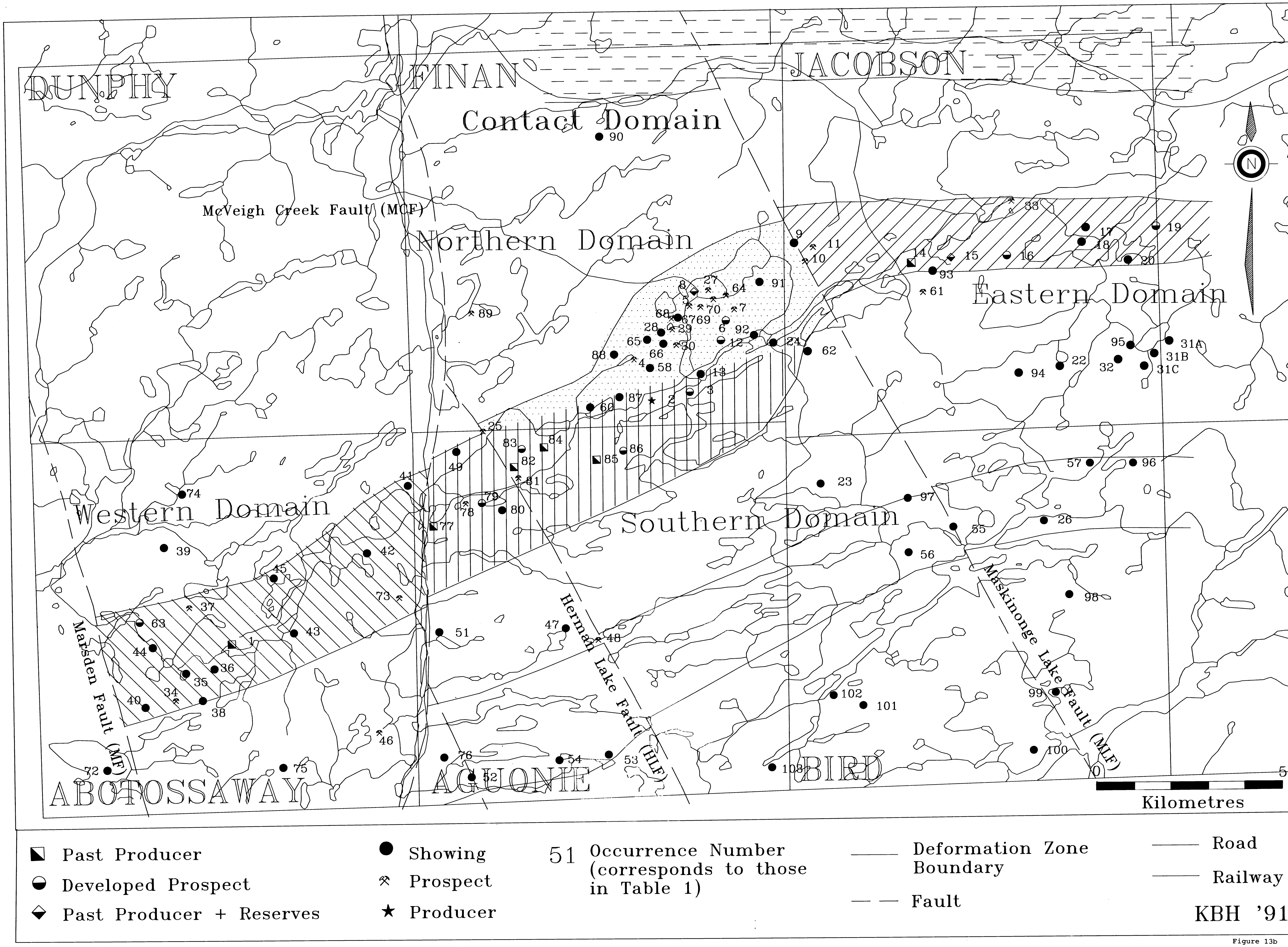


FIGURE 13: (a) Development status of the known gold, base-metal and iron deposits and occurrences in the Goudreau- Lochalsh area. (b) Orientation of the known gold, base-metal and iron deposits and occurrences in relation to the regional deformation zones and the structural domains. Numbers beside the deposits and occurrences correspond to those listed in TABLES 2 and 3.

Figure 13b

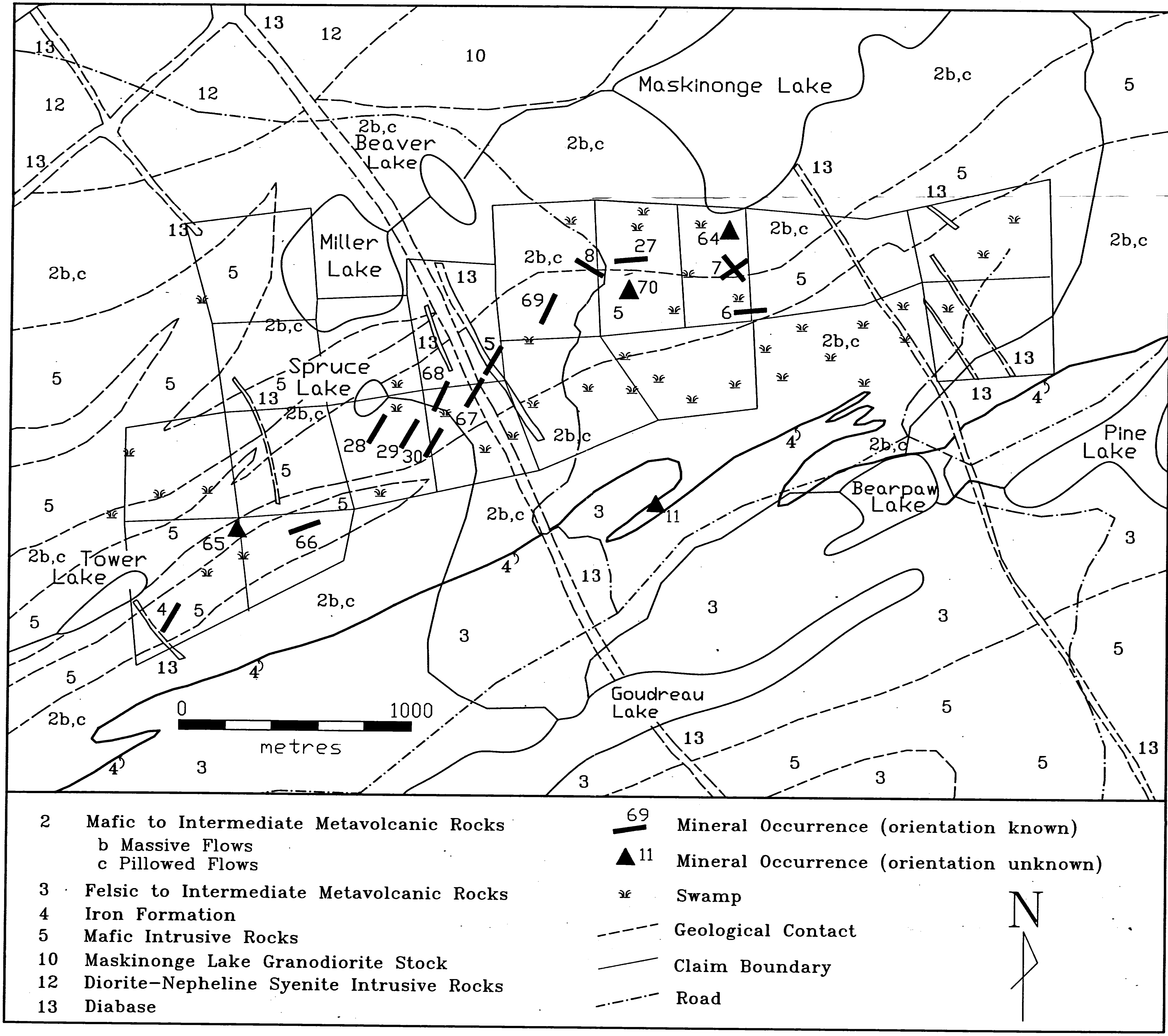


FIGURE 16: Location and general geology of the gold occurrences on the Kremzar property. Compiled from Moore (1931), Burwash (1937a) and assessment file data.

