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VARIATIONS IN STRUCTURAL GEOMETRY ACROSS THE CONTINENTAL DIVIDE THRUST FRONT, NORTHEASTERN BROOKS RANGE, ALASKA

by

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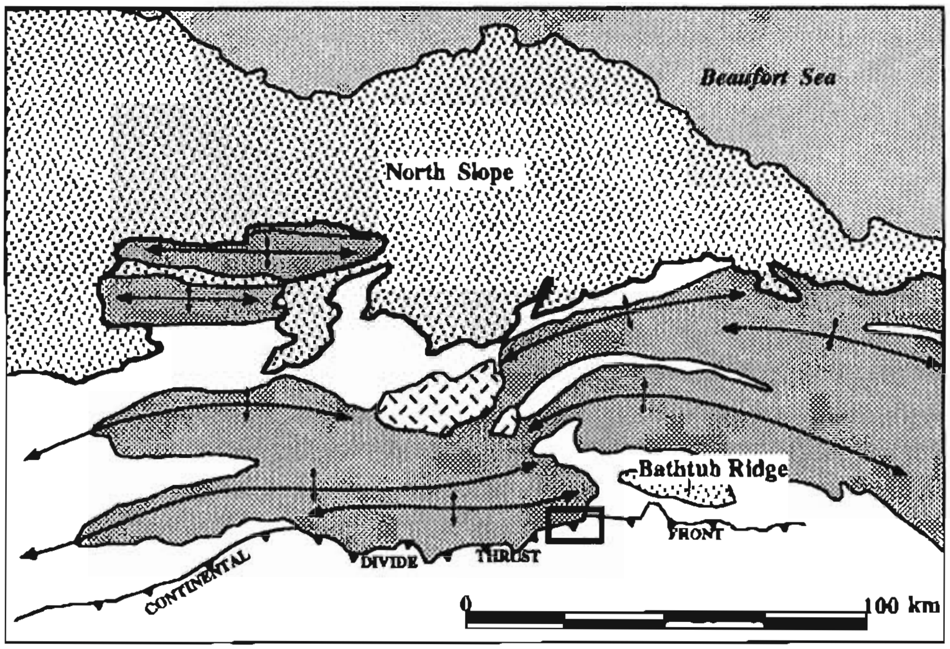
INTRODUCTION

In the eastern Brooks Range, a major structural boundary, the "continental divide thrust front", separates two distinct structural provinces (fig. 1) (Wallace et al., 1988). To the south, the main east-west axis of the Brooks Range is an area of complex closely spaced north-vergent folds and imbricate thrust faults formed mainly during the Late Jurassic to Cretaceous part of the Brooks Range orogeny. The younger northeastern salient of the range is distinguished by a different structural style characterized by major east-west trending, doubly plunging anticlinoria cored by lower Paleozoic rocks and overlain by detachment folds formed in Mississippian and younger rocks. The anticlinoria are interpreted to be the surface expression of horses in a regional duplex (Wallace and Hanks, 1990). The Kayak Shale horizon, near the base of the Mississippian rocks, forms a major detachment horizon and is interpreted to be the roof thrust of the regional duplex. For a more detailed discussion of these relationships see Wallace and Hanks (1990).

In the northeastern Brooks Range, the Paleozoic stratigraphic succession consists of two stratigraphic sequences separated by a major regional erosion surface. This surface marks a major change in tectonic setting in northern Alaska. The lower stratigraphic sequence is a poorly understood, lithologically heterogeneous assemblage of pre-Middle Devonian polydeformed, low-grade metasedimentary and metavolcanic rocks (Grantz et al., 1990). These rocks show multiple generations of folds, thrusts, and penetrative structures, and are intruded by Devonian granites (Sable, 1977; Dillon et al., 1987b). Above the erosion surface, the Middle Devonian to Lower Cretaceous Ellesmerian Sequence (as defined by Lerand, 1973) is the depositional record of a south- to southwest-facing passive continental margin (Dutro, 1981; Moore et al., 1992). The age of the last mid-Paleozoic orogeny in northern Alaska is constrained by the abrupt change from polydeformed rocks below the erosion surface to less deformed rocks above. The entire



Regional anticlinoria cored by pre-Middle Devonian rocks

Devonian Okpilak Batholith and Jago Stock

Middle Devonian to Lower Cretaceous rocks, Ellesmerian Sequence includes Eo-Ellesmerian

Lower Cretaceous to Cenozoic foredeep deposits

Box shows study area

Range front

Figure 1. Generalized geologic map of the northeastern Brooks Range showing regional anticlinoria, continental divide thrust front, and the study area.

succession was deformed during the Mesozoic to Cenozoic Brooks Range The entire succession was deformed during the Mesozoic to Cenozoic Brooks Range orogeny.

The study area is located at the headwaters of the Aichilik and Kongakut Rivers, southwest of Bathtub Ridge (fig. 1). In this part of the continental divide thrust front region, polydeformed lower Paleozoic rocks and the overlying Ellesmerian Sequence are exposed on the southeastern flank of a major east-plunging regional anticlinorium. Polydeformed Ordovician Romanzof chert (informal name) cores the anticlinorium (OCcp of Reiser et al., 1980). In the north, Mississippian Kekiktuk Conglomerate unconformably overlies the Romanzof chert with major angular discordance (fig. 2). In the south, a thick Middle Devonian to Mississippian stratigraphic succession consisting of the Ulungarat formation (Anderson, 1991), Mangaqtaaq formation (Anderson and Watts, 1992), and Kekiktuk Conglomerate has been thrust northward on the Aichilik pass thrust over the Romanzof chert and its thin overlying cover of Kekiktuk Conglomerate. The anticlinorium within the pre-Middle Devonian rocks and the folds and duplexes within the Middle Devonian and younger rocks are the result of Late Cretaceous(?) to Cenozoic deformation which formed the northeastern Brooks Range (Wallace and Hanks, 1990).

Restoration of displacement on the Aichilik pass thrust shows that the Middle Devonian to Mississippian deposits form a southward-thickening clastic wedge. The Ulungarat and Mangaqtaaq formations in the lower part of this wedge have been interpreted to be syn-rift deposits (Anderson, 1993). The abrupt change from thin clastic rocks of the Mississippian Kekiktuk Conglomerate in the footwall of the Aichilik pass thrust to a thick Middle Devonian to Mississippian clastic succession in the hangingwall is interpreted to reflect deposition across an ancient rift-basin margin (Anderson et al., 1992; Anderson 1993).

This report summarizes the results of a structural study that characterizes the differences in structural history across the unconformities and the geometry of Brookian structures. The only previously published works on the area are the reconnaissance-scale

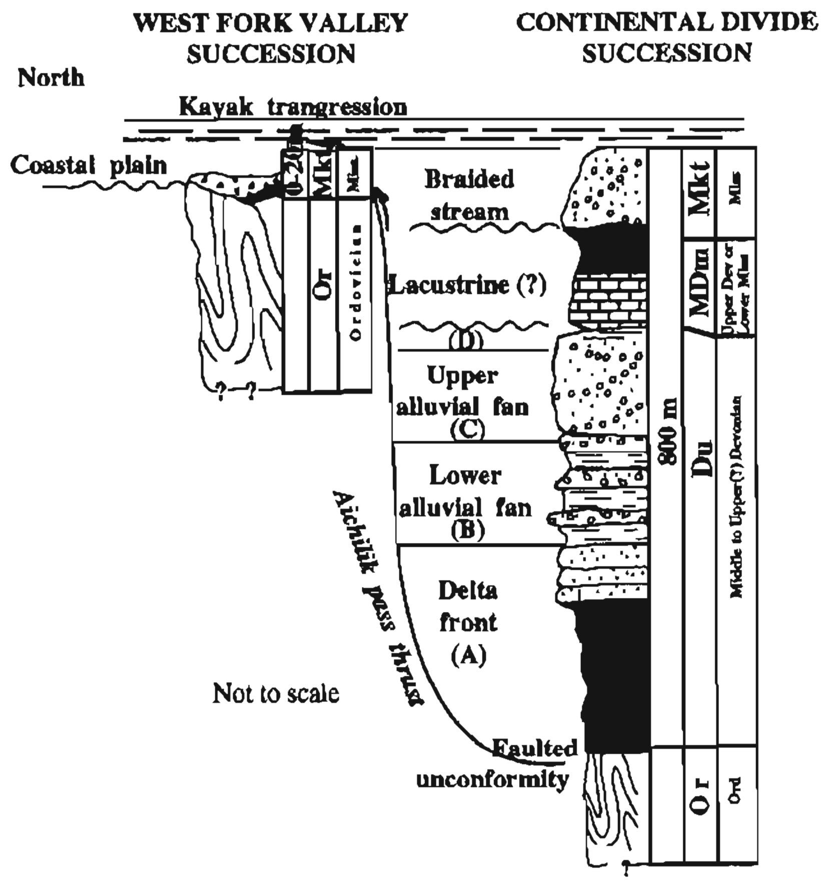


Figure 2. Generalized columns illustrating stratigraphic sequence exposed in for the study area showing differences in stratigraphy and depositional environmentswith abrupt southward increase in thickness of Middle Devonian to Mississippian clastic rocks across the Aichilik pass thrust. Displacement across the Aichilik pass thrust varies from an estimated few hundred meters to 2 km. Romanzof chert (Or), Ulungarat formation (Du), Mangaqtaaq formation (MDm), and Kekiktuk Conglomerate (Mkt).

maps of Reiser et al. (1980) and Brosge et al. (1976). For this study, detailed mapping at the scale of 1:25,000, analysis of minor structures, and measurement of stratigraphic sections were carried out to characterize the structural geometry and determine lateral variations in the stratigraphy in the field area.

STRUCTURAL DOMAINS

The major structures of the field area are north-vergent folds and thrust faults formed during Late Cretaceous(?) to Cenozoic Brookian deformation. Based on differences in structural style, the area is divided into four structural-stratigraphic domains (fig. 3). These differences correspond with and likely are controlled by differences in the stratigraphy of each domain (fig. 4). These relationships are shown in Table 1.

In the north, Domain I consists of the Romanzof chert and overlying thin Kekiktuk Conglomerate exposed in the regional anticlinorium. To the south, Domain II consists of a thick succession of Middle Devonian to Mississippian clastic rocks which have shortened by thrust duplication. Domain III consists of Kayak Shale which throughout the area serves as a detachment horizon. Domain IV consists of the Lisburne Group and Sadlerochit Group which shorten primarily by detachment folding.

