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# STRUCTURAL GEOLOGY OF PART OF THE CROOKED LAKE AREA, QUESNEL HIGHLANDS, BRITISH COLUMBIA

By

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to the required standard

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## ABSTRACT

The Crooked Lake area, which lies at the boundary of the Omineca Crystalline Belt and the Intermontane Belt of the Canadian Cordillera, has been examined with close attention being paid to the detailed structural relations of the five lithologies that comprise this map area - the late Proterozoic Snowshoe Formation, the late Paleozoic Antler Formation, Upper Triassic to Lower Jurassic phyllites and phyllitic siltstones and a unit of micaceous quartzite, herein named the Crooked Lake Phyllite and the Eureka Quartzite, respectively, and the Upper Triassic to Lower Jurassic Takla Group. These units form a normal stratigraphic succession with respect to each other, though given data suggests far more complicated internal relations for each of the five units. The major contacts, where exposed, were seen to be continuous with internal foliation fabrics, sharply planar (to somewhat gradational in the case of the Takla base), and occasionally associated with mylonitic fabrics. These surfaces may represent faults, though sufficient data is not available for estimates of displacement magnitude and/or direction to be given.

Structural features used to develop a relative timing sequence for internal progressive deformation of the Crooked Lake rock units include bedding surfaces and compositional layerings, foliations and cleavages, crenulations and other linear structures, minor fold forms and fold interference patterns, and fracture sets. The five distinct sets of deformation features that represent this timing sequence are the following: isoclinal, intrafolial, rootless folds of compositional layering found exclusively in the Snowshoe and Antler Formations (D1), open to tight folds of bedding, compositional layering, earlier foliations, and major contacts and a pervasive mica/amphibole foliation (D2 relative to Snowshoe and

Antler), upright open to medium folds of earlier surfaces and major contacts (D3), gentle to open folds and kink folds of pervasive D2 foliation and compositional layering (D4), and northeasterly directed faults and fracture sets (D5).

The metamorphic history of the Crooked Lake rock units has been deduced from extensive microscopic examination of textures and mineral assemblages. Barrovian-type metamorphism accompanied the first three deformational episodes; the first event may have reached amphibolite grade, the second episode reached temperatures of 500-575° at pressures of 4-7 kbars (from equilibria of pelitic and mafic assemblages), and the third approached only the lower to middle greenschist grade.

Appendices have been included summarizing rock description data, structural data, fold form data, and stereo-photography of prominent structural features.

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## MINERAL ABBREVIATIONS
(used in text, figures, tables, plates, and appendices)

| ABBREV. | FULL NAME | ASSOCIATED FORMULA OR MEANING |
|---|---|---|
| Ab | albite | ($Na[AlSi_3O_8]$) |
| Act | actinolite | ($Ca_2(Mg, Fe^{+2})_5[Si_8O_{22}](OH, F)_2$) |
| Anda | andalusite | ($Al_2SiO_5$) |
| Ands | andesine | (30-50% Anorthite) |
| Ank | ankerite | ($Ca(Mg, Fe^{+2}, Mn)(CO_3)_2$) |
| Amph | amphibole | act, trem, hnbd, parg |
| An | anorthite | ($Ca[Al_2Si_2O_8]$) |
| Ask | aluminium silicates | anda, sill, ky |
| Bio | biotite | ($K_2(Mg, Fe^{+2})_{6-4}(Fe^{+3}, Al, Ti)_{0-2}[Si_{6-5}Al_{2-3}O_{20}](OH, F)_4$) |
| Cc | calcite | ($CaCO_3$) |
| Chl | chlorite | ($(Mg, Al, Fe)_{12}[(Si, Al)_8O_{20}](OH)_{16}$) |
| Ctd | chloritoid | ($(Fe^{+2}, Mg, Mn)_2(Al, Fe^{+3})Al_3O_2[SiO_4]_2(OH)_4$) |
| Clz | clinozoisite | ($Ca_2Al \cdot Al_2O_3 \cdot OH \cdot Si_2O_7 \cdot SiO_4$) |
| Cord | cordierite | ($Al_3(Mg, Fe^{+2})_2[Si_5AlO_{18}]$) |
| Ep | epidote | ($Ca_2Fe^{+3}Al_2O \cdot OH \cdot Si_2O_7 \cdot SiO_4$) |
| Felsic | felsic minerals | feldspar or quartz |
| Gn | garnet-almandine | ($Fe_3{}^{+2}Al_2Si_3O_{12}$) |
| Graph | graphite | (C) |
| Hnbd | hornblende | ($(Na, K)_{0-1}Ca_2(Mg, Fe^{+2}, Fe^{+3}, Al)_5[Si_{6-7}Al_{2-1}O_{22}](OH, F)_2$) |
| Ilm | ilmenite | ($FeTiO_3$) |
| Kspar | Potassium feldspar | ($K[AlSi_3O_8]$) |
| Ky | kyanite | ($Al_2SiO_5$) |
| Mgt | magnetite | ($Fe^{+2}Fe^{+3}{}_2O_4$) |
| Musc | muscovite | ($K_2Al_4[Si_6Al_2O_{20}](OH, F)_4$) |
| Olig | oligoclase | (10-30% Anorthite) |
| Ol | olivine | ($Mg_2SiO_4$-$Fe_2SiO_4$) |
| Opaque | opaque minerals | ilmenite, magnetite, pyrite |
| Opx | orthopyroxene | ($MgSiO_3$-$FeSiO_3$) |

| ABBREV. | FULL NAME | ASSOCIATED FORMULA OR MEANING |
|---|---|---|
| Para | paragonite | $(Na_2Al_4[Si_6Al_2O_{20}](OH,F)_4)$ |
| Parg | pargasite | $((Na,K)_{0-1}Ca_2(Mg,Fe^{+2},Fe^{+3},Al)_5[Si_{6-7}Al_{2-1}O_{22}](OH,F)_2)$ |
| Plag | plagioclase | $(Na[AlSi_3O_8]-Ca[Al_2Si_2O_8])$ |
| Py | pyrite | $(FeS_2)$ |
| Qtz | quartz | $(SiO_2)$ |
| Rutile | rutile | $(TiO_2)$ |
| Serp | serpentine | $(Mg_3[Si_2O_5](OH)_4)$ |
| Sill | sillimanite | $(Al_2SiO_5)$ |
| Sphene | sphene | $(CaTi[SiO4](O,OH,F))$ |
| Staur | staurolite | $((Fe^{+2},Mg)_2(Al,Fe^{+3})_9O_6[SiO_4]_4(O,OH)_2)$ |
| Tour | tourmaline | $(Na(Mg,Fe,Mn,Li,Al)_3Al_6[Si_6O_{18}](BO_3)_3(OH,F)_4)$ |
| Trem | tremolite | $(Ca_2Mg_5[Si_8O_{22}](OH,F)_2)$ |
| Vap | vapour phase | water or carbon dioxide |
| Zo | zoisite | $(Ca_2Al \cdot Al_2O_3 \cdot OH \cdot Si_2O_7 \cdot SiO_4)$ |

## ACKNOWLEDGEMENTS

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Finally this work has been completed with financial support from N.S.E.R.C. to J.V. Ross (A-2134) and this is greatly appreciated.

*... It is part of the martyrdom which I endure for the cause of the Truth that there are seasons of mental weakness, when Cubes and Spheres flit away into the background of scarce possible existences; when the Land of Three Dimensions seems almost as visionary as the Land of One or None; nay, when even this hard wall that bars me from my freedom, these very tablets on which I am writing, and all the substantial realities of Flatland itself, appear no better than the offspring of a diseased imagination, or the baseless fabric of a dream.*

- from FLATLAND, A ROMANCE OF MANY DIMENSIONS , E. A. Abbott -

# INTRODUCTION

## Location and Access

The Crooked Lake area is located 60 miles east of Williams Lake in east-central British Columbia (Figure 1). This 25 square kilometer map-area centers approximately at longitude 120° 45' and latitude 52° 15'. Hendrix Lake, a Noranda mining town 30 kilometers to the south, is the closest populated area to Crooked Lake. Figure 2 illustrates the exact location and areal extent of the area mapped.

Crooked Lake can be approached from either of two directions via well maintained logging roads that extend as far as Horsefly to the west and Canim Lake to the south; paved roads connect these two towns with the Cariboo Highway to the west (Figures 1 and 2).

## Physiography and Glaciation

Crooked Lake lies in the Quesnel Highlands of the Interior Plateau (Holland 1964). This region is typified by gently rolling ridge-tops that range from 5500 to 7000 feet in elevation. Glacial activity has caused the valley walls to be considerably steeper than their corresponding ridge-tops. Average local relief ranges from 3000 to 3500 feet.

An axis of the latest two glacial advances occurred in the Cariboo Mountains to the northeast (Tipper 1971). Ice must have flowed across the Crooked Lake area toward the west and southwest to reach the Interior Plateau (see Figure 3). Most of the glacial striae and deposits observed confirm this general direction, though high standing rock units and prominent rock structure were important local controls on ice movement direction.

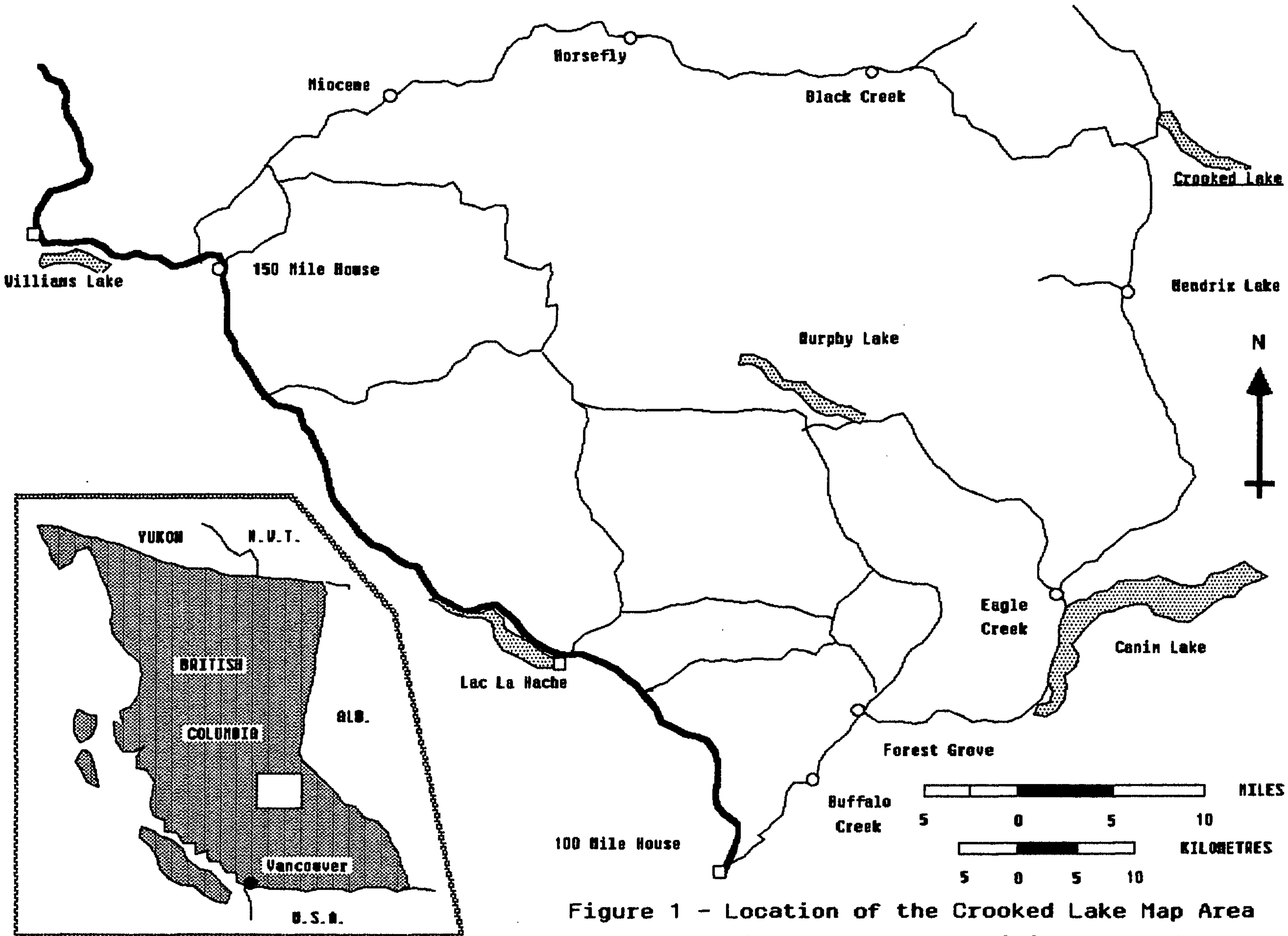



Figure 1 - Location of the Crooked Lake Map Area in east-central British Columbia

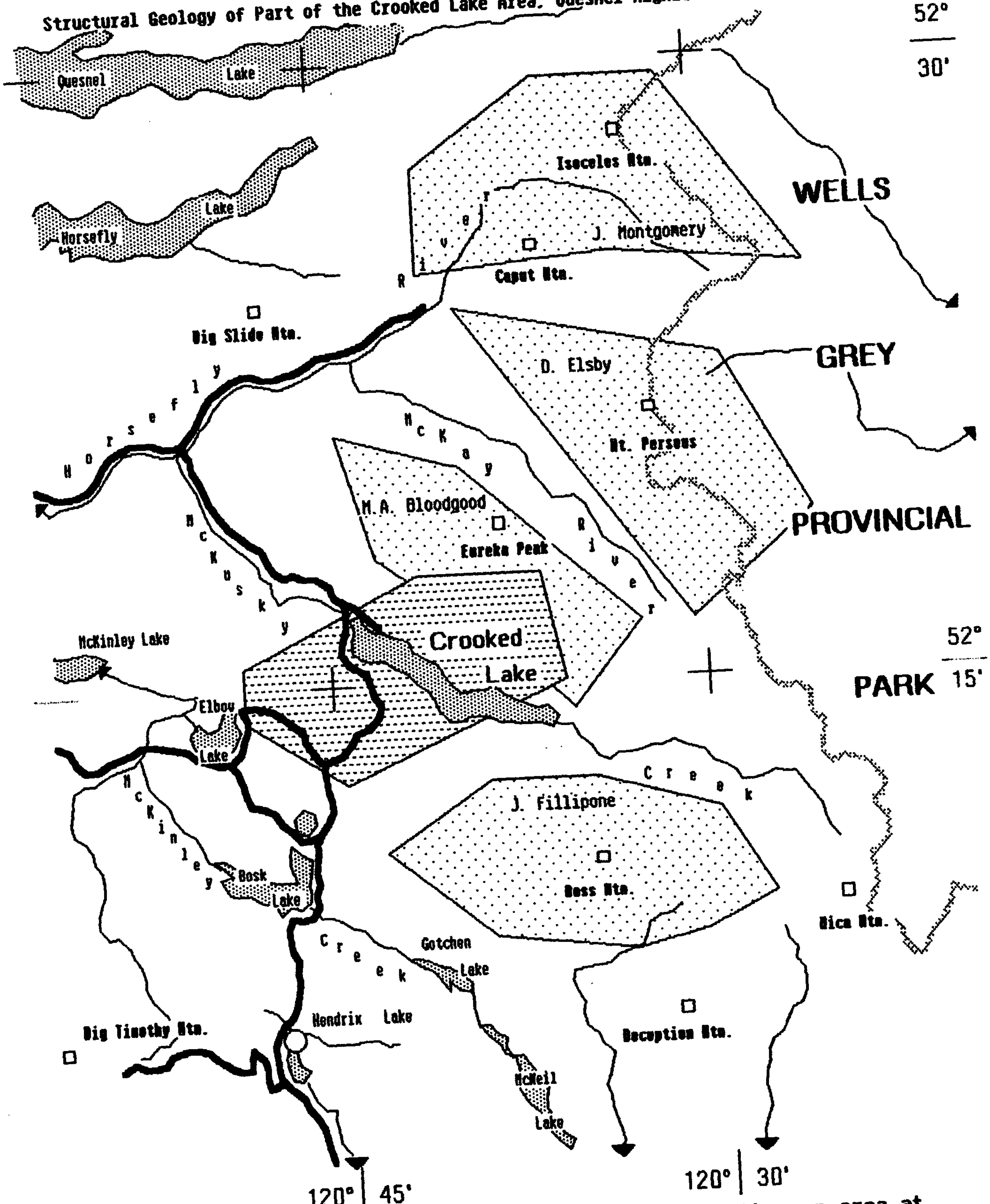



FIGURE 2 - Detailed location and areal extent of the map area at Crooked Lake (study area of other UBC masters' students also shown).

Extensive valley glaciation is characteristic of more recent times. Numerous north-facing cirques, steep walled `U-shaped' valleys (see Figure 4), systems of arêtes and horns, and year-round ice accumulations above 7000' attest to this on-going process.

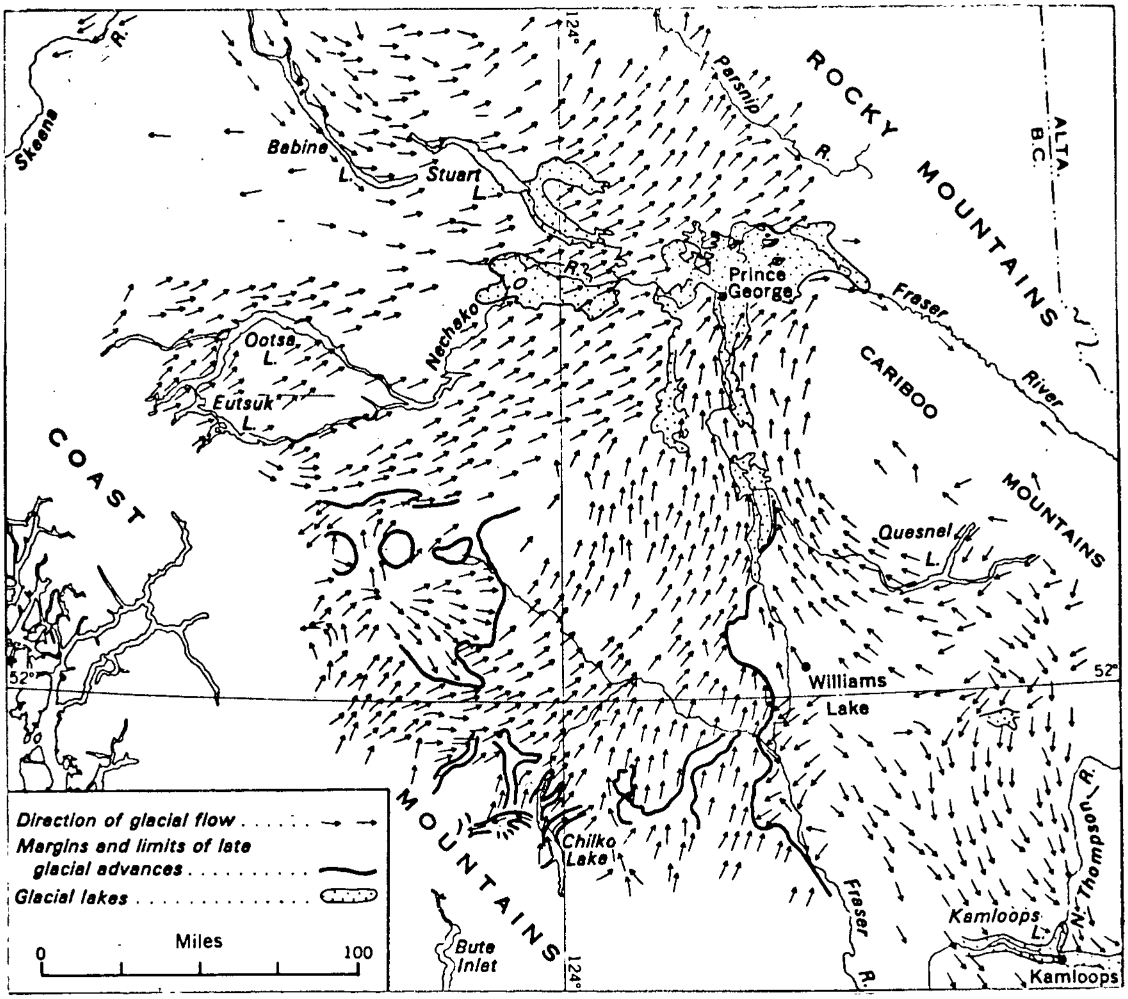



Figure 3 - Direction of ice movement of Fraser Ice Sheet and late ice re-advances in Central British Columbia (from Tipper 1971, p. 39)

## Previous and Current Work

Geologic mapping took place as early as 1889 to the northwest in the Barkerville area (Bowman 1889) and 1927 just 30 kilometers to the east in the

Clearwater Lake area (Marshal 1927), though no systematic work is recorded for the Crooked Lake area until R.B. Campbell's reconnaissance mapping of the early 1960's (Campbell 1963 and 1978). Campbell recognised a major structural sequence (two antiforms and an intervening synform) involving units ranging in age from Precambrian to Jurassic. It was believed that this sequence straddled the boundary between two major geologic provinces of the Canadian Cordillera - the Omineca Geanticline to the east and the Intermontane Belt to the west.

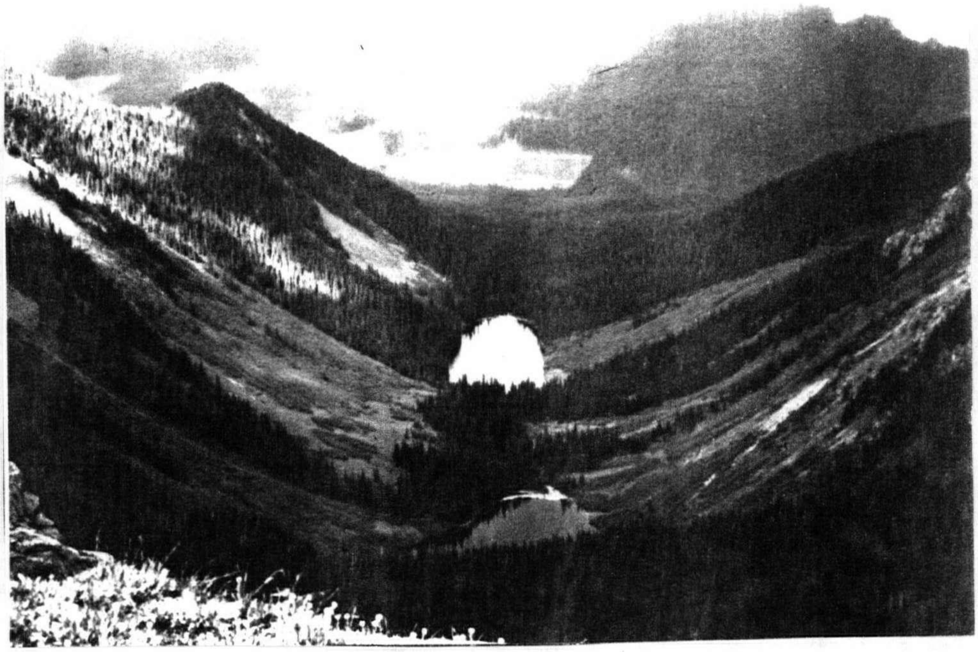


Figure 4 - Glacial valleys typical of the northeastern slopes of Eureka Syncline

K.V. Campbell (1971) mapped the Crooked Lake area at a scale of one inch to one mile paying close attention to major lithologic contacts, petrology, and petrochemistry. He found four major rock units represented in the above mentioned structural sequence, much in accord with R.B. Campbell's earlier observations. In addition, he noted that contacts between the units were discordant (possible low angle thrusting) and that deformation and metamorphism occurred during one progressive episode involving all rock units. These findings are significant in that they link the histories of two contrasting geologic provinces at least since the Mesozoic (Campbell, K.V. 1971).

The present author and four other masters' students at the University of British Columbia have undertaken to examine parts of and beyond the area covered by K.V. Campbell (1971) with close attention being paid to detailed structural field relations(see Figure 2). D. Elsby, J. Fillipone, and J. Montgomery were responsible for the structurally underlying Precambrian Kaza Group strata and upwards into the Slide Mountain Group rocks. M.A. Bloodgood has examined the Upper Triassic to Jurassic core rocks of the Eureka Syncline, paying close attention to volcanic stratigraphy and provenance. The present author has covered parts of the overlying Triassic/Jurassic units and worked downwards into the structural pile as far as and slightly below the Kaza Group/ Slide Mountain Group contact.

## GENERAL GEOLOGY

### Regional Geology

The Crooked Lake map area is located in the southern portion of the Canadian Cordillera; this region has been divided into 5 tectonic belts by Wheeler (1967, 1970) that roughly coincide with the major landforms outlined by Holland (1964). Three of these belts (Rocky Mountain, Intermontane, and Insular) are composed of only slightly metamorphosed suprastructure and the two that comprise the rest (Omineca and Coast Plutonic) are formed of a mixture of high-grade metamorphic to plutonic infrastructure and low metamorphic suprastructure. The rock units of the present study occur on the boundary of the Omineca Crystalline Belt and the Intermontane Zone (see Figure 5).

Geologic mapping between the Rocky Mountain and Omineca belts has demonstrated that rock units at least up to lower Paleozoic are continuous across the two zones (Campbell et al. 1973). These largely miogeoclinal/platformal carbonates and continentally-derived clastics rest on continental basement that continues as part of the craton, in a strict sense, only up to the Rocky Mountain Trench (Mereu et al. 1977). Beneath the Omineca rocks Precambrian basement has been identified in the Shushwap Terrain (Duncan 1984), though seismic studies indicate that its characteristics (e.g. - thickness, seismic velocity) change markedly from east to west (Berry and Forsyth 1975).

Compared to the relatively simple imbricate thrusting and open folding of the Rocky Mountain belt, the rocks of the Omineca Geanticline have experianced a much more complex deformational and metamorphic history. Several broad north-south trending anticlinoria and synclinoria alternate across a major part of the belt from east to west; these structures are generally third in a series of

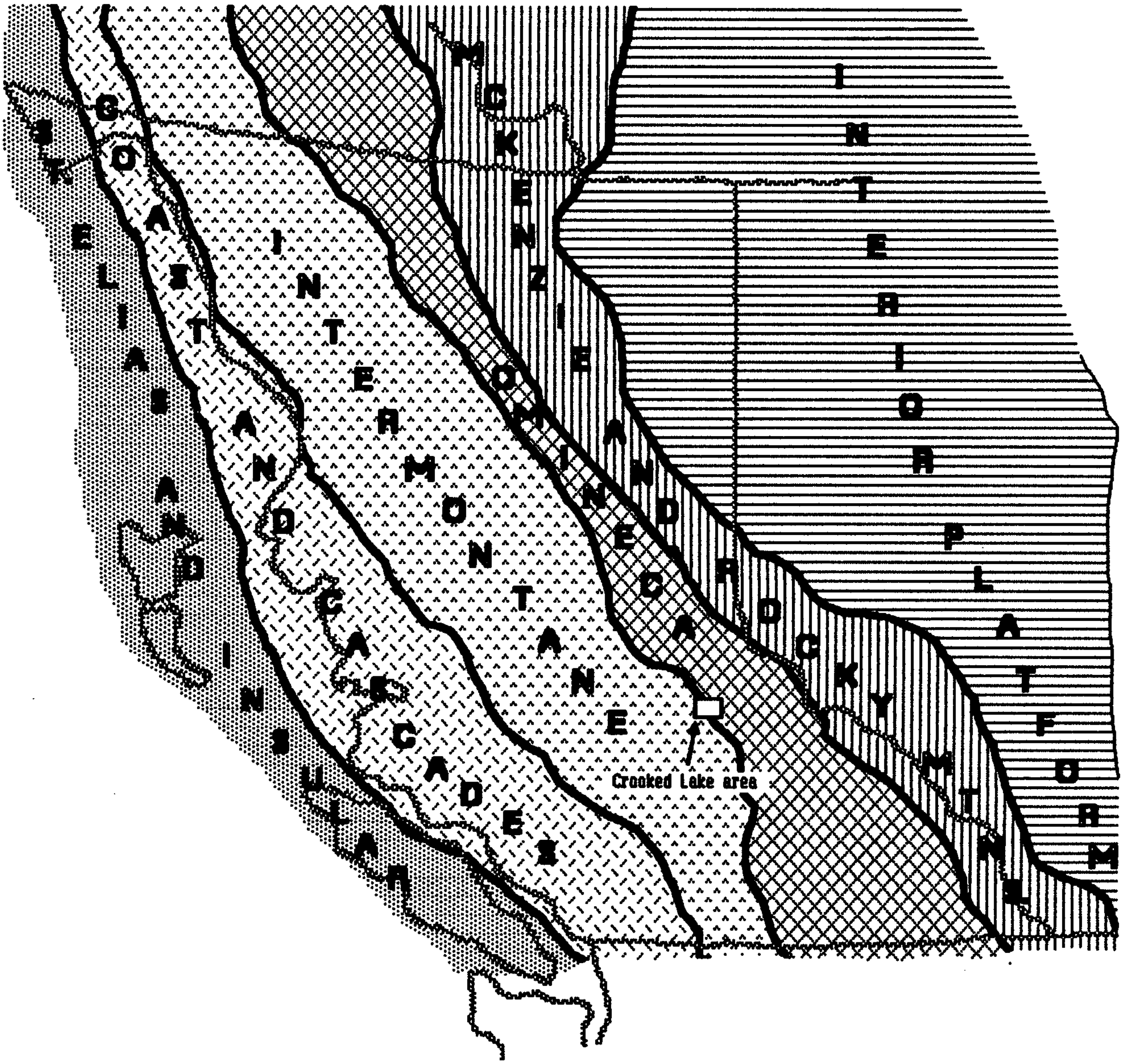



Figure 5 - Tectonic subdivisions of the Canadian Cordillera showing present study area (adapted from Tectonic Assemblage Map of the Canadian Cordillera, Tipper et al. 1981)

fold forms, the earliest of which is thought to comprise recumbent nappes with limb lengths on the order of several kilometers (Ghent et al. 1977; Murphy and Journeay 1982; Pell and Simony 1982). Metamorphism throughout the belt ranges from lower greenschist to upper amphibolite and to the south in the belt, metamorphic core complexes are unroofed in the Monashee Complex (Crittenden et al. 1980; Brown and Read 1983; Okulitch 1984).

The boundary of the Omineca belt with the Quesnel sub-terrane of the eastern Intermontane zone is characterized by structural complexity similar to that seen in the Omineca belt. This is remarkable since further into the Intermontane zone simple thrust faulting and gentle folding are more characteristic (Campbell and Tipper 1970; Travers 1978). Thrust faulting, tectonic imbrication, and mylonite development are very common along this zone (Campbell 1971; Montgomery 1978; Ross 1981; Brown and Read 1983).

Perhaps the most striking feature of the Omineca/Quesnel boundary is a ubiquitous belt of ultramafics, amphibolites, basalts, and sediments of strong oceanic affinity that some have suggested is the remains of a late Paleozoic ocean crust locally obducted on to the miogeoclinal rocks to the east (Montgomery 1978; Rees 1981). This belt can be found consistently from north to south separating the rock types of the two provinces (see Figure 6).

The Quesnel rocks consist of volcaniclastics, volcanics, argillites, and carbonates, possibly forming a Late Triassic subduction arc complex formed on upper Paleozoic rocks (Monger 1977; Travers 1978). Examination of faunal distributions and paleomagnetic determinations in rocks of Permian to Jurassic age suggest transcurrent displacements relative to similar rock types in North America on the order of one to two thousand kilometers (Monger et al. 1982). This would

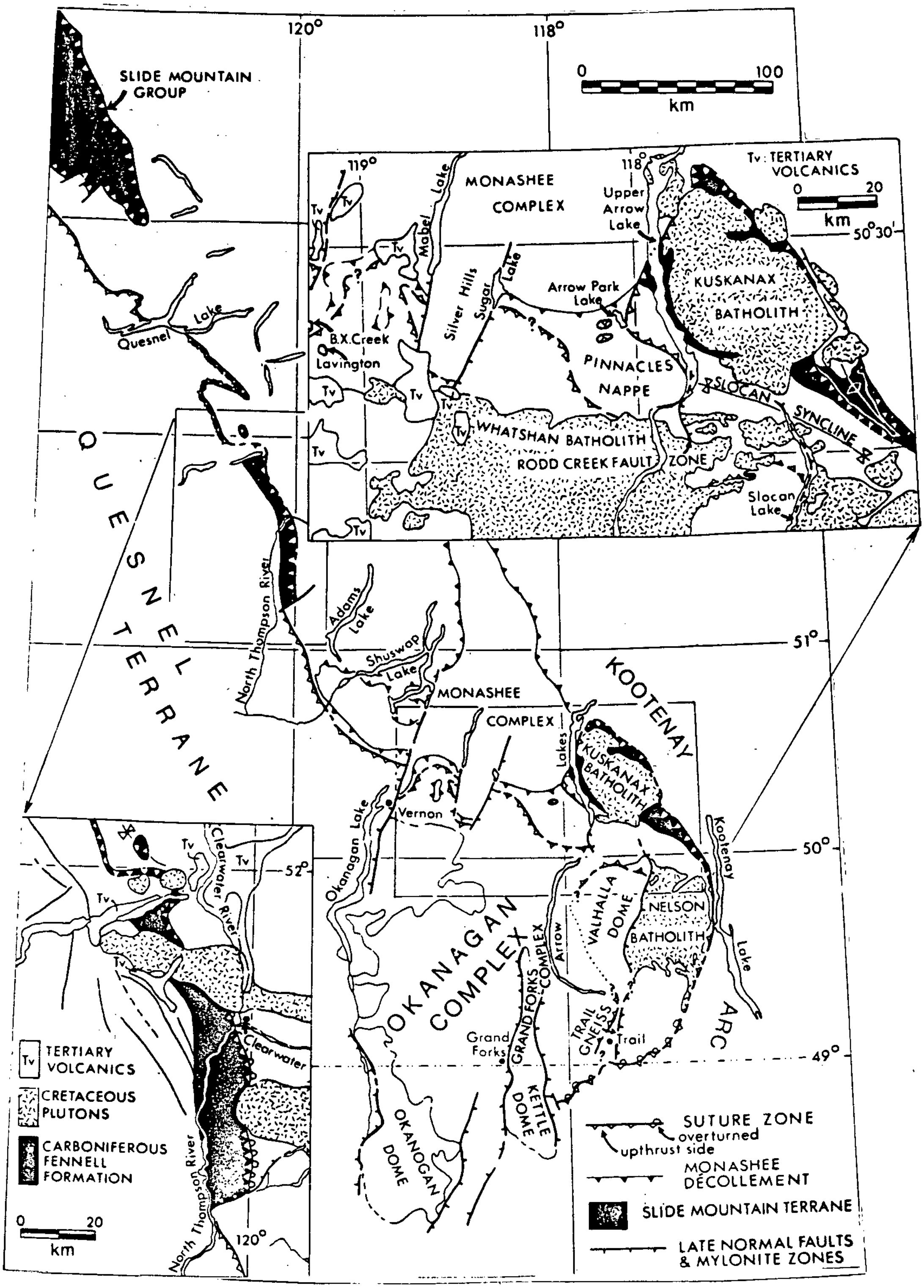



Figure 6 - The Okanagan Plutonic and Metamorphic Complex: major structural components and the Quesnel - North America suture zone (Figure 4 of Okulitch 1984, p. 1181)

imply that development of an island arc setting for this terrane may not have an immediate tectonic relationship to the North American situation that developed in the early Mesozoic.

Certain rock types occurring within or across the two belts provide important evidence that they have shared a common history at least since the late Mesozoic. The most notable example of this is in the Bowser Basin to the northwest in the Intermontane belt; Lower Cretaceous deposits contain metamorphic detritus that could only have been derived from Omineca belt rocks to the east (Eisbacher 1974; Monger et al. 1978). In addition, a period of intrusive activity links the histories of the two belts; these are the "100 m.y." intrusives of Campbell and Tipper (1970).

The most recent history has seen extensive Eocene volcanic and volcaniclastic activity followed by Miocene to Pliocene plateau basalts. Extensive Quaternary glacial deposits from at least three distinct events cover large parts of the region (Tipper, 1971).

## Local Geology

The four rock units identified by R.B. Campbell (1963) and examined by K.V. Campbell (1971) are, in stratigraphic/structural succession, the Proterozoic Kaza group, the Pennsylvanian to Permian Antler Formation, a micaceous quartzite and grey to black phyllites of probable Upper Triassic to Lower Jurassic age, and a Lower Jurassic volcanic/volcaniclastic assemblage. This same sequence of units, with minor variations, continues to the northwest and southeast (see Figure 6) and has been described and dated by numerous workers (Sutherland Brown 1957 & 1963; Campbell et al. 1973; Struik 1980; Rees 1981; Uglow 1921; Campbell and Tipper 1971; Orchard & Struik 1985).

All rock units have been involved in late stage, northwest trending folds - Perseus Anticline, Eureka Syncline, Boss Mountain Anticline (Campbell, K.V. 1971). Barrovian metamorphism possibly coincided with the development of these structures, though earlier events could also be present (Campbell, K.V. 1971). North to northeast trending folds deform all earlier structures.

Late events effecting the units at Crooked Lake include northeast trending high angle faults, Tertiary olivine basalt, and thick (30-50 m) glacial deposits in the valley bottoms and low lying regions.

# STRATIGRAPHY

## Introduction

In the Crooked Lake area the present author has further separated the four lithologies of R.B. Campbell (1963) and K.V. Campbell (1971) into five distinct units on the basis of colour, textures, and mineralogy. The additional unit, a micaceous quartzite, was originally included with the black phyllite unit of K.V. Campbell (1971). In this report, these two units shall be referred to as the Eureka Quartzite and the Crooked Lake Phyllite, respectively.

In low lying regions, where glacial cover is significant, contacts between the units were never clearly observed (see Figure 7b; note: all subsequent photographs in the text will indicate the direction a photograph was taken, as an azimuth {DIR-045} and, where applicable, its location as a station number {LOC-J11}). As the geologic map (Plate 1) shows, contacts across the southwestern portion of the area were interpolated from outcrops of the various lithologies. Although, control for the placement of these contacts is poor in places, it is believed they have the best possible configuration for the distribution of the available given data.

The steep slopes northeast of Crooked Lake, on the other hand, offered an excellent opportunity to observed the units' contacts exposed for considerable distances (see Figure 7a and Plate 1). The two lowest contacts were seen to be tightly interfingering in places (within a zone of a few meters thickness), though otherwise to be sharply planar. The uppermost contact (Figure 7c) shows obvious interfingering, as well, though relations are not as clear cut as the lower contacts. The middle contact between the Eureka Quartzite and the Crooked Lake

Figure 7 - Contacts of the Crooked Lake rock units

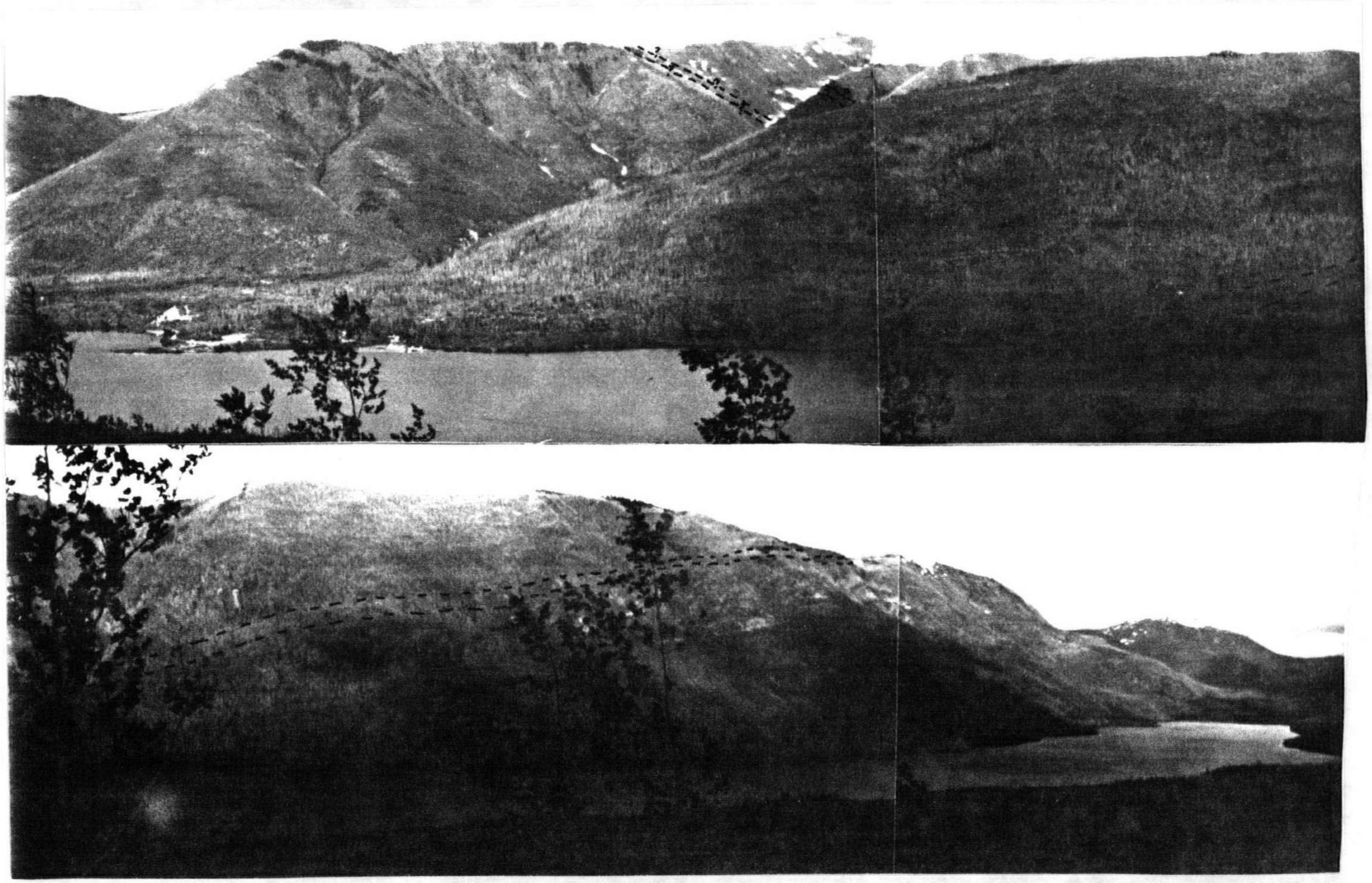


Figure 7a - Panorama of the southwest side of Eureka Syncline; upper and lower contacts of Antler are shown as mapped, Crooked Lake Phyllite/ Takla contact zone is assumed from K.V. Campbell (1971) {DIR-045}

Figure 7b - Southwestern Crooked Lake Phyllite/Takla contact zone as mapped {DIR-045}

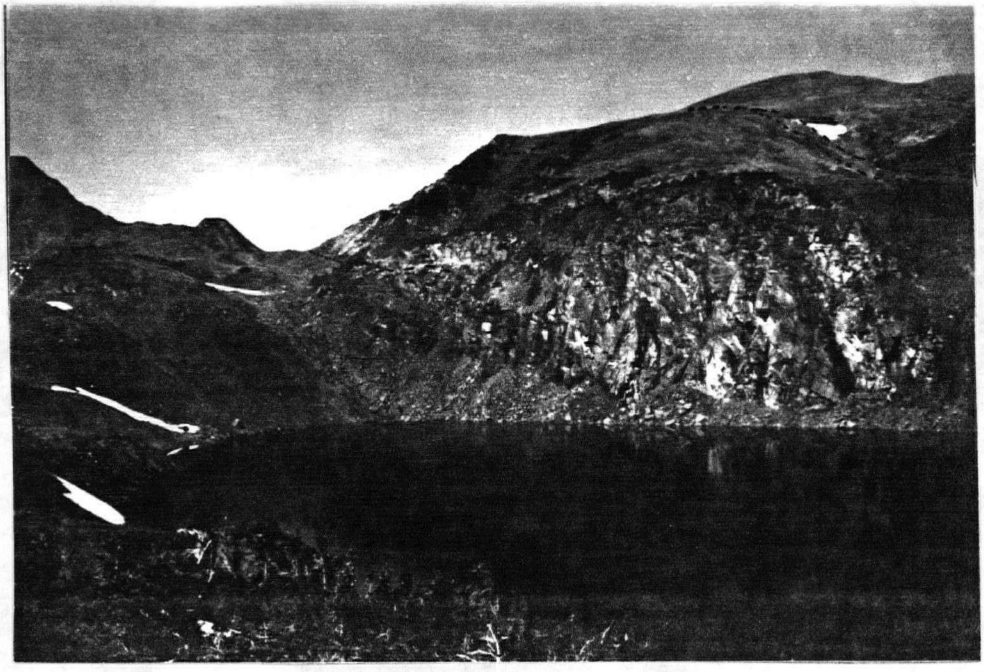


Figure 7c - Mapped contacts between Crooked Lake Phyllite and Takla in the northeastern contact zone; note possible phyllite infold at top right re Figure 16d {DIR-318}

Phyllite was not seen exposed; talus from the rapidly eroding phyllite builds up above the more resistant quartzite and obscures this surface.

Plate 1 does not show internal subdivision for the Crooked Lake units; fine scale original gradation and interfingering (most likely due to ductile response of subunits and complex folding) occurs on a scale that is impossible to show on the map. In order to present the internal subdivisions of these units structural/stratigraphic columns were constructed once the later (post D2; see STRUCTURE, below) large-scale structural features were understood; these diagrams (see Plate 1 and Plate 4) are oriented, as much as possible, in the direction of original lithologic variation and do represent a stratigraphic succession with respect to the major lithologic units. It must be stressed, however, that since the earlier structural features could not be removed, these columns merely outline the thicknesses of existing subunits and their existing relative placement, and should not be interpreted as suggesting original thicknesses (for any unit or subunit) nor probable original stratigraphic successions for internal subunits of the major lithologies. Appendix A contains rock descriptions referenced to segments of the structural/stratigraphic columns (Plate 4) and to station locations shown on the geologic map (Plate 1).

Below is an account of ages, distributions, thicknesses, sub-units, origin, and contact relationships of the five units at Crooked Lake. The geologic map (Plate 1), the structural/stratigraphic columns (Plate 4), and Appendix A should be referred to during the course of this discussion.

## Kaza Group - Snowshoe Formation

This unit is believed the oldest exposed in the map-area. An age of Late Proterozoic stems from R.B. Campbell et al. (1973) who have correlated it with the middle Miette Group of the same age in the Rocky Mountain belt on the basis of gross lithology. The type area for the Kaza is Bowron Lakes Provincial Park (Sutherland Brown 1963); there, the 12,000 foot thick unit consists of unsorted, feldspathic grit interlayered with schist and greenish-grey to dark grey phyllite.

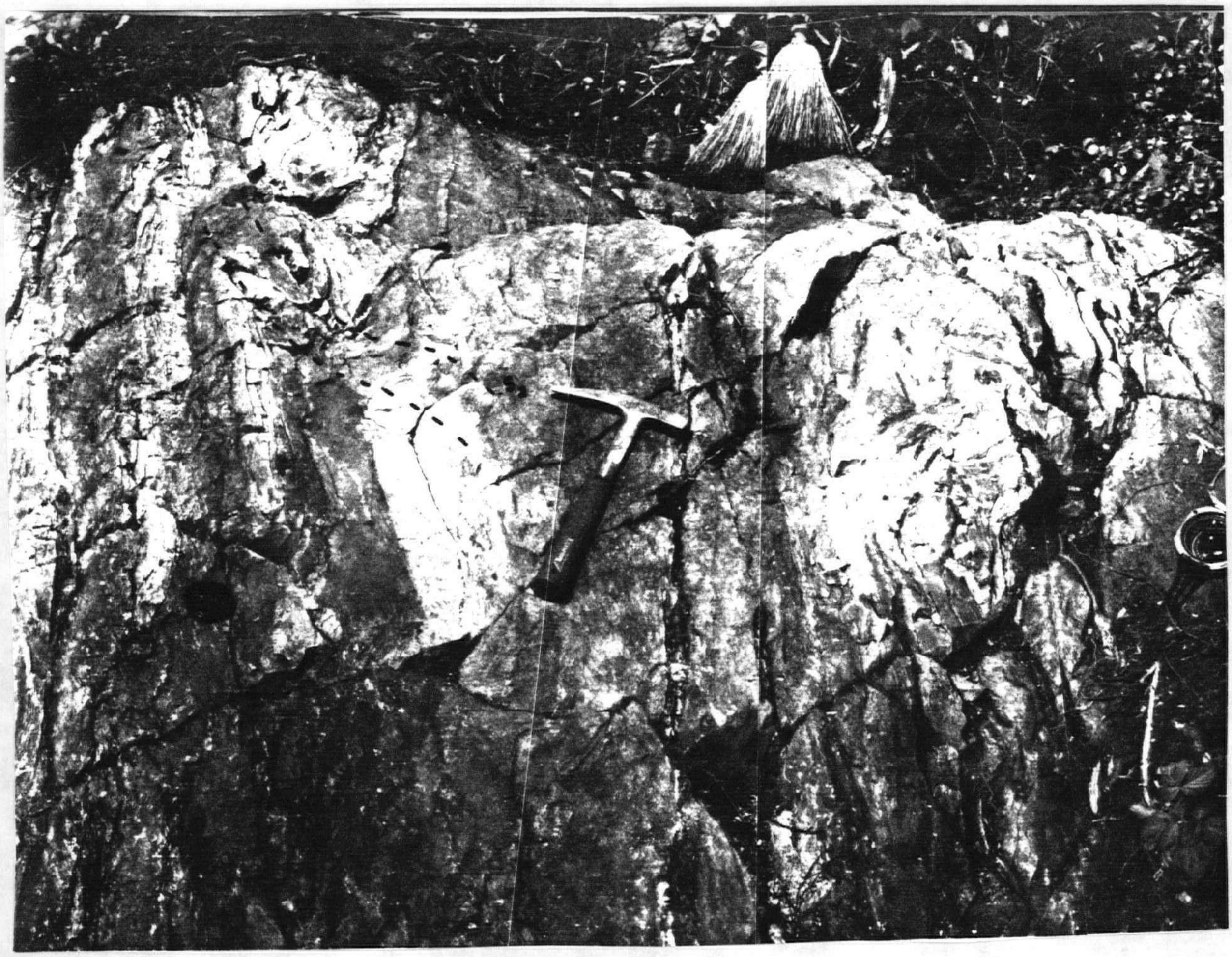


Figure 8 - Interlayered plag-bio-qtz schist and musc quartzite typical of the Snowshoe Formation in the Crooked Lake area {DIR-350, LOC-RZ10}

In the map-area the Kaza occurs in the cores of all antiformal structures and underlies the synforms; outcrops are restricted to the southernmost part of the area. K.V. Campbell (1971) has estimated the exposed thickness of the Kaza in the Crooked Lake area as being between 15,000 and 30,000 feet; since very little stratigraphic or structural detail is known about the unit to date it is difficult to ascertain the amount of tectonic thickening this figure might include (it is, though, expected to be a minimum of 100% because compositional layering is a transposed foliation, see STRUCTURE below).

Snowshoe rocks consist predominately of interlayered plag-mica-qtz schist and mica quartzite with subordinate horizons of mica-plag-qtz schist and qtz-plag-mica schist (note: mineral names used through the text are given in a 'least-to-most format', i.e., qtz-plag-mica schist is a rock with qtz ≤ plag ≤ mica). This unit is medium to coarse grained with layering between the gradational lithologies ranging from very fine (millimeters) to very coarse (meters). Figure 8 shows a typical exposure of this rock type. The only outstanding textural features this unit displays locally are perthite porphyroblasts and a fine banding composed of cryptocrystalline material (these are best seen in the southwestern portion of the map area; refer to Figure 38a).

Minor lithologies include pelitic marbles, qtz-ep-hnbd schist, chl-rich schist, and dark phyllite (or very fine grained schist). Coarse grained marbles are found restricted to two 30 meter thick bands of mica schist and marble within the main schist; muscovite defines a weak foliation and quartz occurs as rounded grains. These marbles show banding (composed of very fine calcite and minor muscovite; refer to Figure 48) similar to that seen in the schist. Structurally below the marble band on the northeastern side of the lake, a 40 meter thickness of qtz-ep-hnbd schist crops out; this unit is medium to coarse grained with well developed compositional layering of epidote and quartz/hornblende. Chl-rich schists horizons are distinctive because of their colour difference, but

Figure 9 - Snowshoe/Antler contact

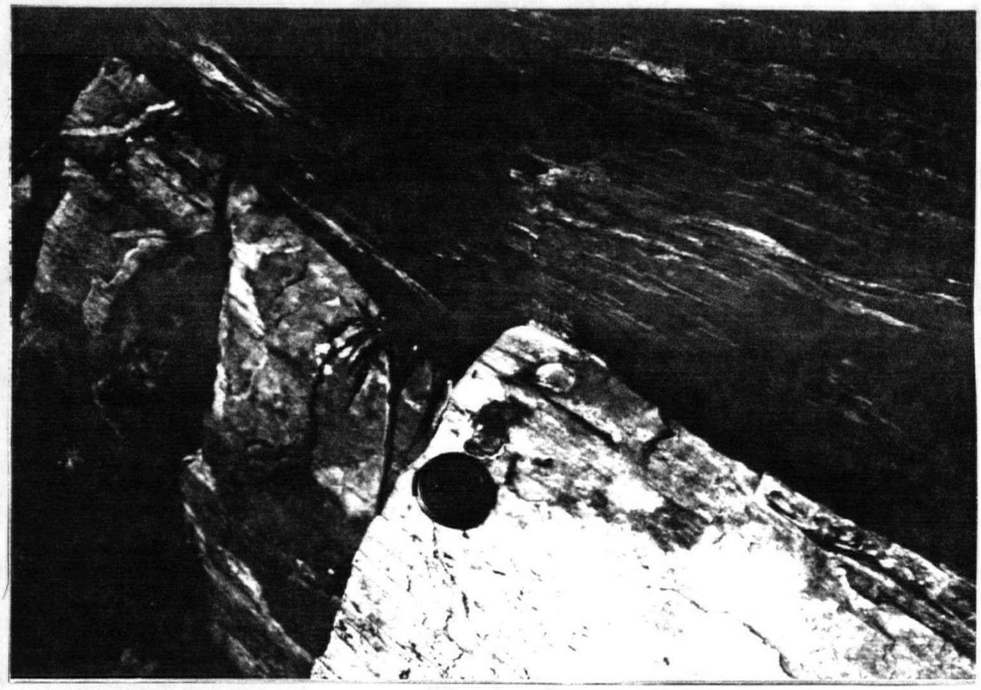


Figure 9a - Sharply defined contact between Snowshoe Formation (below) and Antler Formation (above) {DIR-030, LOC-J112}

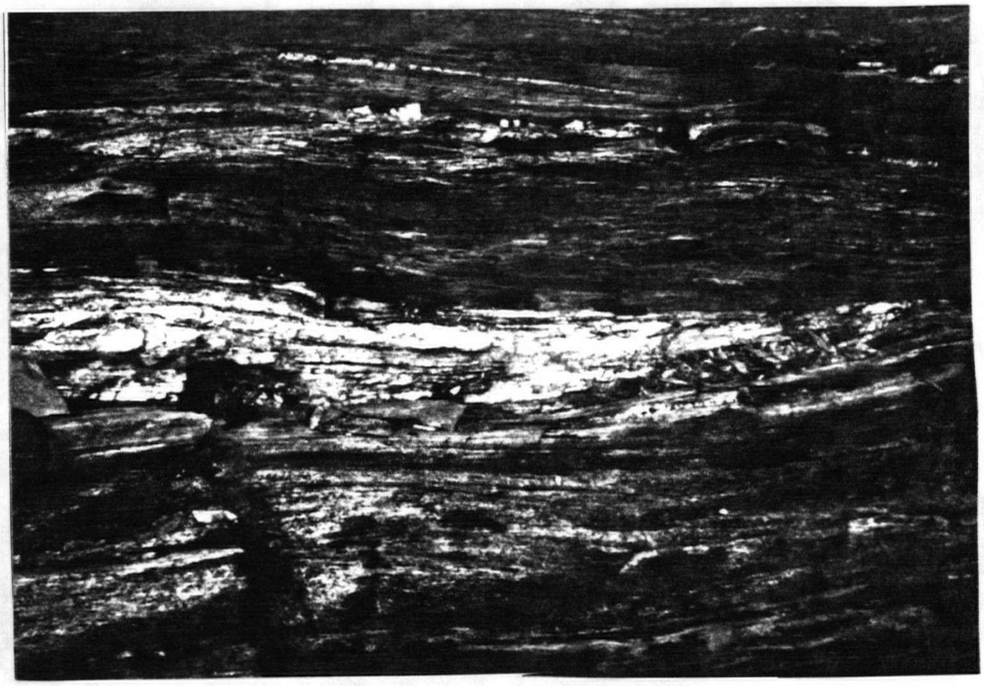


Figure 9b - Snowshoe sliver within Antler plag-hnbd schist and chl-hnbd schist; sliver is part of a D2 fold form involving the contact between the two units; similar feature is shown in Figure 12 {DIR-020, LOC-J114} do not essentially differ from the main schist package (i.e. chl is the main or only mica, but felsics predominate). Rare dark phyllites (very fine grained schists) were found in the southwestern map area and are believed to represent a true Snowshoe sub-lithology as opposed to being a structural infold of the overlying, younger Crooked Lake Phyllite (the only likely source in the area for this lithology).