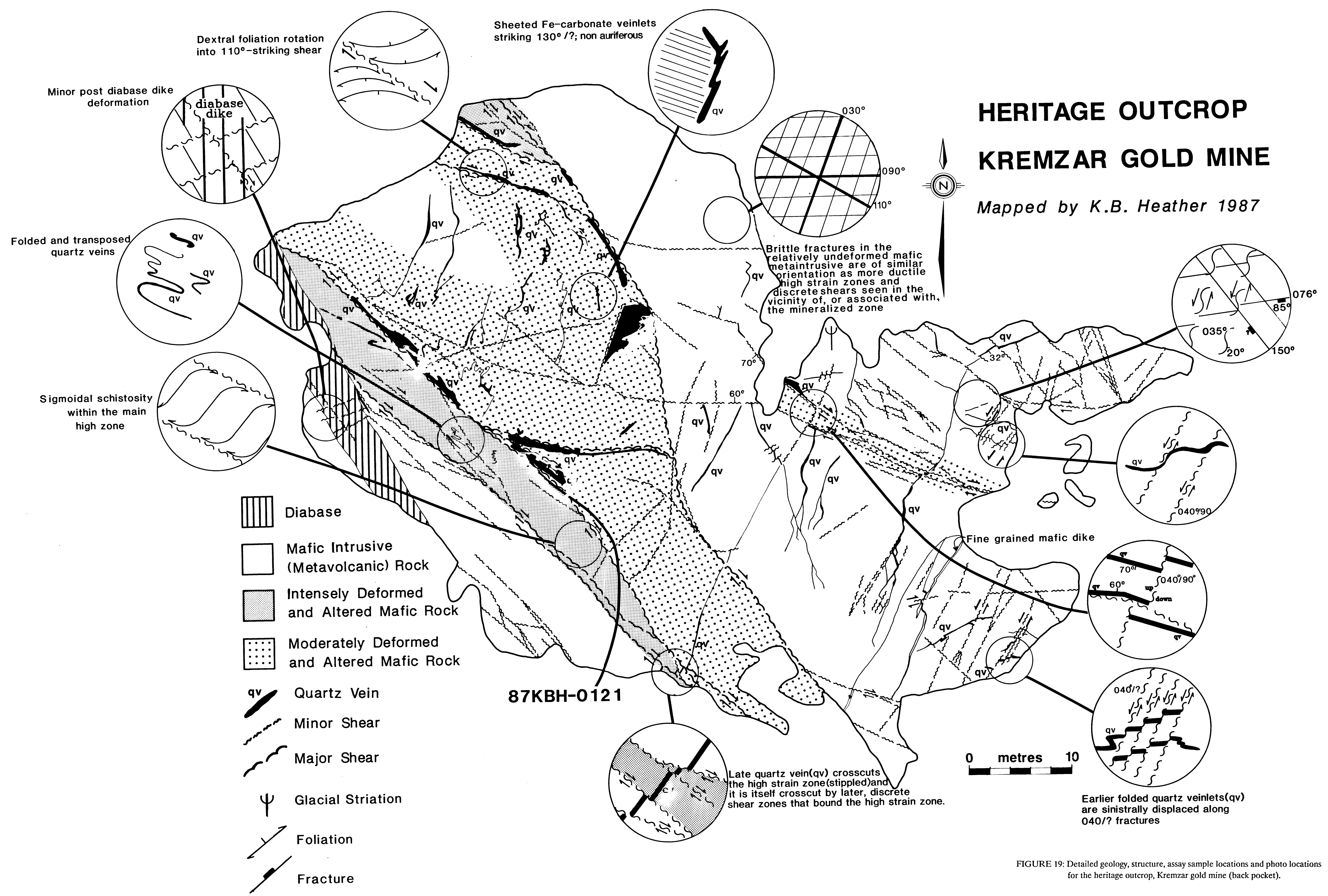


FIGURE 19: Detailed geology, structure, assay sample locations and photo locations for the heritage outcrop, Kremzar gold mine (back pocket).

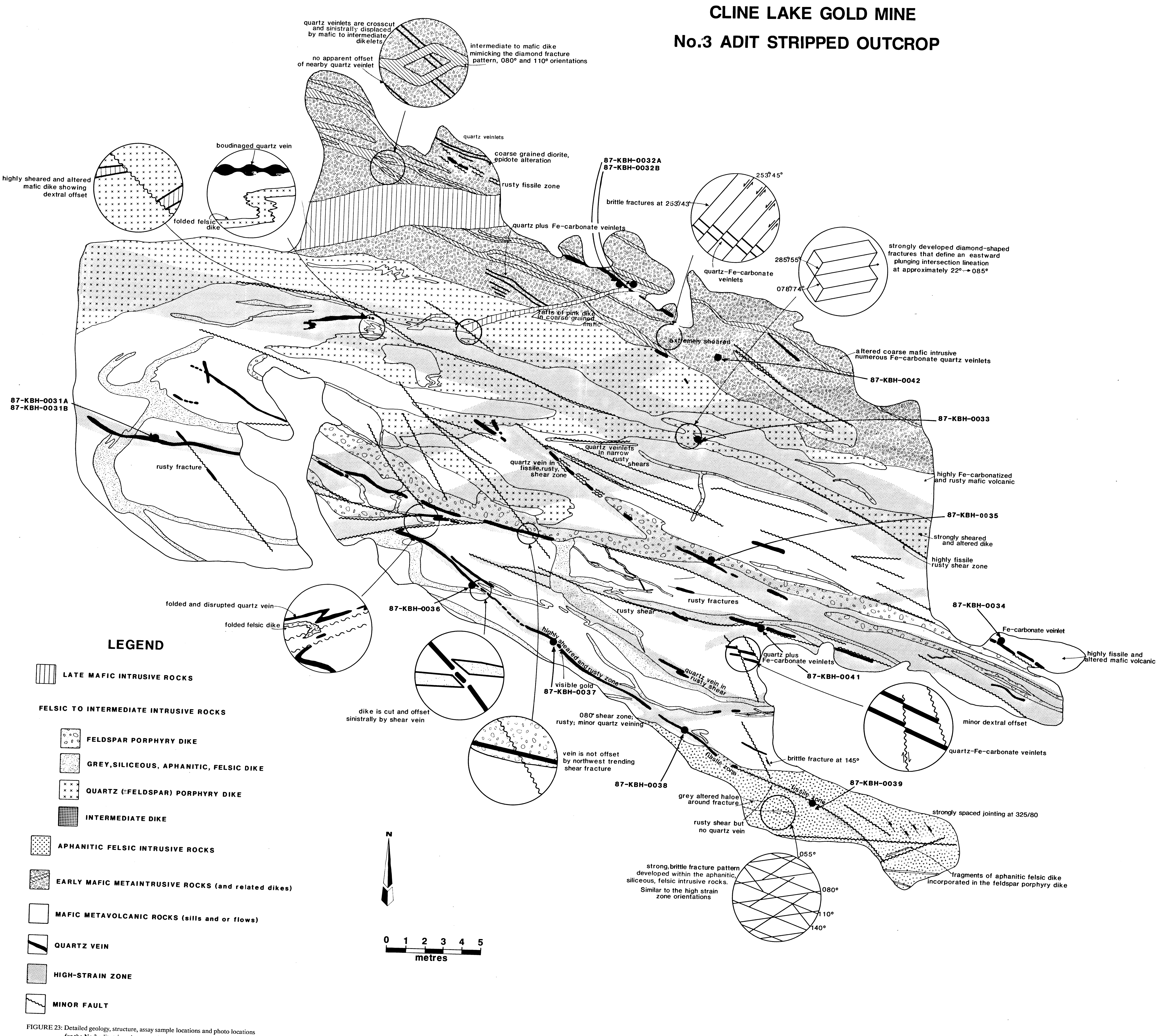


FIGURE 23: Detailed geology, structure, assay sample locations and photo locations for the No.3 adit stripped outcrop (the "amphitheatre"), Cline Lake gold mine (back pocket).