Domain I

In the northwestern part of the map area, the regional anticlinorium is cored by Ordovician Romanzof chert. Mississippian Kekiktuk Conglomerate less than 30 meters thick depositionally overlies the chert with major angular discordance. This stratigraphic succession forms the footwall of the Aichilik Pass thrust and is defined as Domain I. The anticlinorium in Domain I is one of a series of large anticlinoria in the northeastern Brooks Range that have been interpreted to be fault-bend folds in a duplex between floor thrust at

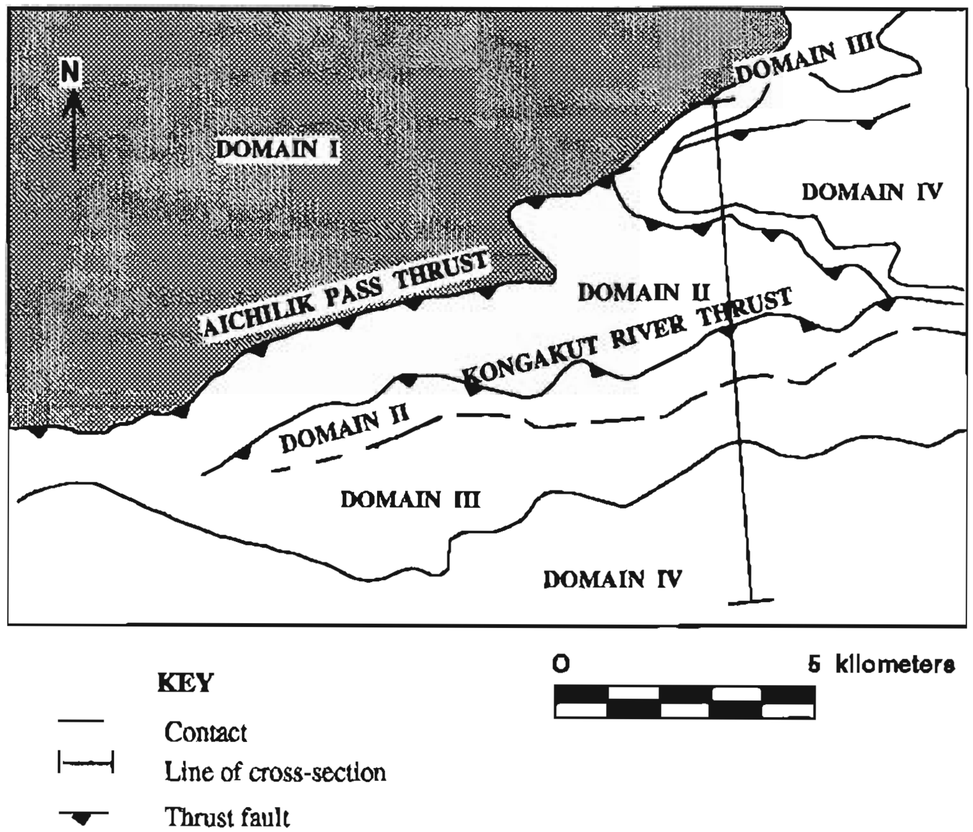
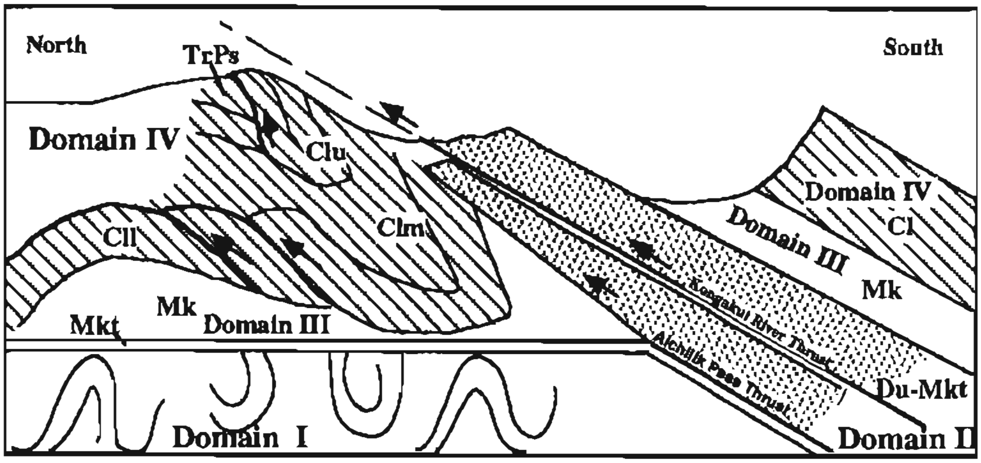


Figure 3. Generalized geologic map showing structural-stratigraphic domains in the study area. Line indicates approximate location of schematic cross-section in figure 16.4.



Not to Scale

Domain I, Or, Mkt

Domain II, Du, MDm, Mkt

Domain III, Mk, detachment horizon

Domain IV, Cl (Cll, Clm, Clu), TrPs

Figure 4. Schematic north-south cross-section illustrating structural geometry of each structural-stratigraphic domain. See Table 16.1 for formation names. Line of cross-section shown on fig. 16.3.

Table 1. Stratigraphic units and structural style in each domain north and south of the Aichilik pass thrust. The Aichilik pass thrust is the approximate position of the Middle Devonian to Mississippian rift-basin margin.

Structural - Stratigraphic Unit	North of Aichilik Pass Thrust	South of Aichilik Pass Thrust
DOMAIN IV Sadlerochit Group (TrPs) Lisburne Group (Cl)	Short wave-length detachment folds	Imbricate thrusts
DOMAIN III Kayak Shale (Mk)	Detachment horizon	Detachment horizon
DOMAIN II Kekiktuk Conglomerate (Mkt) Mangaqtaaq Formation (MDm) Ulungarat Formation (Du)	Not present	Duplex
DOMAIN I Kekiktuk Conglomerate (Mkt) Romanzof chert (Or)	Major regional anticlinorium	Not present

depth in the pre-Middle Devonian rocks and a roof thrust in the Kayak Shale (Namson and Wallace, 1986; Wallace and Hanks, 1990).

The Romanzof chert is the structurally lowest unit in the field area, but forms topographic highs due to its resistance to erosion. The unit consists of 40-60% massive and bedded chert which occurs as rootless lenses in a phyllite matrix. Lenses or groups of lenses define mappable linear features that extend for kilometers in an east-west orientation. Individual chert lenses crop out for up to 100's of meters. Bedding and cleavage in the chert and phyllite are at a high-angle or sub-perpendicular to the overlying unconformity surface. The Romanzof chert is of inferred Ordovician age. This age assignment is supported by graptolites from presumably equivalent rocks along strike to the southwest in the Arctic quadrangle (Moore and Churkin, 1984; Moore et al., 1992) and an older age is precluded by the abundance of radiolaria in the bedded cherts.

The chert displays at least two generations of tight to isoclinal folds with variably plunging refolded axes. The fold geometry indicates significant shortening. It is not possible to distinguish D1 and D2 folds in most places. Structures are best exposed at several localities referred to on figure 5 as locations I, II, III, and IV. At locality I, tight to isoclinal chevron folds plunge steeply to the northeast (Appendix 1.A) and are generally less than 4 m in wavelength. At locality II, the opposing asymmetry of small "S" and "Z" folds (< 0.5 m wavelength) across steep west-striking surfaces suggest parasitic folds on the limbs of a larger structure 10's of m in wavelength (Appendix 1.B). Orientation of these limbs sub-perpendicular to the overlying unconformity suggests that the fold is sub-vertical. At locality II, small thrusts offset some of the chevron folds. Where seen, displacement across these thrusts is less than 0.5 m, suggesting out-of-syncline thrusting related to space problems. The general east-west orientation of the large synform at location II, with limbs oriented sub-perpendicular to the unconformity surface, suggests that the regional east-west structural grain of the chert "lenses" is a result of D2 deformation. Clearly refolded folds are exposed at localities III and IV (fig. 5 and 6).

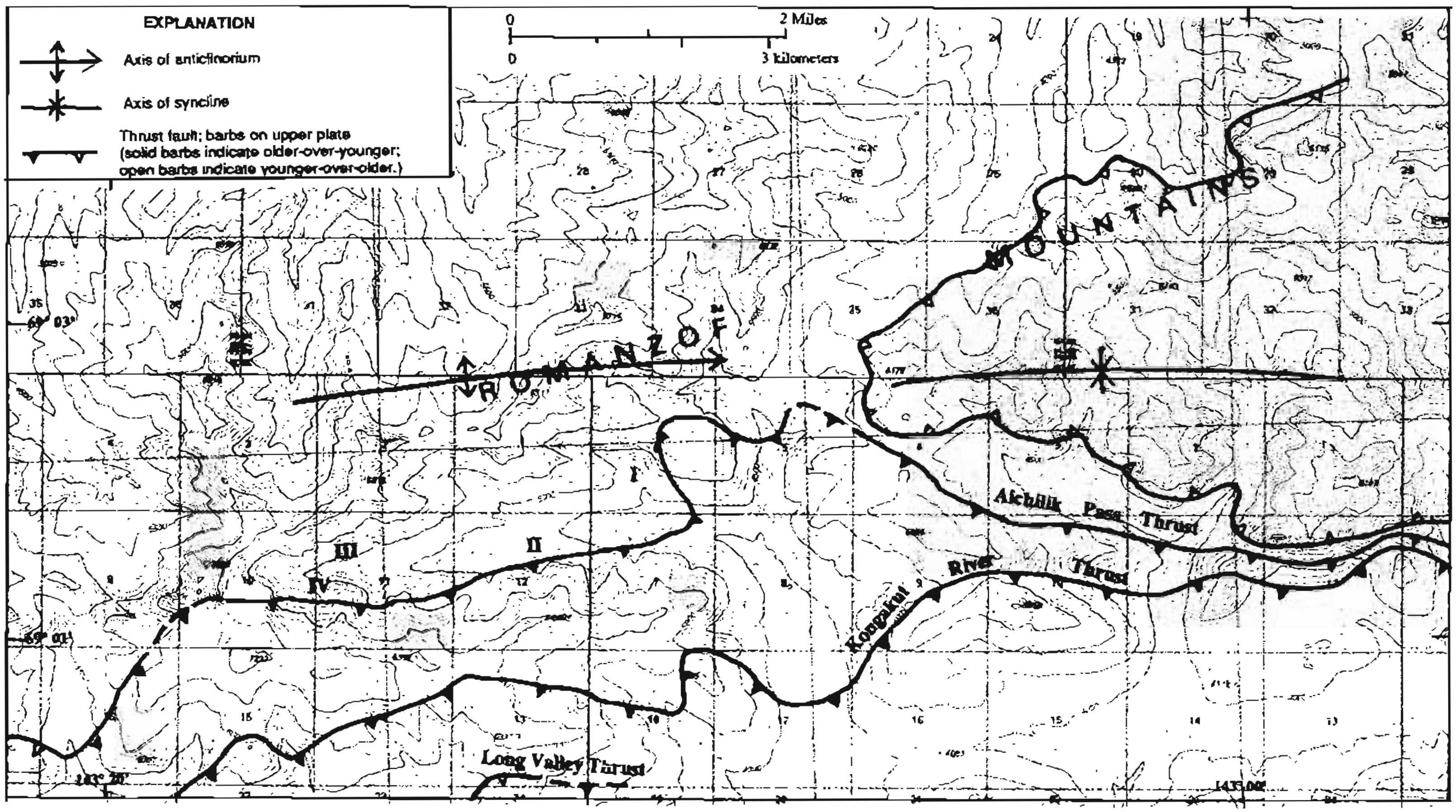


Figure .5. Simplified geologic map showing referenced locations.

