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Michael Horder, B.Sc.

C 318 FIELD MAPPING

FIELD REPORT

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THE GEOLOGY OF THE SKOROVASS AREA, NORWAY

CONTENTS :-

INTRODUTION

The area mapped lies in north Trondelag, Norway, in the vicinity of the mining town of Skorovass. The area is of great structural complexity and the rocks form part of the Gjersvik Nappe, a structural unit of the Norwegian Caledonides. They have all been metamorphosed under Greenschist facies conditions. The rocks are unfossiliferous and are of Cambro-Silurian age.

ROCK TYPES

The rocks of the area can be divided into two series. The meta-igneous rocks of the Blåhammeren Volcanic Series, structurally and probably stratigraphically older than the second group, the meta-sediments of the Havdalsvatn Conglomerates Series.

The lavas of the Volcanic series are probably of basaltic and/or andesitic composition and are of two types. The older group, outcroping along the Tåkefjellet ridge are massive greenstones containing amphibole. A facies of these contains a brown mica, probably stilpnomelane.

The younger group are non-massive and are characterised by two sub-groups : those vesicular and amygdaloidal types (containing amygdaloidal calcite) and those containing epidote as veins, vesicles, knots and as pillow rims and centres. The boundaries between the two sub-groups are often arbitary. However, the epidote-rich types appear to be confined, broardly, to a belt between the lake of Blåhammertjern and the contact of the trondhjemite intrusion to the north-west. Both non-massive sub-groups show excellent pillow structures, flattened pillows and shearing out along planes of weakness to give chloritic schists.

Within all the lava types occur outcrops of a mafic crystal tuff (containing fragmented amphibole and chlorite crystals in a pale green matrix) and a micro-gabbro (containing amphibole, plagioclase feldspar breaking down to epidote, free quartz and pyrite as an accessory). The latter occurs as small bosses and as dykes (as to the N.E. of Tåkefjellet). Within the non-massive lavas occurs an interesting rock type - a greenstone agglomerate. It outcrops on the N.W. side of Blåmmertjern lake and in the face of Blahammeren itself. It is composed of conjugate fractured fragments of vesicular lava in a sheared, schistose chlorite matrix which locally shows flow banding.

The felsic rocks fall into two broad groups - those of trondhjemitic composition and those of non-trondhjemitic composition. The first group is represented by an intrusive body of massive trondhjemite occuring in the area of Olåtjern. It has sheared margins and is composed of quartz, calcic feldspar, chlorite and

pyrite. Minor bodies of micro-trondhjemite occur within the area as dykes. The other rock type of the first group is called the 'trondhjemite schist'. It is a pyroclastic rock (shows transgressive contacts) of trondhjemitic composition occuring in a belt of varying thickness throughout the whole area. It is highly varied but is usually a foliated felsic schist. It shows an agglomeratic facies (at Y0700X68000) and in a cliff face (at Y0150'X67910) it is seen to vary from massive at the base to a finely foliated schist at the top. This is interpreted as a possible plug to a former centre of eruption of this rock type.

The second group of felsic rocks is represented by a suite of minor intrusives forming dykes and sheets. They include a felsic crystal tuff (quartz fragments in a felsic, chloritic matrix), quartz-feldspar porphyry, quartz keratophyre and keratophyre (a phyric albite rock with pyrite and a flinty fracture). They are extremely widespread throughout the whole area, the latter type is the most common.

The two groups of felsic rocks locally show close field relations although compositionally they are apparently unrelated. The keratophyre and other types of dyke represent a phase which post-dates the main trondhjemite intrusion, with which they may be related genetically by some differentiation process.

The remaining rocks of the Volcanic Series are, broadly, minerallized horizons. The vasskis is a banded sedimentary ore deposit of magnetite and pyrite (the only rock to show bedding surfaces). The Rustschieffer is an horizon of felsic and /or basic rocks which is highly impregnated with pyrite and magnetite and is confined to areas of tectonic weakness. The jaspellite is composed of haematite and micro-crystalline silica. The marble has a saccharoidal texture and probably contains iron carbonate as an impurity. The jaspellites occur in several groups, the latter one contains the marble band as well. The latter two types represent quiescent phases during the eruption or the pillow lavas.