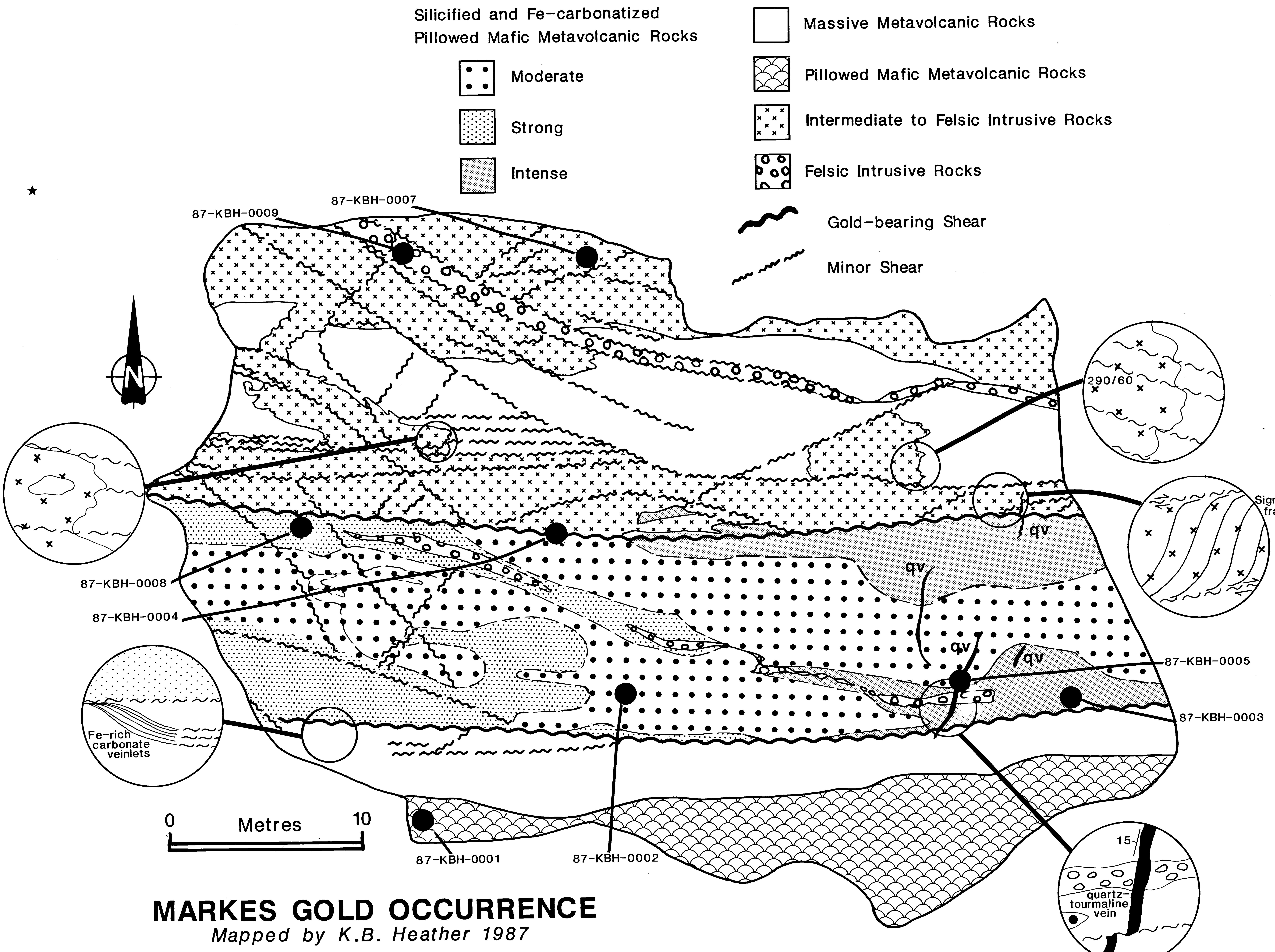
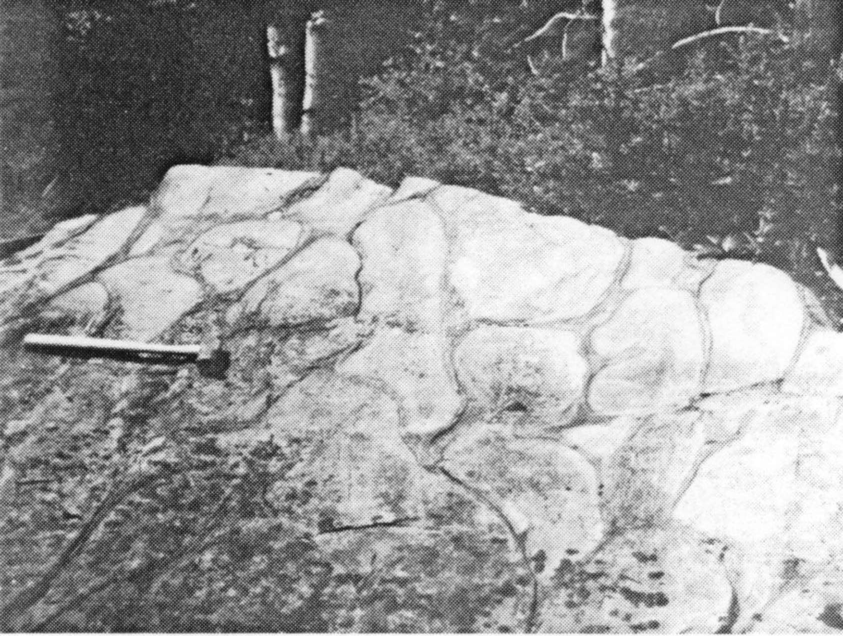
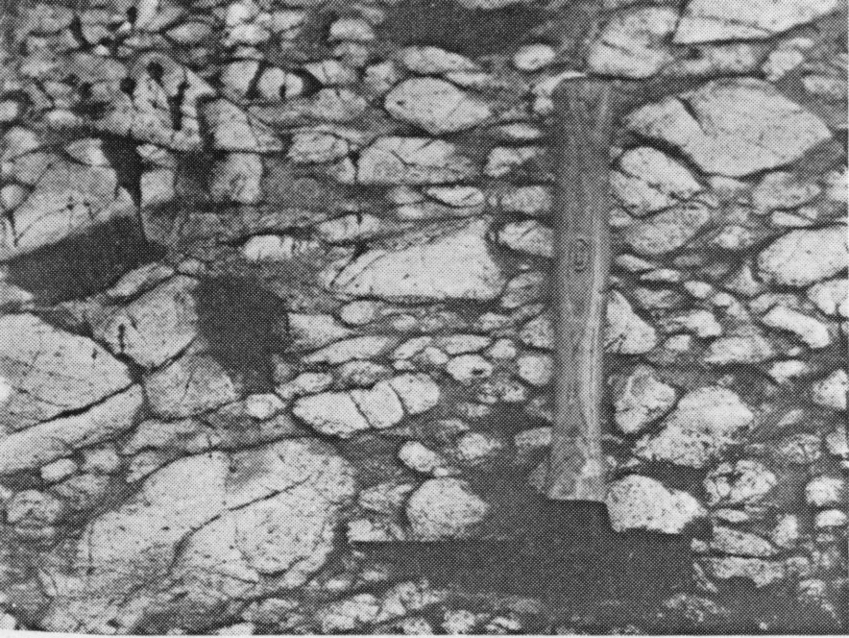


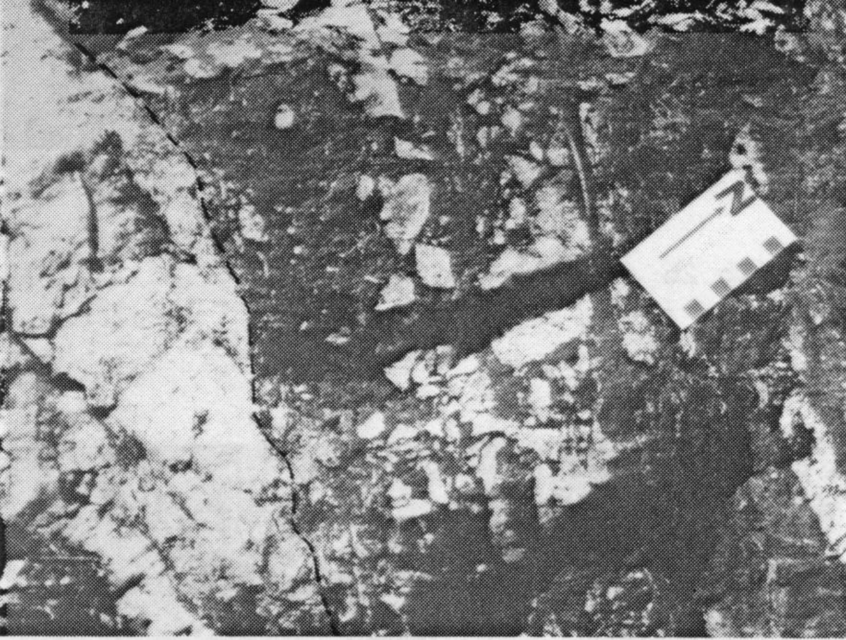
FIGURE 27: Detailed geology, structure, assay sample locations and photo locations for the main Markes stripped outcrop and some of the surrounding trenches, Markes gold occurrence (back pocket).