(A)

(B)

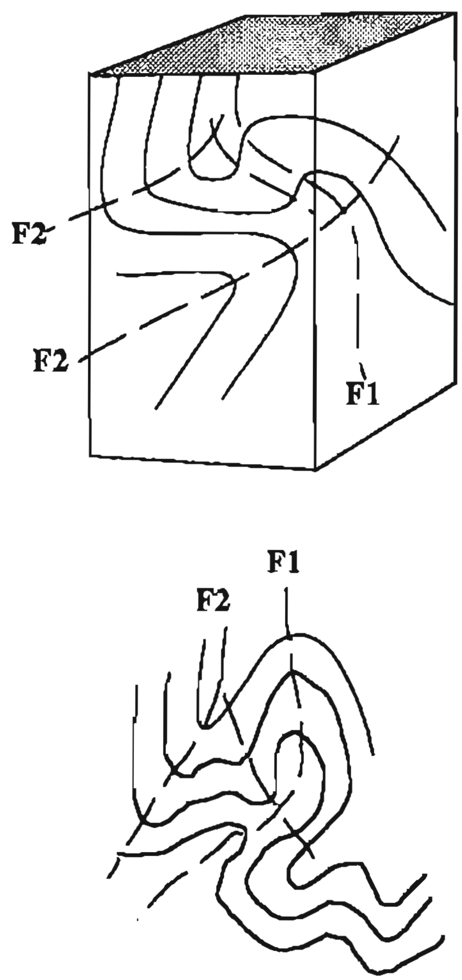


Figure . .6. Line drawings of refolded folds in the Romanzof chert. F2 refolds F1. Figure A shows folds at location III on figure 16.5. Figure B shows folds at location IV on figure 16.5 Both folds < 4 m wavelength..

F1 fold axes refolded about F2 fold axes plunge steeply to the east and to the northwest (Appendix 1.C and D).

The Mississippian Kekiktuk Conglomerate rests depositionally on the unconformity that truncates the underlying Romanzof cherts. The large chert lenses in the Romanzof chert are subperpendicular to the unconformity surface and to bedding in the Kekiktuk Conglomerate. This strong discordance aids in the recognition of the unconformity surface where massive cherty rocks are present both above and below. The Kekiktuk Conglomerate has remained mechanically attached to the underlying Romanzof chert so that the two units have deformed during Brookian deformation as a single structural unit, which defines Domain I. Brookian shortening in Domain I is interpreted to have been accommodated by the northward displacement of one or more large horses in a duplex with a floor thrust at depth and a roof thrust in the Kayak shale. The unconformity and overlying Kekiktuk Conglomerate define the geometry of the upper surface(s) of the horse or horses which form(s) the regional east-plunging anticlinorium. In general, erosion of the Kekiktuk Conglomerate precludes determination of the precise geometry of the anticlines and of the number of horses. However, the eastern end of the regional anticlinorium defines a fault-bend fold that is a minimum of 8 km across.

Domain II

Domain II is in the hangingwall of the Aichilik pass thrust and comprises a different, but partially time equivalent, stratigraphic succession than in Domain I. Domain II consists of a Middle Devonian to Mississippian succession of terrigenous clastic rocks that includes the Ulungarat formation (Anderson, 1991), Mangaqtaaq formation (Anderson and Watts, 1992), and Kekiktuk Conglomerate. This stratigraphic succession is as much as 800 meters thick, but its base is defined by thrust faults everywhere in the study area. The stratigraphic succession in Domain II contains low-angle unconformities between units. The top of the Ulungarat formation is an erosional unconformity overlain in different places by the Mangaqtaaq formation or the Mississippian Kekiktuk Conglomerate. The Mangaqtaaq formation is also overlain with low-angle discordance by the Kekiktuk Conglomerate. There is no more than 5 to 10° discordance and no significant difference in deformation across these unconformities. The lower member of the Ulungarat formation contains shallow-marine invertebrate fossils of Eifelian age (R.B. Blodgett, U.S. Geological Survey, personal communication, 1991). The Mangaqtaaq formation contains Late Devonian and/or Early Mississippian plant fossils (S. Mamay, U.S. Geological Survey, written communication, 1989). The Kekiktuk Conglomerate contains Early Mississippian plant fossils (R. Spicer, University of Oxford, personnel communication, 1990).

The rocks of Domain II have been shortened by thrust duplication. North-displaced thrust sheets dip to the south and are bounded by thrusts that generally parallel bedding in both the hangingwall and footwall. From north to south, the major thrust faults in the study area are the Aichilik pass and Kongakut River faults (fig. 3). These thrust sheets are interpreted to be horses in a duplex with a floor thrust in the lower Ulungarat formation and a roof thrust in the Kayak Shale. The lowest horse includes the thickest stratigraphic sequence and has been thrust northward on the Aichilik pass thrust directly onto strata of Domain I. In the western part of the study area, the Aichilik pass thrust is interpreted to be a faulted unconformity. In that area, the Middle Devonian Ulungarat formation in the hangingwall has been displaced along the contact with the Ordovician Romanzof chert in the footwall. To the east, the Aichilik pass thrust cuts stratigraphically higher in the footwall, successively displacing the hangingwall succession over Kekiktuk Conglomerate, cutting up section across the roof thrust in the Kayak Shale, and forming a footwall syncline in the Lisburne Group of Domain IV (Sheet I). However, the actual thrust truncation of the Lisburne Group is not exposed in the study area but is inferred because the thrust projects above the immediately adjacent syncline in Domain IV. There is insufficient space between exposures of the thrust and the syncline for the thrust to do anything other than cut the syncline. Displacement across the Aichilik pass thrust is estimated to vary from a few 100 m in the west where it is interpreted to be a faulted unconformity to 1 or 2 km in the east where Middle Devonian Ulungarat formtion overlies Mississippian Kayak Shale in the footwall. Farther south, the Kongakut River thrust (Wallace et aL., 1988) and the Long Valley thrust duplicate the same stratigraphic succession (fig. 4).

The structure in Domain II is characterized by gentle southeast dips of bedding that reflect the dip of thrust sheets and, in the fine-grained sediments, by a well-developed cleavage that dips more steeply than bedding.(Appendix 1.F, H, J, L, and M). Stereographic projections of poles to bedding (S_0) and cleavage (S_3) define girdles about northeast-trending axes. These northeast-trending fold axes may reflect fault-bend folds and/or other thrust-related folds, although such folds have been eroded in most of the area.

Domain III

Domain III consists of the Kayak Shale, which has served as a major detachment horizon that commonly defines the boundaries between the other domains and separates thrust sheets in Domain II. The Kayak Shale is a fissile shale that varies in thickness from approximately 300 to 400 m in the Kongakut River thrust sheet to 100 m in the north, where it overlies Domain I. It probably has been structurally thickened in most places, so its true depositional thickness is uncertain. Because of its role as a horizon of slip, the Kayak Shale has been disrupted by minor folding, faulting, and penetrative strain.

Bedding and cleavage dip to the southeast and south (Appendix 1.G, I, K, and N). Penetrative slaty cleavage (S_3) characterizes the unit and is generally parallel to bedding (S_0). A second, spaced cleavage (S_4) is at a higher angle to bedding. Small folds less than 10 m in wavelength generally trend east-west and plunge to the southeast and east. Folds vary from upright to recumbent, open to tight. Asymmetrical folds are north-vergent. Large detachment folds and disharmonic folds characterize the upper Kayak

Shale. These folds are defined by limestone beds in the upper Kayak Shale and are 10's to 100's of meters in wavelength.

The Kayak Shale has served as a detachment horizon that separates domains in which shortening has been accommodated in different ways. Most faults in the area cut up section to or from flats in the Kayak Shale. The unit has served as a detachment horizon for imbrication in Domains II and IV, and for the formation of detachment folds in Domain IV. For these reasons, it is assumed that slip has occurred somewhere within the unit throughout most of the map area. However, it is not generally possible to identify specific fault surfaces within the Kayak Shale. This is because the unit is a thick and lithologically homogeneous shale with few distinctive and stratigraphically continuous markers and is poorly exposed. Also, the unit commonly displays internal deformation in zones of significant thickness, suggesting that slip is commonly distributed over zones rather than on discrete fault surfaces. Thus, where faults cut up section to or from flats in the Kayak Shale, the continuation of those faults within the Kayak Shale is not generally illustrated on the map (Sheet I).

Domain IV

Folds and thrust faults above a detachment horizon in the Kayak shale and with wavelengths of 100's of meters characterize Domain IV, which consists of the Mississippian-Pennsylvanian Lisburne Group and the unconformably overlying Permian-Triassic Sadlerochit Group. The major structures of Domain IV are detachment folds formed above the Kayak Shale, which generally appears to be structurally thickened in the cores of anticlines. Thrust faults commonly have broken through the previously formed detachment folds, forming overturned footwall synclines and hangingwall anticlines. Thrust-truncation of existing folds locally has resulted in relationships that commonly are considered anomalous in thrust-faulted terrains, such as younger-over-older thrust faults and apparent discrepancies in sense of offset. Complications in this overall pattern have resulted from differences in structural behavior of different structural-stratigraphic units in the Lisburne Group during detachment folding and thrust propagation and displacement.

The Lisburne Group is divided into three units which show abrupt lateral changes in thickness and organization. Each of the three (Clu, Clm, Cll) has deformed as a separate structural unit within Domain IV. In different places, minor structures have formed before, during, or after major detachment folding and thrusting. The lowest unit (Cll) is a cliff-forming bioclastic limestone that in places shows pervasive replacement by black chert. It is less than 30 m thick and is depositionally absent from the southern part of the map area. Cll has behaved as a structurally competent unit. It is present in the footwall syncline of the Aichilik pass thrust, where shortening before folding locally was accommodated by displacement of horses in a minor duplex with a floor thrust in the Kayak shale and a roof thrust in Clm. In the northern part of the map area, Cll forms local minor, but spectacular, fault-bend folds, fault-propagation folds, and detachment folds.

Clm is relatively incompetent because it is thin-bedded and has a high percentage of argillaceous interbeds. The interval is approximately 300 to 400 m thick, but thickness is difficult to estimate due to structural complexity. The unit forms a detachment horizon between Cll and Clu. Thin competent beds within Clm form disharmonic detachment folds. Clu is a competent unit that has generally shortened by folding above Clm. In the structurally highest eastern part of the map area, Clu and the Sadlerochit Group have shortened by thrust duplication above Clm. Clu is approximately 200 to 300 m thick, but thickness is difficult to estimate due to erosion and structural duplication.

FRACTURES

Steep to subvertical fractures cut all other structures. Sterographic projections of poles to fracture surfaces are shown in Appendix 1.O to Q. Most fractures strike NE-SW or NW-SE, although there is so much variability in orientation that distinct fracture sets are not apparent. Down-to-the-north normal faulting along the subvertical fractures is indicated by offset bedding and quartz fiber growth. Observed offsets are less than 10 cm. Where both subvertical and moderately dipping (40 to 60°) fractures are developed, the moderately dipping fractures offset the subvertical fractures. Quartz veins commonly fill the moderately dipping fractures.

INTERPRETATION OF STRUCTURES

Each structural-stratigraphic domain exhibits a distinct structural style, reflecting a different structural response to shortening by the mechanically distinct stratigraphy in each domain.

Domain I

Domain I is composed predominantly of a single stratigraphic unit, the Romanzof chert. The unconformably overlying Kekiktuk Conglomerate forms a thin veneer that deformed mechanically with the Romanzof chert. Brookian shortening in Domain I is interpreted to have been accommodated by displacement of large-scale horses in a duplex with a floor thrust at depth and a roof thrust in the Kayak Shale. The large size of horses in Domain I may reflect the great depth of the lower detachment and the fact that the Romanzof chert behaved as a single thick structural unit because of its previous strong deformation and a consequent lack of internal, throughgoing, horizontal detachment horizons. The anticlinorium in Domain I is the southernmost of a series of similar major anticlinoria along the Aichilik River, each cored by large-scale horses composed of early Paleozoic rocks and unconformably overlying Kekiktuk Conglomerate (Hanks, 1993). The displacement of each horse is estimated to be on the order of 5-10 km (Hanks, 1993, fig. 10).