The meta-sediments of the Conglomerate Series are conglomerates, schists (originally impure, argillaceous sandstones) and arkoses. (The latter rock type marks the south easterly extent of the area). The meta-sediments occur in a broad belt to the south east of the trondhjemite schist. The sequence is in part repeated by tight isoclinal folding.

The trondhjemite conglomerate is composed of pebbles of micro-gabbro, trondhjemite, jaspellite, greenstone and occasional carbonate clasts in a foliated matrix of sericite, chlorite and possibly feldspar. The clasts are of varied size and competence and show jointing.

The calcareous conglomerate is composed of calcareous clasts of brown carbonate, together with minor amounts of the other type of clasts, in a schistose matrix.

The transitional conglomerate has clasts of all the types mentioned above in equal proportions to calcareous clasts, together with lenticular bodies of schistose material locally. The boundaries between it and the calcareous and trondhjemite conglomerates are very arbitary ; it is a passage bed only.

The fine calcareous c onglomerate is composed of fine calcareous clasts in a highly schistose chloritic matrix. It is a fine grained equivalent of the calcareous conglomerate but it contains no other type of clasts.

The finer grained material is a chlorite/carbonate/albite schist. It also contains secondary mica and possibly quartz together with pyrite as an accessory, but again the latter is only local. Two horizons of this schist occur - one within the trondhjemite conglomerate and the other at the boundary of the trondhjemite and the calcareous conglomerates. This latter one is diachronous and occurs also within the calcareous conglomerate and at the boundary with the transitional conglomerate.

The sequence of the meta-sediments is as follows (combined from several areas):

Arkoses

Fine Calcareous Conglomerate

Chlorite/carbonate/albite Schist 2

Calcareous Conglomerate

" " " " "

Transitional Conglomerate

Trondhjemite Conglomerate

Chlorite/carbonate/albite Schist 1

Trondhjemite Conglomerate

STRUCTURE

The structure of the area is complex. The rocks have been described by Dewey and others as part of the Gjersvik nappe. However, no evidence was found which would indicate on which limb of the nappe the rocks occur. The structures are difficult to demonstrate in the greenstones but isoclinal folding can be seen in the meta-sediments. Local way-up was indicated by the way-up of pillow lava sequences and finig-up successions within the conglomerates.

It is possible to recognise four (or five) phases of folding within the area. The first phase, F_1, is the formation of the major nappe structure. This feature probably originates from the N.W. and has produced isoclinal folds in the rocks of the area. These folds have axial trends of between 054° and 070°, with plunges of about 4° to 10°. These folds are rarely preserved, but are seen occasionally in in folded jaspellites within the greenstones and in the schists of the conglomerate series. The F_1 plane of deformation is coincident with the development of the S_1 schistosity - 040° to 070° trend and 30° to 70° dip to the S.E.- which is probably

axial planar in nature. It is imposed over all the rocks of the area to differing degrees.

The second phase of folding, F_2, is preserved in the meta-sediments. These trend 177° to180° and plunge at about 50°. These folds are seen to overprint preserved F_1 folds.

The third phase of folding, F_3, is restricted to areas of tectonic weakness, i.e. thrust planes. These folds occur in the sheared out lavas of these zones and have trends of 220° to 240° and plunges of 25° to 40°.

The fourth phase of folding, F_4, is of a late and very open style. The limbs of these folds are defined by the dip of conglomerate pebbles in the meta-sediments. The pebbles plunge on 250° at about 8° to 10°. The axis is orientated, presumably, at about160°.

The fifth phase of folding is not seen in the area. It is of an exceptionally large and open style. Itis seen in the displacement of the original S_1 schistocity.

All the phases of folding seen in the area, probably have coincident periods of metamorphism associated with them. However, the unravelling of the affects of these separate phases is not possible. The metamorphic mineralogy preserved is that of the Greenschist facies;- albite, chlorite, quartz, calcite,actinolite and epidote together with secondary mica and pyrite. These probably represent temperatures of between 300° and 500° C.