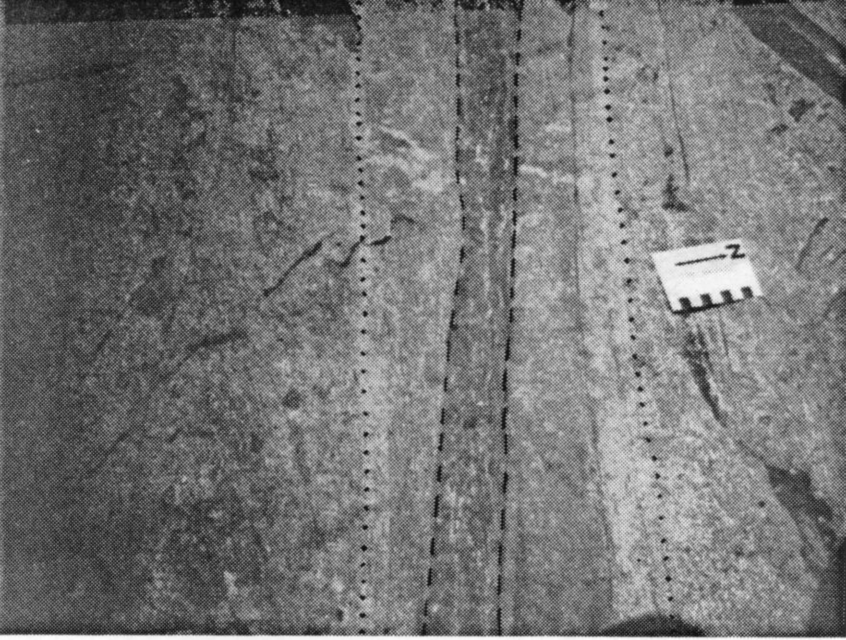
FIGURE 28: Markes property geology; main stripped area, surrounding trenches and diamond drill hole collar locations.

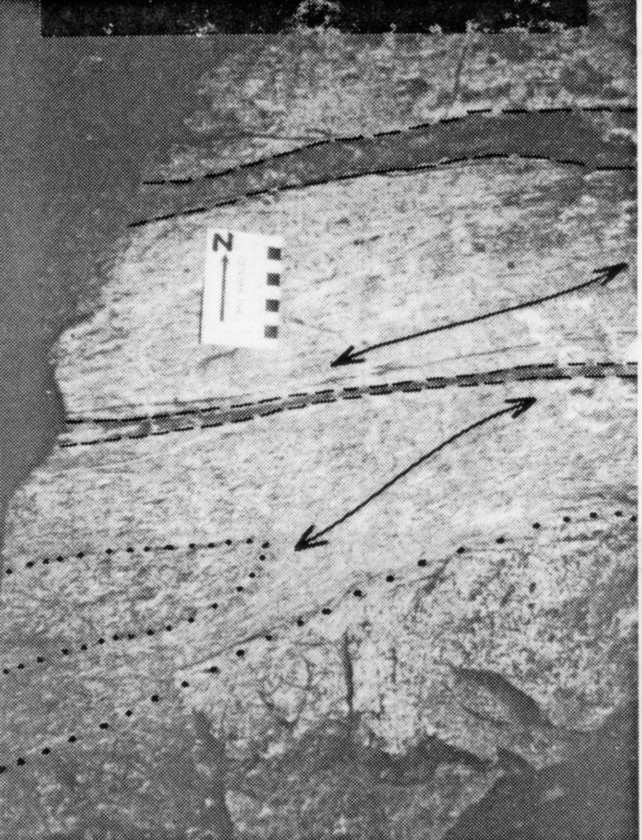
FIGURE 29: Detailed trench maps for the Markes property. Trench numbers correspond to those shown in Figure 28.







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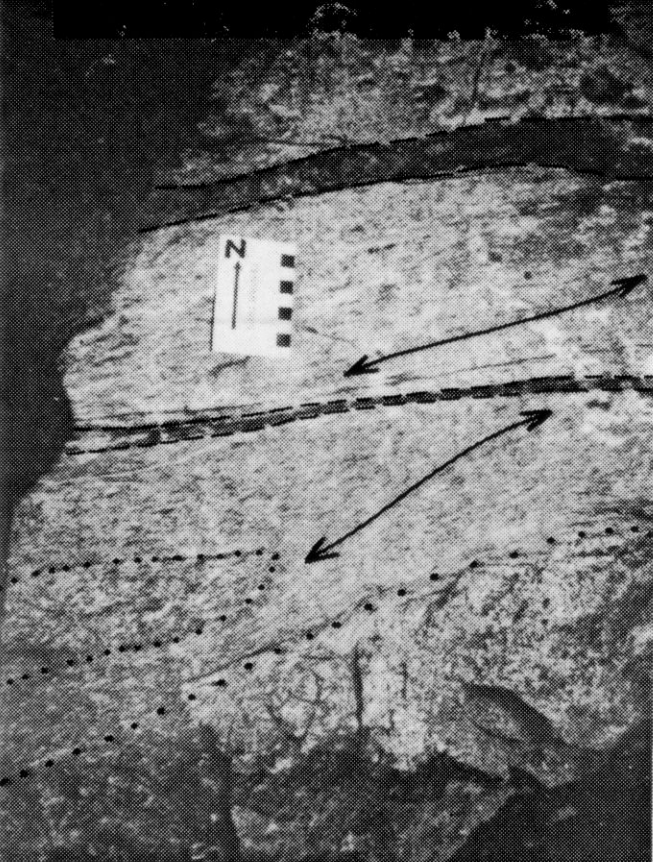
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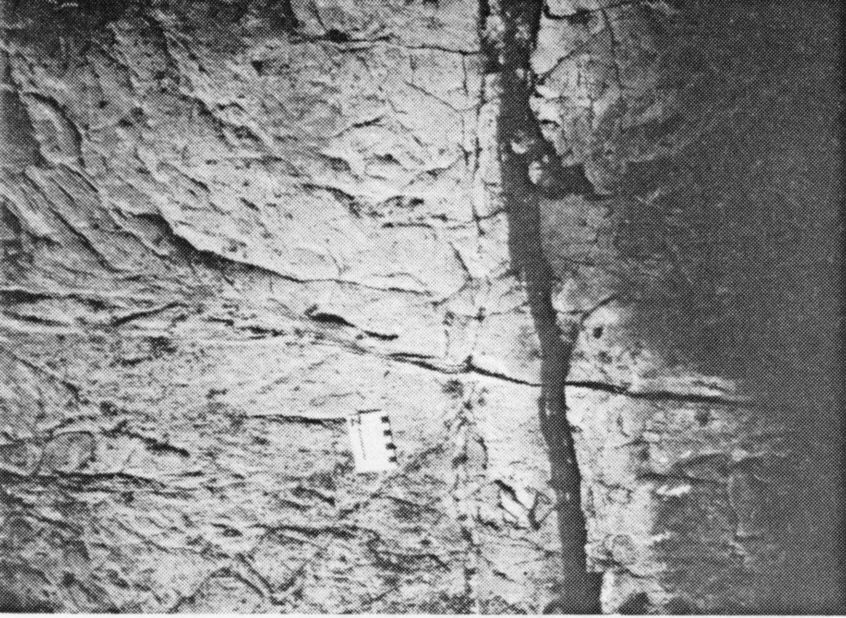