Domain II

Shortening in Domain II was accommodated by displacement of smaller-scale horses in a duplex with a floor thrust beneath marine shales of the lower Ulungarat formation and a roof thrust in the Kayak Shale. These horses consist of a succession of Endicott Group terrigenous clastic rocks, up to at least 800 m thick, that were deposited south of a rift-basin margin (Anderson, 1993). In its hangingwall, the Aichilik pass thrust cuts abruptly up section northward through the Ulungarat formation. To the east, the Aichilik pass thrust ramps across the Kayak Shale to a higher detachment horizon, perhaps the now eroded Kingak Shale, as has been documented elsewhere (Wallace et al., 1988; Wallace, 1989; and Homza, 1992). The ramping of the Aichilik pass thrust across the roof thrust to a higher detachment horizon may be related to Devonian normal faults along the rift-basin margin. Depositional termination of sub-Kayak clastic deposits against one or more basin-margin normal faults could deflect the northward propagating thrust fault upwartd at a high angle, causing the fault to ramp higher, rather than flattening in the Kayak Shale.

Domain III

Domain III consists of the incompetent Kayak Shale, which serves as the roof thrust for the duplexes in the underlying rocks of Domains I and II, and serves as the basal detachment for structures in Domain IV. The role of the unit as a detachment horizon is reflected by internal disharmonic folding, thrust-faulting, and penetrative cleavage.

Domain IV

Domain IV deformed independently of underlying domains and is characterized by a different, more complex, structural style. The domain consists mostly of the structurally competent Lisburne Group. Shortening was accommodated above the Kayak Shale detachment horizon by detachment folds and thrust duplication. Incompetent horizons within the Lisburne Group and Sadlerochit Group formed local detachment horizons which permitted the development of short-wavelength folds and local duplexes within Domain IV.

SEQUENCE AND AGE OF DEFORMATION

Four generations of structures have been identified in the study area and are summarized in Table 2. The D1 and D2 structures present in the Ordovician rocks of Domain I are absent in the unconformably overlying Middle Devonian and younger rocks. Thus, they document one or more pre-Middle Devonian contractional events. D3 and D4 structures record Late Cretaceous(?) to Cenozoic Brookian deformation and are present in the entire Ordovician through Triassic stratigraphic succession. D3 structures are best developed above the roof thrust of Domain I. D4 structures reflect formation of the anticlinorium in Domain I.

Apatite fission-track analysis from samples collected in Domains I, II, and III indicates a cooling age of about 59 Ma in the study area (P. O'Sullivan, written communication, 1991). The long track lengths reported indicate rapid cooling, probably due to uplift and consequent erosional unroofing. The similarity in ages from the Kongakut River thrust sheet, the Aichilik pass thrust sheet, and the underlying rocks of Domain I suggest that this cooling age dates formation of the anticlinorium in Domain I. These data are in agreement with a similar age for rapid uplift and unroofing at Bathtub Ridge (O'Sullivan et al., 1993). Formation of the duplex in Domain II probably predates that of the Domain I anticlinorium since the duplex structurally overlies and was folded during formation of the anticlinorium.

INFLUENCE OF THE DEVONIAN-MISSISSIPPIAN RIFT-BASIN MARGIN ON BROOKIAN STRUCTURES

The change in structural style that marks the continental divide thrust front corresponds approximately with the mid-Paleozoic rift-basin margin. Two distinct stratigraphic successions are present below the Kayak Shale detachment horizon. Each occupied a different position across the rift-margin (fig.7). To the south, the southward-thickening wedge of syn-rift and early passive-margin deposits shortened as horses in a duplex. This stratigraphic succession is Domain II. The wedge-shaped depositional geometry of this stratigraphic unit resulted in termination of this duplex at the basin-margin where the floor thrust of the duplex cuts abruptly upward to the roof thrust in the Kayak Shale, and locally to an even higher detachment. The abrupt termination of the duplex resulted from depositional termination of the wedge and, possibly, upward deflection of the floor thrust against the ancient basin-margin. North of the rift-basin margin, the lithologically and thus mechanically different stratigraphic succession of Domain I deformed as thick horses in a different duplex with an apparently deeper detachment and significant structural relief. The Domain I anticlinorium is the southernmost of a series of anticlinoria that characterize the northeastern Brooks Range.

The change in structural style below the Kayak Shale detachment is reflected in a less abrupt, but distinct change in Domain IV above the Kayak. From the approximate position of the rift-basin margin to approximately 17 km to the north, Domain IV rocks show a progressive change in structural style from imbricate thrust faults to detachment folds. This change was recognized by Wallace (1989) and documented by Homza (1992).

Table .2. Summary of meso- and macroscopic structures in the study area.

		DESCRIPTION	INTERPRETATION
Brookian Orogeny	D 4	Limbs of large fault-bend fold defined by sub-perpendicular relation between Mkt and chert lenses in Or Fold > 8 km wave-length Thickness of fold > 1 km Thrust sheet > 1 km thick	Duplex with floor thrust at depth and roof thrust in Mk Significant structural relief of regional anticlinorium E-W orientation controlled by D2 structural grain
Brookian Orogeny	D 3	Domain II and III NE to E striking, moderately S-dipping bedding, cleavage,and spaced cleavage dip steeper than bedding Displacement on Aichilik pass thrust <2 km, Kongakut River thrust > 1 km Thrust sheets < 1 km thick Domain IV Large detachment folds with 100's m wave-length	So defines gently south-dipping thrust sheets Shortening accommodated in a duplex with a floor thrust below Du and a roof thrust in Mk. Above Mk by detachment folding and thrust duplication.
		Major Regional Erosional	Unconformities
Pre-Middle Devonian Orogeny	D 2	Steeply NE plunging, tight to isoclinal, chevron folds Changes in asymmetry of folds associated with small thrust faults Defines E-W structural grain of large chert "lenses"	F1 folds refolded about F2 axes Suggests parasitic folds on limbs of large synform 100+ m wave-length
Pre-Middle Devonian Orogeny	D 1	Tight to isoclinal folds plunge steeply NW and NE, < 4 m wavelength	Earliest identified folding event, refolded during D2.

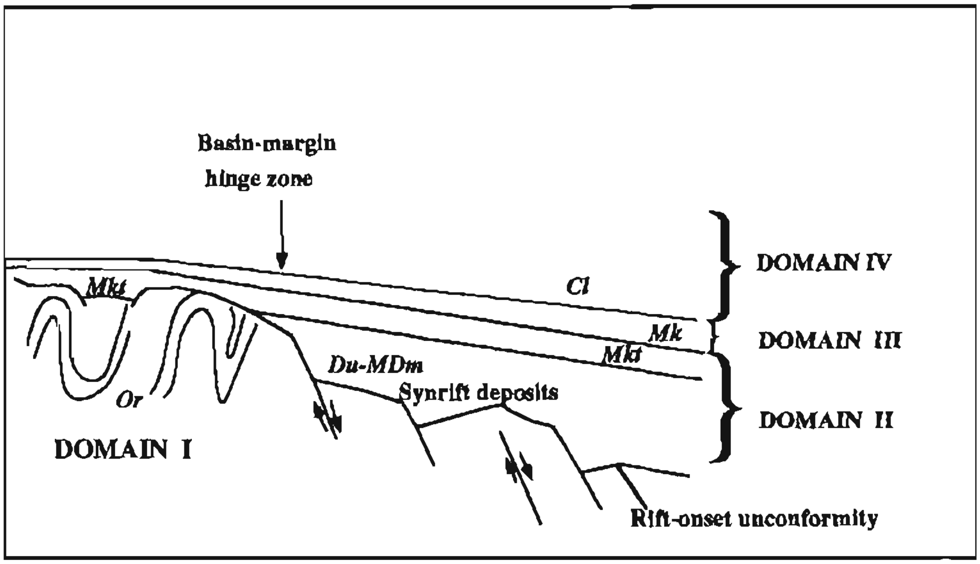


Figure 7. Schematic diagram of rift-basin margin showing relationship of structural domains in relation to tectonic elements across the interpreted rift-basin margin. Romanzof chert (Or), Ulungarat formation (Du), Mangaqtaaq formation (MDm), Kekiktuk Conglomerate (Mkt), and Lisburne Group (Cl).

SUMMARY AND CONCLUSIONS

Detailed mapping and structural analysis suggest the following conclusions:

1. At least two generations of structures within the Ordovician Romanzof chert have been truncated and overlain with angular unconformity by Middle Devonian to Mississippian clastic rocks. This constrains the latest major mid-Paleozoic contractional deformation to pre-Middle Devonian time.

2. The Middle Devonian through Triassic stratigraphic succession records only Brookian contractional deformation.

3. Where the Mississippian Kekiktuk Conglomerate was deposited directly on the erosional surface overlying the Romanzof chert (Domain I), the two deformed as a single structural unit during Brookian shortening. Shortening in Domain I was accommodated by displacement of large horses with a floor thrust at depth and a roof thrust in the Kayak Shale. The horse(s) in Domain I form a regional east-plunging anticlinorium.

4. In the south, a stratigraphic succession consisting of Middle Devonian to Mississippian clastic rocks (Domain II) forms south-dipping horses in a duplex with a floor thrust within or below the Ulungarat formation and a roof thrust in the Mississippian Kayak Shale.

5. The Kayak Shale (Domain III) serves as the roof thrust for the duplexes in the underlying rocks of Domains I and II, and serves as the basal detachment for structures in Domain IV. The role of the unit as a detachment horizon is reflected by internal disharmonic folding, thrust-faulting, and penetrative cleavage.

6. Detachment folds and thrust faults in the Lisburne Group and Sadlerochit Group (Domain IV) accommodate shortening above the Kayak Shale.

7. The change in structural style that is marked by the continental divide thrust front corresponds with a change in stratigraphy across the Devonian to Mississippian rift-basin margin at the base of the Ellesmerian rift to passive-margin succession.

8. The Domain II duplex ends at the rift-basin margin probably due to depositional "pinch out". The decollement stepped down across the rift-basin margin into a mechanically different unit (Domain I) which accommodated shortening as thick horses in a different duplex. These changes in the response of rocks below the Kayak Shale are reflected in a change in structural style above the Kayak. The structural style of Domain IV shows gradual northward change from imbricate thrust faults to detachment folds.