Kaza rocks probably originated as a sequence of immature to submature quartz arenites, quartz arkoses, and quartz wackes deposited in a nearshore fluvial environment. The minor rock types may represent organic-related carbonate accumulations (the marble and possibly the qtz-ep-hnbd schist) and/or localized volcanic activity (the qtz-ep-hnbd schist).

The lower contact of the Kaza Group is not seen anywhere in the Crooked Lake area. Further to the east, though, the correlative Horsethief Creek Group lies above the pre-Hadrynian Malton Gneiss, (Ghent et al. 1977), which may represent Archean basement to both these units.

The upper Kaza contact is exposed throughout half of the map-area and clearly inferred for the rest. This surface is sharp against the overlying Antler rocks (Figure 9a) and at one locality tight folding involves the contact (Figure 9b; this feature is very likely a D2 fold form, see STRUCTURE below); this causes an apparent repetition of the different units in the vicinity of the contact. This geometry suggests that the `tectonic slices of Antler-like lithologies within the Kaza' reported by K.V. Campbell (1971) are manifestations of this same tight folding (e.g., rootless fold hinges of Antler appearing as lensoid bodies within the Kaza). Even though structures to either side of this contact were found to be consistently concordant (within reasonable error) within the map area, the degree to which the adjacent rocks have been folded and possibly mylonitized indicates that some amount of separation must be associated with this surface; numerous researchers (Campbell, K.V. 1971; Rees and Ferri 1983; Montgomery 1978; Struik 1981), including the present author, believe that this unit is in fault contact with the overlying Antler Formation.

## Slide Mountain Group - Antler Formation

The Antler Formation was first defined by Sutherland Brown (1957 and 1963) when he modified formations of the Slide Mountain Group proposed by Johnson and Uglow (1926). Recent work in the type area north of Barkerville and the Cariboo River by Struik (1981) has yielded Pennsylvanian and Permian ages for conodonts in chert of the Antler Formation (Orchard and Struik 1985). There, the major rock types include pillow basalt, diorite, minor gabbro and ultramafic rocks, argillaceous chert, slate, and greywacke. Figure 6 shows the distribution of the Slide Mountain Group rocks throughout central British Columbia and in relation to the map-area.

Antler rocks everywhere separate the Kaza Group from the overlying Eureka Quartzite and Crooked Lake Phyllite. In the western part of the map-area a maximum present thickness of 1200 meters is estimated for the hinge region of the antiform/synform pair shown in Plate 3 (this feature on the western flank of the Boss Mountain Anticline shall be henceforth called the Basset/Stark structural pair); thinning occurs within the unit as it arches over the Boss Mountain Anticline bringing it to a minimum thickness of under 300 meters on the northeast side of Crooked Lake (see Figure 10). Mapping by R.B. Campbell (1978) and K.V. Campbell (1971) suggests that such thickening and thinning is also characteristic of this unit outside the map-area.

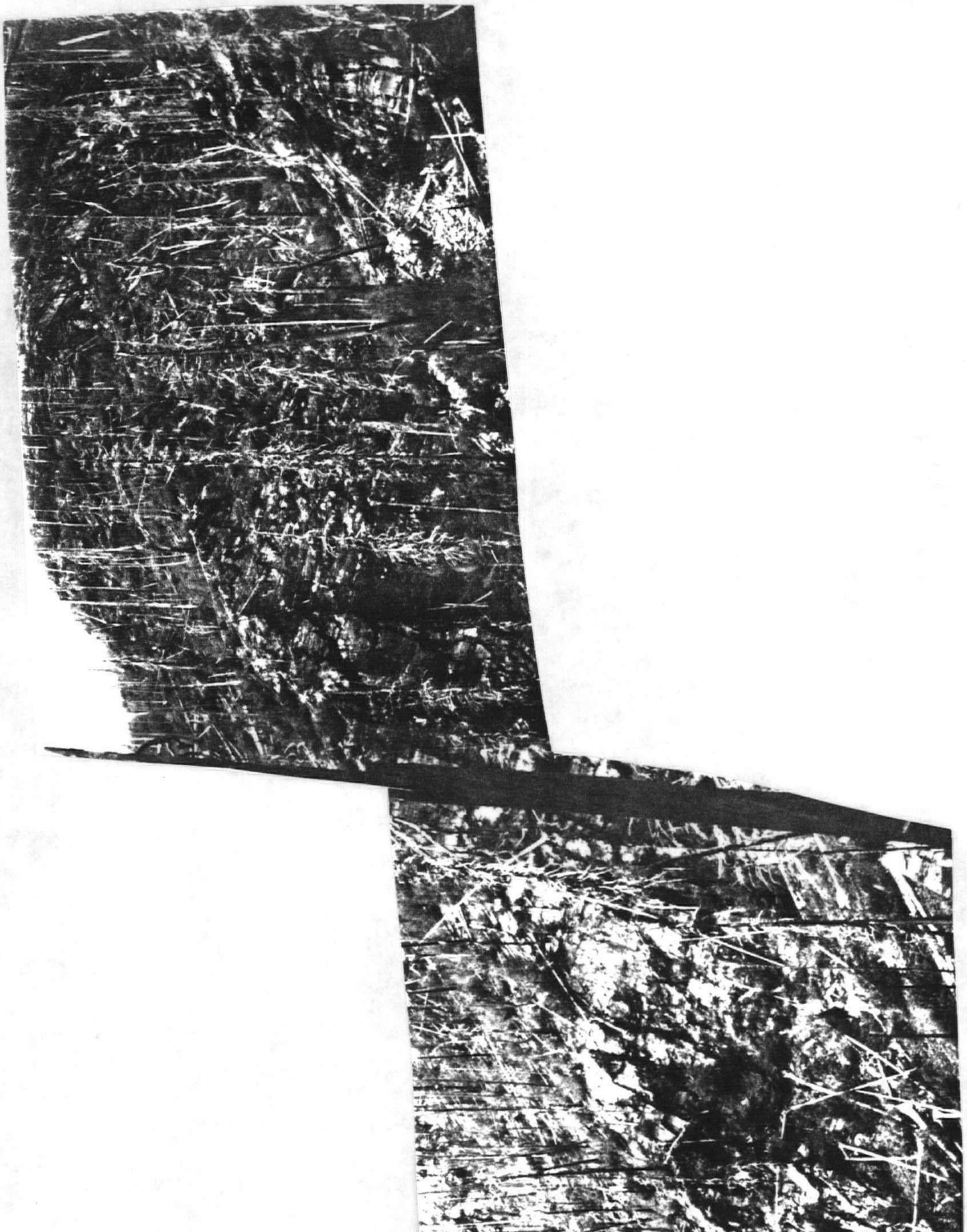
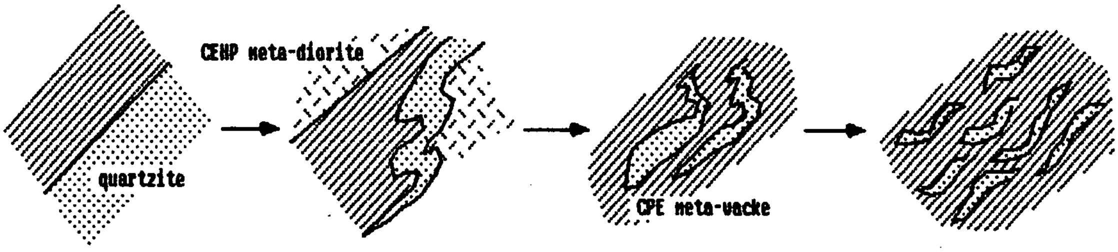


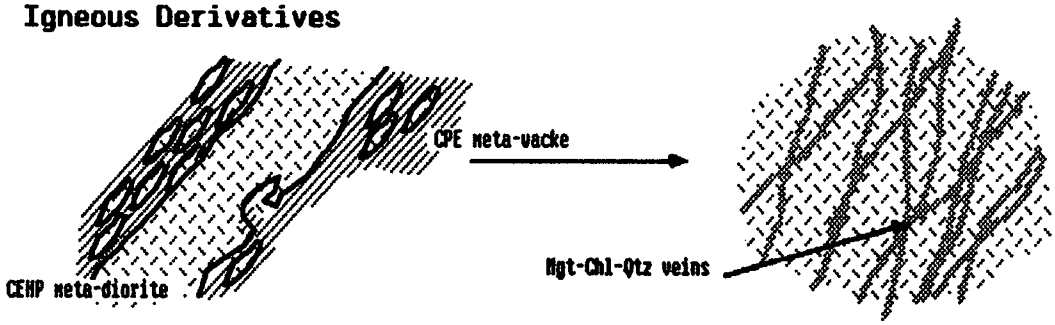
Figure 10 - Nearly continuous 150 meter section of the Antler Formation bounded top and bottom by exposed contacts (shown) (DIR-320)

**Sediment Derivatives:**



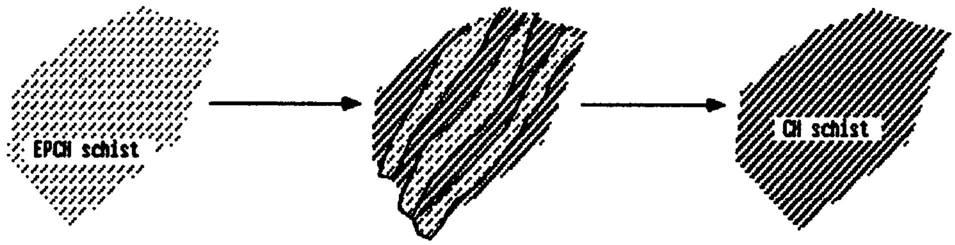

Massive (mgt)-chl-plag-ep Meta-wacke and Massive Quartzite

**Igneous Derivatives**




Massive and Cross-fractured chl-ep-hnbd-plag Meta-Diorite

**Metamorphic Types**




Ep-plag-chl-hnbd schist to chl-hnbd schist

Figure 11 - Summary of the principal Antler lithologies

The Antler Formation in the Crooked Lake area is a diverse collection of gradational lithologies. Figure 11 pictorially outlines the main sub-lithologies encountered across the map area; three common textural variants - the clastic appearing `meta-wackes', the igneous appearing `meta-diorites', and the metamorphic phyllites and schists, - are shown. The meta-wackes (Plates 6c, f) are characterized by an abundance of quartz, feldspar, and epidote; they range from very fine to medium grained and are generally light in colour (see Figure 45). They are interlayered on a fine to medium scale with phyllites/schists and it is not unusual to find them as lensoid bodies 'floating' in a phyllitic/schistose matrix ( Figure 11 & Plate 6c). This lithology is most abundant in the southwestern map area. The meta-diorites (Plates 6a, b, d) contain 30-60% evenly distributed dark mafic minerals (chlorite, hornblende) with plagioclase, epidote, and quartz; the grain size is medium to coarse and the texture is best described as spotted (light felsic matrix with green mafic aggregate spots distributed evenly throughout). This unit is found either interlayered with phyllite/schist or as massive units with numerous cross-cutting fractures and mgt-ep-qtz veining (Figure 11 & Plates 6a, b). Phyllite and schist together constitute the dominant lithology in the Antler, though they seem to be less representative in the southwestern map area. These 'schists' are fine to medium grained qtz-ep-plag-chl-hnbd aggregates with very well developed foliation and occasionally fine layering.

Antler rocks include as minor lithologies bluish quartzite, calcareous schist, and serpentinized peridotite. The quartzite occurs in association with the meta-wacke lithology as thin lenses (< 1 decimeter) and often is so fine grained as to appear `cherty' (this may represent silicification of a very fine grained sediment or, conversely, mylonitization of pre-existing quartzite units). Medium grained calcareous schist occurs as a fairly major part of the Antler (10-20%) from just west of Stark Lake, eastward and north to Crooked Lake; the calcite in the unit defines a metamorphic layering and veining (probably from different events) and does not occur with hornblende. Much of this schist is also associated with the meta-wacke lithology. One pod of serpentinized peridotite was found in the southernmost part of the southwestern map area; it is coarse grained and highly fractured (two sets of fractures contain serpentine and calcite respectively). It is unknown what relationship this unit has to the surrounding units as no contacts were seen.

From this discussion of lithologies it should be clear that there exists a generalized distribution of units within the Antler across the map area. Plate 4, Sections1, 2, 4 and 5 demonstrate this change. In the southwest map area all of the major units are represented in nearly equal proportions and two of the minor units, quartzite and serpentinized peridotite, occur locally. To the north, the calcareous lithology becomes more abundant, intermixed with meta-wacke and schist; this is an area where some degree of carbonate veining occurs and minor sulfides are present (mostly pyrite). The Antler encountered in the northeastern map area consists of meta-diorites and schist with a significantly smaller proportion of meta-wacke.

This lithologic change within the body of the Antler from southwest to northeast may stem from an original lithologic distribution (i.e., a western sediment facies versus an eastern igneous facies) or from early phase tight folding (i.e., causing localized repetition or stacking of meta-wacke units).

Minor features within the Antler rocks suggest that both of these factors have played a part in the production of this present distribution.

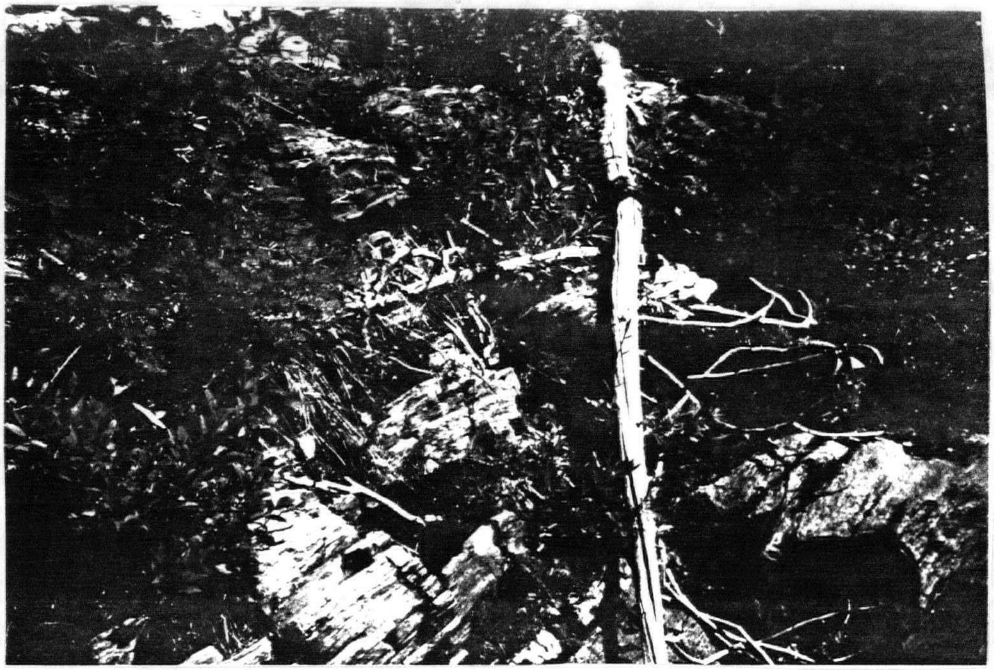


Figure 12 - Interfingering of Antler qtz-plag-chl-hnbd schist (dark unit) with Eureka Quartzite (light unit) {DIR-055, LOC-J101}

Because of the amount of internal deformation undergone by this unit and lack of preservation of good primary features, the nature of the original configuration of units is speculative at best. It is clear, though, that this unit originated as a volcanigenic sequence of intermediate to basic composition. The occurrence of ultramafics and very fine grained sedimentary interbeds would suggest an oceanic setting for this sequence, and perhaps, as Montgomery, (1978) has suggested, an ophiolite association.

The upper contact of the Antler rocks is well exposed on the northeast side of the field area (Plate 6d), but is inferred to the southwest. Where exposed, this surface shows the type of unit repetition seen in the lower contact (Figure

12), although far more pronounced . The origin of this surface is probably similar to that of the Antler's lower contact (i.e. a thrust fault) ; the relationships between adjacent structural features and the two surfaces are essentially equivalent, and indicate that they have shared a common history since before the D2 deformation.

## Eureka Quartzite

This unit was originally included with the phyllite by K.V. Campbell (1971), but here is separated on the basis of general dissimilarity in terms of composition and texture. No indication of the age of this unit is available from the Crooked Lake area, though information concerning units of similar lithology and structural position to the north suggests this quartzite may be Lower Jurassic and thus younger than the overlying Crooked Lake Phyllite (Struik 1981). The present author doubts that this is so, if indeed it is the same unit; it is more likely, considering that it occurs below the Crooked Lake Phyllite, that it is the older of the two.

The quartzite occurs as a wedge between the phyllite and the Antler cropping out along the northeast side of Crooked Lake (see Plate 4, Sections4 & 6); K.V. Campbell (1971) has mapped the unit around the nose and along the northeast limb of Eureka Syncline. Its thickness within the map area is less than 20 meters, though according to K.V. Campbell (1971), it increases in thickness toward the east.

In outcrop the unit is fine to medium layered, fine to medium grained, micaceous quartzite and graphitic micaceous quartzite (see Figure 13). Occasionally, horizons contain hornblende, though this is believed the result of degradation of garnet in the presence of biotite, magnetite, and quartz. These rocks possibly formed in a distal fluvial or near shore beach environment.

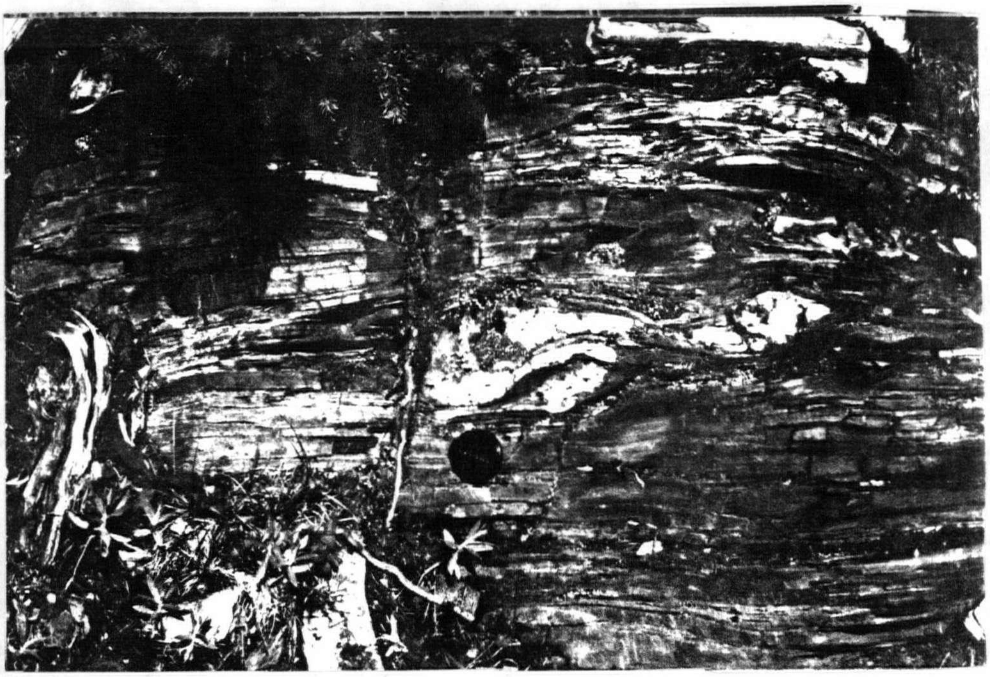


Figure 13 - Micaceous quartzite with pervasive platy texture; boudined and folded quartz veining is a common feature in this unit {DIR-062, LOC-J94}

Only the lower contact of the quartzite was seen exposed (see Plate 6d). The upper contact is buried beneath abundant talus formed from the highly recessive overlying phyllite.

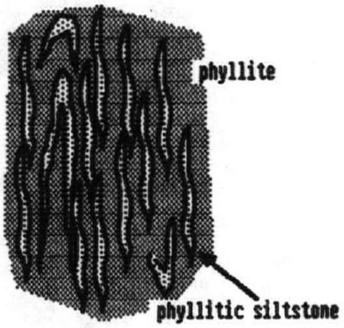
## Crooked Lake Phyllite

This unit occurs as a roughly continuous belt on the west side of the Slide Mountain Group shown in Figure 6 (R.B. Campbell et al. 1973). R.B. Campbell and Tipper (1971) found belemnites of possible upper Triassic age within this belt in the Bonaparte map area to the south, although, as Campbell, R.B. et al. (1973) point out, none of these finds is conclusive due to 'lack of critical exposures'. The present author found several lithologic sub-units that might have possibly yielded results in terms of conodont dating; unfortunately the results from a sample sent to the Geological Survey of Canada were inconclusive (R.B. Campbell, personal communication, 1982).

Figure 14 - Black phyllite and grey phyllitic siltstone with characteristic strong foliation and discontinuous, transposed layering; note tight fold at upper right hand corner {DIR-020, LOC-J88}

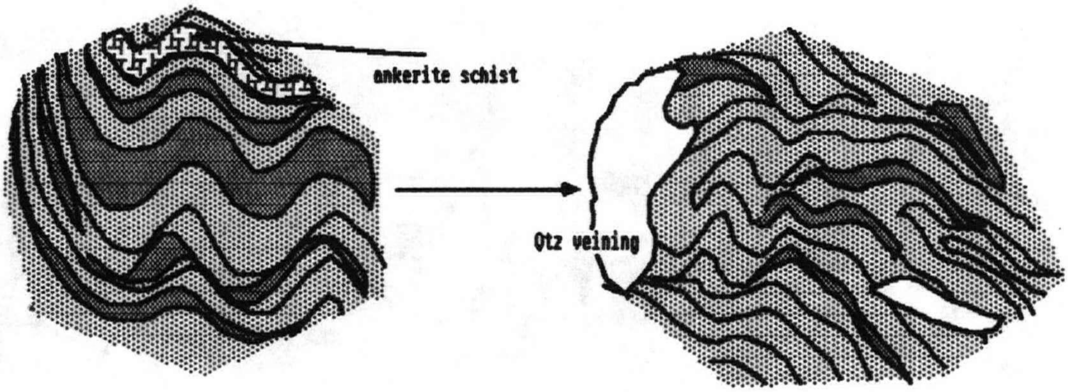
Phyllites crop out over a good part of the western portion of the map-area and cap the first ridge northeast of Crooked Lake (Talbot Ridge of K.V. Campbell (1971)). A minimum of 1800 meters of present thickness of phyllite occurs between the Antler rocks and the overlying volcanic/volcaniclastics to the northeast of Crooked Lake. A maximum figure for this unit is not available because its upper surface cannot be traced continuously across the map-area, though it is believed to be in excess of the above-mentioned minimum figure and possibly in excess of the maximum cited by K.V. Campbell (1971) (around 2600 meters).

**80% of Crooked Lake Phyllite**



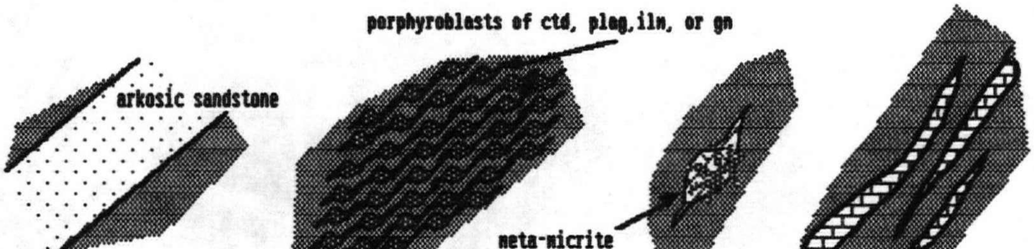

Highly transposed phyllite with phyllitic siltstone

**15% of Crooked Lake Phyllite**




Well-bedded to contortedly folded phyllitic siltstone
with phyllite and occasionally ankerite schist

**5% of Crooked Lake Phyllite**




Massive sandstone, porphyroblastic phyllite, synerisis-cracked
meta-micrite, sandy limestone

Figure 15 - Summary of the principal Crooked Lake Phyllite lithologies

The Crooked Lake phyllite is composed almost entirely of finely layered, micaceous phyllitic siltstone and graphitic phyllite (refer to Plate 4, Sections 2, 3, 4, & 6). In most exposures, muscovite, quartz, and graphite are the major constituents; chlorite, ilmenite, and tourmaline are minor but nearly always present. The phyllitic siltstone usually forms discontinuous layering and/or `folded' lensoid shapes in a matrix of phyllite (see Figure 14); when phyllitic siltstone predominates the unit takes on a more regular layered (or bedded) appearance. Figure 15 demonstrates the change in character typical of the bulk this unit, in addition to outlining minor sub-lithologies. Thin quartzite and felsic schist are very minor lithologies not mentioned on this diagram.

The response of this unit to several deformation episodes has been extreme (most likely because of its uniform character and fine grained texture); any original layering that occurred in the unit has been transposed and now, in most localities, defines a highly discontinuous layering sub-parallel to a strong foliation (see Figure 14). As a consequence, coarser, more competent horizons occurring in the phyllite package no longer exist as clearly mappable units, though it is possible, in a very general sense, to identify packages of contrasting lithology within the phyllite.

These packages in the phyllite roughly parallel the major contacts. There are three different types that occur - siltstone/sandstone, a porphyroblastic lithology, and a limestone/volcanigenic lithology. The siltstone/ sandstone package consists of light coloured siltstone and fine sandstone of quartz arenite to arkose composition; it is fine to medium layered and contains chl-ankerite schist and nodules of syneresis cracked micritic limestone (Figure 15). This lithology is common on the northeastern flank of the major hill in the western map area and along the top and northeast side of Talbot Ridge. The porphyroblastic lithology is typified by strong porphyroblastic textures (see Figures 42-44); porphyroblasts include almandine garnet, chloritoid, staurolite, plagioclase, and ilmenite; very fine to fine muscovite, quartz, graphite, and chlorite form the matrix for these coarse to very coarse porphyroblasts. This package crops out along much of the steeper southwest slopes of Talbot Ridge; its abundance increases significantly toward the southeast. One isolated occurrence of this unit exists in the western map area on the northern slope of the major hill (Station J47). The limestone/volcanigenic package was examined in the northeastern map area below Alex and Reggie Lakes and also to the northwest of the current map area, both in apparent association with the upper Crooked Lake Phyllite/Takla contact zone. Limy sediments (<30% calcite) are interspersed with phyllites and phyllitic siltstones that look more green than grey. These units contain very fine grained ank-musc-chl-py-ab-ep-qtz-cc and bio-ep-felsic-act, assemblages respectively. In one sample of the latter lithology, crystals of tan hornblende appear to be of relict igneous origin.

The rhythmic nature of this phyllite, the abundance of graphite (30% or more), and a fine grain size suggest perhaps a distal, restricted to anaerobic(abundance of pyrite) submarine fan environment as an origin of this unit. If it is possible to relate this sequence to the overlying Takla Group rocks then this fan may have formed adjacent to a quiescent island arc occasionally receiving calcareous material and volcanic detritus from nearby regions and eventually becoming emergent as an active part of the arc itself.

The lower contact of the phyllite was never seen exposed. To the southwest Antler rocks underlie this unit; to the northeast the Eureka Quartzite wedges in between the two to underlie the phyllite. The upper contact of the phyllite occurs in two distinct localities. To the west it is largely covered in a zone approximately 300 meters between outcrops of Takla and Crooked Lake Phyllite lithologies (Figure 7b) and is associated with tight folding and strong mylonite development in the Takla rocks; to the east the contact zone consists of a series of interdigitations of the two units (see Plate 3 and Figure 7c) and is associated with a large amount of tight folding, again in a zone about 300 meters thick. This contact probably originated as a primary surface of deposition, with later, localized displacement occurring along it.

## Takla Group

This unit is given the formal name of Takla Group rocks according to Tipper et al. (1979). It is an extensive unit in the Quesnel Terrain to the west and south where it occurs near Upper Triassic volcanics and sediments of the Nicola Group. The Takla Group is typified by basaltic to andesitic volcanics and volcaniclastics with minor shale, sandstone, conglomerate, and limestone.

Takla Group rocks occur at the extremities of the field area to the southwest and northeast. K.V. Campbell (1971) shows rocks of this group cropping out in the center of the Eureka Syncline; to the north phyllites similar to the underlying unit overlie the Takla rocks. Approximately 2300 meters of Takla and phyllite is contained in the Eureka Syncline above the lower phyllite unit.

In the map area units observed include chlorite phyllites, matrix-supported hornblende-diorite breccias, clast-supported diorite conglomerates, immature feldspathic sandstones, and augite porphyry flows (see Figures 19a-d). Within the Takla the general configuration is one of coarsening upwards; from west to east finer silts grade into coarser

Figure 16 - Distinctive lithologies of the Takla Group rocks

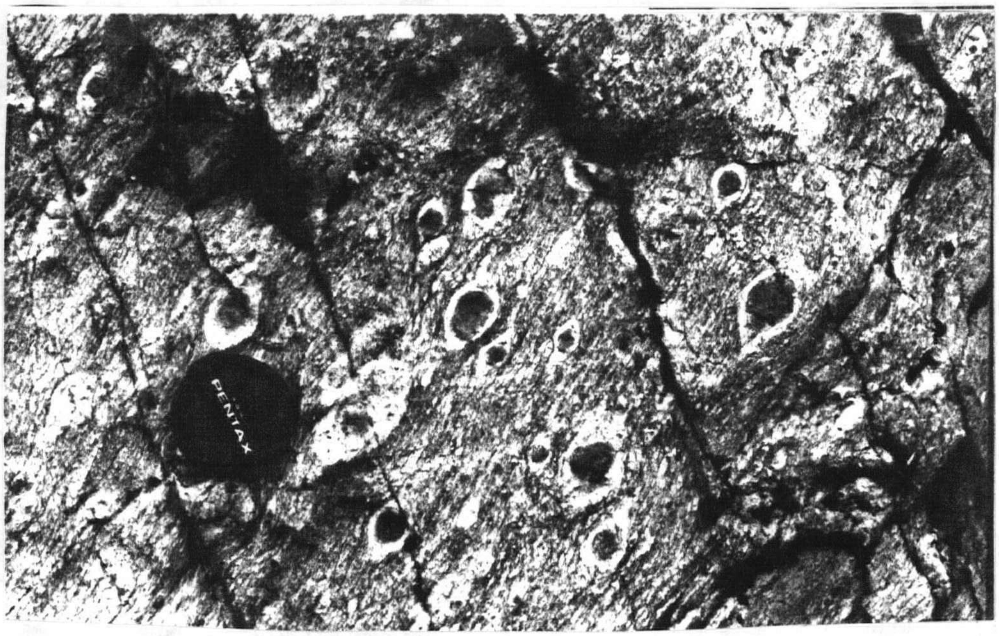



Figure 16a - Foliated chl-hnbd-plag meta-diorite with lensoid/spheroids of plag-chl-ep directed along the main foliation {DIR-100, LOC-J59}

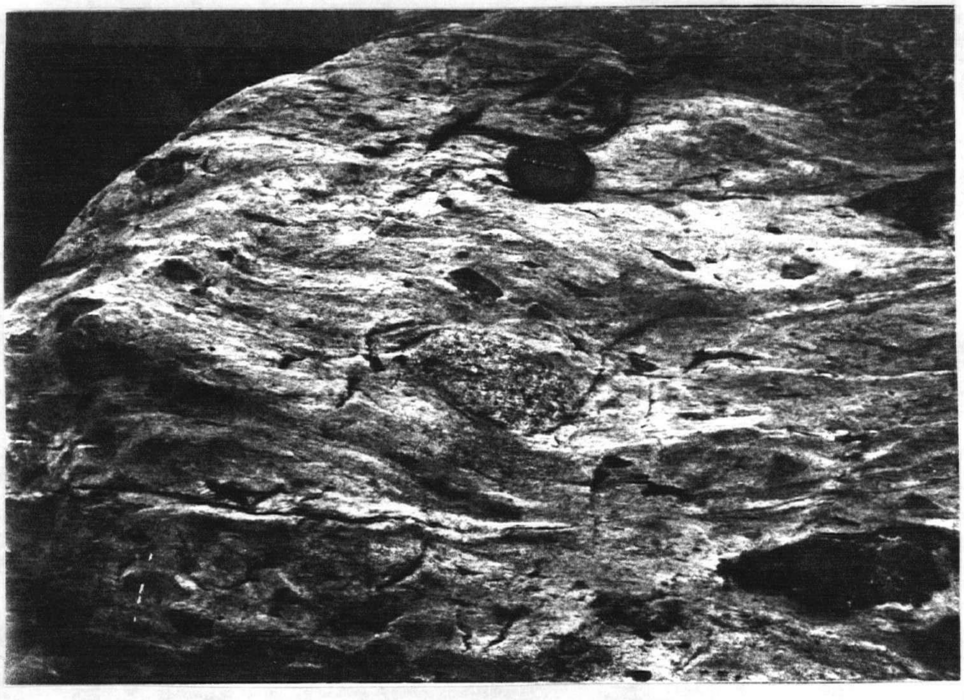


Figure 16b - Matrix-supported breccia with diorite and massive hnbd clasts elongate in the direction of the main foliation {DIR-090, LOC-J60}

Figure 16c - Clast-supported conglomerate with diorite clasts that show a weak elongation in the plane of the main foliation {DIR-335, LOC-J144}

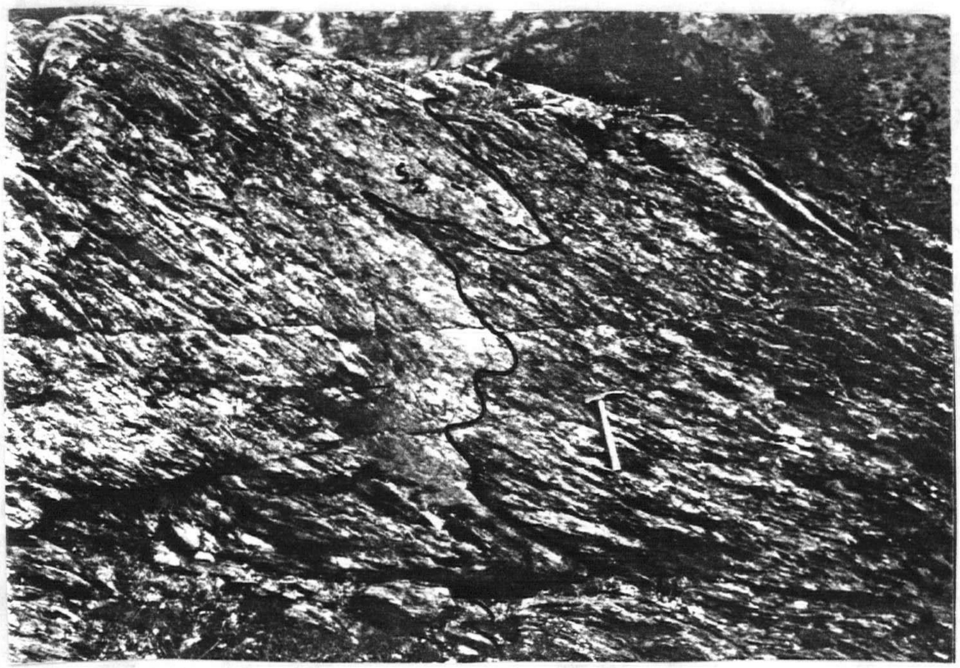


Figure 16d - Folded contact between volcanic arenite and phyllite; this phyllite, more typical of the Crooked Lake Phyllite, is fully contained within the Takla Group rocks {DIR-318, LOC-J163} sandstones and matrix-supported breccias give way to clast-supported conglomerates. This lithology probably originated as intermediate volcanics and associated volcaniclastics in an island arc setting.

A short excursion into a cirque on the north limb of the Eureka Syncline showed a considerable size body of fairly fresh gabbro to have intruded Takla-like rocks. The rock units at the base and extending up the side of Eureka Peak were extremely sheared and hydrothermally veined. Some copper mineralization was associated with this veining and an adit some 20 meters long had been excavated 100 meters from the base of the peak.

# STRUCTURE

## Introduction

Deformational episodes have left an obvious imprint on the Crooked Lake rock units. Some prominent effects of these events include transposition of primary bedding, development of secondary compositional layering, strong mica or amphibole foliations, weak to strongly developed cleavage, and abundant fracturing. Many of these deformationally derived surfaces (and some original ones) exhibit fold forms that are exceptionally common throughout the rock mass as well. Additional features such as mylonization, linear fabrics, boudinage, veining (calcite, quartz, and/or epidote), and faulting are either less conspicuous in nature or only of local importance.

Analysis of these structural elements allows one to decipher the structural history of an area. On the scale of a single outcrop measurements of the orientations of the various structural features were taken and the relative prominence of each noted (see Structure Map, Plate 2); a relative time sequence of features was then determined based on any `cross-cutting' relationships that may exist. Extending this type of analysis to the greater map scale involves deciding which features at one locality relate to others elsewhere. Because contemporaneously formed elements may show different characteristics, different orientations, or may only be locally developed, the time sequences noted at the lesser scale together with knowledge of major contact distributions form the basis of the interpretation of the overall geometry (refer to Cross Sections, Plate 3) and developmental history in the rock mass as a whole. An important assumption that had to be made to allow the bridging of small scale observations to large scale interpretations is that features and forms (especially fold forms of surfaces) seen in outcrop have similar counterparts in the larger dimension.

TABLE I
Characteristic Features of the Five
Phases of Deformation at Crooked Lake

| Respective Events † | | General Characteristics | Preferred Terminology |
|---|---|---|---|
| D5 | {D4} | - Northeast directed faults and fracture sets | S5 |
| D4 | {D3} | - Gentle to open folds and kink folds (mostly of S2); reclined (Domain I) and upright plunging (Domain II) | F4 |
| | | - symmetry plane of folds, kink band boundary planes | S4 |
| | | - hinge line of folds, ext. rot. axis of kinks | L4 |
| D3 | {D2} | - Open to medium folds; upright plunging (Domain II) | F3 |
| | | - symmetry plane of folds, spaced cleavage | S3 |
| | | - hinge line of folds, weak to strong crenulation lineation | L3 |
| D2 | {D1} | - Open to very tight folds; upright plunging (Domain I) and recumbent to inclined plunging (Domain II) | F2 |
| | | - symmetry plane of folds, strong mica/amphibole foliation, weak gneissic layering and/or lensoid development, localized cleavage to spaced cleavage | S2 |
| | | - hinge line of folds, strong crenulation lineation, quartz rod lineation, localized amphibole lineation | L2 |
| D1 | | - Isoclinal, intrafolial, rootless folds; nearly completely transposed $\parallel$ to D2 features | F1 |
| | | - symmetry plane of folds, foliation or cleavage lying closest to compositional layering and/or with strongly crenulated form | S1 |
| | | - hinge line of folds, weak sulfide smear lineation | L1 |
| | D0 | - Compositional layering, original bedding | S0 |
| D0 | Takla Gp. | | |
| Antler Fm. | Crooked Lake Phyl. | | |
| Snowshoe Fm. | Eureka Qztite. | | |

† - Event symbols used in the text are with respect to the lower units; symbols shown in curlibrackets refer to an alternate terminology for all but the earliest event (D1).

The result of this analysis has lead the present author to group the Crooked Lake deformational features into five distinct sets of structural elements (see Table I above) each of which can be related to a single event in time (D1 to D5); Table I outlines these five episodes, their characteristic features, and the preferred terminology used in the following discussion (please note that events are numbered with reference to the oldest units).

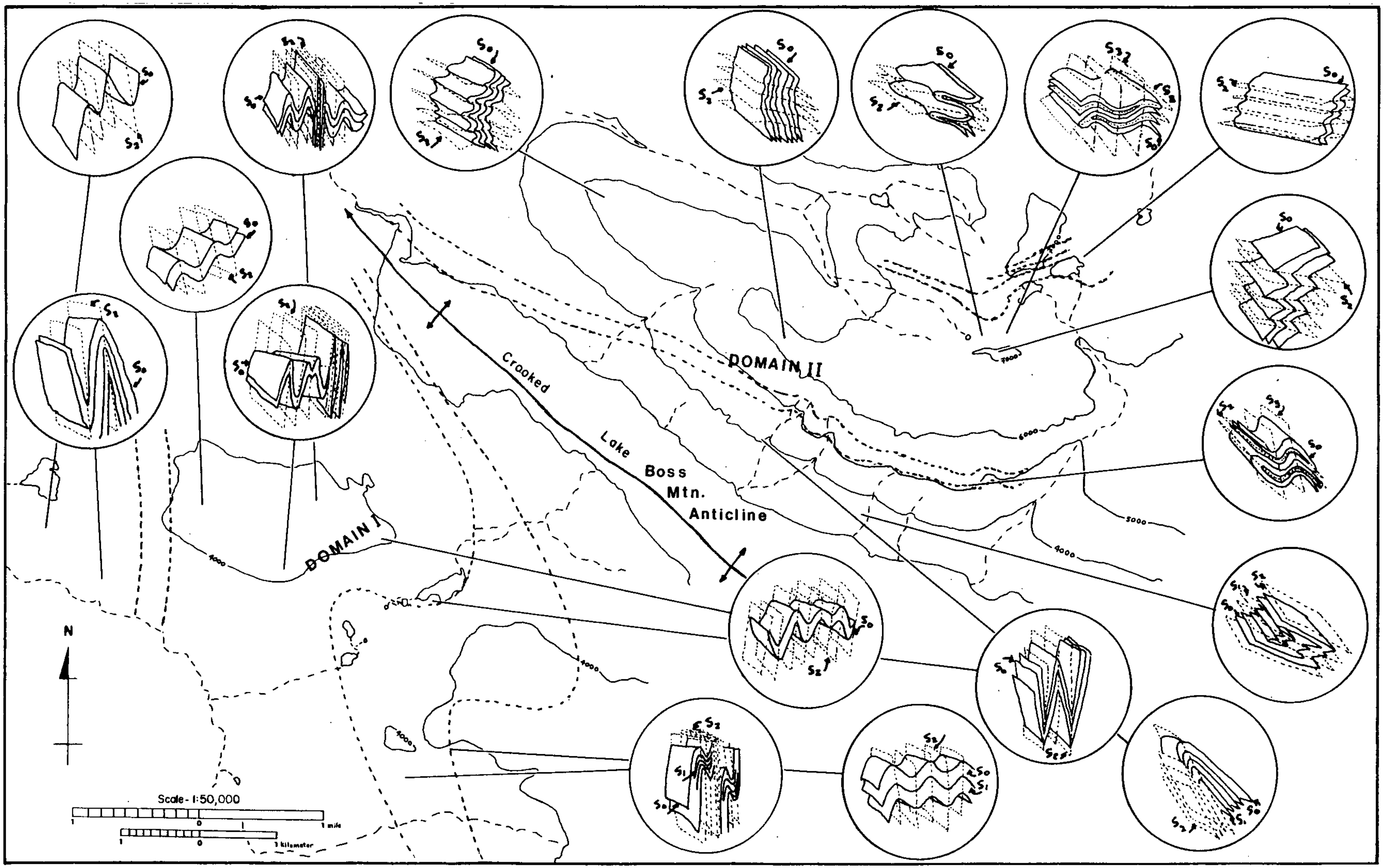



Figure 17 - Variation of minor fold forms and their orientations across the Crooked Lake area; Domains I and II are separated by the Boss Mtn. Anticline; major contacts shown as heavy dashed lines.

## Maps and Cross Sections

Data collected for the map area is presented on the Structure Map (Plate 2). Individual measurements for the various possible structural features are indicated by an array of symbols as shown in the legend and plotted as near to the station locations (see Geologic Map, Plate 1) as possible. The majority of these measurements refer to structural elements of a single event (shown below to be D2; see Table I above for description) and it is for this reason that an attempt has been made to emphasize this dominant fabric (light dashed lines without double arrows). The form of these surfaces was determined by following the trends of mapped data and were assumed to be projected onto a flat horizontal plane; topography has not been considered with respect to this feature! Since these surfaces represent a penetrative feature (down to the microscopic scale), the number of surfaces and the distances between them are arbitrary; the choice was made so as to clearly show the basis form, while not obscuring other features on the map. Also included on this map are traces of axial surfaces for macroscopic fold forms with plunges shown, where applicable.

A second important set of features, in addition to the strong foliation fabric, is shown in Figure 17; across the area, well developed folds occur that show a very close orientation relationship with the dominant fabric (compare with Plate 2). Examination of these forms revealed that the surface being folded was consistently a primary one, in the case of the upper three units (Eureka Quartzite, Crooked Lake Phyllite, and Takla Group), which makes the folding event associated with these forms and the dominant foliation the first these lithologies have experienced ({D1} or D2 in Table I); the Antler and the Snowshoe, on the other hand, show evidence for one earlier folding event (D1 in Table I). These relationships are shown in Figure 17 by surface designations (e.g. the dominant foliation is called S2 in all units).

The structural cross sections (Plate 3) were derived from features and measurements that cross the two section lines shown on Plate 2. The remainder of the sections is partially projected from the Structure Map and partially interpreted from known facts concerning the character of deformational forms at the outcrop scale. An important point to note concerning these sections is the relationship between the two fold forms outlined by the major contacts. Originally, the antiform/synform pair (here designated the Bassett/Stark pair) to the west was believed to be parasitic to the Boss Mountain Anticline (K.V. Campbell 1971). The present author holds that this cannot be the case. All minor fold forms to the west (refer to Figure 17) with orientations similar to the Bassett/Stark pair (upright-plunging) are always found associated with the pervasive foliation, S2, in an axial planar relationship. This set of surfaces (see Plate 2) is clearly not folded about the Bassett/Stark pair, but lies in an axial planar relationship to them, as well. The fact that fold forms to the east (see Figure 17) with similar characteristics to those in the west have the same axial planar relationship to the main foliation, S2, and here lie in a recumbent to inclined-plunging position, gives credence to the suggestion that forms associated the Bassett/Stark pair are actually folded over the Boss Mountain Anticline (which is, thus, interpreted as a D3 feature).

## Domains

As the Structure Map and Cross Sections, Plates 1 & 2, show, Crooked Lake follows the trace of the axial surface of the D3 Boss Mountain Anticline (K.V. Campbell 1971), and accordingly can be used as the dividing line between two

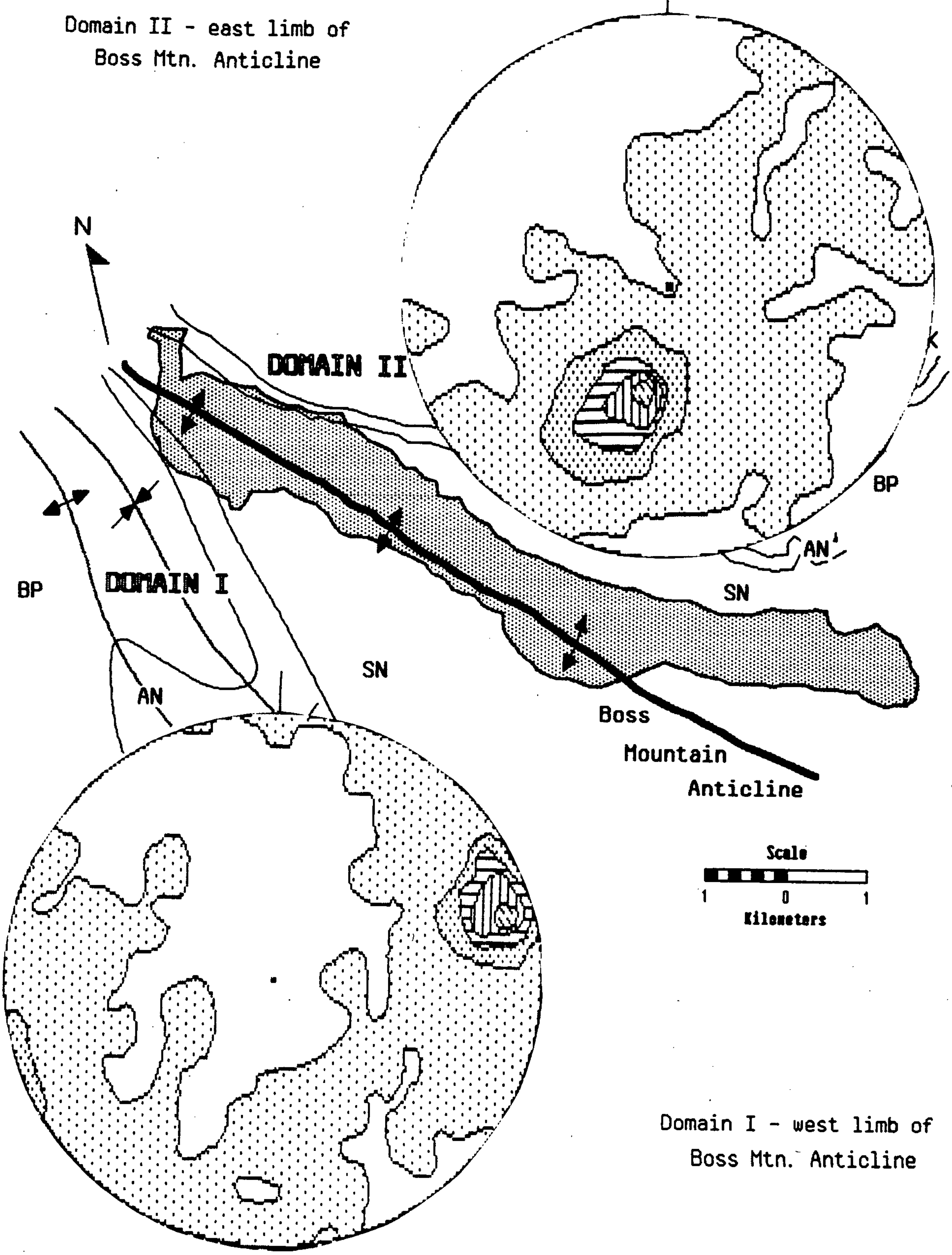



Figure 18a - Contour plots of poles to S2 foliations from Domains I & II
(contours represent 0, 5, 10, 15, 20% of points per 1% stereonet area)

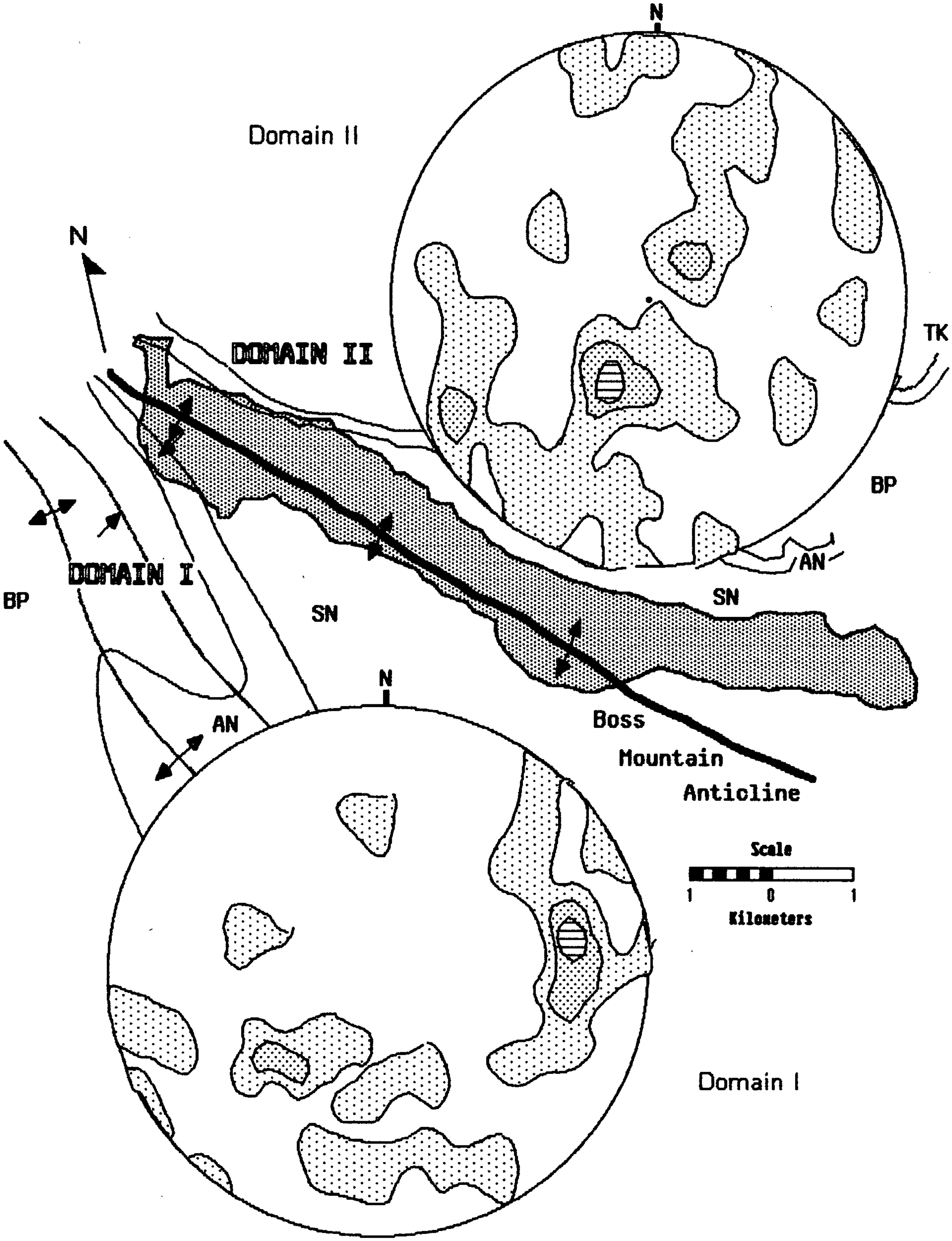



Figure 18b - Contour plots of poles to compositional layering (bedding?) and envelopping surfaces of D2 folds (contours are 0,5, &10% per 1% area) distinct groups of measurements, i.e. the west and east limbs of this feature. The total data contour plots for poles to the S2 foliation shown in Figure 18a (and to a lesser extent the contour plots of compositional layering in Figure 18b) illustrate that there are significant differences between these two regions(to the southwest the S2 foliation planes average 165°/vertical and to the northeast 110°/50°NE). This difference, then, forms the basis for a breakdown of the Crooked Lake data into two main Domains, I, to the southwest and, II, to the northeast (see Figure 17).

The following is a disoussion of each of the phases of deformation as they were observed as minor features in the field and reflected in the overall large-scale map-pattern. Consideration has been given as to how each phase has effected the five different units, their contacts, and earlier surfaces in each of the two Domains. Thin sections were examined to corroborate, where possible, mesoscopic field observations and to provide information relating mineral growth and deformation histories.