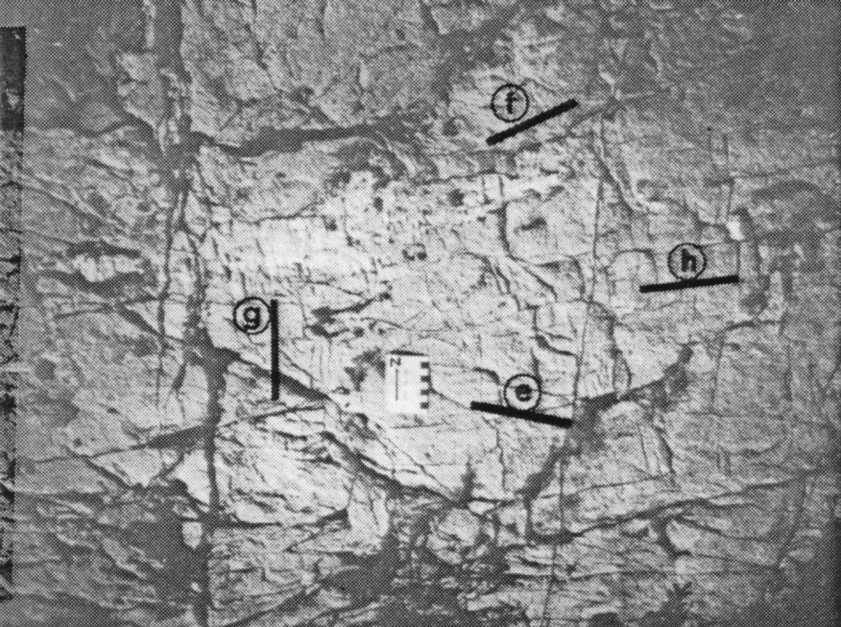
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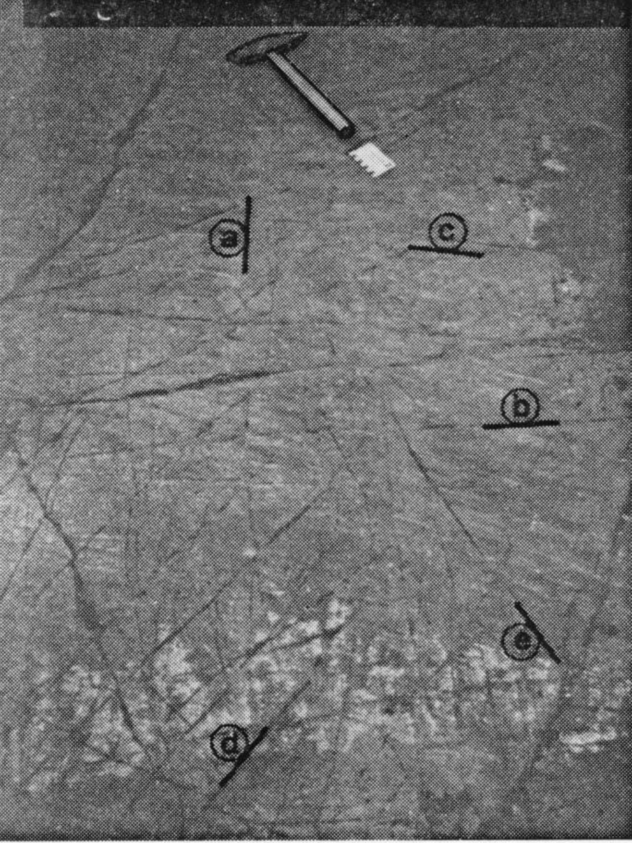
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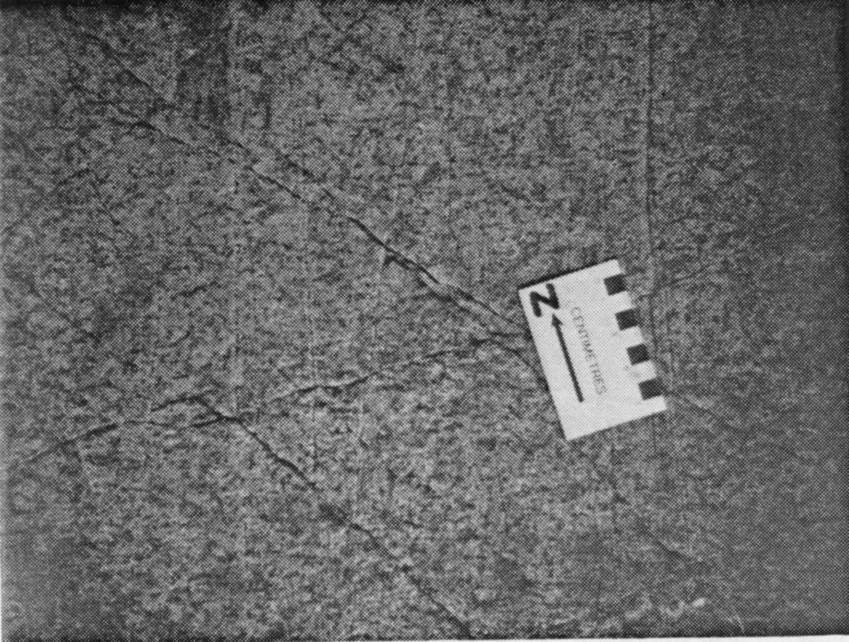
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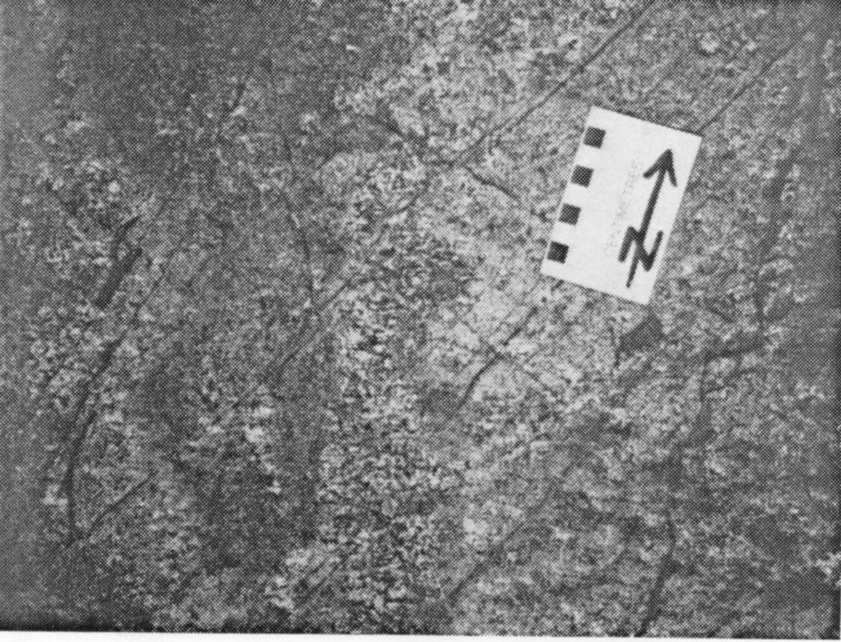