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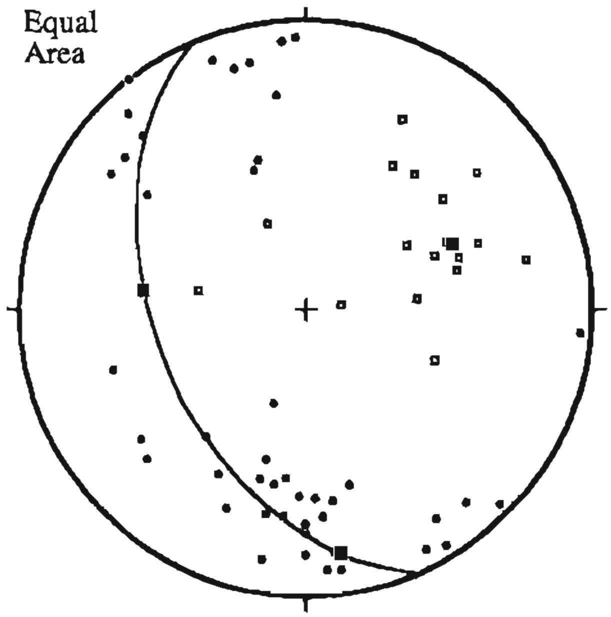
APPENDIX. EQUAL-AREA STEROGRAPHIC PROJECTIONS

Equal-area sterographic projections of poles to planes for mesoscopic structures and trend and plunge of fold hinges. D1 and D2 are pre-Middle Devonian events and D3 and D4 are Cretaceous(?) to Cenozoic events. Folds in the Romanzof cherts (A-E); Bedding and cleavage in the Endicott Group (F-M); Major fracture surfaces (N-P).

APPENDIX I. EQUAL-AREA STEROGRAPHIC PROJECTIONS

(A) Romanzof Chert



Location I

D2 Fold

So = 45
FH = 17

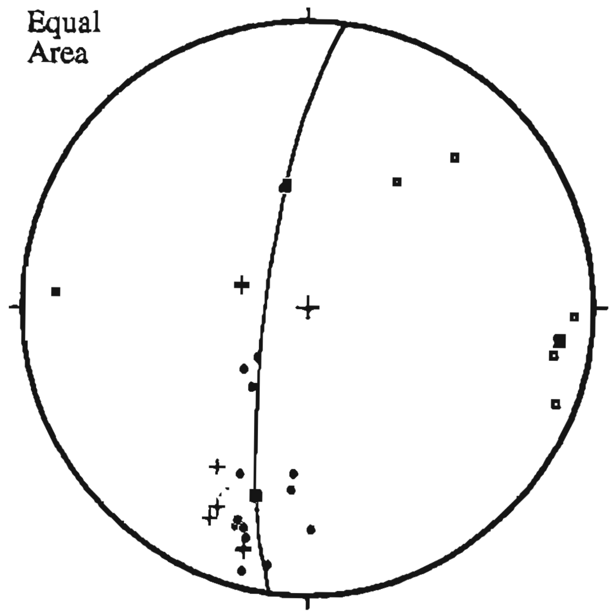
BFGC = 157, 47 W
FA = 67, 43

KEY

- ● Pole of Bedding, So
- ■ Fold Hinge, FH
- + Pole of Fold Axial surface, AS
- ⌒ Best Fit Great Circle, BFGC
- ■ Pole of Great Circle = Fold Axis, FA

Appendix I. Equal-area sterographic projections of poles to planes for mesoscopic structures and trend and plunge of fold hinges. D1 and D2 are pre-Middle Devonian events and D3 and D4 are Cretaceous(?) to Cenozoic events. Folds in the Romanzof cherts (A-E); bedding and cleavage in the Endicott Group (F-M); major fracture surfaces (N-P).