## Phase One

This early phase is not represented totally throughout the lithologic/ structural pile. Direct evidence of a clear pre-D2 stage of folding was found by the present author only in the Antler Formation (see Figure 19), though K.V. Campbell (1971, p.173) shows good examples of rootless, intrafolial isoclines involved in what appear to be medium, phase two folds in Snowshoe (in the following discussion, the terms open, medium, tight, and isoclinal refer to the interlimb [dihedral] angles: 180-120°, 120-60°, 60-20°, 20-0°, respectively). In the upper three units evidence for this phase does not exist; this would imply that

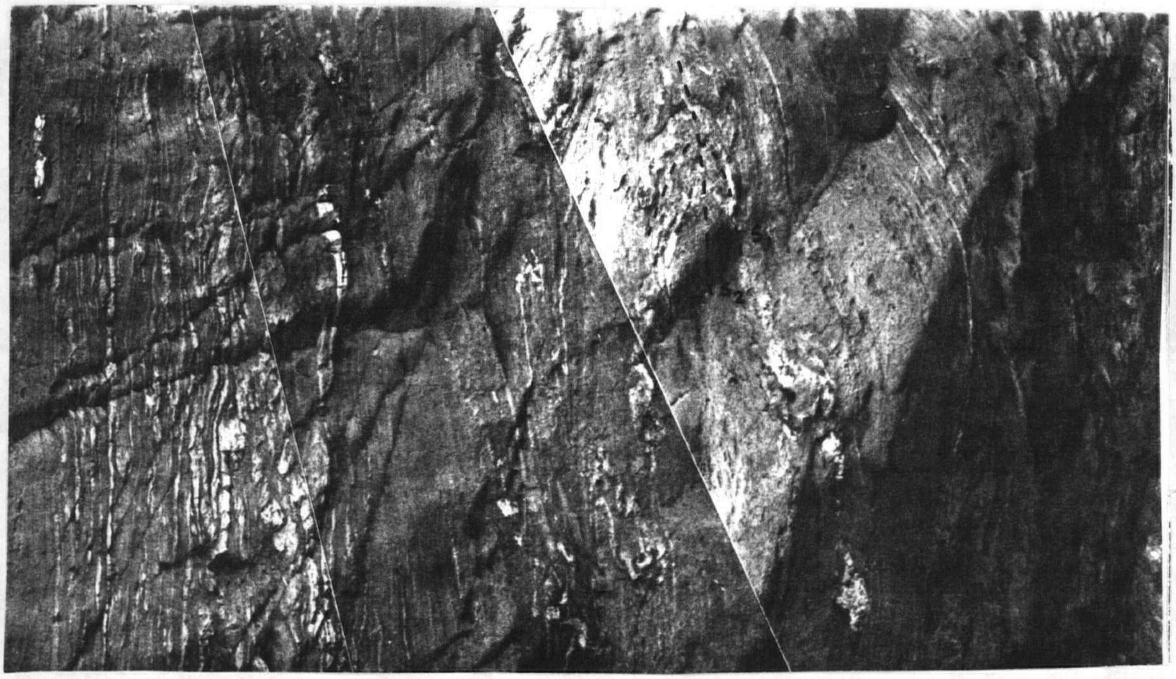


Figure 19 - Qtz-plag-ep subunits in chl-qtz-hnbd schist show tightly folded and refolded forms (outlined) {DIR-345, LOC-RZ6}

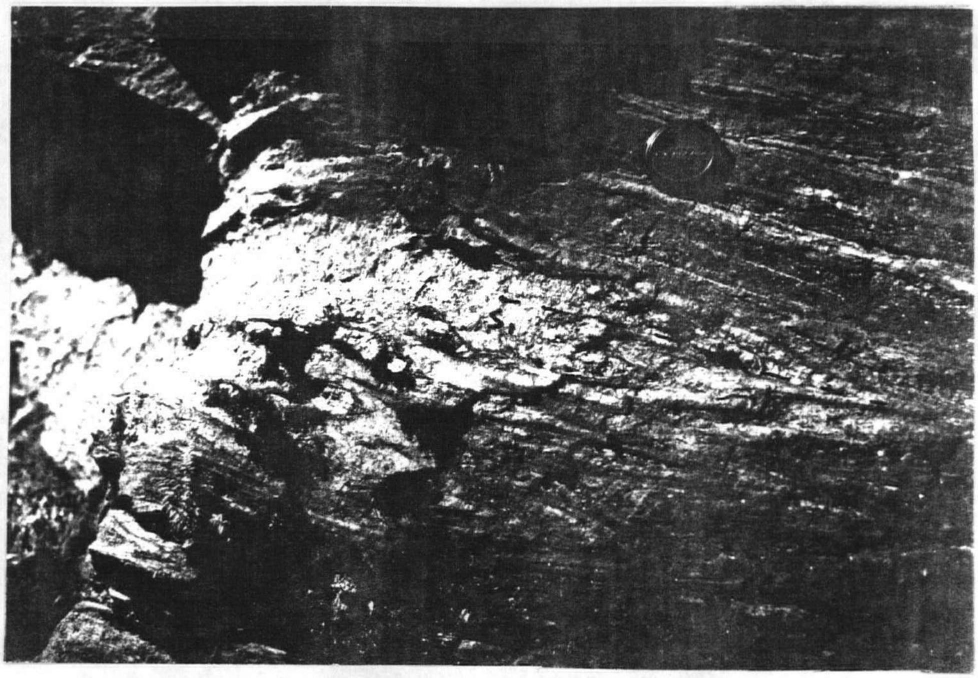
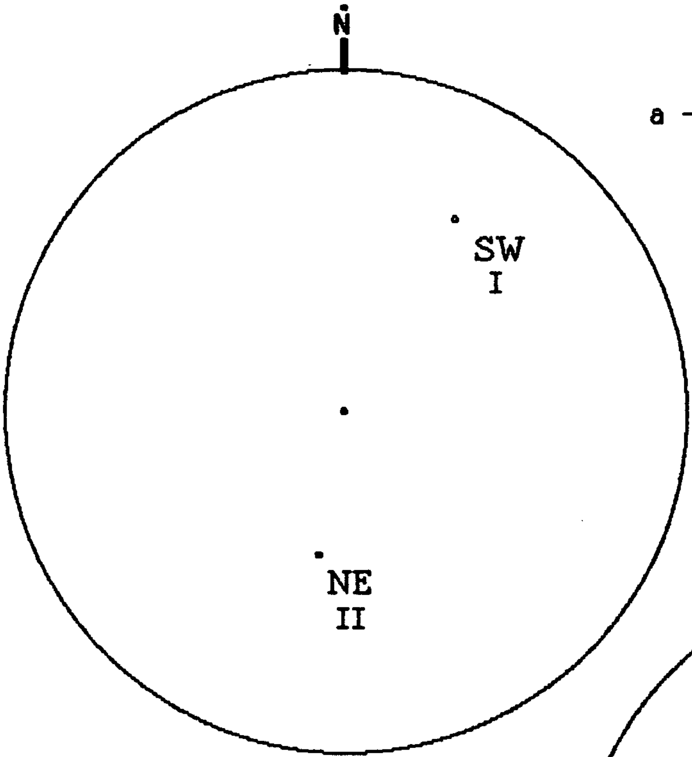
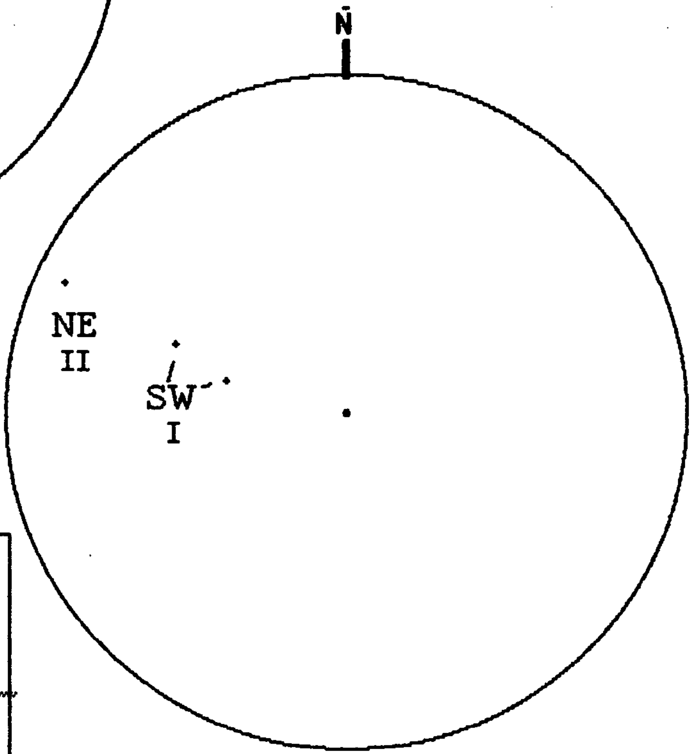


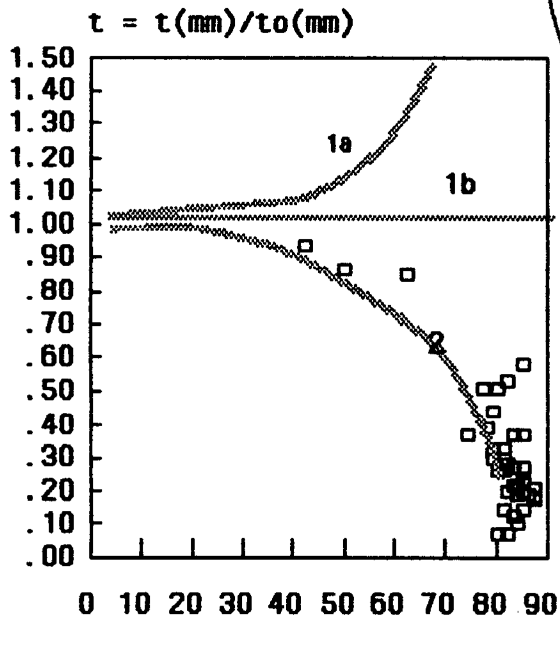
Figure 20 - Isoclinal fold closure involving compositional layering of qtz-musc marble and plag-musc-bio-qtz schist {DIR-330, LOC-J74}




a - Equal-area net plot of poles to axial surfaces of D1 folds from both Domains




b - Equal-area net plot of D1 fold hinges from both Domains




c - t-alpha plot of D1 Fold Forms Snowshoe J72, J74, J74b, Antler RZ6; (see Appendix C for explanation of fold form curves)

Figure 21 - Characteristics of D1 minor fold forms

deposition (or emplacement) of these units post-date phase one deformation of the lower two units.

The most typical forms representing D1 in the Snowshoe and Antler are intrafolial isoclinal folds of compositional layering and/or bedding (Figure 20 and Plate 6f); most often these forms are very small, rootless features (they take up less than 1 or 2 sq. dm.) embedded in a highly foliated and compositionally streaked matrix. An S1 mica foliation is best seen as a transposed feature in thin sections of Snowshoe rocks from Domain I (see Figure M1). In the field this feature is certain only when interference of D1 features with D2 folding can be demonstrated (most easily seen when D2 folds have a medium form and S2 occurs as a prominent spaced cleavage).

Figure 21 summarizes the orientation and form data for D1 folds from the Snowshoe and Antler. The rarity of such forms in the area mapped is reflected in the very small number of data points; nevertheless, the orientation of these folds (Figure 21a, b) lies within the range of D2 fold data (Figure 25 ) which reflects the near complete transposition of D1 surfaces that was observed in the field. The t-alpha plot (technique from Ramsay, 1967; see Appendix C for explanation and data) of D1 fold forms (Figure 21c) shows a distribution of points that suggests Class 2 to Class 3 type folds with very low interlimb angles (« 15°).

Interference forms between D1 and D2 observed in the map area are shown in Figure 19 and Plate 6h; forms between D1 and other events were not seen. Figure 19 and Plate 6h show D1 folds of compositional layering wrapped about D2 medium folds. The rarity of such forms is believed the result of the strength and pervasiveness of the D2 deformation.

Large scale features that might outline the effect that this deformation has had on the rock units at Crooked Lake are not definitive. Tight interfingering of the Snowshoe/Antler contact in Domain II nearly always shows the same characteristics as the surface above (the Eureka/Antler contact), so it is thought to be primarily a D2 effect; unfortunately large enough profile sections of these surfaces were never observed so the present author can offer no confirmation or denial of possible multiple folding of this surface. Zones of mylonite within the Snowshoe were always seen involved in D2 folding and may be a result of D1 deformation and/or some period of deep level thrust faulting. Very detailed mapping of the Snowshoe, with careful attention paid to stratigraphy might be able to discern the complex nature of these earlier features; if it is reasonable to relate the first phase minor forms seen at Crooked Lake with ones from areas to the east and south (Ghent et al. 1977; Murphy and Journey 1982; Pell and Simony 1982), such mapping should have a broad areal extent.

## Phase Two

Effects of the second deformation vary mostly as a result of lithologic variation. This change produces slightly different structural features in each major unit and between subunits where rheologic heterogeneity is important. In a general sense all major units display some degree of internal heterogeneity and so all can be expected to show the full range of elements possible for the D2 event; the difference between major units observed was thus one of relative abundance of the various features. By far, the Crooked Lake Phyllite shows the most varied set of D2 features while the Eureka Quartzite and Snowshoe show the least (the Antler Formation and the Takla Group lie somewhere midway).

The textural feature associated with the D2 event that occurs most frequently in all rock units is a prominent mica or amphibole foliation and attendant compositional layering. This foliation characteristically has a 'wavy'

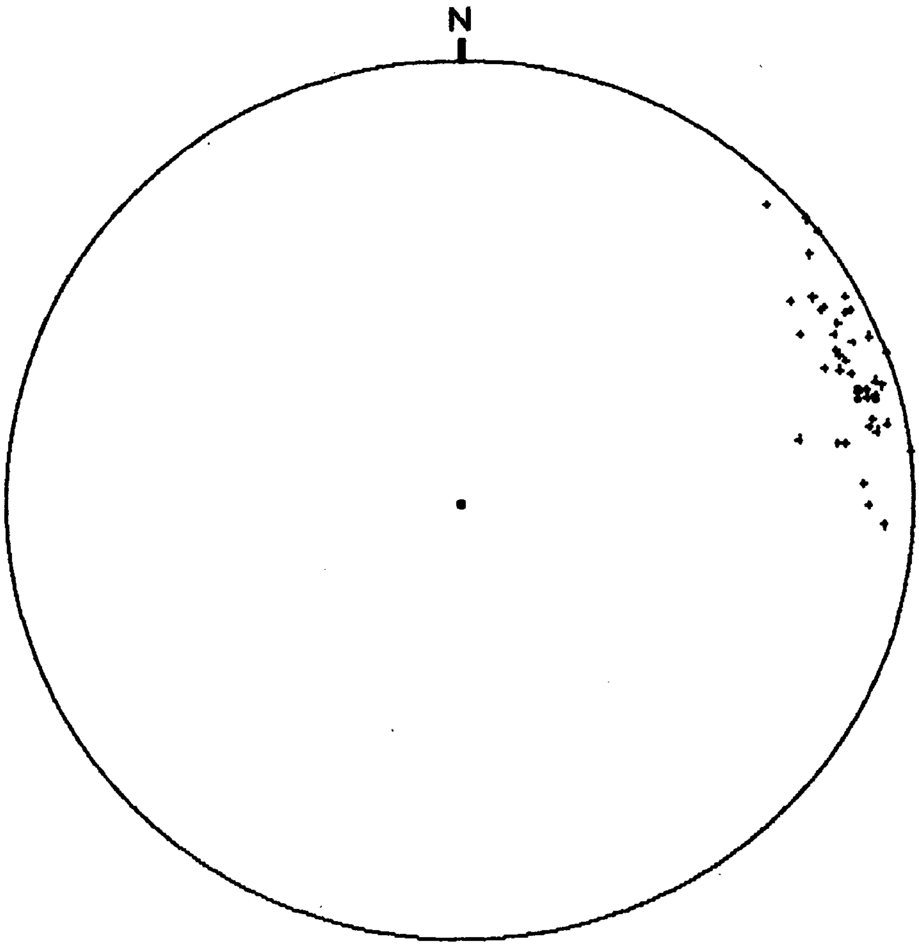



Figure 22 - Equal area net plot of poles to planar measurements from a single S2 foliation surface at RZ11 in the Snowshoe; this variability is characteristic of S2 foliation surfaces across the area

form (Figure 22 shows an equal area net plot of poles to planar measurements from a single foliation surface) due primarily to interference of D4 folding (see Phase Four below). The compositional layering accompanies this foliation in a position near parallel to it; this layering may be mildly continuous for a short distance (on the order of decimeters to a meter at most), but is streaky and

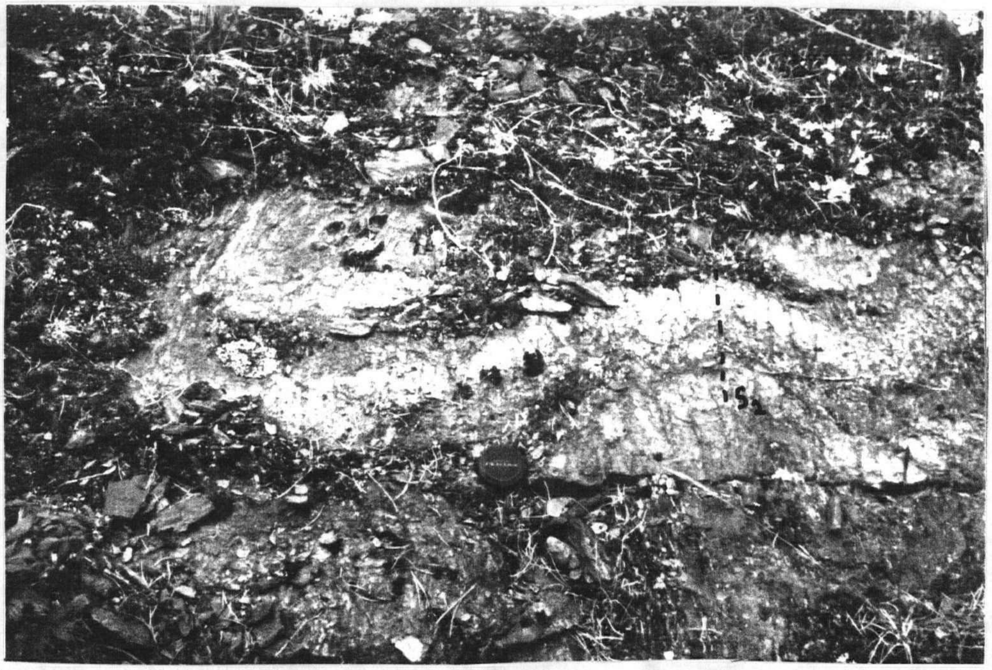
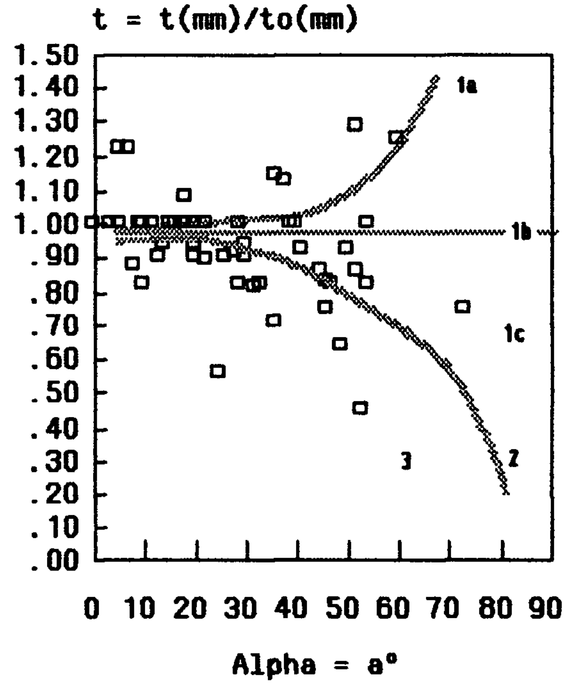


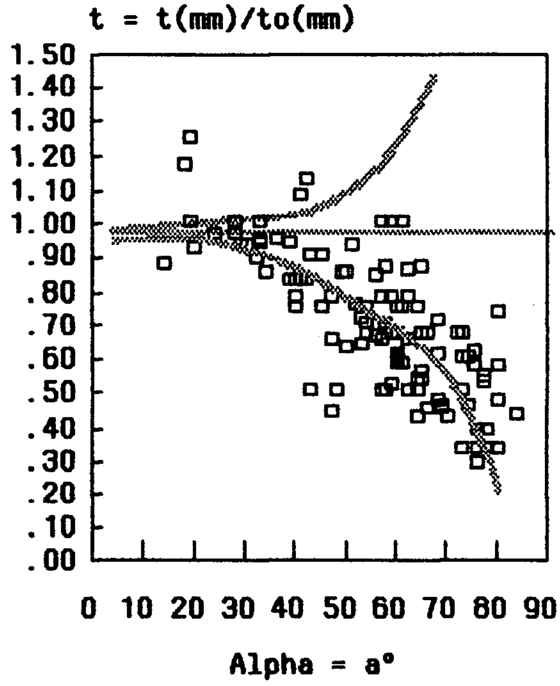

Figure 23a - Upright open to medium folds in interlayered phyllite/phyllitic siltstone; the sigmoidal shape of segments of siltstone unit between cleavage planes indicate shear along those planes; units drastically thin toward left {DIR-340, LOC-J40}


Figure 23b - Upright tight similar fold truncated on the right against planar foliated phyllite {DIR-350, LOC-J36}

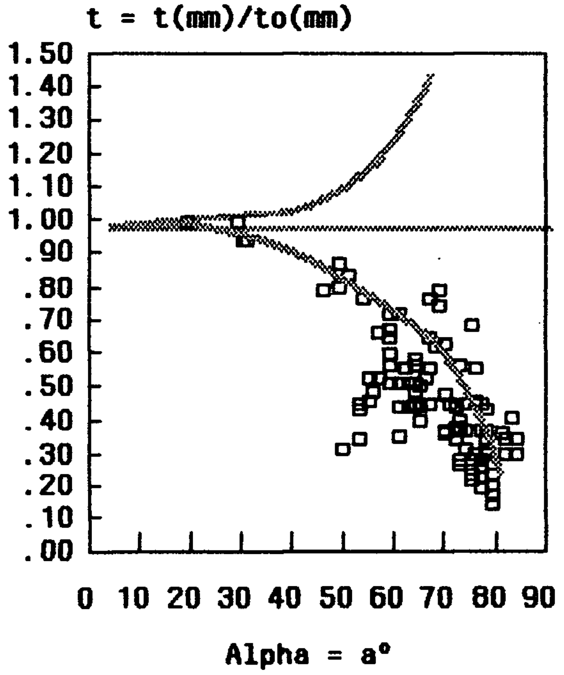
Figure 24 - t-alpha plots of D2 folds



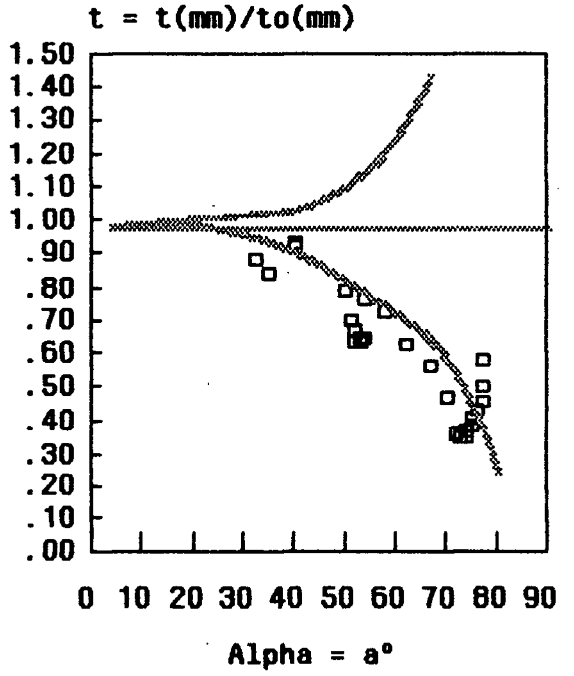

a - Open folds at J40, J89, J57, RZ8; (curves explained in Appendix C)




b - Medium folds at J41, J5, RZ5, RZ6, RZ7, RZ10




c - Tight folds from J26, J117, J36, J26b, J41b




d - Bassett/Stark pair taken from Plate 3, Cross Section 1

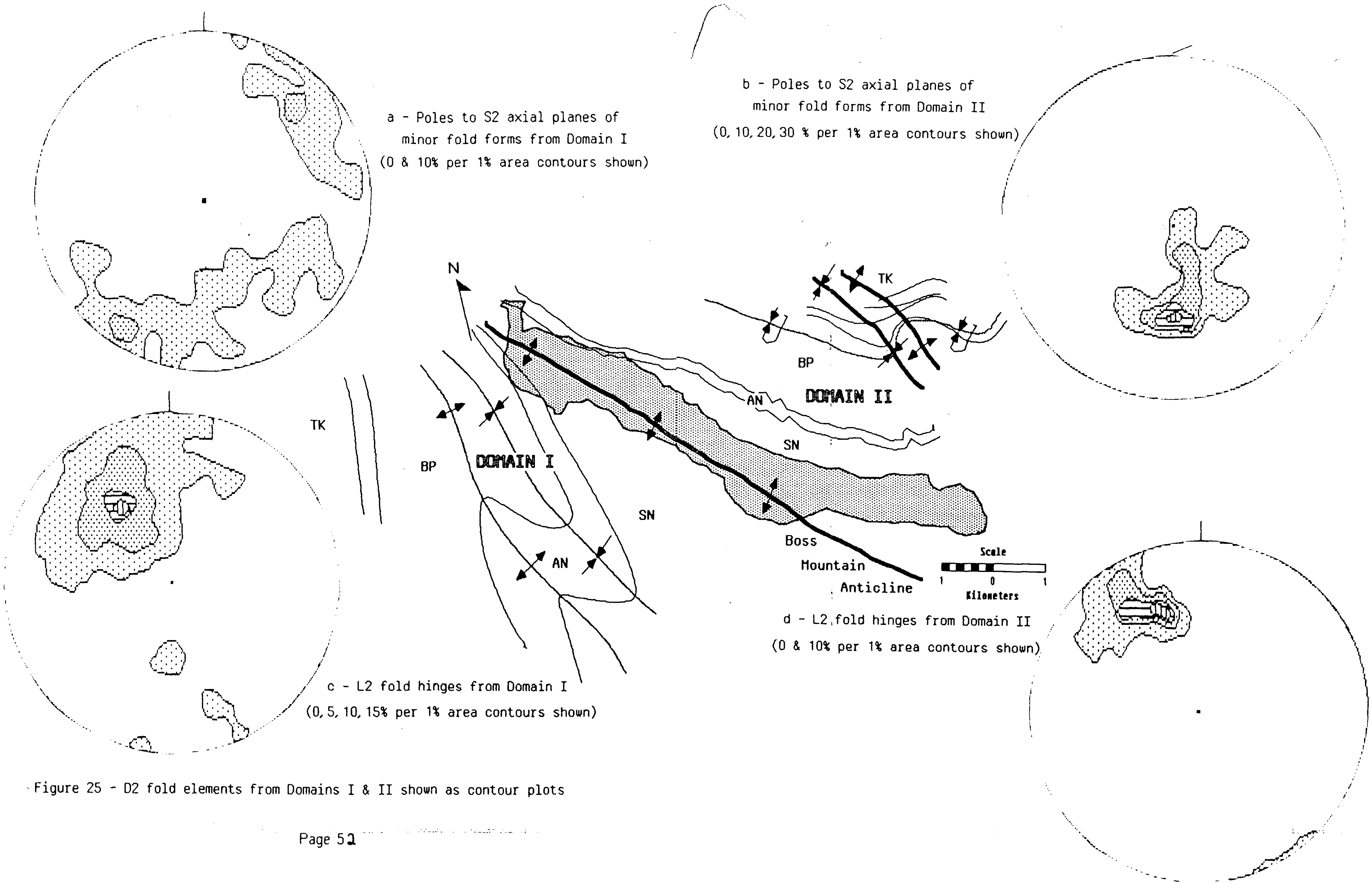



Figure 25 - D2 fold elements from Domains I & II shown as contour plots

Figure 26a - Recumbent open folds in phyllitic siltstone {DIR-295, LOC-J89}

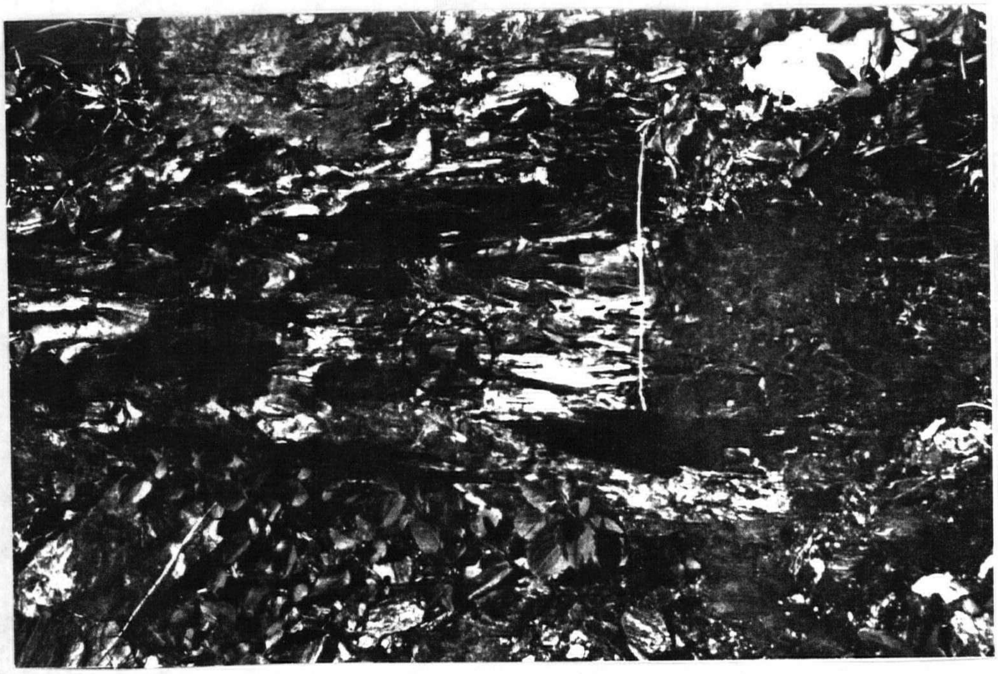


Figure 26b - Recumbent tight folds in phyllitic siltstone; note curved fold hinges ('sheath-like' fold form) {DIR-345, LOC-J171} discontinuous over all. Lensoid formation from boudinage of more competent subunits accompanies or makes up a substantial portion of this layering; the shape of these bodies can range from discs to small isolated fold hinges (Plate 6i) to continuous, though highly attenuated fold forms (one seen could be followed for 12 meters and had < 2 centimeter thick limbs). Occasionally the layering is repetitive enough to develop tight fold forms (Figures 23b, 26b) whose axial plane lies parallel to the main foliation.

This typical fabric (proportions are outlined in Figure 14) forms a matrix for volumetric regions where lithology is not as homogeneous. Here, layering tends to be more continuous (on the order of meters) and a strong cleavage occurs as the dominant D2 structural element (see Figure 23a). The layering shows different types of folded forms all with axial planes parallel to the S2({S1}) cleavage (see Figures 23a & 26a). The size of these folded zones was difficult to determine because of lack of sufficient exposures where they occur, but their shape is most certainly lens-like - the long dimension runs parallel to S2 cleavage and S2 foliation in the matrix. Groups of these zones (if we can assume that their long dimension is shorter than the average distance between exposures) appear to be distributed parallel to the major contacts, except in the vicinity of the Bassett/Stark antiform/synform pair (where they are near perpendicular to contacts).

D2 fold forms have been grouped into three types of forms: tight, medium, and open corresponding to the most significantly different levels of heterogeneity observed. Figure 24 shows t-alpha plots of each of these forms. The tight forms (24c) fall between the Class 2 to Class 3 categories, the intermediate forms (24b) are Class 1 to Class 2 folds, and the open folds (24a) fall into Class 1. The former two differ essentially by the amount of fold closure and degree of limb attenuation; in comparison to D1 folds, the tight folds are not so clearly isoclinal, though they do show quite similar values for limb attenuation. The relatively wide spacing that occurs between S2 cleavage surfaces of open folds causes more physical disruption of the layers than any appreciable limb thinning (Figure 23a); as a consequence these folds show relatively constant limb thickness.

A pictorial demonstration of the contrasting orientations of D2 deformational elements is presented in Figure 17 (also see Figures 23 & 26). Within each of the two Domains, S2 features (here represented by axial planes of D2 folds) show minor variability from a vertical orientation in Domain I and from a shallow northeast dipping orientation in Domain II. Contour plots of poles to these planes from Domain I (Figure 25a) indicate an approximate maximum in a vertical position; the spread of this data suggests that these planes alternate from steep east dipping planes with strikes from 110°-135° bearing to steep west dipping planes with strikes from 135°-170° bearing. Figure 25c shows the plunge of these folds to have an average orientation of 330°-345° trend, plunging 45°-50°. The Domain II plot (Figure 25b) shows a more constant orientation for S2, i.e. 80°-110° strike and dipping 45°-50° to the north and folds plunge 30°-40°and trend 335°-345°.

D2 structural elements have been visually effected by two of the later three deformations (i.e. D3 and D4). In Domain I, a combination of the D3 and D4 events is believed to cause the wavy form of S2 shown in Figures 22 & 25. D3 causes the strong sub-horizontal crenulations on S2, while D4 is responsible for near-vertical crenulations. This surface is seen in outcrop to be open to medium flexurally folded by D4 (Plate 61); Figure 31a demonstrates how poles to S2 spread out along a great circle whose pole approximates the placement of L4 fold hinges. Evidence of D3 folds of S2 in Domain I was lacking. Domain II contains excellent examples of D3 refolding of D2 forms (Figure 27 & Plate 6j). Figure 31b, c show

Figure 27 - Interference of recumbent tight phase two folds with upright phase three folds (to left near quartz vein) {DIR-317, LOC-J117}

combined data plots depicting this relationship; the data for Figure 31b was taken along the extent of the upper and lower Antler contacts that were often seen involved in phase three folding; the data for Figure 31c came from the area around Reggie and Alex lakes. Kinking and very mild folding of S2 (Figure 32) is attributed to the D4 event's effect in Domain II.

On the macroscopic scale the Basset/Stark fold pair in Domain I (Cross Section 1, Plate 3) and the repetition along the Antler (Figures 9b, 12) and Phyllite/Takla (Cross Section 2, Plate 3 and Figure 7c) contacts in Domain II are believed to be representative phase two structures. The form of the Antler Formation, as it appears in the Cross Section 1 (Plate 3), is shown as a t-alpha plot in Figure 24d; this data agrees reasonably well with the smaller scale tight to medium D2 fold forms(Figure 24b).

## Phase Three

A number of features represent the third phase of folding in the Crooked Lake rock units. The most obvious effect is that phase two structures drastically change their orientations from one side of Crooked Lake to the other; this has been interpreted as folding of D2 elements over the macroscopic Boss Mountain

Figure 28 - Upright open D3 folding of Antler/Eureka contact {DIR-325, LOC-J102}

Anticline. On the smaller scale, exposed contacts across Domain II often show an upright fold form (Figure 28) and phase two elements (S2 foliation and tight fold forms) are actually seen folded by this same type of fold form (Figure 27 and Plate 6j). In both domains, sub-horizontal to shallow-plunging crenulations on S2 are ubiquitous and occasionally associated with a near upright spaced cleavage (S3).

The basic form of D3 folds is shown in terms of a t-alpha plot in Figure 30c. The spread of data in this plot suggests that D3 folds are Class 1c folds at most. Plate 6k demonstrates the gradual change in form that is characteristic of D3 folding. This change in form was observed to occur in a direction perpendicular to the major contacts. Cross Section 2 demonstrates this form change with a parasitic fold that crops out in the vicinity of Reggie and Alex lakes.

Orientation of important D3 features is depicted in Figure 29a, b and 30a. A distinctive spaced cleavage is the most common D3 planar form found through both Domains I & II (Figure 29). Comparison of these surfaces with the axial planes of D3 fold forms from Domain II (Figure 30a) show them to be moderate to steeply-northeast dipping surfaces that strike to the northwest. Linear fabrics associated with D3 (Figure 29 c, d & 30b) vary in a regular fashion across the two Domains from NNW with a moderate plunge in Domain I to NW with a sub-horizontal plunge along the Antler contacts (also see Figure 31b, c) to NW with a moderate plunge near Reggie and Alex lakes.

The interference of D3 elements with younger events is not immediately clear, especially from outcrop analysis. It is possible that the change in plunge of D3 linear forms (compare Figures 31b and 31c) may be a D4 effect. The form suggested for the Boss Mountain anticlinal axial surface shown in Plate 2 is meant to show the same kind of D4 warping seen throughout the dominant D2 fabric across the area.

Besides the Boss Mountain Anticline, the only other macroscopic D3 form observed was the fold form shown in Cross Section 2 (Plate 3). The change of orientation that occurs to numerous D2 features (S2 foliations, fold forms) in this area is gradual and deliberate. Refolded fold forms and upright folds of contacts of a number of internal horizons are common in this area (Figure 30b).

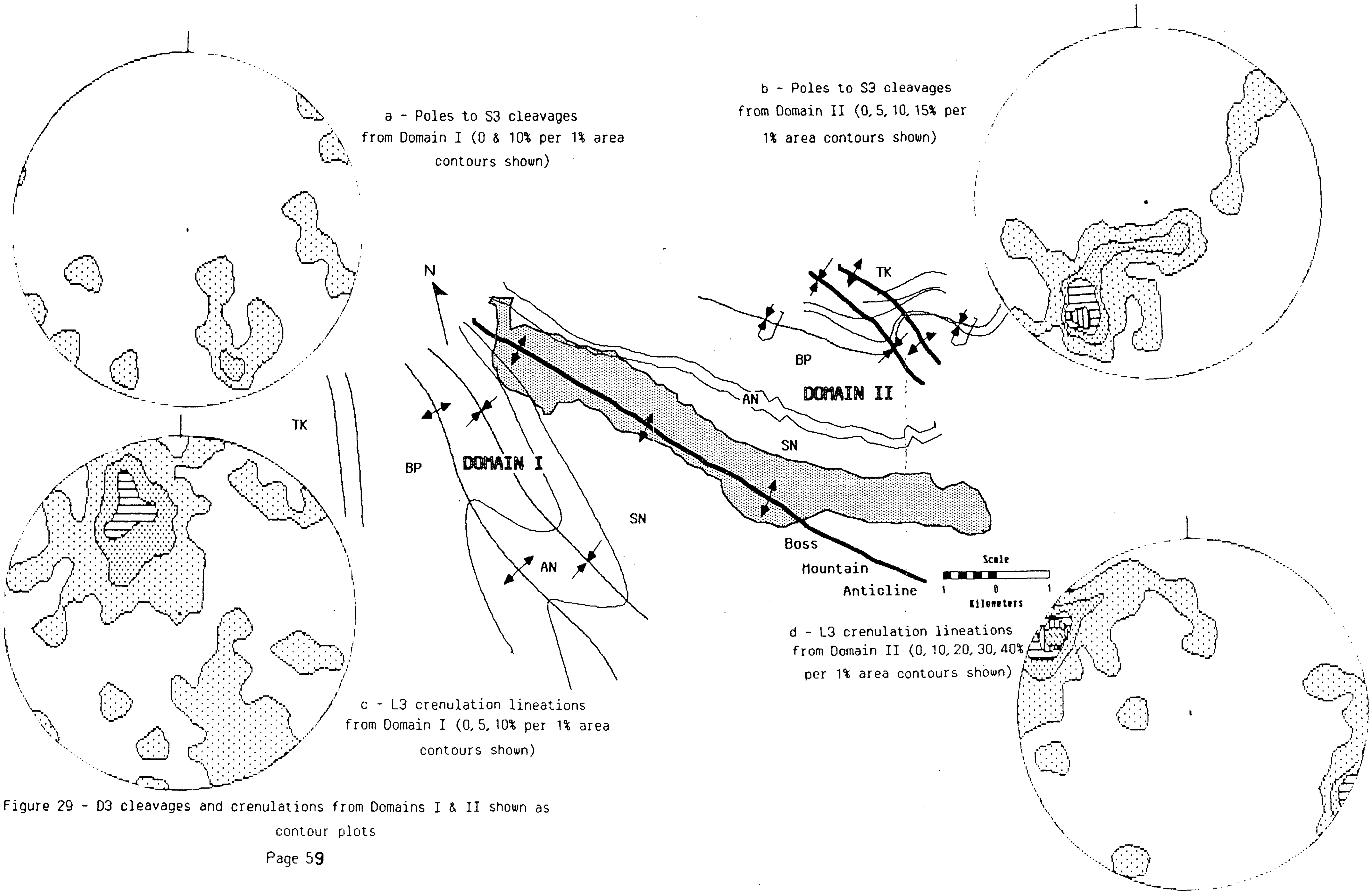
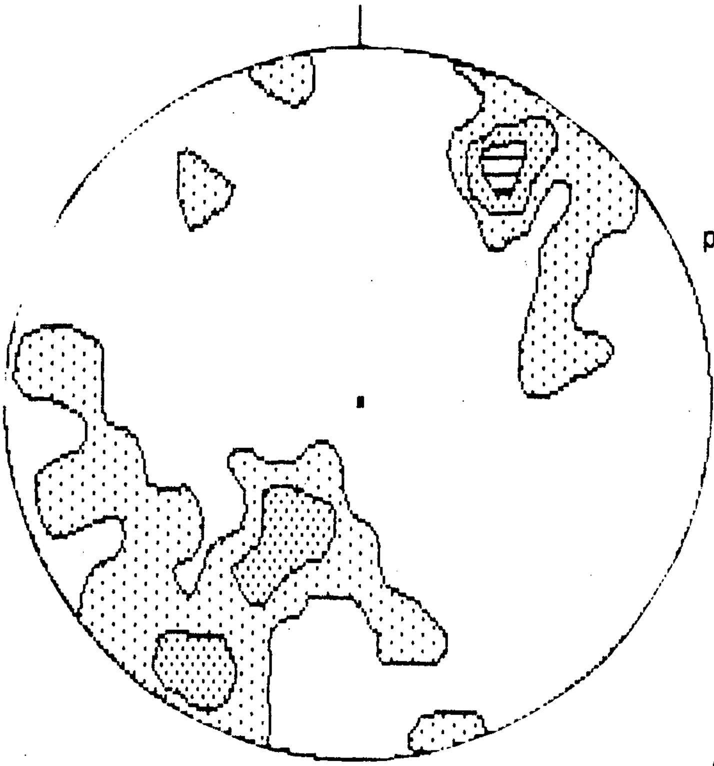
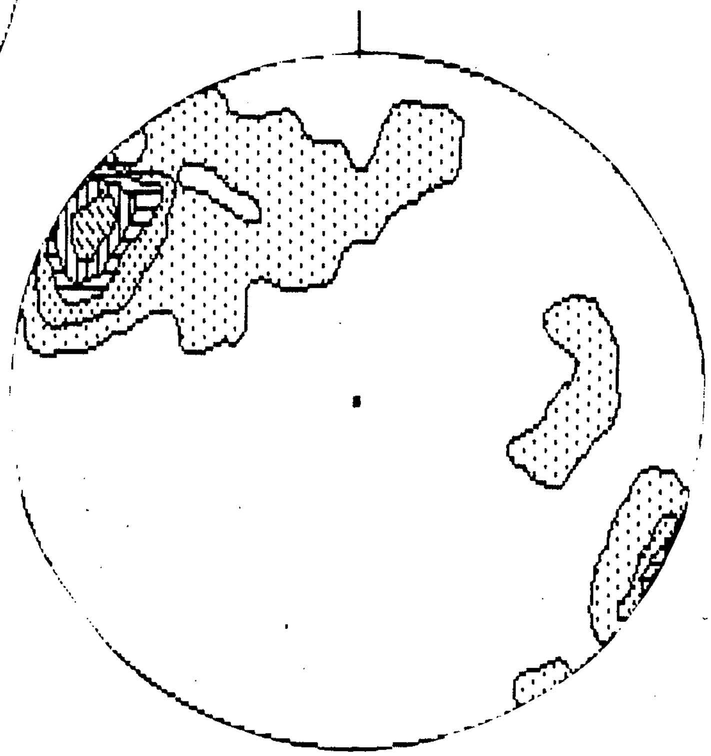


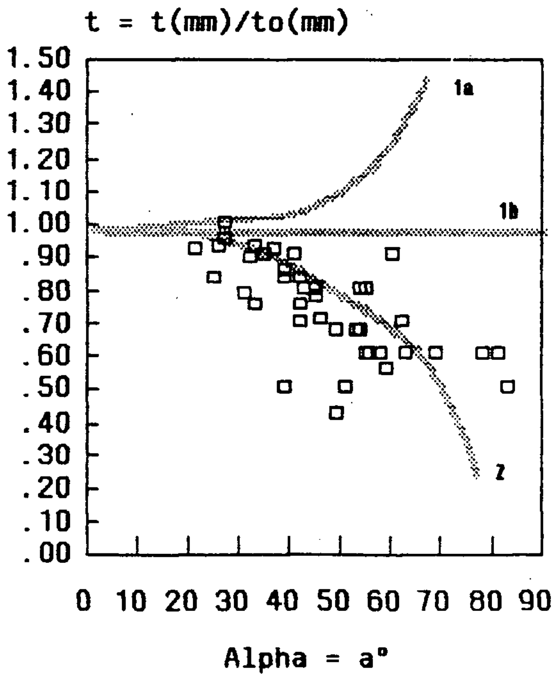

Figure 29 - D3 cleavages and crenulations from Domains I & II shown as contour plots



a - Contour plot of poles to axial planes of D3 fold forms from Domain II (0, 5, 10% per 1% area contours shown)



b - Contour plot of fold hinges to D3 fold forms from Domain II (0, 5, 10, 15, 20% per 1% area contours shown)




c - T-alpha plot of D3 Fold Forms C.L. Phyllite J98, J104, J117; curves explained in Appendix C

Figure 30 - Characteristics of D3 minor fold forms

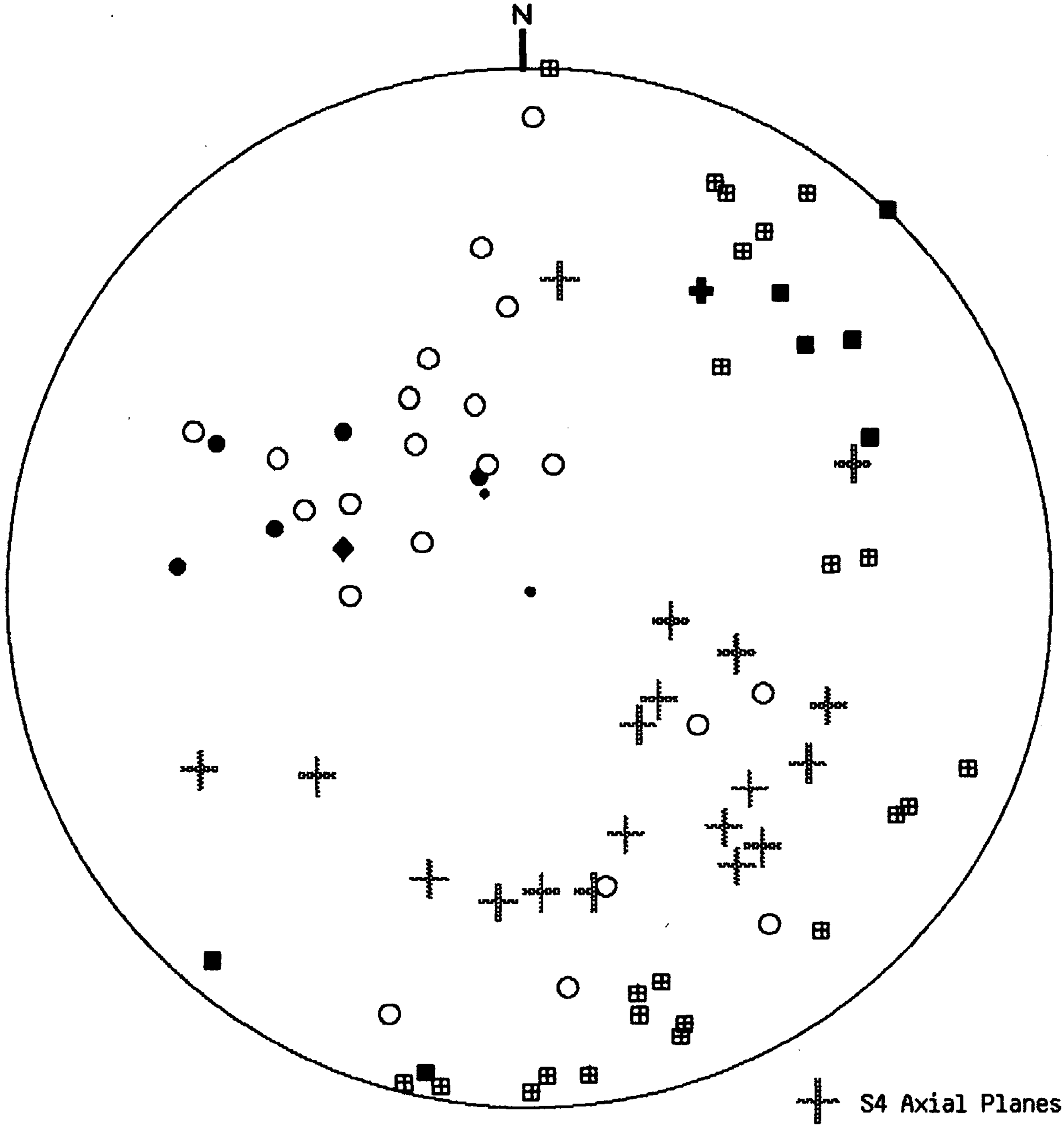



Figure 31a - Combined data plot (equal area) to show typical spread of poles to S2 foliation and axial planes and L2 fold hinges in relation to D4 features from Domain I (D1 features included)

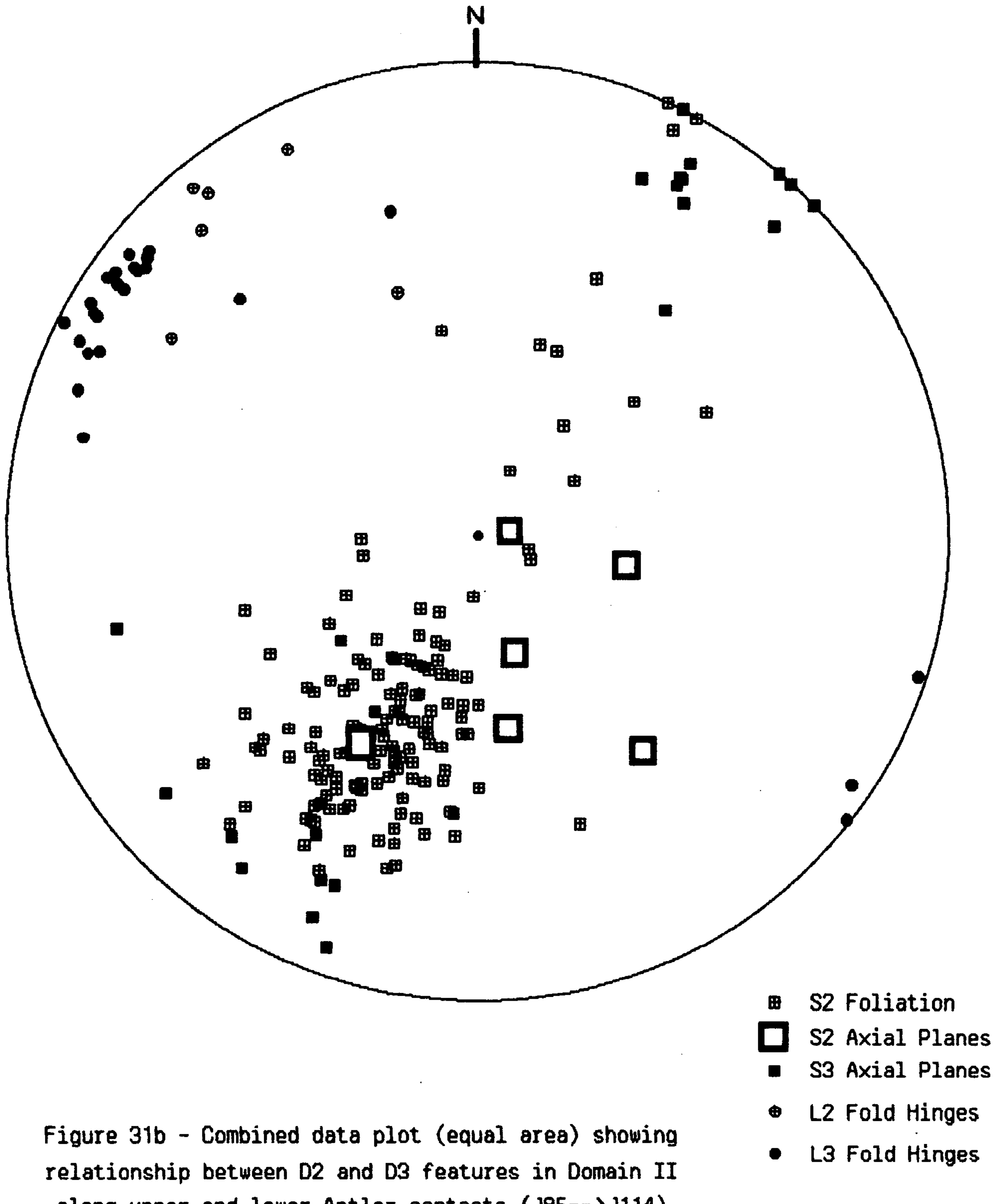



Figure 31b - Combined data plot (equal area) showing relationship between D2 and D3 features in Domain II along upper and lower Antler contacts (J85-->J114)

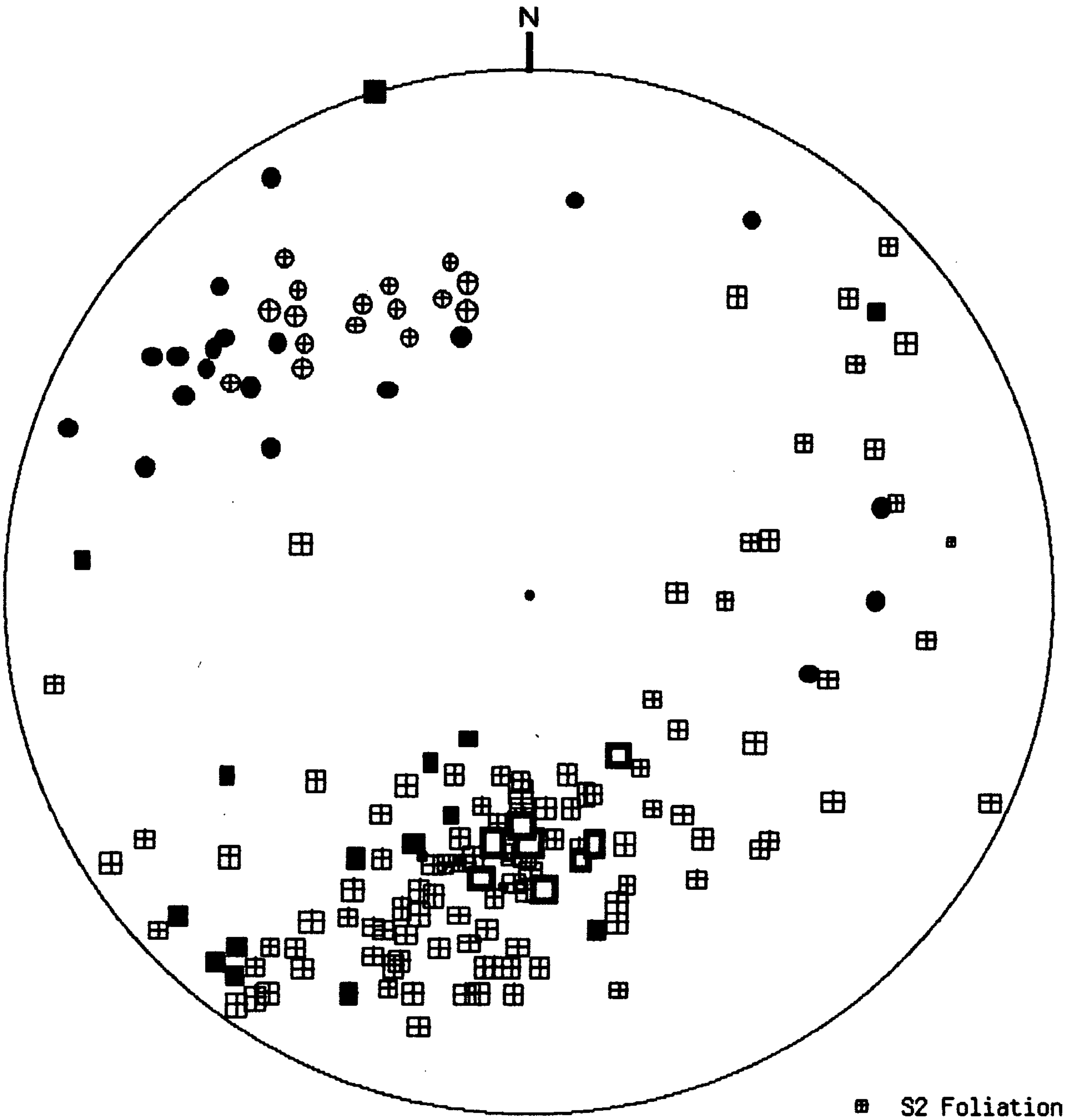



Figure 31c - Combined data plot (equal area) showing relationship between D2 and D3 features in Domain II in the northeastern-most part of the map area (J142-->J171)


Figure 32a - Double kink of main foliation (S2) in Crooked Lake Phyllite; note change with depth to very open folding {DIR-060, LOC-J77}