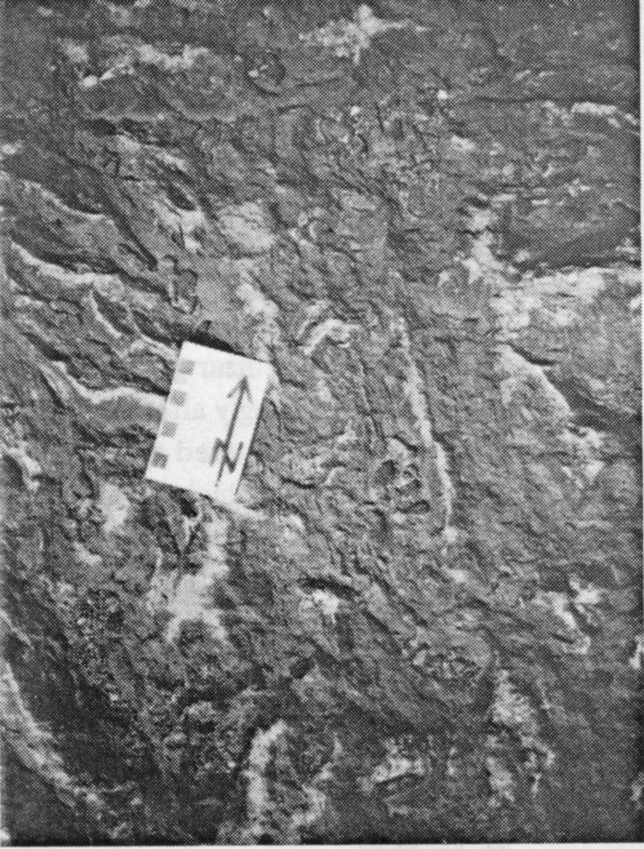

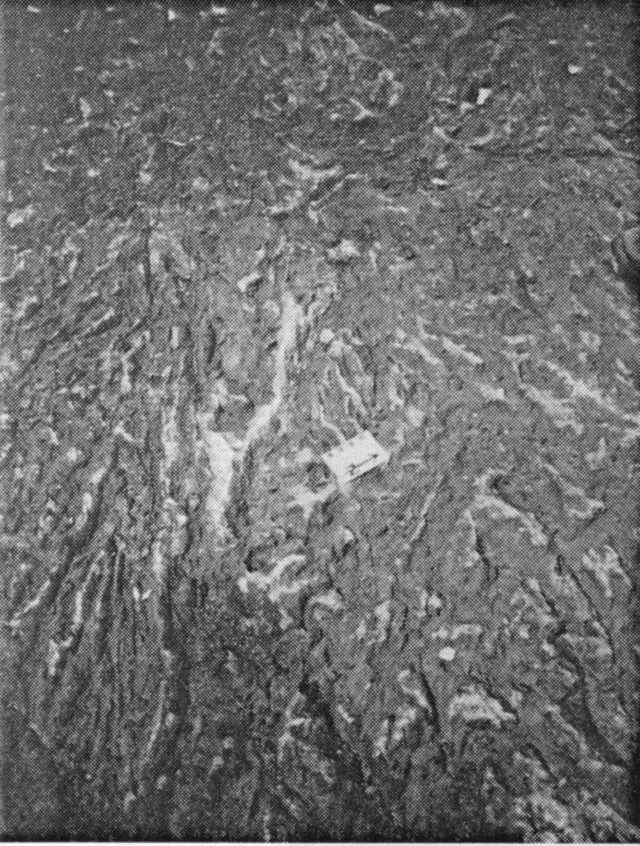

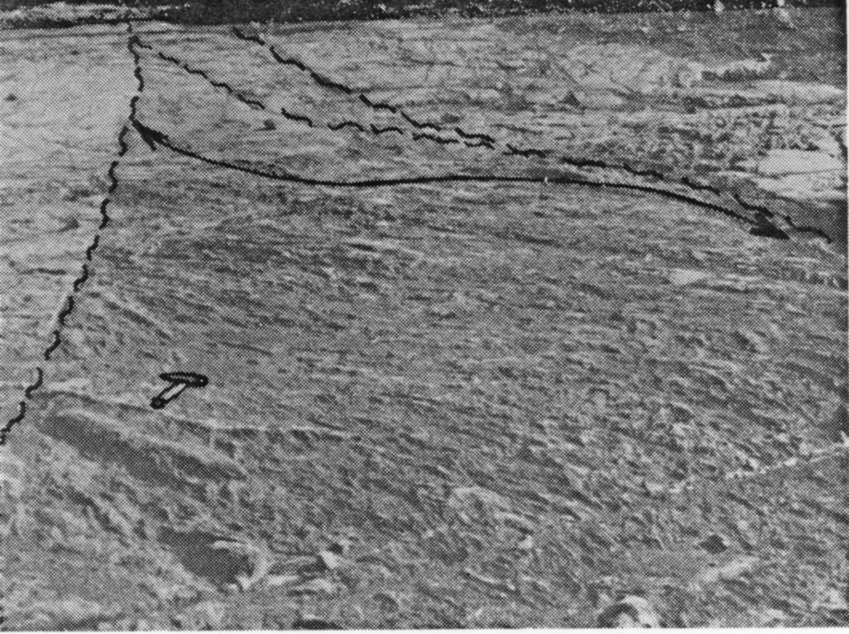


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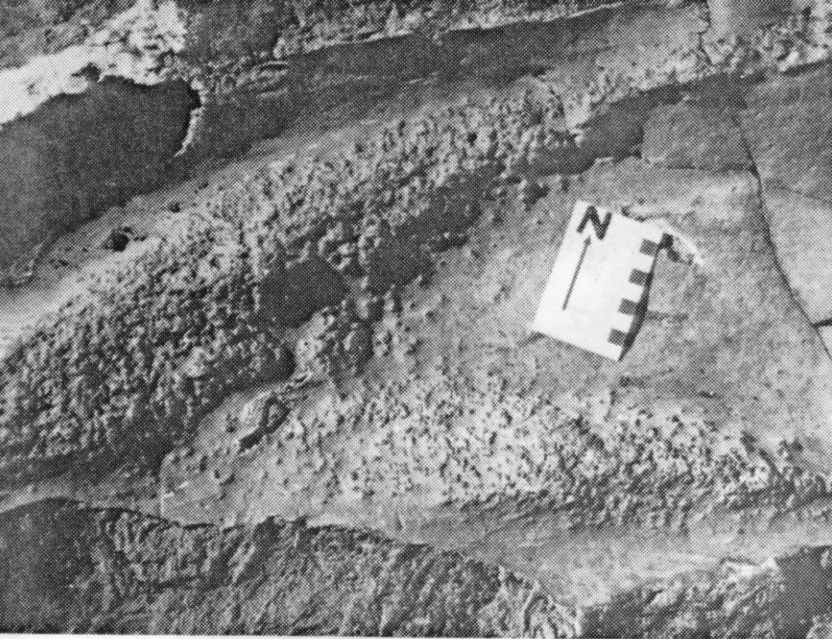
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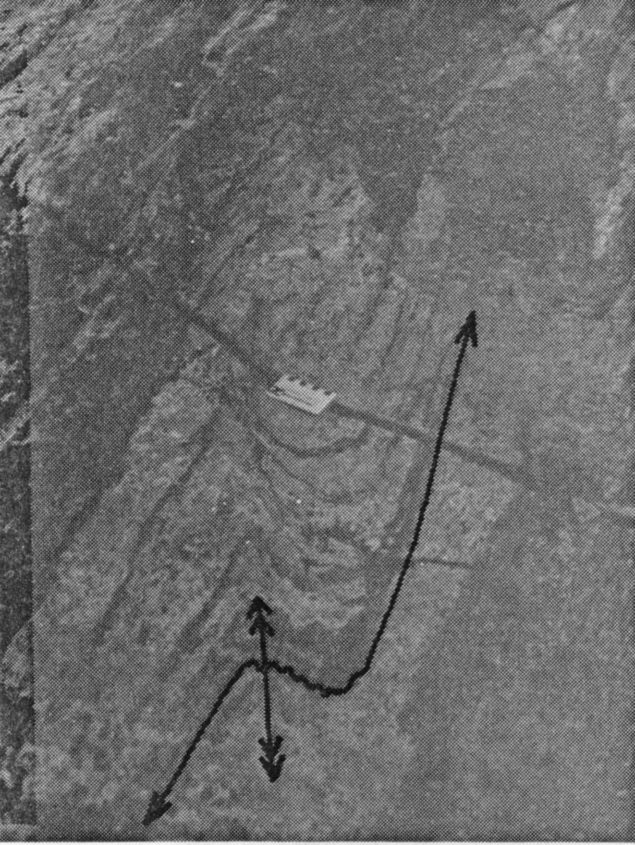