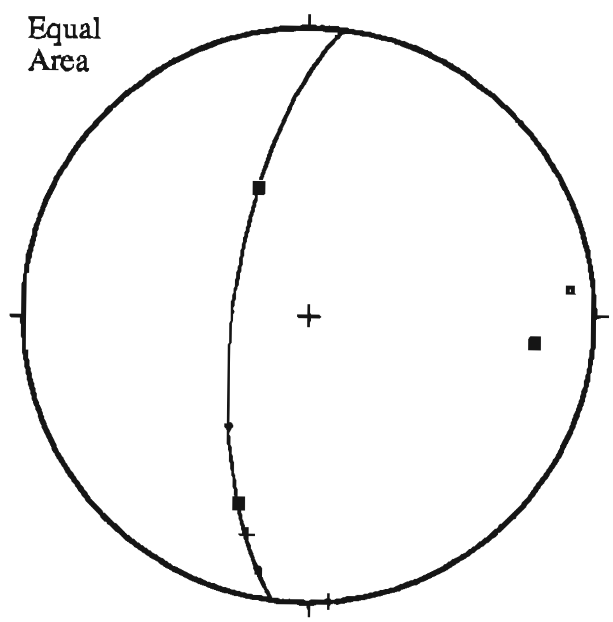
(B) Romanzof Chert



Location II A
D2 Fold

So = 14
FH = 7
AS = 6

BFGC = 187, 78 W
FA = 97, 12

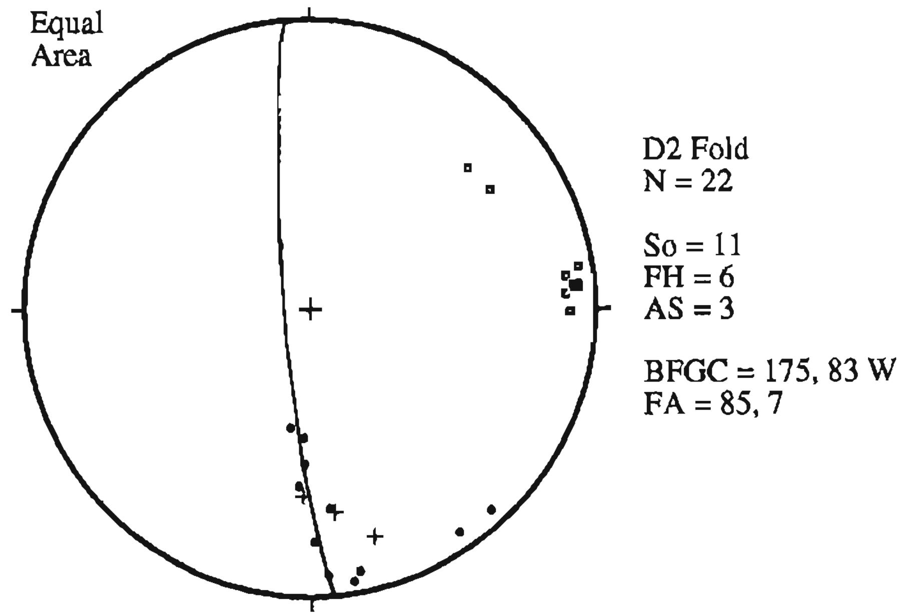


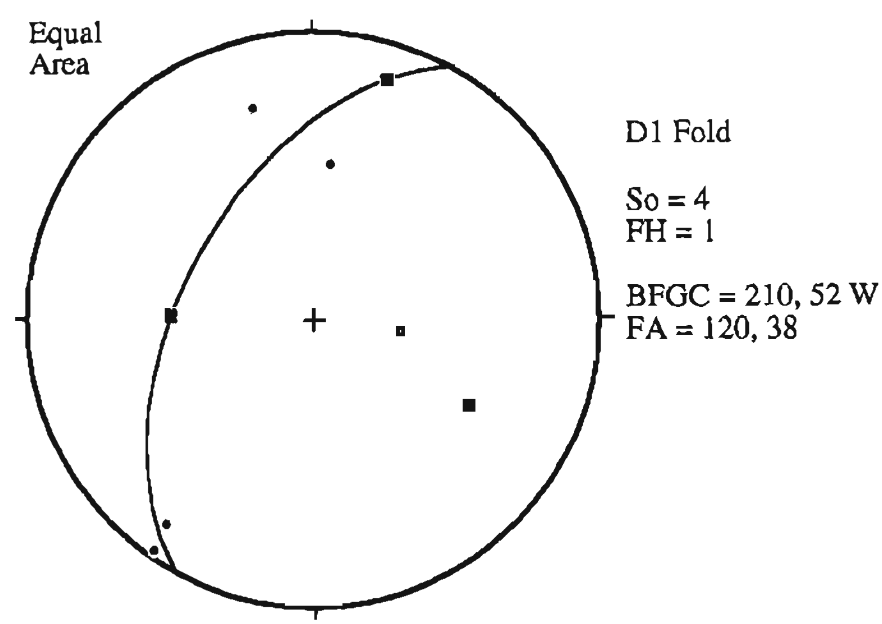
Location II B
D2 Fold

So = 2
FH = 2
AS = 1

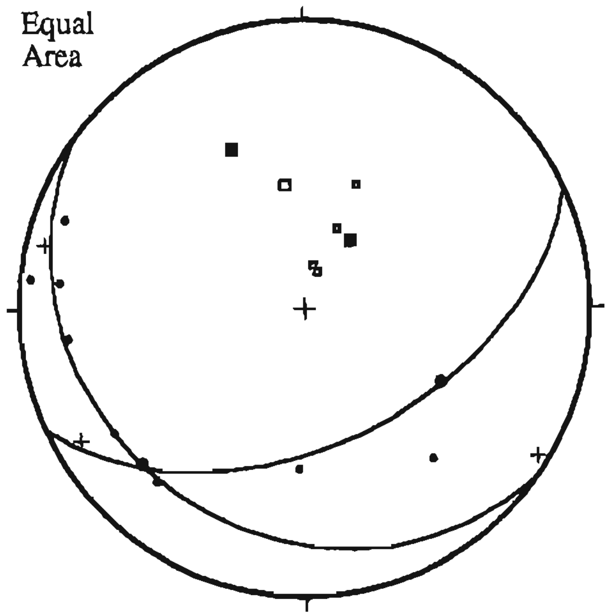
BFGC = 187, 69 W
FA = 97, 21

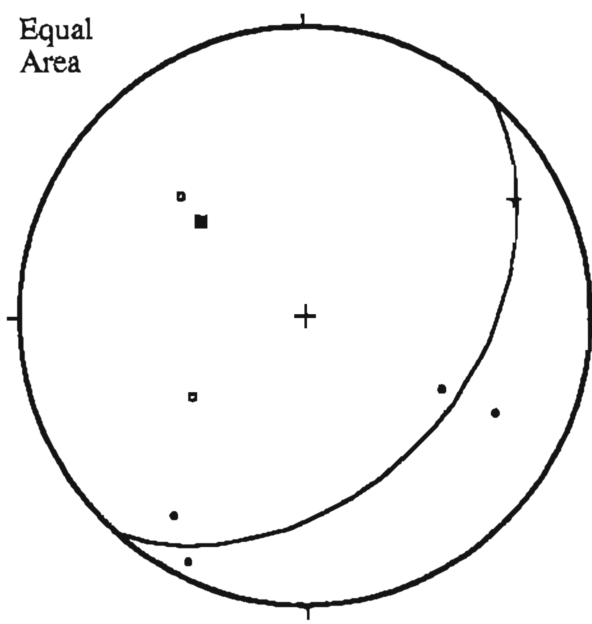
(C) Romanzof Chert
Location III



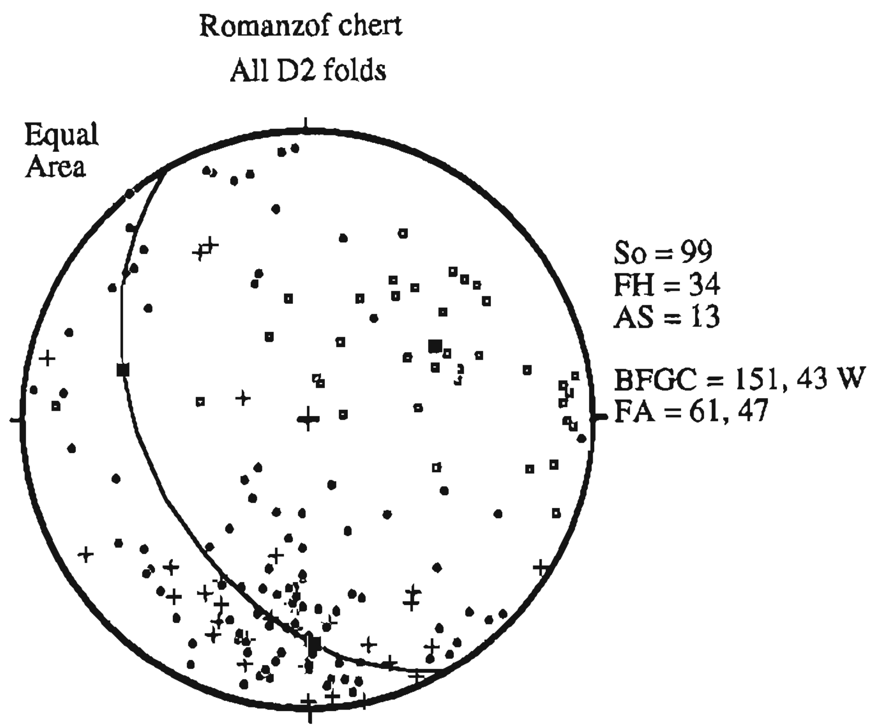


(D) Romanzof Chert
Location IV



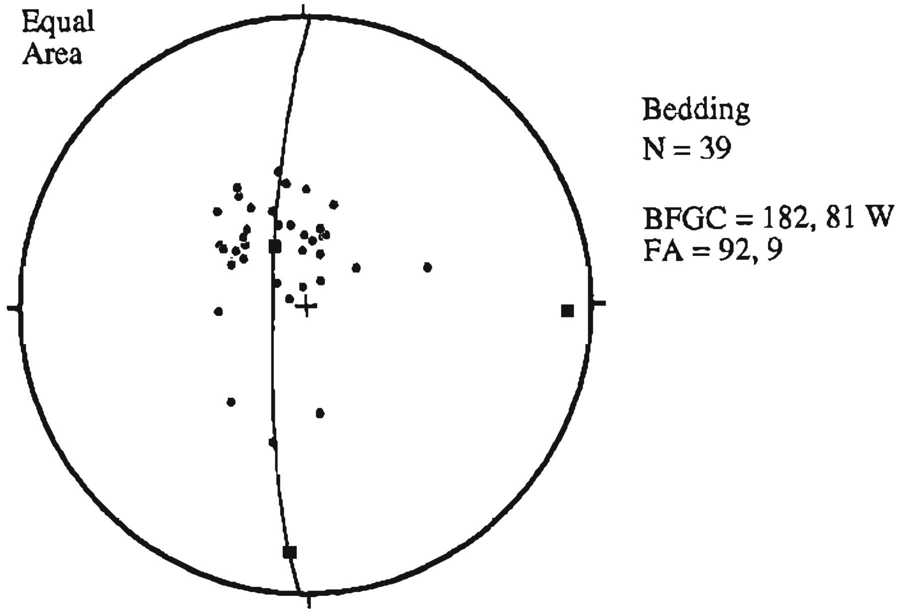


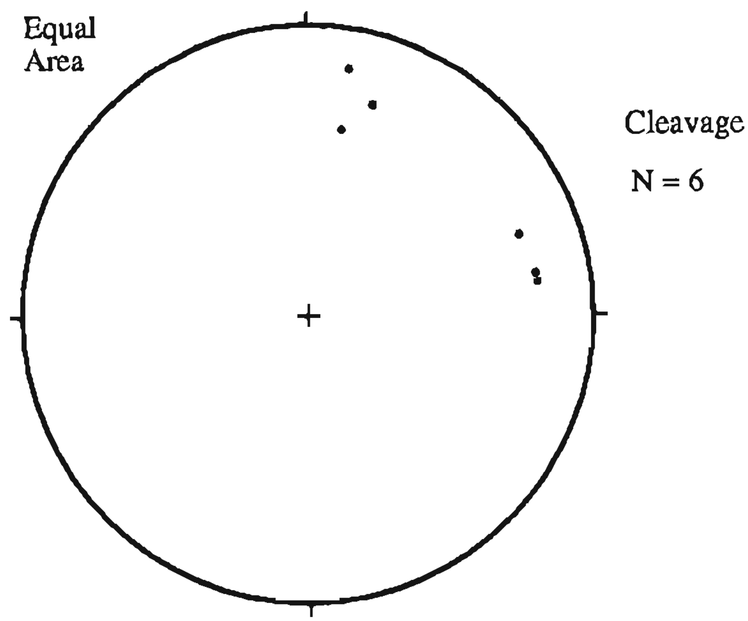
(E)


Romanzof chert
All D2 folds
Equal
Area
So = 99
FH = 34
AS = 13
BFGC = 151, 43 W
FA = 61, 47

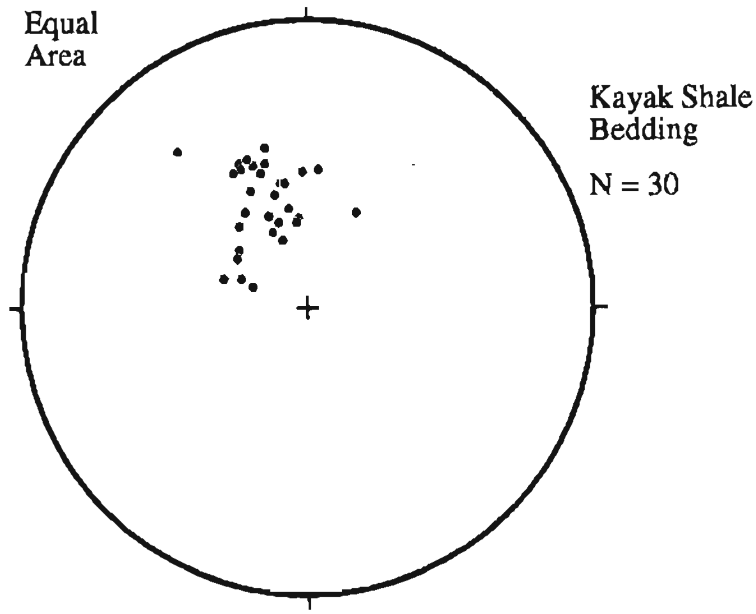
(F)

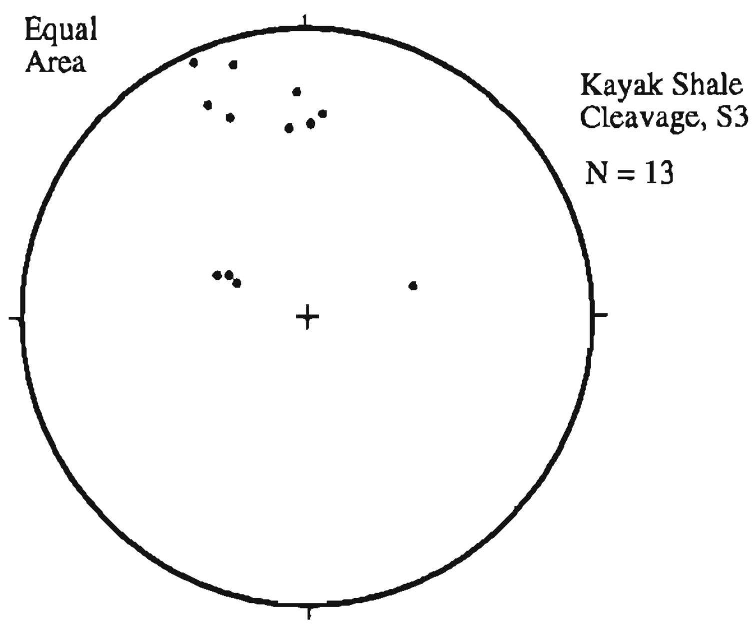
West Fork Valley Sheet
Kekiktuk Conglomerate