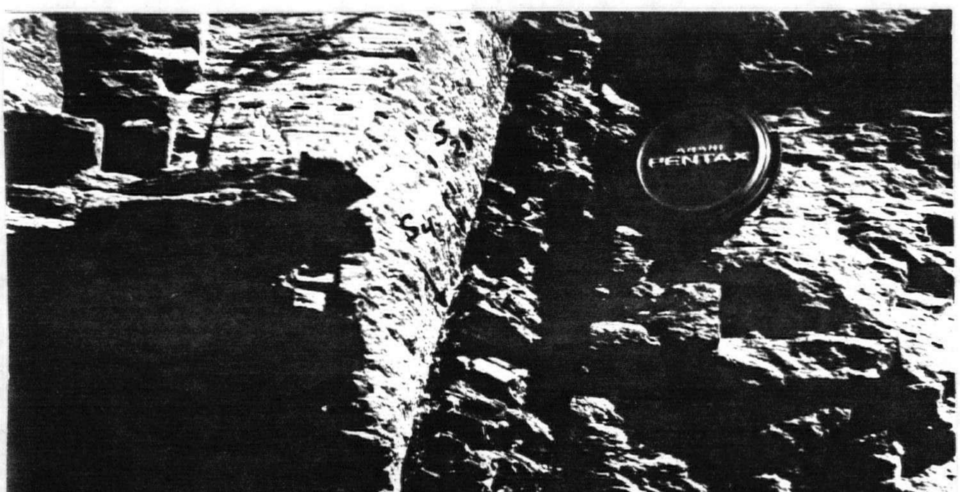



Figure 32b - Clockwise kink in Crooked Lake Phyllite; zone is 3-4 cm wide and grades into very open folding below {DIR-005, LOC-J84}

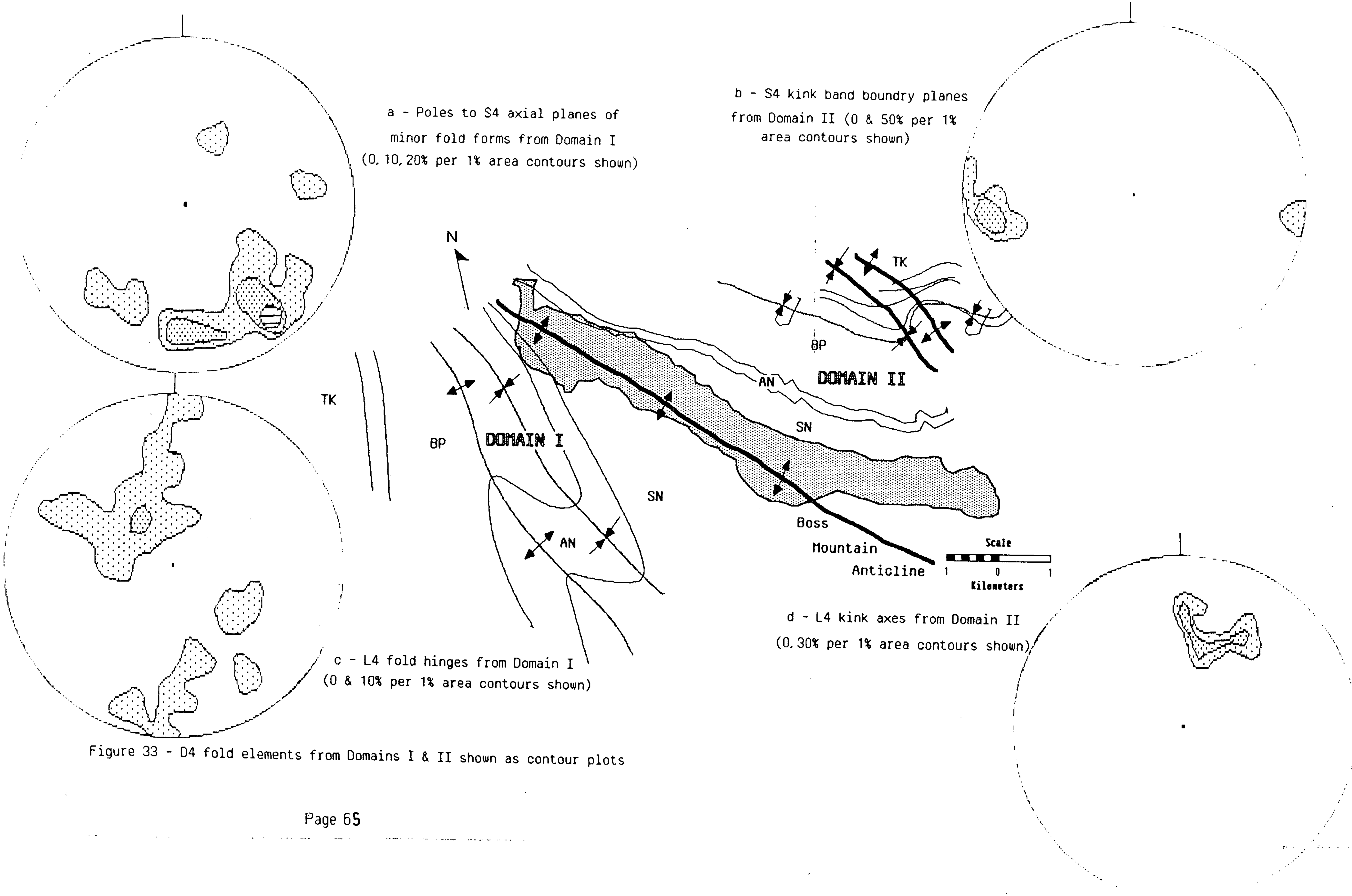
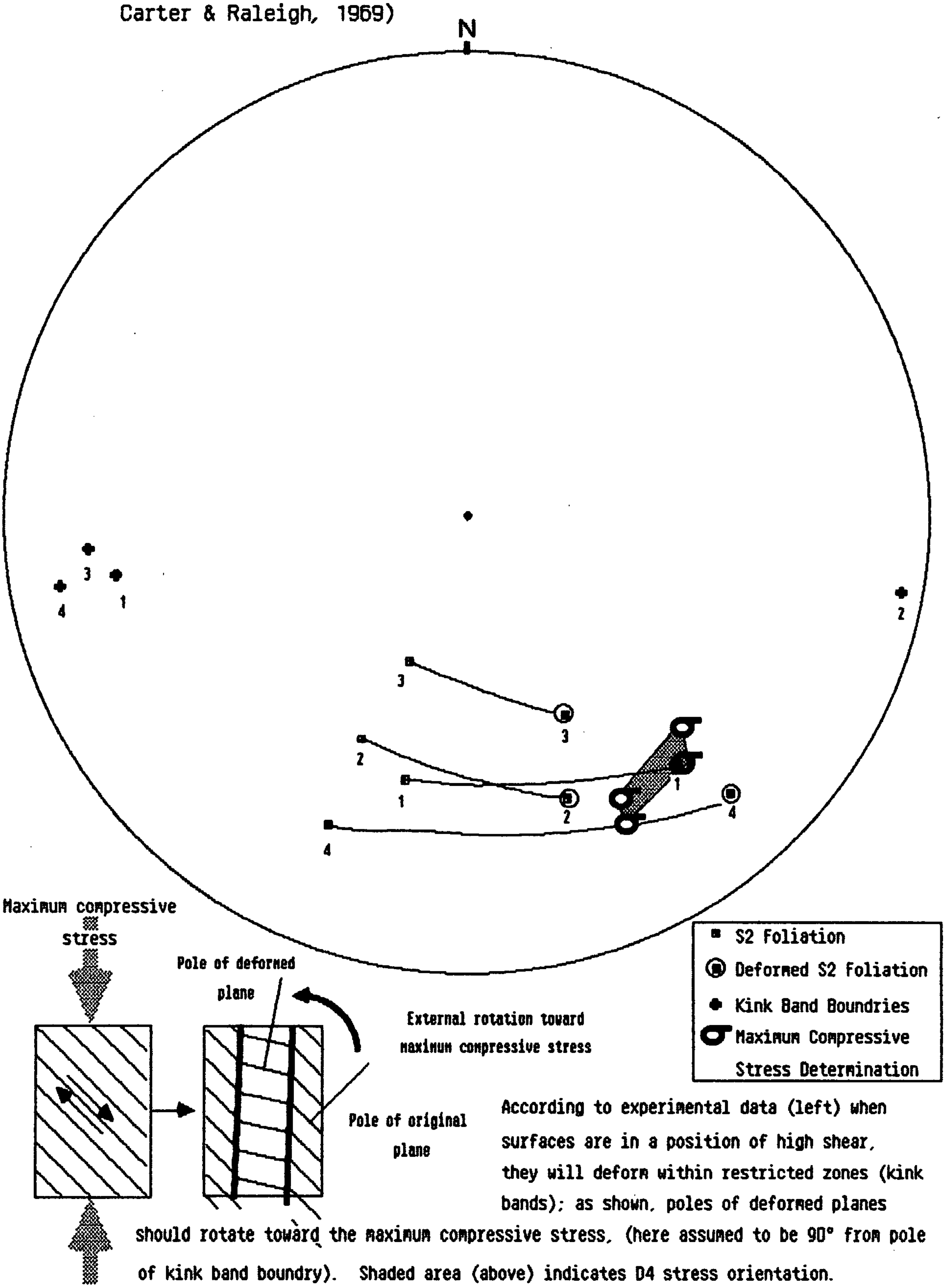



Figure 33 - D4 fold elements from Domains I & II shown as contour plots

Figure 34 - Stress determination of D4 episode from deformed S2 foliations (from Carter & Raleigh, 1969)




According to experimental data (left) when surfaces are in a position of high shear, they will deform within restricted zones (kink bands); as shown, poles of deformed planes should rotate toward the maximum compressive stress, (here assumed to be 90° from pole of kink band boundry). Shaded area (above) indicates D4 stress orientation.

## Phase Four

The minor forms resulting from the fourth deformation differ largely as a function of the fabric within each of the domains. In Domain I, where the S2 foliation is close to vertical, phase four folds are buckle folds (often occurring as conjugate pairs) with steep hinges (55°-65° to the NW) and near vertical axial planes striking ENE (Figure 33a, c & Plate 61); these flexural style folds quickly die out in amplitude within a few meters at most. To the northeast in Domain II, conjugate kinking of the S2 foliation is the clearest recognizable D4 effect. The plunge of very gentle folds associated with these kinks is gentle to the northeast (like the dip of the foliation) and the kink bands are steep to vertical and strike N (Figures 32a, b) and are never more than a few centimeters in width.

Figure 34 shows a determination of possible D4 maximum compressive stress orientations using the technique of Carter & Raleigh, (1969) for kink banding. Relative to the present orientation of the S2 fabric in Domain II the D4 stress field should be oriented with the maximum compressive stress slightly inclined toward the south east.

## Late Brittle Phase

Late high angle faulting of the Antler Formation contacts has been mapped by Campbell, R.B. (1978) and Campbell, K.V. (1971) to the south near to the nose of Eureka Syncline (the pair of the Boss Mountain Anticline). It appears as though the northwest side has moved southwestward relative to the southeast side. The orientation of this feature is similar (i.e. vertical, striking NE) to the maximum shown for fractures in Domain I (Figure 35a). To the northeast an entirely different maximum, shown in Figure 35b, turns out to be associated with conjugate

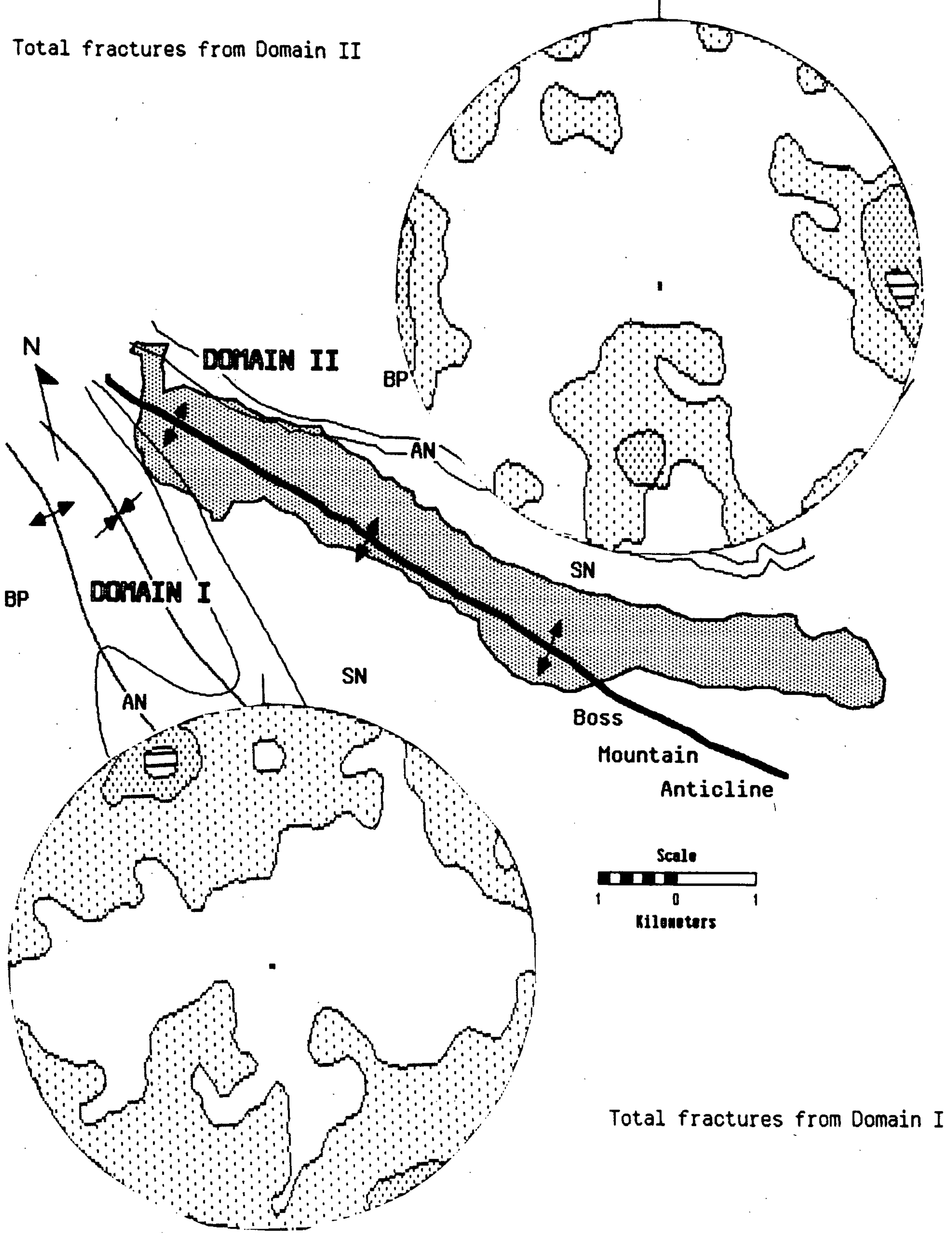



Figure 35 - Contour plots of poles to fractures from Domains I & II
(contours represent 0, 5, 10% of pts per 1% stereonet area)

fracture pairs found throughout Domain II; the orientation of these pairs very closely parallels these two planes. Other fracture sets contained within these plots can easily be related to weaknesses in the rocks due to some or all of the earlier deformations.

Northwest trending faults have been located in adjacent regions (Montgomery, 1978; Fletcher, 1972) with some degree of displacement. In fact, the linear trend of Crooked Lake combined with the extremely steep slopes to the northeast is suggestive that at least a prominent fracture zone may be positioned there. It is seriously doubted, though, on the basis of the stratigraphic continuity of the Crooked Lake units that any considerable separation has taken place in this area.

## Structural Summary

Emplacement of the Antler Formation onto the Snowshoe may or may not have been associated with D1 folding. The present author has chosen to present this possibility in the schematic summary (Figure 36), but the reader must bear in mind that data for this event is limited. It is also possible that each unit carried with it a unique episode of deformation to their coupling location. It seems that the first deformation has not affected the surface separating the Snowshoe and the Antler, which leads the present author to believe that this surface is either contemporaneous with or post-dates D1 folds (a thrust fault genesis could explain this temporal relationship).

An hiatus presumably separated the earliest event affecting the Snowshoe and Antler Formations from the eventual emplacement of the three youngest units. Again it is not known whether this emplacement was associated with deformation or not (e.g. the early 'open folding' phase of D2 deformation could have formed during

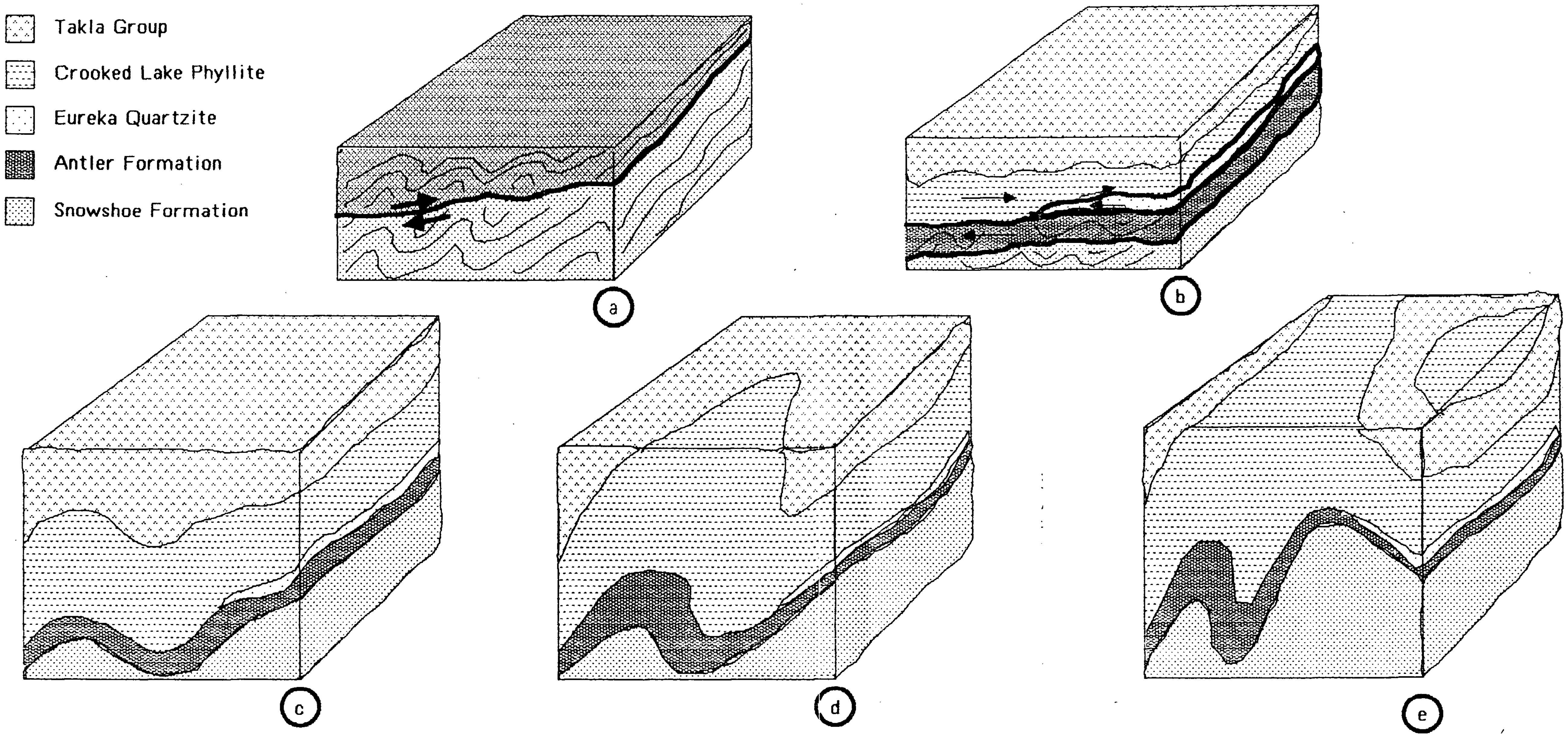



Figure 36 - Schematic structural summary. (a) Antler Formation is emplaced on top of the Snowshoe Formation with attendant D1 folding. (b) The upper three units are emplaced atop the lower two presumably at a higher level of the crust (no associated deformation); thrust splicing may account for the pinching out of the Eureka Quartzite. (c) Early stage of D2 deformation develops parallel folds. (d) As temperatures and degree of deformation increases, parallel folding gives way to similar folding, and considerable limb thinning of units. (e) D3 folding produces present day pattern

emplacement). It is clear that the D2 deformation has affected all major contacts which sets a pre or syn-D2 date on the time that the five units have shared a common history.

The second deformation represents an extreme in the kinematic history of the area. Parallel folding of the rock units (as evidenced by open fold packages) eventually gave way to more extreme flattening, shear folding, and intense foliation development(Figure 36 c, d). Obviously this event occurred at a time when overall tectonic conditions were changing, (the most important of which was probably increase of temperature). The major compressive stresses causing these effects were most likely directed from an orientation plunging slightly toward the northeast; this orientation is suggested by the vergence shown by the D2 Basset/Stark pair when they are unfolded about an average D3 fold axis to the northwest.

The subsequent D3 event is mainly evidenced by the gross change in orientation of D2 elements between the two Domains (Figure 36e). In other areas, to the south and west (Montgomery, 1978; Murphy and Rees, 1983) a similar orientation change for contemporaneously formed elements has been attributed to changing deformational style with depth in the lithologic pile (i.e. flattening of fold forms with depth). In the present study, stratigraphic continuity forces a different interpretation from the faults separating low and high grade zones of Montgomery, (1978) and the thickness of rock considered combined with east/west variation (instead of north/south) rules out the applicability of Murphy and Rees', (1983) findings to the Crooked Lake area.

Unfortunately, there remains some significant ambiguity as to how the proposed D3 event consistently effects D2 elements across the two Domains. The placement and orientation of the Boss Mountain Anticline and minor fold forms from Domain II are relatively consistent with each other; it should follow that D3 forms elsewhere are similarly oriented. What we see, though, in Domain I are fold forms with the appropriate placement and orientation, but with associations that very strongly suggest these folds are of the same generation as those folded by D3 in Domain II, i.e. D2 forms! The present author suggests that an unusual original orientation for D2 fabrics within D3 deformation fields may have allowed certain parts of that fabric (Domain I) to rotate into positions that cause strain to be taken up by tightening of earlier features rather than creating new ones. D3 forms are believed to only be represented in Domain I by cleavages, crenulations, and the wavy form of the S2 foliation.

The D3 event is believed to result from a compressive maximum stress directed from an orientation slightly inclined toward the southwest; the evidence for this is from the vergence of the Boss Mountain Anticline/Eureka Syncline pair as shown on cross sections of Campbell, K.V. (1971). The level temperature (and possibly pressure) existing during this event were certainly much lower than during the previous episode; in thin section, it is rare to see growth of chlorite and/or muscovite parallel to a S3 cleavage (see METAMORPHISM below).

The fourth episode represents an entirely different stress field than could be postulated for the earlier events, i.e. maximum compression from the southeast. Its effect differed between the two domains largely because of the orientation of the different fabrics; in Domain I foliations and cleavages were favourably positioned for folding to take place. In Domain II foliations presumably lay at an angle to the maximum compressive stress that forced a large amount of shearing and local development of kinking; had this event been longer lasting, it is possible that more extensive kink development across Domain II would have resulted.

The last major event to have deformed the Crooked Lake rock units has been associated with fracture surfaces that locally occur together as a conjugate set. Surprisingly each Domain is associated with one of the pair; Domain I contains the northeast striking set and completely lacks representatives of the other (see Figure 35a), whereas Domain II contains mostly the north striking set. Since faults in the area mostly belong to the northeast set, it is the most likely surface along which movements and breaking could have occurred. Domain II, however, has provided the D5 stress field with a preexisting alternative (D4 kink band boundary planes), which just happens to be a conjugate to the northeast set. The likely stress field to produce these surfaces is with maximum compressive stress directed toward the NNE and is indicative of trancurrent faulting (Anderson, (1951)).

# METAMORPHISM

## Introduction

The process of metamorphism is intrinsically related to deformation in a number of important ways. In the first place both are dependent on externally controlled factors such as pressure and temperature and as a consequence should show a systematic variation at different positions within gradient fields of these two variables (pressure includes depth within the lithologic/structural pile). Next, it has been observed that the physical effects of metamorphism and deformation often result in the same features, (e.g. foliations are formed of metamorphically grown mica or amphiboles), and in the case of both processes, these effects are seen to change as a result of lithologic variation within the existing bodies of rock. Finally, time bounds the beginning and end of discrete metamorphic and/or deformational events and influences certain rates important to the completion of a process or generation of effects of a process.

Metamorphism, in general, is concerned with the series of possible reactions that can occur to any composition type from the upper limit of diagenetic processes to the pressures and temperatures where melting occurs (see Figure 37); this includes all reactions that involve solid phases with or without a vapour phase. These reactions are, of course, subject to the laws of kinetics that allow for the occurrence of deep-seated mineral assemblages at the surface of the earth, but as far as 'normal' prograde metamorphic processes are concerned time is usually not a significant factor so the theory of thermodynamic equilibrium can safely be assumed. The two most important factors used to prove the existence of a possible reaction (and accompanying equilibrium) are the textures within and among existing mineral phases and

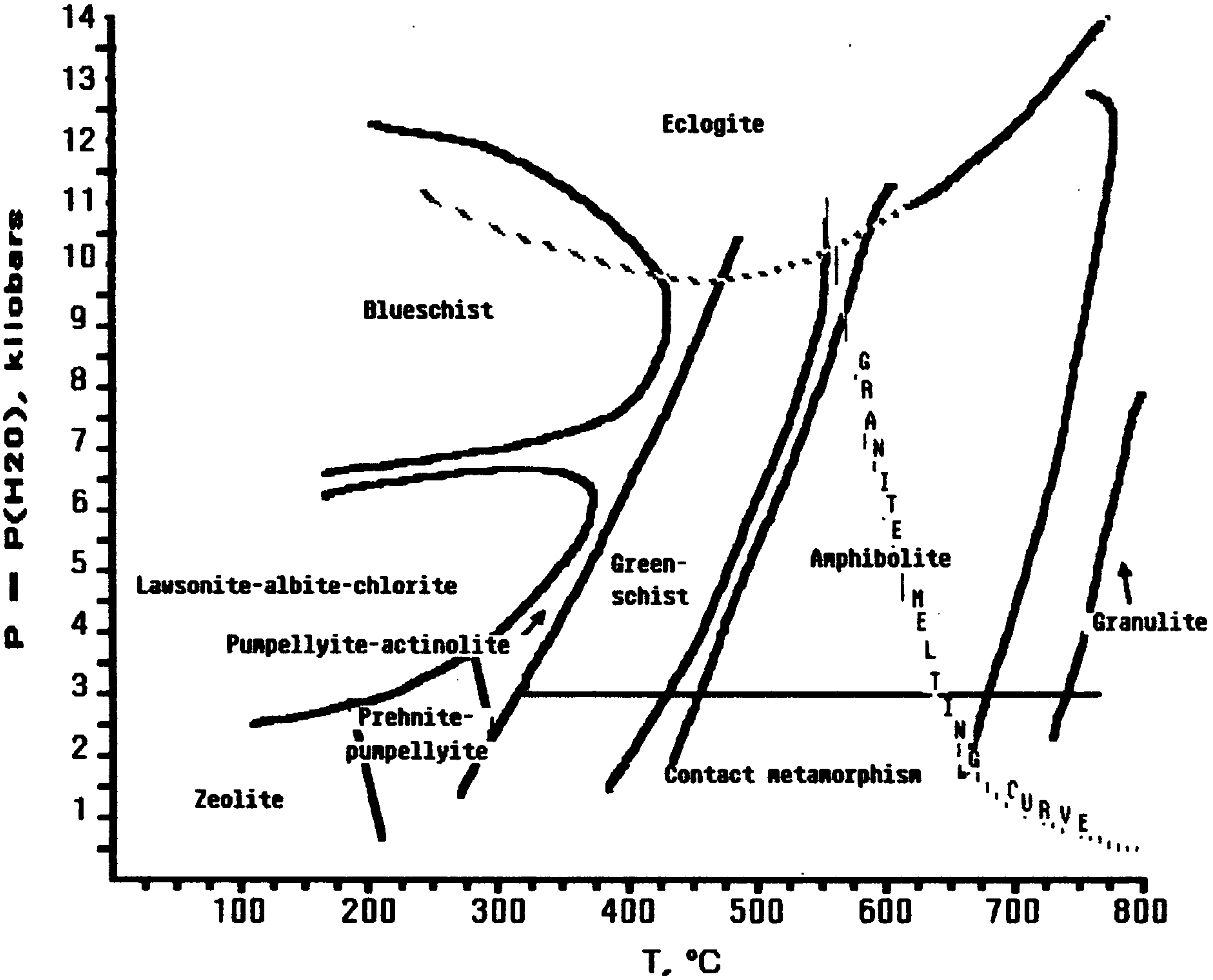



Figure 37 - Pressure and temperature ranges for metamorphism and facies subdivision of the 'P-T' field (adapted from Turner [1981] p.420)

observation of the number of existing phases that should be in accord with the phase rule:

$$F = C - P + 2$$

(F is the degrees of freedom in pressure/temperature space [this should be one in the case of a single reaction], C is the number of components in the system, P is the number of phases in the system, and the 2 refers to the two externally controlled factors, pressure and temperature). The physical significance of

# TABLE II-A
## DISTRIBUTION OF MINERAL ASSEMBLAGES IN DOMAIN I OF THE CROOKED LAKE AREA

| Unit | SW → NE |
|---|---|
| TAKLA | Cc-Qtz-Chl-Hnbd-Ep-Musc-Ab |
| | Hnbd-Ep-Cc-Qtz-Musc-Ab |
| | Cc-Ep-Chl-Qtz-Ab-Act |
| | Act-Chl-Qtz-Cc-Ab |
| | Chl-Qtz-Ab |
| CROOKED LAKE PHYLLITE | Chl-Graph-Qtz-Musc |
| | Musc-Qtz-Chl-Ank |
| | Cc-Chl-Graph-Qtz-Musc |
| | Musc-Chl-Qtz |
| | Py-Qtz-Kspar |
| | Chl-Gn-Staur-Ilm-Musc-Qtz |
| | Chl-Musc-Qtz-(Graph) |
| | Qtz-Musc-Ank |
| | Musc-Ank-Qtz-Chl |
| | Ilm-Graph-Chl-Qtz-Musc |
| | Ilm-Chl-Musc-Qtz-Graph |
| ANTLER | Mgt-Chl-Qtz-Ab |
| | Musc-Bio-Chl-Ep-Olig |
| | Py-Musc-Qtz-Ank |
| | Ep-Ilm-Bio-Olig-Chl-Qtz |
| | Ep-Ilm-Chl-Cc-Qtz-Olig |
| | Qtz-Mgt-Ep-Chl-Cc-Ab |
| | Chl-Ep-Qtz-Cc-Ab |
| | Cc-Chl-Ep-Ab-Hnbd/Act |
| | Cc-Mgt-Qtz-Chl-Hnbd-Ab-Ep |
| | (Bio)-Ep-Hnbd-Mgt-Chl-Qtz |
| | Hnbd-Ab-Chl-Qtz-Ep |
| | Mgt-Cc-Chl-Ep-Hnbd/Act-Qtz |
| | Cc-Serp-Opx-Ol |
| | Chl-Cc-Qtz-Ab-Ep |
| | Mgt-Hnbd/Act-Chl-Ep-Qtz-Ab |
| | Chl-Felsic-Ep-Hnbd/Act |
| | Hnbd-Chl-Ep-Qtz |
| SNOW SHOE | (Ands)-(Bio)-Musc-(Chl)-Qtz |
| | Qtz-Musc-Cc |
| | (Olig)-(Chl)-(Perth)-Musc-Bio-Qtz |

NOTE: The vertical lines in these Tables are meant to designate the relative placements of assemblages or groups of assemblages on an hypothetical section line across the specific Domain.

# TABLE II-B

## DISTRIBUTION OF MINERAL ASSEMBLAGES IN DOMAIN II OF THE CROOKED LAKE AREA

NW → SE

| | |
|---|---|
| TAKLA | Qtz-Hnbd-Ep-Chl-Ab<br>Chl-Qtz-Hnbd-Ep-Ab<br>Opaq-Chl-Qtz-Ab |
| CROOKED LAKE PHYLLITE | Hnbd-Ep-Bio-Felsic-Act<br>Bio-Ep-Act-Felsic<br>Musc-Py-Ab-Qtz-Cc<br>Musc-Cc-Ank-Ep-Ab-Qtz<br>Chl-Musc-Qtz<br>Chl-Musc-Qtz-Graph<br>Musc-Qtz-Chl-Ank<br>Chl-Musc-Qtz-Graph<br>Chl-Graph-Qtz-Musc<br>Graph-Chl-Qtz-Musc<br>Ctd-Ilm-Chl-Musc-Ands-Qtz<br>Chl-Ctd-Ilm-Graph-Ands-Qtz-Musc<br>Ctd-Ilm-Gn-Chl-Graph-Ands-Musc-Qtz<br>Gn-Ilm-Ctd-Musc-Chl-Qtz<br>Chl-Musc-Qtz-Graph<br>Graph-Chl-Cc-Qtz-Musc |
| EUREKA QZTITE | Opaq-Chl-Musc-Bio-Olig-Qtz<br>Ep-Hnbd-Bio-Qtz<br>Gn-Mgt-Chl-Musc-Bio-Qtz |
| ANTLER | Ilm-Ep-Parg-Ab-Chl-Bio-Hnbd-Qtz<br>Cc-Qtz-Ep-Chl-Ab-Hnbd<br>Ep-Ab-Opaq-Qtz-Hnbd<br>Opaq-Chl-Ab-Cc-Hnbd-Qtz<br>(Ands)-Act-Clz-Chl-Qtz<br>Cc-Ands-Qtz-Clz-Chl<br>Ep-Ands-Hnbd<br>Ands-Act-Clz<br>Ep-Felsic-Hnbd<br>Felsic-Clz-Act |
| SNOWSHOE | (Ilm)-Bio-Musc-(Olig)-Qtz<br>Bio-Musc-Qtz-(Feld)<br>(Olig)-(Bio)-Musc-Qtz<br>(Musc)-(Gn)-Bio-Qtz<br>Qtz-Musc-Cc<br>Qtz-Ep-Hnbd<br>Gn-Bio-Musc-Qtz-Ands |

reactions as surfaces and planar-like volumes can be taken into account by detailed sampling and comparison of samples of similar to equal composition type.

A quantitative estimate of the pressures and temperatures attained during one or more metamorphic events can be estimated by identifying or inferring reaction assemblages in thin sections or in the field and correlating these findings with work done on these same reactions in the experimental petrology environment (this will include theoretical thermodynamic determinations as well as reversal equilibria experiments). Not all composition types can be expected to be useful in this regard for some may show minimal changes outside of textural readjustment to the local stress conditions, while other types may undergo repeated mineralogical and textural transformations the complexity of which can hardly be expected to be reproducible in the laboratory environment. In short, one is faced with the dilemma of choosing to observe composition types that are suitably reactive to provide meaningful reaction data, on the one hand, while keeping reactions and assemblages as simple as is warranted by current theoretical and experimental research.

Ultimately the study of the metamorphic history of an area should yield a qualitative statement of the relationship between metamorphic and deformational events. This has been accomplished, in the present study, by relating growth of minerals as observed in thin sections to the development of structural features known from the outcrop scale. Metamorphism is believed to coincide with the first three deformational events (see Figure 50), occurring as three distinct pulses of metamorphic activity (M1, M2, and M3, with respect to oldest units).

Assemblages characteristic of the Crooked Lake units are outlined in Table II-A,B (note: mineral names given in 'least-to-most' format); the present author has chosen to groups these assemblages into five major compositional types (quartzo-feldspathic, pelitic, basic, calcareous, ultramafic) that correspond to those often cited in the metamorphic literature, (Turner [1981]; Miyashiro [1973]). The following is a detailed treatment of the assemblages corrsponding to each compositional type with consideration given particularily to possible reactions and experimental supporting evidence; detailed petrologic information can be found in Appendix A.

## Quartzo-Feldspathic Type

This compositional type is characterized by an abundance of quartz and feldspar since rocks of this type are usually derived from acid igneous rocks or quartzose sedimentary rocks. The Snowshoe and micaceous quartzite are composed almost entirely of this composition type; the other three units contain moderate to minor amounts of quartzo-feldspathic rocks.

The most common assemblage seen in this composition domain is muscovite-quartz (± chlorite ± biotite ± garnet ± feldspar) (Figure 38). The two main minerals muscovite and quartz show little change across the field area except in relative abundance (probably reflecting heterogeneity of subunits) and are known to occur over a wide range of pressures and temperatures (from upper zeolite to middle amphibolite facies; Miyashiro, 1973). The occurrence of chlorite, garnet, and biotite probably represent compositional variation, though the preferential appearance of chlorite in some localities and chlorite-garnet- biotite in others could be taken as an indication of changing grade. Chlorite seems to be the sole mafic mineral in quartzofeldspathic rocks above the Eureka Quartzite and the Antler Formation, whereas in the rocks below and especially toward the east and southeast biotite and garnet

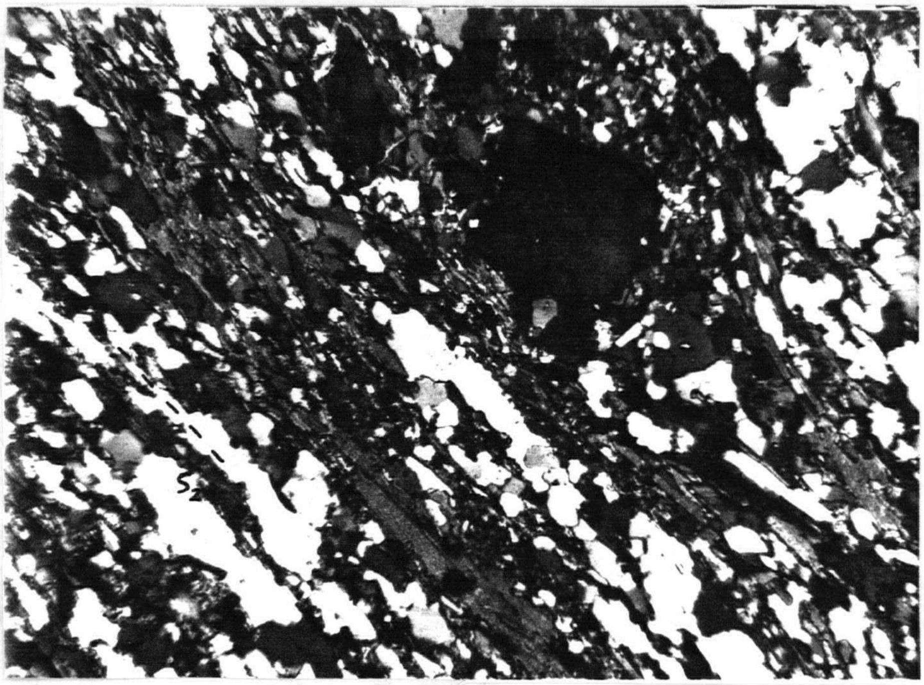


Figure 38a - Bio-qtz schist with minor muscovite and porphyroblast of garnet; micas and 'cryptocrystalline' banding (felsics?) define S2 foliation {cross-nicols inserted, X12.5, LOC-RZ10}

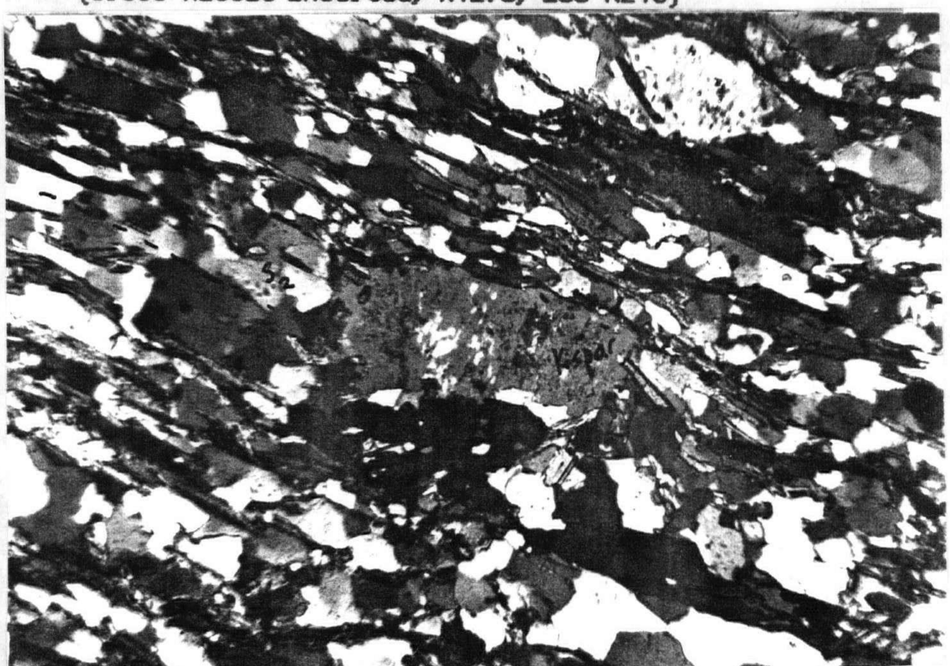


Figure 38b - Musc-bio-qtz schist with garnet and K-spar porphyroblasts; K-spar is aligned with S2 foliation defined by micas {cross-nicols inserted, X12.5, LOC-RZ10} are of increasing importance. Reactions involving the destruction of chlorite and subsequent formation of biotite are typical of the upper greenschist facies and garnet starts to form at the greenschist/amphibolite transition (Turner 1968, 1980).

Plagioclase feldspar is exclusively found in the groundmass with quartz. In Domain I, all quartzo-feldspathic units above the Antler Formation have albite as the sole plagioclase, whereas plagioclase in similar units found at the base of or below the Antler were found to range from An22 to An24. Two points of caution must be made, however. Firstly, in terms of the reaction that may be responsible for this change:

albite + epidote = oligioclase + epidote

clinozoisitic epidote is not consistantly found to occur with all of the observed plagioclases, and secondly there is a very large gap (1 to 3 km thickness) between albite-bearing and oligoclase-bearing units where no plagioclase-bearing quartzo-feldspathic rocks were found. In Domain II albite-bearing quartzo-feldspathic rocks were found in the Takla Group rocks and oligoclase-bearing assemblages were recorded in the Eureka Quartzite and Snowshoe Formation; all of these occurrences did involve clinozoisitic epidote, but again the thickness of rock between the different plagioclase assemblages was large (1 to 2 km). Unfortunately an isograd based on this data cannot be confidently placed except to say that the structurally highest unit in the pile is on its downgrade side and the surface must fall somewhere (and with some uncertain shape) within the mass of the Crooked Lake Phyllite.

Potassium feldspar was found at two different localities in the Crooked Lake area. In the Crooked Lake Phyllite a pyritic sandstone found at one locality

(J41) is composed of moderately sericitized orthoclase with abundant (myrmekitic-like) inclusions of quartz. Though recrystallization is widespread, apparent relict clastic grain and cement relationships are still discernable in plane-polarized light outlined by very fine opaque material

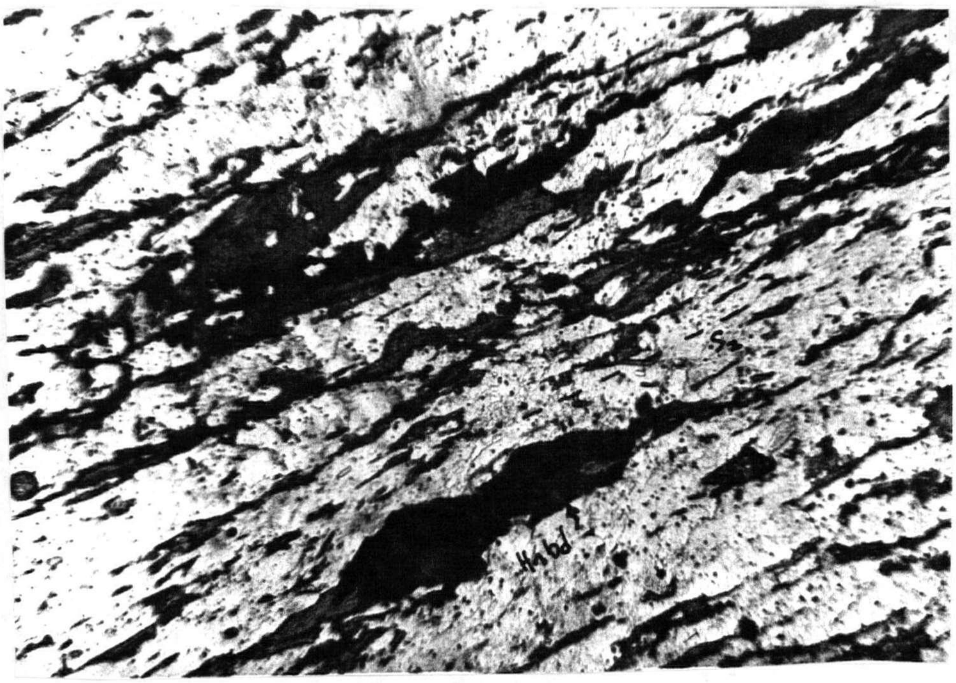


Figure 39 - Biotite quartzite of Eureka Quartzite with magnetite veining and unusual hornblende crystals; the biotite here is green; ordinarily it is brown and muscovite is the more common mica (Plane polarized light, X12.5, LOC-J104)

at old grain boundries. The Snowshoe Formation of Domain I contains perthite porphyroblasts, again found at only one locality (RZ10; see Figure 38). These coarse crystals often contain fine opaque inclusion trails that are at a high angle to and not continuous with the main foliation. This fact may suggest a metamorphic origin, implying that they would have formed at an earlier time than the D2 event at a grade sufficient for K-feldspar formation; the most probable reaction for this composition type would be:

$$\text{Muscovite} + \text{Quartz} = \text{K-feldspar} + Al_2SiO_5 + H_2O$$

which from the reversal equilibria of numerous workers (Evans 1965, Kerrick 1972, Chatterjee and Johannes 1974) is known to be characteristic of the upper amphibolite facies (e.g. 5 kilobars & 700 degrees C). Of course, it is also likely that this potassium feldspar belongs to a primary mineralogy that has survived the various metamorphic episodes.

Textures in these rocks are controlled by the prismatic nature of the quartz and feldspars. These minerals are characteristically equant to elongate in form and so impart a foliation to the rock as a whole (Figure 38), and it is not uncommon for feldspar elongation to be extremely well developed on a local scale, as well (Figure 38b). Internal deformation in all felsics (undulatory extinction, deformation banding and twinning, partial internal grain sub-division) is always apparent. Micas lie mostly parallel to the S1 or S2 foliations; those that lie at a high angle to a particular foliation (say S2; see Figure 40) probably belong to an earlier formed (S1) foliation. Garnets (Figure 38)and magnetite are skeletal to subidioblastic and idioblastic, respectively or occur together in veins with quartz that lie sub-parallel to the main foliation (Figure 39 shows magnetite veining parallel to S2 in Eureka Quartzite).

## Pelitic Type

Rocks of a pelitic composition are usually derived from fine grained sediments rich in aluminum and potassium; for this reason the most common minerals observed in pelites are micas which impart to the rock a schistose or foliated texture. The Crooked Lake Phyllite is composed of over 80% of this composition type (Figure 41), and the Snowshoe's quartzo-feldspathic rocks are often interlayered with pelitic schists (Figure 40).

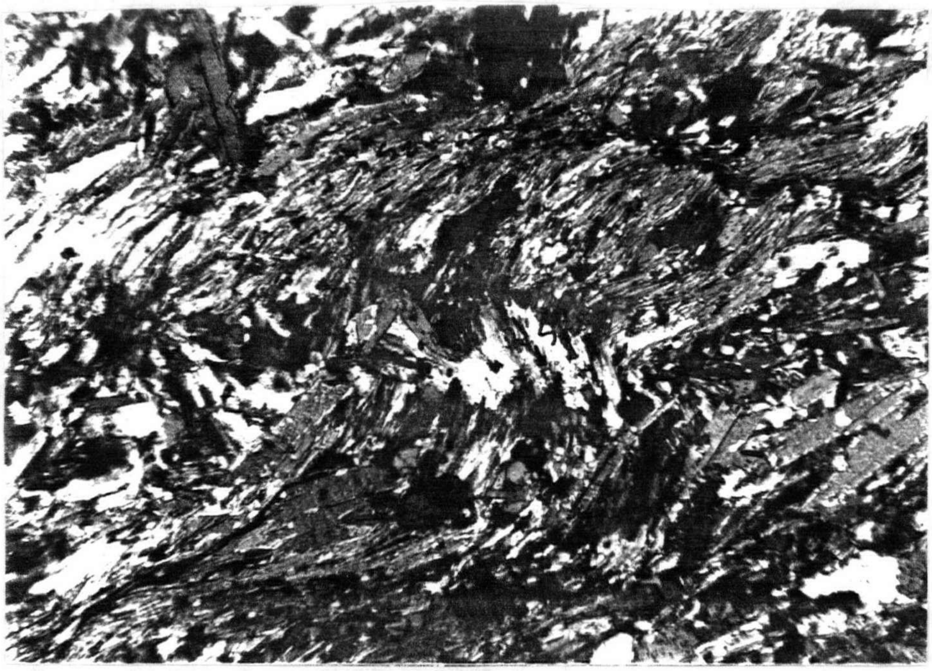


Figure 40 - Pelitic schist from Snowshoe Fm.; an earlier foliation S1 has been disrupted by the S2 foliation; numerous 'high angle' biotites are common (top of photo) and are crossed by S2 muscovites (cross-nicols, X12.5, LOC-RZ10)

Two assemblages are common in this domain; chlorite-biotite-muscovite-quartz (±plagioclase) is generally typical of Snowshoe pelites observed, while chlorite-'graphite'-muscovite-quartz (±garnet ±ilmenite ±chloritoid ±staurolite ±plagioclase) is characteristic of the Crooked Lake Phyllite.

The pelitic rocks of the Snowshoe vary in composition in a similar way as their interlayered quartzo-feldspathic equivalents. The proportions of quartz, muscovite, and biotite tend to change unsystematically and plagioclase of low to medium anorthite content (from $An_{35}$ to $An_{40}$) occurs locally. The textures of these rocks are governed by the micas (as opposed to the felsics; compare bottom and top of Figures 38 and 40, respectively). One dominant fabric and two poorly represented fabrics were observed. The main fabric, corresponding to the main metamorphic event, has allowed extensive parallel mica growth that defines the grossly obvious macroscopic foliation seen across the area. The first of the less obvious fabrics is a biotite (less commonly muscovite) foliation consisting of high angle (w.r.t. main foliation) masses of mica disrupted and cross-cut by the main foliation (Figure 40) or isoclinally

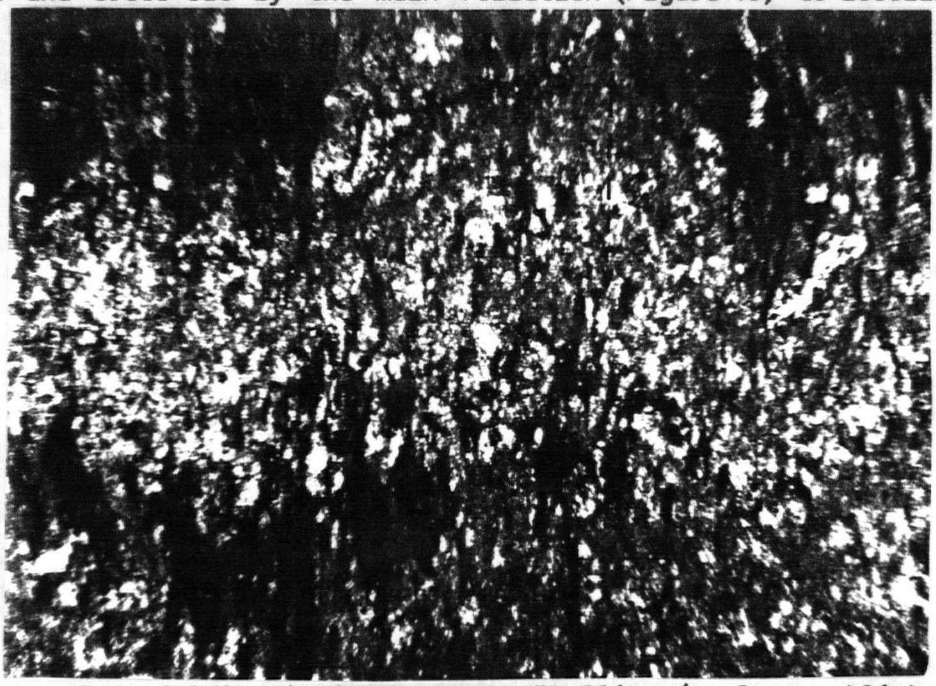


Figure 41 - Open folding in Crooked Lake Phyllite (a slaty sublithology); note dark layers have large amount of graphite that has been injected up into S2 cleavage planes (probably while unit was still unconsolidated and wet) (cross-nicols, X12.5, LOC-J7)

folded arrangements of mica lying parallel to the foliation; this has been interpreted as indicative of an earlier metamorphic event (M1). The second fabric involves the growth of muscovite and chlorite parallel to D3 deformational spaced cleavages and appears to accompany the crenulation of the main foliation commonly seen across the area; this feature is only seen in Domain II of the Crooked Lake area.

In the rocks of the Crooked Lake Phyllite the proportions of muscovite, quartz, and `graphite' vary somewhat irregularly as does the grain size of the interbeds. The full spectrum of mica foliation development was observed (see Figures 41 to 44) from microscopic growth parallel to axial planes of open folds (with accompanying soft- sediment injection into cleavage planes on the mesoscopic scale, see Figure 41) to domination of the total fabric by the mica foliation (with accompanying transposition of all layering sub-parallel to this foliation, Figures 42, 43, and 44). This foliation is very often seen crenulated, though the existence of mica growth parallel to D3 structures (as in the Snowshoe) was not observed. It is strongly believed that M2 (again we could use an alternate terminology, such as {M1}) was the first metamorphic event to affect the Crooked Lake Phyllite.

So far the mineral assemblages mentioned above do not add any more detailed information concerning grade than those of the quartzo-feldspathic rocks. It was, of course, observed that biotite seems to be an important M1 fabric constituent (over muscovite) and this could be taken to suggest that that event was more or less of a higher grade than M2; no more can be said of this early event given the available data. The fact that biotite was rarely observed in the Crooked Lake Phyllite (see below on discussion of staurolite), but is common in the Snowshoe is important to note. It is possible that the composition of the Crooked Lake Phyllite is different enough from the Snowshoe pelitic rocks that a true `biotite' isograd can not be postulated based on this evidence; the ubiquitous occurrence of chlorite may indicate unusually high MgO/FeO ratios for this unit which is known to be responsible for the delay of many biotite formation isograds (Chinner 1960).