The tectonic breaks of the area are of two types - low angle thrusts, coincident with the F_3 folding, and tear faults which postdate the phases of folding.

The low angle thrusts are confined to the volcanic sequence. They displace the volcanics and are characterised by sheared out greenstones producing chloritic schists which show small scale folds of F_3 age.They are zones of minerallization - pyrite is found disseminated throughout them. The majority originate from the N.W., while minor ones (e.g. at Y0560X68560)have an origin from a south westerly direction. The system of thrusts at the southern end of Blåhammertjern lake bring in greenstones from the N.W. to lie over the trondhjemite schist.

The tear faults post-date the thrusts. They have trends of 010° to020° for the minor ones and a trend of 040° at the contact of the trondhjemite intrusion. They are all sinistral in their sense of movement. The minor ones displace such rocks as the jaspellites, the vasskis and keratophyre dykes. The major one or the Olåtjern fault is seen to bring the massive trondhjemite body against the massive lavas. The line of this fault has been exploited by erosion producing a valley occupied by lakes. Associated with this faulted contact of the trondhjemite is a mélange zone which contains a confused system of tongues of felsic and basic material, all infolded into each other and covered in quartz net veins. This too has been exploited

by erosion. It was probably formed during movement along that fault plane.

The degree of tectonic flattening varies and is difficult to estimate. However, from the flattening of pillow lavas, it would seem that it might be between four and twelve times locally.

SEQUENCE OF GEOLOGICAL EVENTS

(1) Eruption of massive lavas
(2) Eruption of non-massive lavas, greenstone agglomerate, etc.
(3) Intrusion of massive trondhjemite body ((2) is still probably happening)
(4) Intrusion of minor felsic bodies - keratophyre, etc.
(5) Mineralization - pyrite and magnetite dissemination
(6) Formation of jaspellite, vasskis, and marble (marks a quiescent phase at the end of eruption of the non-massive lavas)
(7) Erosion and production of Conglomerate Series (contemporaneous with the last phases of volcanic activity)
(8) F_1 folding - main nappe formation
(9) F_2 folding
(10) Low angle thrusts and F_3 folding
(11) Late open style F_4 folding
(12) Sinistral tear faulting
(13) Glaciation and erosion to present topography

(8) to (11) : Greenschist Facies Metamorphism

NOTE : The phases of folding here distinguished might be considered to be part of one continuous process of deformation.
The phases of this sequence are by no means discrete but probably overlap in time and space.

SUMMARY

The rocks of this area have been classically described as representing an ophiolite sequence. However, they more likely represent a dismembered ophiolite since no ultramafic rocks are found in the area. The rocks were probably formed in an island arc environment, in which the clastics represent the eroded portions of the volcanic sequence. The subsequent folding and metamorphism, as part of the Norweigian Caledonides, has produced the rocks and structures observed today.