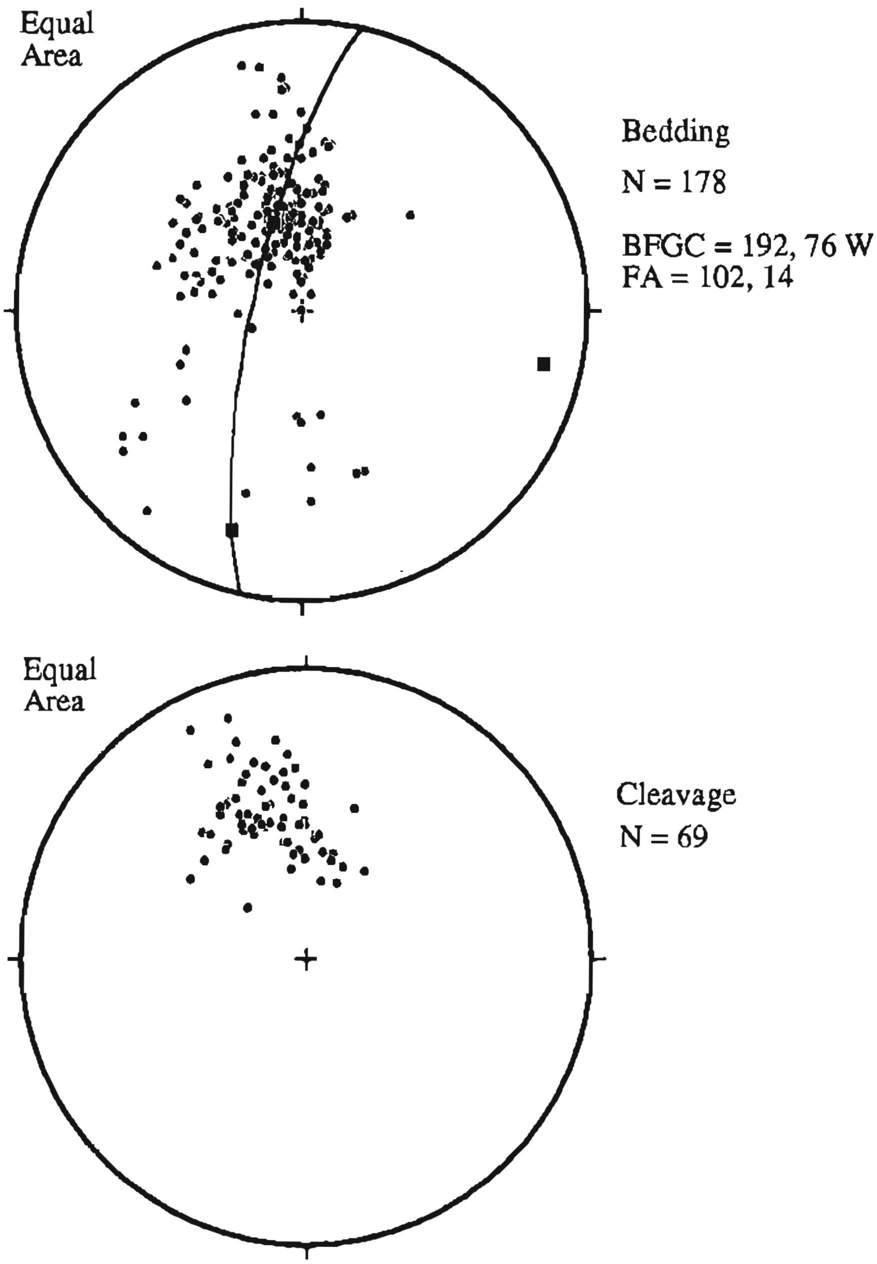


(G) West Fork Valley Thrust Sheet

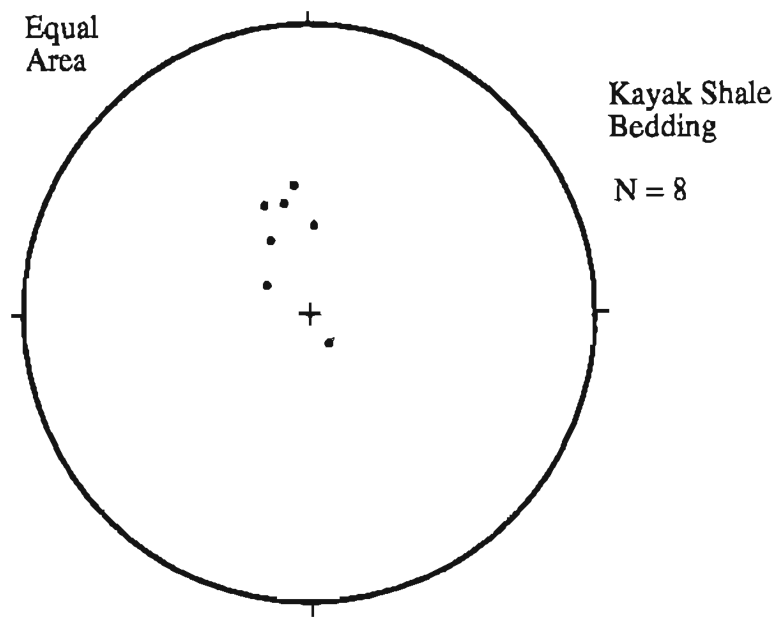


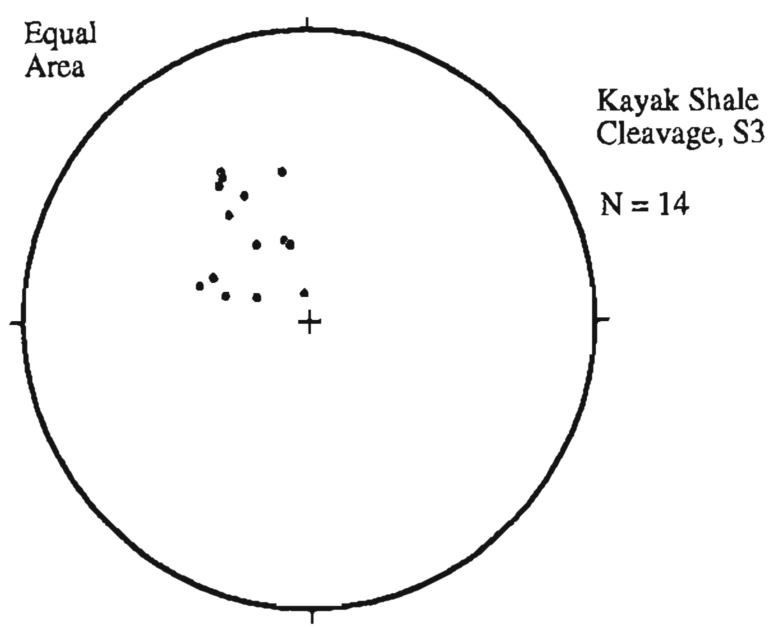


(H) Aichilik Pass Thrust Sheet
Ulungarat Formation, Mangaqtaaq Formation
Kekiktuk Conglomerate

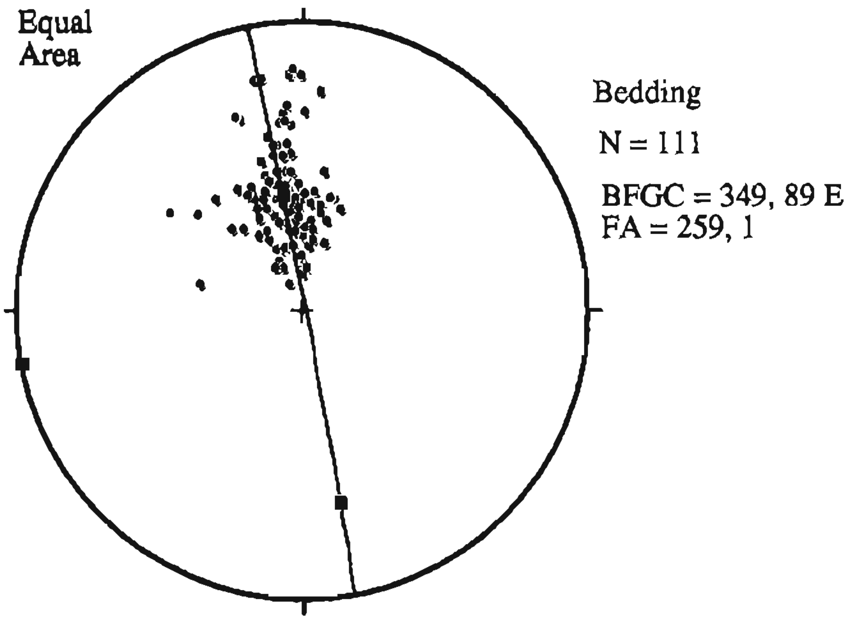


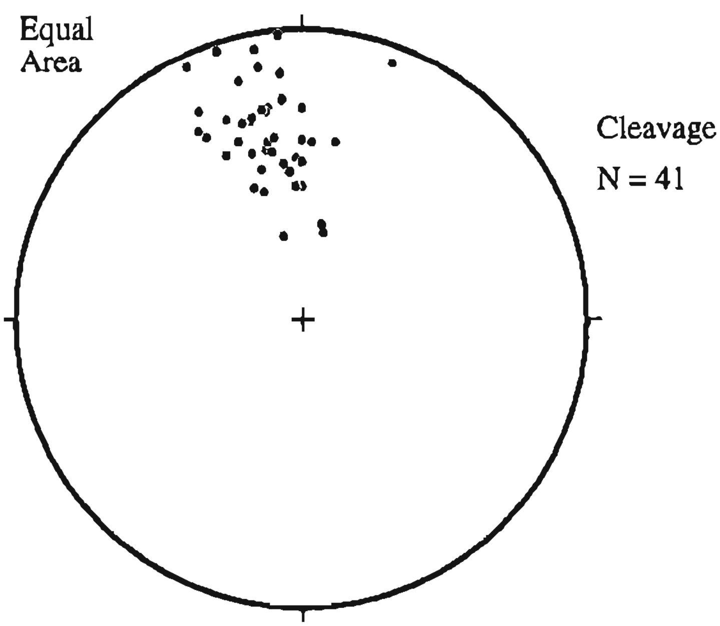
(I) Aichilik Pass Thrust Sheet



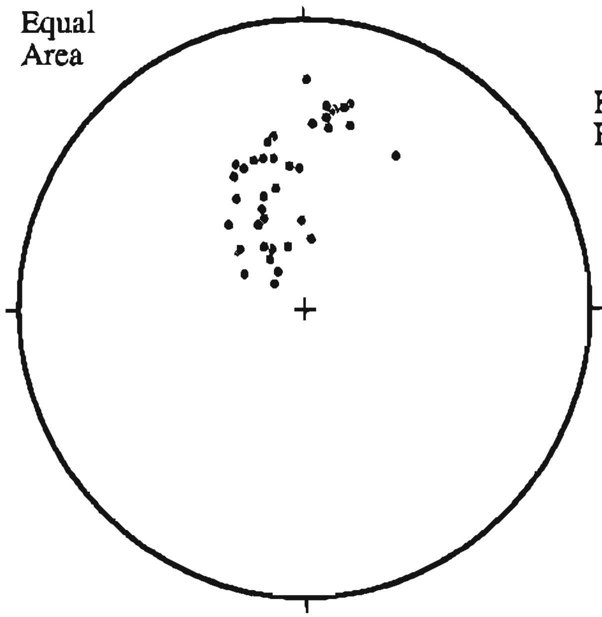


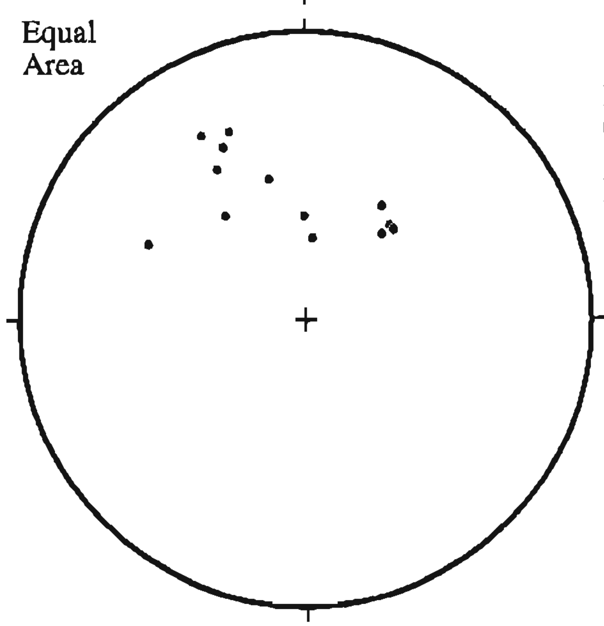
(J) Kongakut River Thrust Sheet
Ulungarat Formation, Mangaqtaaq Formation
Kekiktuk Conglomerate