Figure 42a - Ctd-gn-plag-qtz-musc porphyroblastic phyllite {DIR-005, LOC-J85}

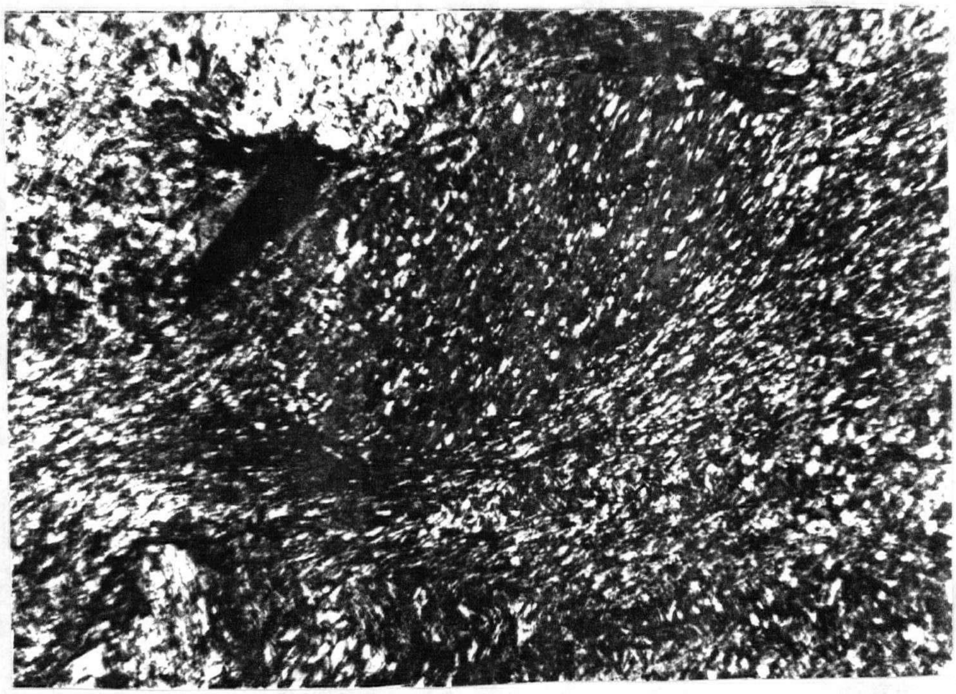


Figure 42b - Microscopic fabric of porphyroblastic phyllite showing plag and ilm porphyroblasts in matrix of muscovite/sericite-graphite-quartz; S2 foliation typically wrapped around porphyroblasts; $S_i$ in plag = $S_e$ of foliation {cross-nicols inserted, X12.5, LOC-J85}

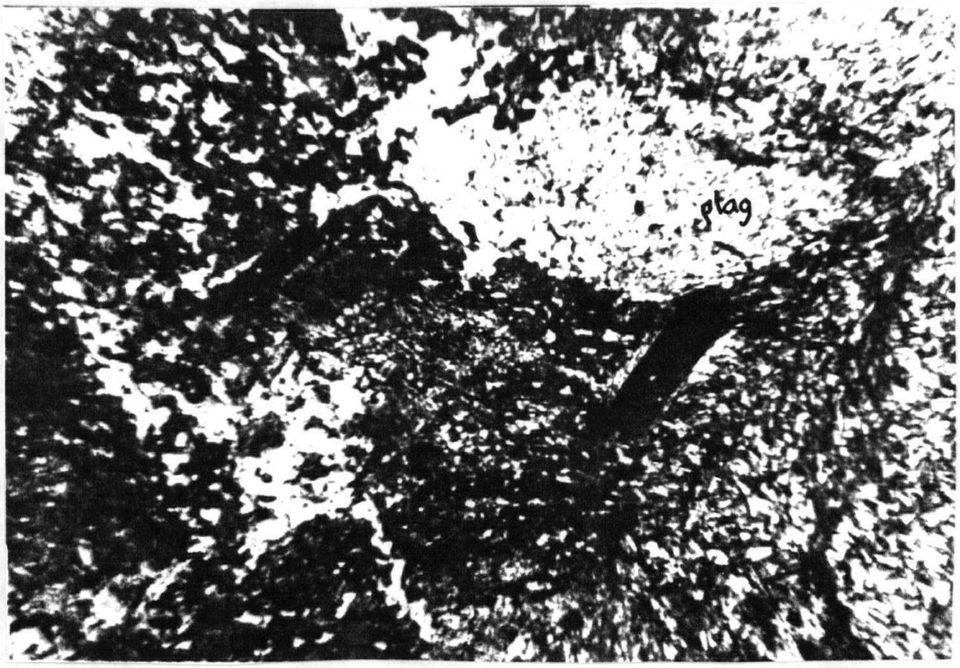



Figure 43a - Porphyroblastic phyllite with plag, ctd, chl, and ilm in contact; chl occurs in center of ctd crystal (dark), the corroded form of which contrasts with units where ctd occurs with no plag {plane polarized light, X12.5, LOC-J85}

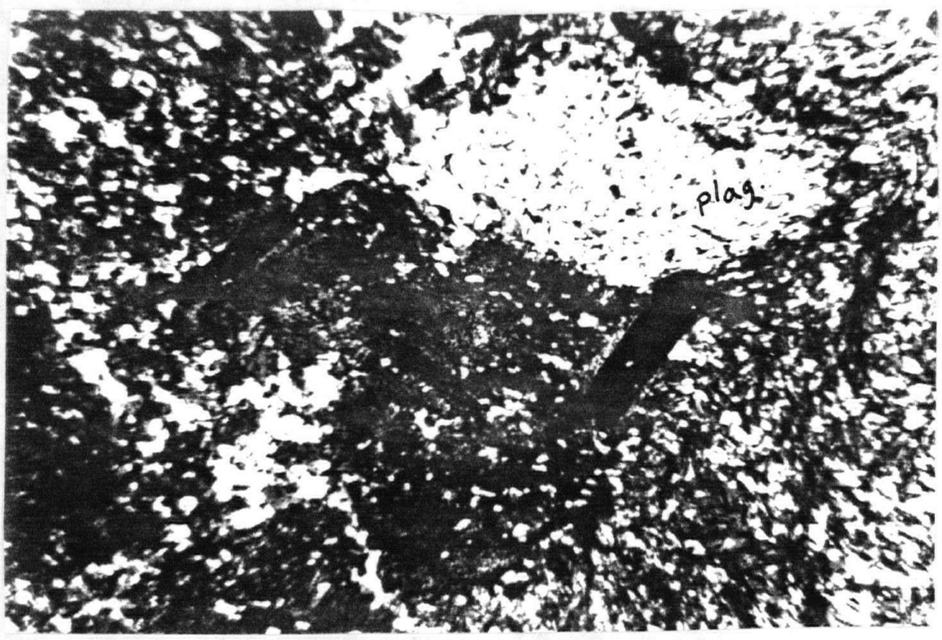



Figure 43b - Same sample as above with cross-nicols inserted; S2 foliation though deflected by porphyroblasts is continuous with inclusions in crystals {X12.5, LOC-J85}

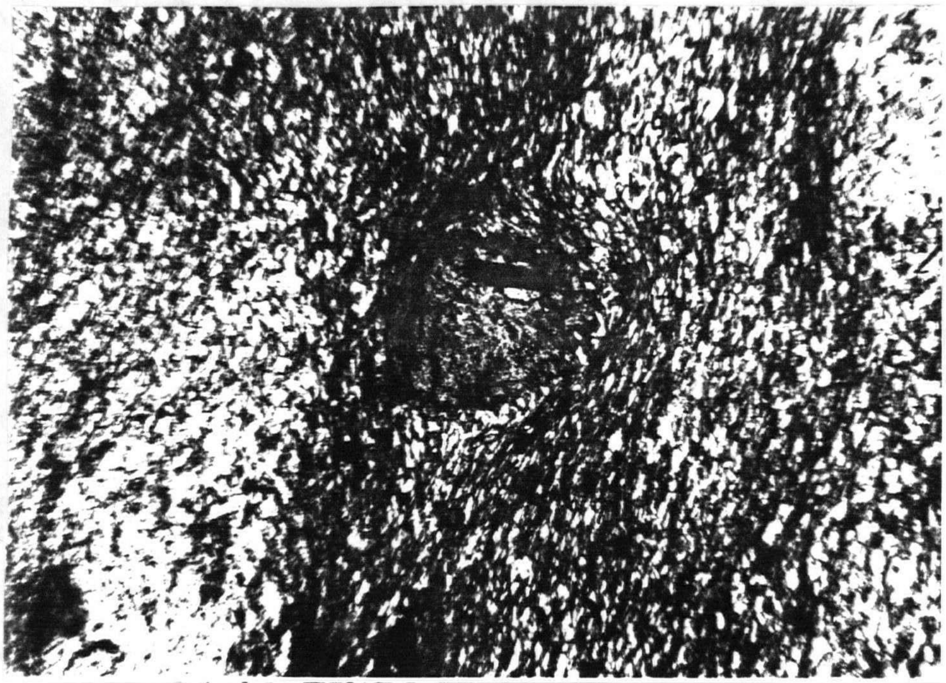


Figure 44a - Garnet and ilmenite within porphyroblastic phyllite; garnet shows rotated inclusions that are continuous with S2 foliation at crystal boundaries {plane polarized light, X50, LOC-J85}

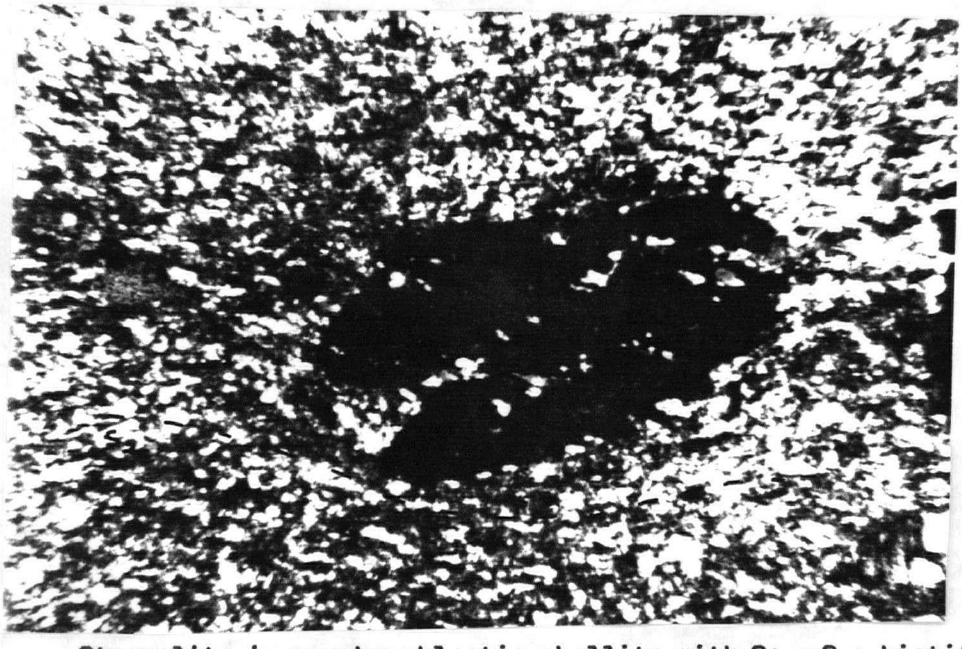


Figure 44b - Staurolite in porphyroblastic phyllite with $S_i = S_e$; biotite crystal nearby is the only example of biotite in Crooked Lake Phyllite {cross-nicols inserted, X12.5, LOC-J47}

Certain poorly defined horizons in the Crooked Lake Phyllite contain assemblages from which significant isograds may be deduced. The bulk of this pelitic variant occurs along the steep southwest slopes of Talbot Ridge in Domain II and one occurrence crops out in the northernmost part of Domain I (J47). This unit is characterized by porphyroblastic development of garnet, ilmenite, and plagioclase, chloritoid or staurolite within a matrix of chlorite-muscovite-quartz (Figures 42, 43, 44); the occurrence of chloritoid or staurolite should be indicative of a fairly restrictive compositional range (high $Al_2O_3$ & high Fe/Mg) (Hoschek 1969; Halferdahl 1961).

All samples examined contained garnet and ilmenite (Figure 44a) together with chloritoid, chloritoid and plagioclase (Figure 43), or staurolite (Figure 44b). This first assemblage occurred in Domain II well into the mass of the Crooked Lake Phyllite. Chloritoid forms coarse, subidioblastic, platy crystals lying at low to moderate angles to the main foliation and is highly included with fine quartz and opaques (Si parallel Se); garnets have a xenoblastic, serrated outline and rotational inclusion trails which in most cases show Si continuous to Se on the outermost crystal outlines; ilmenite, in this and all specimens, occurs as platy subidioblastic crystals mostly aligned with the main mica foliation (high angle crystals are bent, broken, and/or quartz pressure shadowed). Nearer to the lower Crooked Lake Phyllite contact in Domain II (within 100-150 meters) the second assemblage is more predominant. Andesine ($An_{35}$) is the most abundant porphyroblast forming augen-shaped crystals aligned with the main foliation with rotational inclusion trails (Si continuous Se) of quartz, ilmenite, tourmaline, muscovite, and fine opaques; chloritoid becomes progressively more corroded in the vicinity of andesine (Figures 43a, b) and/or in samples occurring further to the northwest along these steep slopes. The third assemblage occurs as a single exposure in Domain I; staurolite, garnet and ilmenite porphyroblasts occur in the usual matrix with the addition of small amounts of biotite. Staurolite is idioblastic with the long crystal direction (Z axis) lying within the plane of the main foliation (Figure 44b shows a length-fast/end section of staurolite with S2 perpendicular to the thin section), defining a weak linear fabric, and possibly representing an axis of rotation (quartz inclusion trails suggest that Si may be continuous with Se); chlorite is a common associate. Garnet crystals show irregular weakly included cores with strongly included idioblastic rims. Biotite occurs as xenoblastic small crystals.

Within the volume spanned by this series of samples two distinct mineral assemblage populations exist (chloritoid-bearing versus staurolite-bearing) and a progression in time between the two may or may not have occurred; a reaction of the form:

$$\text{ctd} + \text{musc} + \text{qtz} = \text{staur} + \text{bio} + H_2O$$

could link the two groups (this is most likely to occur to chloritoid assemblages as higher grades are reached), although staurolite assemblages can be derived from reactions of the form:

$$\text{chl} + \text{musc} = \text{staur} + \text{bio} + \text{qtz} + H_2O$$

as well (staurolite can exist in a wider range of composition than chloritoid; Hoschek 1967). Regardless of the overall similarity of textures and background mineralogy between the two groups, without certain intermediate chloritoid-staurolite assemblages and/or chemical analyses it is difficult to show which reaction is most likely represented. Fortunately these reactions, along with a series of related pelitic reactions {Ganguly 1969, Hoschek 1969, Albee 1972} occupy a restrictive temperature range of 500 to 575° C at pressures of 4 to 7 kbars. Some additional amount of uncertainty may be due to unknown values of the partial pressure of water and fugacity of oxygen at the time these reactions would have occurred.

An additional reaction may be suggested by the textural relations observed in chloritoid-plagioclase bearing units (Figure 39b shows corroded chloritoid in the presence of plagioclase). According to the experimental work of Hoschek, (1969) the reaction:

Chl + Para + Qtz = Ctd + Ab + vapour

was found to have a restricted temperature range (510°-570°C) and be relatively independent of pressure (see PT diagram, Figure 47, below); the assemblage pair ctd-ab was said to be relatively rare because of the close proximity of this reaction to chloritoid's stability limits in the upper regions of the greenschist facies. Since plagioclase, and not albite, is involved with chloritoid it is believed that a counterpart sliding reaction that takes the various solid solutions into account would have the above reaction as one end limit.

## Basic Type

This composition type is characterized by minerals such as chlorite, epidote, actinolite, and hornblende with less than or equal amounts of feldspars and sometimes quartz; a likely parentage would be intermediate to basic igneous rocks, mafic graywackes, and volcaniclastic sediments. Both the Antler Formation and the Takla Group rocks fall into this composition category, though the former is more basic in composition; the other units show only minor representation in rocks of this type the most notable of which is the qtz-ep-hnbd schist found in Domain II.

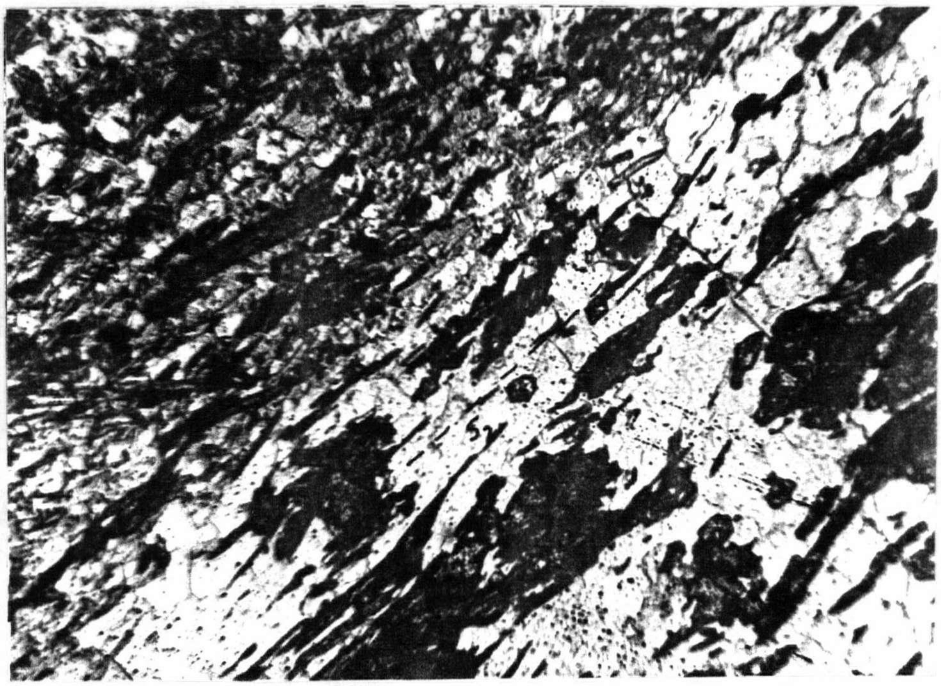



Figure 45 - Chl-Hnbd-Ep-Qtz Meta-wacke; mafic minerals define the S2 foliation in these and other basic units (plane polarized light, X12.5, LOC-RZ4)

The most common assemblage for Antler rocks is hornblende-(actinolite)-epidote-chlorite-plagioclase (±quartz ±calcite ±magnetite). Takla group rocks, on the other hand, show assemblages composed of actinolite-epidote-chlorite-albite ( ±quartz ±calcite); occasionally, zoned amphiboles or two amphiboles occur, but one is most certainly primary (relict igneous).

The Takla Group rocks show a wide range of mesoscopic textures mostly of primary volcaniclastic origin, and superimposed secondary textures are limited to mild foliations, occasional folding, and localized mylonization. The typical assemblage (act-ep-chl-ab) occurs as very fine growths that barely disrupt many primary features. The growth of new amphibole (actinolite), ubiquitous occurrence of chlorite, and some veining of quartz, epidote, and/or calcite represent the extent that metamorphism has affected this unit.

The Antler rocks, on the other hand, display predominately metamorphic effects (having lost most or all primary features) on both mesoscopic and microscopic scales. The S2 foliation is formed by chlorite, amphibole (actinolite, hornblende, and rarely other amphiboles occur), and epidote (±felsics) (Figure 45); chlorite has usually grown in planar masses, the amphiboles can occur as random splays or near-perfectly aligned (producing a very good linear fabric) within planar zones, and the epidote (± felsics) forms fine to medium grained granoblastic masses with an overall lensoid appearance (Figure 45). The prismatic nature of feldspar (and sometimes quartz) in the more felsic Antler subunits also aids in the definition of the S2 foliation.

The general distribution of assemblages in the Antler across the area has been summarized in Figure 46. This map shows a subdivision of these assemblages into three mineral assemblage population groups: 1) actinolite as the only secondary amphibole, 2) actinolite, hornblende, epidote, and albite coexisting, and 3) oligoclase coexisting with epidote. This breakdown is based on two generalized reactions:

albite + epidote = oligoclase + epidote

chlorite decreasing/hornblende increasing

which are also shown on Figure 46. The first reaction has been discussed above (see Quartzo-feldspathic Type). The second reaction has recently been looked at by Moody et al. (1983) with relation to the transition from the greenschist facies to the amphibolite facies (compare Figure 37 and Figure 47). Figure 47 summarizes

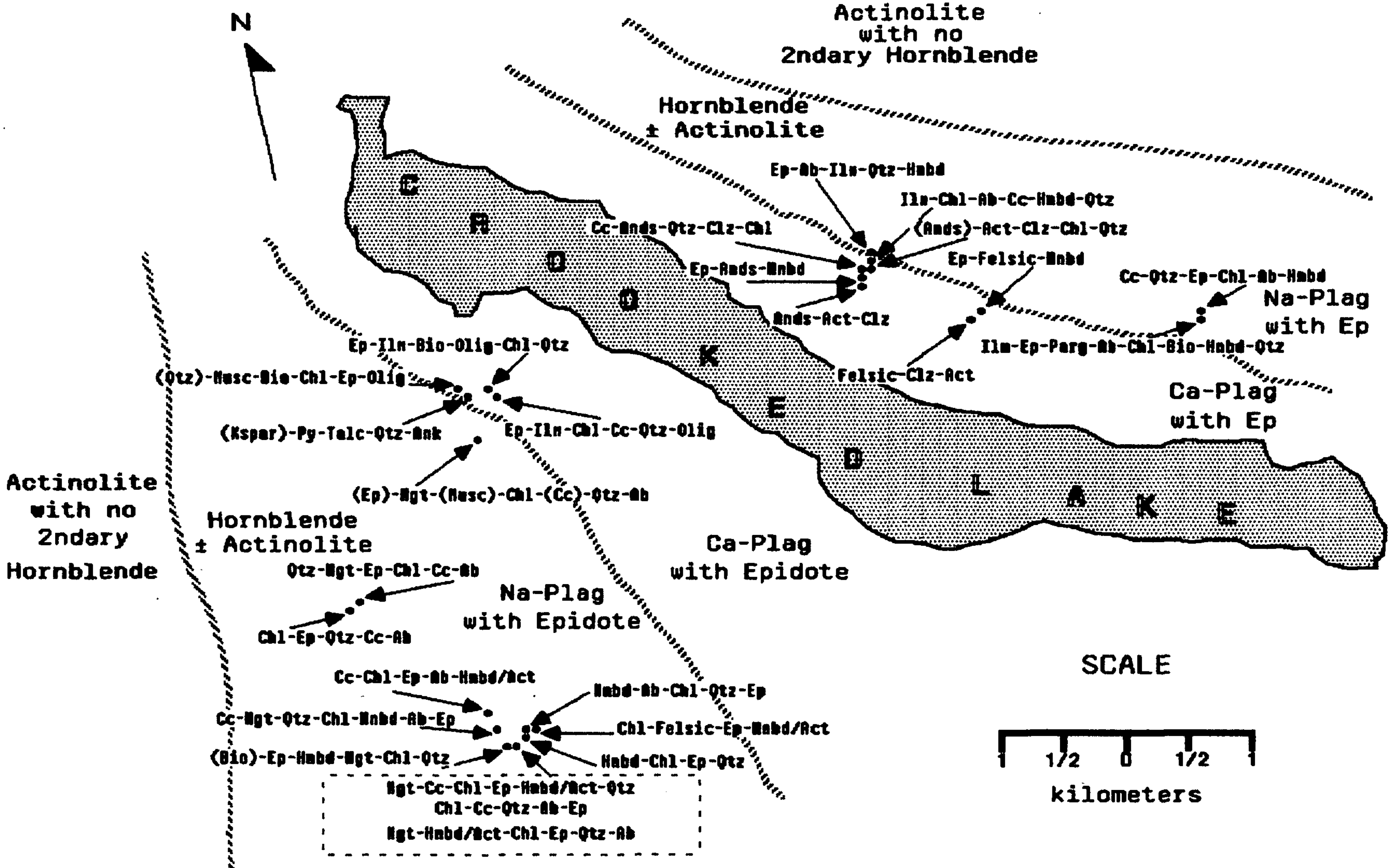



Figure 46 - The distribution of mafic assemblages for the Antler Formation; surfaces shown separate assemblages on either side of two reactions (hornblende in and oligioclase in) discussed in the text

their results as a plot of pressure-temperature space; the transition zone outlined shows the above reactions on the low temperature side and a second reaction:

chlorite out

on the high temperature side. The Antler rocks have clearly not left this zone (as the chlorite found across the area is not alteration growth), but must have reached far enough to pass any possible zone of two coexisting feldspars.

The surfaces outlined in Figure 46 are assumed to have the same general orientation as the major contacts; their repetition from east to west would suggest that they form folded shapes with essentially a D3 fold axis orientation. Since the reactions associated with these surfaces are, for the most part, independent of pressure the core of these folded shapes represents a thermal maximum for the M2 metamorphic episode. Temperatures can be expected to have been in the range of 500°-575° C at pressures from 4-7 kbars.

## Calcareous Type

Rocks of this composition may be composed of calcite and/or dolomite and/or any combination of calcsilicates (e.g. talc, tremolite, diopside, wolllastonite) dependent on the amount of magnesia and silica in the original rock; significant amounts of alumina will allow the minerals hornblende, epidote, and plagioclase to form as well; if iron is present the carbonate ankerite might form. Usually, these rocks are derived from limestones, siliceous limestones and dolostones, and calcareous and dolomitic sediments, but some degree of overlap is unavoidable with calcareous mafic igneous rocks, as well. This type, in general, is poorly represented in the Crooked Lake units; calcareous and ankeritic rich assemblages are present in the Antler and the phyllite, whereas bands of quartz-musc-calcite occur in the Snowshoe Formation.

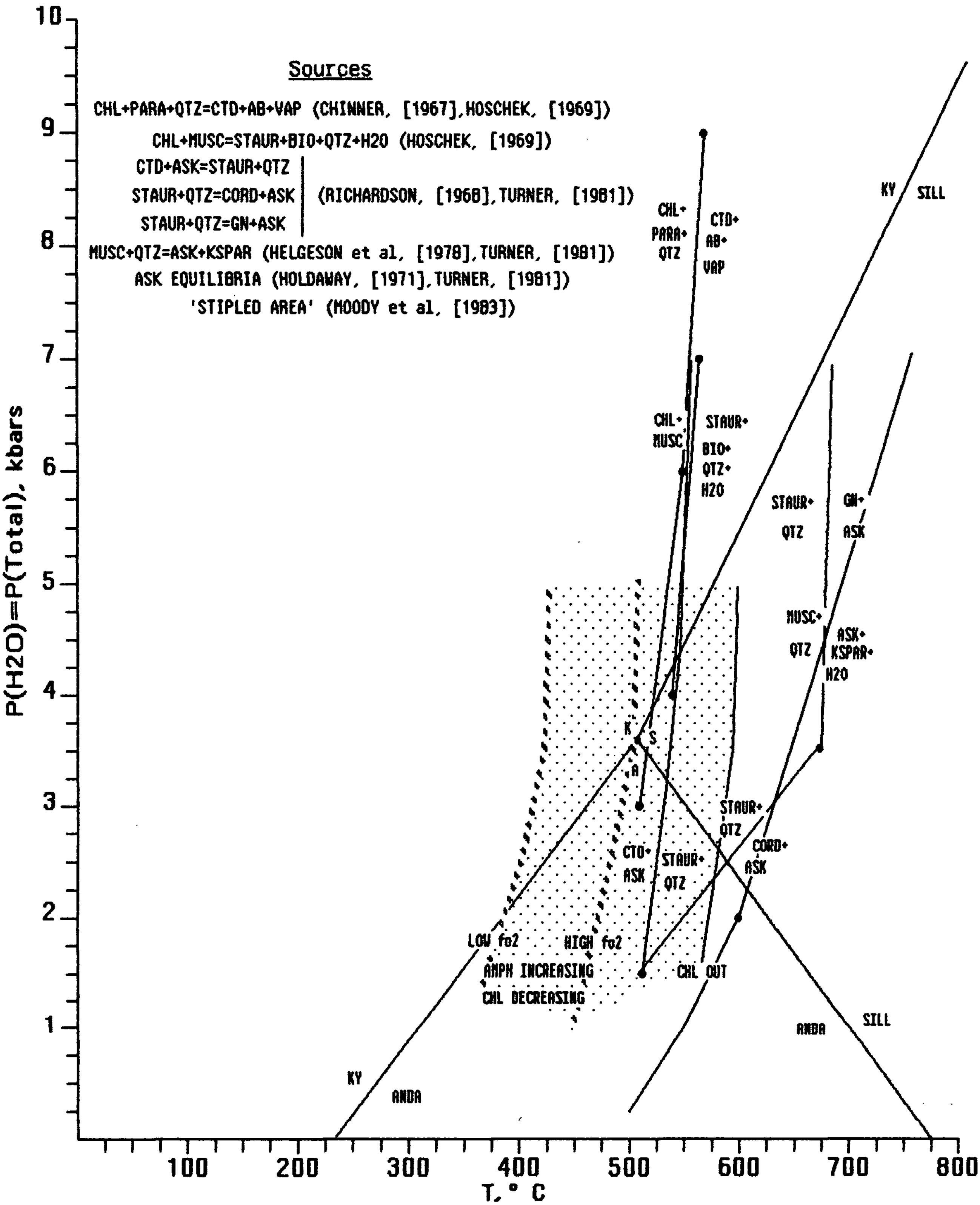



Figure 47 - Pressure temperature plot of equilibria relevant to the Crooked Lake quartzo-feldspathic, pelitic, and mafic composition types

By far the most obvious calcareous units occur in the Snowshoe formation where qtz-musc-cc and zo-plag-musc-cc assemblages occur. In the Crooked Lake Phyllite and Antler assemblages include musc-qtz-chl-ank, graph-chl-ank-musc-qtz, and less commonly ank-py-ep-cc-ab-qtz. Unfortunately, these assemblages are common over most of the greenschist and into the amphibolite facies so are not particularly diagnostic.

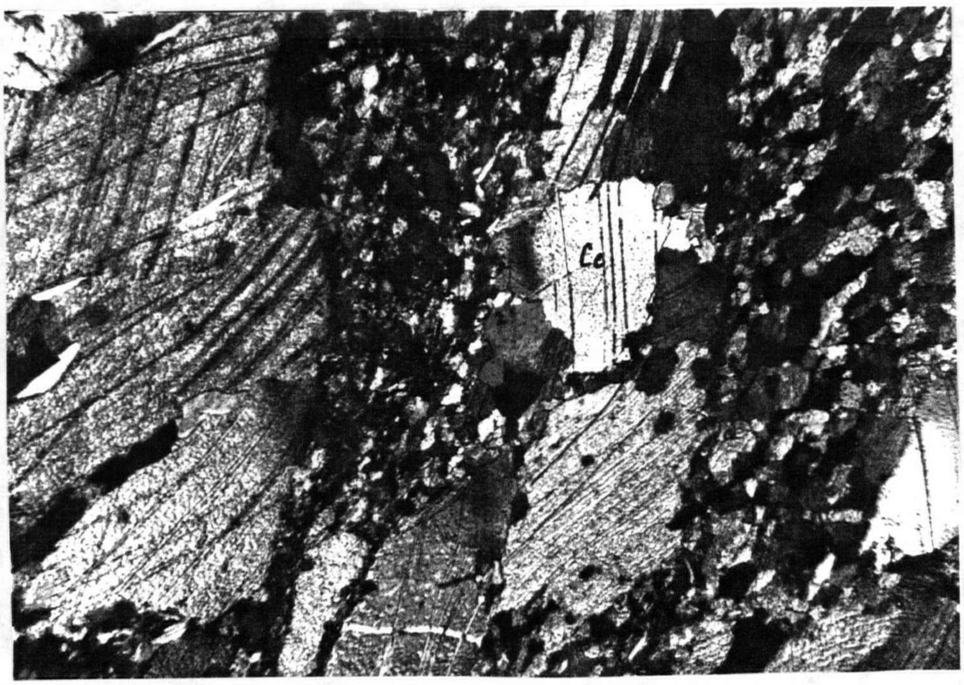



Figure 48 - Coarse and very fine banding texture in pelitic marble of Snowshoe that outlines S2 foliation (cross-nicols, X12.5, LOC-RZ11)

In general, these units are granoblastic with a foliation developing only where muscovite or chlorite is abundant. The only instance of a departure from this pattern occurs in Domain I where cryptocrystalline bands parallel the main S2 foliation in the Snowshoe. In thin section (Figure 48), these bands are seen to consist of very fine calcite and minor muscovite and fine rounded grains of quartz;

next to these bands the main rock type is coarse calcite that shows abundant deformation twinning and kinking.

## Ultrabasic Type

This composition type is characterized by the absence of feldspar and occurrence of antigorite, talc, anthophyllite, and other magnesian minerals; ultrabasic igneous rocks are the usual parentage. A serpentinized peridotite unit was found in the Antler Formation; reports of similar units in the Snowshoe of this area (R.B. Campbell (1963) and K.V. Campbell (1971)) most likely refer to structural infolds of the Antler into the Snowshoe.

The characteristic primary assemblage of this unit is opx-ol and secondarily serp and cc occur as extensive veining across, between, and within grains. Serpentine has developed from the primary rock as it grows even along orthopyroxene cleavage planes, but the calcite has probably been introduced from the surrounding rocks. The overall texture is granoblastic with a high degree of fracturing.

## Metamorphism and Deformation

A definite relationship exists between the metamorphic features described above and those of the three deformational events. Figure 49 outlines the results of microscopic examination of deformational features; this figure is a composite taken from the mineral vs. deformation charts shown in Appendix A for individual rock samples. The earliest mineral growth (M1) is restricted to the oldest units and consists of refolded features and/or features that are earlier than the D2 deformation. Unfortunately, a positive connection was never made between mesoscopic D1 elements and these metamorphic features; this uncertainty is reflected in Figure 49 for many of the minerals that may represent D1 features

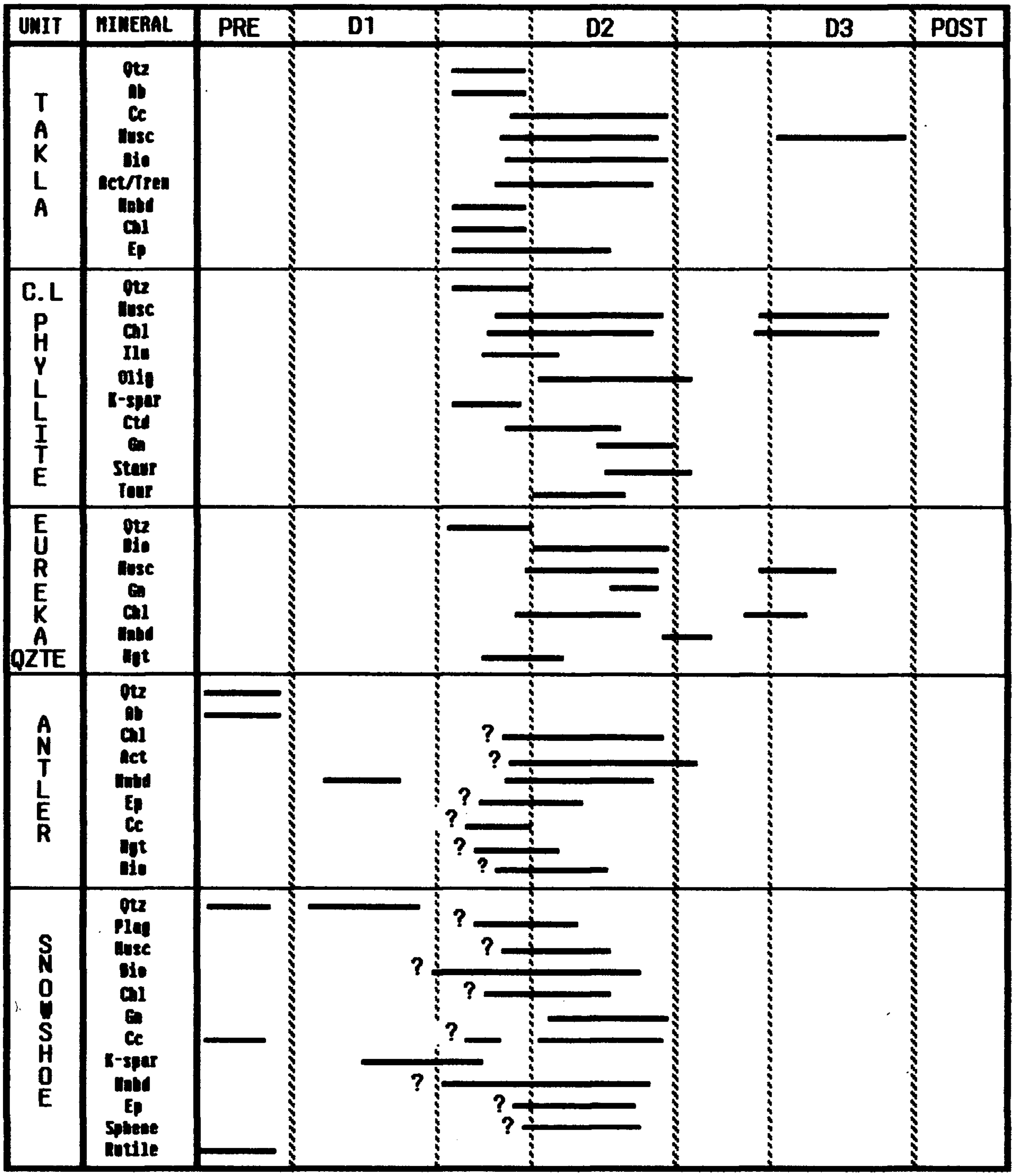



Figure 49 - Summary of mineral growth relative to deformation features composed from diagrams of individual samples and thin sections described in

transposed parallel S2 in the lower two units. The D2 episode corresponds with the greatest amount of mineral growth in all units (the M2 event) and thus represents a culmination in the metamorphic history of the area. A small amount of muscovite and chlorite growth seen along later S3 cleavages links the third event (M3) to the D3 deformation.

Evidence for the M1 event consists of refolded biotite foliations and high angle inclusions within K-feldspar. Both of these minerals are common associates of amphibolite facies metamorphism and if indeed this early event had reached such a high level of temperature and pressure the two lowest units should have been extensively affected. A strong and enduring history for the D2 episode is believed, by the present author, to account for the total obliteration of earlier features. Some degree of uncertainty about the height reached by this event exists because K-feldspar may equally or more likely be a primary phase.

A clear picture has evolved concerning characteristics of the M2 event. Extensive mineral growth in all units has largely masked original features causing the development of very dominant secondary fabrics. Mineral equilibria from two of the five composition groups have allowed maximum temperatures to be estimated and the latest existing temperature gradient fields to be understood; temperatures of 500°-575° C at pressures from 4-7 kbars were derived from chloritoid equilibria, and the transitions from actinolite to hornblende assemblages and from albite- epidote to oligioclase-epidote assemblages. The configuration of surfaces associated with the last two transition equilibria suggest that temperature gradients increase toward the southeast; their folded form most likely developed after the D2 episode as a result of D3 folding.

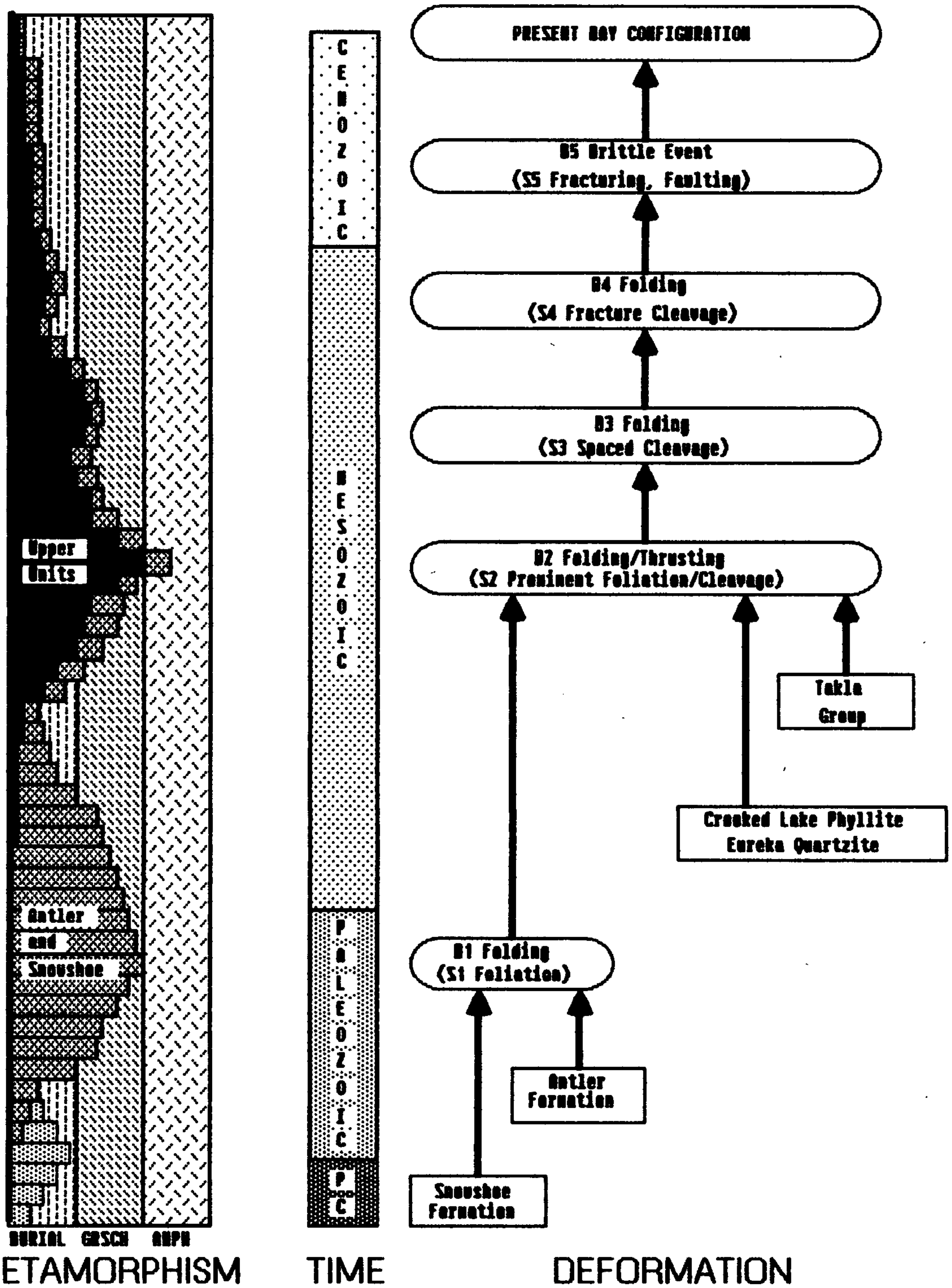



Figure 50 - Relative timing relations between metamorphism and deformation and tentative correlation with the absolute time scale; metamorphic scale shows three generalized grades: burial, greenschist, amphibolite

Pressure estimates are rather wide, compared to those of temperature, but no suitable reactions to determine pressure were observed. It may be assumed based on previous findings in the region (K.V. Campbell 1971, Fletcher 1972) that a typical Barrovian trajectory is characteristic of this event (pressure of about 4 kbars); the mineral assemblages represented would be associated with this type of 'P-T' trajectory.

Figure 50 shows a summary of the metamorphic/deformational relationships deduced. In this diagram relative timing of the different events is shown. Three different packages are considered to have occupied this area over time (shown by left-most bar graphs) and are shown with distinct metamorphic histories(shown as the width of bar graphs from left-hand side). The Snowshoe is shown as a separate package experiancing burial metamorphism before the time of Antler emplacement, not on the basis of evidence to the effect but simply to illustrate that the origin of the two units were distinct from one another; following that time these two units are shown joined and together experienced the M1 episode while D1 folding took place. These units remain buried while the upper units were emplaced and from that point onward their common history shows two final metamorphic/ deformational episodes followed by two largely deformational events.

# CONCLUSION

The Crooked Lake map-area lies at the boundary between two distinct geotectonic provinces of the Canadian Cordillera that have shared a common history at least since the mid Jurassic. The belts to the east originated as a platformal sequence off the coast of the North American craton from Proterozoic to early Phanerozoic time. To the west the terranes show evidence of a mid-Phanerozoic origin in an oceanic setting. The two regions could easily have developed thousands of kilometers from each other.

The earliest recorded interactions between units at Crooked Lake involved rocks of the Kaza Group, local platformal representatives, and a unit, the Antler Formation, that is believed to be a section of ocean crust (Campbell, 1971; Montgomery, 1978). Thrusting of the Antler over the Kaza caused mylonitic textures to form at the contact between the units; the early phase of folding recorded in both rock types could have accompanied this thrusting episode, though it is also possible that these features record events that pre-date thrusting, thus being unique to the individual units.

The remaining units were introduced into the area perhaps by thrusting, as well; this interpretation seems more reasonable than simple deposition because of the possible allochthonous association these upper units have with terrane rocks to the west. Thrusting would explain truncation of the Eureka Quartzite as well as the strong mylonite development at the top of the phyllite.

The age of the Crooked Lake Phyllite is a significant problem in terms of the regional picture. Considering the abundance of slaty rock types in the Omineca belt to the north and northeast, it is understandable that early workers linked the phyllites with these rocks (Campbell and Tipper, 1971). The present author, in fact, cannot help but notice the similarity between stratigraphy of the Crooked Lake Phyllite and units such as the Paleozoic Black Stuart Formation as described by Struik, (1981). Such correlations, though, oppose the fossil collections known to date that suggest an upper Triassic age. It is believed that the Crooked Lake phyllite with its occasional limy horizons and good high elevation exposures will one day yield the fossils to date this unit.

The flexural folding recorded in the phyllite could be related to an emplacement process and seems to have occurred while the material was still wet. The continuing deformation coincided with an increase of metamorphic grade (that probably followed a Barrovian trajectory to the boundary between the greenschist and amphibolite metamorphic facies); in turn, at progressively higher and higher temperatures the response of the rock units changed so that folds became more characteristically similar in style. Abundant shearing of the units took place along previously formed axial planar fabrics to accommodate the strain within the rock mass.

The next phase saw the onset of deformation forming westerly verging folds. By this time, metamorphic grade had decreased and accordingly folds had changed to a more flexural style. The coplanarity (and colinearity) of this event (w.r.t. the previous events) has made separation of these folds from earlier minor fold forms difficult or impossible in certain areas (i.e. Domain I, southwest of Crooked Lake); it is believed that much of the strain energy involved in this phase would be used to tighten existing forms rather than create new ones.

The final folding phase with its fold forms (including kinking) transverse to the previous ones represents a significant departure from the type of mechanism operating in the region up to this time.

Subsequently, brittle deformation (fracturing and faulting) with a possible transcurrent configuration affected the Crooked Lake units.

The later history of the area, as evidenced from nearby regions, include the 100 Ma intrusives of Campbell and Tipper, (1970), Eocene volcanic activity, Miocene to Pliocene plateau basalts, and most recently an extended period of cyclical glacial activity (Tipper, 1971).

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## APPENDIX A

This section summarizes rock description data for the five units at Crooked Lake. Most of the information presented is from extensive microscopic examination of thin sections cut from samples taken in the field and a few descriptions are taken from mineralogical and textural data recorded in the field. The following format was used exclusively:

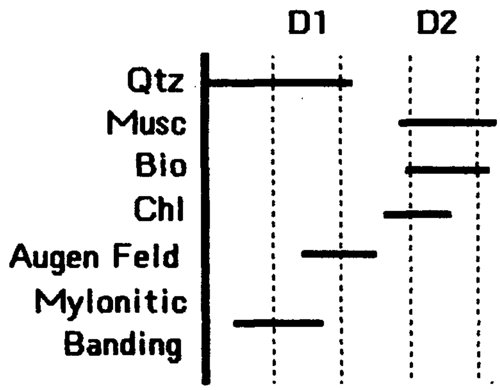
| | |
|---|---|
| Colour | Weathered and fresh surfaces were examined |
| Grain Size | The standard used was the one commonly used for sandstones taken from Pettijohn et al, (1972)- very fine = .0625 -.125mm<br>fine = .125 -.25mm<br>medium = .25 -.50mm<br>coarse = .50 - 1.00mm<br>very coarse = 1.00 - 2.00mm<br>measurements in thin section were made by comparing grains to known field-of-view diameters. Estimations were made in the field. |
| Mineralogy | Evaluation of mineral percentages is based on two or more thin sections (where possible) cut at different orientations through the rock so that the whole volume of rock is considered. Ranges given attempt to account for the fine scaled heterogeneity often encountered (banding, veining, variable sorting). |
| Texture | First, the overall texture of the rock is described, followed by important microscopic features of constituent minerals. |
| Assemblages | Coexisting phases are given for the rock |
| Name | A name is given to the rock |
| History | In the case of most of the data a relative dating diagram has been constructed associating growth of minerals with mesocopic deformational elements |

The units described in this appendix correlate exactly to those shown on Plate 4, the Structural/Stratigraphic Sections; the order used here is, first, relative to each lithologic unit (i.e. A for Snowshoe, B for Antler, etc.) and, second, relative to increasing section number (e.g. Snowshoe has representatives in Sections 1, 4, & 5).

## SNOWSHOE FORMATION

[A1a]
{RZ10, RZ11}

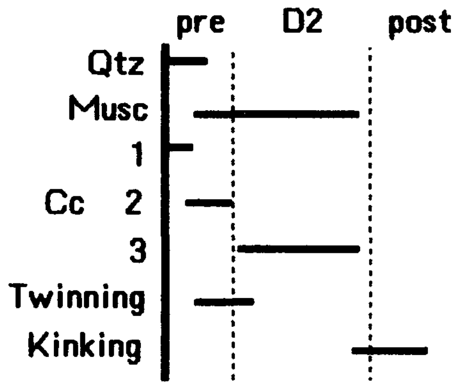
| | | |
|---|---|---|
| Colour | weathered - yellow-brown to tan<br>fresh - tan to grey-green | |
| Grain Size | fine to medium with coarse biotite andgarnet, coarse quartz veining and interlaminated very fine clastics and opaques | |
| Mineralogy | Quartz..............60-90%<br>Muscovite...........15-08%<br>Chlorite............20-00%<br>Biotite/Fe Oxide....05-02% | Accessory<br>Garnet<br>Tourmaline |
| Textures | Finely laminated to finely layered (mm- dm scale); compositional layering of pelitic-felsic schist and minor quartzite \|\| S2 foliation and generally discontinuous; mylonite banding also \|\| S2 foliation. S2 foliation ranges from a spaced cleavage in felsic subunits to a penetrative foliation in pelitic subunits and has been crenulated by at least one later cleavage. Wavy and undulating form. Packages show medium to tight folding<br><br>Micas - dimensional-preferred orientation defines S2 foliation and possible earlier fabric(s) | |
| Assemblages | Chl-Musc-Qtz<br>Bio-Musc-Chl-Qtz<br>Musc-Qtz | |
| Name | Bio-Chl-Musc-Qtz Schist | |




Units A1a, A1b, A1c

[A2a]
{RZ8, RZ11}

| | | |
|---|---|---|
| | Colour | weathered - dark yellow-brown to yellow-orange<br>fresh - rusty, light grey to white |
| | Grain Size | two interlayered varieties:<br>-coarse crystalline with < 5% fines at grain boundries<br>-very fine crystalline with < 5% coarse supported by matrix |
| | Mineralogy | Calcite.............90-95%<br>Muscovite...........08-05%<br>Quartz..............02-00% |
| | Textures | Medium layered with felsic-pelitic schist (dm to m scale); massive, to mildly foliated where muscovite is abundant, grain size banding (mm to cm scale) is \|\| S2 foliation and discontinuous<br><br>Calcite - shows early deformation twinning and late kinking; elongation crystals \|\| S2 foliation; large crystals with qtz-musc inclusions show very jagged grain boundries<br><br>Muscovite - shows shredded form and bent crystals; strong lattice-preferred and dimensional-preferred orientation outlines S2 foliation<br><br>Quartz - undeformed, rounded medium sized grains as inclusions or in fine matrix |
| | Assemblage | Qtz-Musc-Calcite |
| | Name | Qtz-Musc-Calcite Marble |




Units A2a, A2b

| | | |
|---|---|---|
| [A1b] {RZ8, RZ9, RZ10, RZ11} | Colour | weathered - rusty brown to tan<br>fresh - tan to pale olive |
| | Grain Size | fine to coarse with interlaminated cryptocrystalline material; < 5% K-feldspar porphyro-blasts/clasts |
| | Mineralogy | Quartz..............67-89%<br>Biotite.............12-05%<br>Muscovite...........08-03%<br>Chlorite............03-00%<br>K-feldspar..........05-02%<br>Plagioclase(An24)...03-01%<br><br>Accessory: Garnet, Ilmenite, Ctd, Apat, Sphene |
| | Textures | Finely laminated to finely layered; compositional layering and mylonite banding \|\| S2 foliation and generally discontinuous; S2 foliation ranges from a spaced cleavage to a penetrative foliation dependant on lithology; an earlier fabric(s) is folded within forms associated with S2 foliation; S2 foliation crenulated by at least one later cleavage, feldspar elongation \|\| one of these late crenulations<br><br>Quartz - common undulatory extinction and internal grain subdivision; fine material along grain boundries; boundries straight to curved, sometimes serrated and hazy<br><br>Micas - generally grow epitaxially; dimensional-preferred orientation defines S2 |

foliation and earlier fabrio(s); biotite shows zircon inclusion haloes

K feldspar - fine material inclusion trails have $S_i * S_e$

Assemblages — Olig-Chl-K feldspar-Muso-Bio-Qtz
Musc-Bio-Qtz

Name — Musc-Bio Quartzite and K feldspar augen
Olig-Chl-Musc-Bio-Qtz Schist

[A3a]
{J112, J113, J114}

Colour — weathered - white to rusty brown
fresh - tan to blue grey

Grain Size — medium with coarse biotite porphyroblasts

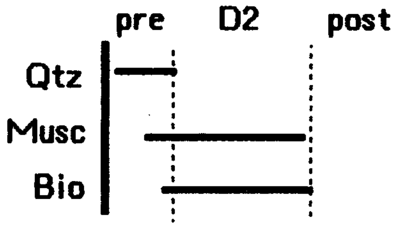
Mineralogy — Quartz/Feldspar.....90-95%
Muscovite...........05-03%
Biotite.............05-02%

Textures — Coarsely layered ( > m scale ); compositional layering of massive quartzite and felsic-pelitic schist || to S2 foliation

Micas - dimentional-preferred orientation outlines S2 foliation

Assemblages — Bio-Musc-Qtz-Feldspar

Name — Bio-Musc Quartzite and Bio-Musc-Qtz-Feldspar Schist




Units A3a, A3b

[A1c]
{J76}

Colour — weathered - rust brown
fresh - tan to grey

Grain Size — medium to coarse

| | | |
|---|---|---|
| | Mineralogy | Quartz..............65-89%<br>Muscovite...........20-05%<br>Biotite.............10-05%<br>Plagioclase(An26)...05-01% |
| | Textures | Finely laminated to finely layered; compositional layering is tightly folded and sub-\|\| to S2 foliation; S2 foliation is involved in upright open to medium fold forms |
| | Assemblages | Olig-Bio-Musc-Qtz<br>Musc-Qtz |
| | Name | Bio-Musc-Qtz-Olig Schist and minor Musc Quartzite |
| [A3b]<br>{J76} | Colour | weathered - pale yellow brown<br>fresh - medium blue grey |
| | Grain Size | medium with coarse garnet porphyroblasts |
| | Mineralogy | Quartz.................90%<br>Biotite................05%<br>Muscovite..............02%<br>Garnet porphyroblasts..03% |
| | Textures | Massive with very strong linear fabric; S2 foliation not well outlined<br><br>Micas - dimensionally related to tight fold features; plates always \|\| to linear fabric<br><br>Garnet - irregular (web-like) to idioblastic; contains random inclusions |
| | Assemblage | Musc-Gn-Bio-Qtz |
| | Name | Bio Quartzite |
| [A1d]<br>{J107} | Colour | weathered - white to rusty brown<br>fresh - rust tan to grey |
| | Grain Size | medium with coarse muscovite/biotite |
| | Mineralogy | Quartz.................50% Accessory<br>Plagioclase(An22)......28% Garnet<br>Muscovite..............15% Chloritoid<br>Biotite................05% |

Ilmenite...............02%

Textures

Coarsely layered; compositional layering of felsic-pelitic schist and quartzite || to S2 foliation and generally discontinuous; S2 foliation is well developed throughout; S2 foliation is crenulated by a spaced cleavage

Micas - grow epitaxially; dimensional-preferred orientation defines S2 foliation and possible earlier fabric (occur at high angle to and are cut by S2 foliation); occassional grains cross cut foliation

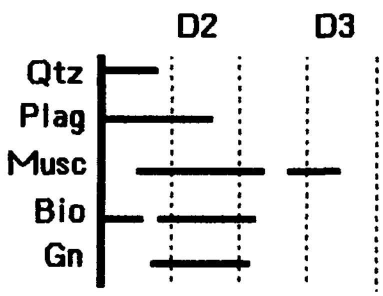
Felsics - show mild undulatory extinction; straight to curved grain boundries

Assemblages

Ilm-Bio-Musc-Olig-Qtz<br>
Bio-Musc-Qtz

Name

Bio-Musc-Olig-Qtz Schist and Bio-Musc Quartzite




Units A1d, A1e

[A2b]<br>
{J74}

Colour

weathered - tan to rust brown<br>
fresh - tan to blue grey

Grain Size

medium

Mineralogy

Calcite.............85-05%<br>
Muscovite...........10-20%<br>
Quartz..............05-40%<br>
Plagioclase(An90)...00-30%<br>
Biotite.............00-05%

Accessory<br>
Sphene

Textures

Fine to medium layered; on fine to medium scale compositional layering of marble and schist to quartzite discontinuous to vaguely gneissic and outlines intrafolial rootless isoclinal folds; on medium to coarse scale marble occurs as isoclinally folded lenses within schist/quartzite; S2 foliation shows mildly undulating form and is crenulated by at least one later cleavages

Assemblages: Qtz-Felds-Musc-Cc
Bio-Musc-Qtz

Name: Qtz-An-Musc-Cc Marble, Musc Quartzite, and Bio-Musc-Qtz Schist

[A4a]
{J75}

Colour: weathered - greenish grey
fresh - light grey to dark grey

Grain Size: medium to coarse

Mineralogy:

| | | |
|---|---|---|
| Hornblende | 70-18% | Accessories |
| Quartz | 07-22% | Pyrite, Rutile |
| Epidote | 23-60% | Spinel |