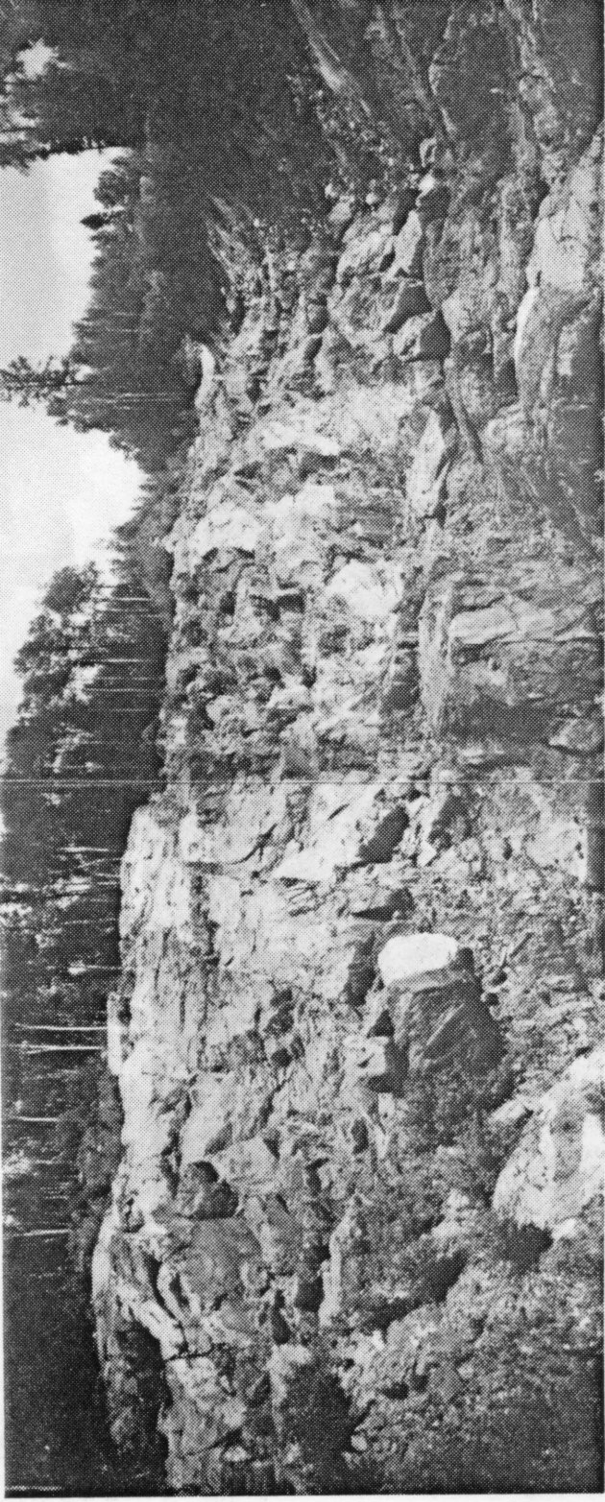

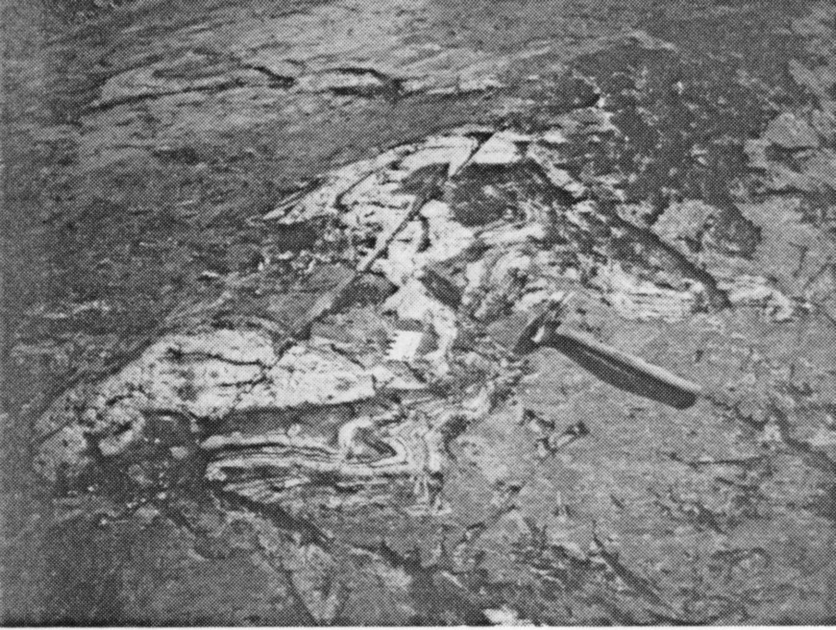


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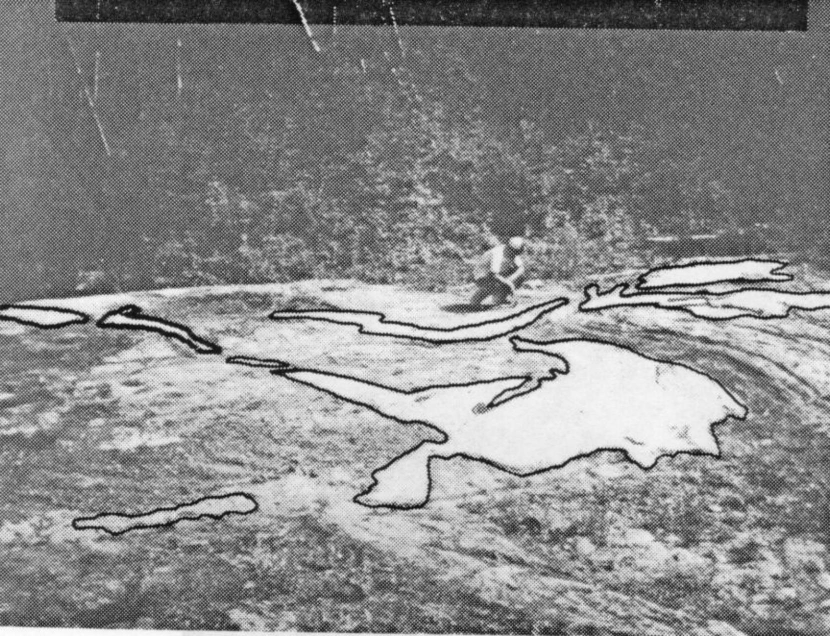

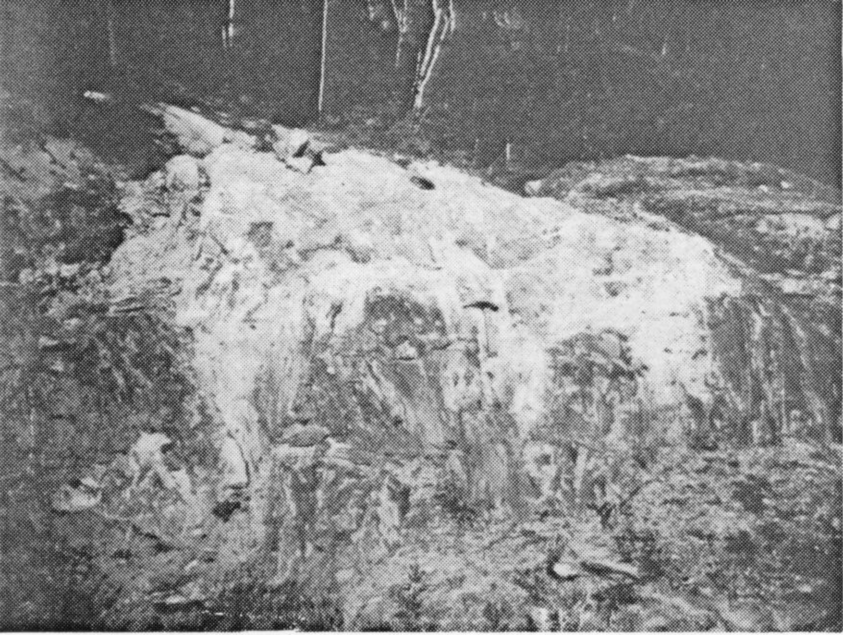

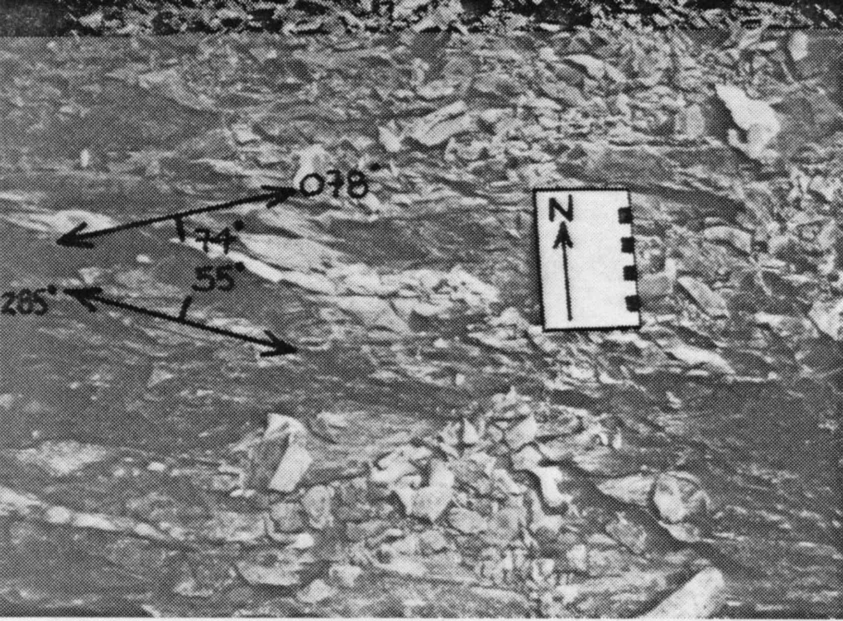
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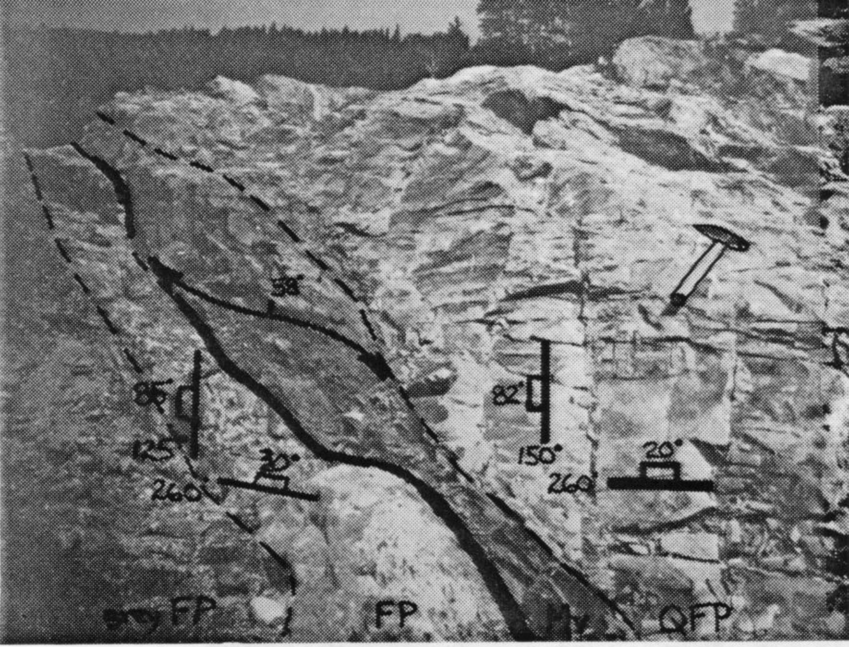
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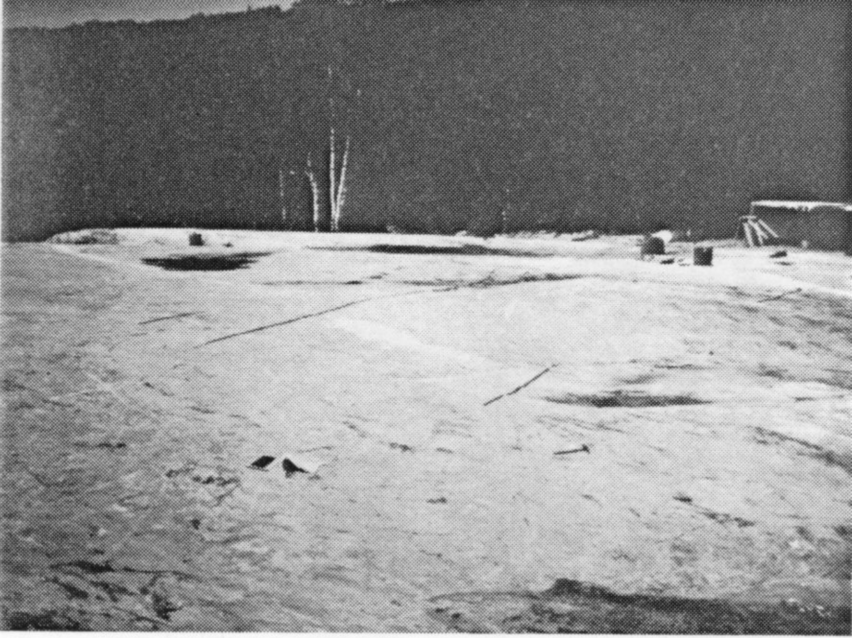