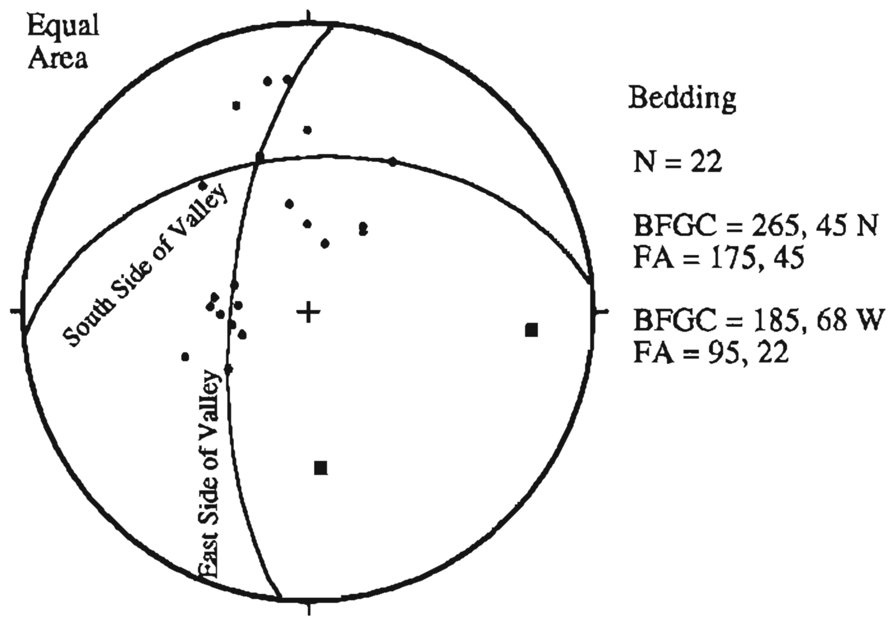


(K) Kongakut River Thrust Sheet

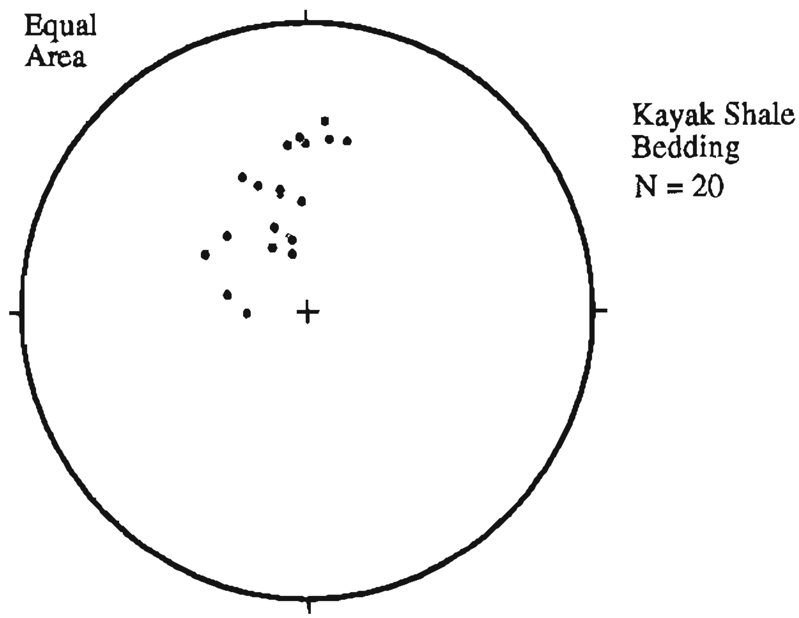


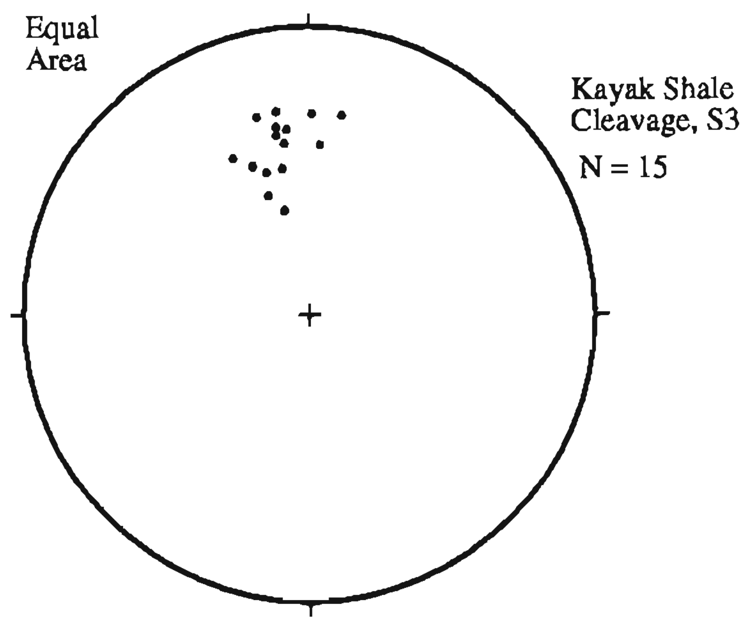


(L) Long Valley Thrust Sheet
Kekiktuk Conglomerate

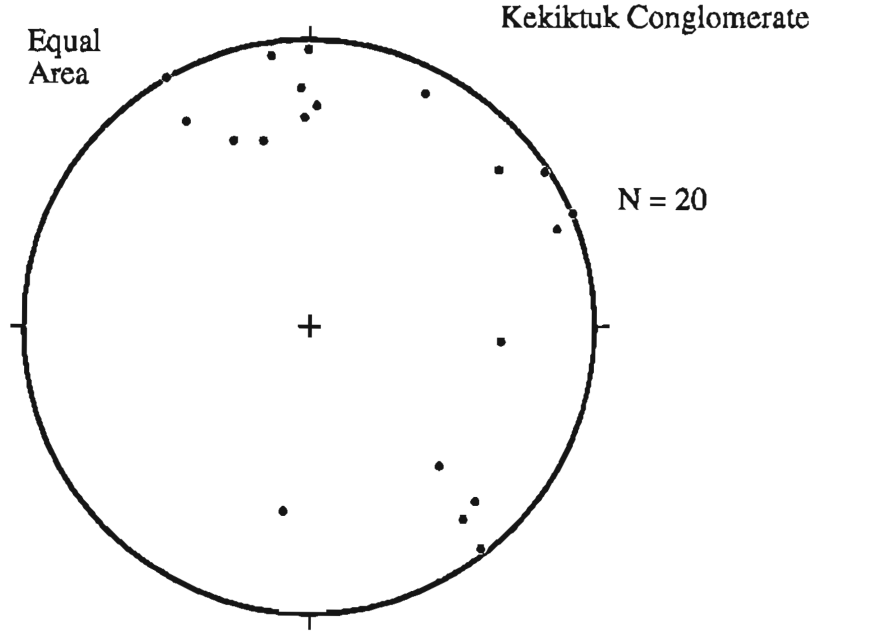


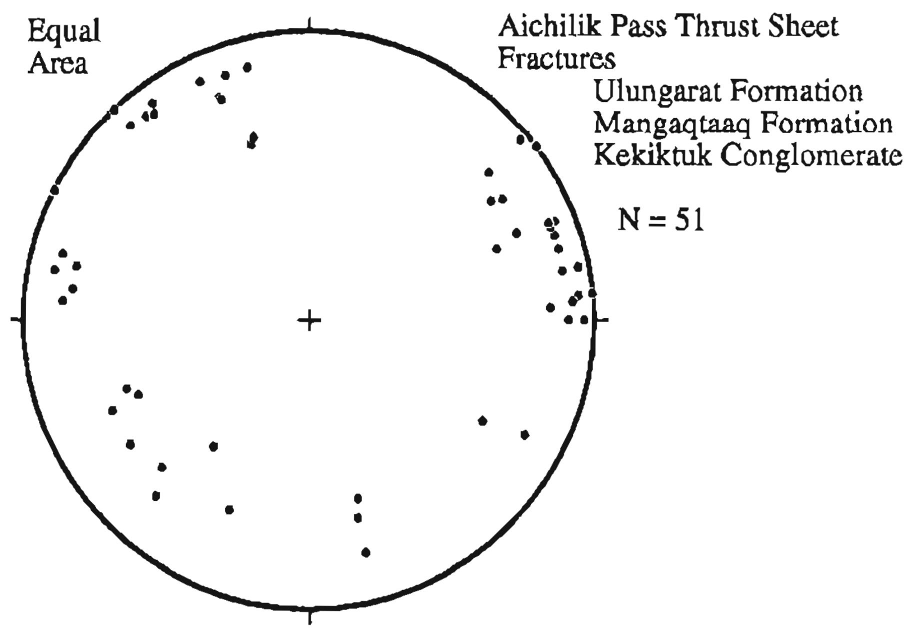
(M) Long Valley Thrust Sheet



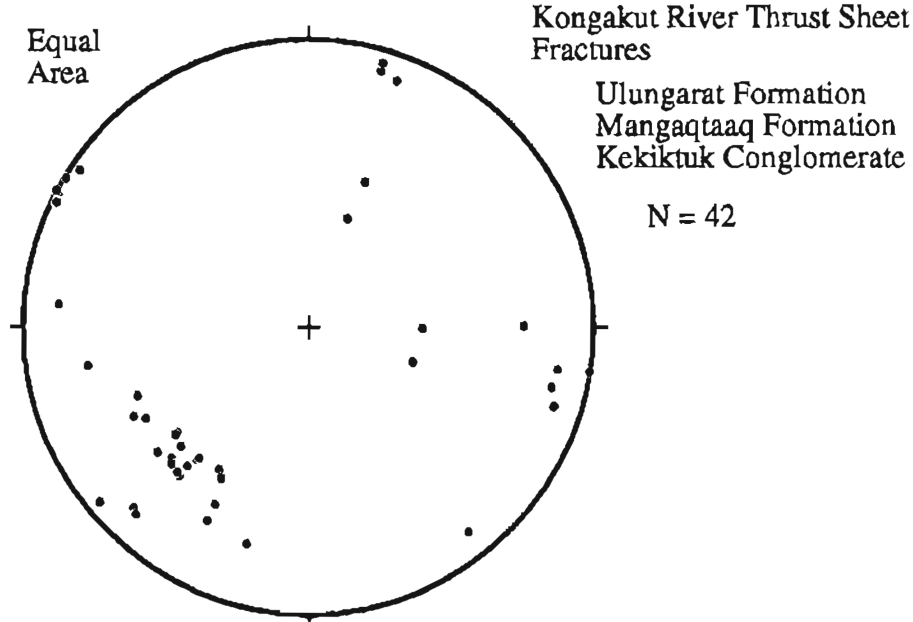


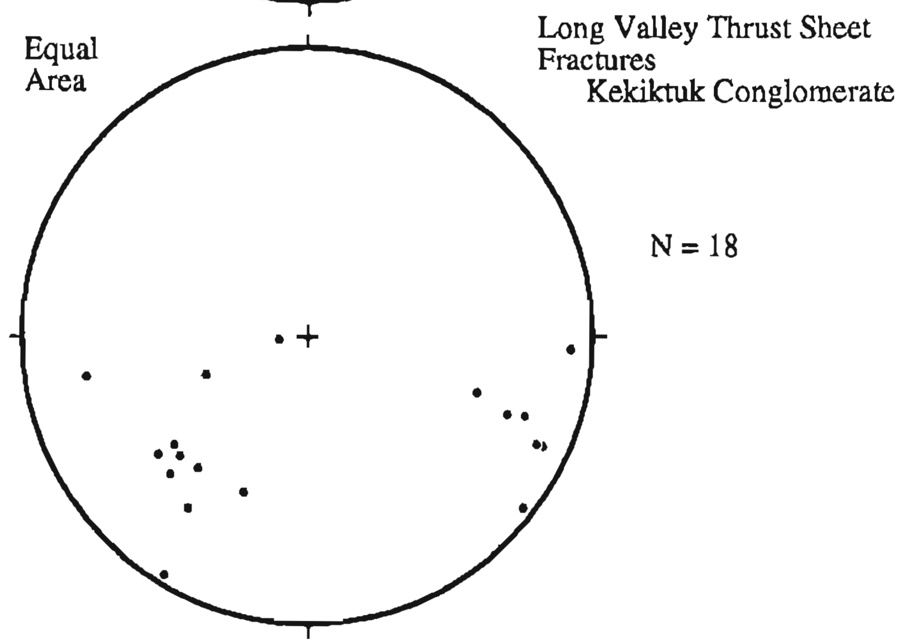
(N)


West Fork Valley Thrust Sheet
Fractures
Kekiktuk Conglomerate
Equal
Area
N = 20


Aichilik Pass Thrust Sheet
Fractures
Ulungarat Formation
Mangaqtaaq Formation
Kekiktuk Conglomerate
Equal
Area
N = 51

(O)


Equal
Area
Kongakut River Thrust Sheet
Fractures
Ulungarat Formation
Mangaqtaaq Formation
Kekiktuk Conglomerate
N = 42


Equal
Area
Long Valley Thrust Sheet
Fractures
Kekiktuk Conglomerate
N = 18

(P)