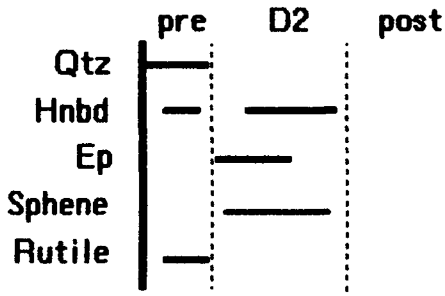
Textures: Finely laminated to finely layered; compositional layering of hornblende-rich and epidote-rich subunits is discontinuous to gneissic (possibly of metamorphic origin) and involved in rootless intrafolial isoclines; S2 foliation is pervasive throughout

Hornblende - some high angle grains cut by foliation may represent early formed fabric; strongly defines S2 foliation and a linear fabric within foliation; poikiloblastic grains show inclusion trails with Si # Se

Quartz - shows deformation bands and strong undulatory extinction; grain boundries are curved but distinct

Assemblage: Qtz-Ep-Hnbd

Name: Qtz-Ep-Hnbd Schist

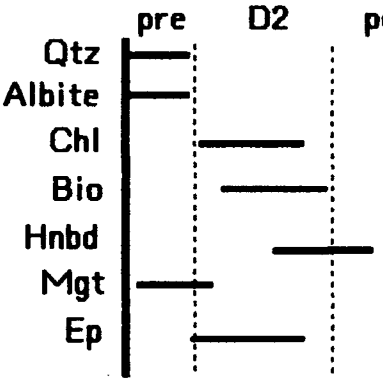



Unit A4

| | | |
|---|---|---|
| [A1e] {J73, J72} | Colour | weathered - rust brown to red brown<br>fresh - red brown to dark grey |
| | Grain Size | medium to coarse |
| | Mineralogy | Quartz..............05-75%<br>Muscovite...........70-05%<br>Biotite.............10-10%<br>Plagioclase(An36)...10-05%<br>Garnet..............00-05% |
| | Textures | Finely laminated to finely layered; compositional layering of pelitic and pelitic-felsic schists discontinuous to gneissic and involved in rootless intrafolial isoclines |
| | Assemblage | Gn-Ands-Bio-Musc-Qtz |
| | Name | Gn-Ands-Bio-Musc-Qtz Schist |

## ANTLER FORMATION

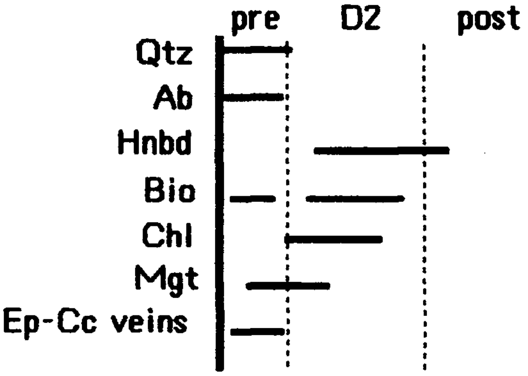
| | | |
|---|---|---|
| [B1a] {RZ1, RZ1} | Colour | weathered - rusty brown to light green<br>fresh - blue green to light green |
| | Grain Size | very fine with fine to medium chl, bio, hnbd, mgt |
| | Mineralogy | Quartz..............40-88%<br>Albite..............35-00%<br>Chlorite............10-03%<br>Biotite.............05-00%<br>Hornblende..........05-03%<br>Magnetite...........00-04%<br>Epidote.............03-01%<br>Calcite.............02-01% |
| | Textures | Finely laminated; compositional layering of chl-qtz schist and ep-hnbd-chl meta- wacke discontinuous and \|\| to S2 foliation; S2 foliation ranges from a penetrative fabric in mafic rich units to a congugate spaced cleavage/fracture in felsic rich units; S2 foliation is crenulated by one later cleavage<br><br>Felsics - show clastic or possibly cataclastic texture<br><br>Micas - dimensional-prefered orientation outlines S2 foliation<br><br>Hornblende - grains found to lie at high angle to S2 foliation cross-cut chlorite grains; some show corroded outlines |
| | Assemblages | Cc-Ep-Bio-Hnbd-Chl-Ab-Qtz<br>Hnbd-Chl-Mgt-Qtz |
| | Name | Bio-Hnbd-Chl-Ab-Qtz Schist, Hnbd-Chl-Mgt-Qtz Schist, and minor massive Quartzite |




Units B1a, B1d

| | | |
|---|---|---|
| [B2a] {RZ1, RZ1, RZ3} | Colour | weathered - tan to rusty brown<br>fresh - blue green to dark green |
| | Grain Size | very fine with fine to medium hnbd, bio |
| | Mineralogy | Quartz..............03-10%<br>Albite..............40-20%<br>Chlorite............10-05%<br>Epidote.............10-35%<br>Hornblende..........30-00%<br>Biotite (oxy-verm?).00-20%<br>Calcite.............05-10%<br>Magnetite...........02-00% |
| | Textures | Finely laminated; compositional layering of epidote rich and hornblende rich units sub \|\| to S2 foliation and shows involvement in possible tight intrafolial fold forms; numerous ep-felsic veins, lensoids, and spheroids show an arrangement \|\| to compositional layering; S2 foliation shows a penetrative or spaced fabric dependent on lithology<br><br>Hornblende - grains grow across grains that outline S2 foliation<br><br>Chlorite - dimensional-preferred orientation outlines foliation<br><br>Biotite - some grains lie at high angle to and are cut by other grains that outline/define S2 foliation |

| | |
|---|---|
| | Magnetite - grains have quartz pressure shadows aligned with S2 foliation |
| Assemblages | Mgt-Qtz-Cc-Ep-Chl-Hnbd-Ab<br>Chl-Cc-Qtz-Bio-Ab-Ep |
| Name | Ep-Chl-Hnbd-Ab Schist and Cc-Qtz-Bio-Ab-Ep meta-wacke |




Unit B2a

[B3a]
{RZ3,
RZ4}

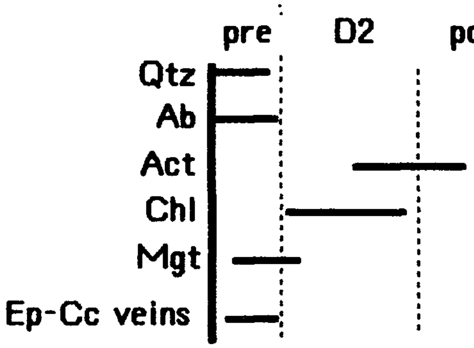
| | |
|---|---|
| Colour | weathered - tan to rusty brown to white green<br>fresh - dark green to pistachio green |
| Grain Size | very fine to fine |
| Mineralogy | Quartz..............42-40% Accessory<br>Epidote.............35-30% Biotite<br>Chlorite............05-25%<br>Hornblende..........05-04%<br>Magnetite...........05-00%<br>Calcite.............02-01%<br>Albite..............05-00% |
| Textures | Finely laminated to finely layered; compositional layering ranges from fairly continuous to discontinuous becoming lense-like and spheroidal and is mostly \|\| to S2 foliation; foliation is penetrative in chlorite rich units, otherwise is best outlined by felsic-cc-ep lensoid/spheroids; S2 foliation has been crenulated by two later cleavages<br><br>Chlorite - dimensional-preferred orientation defines S2 foliation |

Hornblende - some grains oross S2 foliation chlorites; show zoning from clear (actinolitic) interiors to pleochroic (hornblendic) rims

Calcite - grains show high degree of twinning

Assemblages — Ab-Cc-Mgt-Hnbd-Qtz-Chl-Ep
Ab-Cc-Qtz-Hnbd-Chl-Ep

Name — Ab-Hnbd-Chl-Ep-Qtz Schist and
Ab-Hnbd-Chl-Ep-Qtz meta-lithic wacke




Unit B3a

[B1b]
{RZ4}

Colour — weathered - rust brown to light green
fresh - light green to tan

Grain Size — fine to medium

Mineralogy —
Albite.................45%
Quartz.................35%
Hornblende.............10%
Chlorite...............05%
Epidote................03%
Magnetite..............02%

Textures — Massive to finely layered; S2 foliation distinct only where hornblende/chlorite are abundant, otherwise is represented by a conjugate spaced cleavage

Hornblende/Chlorite - dimensional- preferred orientation defines foliation; probably not reflecting pre-foliation compositional layering

Assemblage — Mgt-Ep-Chl-Hnbd-Qtz-Ab

Name — Hnbd-Qtz-Ab Meta-wacke and Ep-Chl-Qtz-Ab Meta-wacke

[B4a]
{RZ4}

Colour — weathered - orange brown
fresh - medium bluish-grey to greenish-grey

Grain Size — very coarse with fine serpentine along fractures

Mineralogy
Olivine................40%
Orthopyroxene..........35%
Crysotile..............20%
Calcite................05%

Textures — Massive and highly fractured

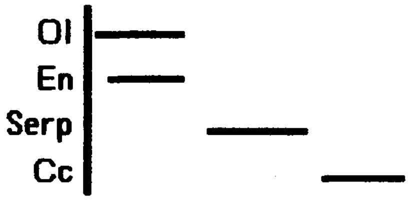
Serpentine - lies along fracture planes in olivine and along cleavage planes in orthopyroxene (grain boundries???)

Olivine/Orthopyroxene - assumed to represent original makeup of rock, now is seen as small peices of grains floating on a background of serpentine; many adjacent grains are optically coincident

Calcite - occurs with serpentine and also in larger scaled veins

Assemblage — Cc-Serp-Opx-Ol

Name — Serpentinized peridotite




Unit B4a

[B1c]
{RZ5}

Colour — weathered - greenish-grey to light grey
fresh - bluish-grey to tan

Grain Size — fine to medium

| | | |
|---|---|---|
| Mineralogy | Quartz | 45-10% |
| | Epidote | 25-30% |
| | Chlorite | 20-05% |
| | Hornblende | 05-50% |
| | Magnetite | 05-00% |
| | Albite | 00-05% |

Textures

Finely laminated to finely layered; compositional layering of chl-hnbd and ep-felsic units ranges from fairly continuous to discontinuous becoming lensoid to spheroid (particularily the felsic units) and is || S2 foliation; S2 foliation is best seen in chl/hnbd units and invoved in upright medium "Z" folding (wavelengths dm to m scale); folds are often associated with axial faults that slice or destroy the short limb

Hornblende - most grains show dimensional-preferred orientation that defines the S2 foliation; some grains lie at high angle to and are cross-cut by S2 foliation grains

Chlorite - dimensional-preferred orientation outlines S2 foliation

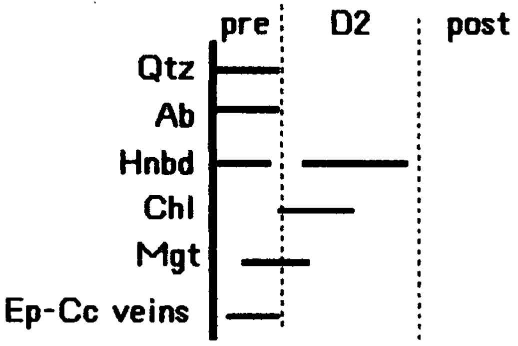
Epidote - grains commonly form lensoidal masses || to S2 foliation

Assemblages

Chl-Ep-Qtz
Ab-Chl-Qtz-Ep-Hnbd

Name

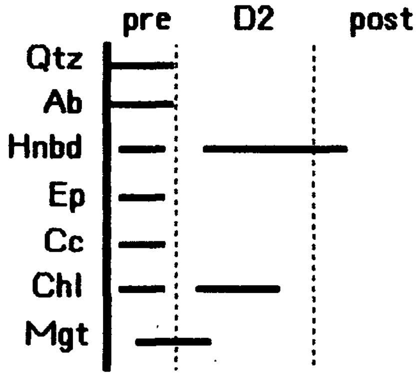
Chl-Ep-Qtz Meta-wacke Ab-Chl-Qtz-Ep-Hnbd Schist




Unit B1c

[B5a]

| | | |
|---|---|---|
| {V5b} | Colour | weathered - tan to olive grey<br>fresh - white to medium greenish grey |
| | Grain Size | fine to medium with very coarse hornblende |
| | Mineralogy | Hornblende.............50%<br>Quartz.................35%<br>Plagioclase(An0-10)....05%<br>Opaque.................08%<br>Epidote................02% |
| | Textures | Fine to medium layered; compositional layering of ep-felsic and hornblende units \|\| to S2 foliation; S2 foliation involved in medium to tight intrafolial fold packages<br><br>Hornblende - semi-random splays occur in planar zones outlining S2 foliation<br><br>Epidote - occurs as lensoid/spheroid bodies that outline foliation; more concentrated toward the top<br><br>Felsics - commonly incuded with hornblende porphyroblasts |
| | Assemblage | Ep-Ab-Opaque-Qtz-Hnbd |
| | Name | Ab-Qtz-Hnbd Schist |



Unit B5a

| | | |
|---|---|---|
| [B2b]<br>{V5a} | Colour | weathered - olive grey |

| | | |
|---|---|---|
| | | fresh - medium greenish grey |
| | Grain Size | fine to medium with coarse carbonate lensoids/veins |
| | Mineralogy | Quartz.................40%<br>Plagioclase(An0-10)....10%<br>Hornblende.............20%<br>Carbonate..............15%<br>Chlorite...............10%<br>Opaque.................05%<br>Accessory: Fe-oxide staining |
| | Textures | Massive to weakly layered; compositional layering of hornblende and chlorite-carbonate units \|\| to foliation; extremely schistose toward top<br><br>Hornblende - occurs as random splays in planar zones outlining foliation or as evenly distributed porphyroblastic masses giving spotty appearance to unit<br><br>Chlorite - dimensional preferred orientation outlines weak foliation |
| | Assemblages | Opaque-Chl-Ab-Cc-Hnbd-Qtz |
| | Name | Chl-Ab-Cc-Hnbd-Qtz Meta-wacke |
| [B1f]<br>{V4} | Colour | weathered - yellowish green<br>fresh - greyish green |
| | Grain Size | fine to medium with coarse hornblende |
| | Mineralogy | Quartz.................35%<br>Chlorite...............30%<br>Clinozoisite/Epidote...25%<br>Plagioclase(?An35?)....05%<br>Actinolite.............05% |
| | Textures | Medium layered and massive; fairly continuous clz-qtz units alternate with hnbd units; upsection grades into lensoid/spheroids in a chloritic matrix; compositional layering \|\| to foliation |
| | Assemblages | Ands-Act-Clz-Chl-Qtz |
| | Name | Clz-Chl-Qtz Schist |

[B4b]
{V3}

| | | |
|---|---|---|
| Colour | weathered - yellow green to white<br>fresh - pale green | |
| Grain Size | fine to medium | |
| Mineralogy | Chlorite...............35%<br>Clinozoisite...........30%<br>Quartz.................20%<br>Plagioclase(An37)......10%<br>Calcite................05% | |
| Textures | Generally massive with Qtz-Cc-Clz veining \|\| to foliation<br><br>Chlorite - dimensional preferred orientation outlines foliation<br><br>Clinozoisite - often seen zoned with epidotic cores | |
| Assemblages | Cc-Ands-Qtz-Clz-Chl | |
| Name | Ands-Qtz-Clz-Chl Schist | |

[B5b]
{V2a, b}

| | | |
|---|---|---|
| Colour | weathered - brownish-grey to greenish grey<br>fresh - yellow green to olive black | |
| Grain Size | medium to coarse | |
| Mineralogy | Hornblende/Actinolite..60%<br>Plagioclase(An36)......25%<br>Epidote................15% | |
| Textures | Medium to coarsely layered; compositional layering of massive hornblende and amph-ands-ep units \|\| to foliation; some tight intrafolial folding of compositional layering and foliation<br><br>Amphiboles - dimensional preferred orientation of smaller grains outline foliation; larger grains lie at higher angles to foliation and are often truncated by smaller; pargasite occurs in massive units | |
| Assemblages | Ep-Ands-Hnbd | |
| Name | Ep-Ands-Hnbd Schist | |

[B2c]
{V1}

| | | |
|---|---|---|
| Colour | weathered - greenish grey<br>fresh - greyish green | |
| Grain Size | coarse with very coarse amphiboles | |
| Mineralogy | Clinozoisite...........50%<br>Actinolite/Tremolite...40%<br>Plagioclase(An38)......10% | |
| Textures | Massive to weakly layered; compositional layering of clz and amph-plag units \|\| to foliation<br><br>Amphibole - weak dimensional preferred orientation outlines foliation | |
| Assemblages | Ands-Act-Clz | |
| Name | Ands-Act-Clz Schist | |

[B5c]
{J108}

| | | |
|---|---|---|
| Colour | weathered - rusty brown<br>fresh - dark green to black | |
| Grain Size | fine to medium | |
| Mineralogy | Hornblende/Actinolite..50%<br>Epidote................15%<br>Felsic.................35% | |
| Textures | Medium to coarse layered; compositional layering of ep-felsic and hnbd units \|\| to foliation<br><br>Amphiboles - dimensional preferred orientation outlines foliation | |
| Assemblages | Ep-Felsic-Hnbd | |
| Name | Ep-Felsic Hnbd Schist | |

[B5d]
{J107}

| | | |
|---|---|---|
| Colour | weathered - rust brown to white green<br>fresh - grey green to dark green | |
| Grain Size | very fine to fine with coarse actinolite | |
| Mineralogy | Actinolite.............70%<br>Clinozoisite...........20% | Accessory<br>Fine opaque |

| | | |
|---|---|---|
| | | Felsics...............10% |
| | Textures | Medium to coarsely layered; compositional layering of opaque 'streaked' and clear units \|\| to foliation<br><br>Actinolite - dimensional preferred orientation of smaller grains outline S2 foliation; larger grains oriented at various angles to and truncated by foliation |
| | Assemblages | Felsic-Clz-Act |
| | Name | Felsic-Clz-Act Schist |
| [B5e] {J101, J104} | Colour | weathered - grey green to rust brown<br>fresh - grey green |
| | Grain Size | fine to medium with coarse to very coarse hornblende |
| | Mineralogy | Hornblende..........20-50%<br>Quartz..............56-20%<br>Albite..............05-05%<br>Epidote.............03-05%<br>Biotite.............10-00%<br>Chlorite............05-17%<br>Calcite.............00-03%<br>Ilmenite............01-00% |
| | Textures | Finely layered; compositional layering of hnbd rich and ep-felds rich units \|\| to S2 foliation; S2 foliation most distinct in hnbd rich units, though also outlined by orientation of ep-felds lensoid/spheroids; possible S2 foliation involvement in medium to tight folding<br><br>Hornblende - locally present with smaller amounts of pargasite; shows a semi-random arrangement mostly within planar zones<br><br>Chlorite/Biotite - dimensional preferred orientation outlines foliation; forms along fractures in hornblende<br><br>Felsics - undulatory extinction and deformation banding is common |

| | |
|---|---|
| Assemblages | Cc-Qtz-Ep-Chl-Ab-Hnbd<br>Ilm-Ep-Parg-Ab-Chl-Bio-Hnbd-Qtz |
| Name | Ep-Chl-Bio-Ab-Qtz-Hnbd Schist |

## EUREKA QUARTZITE

[C1a]
{J86}

| | | |
|---|---|---|
| Colour | weathered - light brown to grey<br>fresh - light grey to blue grey | |
| Grain Size | fine to medium | |
| Mineralogy | Quartz..............85-90%<br>Biotite.............10-05%<br>Muscovite...........05-03%<br>Chlorite............00-02% | Accessory<br>Garnet<br>Magnetite |
| Textures | Fine to medium layering; compositional layering of graphitic and quartzose units mostly \|\| to S2 foliation; tight folds of compositional layering with S2 foliation as axial plane are involved in coaxial upright medium folds whose axial plane is represented by a spaced cleavage<br><br>Micas - dimensional preferred orientation defines S2 foliation; some grains at high angle to foliation are kinked; associated with opaques; some growth along S3 cleavage planes<br><br>Quartz - elongate \|\| to S2 foliation; grain boundries are serrated and hazy; undulatory extinction and deformation bands are common; coarser grains could belong to veining \|\| S2 | |
| Assemblages | Bio-Qtz<br>Musc-Bio-Qtz | |
| Name | Musc-Bio Quartzite | |

[C1b]
{J104}

| | | |
|---|---|---|
| Colour | weathered - light brown and dark grey<br>fresh - grey to medium blue grey | |
| Grain Size | fine to medium | |
| Mineralogy | Quartz..............85-90%<br>Biotite.............08-05%<br>Muscovite...........00-03%<br>Chlorite............00-02%<br>Hornblende..........05-00% | Accessory<br>Garnet<br>Magnetite<br>Epidote<br>Graphite |
| Textures | Fine to medium layering; compositional layering of graphitic and quartzose units mostly \|\| to S2 foliation; tight folds of | |

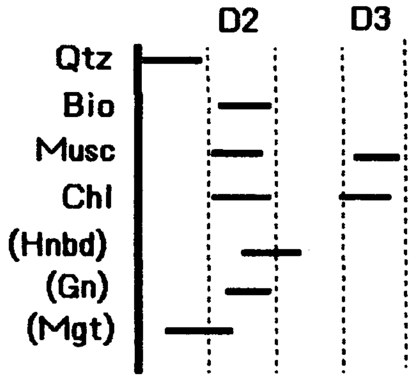
compositional layering with S2 foliation as axial plane are involved in coaxial upright medium folds whose axial plane is represented by a spaced cleavage

Micas - dimensional preferred orientation defines S2 foliation; some grains at high angle to foliation are kinked

Quartz - elongate || to S2 foliation; undulatory extinction and deformation bands are common; grain boundries are serrated and hazy

Garnet - a relationship with mgt-hnbd-bio-ep is suggested

| | |
|---|---|
| Assemblages | Ep-Hnbd-Bio-Qtz<br>Gn-Mgt-Chl-Musc-Bio-Qtz |
| Name | Bio Quartzite with local Ep-Hnbd-Bio Quartzite or Gn-Mgt-Chl-Musc-Bio Quartzite |

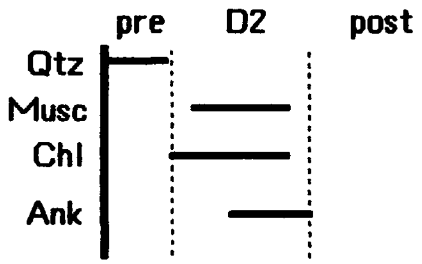



Unit C1b

## CROOKED LAKE PHYLLITE

[D1a]
{J45}

| | | |
|---|---|---|
| Colour | | weathered - grey brown to tan and rusty brown to pale green<br>fresh - grey to grey black and rusty orange |
| Grain Size | | two interlayered varieties :<br>- very fine to fine phyllite<br>- fine to medium schist with very coarse ankerite |
| Mineralogy | | Quartz..............15-30%<br>Muscovite...........05-35%<br>Ankerite............50-00%<br>Chlorite............30-05%<br>Graphite............00-30% |
| Textures | | Medium layered; compositional layering of black to grey phyllite and ankerite schist \|\| to S2 foliation; foliation is crenulated by two later cleavages |
| Assemblages | | Chl-Graph-Qtz-Musc<br>Musc-Qtz-Chl-Ank |
| Name | | Graph-Qtz-Musc Phyllite interlayered withz Qtz-Chl-Ank Schist |




Unit D1a, D1b, D1c

[D2a]
{J52}

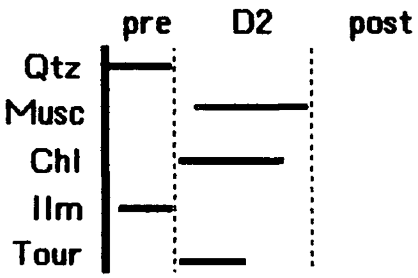
| | | |
|---|---|---|
| Colour | | weathered - rusty coal grey to light grey and brown<br>fresh - grey white to medium grey and red brown |
| Grain Size | | very fine to fine |
| Mineralogy | | Quartz..............80-25% |

Muscovite............08-40%
Chlorite.............10-05%
Graphite.............02-25%
Calcite..............00-05%

Textures — Fine to medium layered; compositional layering of phyllite and sandstone at high angle to S2 foliation/cleavage; S2 foliation associated with open folding of compositional layering; foliation is open folded about a steep axis toward the north

Assemblages — Cc-Chl-Graph-Qtz-Musc
Musc-Chl-Qtz

Name — Chl-Graph-Qtz-Musc Phyllite with very minor Musc-Chl Quartzite




Unit D2

[D3a]
{J41}

Colour — weathered - dark brown to yellow rust brown
fresh - light grey to yellow grey

Grain Size — fine to medium

Mineralogy — K-Feldspar.............80%
Quartz.................10%
Pyrite.................10%

Textures — Massive; a solitary one to two meter unit set in phyllite matrix

K-Feldspar - contains abundant quartz inclusions that resembles myrmekite; possible sericitization; clastic grain boundries preserved with quartz cement

| | | |
|---|---|---|
| | Assemblages | Py-Qtz-Kspar |
| | Name | Myrmekitic-Kspar Meta-arkose |
| [D2b] {J40} | Colour | weathered - rusty coal grey and tan<br>fresh - grey black and white grey |
| | Grain Size | very fine to medium |
| | Mineralogy | Quartz..............70-30%<br>Muscovite...........20-30%<br>Chlorite............10-05%<br>Graphite............00-35% |
| | Textures | Medium layered; `sandy' units constitute 10-50% of lithology; compositional layering at high angle to S2 foliation/cleavage; foliation is axial planar to open/medium folds of compositional layering; foliation is open/medium folded |
| | Assemblages | Chl-Musc-Qtz-(Graph) |
| | Name | Chl-Musc-Qtz-Graph Phyllite interlayered with Chl-Musc Quartzite |
| [D1b] {J57} | Colour | weathered - grey-brown to tan<br>fresh - grey to grey-black, white, and rusty orange |
| | Grain Size | very fine with coarse ankerite |
| | Mineralogy | Ankerite............85-10%<br>Chlorite............00-45%<br>Quartz..............02-20%<br>Muscovite...........10-05% |
| | Textures | Finely layered; vague compositional layering of ankerite and musc-chl-qtz units at high angle to S2 foliation<br><br>Ankerite - alignment of grains in direction of S2 foliation suggests development of new compositional fabric<br><br>Muscovite - dimensional preferred orientation outlines weak foliation |

Assemblages — Qtz-Musc-Ank
Musc-Ank-Qtz-Chl

Name — Qtz-Musc-Ank Schist and Musc-Ank-Qtz-Chl Schist interlayered with phyllite and quartzite

[D2c]
{J9} Colour — weathered - rusty coal grey to light grey
fresh - grey white and medium grey

Grain Size — very fine to fine with coarse ilmenite

Mineralogy

| | | |
|---|---|---|
| Quartz | 30-40% | Accessory |
| Muscovite | 20-50% | Tourmaline |
| Chlorite | 01-05% | |
| Fine opaque | 48-04% | |
| Ilmenite | 01-01% | |

Textures — Finely layered and medium layered; compositional layering of qtz-musc and 'graphitic' units on the smaller scale and quartzite/sandstones and phyllite/siltstones on the larger scale predominately || to S2 foliation where folding of compositional layering is tight; less common are occurrences of open to medium folding of compositional layering where the S2 foliation/ cleavage is axial planar; one later cleavage lies sub-|| to S2 foliation; another cleavage lies at a large angle to S2 foliation and is associated with open to medium buckle folding of S2 foliation, and compositional layering especially where tightest early folds occur

Muscovite - dimensional preferred orientation outlines S2 foliation; polygonal arcs suggest transposition of an earlier fabric

Chlorite - forms augen-like masses; basal cleavage is generally oriented at high angle to S2 foliation

Ilmenite - high angle grains are bent and show pressure shadows || to S2 foliation

Assemblages — Ilm-Graph-Chl-Qtz-Musc

Ilm-Chl-Musc-Qtz-Graph

Name — Graphitic Musc-Qtz Phyllite, Chl-Qtz-Musc Meta-siltstone, and minor Musc-Chl Quartzite

[D3b]
{J78}

Colour — weathered - light green to tan green
fresh - green grey

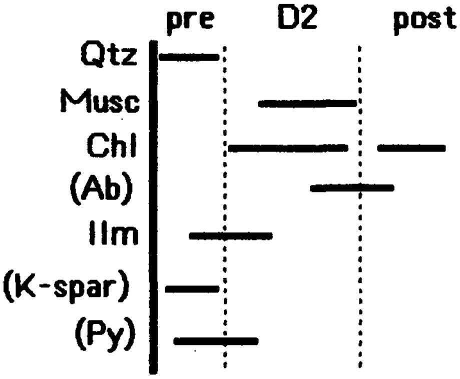
Grain Size — fine

Mineralogy — Quartz.................90%
Muscovite..............08%
Chlorite...............02%

Textures — Finely layered; compositional layering of phyllite and phyllitic siltstone || and at high angle to foliation; foliation associated with recumbant open/medium folds of compositional layering; foliation is involved in upright open/medium folds especially where compositional layering is transposed; upright kink forms of foliation also occur with trends at high angle to the earlier fold forms

Assemblages — Chl-Musc-Qtz

Name — Musc-Qtz Phyllitic siltstone




Unit D3

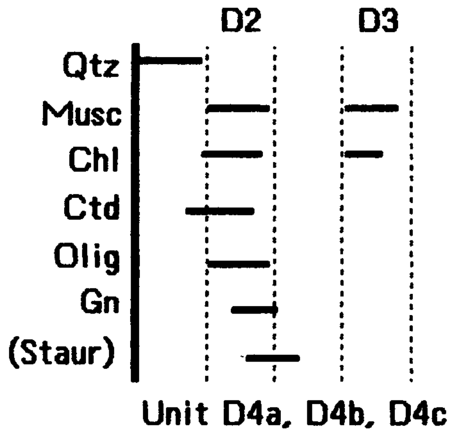
[D2d]
{J69}

Colour — weathered - rusty coal grey to light grey
fresh - grey white and medium grey

Grain Size — very fine to fine with coarse muscovite

| | | |
|---|---|---|
| | Mineralogy | Quartz..............30-40%<br>Muscovite...........20-50%<br>Chlorite............02-06%<br>Fine opaque.........48-04% |
| | Textures | Fine to medium layered; compositional layering of phyllitic siltstone and phyllite \|\| to S2 foliation; an extremely pervasive horizontal foliation is crenulated by S2 foliation; abundant quartz veining occurs |
| | Assemblages | Chl-Musc-Qtz-Graph<br>Graph-Chl-Qtz-Musc |
| | Name | Musc-Qtz-Graph Phyllite interlayered with Chl-Qtz-Musc Meta-siltstone |
| [D1c]<br>{J77} | Colour | weathered - tan to grey and rusty brown to pale green<br>fresh - light grey to dark grey and grey green |
| | Grain Size | two interlayered species:<br>- very fine to fine phyllite<br>- fine to medium schist with coarse ankerite |
| | Mineralogy | Quartz..............15-30%<br>Muscovite...........05-35%<br>Ankerite............50-00%<br>Chlorite............30-05%<br>Graphite............00-30% |
| | Textures | Medium layered; compositional layering of phyllite, schist, and quartzite is \|\| to and at high angle to foliation; S2 foliation crenulates a very flat cleavage; S2 foliation is openly folded |
| | Assemblages | Musc-Qtz-Chl-Ank<br>Chl-Graph-Qtz-Musc |
| | Name | Graph-Qtz-Musc Phyllite interlayered with<br><br>Qtz-Chl-Ank Schist and minor Quartzite |
| [D4a]<br>{J67} | Colour | weathered - light grey to coal grey |

| | |
|---|---|
| | fresh - medium grey |
| Grain Size | very fine to fine with coarse ilmenite and very coarse plagioclase and chloritoid |
| Mineralogy | Quartz..............55-30% Accessory<br>Muscovite...........10-40% Tourmaline<br>Chlorite............10-05%<br>Plagioclase.........15-10%<br>Chloritoid..........05-05%<br>Graphite............00-05%<br>Ilmenite............05-05% |
| Textures | Finely layered; compositional layering of phyllite and porphyroblastic units \|\| to S2 foliation; foliation is locally deflected by porphyroblasts<br><br>Micas - dimensional preferred orientation outlines foliation<br><br>Andesine - most abundant porphyroblast; as single crystals and aggregates; poikiloblastic, containing inclusions of chlorite, quartz, and tourmaline<br><br>Chloritoid - poikiloblastic, containing mostly quartz and ilmenite; Si \|\| Se; related to masses of quartz-muscovite-chlorite; separated from andesine by chlorite-Fe oxide rim; basal planes are consistantly oriented at 30 degree angle to S2 foliation<br><br>Ilmenite - mostly aligned \|\| to S2 foliation; where at high angle show well developed pressure shadows of quartz |
| Assemblages | Ctd-Ilm-Chl-Musc-Ands-Qtz<br>Chl-Ctd-Ilm-Graph-Ands-Qtz-Musc |
| Name | Ilm-Ctd-Graph-Chl-Musc-Ands-Qtz Schist |




[D2e]
{J66}

| | | |
|---|---|---|
| Colour | | weathered - rusty coal grey to light grey<br>fresh - grey white and medium grey |
| Grain Size | | very fine to fine with coarse muscovite |
| Mineralogy | | Quartz..............30-35%<br>Muscovite...........20-45%<br>Chlorite............02-06%<br>Graphite............48-04%<br>Calcite.............00-10% |
| Textures | | Finely layered; compositional layering of limy phyllitic siltstone and phyllite \|\| to S2 foliation; abundant quartz and calcite veining occurs |
| Assemblages | | Chl-Musc-Qtz-Graph<br>Graph-Chl-Cc-Qtz-Musc |
| Name | | Musc-Qtz-Graph Phyllite interlayered with Chl-Cc-Qtz-Musc Meta-siltstone |

[D3c]
{J166}

| | | |
|---|---|---|
| Colour | | weathered - brown grey to tan<br>fresh - light grey to green grey |
| Grain Size | | very fine to fine |
| Mineralogy | | Quartz..............10-25-45%<br>Calcite.............05-35-00%<br>Muscovite...........00-10-15%<br>Chlorite............20-10-00%<br>Plagioclase(An0)....50-15-00%<br>Epidote.............10-00-15%<br>Fine opaque.........05-02-00% |

| | | |
|---|---|---|
| | | Graphite............00-03-25% |
| | Textures | Complexly layered; compositional layering of limy units, phyllite, sandstone || to S2 foliation; foliation is kinked<br><br>Micas - dimensional preferred orientation outlines S2 foliation |
| | Assemblages | Musc-Ab-Qtz-Cc<br>Ep-Ab-Qtz<br>Chl-Musc-Qtz-Graph |
| | Name | Interlayered Musc-Py-Ab-Qtz Marble with Ep-Ab-Qtz Meta-siltstone |
| [D2f]<br>{J169} | Colour | weathered - rusty grey to light grey<br>fresh - grey white and medium grey |
| | Grain Size | very fine to fine |
| | Mineralogy | Quartz..............30-35%<br>Muscovite...........20-45%<br>Chlorite............02-06%<br>Graphite............48-04%<br>Calcite.............00-10% |
| | Textures | Finely layered; compositional layering || to S2 foliation; abundant quartz veining occurs |
| | Assemblages | Chl-Musc-Qtz-Graph<br>Graph-Qtz-Musc |
| | Name | Musc-Qtz-Graph Phyllite interlayered with Chl-Cc-Qtz-Musc Meta-siltstone |
| [D2g]<br>{J115} | Colour | weathered - rusty grey to tan<br>fresh - grey white and medium grey |
| | Grain Size | very fine to fine |
| | Mineralogy | Quartz..............30-35%<br>Muscovite...........20-45%<br>Chlorite............02-06%<br>Graphite............48-04%<br>Calcite.............00-10% |
| | Textures | Finely layered phyllite and minor phyllitic siltstone; compositional layering of || to S2 |

| | | |
|---|---|---|
| | | foliation with som tight folds developing; abundant quartz veining |
| | Assemblages | Chl-Musc-Qtz-Graph<br>Graph-Chl-Qtz-Musc |
| | Name | Musc-Qtz-Graph Phyllite interlayered with Chl-Qtz-Musc Meta-siltstone |
| [D2h]<br>{J84} | Colour | weathered - rusty coal grey to dark grey<br>fresh - grey white and medium grey |
| | Grain Size | very fine to fine with coarse muscovite |
| | Mineralogy | Quartz..............30-35%<br>Muscovite...........20-45%<br>Biotite.............02-06%<br>Graphite............48-04%<br>Calcite.............00-10% |
| | Textures | Finely layered with abundant quartz veining and boudinage; compositional layering \|\| to S2 foliation; some biotite porphyroblasts |
| | Assemblages | Bio-Musc-Qtz-Graph<br>Graph-Bio-Qtz-Musc |
| | Name | Musc-Qtz-Graph Phyllite |
| [D4b]<br>{J85} | Colour | weathered - light grey to coal grey<br>fresh - medium grey |
| | Grain Size | very fine to fine with coarse ilmenite and very coarse plagioclase and chloritoid |
| | Mineralogy | Quartz..............55-30% Accessory<br>Muscovite...........10-40% Tourmaline<br>Chlorite............10-05%<br>Plagioclase.........15-10%<br>Chloritoid..........05-05%<br>Graphite............00-05%<br>Ilmenite............05-05% |
| | Textures | Finely layered; compositional layering of phyllite and porphyroblastic units \|\| to S2 foliation; foliation is locally deflected by |

| | | |
|---|---|---|
| | | porphyroblasts; locally crenulations are well developed away from porphyroblasts |
| | | Micas - dimensional preferred orientation outlines foliation; |
| | | Andesine - most abundant porphyroblast; as single crystals and aggregates; poikiloblastic, containing inclusions of chlorite, quartz, and tourmaline; shows internally rotated $S_i$ \|\| $S_e$ near grain boundries |
| | | Chloritoid - poikiloblastic, containing mostly quartz and ilmenite; Si \|\| Se; related to masses of quartz-muscovite-chlorite; never in contact with andesine; basal planes are consistantly oriented at low to moderate degree angle to S2 foliation |
| | | Ilmenite - mostly aligned \|\| to S2 foliation; where at high angle show well developed pressure shadows of quartz |
| | Assemblages | Ctd-Ilm-Chl-Musc-Ands-Qtz<br>Chl-Ctd-Ilm-Graph-Ands-Qtz-Musc |
| | Name | Ilm-Ctd-Graph-Chl-Musc-Ands-Qtz Phyllite |
| [D2i]<br>{J154} | Colour | weathered - brown grey to green grey<br>fresh - light to medium blue grey |
| | Grain Size | very fine to fine with medium actinolite |
| | Mineralogy | Felsic..............25-62%<br>Biotite.............05-03%<br>Epidote.............05-15%<br>Actinolite..........60-20%<br>Relict Hornblende...03-00%<br>Fine opaque.........02-00% |
| | Textures | Finely layered; compositional layering of felsic and amphibolitic units \|\| to S2 foliation; foliation is openly folded |
| | | Actinolite - dimensional preferred orientation outlines S2 foliation |

| | | |
|---|---|---|
| | | Hornblende - crystals generally have dark cores (original) and light rims (actinolite); biotite is associated with these crystals |
| | Assemblages | Hnbd-Ep-Bio-Felsic-Act<br>Bio-Ep-Act-Felsic |
| | Name | Ep-Bio-Felsic-Act Phyllite interlayered with Ep-Act-Felsic Meta-siltstone |
| [D3d]<br>{J152} | Colour | weathered - brown grey and pale green<br>fresh - medium grey and greyish green |
| | Grain Size | very fine to fine with medium pyrite and/or ankerite |
| | Mineralogy | Quartz..............15-45%<br>Plagioclase(An0)....10-35%<br>Calcite.............30-05%<br>Epidote.............20-08%<br>Pyrite..............10-00%<br>Ankerite............00-05%<br>Muscovite...........05-02%<br>Chlorite............10-00% |
| | Textures | Massive to slightly layered; compositional layering of calcite and rusty opaque bearing units \|\| to S2 foliation; foliation is kinked<br><br>Micas - dimensional preferred orientation outlines S2 foliation<br><br>Calcite - shows early twinning and late kinking; mosts twins are oriented close to 30 degrees from S2 foliation; kinking predominates where twins are oriented \|\| to S2 foliation |
| | Assemblages | Musc-Py-Ab-Qtz-Cc<br>Musc-Cc-Ank-Ep-Ab-Qtz |
| | Name | Musc-Py-Ab-Qtz Marble interlayered with Ep-Ab-Qtz Meta-siltstone |
| [D2j]<br>{J118} | Colour | weathered - rusty coal grey to light grey<br>fresh - grey white and medium grey |
| | Grain Size | very fine to fine with coarse muscovite |

| | | |
|---|---|---|
| Mineralogy | Quartz..............30-35%<br>Muscovite...........20-55%<br>Chlorite............02-06%<br>Graphite............48-04% | |
| Textures | Finely layered; compositional layering of limy phyllitic siltstone and phyllite \|\| to S2 foliation; foliation is kinked | |
| Assemblages | Chl-Musc-Qtz-Graph<br>Graph-Chl-Qtz-Musc | |
| Name | Musc-Qtz-Graph Phyllite interlayered with Chl-Qtz-Musc Meta-siltstone | |

[D4c]
{J120}

| | | |
|---|---|---|
| Colour | weathered - light grey to coal grey<br>fresh - medium grey | |
| Grain Size | fine to medium with very coarse chloritoid and garnet | |
| Mineralogy | Chlorite............20-10%<br>Muscovite...........20-45%<br>Quartz..............45-30%<br>Chloritoid..........03-03%<br>Ilmenite............01-01%<br>Garnet..............01-01% | Accessory<br>Tourmaline<br>Graphite |
| Textures | Finely layered; compositional layering of micaceous and quartzose units \|\| S2 foliation; a second compositional layering is seen developing at high angle to S2 foliation related to a spaced cleavage that crenulates S2 foliation<br><br>Micas - dimensional preferred orientation outlines S2 foliation and to a lesser degree later spaced cleavage<br><br>Chloritoid - low to moderate angle to foliation<br><br>Garnet - serrated edges; rotational inclusion trails with $S_i$ \|\| $S_e$ close to grain boundries<br><br>Ilmenite - mostly \|\| to foliation; where at high angle shows well developed quartz pressure shadows | |

| | |
|---|---|
| Assemblages | Gn-Ilm-Ctd-Musc-Chl-Qtz |
| Name | Gn-Ilm-Ctd-Musc-Chl-Qtz Phyllite interlayered with phyllite and phyllitic siltstone |

## TAKLA GROUP

| | | |
|---|---|---|
| [E1a] {J59} | Colour | weathered - rusty yellow green to dark green<br>fresh - pistachio green and dark green |
| | Grain Size | very fine to fine with extremely coarse aggregates of medium to coarse hnbd, hnbd-ep, hnbd-ep-plag-(qtz), and ep-plag-(qtz) |
| | Mineralogy | Plagioclase(An0)....50-45%<br>Epidote.............07-03%<br>Calcite.............03-05%<br>Muscovite...........25-35%<br>Chlorite............05-00%<br>Quartz..............05-10%<br>Hornblende..........05-02% |
| | Textures | Massive to very coarsely layered; contains clasts/fragments with or without pressure shadows, spherulites, and abundant contorted cross cutting veins<br><br>Micas - dimensional preferred orientation outlines foliation; high angle varieties are included with fine opaque and grow on or around hornblende<br><br>Epidote - forms veins that cut across foliation at low to high angles; broken, discontiuous, and highly contorted<br><br>Hornblende - form pressure shadows on ep-plag aggregates |
| | Assemblages | Cc-Qtz-Chl-Hnbd-Ep-Musc-Ab<br>Hnbd-Ep-Cc-Qtz-Musc-Ab |
| | Name | Qtz-Ep-Musc-Ab Meta-Breccia with clasts of Hnbd, Hnbd-Ep, Hnbd-Ep-Ab-(Qtz), and Ep-Ab-(Qtz) |
| [E2a] {J65, J1, J2} | Colour | weathered - green olive to olive black<br>fresh - grey green to green black and white green |

Grain Size — cryptocrystalline to fine with coarse porphyroclasts and ellipsoidal objects

Mineralogy

| | | |
|---|---|---|
| Quartz.............. | 15-15% | Accessory |
| Plagioclase(An0).... | 23-50% | Sphene |
| Actinolite.......... | 45-02% | |
| Calcite............. | 05-30% | |
| Epidote............. | 05-00% | |
| Chlorite............ | 07-03% | |

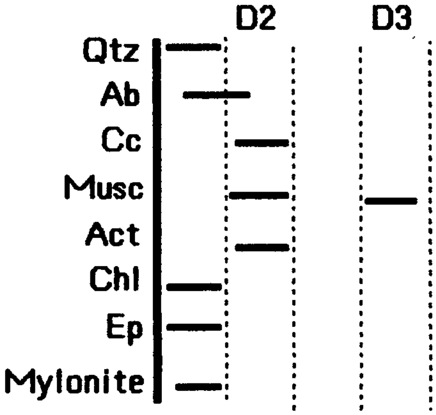
Textures — Finely layered; compositional layering of cc-ab-qtz and act-ab-qtz units is discontinuous and isoclinally folded || to S2 foliation; an earlier fabric is possibly folded as well; foliation is involved in open folds associated with a spaced clevage

Quartz - shows undulatory extinction, deformation banding, and ribbon grains; generally c-axes of grains lie close to plane of foliation

Actinolite - dimensional preferred orientation outlines S2 foliation and possibly an earlier one

Assemblages — Cc-Ep-Chl-Qtz-Ab-Act
Act-Chl-Qtz-Cc-Ab

Name — Qtz-Cc-Ab-Act Mylonite with Cc-Ab-Qtz and Chl-Ep veining

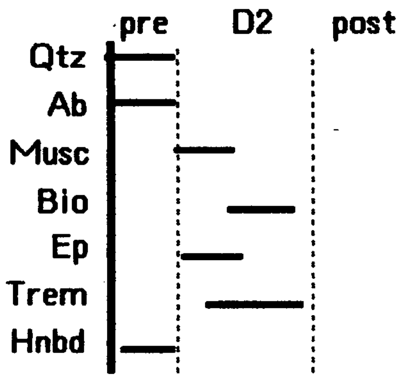



Unit E2a

[E3a]
{J44} Colour — weathered - brown grey to rusty grey green

| | | |
|---|---|---|
| | | fresh - blue grey to grey green |
| | Grain Size | very fine to fine |
| | Mineralogy | Quartz..............20-57% Accessories<br>Plagioclase(An0)....69-40% Apatite<br>Opaques.............01-01% Actinolite<br>Chlorite............10-02% Calcite |
| | Textures | Medium layered; compositional layering of rusty looking and sandy looking units \|\| to S2 foliation<br><br>Chl/Act - dimensional preferred orientation outlines foliation<br><br>Calcite - seems to form a cement for felsic grains |
| | Assemblages | Chl-Qtz-Ab<br>Chl-Ab-Qtz |
| | Name | Interlayered Qtz-Ab and Ab-Qtz Meta-siltstones |
| [E2b]<br>{J168} | Colour | weathered - pale green to rusty green grey<br>fresh - green grey |
| | Grain Size | medium with some coarse angular fragments |
| | Mineralogy | Plagioclase(An0)....60-45%<br>Quartz..............20-35%<br>Chlorite............18-15%<br>Opaques.............02-05% |
| | Textures | Coarse layering of sandy units with some local breccia units. Layering \|\| S2 foliation. |
| | Assemblages | Chl-Qtz-Ab |
| | Name | Chl-qtz-ab meta-sandstone |
| [E1b]<br>{J144} | Colour | weathered - rusty pale green<br>fresh - grey to grey green and dark green |
| | Grain Size | extremely coarse clasts with minor fine grained matrix |
| | Mineralogy | Plagioclase(An0)....45-40%<br>Quartz..............02-10%<br>Hornblende..........05-20% |

| | |
|---|---|
| | Chlorite............35-05% <br> Epidote.............13-25% |
| Textures | Massive; clasts are rounded to sub- rounded with less than 20% matrix; foliation cannot be clearly discerned within this unit; contact with lower units \|\| to local orientation of S2 foliation and is involved in upright medium folds |
| Assemblages | Qtz-Hnbd-Ep-Chl-Ab <br> Chl-Qtz-Hnbd-Ep-Ab |
| Name | Qtz-Hnbd-Ep-Ab Meta-conglomerate with minor Ep-Chl-Ab matrix |




Unit E2b

[E2c]
{J143}

| | |
|---|---|
| Colour | weathered - pale green to rusty green grey <br> fresh - green grey |
| Grain Size | fine to medium |
| Mineralogy | Plagioclase(An0)....68-45% <br> Quartz..............20-40% <br> Chlorite............10-10% <br> Opaques.............02-05% |
| Textures | Coarsely layered with chl schist, black to green grey phyllite, and a pophyroblastic meta-andesite; foliation is best outlined in finer grained units; contacts are seen to \|\| foliation; upright medium folds of foliation and contacts are common |

| | | |
|---|---|---|
| | Assemblages | Opaque-Chl-Qtz-Ab |
| | Name | Chl-Qtz-Ab Meta-sandstone interlayered with phyllites, chl schist, and porphyroblastic meta-andesite |
| [E4a] {J155} | Colour | weathered - pale green to rusty green grey<br>fresh - green grey |
| | Grain Size | fine to medium |
| | Mineralogy | Plagioclase(An0).....70-40%<br>Quartz...............15-35%<br>Chlorite.............10-20%<br>Opaques..............05-05% |
| | Textures | Massive to medium layered; compositional layering of sandstone and phyllite at high angle to S2 foliation and involved in medium to tight recumbant folds; foliation is gently warped to upright medium folded |
| | Assemblages | Opaque-Chl-Qtz-Ab |
| | Name | Chl-Qtz-Ab Meta-sandstone with minor grey phyllites |

## APPENDIX B

This appendix contains a compilation of the structural data collected at the Crooked Lake area. Geographic coordinates and altitudes are given for the Station Locations indicated (also, see Geologic Map, Plate I). The data, itself, is grossly divided into planar and linear fabrics; the planar data is subdivided into Fractures, Bedding, Foliations, and Cleavages, whereas, the linear data is subdivided into Tight, Medium, and Open Fold Hinges and General Lineations. The following identification codes allow futher subdivided of these 8 basic categories:

FCT - fracture

QVN - quartz veining

KBB - kink band boundry

CF1 - 1st of a congugate fracture set

BDD - bedding or compositional layering

ENS - enveloping surface of folds of BDD

FOL - foliation

DFL - foliation deformed by kinking

FLC - cleavage related to foliation

APO - axial plane of open folds

APM - axial planes of medium folds

APT - axial planes of tight folds

CLV - cleavage

FH - fold hinge

FHS - hinge of fold with 's' vergence

FHZ - hinge of fold with 'z' vergence

FHM - hinge of symmetric fold

LN - lineation

LNC - crenulation lineation

LNS - smear lineation

LNI - intersection lineation

LNR - rod lineation

LNM - mineral lineation

LNV - hinge of folded vein

LNB - boudin lineation

LNK - external rotation axis of kink

| Station ID | Elev. Feet | Long. 120°-x'W | Lat. 52°-y'N | [FRACTURE] IDStrDipDD | [BEDDING] IDStrDipDD | [FOLIATION] IDStrDipDD | [CLEAVAGE] IDStrDipDD | [TIGHT] IDTrePlu | [MEDIUM] IDTrePlu | [OPEN] IDTrePlu | [LIN] IDTrePlu |
|---|---|---|---|---|---|---|---|---|---|---|---|
| J1 | 3200 | 47.4286 | 14.3913 | | | FOL171 85E | APO 42 35NW | | | FHM352 10 | |
| J2 | 3200 | 47.2143 | 14.4130 | FCT 70 90 | BDD172 85E | FOL175 80E | CLV 8 65W | FH355 15 | | | |
| | | | | | | FOL172 85E | | | | | |
| | | | | | | FOL 3 75E | | | | | |
| J3 | 3300 | 46.1429 | 14.4848 | | | FOL 90 21N | | | | | LN 25 16 |
| J4 | 3600 | 43.3571 | 14.5435 | | BDD158 60W | FOL155 66W | CLV 52 59NW | | | | LNC329 71 |
| | | | | | | FOL158 60W | CLV 62 29NW | | | | LN324 46 |
| | | | | | | | | | | | LNS142 20 |
| J5,5a | 3550 | 43.2321 | 14.4891 | | BDD130 88W | FOL140 80W | APT 25 65NW | FHS340 40 | FH294 66 | FHM328 55 | LN288 15 |
| | | 43.6250 | 14.3804 | | | FOL146 76E | APO 32 48NW | | FH313 25 | FH295 30 | |
| | | | | | | FOL120 90 | APO 56 36NW | | | | |
| | | | | | | FOL113 82W | APO 32 66NW | | | | |
| | | | | | | FOL110 90 | APO175 60W | | | | |
| | | | | | | FOL121 90 | | | | | |
| | | | | | | FOL110 78NE | | | | | |
| | | | | | | FOL132 80NE | | | | | |
| | | | | | | FOL130 88W | | | | | |
| | | | | | | FOL140 90 | | | | | |
| | | | | | | FOL142 54W | | | | | |
| | | | | | | FOL158 70W | | | | | |
| | | | | | | FOL130 90 | | | | | |
| | | | | | | FOL125 85E | | | | | |
| | | | | | | FOL128 60NE | | | | | |
| | | | | | | FOL126 57E | | | | | |
| J6 | 3550 | 43.1429 | 14.5000 | | BDD140 56SW | FOL140 56SW | CLV115 76NE | FH292 45 | FH286 45 | | |
| | | | | | | FOL120 70SW | | | FH305 43 | | |
| J8 | 3300 | 43.7500 | 15.4348 | | BDD180 56W | FOL169 65W | CLV170 55W | | | FH295 59 | |
| | | | | | | FOL178 65W | | | | | |
| | | | | | | FOL180 56W | | | | | |
| | | | | | | FOL185 67W | | | | | |
| J9 | 3400 | 43.5536 | 15.2826 | | | FOL157 59W | CLV137 85E | | | | LN314 35 |
| J10 | 3450 | 43.3929 | 15.1196 | | | FOL156 72W | CLV 72 74NW | | | | LNC274 60 |
| J11 | 3500 | 43.1786 | 14.9348 | | ENS 74 62N | FOL 30 73NW | APM133 90 | FH285 60 | FH335 70 | FH198 15 | LNI259 28 |
| | | | | | ENS 93 67N | FOL 72 69NW | APM130 83NE | | FH274 33 | | LN284 8 |
| | | | | | | FOL 76 73NW | APO 14 30W | | FH295 35 | | LN295 46 |
| | | | | | | FOL 72 80NW | APM102 85NE | | FH310 51 | | LN278 58 |
| | | | | | | FOL 72 78NW | APM130 64SW | | FHS284 48 | | LN310 48 |
| | | | | | | FOL 90 88N | APT120 55SW | | | | |
| | | | | | | FOL116 74SW | APM138 60SW2 | | | | |
| | | | | | | FOL115 74W | APM156 61SW | | | | |
| | | | | | | FOL175 48W | APM142 67SW | | | | |
| | | | | | | FOL124 69SW | | | | | |
| | | | | | | FOL100 88E | | | | | |
| | | | | | | FOL 75 70NW | | | | | |
| | | | | | | FOL 22 79NW | | | | | |
| | | | | | | FOL 50 75NW | | | | | |
| | | | | | | FOL 88 83N | | | | | |
| | | | | | | FOL 84 84NW | | | | | |
| | | | | | | FOL 32 70NW | | | | | |
| | | | | | | FOL130 47SW | | | | | |
| | | | | | | FOL174 55W | | | | | |
| | | | | | | FOL122 66W | | | | | |
| | | | | | | FOL104 88NE | | | | | |
| | | | | | | FOL125 82SW | | | | | |
| | | | | | | FOL 92 90 | | | | | |

| Station ID | Elev. Feet | Long. 120°-x'W | Lat. 52°-y'N | [FRACTURE] IDStrDipDD | [BEDDING] IDStrDipDD | [FOLIATION] IDStrDipDD | [CLEAVAGE] IDStrDipDD | [TIGHT] IDTrePlu | [MEDIUM] IDTrePlu | [OPEN] IDTrePlu | [LIN] IDTrePlu |
|---|---|---|---|---|---|---|---|---|---|---|---|
| J12,13 | 3300 | 43.1071 | 15.0543 | | ENS 28 49NW | | APM150 76W | | FM182 50 | | LN312 52 |
| | | | | | ENS 12 36SE | | APM165 62W | | FMZ307 42 | | LN107 35 |
| | | | | | ENS 90 48S | | | | | | |
| J14 | 3500 | 42.9643 | 14.5326 | | | FOL128 76W | APM118 66W | | FMZ298 55 | | LNR306 43 |
| | | | | | | FOL 92 40N | APM120 76E | | FMZ313 41 | | LN309 70 |
| | | | | | | FOL 96 54NE | APM125 82E | | FMZ312 45 | | LN299 41 |
| | | | | | | FOL135 70W | APM 20 56NW | | FMZ305 50 | | |
| | | | | | | FOL158 78W | APM115 68NE | | FMZ299 22 | | |
| | | | | | | FOL132 75W | APM110 66NE | | FMZ302 35 | | |
| | | | | | | FOL148 74W | APM105 64NE | | FMZ311 40 | | |
| | | | | | | FOL124 84SW | APM115 65NE | | FMZ321 38 | | |
| | | | | | | FOL123 74E | APM 92 52N | | FMZ295 39 | | |
| | | | | | | FOL 55 35NW | APM 60 34NW | | FMZ290 33 | | |
| | | | | | | FOL122 84SW | APM125 75NE | | FMZ285 30 | | |
| | | | | | | FOL 85 45N | APM 92 65N | | FMZ290 36 | | |
| | | | | | | FOL130 74NE | APM102 60NE | | FMZ310 45 | | |
| | | | | | | FOL108 80NE | APM 88 49N | | FMZ283 35 | | |
| | | | | | | FOL130 80SW | APM118 80NE | | FMZ306 40 | | |
| | | | | | | FOL104 76NE | APM131 84NE | | FMZ290 35 | | |
| | | | | | | FOL129 64SW | | | | | |
| | | | | | | FOL149 66SW | | | | | |
| | | | | | | FOL144 60SW | | | | | |
| | | | | | | FOL148 78SW | | | | | |
| | | | | | | FOL 82 66N | | | | | |
| | | | | | | FOL115 90 | | | | | |
| | | | | | | FOL129 85SW | | | | | |
| | | | | | | FOL101 60NE | | | | | |
| | | | | | | FOL134 72SW | | | | | |
| | | | | | | FOL144 65SW | | | | | |
| | | | | | | FOL 95 58N | | | | | |
| | | | | | | FOL135 77SW | | | | | |
| | | | | | | FOL 78 40N | | | | | |
| | | | | | | FOL105 76NE | | | | | |
| | | | | | | FOL105 76NE | | | | | |
| | | | | | | FOL 30 36NW | | | | | |
| | | | | | | FOL 80 75NW | | | | | |
| | | | | | | FOL170 49W | | | | | |
| | | | | | | FOL136 72SW | | | | | |
| | | | | | | FOL141 70SW | | | | | |
| | | | | | | FOL164 63W | | | | | |
| | | | | | | FOL119 90 | | | | | |
| | | | | | | FOL145 60SW | | | | | |
| | | | | | | FOL162 57W | | | | | |
| J15 | 3550 | 43.9464 | 14.1413 | QVN100 36N | | FOL133 85W | | | | | LN306 32 |
| | | | | FCT132 85E | | | | | | | |
| J16 | 3550 | 44.4634 | 13.8152 | FCT 82 78N | | FOL128 87W | | | | FM128 56 | LNM151 46 |
| | | | | | | FOL135 88E | | | | | LNM113 63 |
| | | | | | | FOL123 75E | | | | | |
| | | | | | | FOL136 85W | | | | | |
| | | | | | | FOL150 86W | | | | | |
| | | | | | | FOL144 80E | | | | | |
| | | | | | | FOL127 86E | | | | | |
| | | | | | | FOL125 88E | | | | | |
| J19 | 3600 | 45.0357 | 13.9565 | FCT 74 85S | | FOL145 83W | | | | | |
| | | | | | | FOL153 80E | | | | | |

| Station ID | Elev. Feet | Long. 120°-x'W | Lat. 52°-y'N | [FRACTURE] IDStrDipDD | [BEDDING] IDStrDipDD | [FOLIATION] IDStrDipDD | [CLEAVAGE] IDStrDipDD | [TIGHT] IDTrePlu | [MEDIUM] IDTrePlu | [OPEN] IDTrePlu | [LIN] IDTrePlu |
|---|---|---|---|---|---|---|---|---|---|---|---|
| J19 (cont.) | | | | | | FOL165 90 | | | | | |
| | | | | | | FOL165 88W | | | | | |
| | | | | | | FOL165 86E | | | | | |
| | | | | | | FOL153 85E | | | | | |
| | | | | | | FOL170 75W | | | | | |
| | | | | | | FOL153 80W | | | | | |
| J21 | 3500 | 44.6071 | 13.8261 | | | FOL160 63W | | | | | |
| J22 | 3900 | 43.7857 | 13.1739 | FCT 48 26NW | BDD170 63W | FOL165 55W | APM153 68E | | FHZ336 26 | | LNC338 31 |
| | | | | | | FOL360 60W | | | | | |
| | | | | | | FOL170 70W | | | | | |
| | | | | | | FOL185 65W | | | | | |
| J23,24 | 4000 | 43.8036 | 13.2391 | FCT 48 26NW | | FOL165 55W | APM153 68E | | FHZ336 26 | | LNC338 31 |
| | | 43.9464 | 13.3261 | | | FOL 0 60W | | | | | |
| | | | | | | FOL170 70W | | | | | |
| | | | | | | FOL185 65W | | | | | |
| J26 | 3550 | 43.4643 | 14.2935 | | BDD132 90 | FOL125 66SW | APM143 63SW | | FHM300 30 | | |
| | | | | | BDD138 74W | FOL135 85E | APM138 74W | | FHM315 53 | | |
| | | | | | BDD157 68W | FOL156 66W | | | | | |
| J27 | 3600 | 43.6071 | 15.1304 | | ENS 66 35N | FOL192 58W | CLV 75 53N | | FHZ322 29 | FH298 45 | LNZ84 40 |
| | | | | | | FOL175 63W | APO 56 45NW | | | | LN333 34 |
| | | | | | | FOL176 74W | APO 40 70NW | | | | |
| | | | | | | FOL147 77W | | | | | |
| | | | | | | FOL186 21W | | | | | |
| | | | | | | FOL186 50W | | | | | |
| | | | | | | FOL172 66W | | | | | |
| | | | | | | FOL150 70W | | | | | |
| | | | | | | FOL165 76W | | | | | |
| | | | | | | FOL180 84W | | | | | |
| J28 | 3700 | 43.7500 | 15.0217 | | | FOL173 75W | | | | | |
| | | | | | | FOL160 63W | | | | | |
| J29 | 3800 | 43.8929 | 14.9891 | | | FOL174 80W | APM 80 76N | | FH291 52 | | |
| J30 | 3900 | 44.0714 | 15.0326 | | | FOL165 83W | APO 75 68N | | | FH344 60 | LN311 10 |
| | | | | | | FOL160 70W | | | | | |
| | | | | | | FOL158 70W | | | | | |
| | | | | | | FOL182 55W | | | | | |
| | | | | | | FOL135 75W | | | | | |
| | | | | | | FOL162 85W | | | | | |
| J31 | 4000 | 44.2143 | 15.0978 | | | FOL162 85W | | FH318 68 | | | |
| | | | | | | FOL149 85W | | | | | |
| | | | | | | FOL150 85W | | | | | |
| | | | | | | FOL155 75W | | | | | |
| J32 | 4200 | 44.4286 | 14.8804 | | | FOL150 85W | | | FHS335 55 | | |
| | | | | | | FOL140 80W | | | | | |
| | | | | | | FOL155 56W | | | | | |
| J33 | 3700 | 43.6071 | 14.7174 | | ENS140 43NE | FOL167 76W | APO 82 66N | | FH295 71 | FH 10 70 | LN323 65 |
| | | | | | | FOL170 65W | APO 55 68NW | | FH302 68 | FH344 69 | LN322 56 |
| | | | | | | FOL163 82E | APT154 62W | | FH333 31 | FH323 62 | LNC293 46 |
| | | | | | | FOL170 72W | CLV 54 68NW | | FH335 49 | | LNC310 40 |
| | | | | | | FOL171 86E | APO 68 60NW | | FHS340 35 | | LNS327 15 |
| | | | | | | FOL 15 82NW | | | | | LNC311 54 |
| | | | | | | FOL116 85SW | | | | | LNS342 3 |
| | | | | | | FOL163 70W | | | | | LNS349 29 |
| | | | | | | FOL173 85W | | | | | LNS355 28 |
| | | | | | | FOL166 65W | | | | | LNC293 59 |
| | | | | | | FOL165 68W | | | | | LNS324 42 |

| Station ID | Elev. Feet | Long. 120°-x'W | Lat. 52°-y'N | [FRACTURE] IDStrDipDD | [BEDDING] IDStrDipDD | [FOLIATION] IDStrDipDD | [CLEAVAGE] IDStrDipDD | [TIGHT] IDTrePlu | [MEDIUM] IDTrePlu | [OPEN] IDTrePlu | [LIN] IDTrePlu |
|---|---|---|---|---|---|---|---|---|---|---|---|
| J33 | (cont) | | | | | FOL 5 77W | | | | | LNC315 59 |
| | | | | | | FOL117 85NE | | | | | LNC347 39 |
| | | | | | | FOL 5 83W | | | | | LNV318 50 |
| | | | | | | FOL154 86W | | | | | LNC358 60 |
| | | | | | | FOL183 74W | | | | | LNC352 42 |
| | | | | | | FOL168 68W | | | | | LNS348 42 |
| | | | | | | FOL153 69W | | | | | LNC344 66 |
| | | | | | | FOL158 80E | | | | | |
| | | | | | | FOL175 84E | | | | | |
| | | | | | | FOL171 86E | | | | | |
| | | | | | | FOL105 84NE | | | | | |
| | | | | | | FOL175 74W | | | | | |
| | | | | | | FOL165 66W | | | | | |
| | | | | | | FOL175 79E | | | | | |
| | | | | | | FOL144 67W | | | | | |
| | | | | | | FOL150 81W | | | | | |
| | | | | | | FOL 18 77W | | | | | |
| | | | | | | FOL157 67W | | | | | |
| | | | | | | FOL126 81NE | | | | | |
| | | | | | | FOL 11 80W | | | | | |
| | | | | | | FOL175 64W | | | | | |
| | | | | | | FOL173 85W | | | | | |
| | | | | | | FOL 98 86NE | | | | | |
| | | | | | | FOL148 68SW | | | | | |
| J33a | 3800 | | | | BDD170 66W | FOL163 63W | APO 56 76NW | | FHM330 29 | FHS268 62 | LN324 80 |
| | | | | | BDD148 84W | FOL185 65W | APM 32 54NW | | FHS325 45 | FH290 52 | LNI340 21 |
| | | | | | BDD165 66W | FOL154 75W | APO 52 75NW | | FH331 64 | | LNR342 30 |
| | | | | | BDD152 88W | FOL149 70NE | APO 88 68N | | | | LN 30 70 |
| | | | | | | FOL148 84W | | | | | LN325 75 |
| | | | | | | FOL174 62W | | | | | LN328 44 |
| | | | | | | FOL144 70E | | | | | |
| J34 | 3900 | 43.7679 | 14.6739 | | | FOL175 65W | APT 72 46N | FH 11 44 | FH342 67 | FHS337 50 | LN322 40 |
| | | | | | | FOL 5 80E | APM 48 65NW | | | | LN303 54 |
| | | | | | | FOL172 72W | | | | | LN337 48 |
| | | | | | | FOL162 70W | | | | | LN176 50 |
| | | | | | | FOL162 60W | | | | | LN 14 87 |
| | | | | | | | | | | | LN300 70 |
| J35 | 4000 | 44.1071 | 14.6630 | | | FOL160 79W | | | FHS334 25 | | |
| | | | | | | FOL164 85W | | | | | |
| | | | | | | FOL150 80E | | | | | |
| J36,38 | 4150 | 44.4464 | 14.7065 | | | FOL140 80E | APM173 72W | | FHZ335 35 | | LN334 66 |
| | 4400 | 44.7321 | 14.7609 | | | FOL154 78W | APO135 65NE | | FH316 46 | | LN336 38 |
| | | | | | | FOL160 85W | | | FHZ320 45 | | |
| | | | | | | FOL160 85E | | | | | |
| | | | | | | FOL159 80W | | | | | |
| | | | | | | FOL166 75W | | | | | |
| J40 | 4400 | 45.1071 | 14.6957 | | ENS 90 36N | FOL167 85W | | | FHM342 36 | | |
| | | | | | | | | | FHM335 53 | | |
| | | | | | | | | | FHM326 50 | | |
| | | | | | | | | | FHM330 68 | | |
| J41 | 4500 | 45.1786 | 14.7826 | | | FOL168 79W | APO 98 64N | | | FH295 72 | LN334 40 |
| | | | | | | | CLV153 90 | | | | |
| J42 | 3300 | 47.3929 | 14.4674 | | | FOL177 82E | APO 50 43N | | | | LN341 25 |
| | | | | | | FOL130 68NE | | | | | |

| Station ID | Elev. Feet | Long. 120°-x'W | Lat. 52°-y'N | [FRACTURE] IDStrDipDD | [BEDDING] IDStrDipDD | [FOLIATION] IDStrDipDD | [CLEAVAGE] IDStrDipDD | [TIGHT] IDTrePlu | [MEDIUM] IDTrePlu | [OPEN] IDTrePlu | [LIN] IDTrePlu |
|---|---|---|---|---|---|---|---|---|---|---|---|
| J42 | (cont) | | | | | FOL158 80E | | | | | |
| | | | | | | FOL170 90 | | | | | |
| | | | | | | FOL 10 85W | | | | | |
| J43 | 3500 | 47.4107 | 14.6413 | | | FOL 5 66W | APO120 53NE | | | | LN 2 44 |
| | | | | | | FOL170 63E | | | | | LNI359 40 |
| | | | | | | | | | | | LN188 25 |
| | | | | | | | | | | | LN215 35 |
| J44 | 3800 | 46.8929 | 14.8043 | | BDD163 70E | FOL140 85E | CLV155 55E | | | FH114 50 | LNS150 3 |
| | | | | | | | | | | | LNS317 33 |
| | | | | | | | | | | | LNS315 45 |
| J45 | 4000 | 46.5000 | 14.8587 | | | FOL 20 50E | | | | FH175 23 | LN 39 15 |
| | | | | | | FOL 0 56E | | | | | |
| J46 | 3100 | 44.0357 | 16.0000 | | | FOL156 70W | | | | | |
| J47 | 3400 | | | | | FOL130 60E | | | | | |
| J48 | 3700 | 46.2679 | 15.5652 | | | FOL172 65W | | | | | |
| | | | | | | FOL143 83W | | | | | |
| J49 | 3900 | 46.1964 | 15.4891 | | | FOL159 84W | | | | FHM144 22 | LN150 5 |
| | | | | | | FOL155 88W | | | | | LN150 20 |
| | | | | | | FOL153 86E | | | | | |
| J50 | 4000 | 46.1429 | 15.3639 | | | FOL143 90 | | | | | LN135 50 |
| | | | | | | FOL152 87E | | | | | LN 10 60 |
| J51 | 4200 | 46.0714 | 15.2609 | | | FOL158 79W | APO110 35S | | | FH165 40 | |
| J52,52a | 4600 | 45.9643 | 15.1304 | | BDD120 30NE | FOL148 83NE | APO 52 70NW | | FH350 20 | FH352 35 | LN165 43 |
| | 4500 | 45.9286 | 15.0652 | | BDD135 40NE | FOL 5 83E | | | | FH355 45 | LNI356 34 |
| | | | | | | FOL160 74E | | | | | LN158 33 |
| | | | | | | FOL170 75E | | | | | LN153 18 |
| | | | | | | | | | | | LN148 5 |
| J53 | 3600 | 45.2679 | 15.5978 | | | FOL145 83E | | | | | |
| J54 | 3900 | 44.7500 | 15.5435 | | ENS105 65NE | FOL156 88W | | | FHS329 67 | | LN334 40 |
| J55 | 4000 | 44.7143 | 15.2283 | | | FOL148 75E | | | FHM 32 33 | | |
| | | | | | | FOL143 90 | | | | | |
| J56 | 4100 | 44.8750 | 15.1196 | | ENS 14 64W | FOL165 74W | APM118 86NE | | FH338 55 | | |
| | | | | | | | | | FH310 62 | | |
| J57 | 4000 | 45.0179 | 15.2391 | | BDD 0 66W | FOL154 90 | | | FH328 42 | | |
| | | | | | | FOL162 75W | | | FH344 40 | | |
| | | | | | | FOL168 82W | | | | | |
| J59 | 3500 | 47.9821 | 14.8696 | | | FOL141 39E | | | | | |
| | | | | | | FOL178 55E | | | | | |
| | | | | | | FOL159 83E | | | | | |
| J60 | 3400 | 48.1607 | 14.9130 | | | FOL165 56E | | | | | LN340 25 |
| J61 | 3360 | 48.0000 | 14.6087 | | | FOL180 68E | | | | | LN 9 6 |
| | | | | | | | | | | | LN170 20 |
| J62 | 3500 | 48.0000 | 14.7500 | | | FOL168 70E | | | | | |
| J63 | 3650 | 47.8929 | 14.7500 | | | FOL 7 79E | | | | | |
| | | | | | | FOL165 67E | | | | | |
| J64 | 3600 | 47.5000 | 14.7935 | FCT 75 85S | | FOL178 74E | APO 5 15W | | FHZ 30 40 | FH 1 10 | LN348 10 |
| | | | | | | FOL 20 55E | APM 30 77NW | | FHS 12 36 | | LN345 52 |
| | | | | | | FOL 2 80E | APM 53 65NW | | | | |
| | | | | | | FOL177 70W | APM 40 58NW | | | | |
| | | | | | | FOL 2 88W | | | | | |
| | | | | | | FOL 9 75E | | | | | |
| | | | | | | FOL180 85W | | | | | |
| | | | | | | FOL 4 73E | | | | | |
| | | | | | | FOL175 76W | | | | | |
| | | | | | | FOL165 26E | | | | | |

| Station ID | Elev. Feet | Long. 120°-x'W | Lat. 52°-y'N | [FRACTURE] IDStrDipDD | [BEDDING] IDStrDipDD | [FOLIATION] IDStrDipDD | [CLEAVAGE] IDStrDipDD | [TIGHT] IDTrePlu | [MEDIUM] IDTrePlu | [OPEN] IDTrePlu | [LIN] IDTrePlu |
|---|---|---|---|---|---|---|---|---|---|---|---|
| J64 | (cont) | | | | | FOL175 75E | | | | | |
| J65 | 3600 | 47.6250 | 14.5543 | | | FOL162 70E | | | | | LN320 35 |
| | | | | | | FOL169 75E | | | | | |
| | | | | | | FOL164 72W | | | | | |
| | | | | | | FOL 16 68E | | | | | |
| | | | | | | FOL175 73E | | | | | |
| | | | | | | FOL 5 90 | | | | | |
| J66 | 3550 | 41.8571 | 16.3152 | FCT 15 90 | BDD112 32NE | FOL110 38NE | CLV144 57SW | | | | LN311 17 |
| | | | | | | FOL112 32NE | CLV138 78SW | | | | LN317 16 |
| | | | | | | FOL115 30NE | | | | | LN290 9 |
| J67 | 4100 | 41.0179 | 16.2391 | | | FOL111 24NE | | | | | LN296 6 |
| | | | | | | | | | | | LNB293 9 |
| J68 | 4350 | 40.8750 | 16.3043 | | BDD115 70NE | FOL105 33NE | | | FHS295 20 | | |
| | | | | | | FOL115 70NE | | | | | |
| J69 | 4950 | 40.6607 | 16.4239 | | | FOL104 34NE | CLV 82 26N | | | | LN315 22 |
| J70 | 5150 | 40.5357 | 16.4348 | FCT158 84W | | FOL 90 32N | APM 84 35N | | FH320 32 | | |
| | | | | FCT 72 56S | | FOL115 22NE | | | | | |
| J72 | 3150 | 37.6429 | 14.4783 | | | FOL 92 30N | APO150 55SW | | FHZ295 10 | FH305 18 | LNR310 20 |
| | | | | | | FOL 86 34N | | | | | |
| | | | | | | FOL 93 35N | | | | | |
| | | | | | | FOL101 35N | | | | | |
| | | | | | | FOL109 35N | | | | | |
| | | | | | | FOL127 42NE | | | | | |
| | | | | | | FOL 75 15N | | | | | |
| | | | | | | FOL100 40NE | | | | | |
| | | | | | | FOL115 31NE | | | | | |
| J73 | 3350 | 38.8393 | 14.8152 | | BDD116 30NE | FOL116 30NE | APO128 66SW | | | FH308 13 | LN203 10 |
| J74 | 3600 | 38.8036 | 14.8587 | | BDD 82 22N | FOL104 25NE | APT100 35N | FHZ95 10 | | | LN295 5 |
| | | | | | ENS 92 18S | FOL 98 34NE | | | | | LN301 16 |
| J75 | 3600 | 38.6250 | 14.8370 | FCT162 75W | | | APO170 42W | | | FHZ311 21 | |
| J76 | 3850 | 39.7500 | 15.3370 | QVN105 60NE | | FOL110 35NE | APO120 80NE | | FH290 21 | | LN294 4 |
| | | | | | | FOL105 52NE | APM120 60SW | | FH290 14 | | LN292 0 |
| | | | | | | FOL121 45NE | APM123 68SW | | | | LNR310 5 |
| J77 | 5000 | 41.5714 | 17.0217 | KBB170 66E | BDD150 70E | FOL103 50NE | CLV 92 22N | | FH320 41 | FHS335 20 | LNK 5 34 |
| | | 41.9107 | 17.1522 | FCT 98 38NE | ENS150 88W | FOL104 30NE | APM158 70E | | FH336 23 | | |
| | | | | | | DFL 50 60NW | APM 75 15N | | | | |
| | | | | | | DFL 76 28SE | CLV145 30NE | | | | |
| | | | | | | DFL 80 43NW | CLV124 19NE | | | | |
| | | | | | | DFL 60 75NW | CLV 53 18NW | | | | |
| | | | | | | FOL128 55NE | CLV 0 38W | | | | |
| | | | | | | FOL135 65NE | APM146 51NE | | | | |
| | | | | | | FOL132 44NE | | | | | |
| | | | | | | FOL132 12NE | | | | | |
| | | | | | | FOL137 35NE | | | | | |
| | | | | | | FOL160 40E | | | | | |
| | | | | | | FOL143 75NE | | | | | |
| | | | | | | FOL130 38NE | | | | | |
| | | | | | | FOL130 74NE | | | | | |
| | | | | | | FOL137 60NE | | | | | |
| | | | | | | FOL156 73SW | | | | | |
| | | | | | | FOL140 60NE | | | | | |
| | | | | | | FOL120 30NE | | | | | |
| | | | | | | FOL121 35NE | | | | | |
| J78 | 5550 | 40.5357 | 16.6630 | FCT 38 80SW | BDD100 24NE | FOL120 37NE | CLV 44 25NW | | | | LN335 22 |
| | | | | FCT 60 60SE | BDD168 55NE | FOL105 34NE | CLV 55 34NW | | | | LN330 22 |

| Station ID | Elev. Feet | Long. 120°-x'W | Lat. 52°-y'N | [FRACTURE] IDStrDipDD | [BEDDING] IDStrDipDD | [FOLIATION] IDStrDipDD | [CLEAVAGE] IDStrDipDD | [TIGHT] IDTrePlu | [MEDIUM] IDTrePlu | [OPEN] IDTrePlu | [LIN] IDTrePlu |
|---|---|---|---|---|---|---|---|---|---|---|---|
| J78 | (cont) | | | FCT 78 17N | BDD160 73W | FOL100 31NE | APM166 57SW | | | | LN335 25 |
| | | | | QVN 57 30NW | | FOL135 56NE | | | | | LN340 21 |
| | | | | | | FOL140 70NE | | | | | LN297 14 |
| J82 | 5800 | 40.0536 | 16.5543 | | | FOL109 44NE | APO110 80E | | | FHZ295 50 | |
| | | | | | | FOL125 60NE | | | | | |
| J83 | 6100 | 39.1429 | 15.7826 | QVN123 48NE | BDD125 31NE | FLC125 31NE | CLV125 68NE | | | FH315 15 | LN306 3 |
| | | | | QVN114 20NE | | | | | | | LNB337 17 |
| | | | | CF1166 83W | | | | | | | |
| | | | | CF2 50 85NW | | | | | | | |
| J84 | 5900 | 39.1964 | 15.7609 | CF1177 80E | BDD115 25SW | FLC123 20NE | CLV111 52NE | | | | |
| | | | | CF2 70 86W | BDD117 60SW | FLC120 25NE | | | | | |
| | | | | FCT167 74E | | FLC147 35NE | | | | | |
| J85 | 5500 | 39.3393 | 15.6848 | FCT 2 83W | BDD118 25NE | FOL115 34NE | CLV124 74NE | | | | LN294 2 |
| | | | | | | FLC118 25NE | | | | | LN110 8 |
| | | | | | | FLC120 20NE | | | | | LN295 4 |
| | | | | | | FLC134 30NE | | | | | LN299 12 |
| | | | | | | FOL107 20NE | | | | | |
| J86 | 5000 | 39.4464 | 15.5978 | QVN114 45NE | | FLC105 32NE | CLV170 64E | | | FH284 15 | LN290 10 |
| | | | | FCT165 73W | | FLC 95 30NE | | | | | |
| | | | | | | FOL 98 44NE | | | | | |
| | | | | | | FOL114 45NE | | | | | |
| | | | | | | FOL106 42NE | | | | | |
| | | | | | | FOL119 52NE | | | | | |
| | | | | | | FOL112 35NE | | | | | |
| | | | | | | FOL108 40NE | | | | | |
| J87 | 5000 | 39.7500 | 15.6522 | | | FOL108 35SW | APO115 72SW | | | FHS295 10 | |
| | | | | | | FOL104 62NE | | | | | |
| | | | | | | FOL112 48NE | | | | | |
| | | | | | | FOL105 58NE | | | | | |
| | | | | | | FOL 80 36NE | | | | | |
| J88 | 5250 | 39.7500 | 15.7826 | FCT 2 85W | | FLC109 44NE | CLV155 58E | | | | LN114 2 |
| | | | | | | FOL114 42NE | | | | | LN296 9 |
| | | | | | | FOL 95 35NE | | | | | |
| | | | | | | FOL124 26NE | | | | | |
| J89 | 6200 | 39.4464 | 16.0543 | FCT170 66W | BDD118 90 | FLC 95 25NE | CLV120 38NE | | | | |
| J90 | 6250 | 39.0893 | 15.7935 | FCT164 90 | BDD115 25NE | FOL116 50NE | CLV138 38NE | | | | LNK 16 50 |
| | | | | FCT171 78W | | DFL 71 55NW | CLV138 62NE | | | | LNI307 9 |
| | | | | KBB 10 85NW | | FOL125 26NE | CLV138 53NE | | | | LN305 7 |
| | | | | | | FOL116 38NE | CLV132 56NE | | | | LNB 0 36 |
| | | | | | | FOL115 25NE | | | | | LN310 10 |
| | | | | | | FOL110 25NE | | | | | LN300 0 |
| | | | | | | FOL115 39NE | | | | | LN120 2 |
| | | | | | | FOL108 35NE | | | | | LNR111 3 |
| | | | | | | FOL120 25NE | | | | | |
| J91 | 5650 | 39.0893 | 15.7935 | | | FOL116 30NE | CLV116 78NE | | | | LN297 0 |
| | | | | | | FOL105 34NE | | | | | |
| J92 | 5250 | 39.2679 | 15.5978 | FCT165 90 | | FOL104 36NE | APO140 75NE | | | FHS315 30 | |
| | | | | | | FOL102 45NE | APO130 52SW | | | FHS295 10 | |
| | | | | | | FOL106 55NE | | | | | |
| | | | | | | FOL106 49NE | | | | | |
| J93 | 5300 | 39.0893 | 15.5000 | | | FOL109 42NE | | | | | LN310 8 |
| | | | | | | FOL116 36NE | | | | | |
| | | | | | | FOL110 46NE | | | | | |
| J94 | 5400 | 39.0000 | 15.5109 | | | FOL111 20NE | APM118 62NE | | FH300 8 | FH306 6 | LN303 15 |
| | | | | | | FOL178 20E | APM116 90 | | | | |

| Station ID | Elev. Feet | Long. 120°-x'W | Lat. 52°-y'N | [FRACTURE] IDStrDipDD | [BEDDING] IDStrDipDD | [FOLIATION] IDStrDipDD | [CLEAVAGE] IDStrDipDD | [TIGHT] IDTrePlu | [MEDIUM] IDTrePlu | [OPEN] IDTrePlu | [LIN] IDTrePlu |
|---|---|---|---|---|---|---|---|---|---|---|---|
| J94 | (cont) | | | | | FOL103 38NE | | | | | |
| | | | | | | FOL114 50NE | | | | | |
| | | | | | | FOL130 52NE | | | | | |
| | | | | | | FOL108 23NE | | | | | |
| | | | | | | FOL118 40NE | | | | | |
| | | | | | | FOL122 46NE | | | | | |
| | | | | | | FOL116 85SW | | | | | |
| J95 | 5700 | 38.6607 | 15.4565 | | | FOL100 30NE | APO165 68E | | | FH345 30 | |
| | | | | | | FOL 95 32NE | | | | | |
| J96 | 5650 | 38.6429 | 15.3478 | | | FOL115 32NE | | | | | |
| | | | | | | FOL110 43NE | | | | | |
| | | | | | | FOL105 25NE | | | | | |
| J97 | 5600 | 38.5357 | 15.2826 | | | FOL122 50NE | | | | | LN310 12 |
| | | | | | | FOL111 41NE | | | | | |
| | | | | | | FOL115 49NE | | | | | |
| | | | | | | FOL129 45NE | | | | | |
| | | | | | | FOL118 32NE | | | | | |
| | | | | | | FOL120 50NE | | | | | |
| J98 | 5600 | 38.3929 | 15.3043 | FCT 15 83W | | FOL110 30NE | APM112 70NE | | FHS290 11 | | |
| | | | | | | FOL115 54NE | APM113 78NE | | FHS296 12 | | |
| | | | | | | FOL119 42NE | APM134 80SW | | FHS305 5 | | |
| | | | | | | FOL124 70NE | | | | | |
| | | | | | | FOL124 52NE | | | | | |
| | | | | | | FOL125 48NE | | | | | |
| J99 | 5600 | 38.1071 | 15.2283 | FCT 12 72W | | FOL130 36NE | APO120 74SW | | FHS305 10 | FHS301 5 | |
| | | | | FCT 11 85SE | | FOL121 40NE | APO122 72SW | | | FHS305 8 | |
| | | | | FCT137 57SW | | FOL112 25NE | APO110 83NE | | | | |
| | | | | | | FOL110 42NE | | | | | |
| | | | | | | FOL151 19SW | | | | | |
| | | | | | | FOL 24 10NW | | | | | |
| | | | | | | FOL 90 30N | | | | | |
| | | | | | | FOL120 56NE | | | | | |
| | | | | | | FOL116 55NE | | | | | |
| | | | | | | FOL111 30NE | | | | | |
| | | | | | | FOL128 24SW | | | | | |
| J100 | 5600 | 37.7679 | 15.1630 | | | FOL105 63NE | APO120 80SW | | | FH296 7 | |
| | | | | | | FOL119 60NE | | | | | |
| | | | | | | FOL130 65NE | | | | | |
| J101 | 5450 | 37.5000 | 15.1304 | | | FOL120 60NE | | | | | |
| | | | | | | FOL121 60NE | | | | | |
| | | | | | | FOL120 54NE | | | | | |
| J102 | 5350 | 37.4107 | 15.1087 | | | FOL134 48NE | APM125 76NE | | FHS297 2 | | |
| | | | | | | FOL128 48NE | | | | | |
| | | | | | | FOL131 30NE | | | | | |
| | | | | | | FOL162 43E | | | | | |
| | | | | | | FOL134 25NE | | | | | |
| | | | | | | FOL140 65NE | | | | | |
| | | | | | | FOL135 55NE | | | | | |
| | | | | | | FOL136 40NE | | | | | |
| | | | | | | FOL 95 11N | | | | | |
| | | | | | | FOL149 30NE | | | | | |
| | | | | | | FOL 15 9NW | | | | | |
| | | | | | | FOL136 55NE | | | | | |
| J103 | 5300 | 37.2500 | 15.1630 | | | FOL112 62NE | | | | | |
| | | | | | | FOL118 56NE | | | | | |

| Station ID | Elev. Feet | Long. 120°-x'W | Lat. 52°-y'N | [FRACTURE] IDStrDipDD | [BEDDING] IDStrDipDD | [FOLIATION] IDStrDipDD | [CLEAVAGE] IDStrDipDD | [TIGHT] IDTrePlu | [MEDIUM] IDTrePlu | [OPEN] IDTrePlu | [LIN] IDTrePlu |
|---|---|---|---|---|---|---|---|---|---|---|---|
| J104 | 5100 | 37.1250 | 15.1196 | FCT177 62W | | FOL140 36SW | APT 53 50NW | FH342 45 | FH308 10 | | |
| | | | | | | FOL135 36NE | APT 60 34N | FH303 24 | FH309 11 | | |
| | | | | | | FOL130 70NE | APT 10 25W | FH318 14 | FH308 9 | | |
| | | | | | | FOL120 76SW | APT 75 20NW | FH322 9 | FH300 7 | | |
| | | | | | | FOL152 46SW | APT160 5W | FH334 10 | FH311 9 | | |
| | | | | | | FOL125 49NE | APT118 42NE | FH321 6 | FH309 6 | | |
| | | | | | | FOL120 50NE | APM120 76SW | | | | |
| | | | | | | FOL123 40NE | APM132 90 | | | | |
| | | | | | | FOL127 16NE | APM129 72NE | | | | |
| | | | | | | FOL136 53NE | APM136 90 | | | | |
| | | | | | | FOL121 57NE | | | | | |
| | | | | | | FOL114 90 | | | | | |
| | | | | | | FOL120 40NE | | | | | |
| | | | | | | FOL118 90 | | | | | |
| | | | | | | FOL114 35SW | | | | | |
| J105 | 4900 | 36.9821 | 15.1087 | | | FOL125 30NE | CLV126 60NE | | | FH310 10 | |
| | | | | | | | APO130 90 | | | | |
| J106 | 5360 | 38.7500 | 15.2026 | | | FOL121 45NE | APO 53 65SE | | | FH 70 42 | |
| | | | | | | FOL100 55NE | | | | | |
| | | | | | | FOL105 36NE | | | | | |
| | | | | | | FOL138 40NE | | | | | |
| J107 | 5100 | 38.8214 | 15.2391 | QVN152 66W | | FOL130 34NE | CLV113 42NE | | | | |
| J108 | 5300 | 38.8571 | 15.3261 | QVN 95 55NE | | FOL150 42NE | | | | | |
| J109 | 5650 | 38.8750 | 15.5109 | KBB175 71E | | FOL105 35NE | CLV114 52NE | | | FH290 10 | LNK 36 34 |
| | | | | FCT165 53W | | FOL112 34SW | APO114 70NE | | | | LN298 4 |
| | | | | | | FOL115 45NE | | | | | LNB318 12 |
| | | | | | | FOL111 28NE | | | | | LN 5 56 |
| | | | | | | DFL 64 40NW | | | | | LNB290 4 |
| | | | | | | DFL 65 41NW | | | | | |
| | | | | | | FOL112 52NE | | | | | |
| | | | | | | FOL122 32NE | | | | | |
| | | | | | | FOL 96 35NE | | | | | |
| J110 | 6100 | 38.7321 | 15.6087 | FCT180 90 | | FOL115 18NE | | | | | |
| | | | | FCT 72 52W | | | | | | | |
| J111 | 5200 | 39.2143 | 15.4457 | FCT170 80W | | FOL122 52NE | | | | FH124 5 | |
| | | | | | | FOL114 34NE | | | | | |
| | | | | | | FOL100 38NE | | | | | |
| | | | | | | FOL119 65NE | | | | | |
| | | | | | | FOL118 12SW | | | | | |
| | | | | | | FOL100 25NE | | | | | |
| | | | | | | FOL 90 45N | | | | | |
| | | | | | | FOL102 45NE | | | | | |
| | | | | | | FOL105 45NE | | | | | |
| | | | | | | FOL142 52NE | | | | | |
| | | | | | | FOL155 25NE | | | | | |
| | | | | | | FOL120 44NE | | | | | |
| J112 | 4920 | 39.3036 | 15.3913 | FCT 12 84W | | FOL102 52NE | | | | | |
| | | | | FCT 10 76W | | FOL 98 42NE | | | | | |
| | | | | | | FOL170 20NE | | | | | |
| | | | | | | FOL 95 50NE | | | | | |
| | | | | | | FOL115 68NE | | | | | |
| | | | | | | FOL 96 50NE | | | | | |
| J113 | 4700 | 39.6071 | 15.5217 | | | FOL105 52NE | | | | | |
| | | | | | | FOL 94 55NE | | | | | |
| J114 | 4700 | 39.7500 | 15.5543 | | BDD103 42NE | FOL 93 35NE | APM142 30NE | | FH108 2 | | LN294 11 |

| Station ID | Elev. Feet | Long. 120°-x'W | Lat. 52°-y'N | [FRACTURE] IDStrDipDD | [BEDDING] IDStrDipDD | [FOLIATION] IDStrDipDD | [CLEAVAGE] IDStrDipDD | [TIGHT] IDTrePlu | [MEDIUM] IDTrePlu | [OPEN] IDTrePlu | [LIN] IDTrePlu |
|---|---|---|---|---|---|---|---|---|---|---|---|
| J114 | (cont) | | | | | FOL115 50NE | APM120 36NE | | FM128 1 | | LN296 10 |
| | | | | | | FOL115 15NE | | | | | LN305 12 |
| | | | | | | FOL115 85SW | | | | | |
| | | | | | | FOL105 25NE | | | | | |
| | | | | | | FOL112 40NE | | | | | |
| | | | | | | FOL108 58NE | | | | | |
| | | | | | | FOL115 50SW | | | | | |
| J115 | 6420 | 38.7500 | 16.0543 | | | FOL105 25NE | | | | | LNR310 13 |
| J116 | 6950 | 37.5000 | 15.9457 | | ENS 5 64W | | APM 93 40NE | | FM 10 35 | FM 12 35 | |
| | | | | | | | APO 5 70E | | | | |
| J117 | 6950 | 37.0357 | 16.1630 | | | FOL 77 50NW | APM126 42NE | | FMS340 50 | | |
| | | | | | | FOL 90 41NE | | | FM 5 45 | | |
| J118 | 6450 | 37.3393 | 15.6413 | KBB170 78E | | FOL114 63NE | CLV114 68NE | | | | LN301 15 |
| | | | | | | OFL 47 72NW | | | | | LN304 18 |
| | | | | | | FOL115 45NE | | | | | LN332 26 |
| | | | | | | FOL109 49NE | | | | | LNB 21 61 |
| | | | | | | FOL116 60NE | | | | | |
| | | | | | | FOL114 49NE | | | | | |
| | | | | | | FOL101 36NE | | | | | |
| | | | | | | FOL110 46NE | | | | | |
| J119 | 6000 | 36.8036 | 15.4130 | FCT175 70W | | FOL106 55NE | | | | | LN295 3 |
| | | | | | | FOL115 38NE | | | | | |
| | | | | | | FOL112 52NE | | | | | |
| | | | | | | FOL115 55NE | | | | | |
| | | | | | | FOL110 50NE | | | | | |
| | | | | | | FOL115 45NE | | | | | |
| | | | | | | FOL105 31NE | | | | | |
| J120 | 5820 | 36.9107 | 15.2717 | | | FOL125 52NE | | | | | LN300 3 |
| | | | | | | FOL120 56NE | | | | | |
| | | | | | | FOL126 50NE | | | | | |
| J121 | 5900 | 37.2500 | 15.3043 | FCT176 82W | | FOL122 52NE | | | | | |
| | | | | | | FOL118 45NE | | | | | |
| J122 | 6000 | 37.6071 | 15.3587 | | | FOL115 48NE | CLV120 75NE | | | | LN298 9 |
| | | | | | | FOL112 50NE | | | | | |
| J142 | 6920 | 36.6071 | 16.4239 | | | FOL 89 60N | | | | | LN270 4 |
| | | | | | | FOL 93 65NE | | | | | LN 76 20 |
| | | | | | | FOL114 64NE | | | | | LN 78 27 |
| | | | | | | FOL 92 46NE | | | | | LN106 3 |
| | | | | | | FOL105 74NE | | | | | LN116 0 |
| J143 | 7020 | 36.6071 | 16.5326 | | BDD 68 48NW | FOL 92 60N | | | | | |
| J144 | 7000 | 36.5357 | 16.6304 | | | FOL 73 32NW | | | | | LN307 40 |
| J145 | 7300 | 36.6786 | 16.9565 | FCT118 30NE | BDD150 83W | FOL122 55NE | | | | | |
| | | | | FCT113 45NE | | | | | | | |
| J147 | 7220 | 36.7500 | 16.7391 | FCT 68 45NW | BDD118 45NE | FOL 93 58NE | APO122 30NE | | | FM290 6 | LN 94 5 |
| | | | | | BDD 95 73NE | | | | | | LN254 13 |
| | | | | | BDD107 53SW | | | | | | LN290 28 |
| | | | | | | | | | | | LN268 2 |
| J149 | 7100 | 36.8036 | 16.5326 | | | FOL103 35NE | APM109 36NE | | FM345 46 | FM 30 18 | LN295 7 |
| | | | | | | FOL 14 38E | APO115 24NE | | | | |
| | | | | | | FOL 24 84NW | | | | | |
| | | | | | | FOL110 60NE | | | | | |
| | | | | | | FOL 46 54NW | | | | | |
| | | | | | | FOL 34 58NW | | | | | |
| | | | | | | FOL 6 64W | | | | | |
| J150 | 6900 | 36.8929 | 16.4130 | | | FOL105 50NE | | | | | |

| Station ID | Elev. Feet | Long. 120°-x'W | Lat. 52°-y'N | [FRACTURE] IDStrDipDD | [BEDDING] IDStrDipDD | [FOLIATION] IDStrDipDD | [CLEAVAGE] IDStrDipDD | [TIGHT] IDTrePlu | [MEDIUM] IDTrePlu | [OPEN] IDTrePlu | [LIN] IDTrePlu |
|---|---|---|---|---|---|---|---|---|---|---|---|
| J151 | 6730 | 36.6071 | 16.3043 | | BDD125 75NE | FOL 76 54NW | APM 78 55NW | | FMZ300 42 | FM310 24 | LNZ70 0 |
| | | | | | | FOL148 85NE | APO115 45NE | | | FM328 6 | LN314 30 |
| | | | | | | FOL150 50SW | APO148 56NE | | | | |
| | | | | | | FOL177 22W | | | | | |
| | | | | | | FOL125 75NE | | | | | |
| | | | | | | FOL 15 48W | | | | | |
| | | | | | | FOL115 72NE | | | | | |
| | | | | | | FOL102 56NE | | | | | |
| | | | | | | FOL 95 42N | | | | | |
| | | | | | | FOL130 80NE | | | | | |
| | | | | | | FOL125 82NE | | | | | |
| | | | | | | FOL145 75SW | | | | | |
| | | | | | | FOL 0 30W | | | | | |
| | | | | | | FOL165 61W | | | | | |
| | | | | | | FOL165 35SW | | | | | |
| | | | | | | FOL126 74NE | | | | | |
| | | | | | | FOL 98 65N | | | | | |
| | | | | | | FOL 93 44N | | | | | |
| | | | | | | FOL104 50NE | | | | | |
| J152 | 6600 | 36.3750 | 16.2935 | | BDD 76 86NW | FOL107 68NE | APO 73 90 | | | FM 75 32 | |
| | | | | | | FOL140 45NE | CLV123 32NE | | | | |
| | | | | | | FOL148 76NE | | | | | |
| J153 | 6450 | 36.2500 | 16.2935 | FCT125 80NE | | FOL100 66NE | | | | | |
| J154 | 6450 | 36.0893 | 16.3261 | FCT 94 60N | | FOL109 50NE | CLV140 90 | | | | LNZ74 18 |
| | | | | | | FOL 78 66NW | | | | | |
| J155 | 6720 | 36.1429 | 16.4674 | FCT176 90 | BDD160 62NE | FOL111 64NE | APM112 45NE | | FM 90 35 | | |
| | | | | FCT 99 80N | BDD148 78NE | FOL170 82E | CLV 86 44N | | FM105 45 | | |
| | | | | FCT107 58NE | BDD 94 83SW | FOL114 62NE | CLV 92 62NE | | | | |
| | | | | | BDD 78 76SE | FOL110 50NE | CLV113 64NE | | | | |
| | | | | | BDD 30 40SE | FOL140 65NE | | | | | |
| | | | | | BDD130 65NE | FOL110 54NE | | | | | |
| | | | | | BDD 2 74E | | | | | | |
| J156 | 6900 | 35.9286 | 16.4565 | | | FOL105 42NE | | | | | |
| J157 | 7320 | 35.4643 | 16.6087 | | BDD136 25SW | FLC115 30NE | APM124 50NE | | FM302 15 | | |
| | | | | | BDD129 60SW | | CLV118 66NE | | | | |
| | | | | | BDD136 20SW | | | | | | |
| | | | | | BDD130 40SW | | | | | | |
| J158 | 7000 | 35.3393 | 16.5435 | | | FLC110 69NE | APM140 74SW | | FM315 32 | | |
| | | | | | | FOL 42 30NW | | | | | |
| | | | | | | FOL 96 52N | | | | | |
| | | | | | | FOL 94 30NE | | | | | |
| | | | | | | FOL 95 43NE | | | | | |
| | | | | | | FOL156 60SW | | | | | |
| J159 | 6920 | 35.4821 | 16.3587 | | BDD 32 56NW | FOL105 59NE | | | | | |
| | | | | | | FOL 96 60NE | | | | | |
| J162 | 7080 | 38.1071 | 16.6413 | | | | | | | | |
| J163 | 6920 | 36.4286 | 16.5978 | | BDD 98 66NE | FOL 90 35N | APT 88 46N | FM320 30 | FM289 23 | FM300 24 | LN 0 35 |
| | | | | | BDD140 86NE | FOL 76 30NW | APT 80 42N | FM323 27 | FM305 21 | | |
| | | | | | BDD 66 32NW | FOL124 59SW | APT 60 30NW | FM324 21 | FM308 24 | | |
| | | | | | | FOL103 54NE | APT 92 38NE | FM319 34 | FM307 33 | | |
| | | | | | | FOL144 65SW | APT100 40NE | FM315 38 | FM305 25 | | |
| | | | | | | FOL136 72SW | APT107 44NE | | FM314 18 | | |
| | | | | | | FOL105 44NE | APT 98 45NE | | FM325 50 | | |
| | | | | | | FOL 78 40NW | APM130 80NE | | | | |
| | | | | | | FOL 40 24NW | APM129 78NE | | | | |

| Station ID | Elev. Feet | Long. 120°-x'W | Lat. 52°-y'N | [FRACTURE] IDStrDipDD | [BEDDING] IDStrDipDD | [FOLIATION] IDStrDipDD | [CLEAVAGE] IDStrDipDD | [TIGHT] IDTrePlu | [MEDIUM] IDTrePlu | [OPEN] IDTrePlu | [LIN] IDTrePlu |
|---|---|---|---|---|---|---|---|---|---|---|---|
| J163 | (cont) | | | | | FOL125 78NE | APM127 80NE | | | | |
| | | | | | | FOL 60 38NW | APM115 72NE | | | | |
| | | | | | | FOL 95 44NE | APM138 80NE | | | | |
| | | | | | | FOL 47 54NW | | | | | |
| | | | | | | FOL 75 50NW | | | | | |
| | | | | | | FOL 87 35NW | | | | | |
| | | | | | | FOL 33 41NW | | | | | |
| | | | | | | FOL 56 41NW | | | | | |
| | | | | | | FOL 70 41NW | | | | | |
| | | | | | | FOL 76 37NW | | | | | |
| | | | | | | FOL144 65SW | | | | | |
| | | | | | | FOL120 48NE | | | | | |
| | | | | | | FOL165 38W | | | | | |
| | | | | | | FOL 95 47NE | | | | | |
| | | | | | | FOL138 85NE | | | | | |
| | | | | | | FOL124 80NE | | | | | |
| | | | | | | FOL135 85SW | | | | | |
| | | | | | | FOL113 54NE | | | | | |
| | | | | | | FOL125 84NE | | | | | |
| | | | | | | FOL 76 32NW | | | | | |
| | | | | | | FOL120 60NE | | | | | |
| | | | | | | FOL124 70NE | | | | | |
| | | | | | | FOL 97 60NE | | | | | |
| | | | | | | FOL173 70W | | | | | |
| | | | | | | FOL 60 52NW | | | | | |
| | | | | | | FOL 82 32NW | | | | | |
| | | | | | | FOL 72 48NW | | | | | |
| J164 | 7120 | 37.5000 | 16.3804 | | | FOL 97 48NE | | | | | |
| J165 | 6700 | 37.7321 | 16.5000 | | BDD110 70NE | FOL 90 34N | | | | | |
| | | | | | | FOL115 62NE | | | | | |
| J166 | 6620 | 38.3036 | 16.6087 | | | FOL105 39NE | | | | | |
| J167 | 6620 | 38.2857 | 16.5326 | | | FOL125 35NE | | | | | |
| | | | | | | FOL110 63NE | | | | | |
| J168 | 6450 | 38.0357 | 16.4348 | | | FOL100 28NE | | | | | |
| | | | | | | FOL110 47NE | | | | | |
| J169 | 6320 | 38.3214 | 16.1413 | | | FOL 60 35NW | APO 5 75E | | | FH 6 25 | |
| | | | | | | FOL125 42NE | | | | | |
| J170 | 6450 | 38.0714 | 16.0435 | | | FOL125 64NE | | | | | |
| | | | | | | FOL101 36NE | | | | | |
| J171 | 6700 | 37.4107 | 16.0435 | | BDD115 55NE | FOL 85 38NW | APT 78 40NW | FH346 36 | | | |
| | | | | | BDD 85 40NW | FOL 55 46NW | APT 90 36N | FH343 40 | | | |
| | | | | | BDD 85 32NW | FOL 96 45NE | | FH330 35 | | | |
| | | | | | | | | FH316 28 | | | |
| | | | | | | | | FH346 45 | | | |
| | | | | | | | | FH334 40 | | | |
| | | | | | | | | FH348 38 | | | |
| | | | | | | | | FH327 38 | | | |
| | | | | | | | | FH335 35 | | | |
| | | | | | | | | FH305 30 | | | |
| | | | | | | | | FH335 44 | | | |

| Station ID | Elev. Feet | Long. 120°-x'W | Lat. 52°-y'N | [FRACTURE] IDStrDipDD | [BEDDING] IDStrDipDD | [FOLIATION] IDStrDipDD | [CLEAVAGE] IDStrDipDD | [TIGHT] IDTrePlu | [MEDIUM] IDTrePlu | [OPEN] IDTrePlu | [LIN] IDTrePlu |
|---|---|---|---|---|---|---|---|---|---|---|---|
| RZ1 | 3860 | 43.7143 | 13.0435 | FCT 65 64S | | FOL155 61W | | FH336 10 | | | LN338 18 |
| | | | | FCT 28 70NW | | FOL158 76W | | FH359 15 | | | LN331 8 |
| | | | | FCT 58 81S | | FOL161 83W | | FH350 18 | | | LN305 15 |
| | | | | FCT 64 80S | | FOL164 67W | | | | | LN350 22 |
| | | | | FCT 50 80N | | FOL156 84W | | | | | LN331 11 |
| | | | | FCT 48 82S | | FOL167 75W | | | | | LN139 30 |
| | | | | FCT 56 70S | | FOL148 68W | | | | | |
| | | | | FCT 64 78S | | FOL154 70W | | | | | |
| | | | | FCT 62 73S | | FOL153 73W | | | | | |
| | | | | FCT 51 65NW | | FOL151 82W | | | | | |
| | | | | FCT 71 80S | | FOL156 80W | | | | | |
| | | | | FCT 61 71S | | FOL161 73W | | | | | |
| | | | | FCT 60 79N | | FOL161 63W | | | | | |
| | | | | FCT 37 59S | | FOL158 81W | | | | | |
| | | | | FCT 24 90 | | FOL156 84W | | | | | |
| | | | | FCT 41 90 | | FOL154 80W | | | | | |
| | | | | FCT 42 78N | | FOL156 58W | | | | | |
| | | | | FCT 65 71S | | | | | | | |
| | | | | FCT 56 72S | | | | | | | |
| | | | | FCT 76 76S | | | | | | | |
| | | | | FCT 50 73N | | | | | | | |
| | | | | FCT144 45N | | | | | | | |
| | | | | FCT 40 65S | | | | | | | |
| | | | | FCT 27 70S | | | | | | | |
| | | | | FCT153 75E | | | | | | | |
| | | | | FCT133 65NE | | | | | | | |
| | | | | FCT 55 90 | | | | | | | |
| | | | | FCT 47 75S | | | | | | | |
| | | | | FCT 75 59S | | | | | | | |
| | | | | FCT 70 90 | | | | | | | |
| | | | | FCT 64 47S | | | | | | | |
| RZ2 | 3800 | 43.6964 | 13.0761 | FCT 64 90 | BDD155 60W | FOL147 80W | | FH318 25 | FH323 14 | | LN336 13 |
| | | | | FCT 30 80S | | FOL163 65W | | | FH335 20 | | LN 53 8 |
| | | | | FCT 64 76S | | FOL158 75W | | | | | LN325 15 |
| | | | | FCT 73 75S | | FOL161 75W | | | | | |
| | | | | FCT 61 64N | | FOL161 61W | | | | | |
| | | | | FCT 89 50S | | FOL160 67W | | | | | |
| | | | | FCT 50 73N | | FOL160 85W | | | | | |
| | | | | FCT 68 75N | | FOL164 75W | | | | | |
| | | | | FCT 50 58N | | FOL154 78W | | | | | |
| | | | | FCT 56 65N | | FOL156 79W | | | | | |
| | | | | FCT 76 85N | | FOL158 80W | | | | | |
| | | | | FCT101 58N | | FOL161 85W | | | | | |
| | | | | FCT 94 70N | | FOL164 62W | | | | | |
| | | | | FCT 76 90 | | FOL154 80W | | | | | |
| | | | | FCT 69 80S | | FOL153 80W | | | | | |
| | | | | FCT 81 35S | | FOL155 90 | | | | | |
| | | | | FCT 35 78N | | FOL154 80W | | | | | |
| | | | | FCT101 72N | | FOL158 75W | | | | | |
| | | | | FCT 76 41S | | FOL160 65W | | | | | |
| | | | | FCT 52 46S | | FOL151 75W | | | | | |
| | | | | FCT 69 60N | | | | | | | |
| | | | | FCT 66 54S | | | | | | | |
| | | | | FCT 69 68N | | | | | | | |
| | | | | FCT 64 70S | | | | | | | |

| Station ID | Elev.° Feet | Long. 120°-x'W | Lat. 52°-y'N | [FRACTURE] IDStrDipDD | [BEDDING] IDStrDipDD | [FOLIATION] IDStrDipDD | [CLEAVAGE] IDStrDipDD | [TIGHT] IDTrePlu | [MEDIUM] IDTrePlu | [OPEN] IDTrePlu | [LIN] IDTrePlu |
|---|---|---|---|---|---|---|---|---|---|---|---|
| RZ2 | (cont) | | | FCT 35 60S | | | | | | | |
| | | | | FCT 63 90 | | | | | | | |
| | | | | FCT120 60S | | | | | | | |
| | | | | FCT 49 73S | | | | | | | |
| | | | | FCT120 68S | | | | | | | |
| | | | | FCT 58 85N | | | | | | | |
| RZ3 | 6850 | 43.6786 | 13.1196 | FCT142 22E | BDD175 70W | FOL155 62W | | | | | LNM334 8 |
| | | | | QVN 74 90 | BDD155 60W | FOL158 70W | | | | | LN328 20 |
| | | | | FCT 82 90 | | FOL155 70W | | | | | LN332 14 |
| | | | | FCT 95 84S | | FOL158 70W | | | | | |
| | | | | FCT100 65S | | FOL158 68W | | | | | |
| | | | | FCT 98 54N | | FOL168 64W | | | | | |
| | | | | FCT111 90 | | | | | | | |
| | | | | FCT 80 80S | | | | | | | |
| | | | | FCT 24 76SE | | | | | | | |
| RZ4 | 3800 | 43.5714 | 13.0870 | FCT 59 84S | | FOL154 59W | | | | | |
| | | | | FCT102 84S | | FOL159 73W | | | | | |
| | | | | FCT 44 90 | | FOL149 58W | | | | | |
| | | | | FCT108 90 | | FOL153 73W | | | | | |
| | | | | FCT 69 90 | | FOL152 70W | | | | | |
| | | | | FCT 39 85N | | FOL152 85W | | | | | |
| | | | | FCT 50 75S | | FOL140 70W | | | | | |
| | | | | FCT 50 84S | | FOL151 70W | | | | | |
| | | | | FCT 63 85S | | | | | | | |
| | | | | FCT 25 85E | | | | | | | |
| | | | | FCT 50 72SE | | | | | | | |
| | | | | FCT 45 78E | | | | | | | |
| | | | | FCT 64 76S | | | | | | | |
| RZ5 | 3810 | 43.2500 | 13.1304 | FCT 50 80S | | FOL163 70W | | | FHZ322 34 | | LNC320 35 |
| | | | | DCL106 90 | | FOL164 80W | | | FHZ318 68 | | LNC342 33 |
| | | | | FCT135 80W | | FOL175 72W | | | FH328 38 | | LN334 28 |
| | | | | FCT 62 82S | | FOL163 61W | | | FH338 37 | | LN335 24 |
| | | | | FCT 65 87S | | FOL159 78W | | | | | |
| | | | | FCT 65 79S | | FOL161 80W | | | | | |
| | | | | FCT 45 85E | | FOL164 60W | | | | | |
| | | | | FCT 80 82N | | FOL165 65W | | | | | |
| | | | | FCT130 32N | | FOL160 69W | | | | | |
| | | | | FCT 90 80S | | FOL160 73W | | | | | |
| | | | | FCT 56 90 | | | | | | | |
| | | | | FCT 97 90 | | | | | | | |
| RZ6 | 3920 | 43.2857 | 13.2391 | FCT 58 70S | BDD164 68W | FOL157 78W | | FH315 25 | FH327 42 | | LNM338 14 |
| | | | | FCT 49 82S | | FOL167 63W | | FH 0 27 | FHZ355 36 | | LNC345 16 |
| | | | | FCT150 36E | | FOL155 80W | | FH316 48 | FHZ337 49 | | LN330 27 |
| | | | | FCT 56 82S | | FOL156 80W | | FH322 15 | FHZ345 50 | | LN341 10 |
| | | | | FCT 22 90 | | FOL161 68W | | FH340 25 | | | LN337 32 |
| | | | | FCT 76 61S | | FOL162 72W | | | | | LNC337 29 |
| | | | | FCT 50 77S | | FOL159 71W | | | | | |
| | | | | FCT 67 64S | | FOL159 73W | | | | | |
| | | | | FCT131 30N | | FOL161 81W | | | | | |
| | | | | FCT 41 82E | | FOL166 76W | | | | | |
| | | | | FCT 40 90 | | FOL161 76W | | | | | |
| | | | | FCT 78 71S | | FOL160 75W | | | | | |
| | | | | FCT 64 82S | | FOL159 76W | | | | | |
| | | | | FCT 36 90 | | FOL164 85W | | | FHZ346 30 | | LN337 24 |
| | | | | FCT 69 75S | | FOL159 64W | | | FH308 48 | | LNM341 25 |