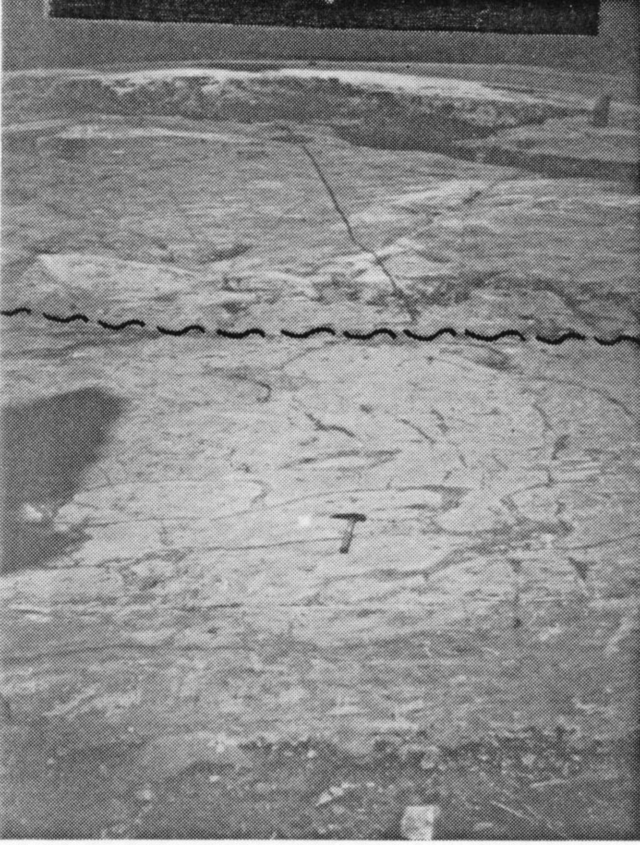

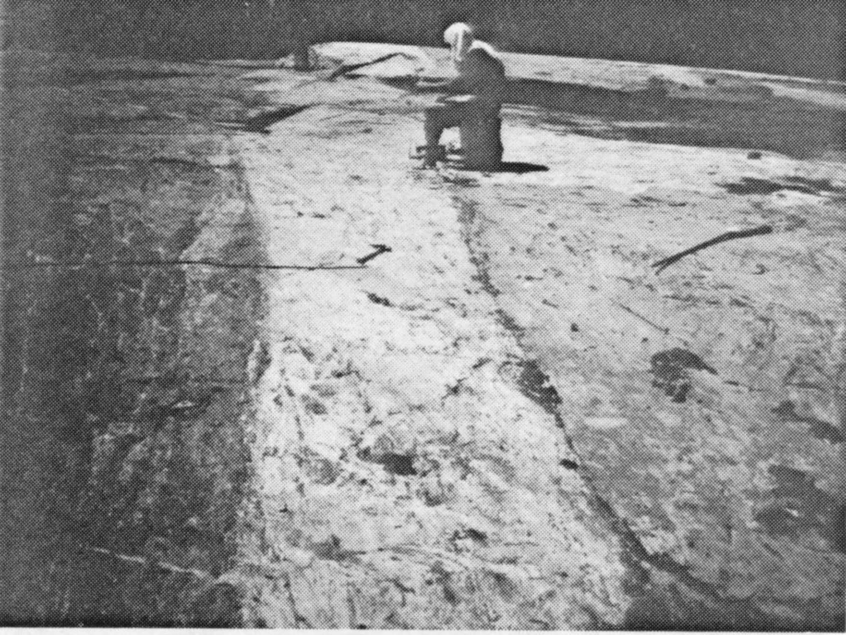

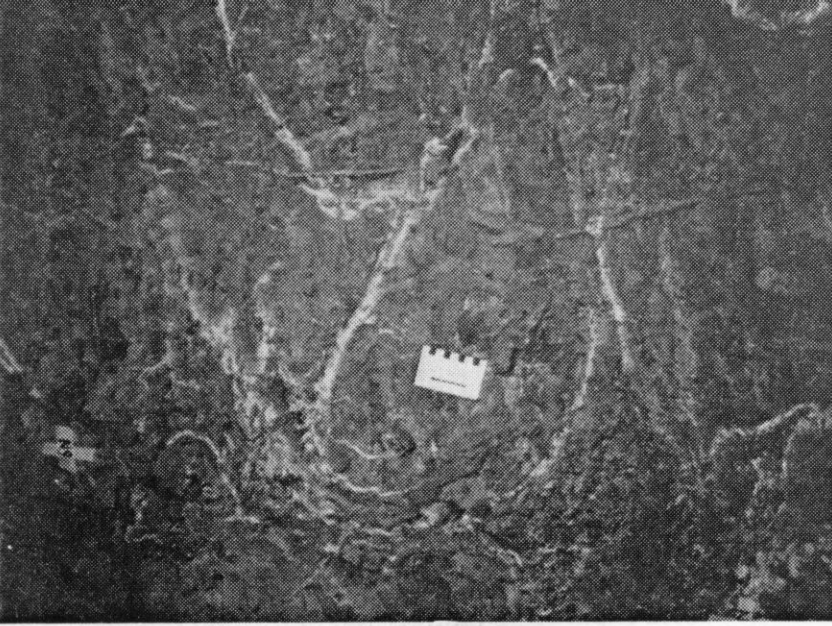

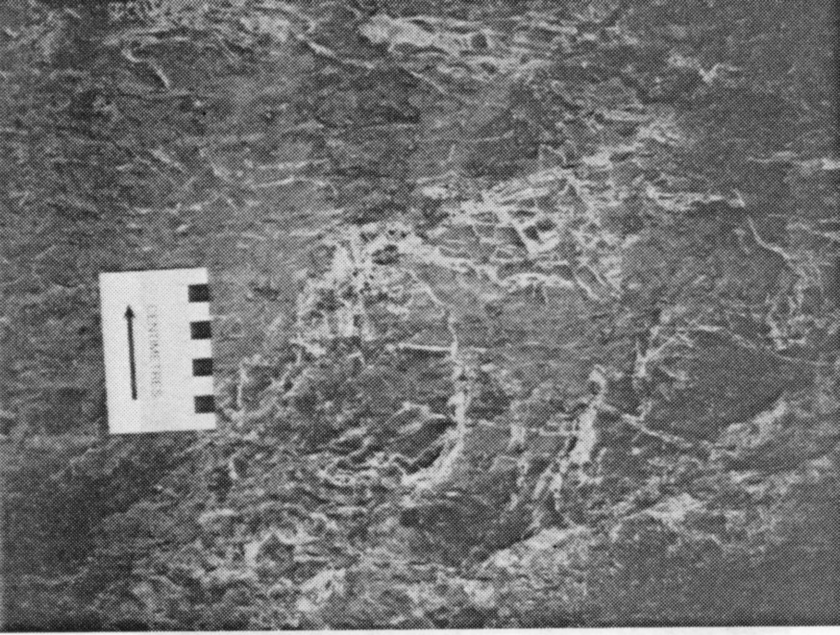
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