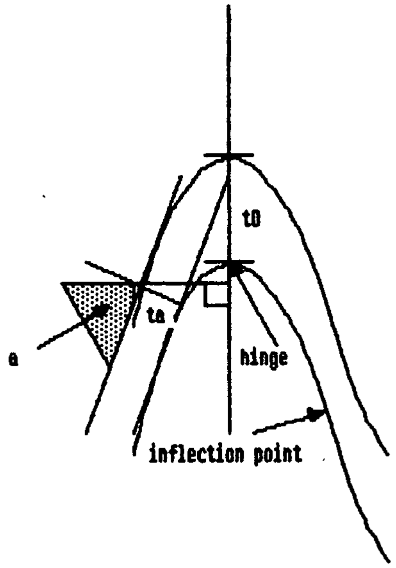
| Station ID | Elev. Feet | Long. 120°-x'W | Lat. 52°-y'N | [FRACTURE] IDStrDipDD | [BEDDING] IDStrDipDD | [FOLIATION] IDStrDipDD | [CLEAVAGE] IDStrDipDD | [TIGHT] IDTrePlu | [MEDIUM] IDTrePlu | [OPEN] IDTrePlu | [LIN] IDTrePlu |
|---|---|---|---|---|---|---|---|---|---|---|---|
| RZ6 | (cont) | | | FCT 61 85S | | FOL170 60W | | | FHZ325 45 | | |
| | | | | FCT 28 90 | | FOL162 76W | | | | | |
| | | | | | | FOL159 59W | | | | | |
| | | | | | | FOL171 51W | | | | | |
| RZ7 | 4000 | 43.3214 | 13.2826 | FCT 54 80S | | FOL167 70W | | | | | |
| | | | | FCT 25 90 | | FOL158 80W | | | | | |
| | | | | FCT 91 61N | | FOL168 80W | | | | | |
| | | | | FCT105 90 | | FOL160 75W | | | | | |
| | | | | FCT 38 90 | | FOL165 70W | | | | | |
| | | | | FCT 28 90 | | FOL152 80W | | | | | |
| | | | | FCT 45 79S | | FOL166 75W | | | | | |
| | | | | FCT 57 67S | | | | | | | |
| | | | | FCT 41 90 | ENS 65 70NW | FOL 45 65NW | | | | | |
| | | | | FCT 68 70S | | FOL 19 60W | | | | | |
| | | | | FCT 35 90 | | FOL 80 75N | | | | | |
| | | | | FCT105 63N | | FOL 38 44N | | | | | |
| | | | | FCT 59 55S | | FOL 63 46N | | | | | |
| RZ8 | 4050 | 42.9643 | 13.2826 | FCT 72 65NW | | FOL 66 40N | | | FHZ326 55 | | LNM320 60 |
| | | | | FCT148 75W | | FOL 18 52N | | | FHM302 70 | | |
| | | | | | | FOL 30 65N | | | FH284 50 | | |
| | | | | | | FOL 15 83N | | | FH295 57 | | |
| | | | | | | FOL 15 86N | | | FH326 43 | | |
| | | | | | | | | | FHZ328 46 | | |
| RZ9 | 3960 | 42.9464 | 13.2283 | FCT126 80N | | FOL164 75W | | FH353 70 | FHZ312 50 | | LNM323 46 |
| | | | | FCT 43 66W | | FOL176 68W | | | | | |
| | | | | FCT 60 65S | | FOL 5 58W | | | | | |
| | | | | FCT136 90 | | FOL168 70W | | | | | |
| | | | | FCT 75 90 | | FOL 3 80W | | | | | |
| | | | | FCT 45 90 | | FOL 0 65W | | | | | |
| | | | | FCT150 85S | | | | | | | |
| RZ10 | 3900 | 43.0000 | 13.2065 | FCT166 85SW | | FOL160 68W | CLV 19 80NW | | FH312 47 | | LNM324 37 |
| | | | | FCT 8 90 | | FOL 45 60W | | | FH355 50 | | LNM326 36 |
| | | | | FCT143 70S | | FOL 5 85W | | | FH318 49 | | LNM332 37 |
| | | | | FCT161 85W | | FOL175 85W | | | FHZ328 50 | | LN330 33 |
| | | | | FCT142 90 | | FOL165 85W | | | FHZ337 67 | | LNM323 27 |
| | | | | FCT 90 55S | | FOL160 85W | | | | | LNM335 35 |
| | | | | FCT133 90 | | FOL 0 85W | | | | | |
| | | | | FCT 44 65S | | FOL175 80E | | | | | |
| | | | | FCT 28 55SE | | FOL 46 50SE | | | | | |
| | | | | FCT 59 68S | | FOL 25 85E | | | | | |
| | | | | FCT 50 84W | | FOL 22 40W | | | | | |
| | | | | FCT 83 58S | | FOL171 81W | | | | | |
| | | | | FCT 70 66S | | FOL165 64W | | | | | |
| | | | | FCT 77 49S | | FOL165 70W | | | | | |
| | | | | FCT 57 62W | | FOL154 76W | | | | | |
| | | | | FCT 54 80SE | | FOL156 85W | | | | | |
| | | | | FCT 66 80S | | FOL168 67W | | | | | |
| | | | | FCT113 67N | | FOL161 72W | | | | | |
| | | | | FCT125 50N | | FOL160 75W | | | | | |
| | | | | FCT 58 80S | | FOL155 75W | | | | | |
| | | | | | | FOL162 90 | | | | | |
| | | | | | | FOL 0 76W | | | | | |
| | | | | | | FOL171 70W | | | | | |
| | | | | | | FOL170 70W | | | | | |
| RZ11 | 3820 | 43.0000 | 13.1196 | FCT 64 60S | | FOL168 82W | | FH332 50 | FH325 50 | | LNM108 15 |

## Structural Geology of Part of the Crooked Lake Area, Quesnel Highlands, British Columbia

| Station ID | Elev. Feet | Long. 120°-x'W | Lat. 52°-y'N | [FRACTURE] IDStrDipDD | [BEDDING] IDStrDipDD | [FOLIATION] IDStrDipDD | [CLEAVAGE] IDStrDipDD | [TIGHT] IDTrePlu | [MEDIUM] IDTrePlu | [OPEN] IDTrePlu | [LIN] IDTrePlu |
|---|---|---|---|---|---|---|---|---|---|---|---|
| RZ11 | | | | FCT 56 57S | | FOL158 79W | | FM339 25 | FM300 26 | | LNC340 40 |
| | | | | FCT 55 48S | | FOL170 83W | | FM163 25 | | | LNC346 44 |
| | | | | FCT 69 39S | | FOL157 83W | | FM 10 8 | | | LNK352 33 |
| | | | | FCT 60 43S | | FOL164 86W | | | | | LNM319 35 |
| | | | | FCT 57 42S | | FOL159 80W | | | | | LNK336 20 |
| | | | | FCT 56 33S | | FOL149 80W | | | | | LNM313 48 |
| | | | | FCT 97 48S | | FOL165 82W | | | | | LNM320 40 |
| | | | | FCT102 50S | | FOL171 73W | | | | | LNM316 42 |
| | | | | FCT102 52S | | FOL169 81W | | | | | LNM336 14 |
| | | | | FCT105 70S | | FOL160 90 | | | | | LNM333 13 |
| | | | | FCT 93 51N | | FOL160 78W | | | | | |
| | | | | FCT 66 66S | | FOL140 90 | | | | | |
| | | | | FCT 69 75S | | FOL163 85W | | | | | |
| | | | | FCT 60 70S | | FOL165 84W | | | | | |
| | | | | FCT 74 75S | | FOL164 82W | | | | | |
| | | | | FCT116 39N | | FOL164 80W | | | | | |
| | | | | FCT 67 80S | | FOL169 65W | | | | | |
| | | | | FCT 56 76S | | FOL159 75W | | | | | |
| | | | | FCT 63 82S | | FOL153 86W | | | | | |
| | | | | FCT 73 60N | | FOL164 80W | | | | | |
| | | | | | | FOL151 81W | | | | | |
| | | | | | | FOL171 75W | | | | | |
| | | | | | | FOL177 78W | | | | | |
| | | | | | | FOL155 80W | | | | | |
| | | | | | | FOL154 82W | | | | | |
| | | | | | | FOL148 75W | | | | | |
| | | | | | | FOL165 84W | | | | | |
| | | | | | | FOL157 88W | | | | | |
| | | | | | | FOL151 80W | | | | | |
| | | | | | | FOL142 90 | | | | | |
| | | | | | | FOL169 85W | | | | | |
| | | | | | | FOL151 87W | | | | | |
| | | | | | | FOL161 80W | | | | | |
| | | | | | | FOL135 85W | | | | | |
| | | | | | | FOL144 85W | | | | | |
| | | | | | | FOL 0 79W | | | | | |
| | | | | | | FOL 3 83W | | | | | |
| | | | | | | FOL157 79W | | | | | |
| | | | | | | FOL173 90 | | | | | |
| | | | | | | FOL153 85W | | | | | |
| | | | | | | FOL153 73W | | | | | |
| | | | | | | FOL164 80W | | | | | |
| | | | | | | FOL171 78W | | | | | |
| | | | | | | FOL168 78W | | | | | |
| | | | | | | FOL175 90 | | | | | |
| | | | | | | FOL162 72W | | | | | |
| | | | | | | FOL168 65W | | | | | |
| | | | | | | FOL164 86W | | | | | |
| | | | | | | FOL169 70W | | | | | |
| | | | | | | FOL154 88W | | | | | |
| | | | | | | FOL164 78W | | | | | |
| | | | | | | FOL167 80W | | | | | |
| | | | | | | FOL162 85W | | | | | |
| | | | | | | FOL172 28E | | | | | |

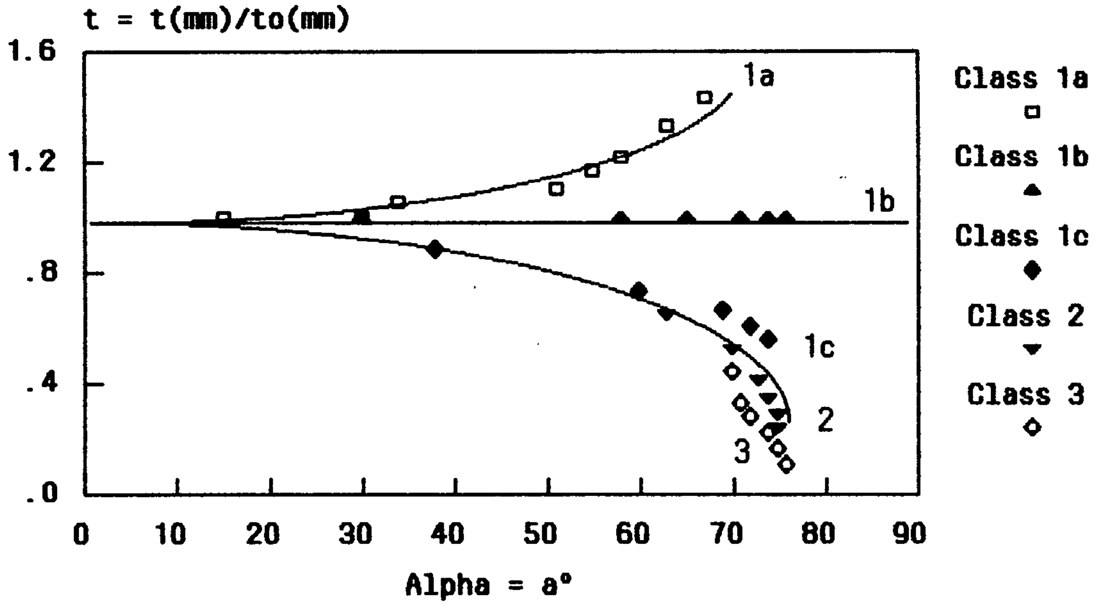
| Station ID | Elev. Feet | Long. 120°-x'W | Lat. 52°-y'N | [FRACTURE] IDStrDipDD | [BEDDING] IDStrDipDD | [FOLIATION] IDStrDipDD | [CLEAVAGE] IDStrDipDD | [TIGHT] IDTrePlu | [MEDIUM] IDTrePlu | [OPEN] IDTrePlu | [LIN] IDTrePlu |
|---|---|---|---|---|---|---|---|---|---|---|---|
| RZ11 | (cont) | | | | | FOL167 72W | | | | | |
| | | | | | | FOL166 65W | | | | | |
| | | | | | | FOL155 73W | | | | | |
| | | | | | | FOL162 75W | | | | | |
| | | | | | | FOL162 64W | | | | | |
| | | | | | | FOL161 65W | | | | | |
| | | | | | | FOL158 84W | | | | | |
| | | | | | | FOL155 67W | | | | | |
| | | | | | | FOL158 65W | | | | | |
| | | | | | | FOL166 78W | | | | | |
| | | | | | | FOL162 55W | | | | | |
| | | | | | | FOL164 64W | | | | | |

# APPENDIX C




A t-alpha plot is generated by measuring first the reference hinge thickness, (t0), followed by sucessive limb thicknesses(ta) away from the hinge toward the fold's inflection point; (ta) is a perpendicular thickness between tangents to the upper and lower surfaces of the fold; next a perpendicular to the axial surface is constructed to intersect the tangent point of either surface of the fold. The intersection angle is the angle between the tangent line and this 'constructed perpendicular'. This angle(a) is plotted against the ratio of limb to hinge thicknesses (ta/t0).

t-alpha plot standard forms



| UNIT-STATION-EPISODE | ALPHA | TAUW | ALPHA | TAUW | ALPHA | TAUW | ALPHA | TAUW |
|---|---|---|---|---|---|---|---|---|
| .....D1 FOLD FORMS..... | | | | | | | | |
| Snowshoe-J72-D1 | 51 | .86 | | | | | | |
| | 80 | .32 | | | | | | |
| | 81 | .25 | | | | | | |
| | 82 | .29 | | | | | | |
| | 43 | .93 | | | | | | |
| | 78 | .50 | | | | | | |
| | 80 | .43 | | | | | | |
| | 82 | .32 | | | | | | |
| | 82 | .25 | | | | | | |
| Snowshoe-J74-D1 | 82 | .29 | 79 | .38 | 81 | .50 | 83 | .84 |
| | 84 | .21 | 83 | .19 | 75 | .38 | 88 | .19 |
| | 85 | .21 | 88 | .57 | 84 | .38 | 88 | .18 |
| | 87 | .18 | | | 86 | .36 | 88 | .16 |
| | 80 | .29 | | | | | 83 | .52 |
| | 82 | .14 | | | | | 84 | .26 |
| | 82 | .14 | | | | | 86 | .26 |
| | | | | | | | 86 | .23 |
| Snowshoe-J74b-D1 | 86 | .14 | 84 | .12 | 86 | .22 | | |
| | 85 | .18 | | | 88 | .17 | | |
| | 88 | .14 | | | | | | |
| | 87 | .18 | | | | | | |
| Antler-R26-D1 | 85 | .09 | | | | | | |
| | 83 | .07 | | | | | | |
| | 81 | .07 | | | | | | |
| | 83 | .27 | | | | | | |
| | 84 | .21 | | | | | | |
| | 85 | .20 | | | | | | |
| | 88 | .20 | | | | | | |
| .....D2 FOLD FORMS..... | | | | | | | | |
| Phyllite-J57-D2 (open) | 18 | 1.08 | | | | | | |
| | 50 | .92 | | | | | | |
| | 5 | 1.00 | | | | | | |
| | 22 | 1.00 | | | | | | |
| | 41 | .92 | | | | | | |
| | 45 | .83 | | | | | | |
| | 48 | .75 | | | | | | |
| Phyllite-J40-D2 (open) | 3 | 1.08 | 0 | 1.00 | | | | |
| | 5 | 1.22 | 10 | .82 | | | | |
| | 7 | 1.22 | 20 | .94 | | | | |

| UNIT-STATION-EPISODE | ALPHA | TAUU | ALPHA | TAUU | ALPHA | TAUU | ALPHA | TAUU |
|---|---|---|---|---|---|---|---|---|
| Phyllite-J40-D2 (open) | 10 | 1.00 | 29 | .82 | | | | |
| (continued) | 22 | .89 | 36 | .71 | 15 | 1.00 | | |
| | 18 | 1.00 | | | | | | |
| | 39 | 1.00 | | | | | | |
| | 40 | 1.00 | | | | | | |
| Phyllite-J89-D2 (open) | 13 | .90 | 14 | .94 | | | | |
| | 26 | .90 | 32 | .81 | | | | |
| | 20 | .90 | 25 | .56 | | | | |
| | 20 | 1.00 | 30 | .94 | | | | |
| | 30 | .90 | 8 | .88 | | | | |
| Snowshoe-RZ8-D2 (open) | 12 | 1.00 | 12 | 1.00 | 28 | .91 | | |
| | 54 | 1.00 | 38 | 1.14 | 49 | .64 | | |
| | 73 | .75 | 52 | 1.29 | 53 | .45 | | |
| | 16 | 1.00 | 9 | 1.00 | 33 | .82 | | |
| | 38 | 1.13 | 29 | 1.00 | 47 | .82 | | |
| | 60 | 1.25 | 45 | .86 | 54 | .82 | | |
| | | | 52 | .86 | | | | |
| Phyllite-J41-D2 (medium) | 58 | .50 | 77 | .29 | 61 | .67 | | |
| | 59 | .70 | 77 | .33 | 59 | .50 | | |
| | 41 | .75 | 75 | .48 | 44 | .50 | | |
| | 74 | .50 | 66 | .67 | 48 | .44 | | |
| | 46 | .90 | 71 | .42 | 49 | .50 | | |
| | 58 | .65 | 80 | .48 | 41 | .83 | | |
| | 61 | .60 | 65 | .54 | 40 | .83 | | |
| | 63 | .50 | 80 | .67 | 23 | .89 | | |
| | 67 | .45 | | | | | | |
| | 63 | .65 | | | | | | |
| | 50 | .85 | | | | | | |
| | 37 | .95 | | | | | | |
| | 80 | .45 | | | | | | |
| | 78 | .55 | | | | | | |
| | 75 | .60 | | | | | | |
| | 65 | .75 | | | | | | |
| | 55 | .70 | | | | | | |
| | 55 | .75 | | | | | | |
| | 51 | .85 | | | | | | |
| | 34 | .95 | | | | | | |
| Phyllite-J5-D2 (medium) | 34 | .95 | 69 | .67 | | | | |
| | 69 | .71 | 74 | .67 | | | | |

| UNIT-STATION-EPISODE | ALPHA | TAUU | ALPHA | TAUU | ALPHA | TAUU | ALPHA | TAUU |
|---|---|---|---|---|---|---|---|---|
| Phyllite-J5-D2 (medium) | 76 | .62 | 74 | .60 | | | | |
| (continued) | 76 | .57 | 78 | .53 | | | | |
| | 63 | .86 | 30 | .93 | | | | |
| | 81 | .57 | 66 | .87 | | | | |
| | 81 | .48 | 81 | .73 | | | | |
| | 85 | .43 | 62 | .93 | | | | |
| | | | 74 | .60 | | | | |
| Antler-RZ6-D2 (medium) | 21 | .92 | | | | | | |
| | 43 | .83 | | | | | | |
| | 55 | .67 | | | | | | |
| | 62 | .58 | | | | | | |
| | 65 | .50 | | | | | | |
| | 65 | .42 | | | | | | |
| | 19 | 1.17 | | | | | | |
| | 42 | 1.08 | | | | | | |
| Antler-RZ5-D2 (medium) | 20 | 1.25 | | | | | | |
| | 43 | 1.13 | | | | | | |
| | 58 | 1.00 | | | | | | |
| | 60 | 1.00 | | | | | | |
| | 62 | 1.00 | | | | | | |
| | 62 | 1.00 | | | | | | |
| | 15 | .88 | | | | | | |
| | 46 | .75 | | | | | | |
| | 51 | .63 | | | | | | |
| | 61 | .75 | | | | | | |
| Snowshoe-RZ10-D2 (medium) | 63 | .78 | 40 | .94 | | | | |
| | 69 | .61 | 58 | .78 | | | | |
| | 66 | .58 | 73 | .67 | | | | |
| | 61 | .61 | 67 | .67 | | | | |
| | 34 | .94 | 79 | .39 | | | | |
| | 77 | .39 | 81 | .33 | | | | |
| Antler-RZ7-D2 (medium) | 44 | .90 | 31 | .93 | 48 | .65 | 29 | 1.00 |
| | 53 | .78 | 42 | .83 | 57 | .84 | 41 | .78 |
| | 57 | .66 | 48 | .78 | | | 34 | 1.00 |
| | 61 | .59 | | | 35 | .85 | 54 | .72 |
| | 60 | .52 | 62 | .75 | 60 | .78 | 54 | .64 |
| | 20 | 1.00 | 66 | .54 | 69 | .48 | 61 | .61 |
| | 29 | .97 | 70 | .46 | 74 | .33 | 61 | .58 |
| | 25 | .97 | | | 79 | .33 | | |
| Phyllite-J26-D2 (tight) | 68 | .64 | | | | | | |

| UNIT-STATION-EPISODE | ALPHA | TAUU | ALPHA | TAUU | ALPHA | TAUU | ALPHA | TAUU |
|---|---|---|---|---|---|---|---|---|
| Phyllite-J26-D2 (tight) | 66 | .43 | | | | | | |
| (continued) | 50 | .79 | | | | | | |
| | 31 | .93 | | | | | | |
| | 32 | .93 | | | | | | |
| | 50 | .86 | | | | | | |
| | 60 | .64 | | | | | | |
| | 60 | .56 | | | | | | |
| | 64 | .43 | | | | | | |
| | 64 | .50 | | | | | | |
| | 62 | .43 | | | | | | |
| | 65 | .50 | | | | | | |
| | 60 | .71 | | | | | | |
| | 65 | .57 | | | | | | |
| | 71 | .36 | | | | | | |
| | 77 | .29 | | | | | | |
| | 76 | .21 | | | | | | |
| Phyllite-J117-D2 (tight) | 70 | .78 | 63 | .55 | | | | |
| | 71 | .47 | 74 | .36 | | | | |
| | 74 | .39 | 78 | .36 | | | | |
| | 73 | .37 | 79 | .36 | | | | |
| | 74 | .37 | 70 | .73 | | | | |
| | 60 | .66 | 75 | .36 | | | | |
| | 65 | .44 | 77 | .45 | | | | |
| | 75 | .44 | | | | | | |
| | 79 | .42 | | | | | | |
| Phyllite-J36-D2 (tight) | 30 | .98 | | | | | | |
| | 62 | .71 | | | | | | |
| | 66 | .49 | | | | | | |
| | 66 | .39 | | | | | | |
| | 71 | .35 | | | | | | |
| | 73 | .33 | | | | | | |
| | 73 | .33 | | | | | | |
| | 69 | .61 | | | | | | |
| | 73 | .43 | | | | | | |
| | 73 | .33 | | | | | | |
| | 74 | .27 | | | | | | |
| | 74 | .27 | | | | | | |
| | 74 | .25 | | | | | | |
| | 78 | .24 | | | | | | |
| | 78 | .22 | | | | | | |

| UNIT-STATION-EPISODE | ALPHA | TAUU | ALPHA | TAUU | ALPHA | TAUU | ALPHA | TAUU |
|---|---|---|---|---|---|---|---|---|
| Phyllite-J38-D2 (tight) | 78 | .18 | | | | | | |
| (continued) | 80 | .16 | | | | | | |
| | 80 | .16 | | | | | | |
| | 80 | .14 | | | | | | |
| Phyllite-J20b-D2 (tight) | 71 | .62 | 70 | .27 | | | | |
| | 83 | .33 | 80 | .19 | | | | |
| | 83 | .29 | 80 | .23 | | | | |
| | 79 | .29 | 75 | .31 | | | | |
| | 79 | .33 | 76 | .23 | | | | |
| | 79 | .29 | 76 | .27 | | | | |
| | 76 | .67 | | | | | | |
| | 85 | .29 | | | | | | |
| | 85 | .29 | | | | | | |
| | 83 | .29 | | | | | | |
| Phyllite-J41b-D2 (tight) | 20 | .90 | 74 | .56 | 52 | .82 | | |
| | 55 | .75 | 62 | .34 | 58 | .65 | | |
| | 65 | .56 | 51 | .31 | 56 | .52 | | |
| | 68 | .55 | 54 | .33 | 62 | .50 | | |
| | 67 | .52 | 65 | .33 | 65 | .43 | | |
| | 58 | .52 | 60 | .59 | 47 | .70 | | |
| | 57 | .48 | 65 | .48 | 77 | .55 | | |
| | 68 | .75 | 54 | .42 | 84 | .40 | | |
| | 60 | .56 | 54 | .44 | 82 | .35 | | |
| | 72 | .44 | 56 | .45 | 79 | .30 | | |
| | 72 | .44 | | | | | | |
| | 70 | .44 | | | | | | |
| | 68 | .44 | | | | | | |
| Antler Cross Section | 33 | .88 | 41 | .91 | | | | |
| (The Basset-Stark D2 Pair | 36 | .83 | 55 | .75 | | | | |
| Cross Section 1 Plate 3) | 41 | .92 | 41 | .92 | | | | |
| | 51 | .70 | 59 | .72 | | | | |
| | 52 | .69 | 70 | .57 | | | | |
| | 53 | .66 | 78 | .49 | | | | |
| | 54 | .64 | 78 | .45 | | | | |
| | 53 | .63 | 77 | .42 | | | | |
| | 54 | .63 | 76 | .40 | | | | |
| | 54 | .63 | 76 | .38 | | | | |
| | 55 | .64 | 75 | .36 | | | | |
| | 63 | .62 | 73 | .35 | | | | |
| | 68 | .56 | 74 | .34 | | | | |

| UNIT-STATION-EPISODE | ALPHA | TAUU | ALPHA | TAUU | ALPHA | TAUU | ALPHA | TAUU |
|---|---|---|---|---|---|---|---|---|
| Antler Cross Section | 71 | .46 | 75 | .34 | | | | |
| (continued) | | | 74 | .34 | | | | |
| .... D3 FOLDS FORMS .... | | | | | | | | |
| Phyllite-J98-D3 | 28 | .95 | 26 | .83 | 34 | .93 | 28 | 1.00 |
| | 32 | .79 | 34 | .75 | 47 | .71 | 55 | .80 |
| | | | 22 | .92 | 27 | .93 | 64 | .60 |
| | | | 38 | .92 | 40 | .86 | 61 | .90 |
| | | | | | | | 82 | .60 |
| | | | | | | | 84 | .50 |
| | | | | | | | 56 | .80 |
| | | | | | | | 70 | .60 |
| | | | | | | | 79 | .60 |
| | | | | | | | 42 | .90 |
| | | | | | | | 59 | .60 |
| | | | | | | | 63 | .70 |
| Phyllite-J104-D3 | 36 | .90 | 43 | .83 | | | | |
| | 44 | .88 | 43 | .75 | | | | |
| | 46 | .80 | 40 | .83 | | | | |
| | 43 | .70 | 55 | .67 | | | | |
| | 56 | .60 | 50 | .42 | | | | |
| | 57 | .60 | 52 | .50 | | | | |
| Phyllite-J117-D3 | 50 | .67 | 33 | .89 | | | | |
| | 54 | .67 | 60 | .56 | | | | |
| | 40 | .50 | 46 | .78 | | | | |

# APPENDIX D

## Stereophotos of various features at Crooked Lake

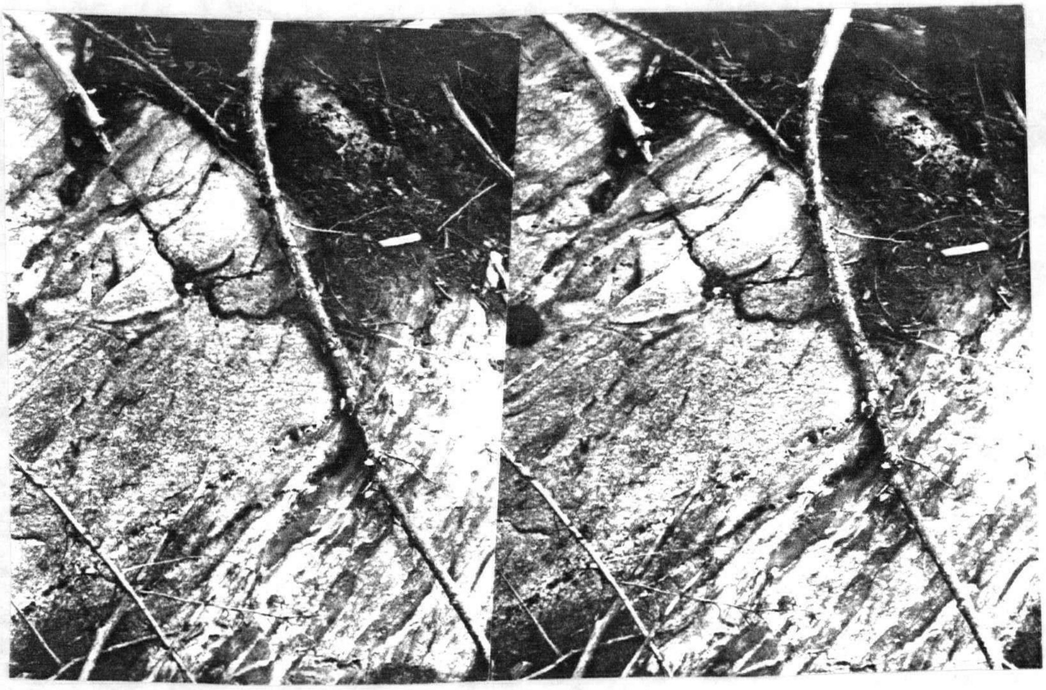


Plate 5a. Chl-hnbd-plag meta-diorite with interlayered/interfolded qtz-chl schist (Antler) {DIR-325, LOC-RZ3}

Plate 5b. Cross-fractured chl-hnbd-plag meta-diorite; fractures filled with epidote, quartz, and magnetite (Antler) {DIR-335, LOC-RZ3}

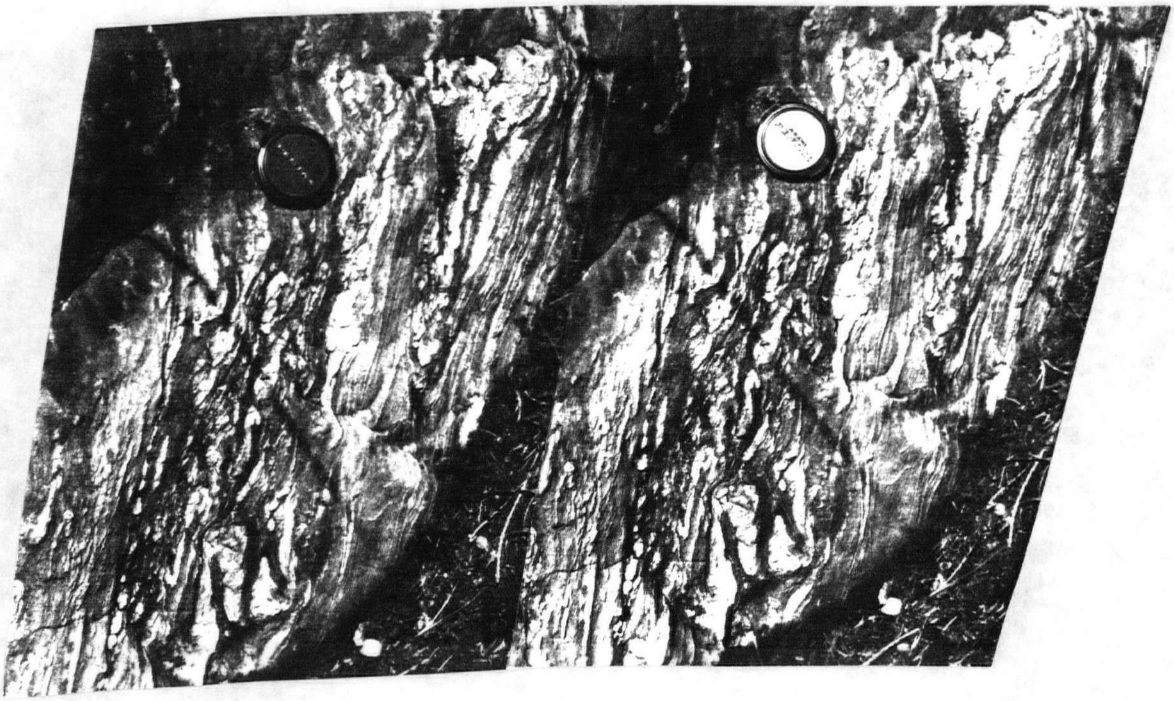


Plate 5c. Qtz-chl-hnbd schist with interlayers of qtz-plag-ep meta-wacke that show tight to isoclinal fold shapes (Antler) {DIR-350, LOC-RZ6}

Plate 5d. Red sandstone contained within phyllite is open to medium folded; note cohesiveness of sandstone (as opposed to severe disruption of phyllite by S2 foliation) (Crooked Lake Phyllite) {DIR-350, LOC-J52}

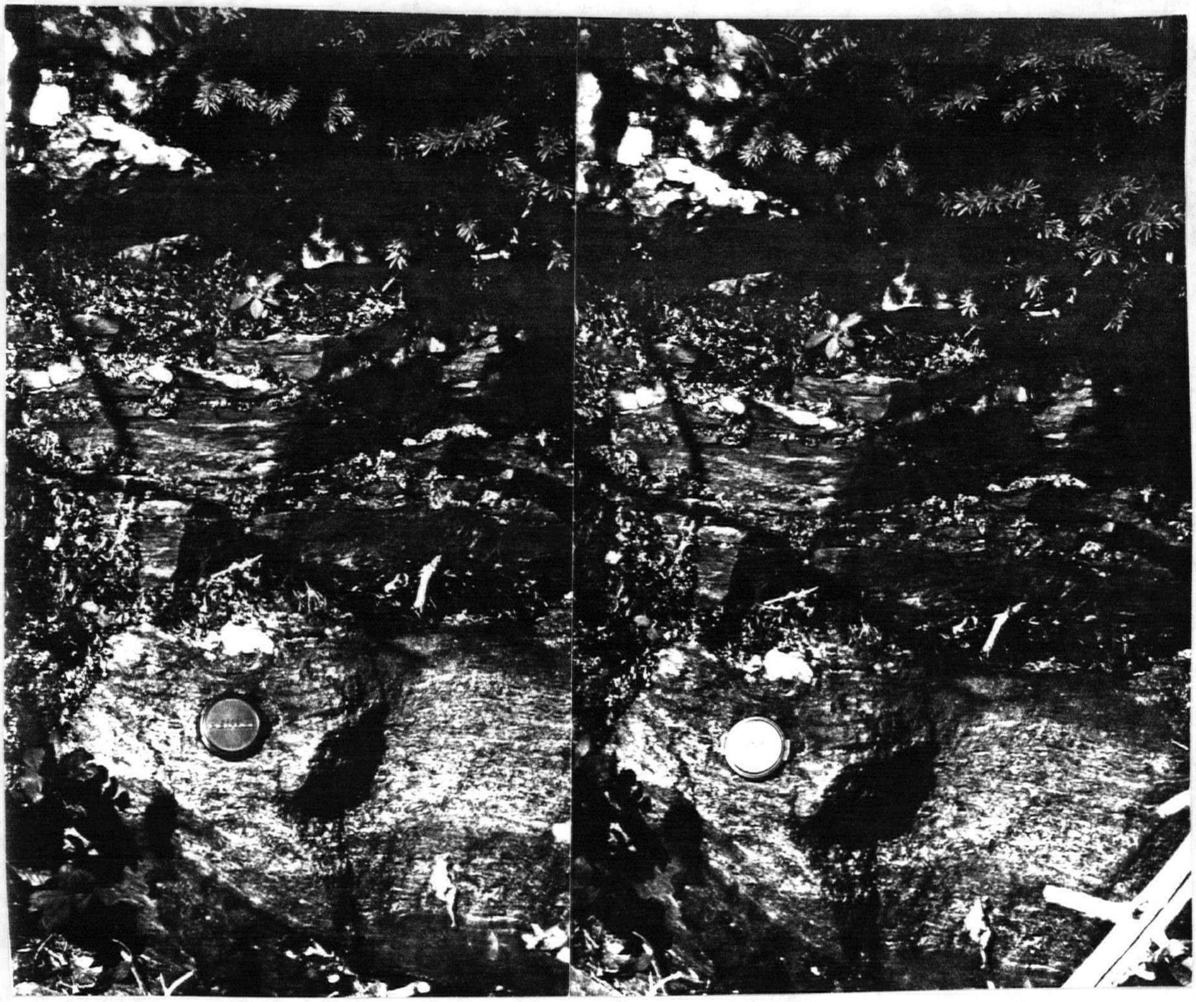


Plate 5e. Typical contact between Antler hnbd-plag meta-diorite and Eureka Quartzite; note very open folded form of contact {DIR-315, LOC-J86}

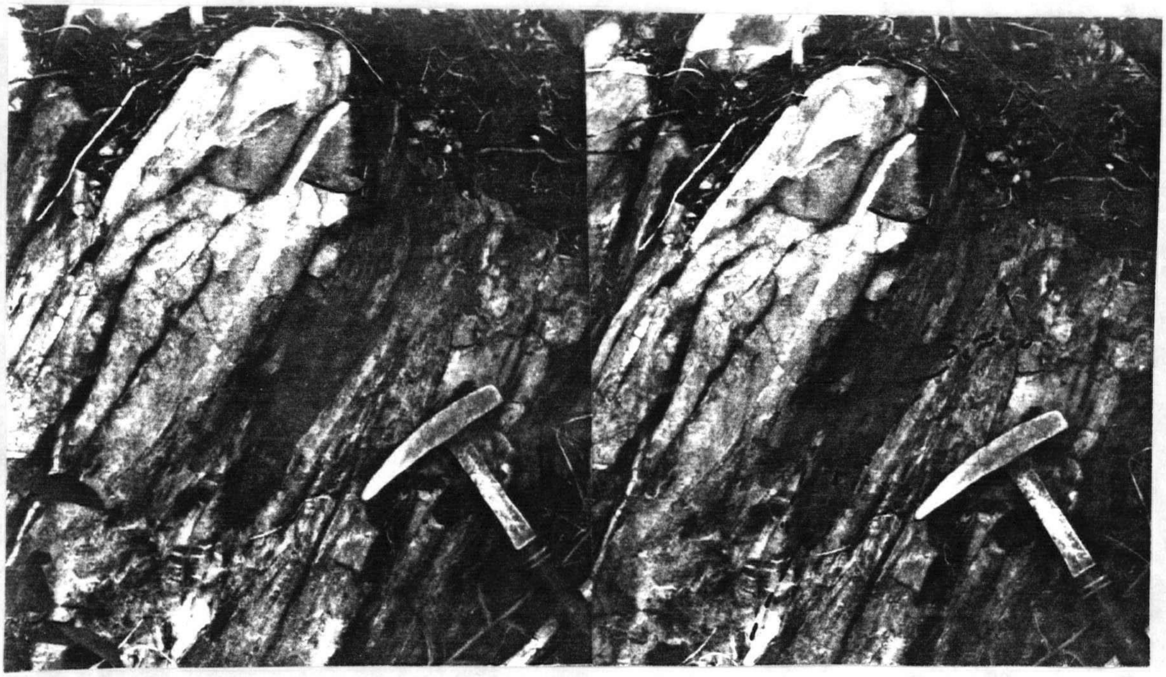


Plate 5f. Phase one isocline of chl-hnbd schist and qtz-plag-ep meta-wacke (Antler) {DIR-350, LOC-RZ6}

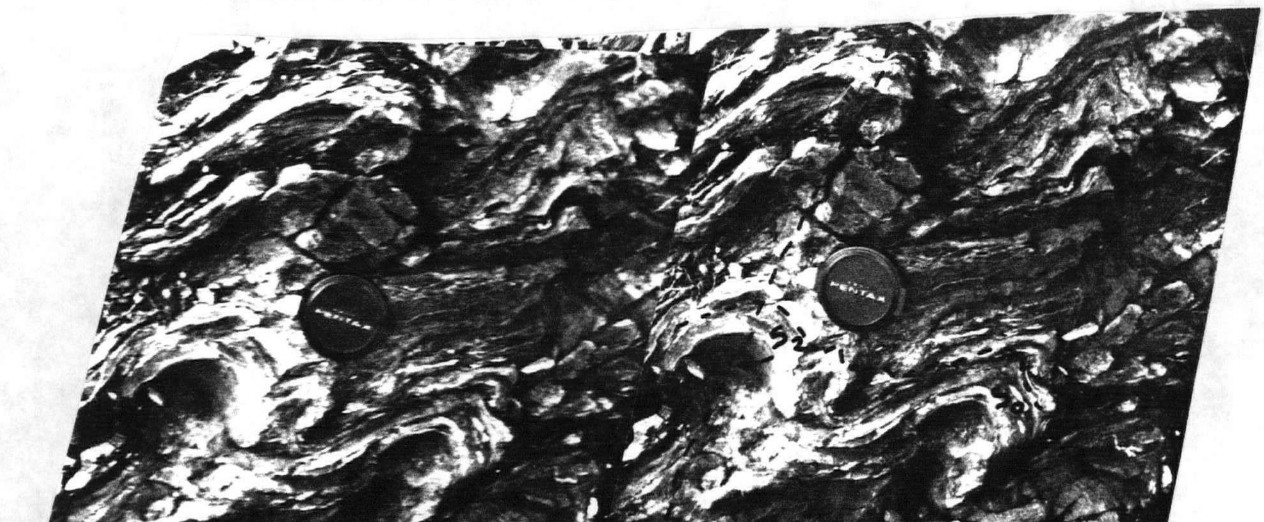


Plate 5g. Inclined phase two medium folds in musc-plag-qtz schist (Snowshoe) {DIR-320, LOC-RZ8}

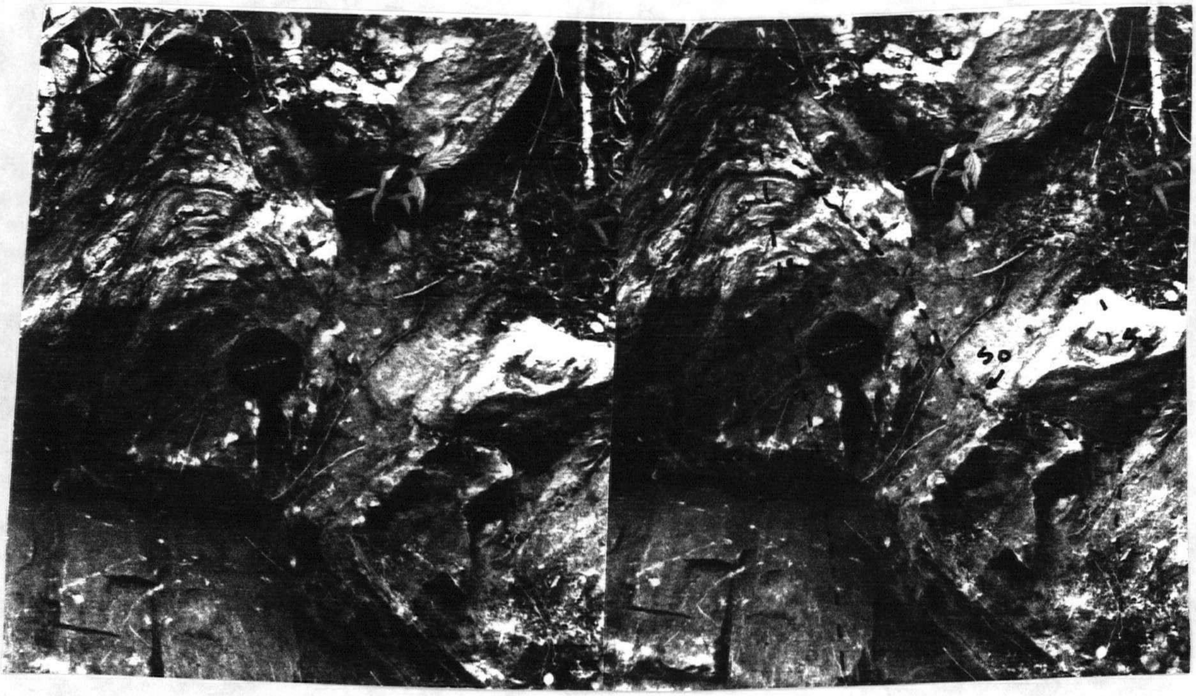


Plate 5h. Upright phase two medium 'clockwise-vergence' fold in chl-plag-hnbd schist ; note possible tight fold forms involved in upper hinge of fold (Antler) {DIR-335, LOC-RZ5}

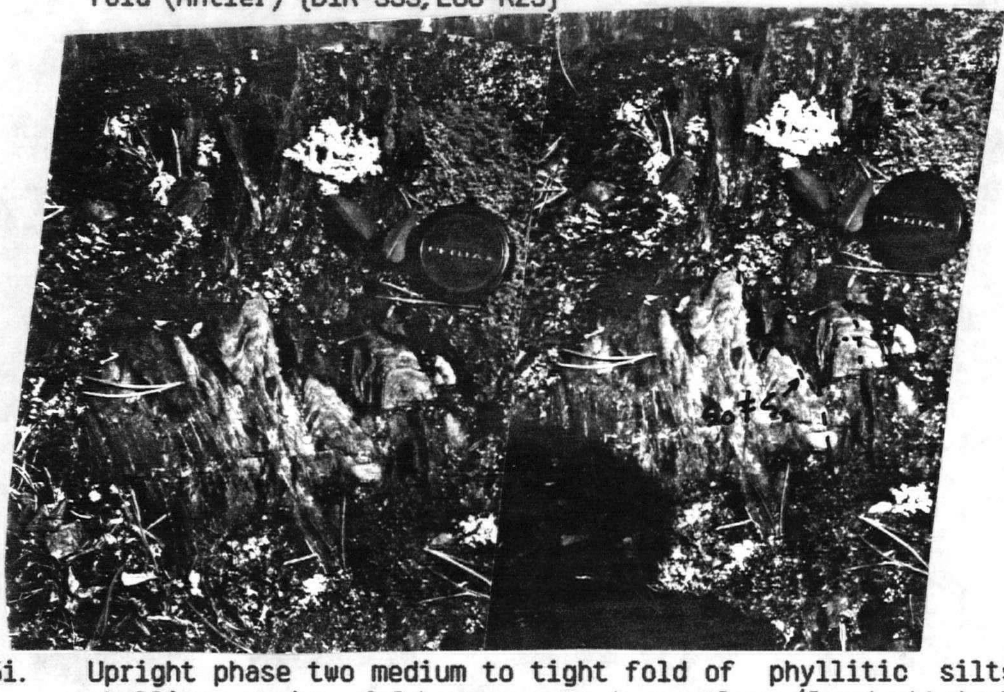


Plate 5i. Upright phase two medium to tight fold of phyllitic siltstone in phyllite matrix; fold appears to be rootless (Crooked Lake Phyllite) {DIR-330, LOC-J33}

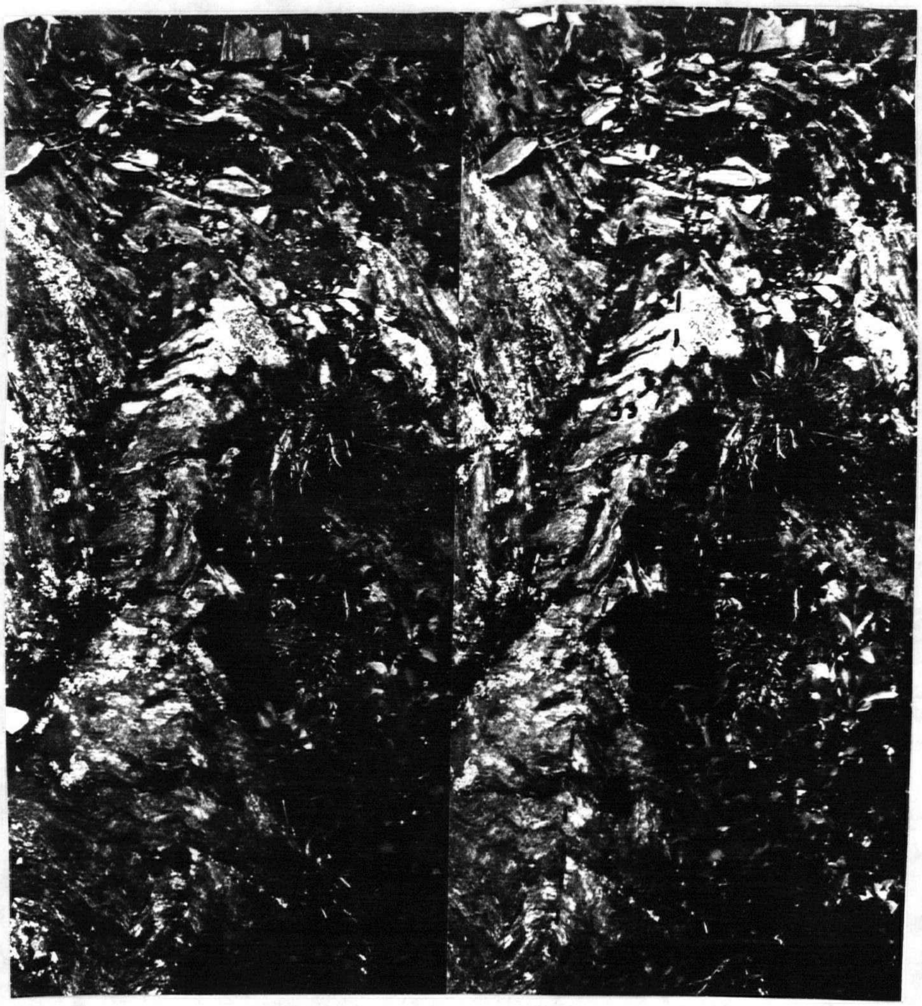


Plate 5j. Upright phase three fold showing gradual change in form from open to medium with depth (Eureka Quartzite) {DIR-310, LOC-J98}

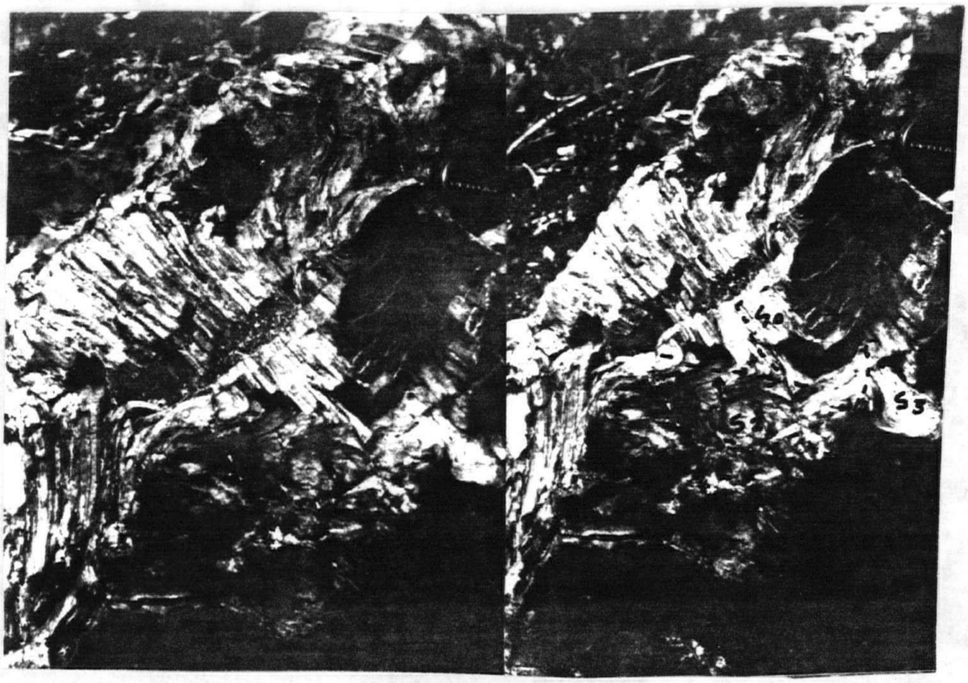


Plate 5k. Recumbant tight phase two fold refolded by upright phase three medium fold (Eureka Quartzite) {DIR-315, LOC-J104}

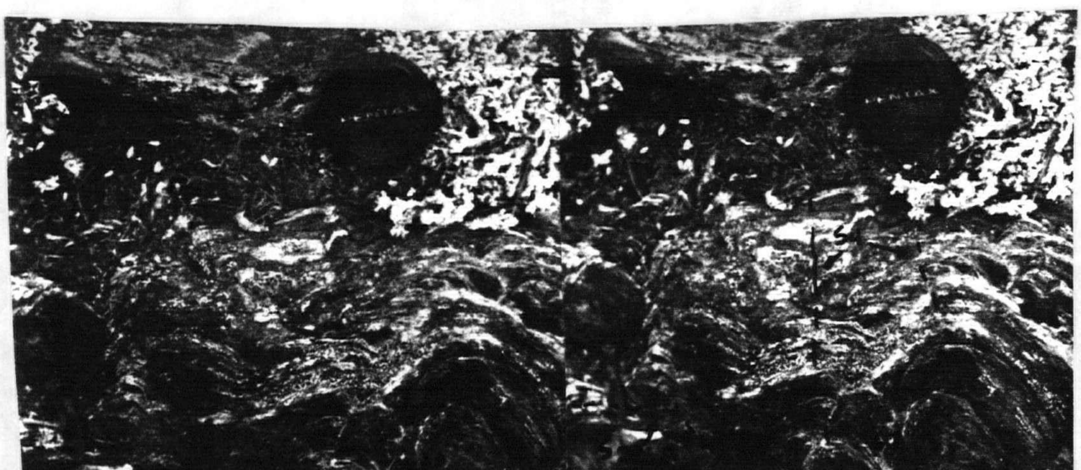


Plate 5l. Upright steep plunging phase four folds in Domain I tight phase two folds are present (near bottom left in photo) {DIR270, LOC-J33}