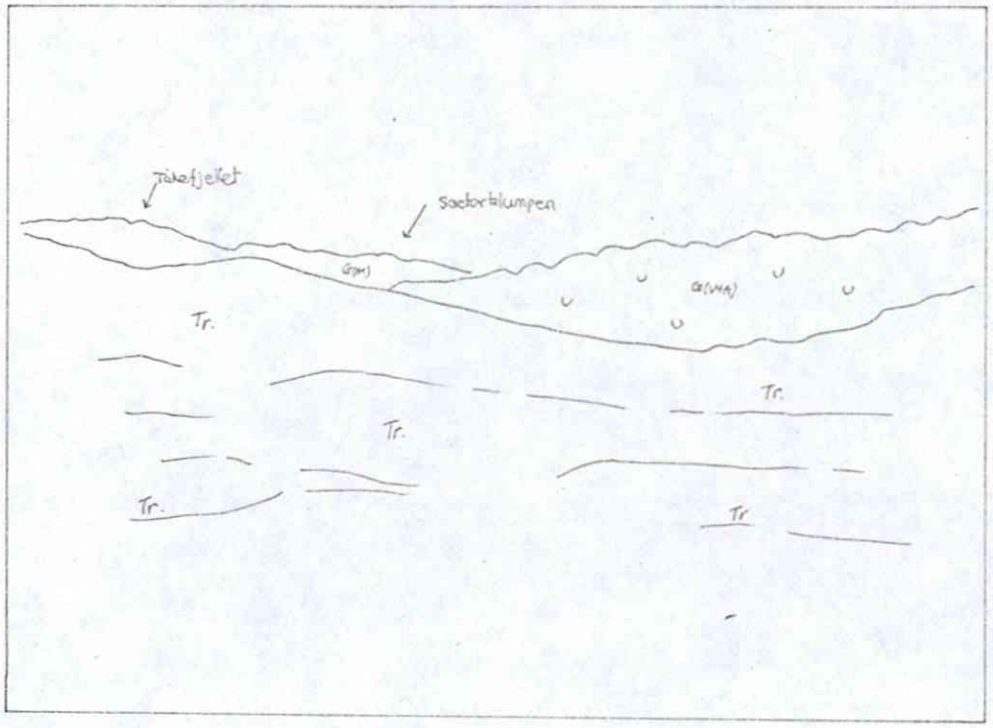

FIG.I.1. Diagram of Plate I.1, showing the main rock types exposed. The pillow lavas to the south, occur in a fan and are seen to 'overlie' the massive greenstones to the north & east, which compose Saetortklumpen and Tåtøfjellet.

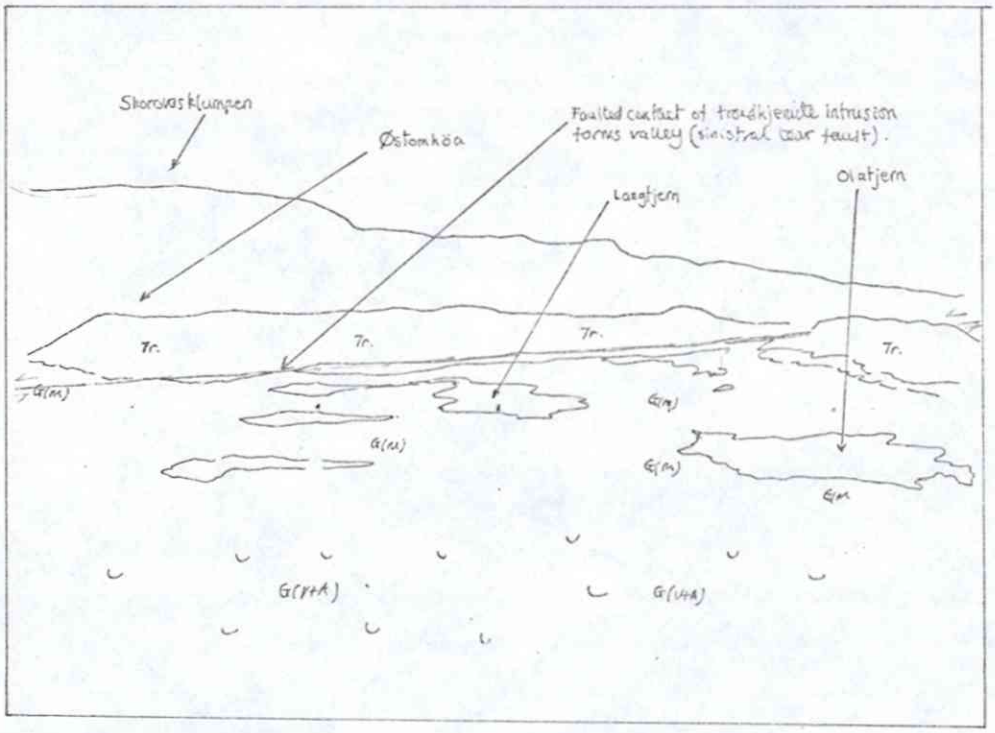

FIG.I.2. Diagram of Plate IV.2. showing the major rock types. The vesicular greenstone in the foreground contains minor intrusive bodies of keratophyre and are mineralized - disseminated pyrite. The faulted contact of the trondhjemite is shown.

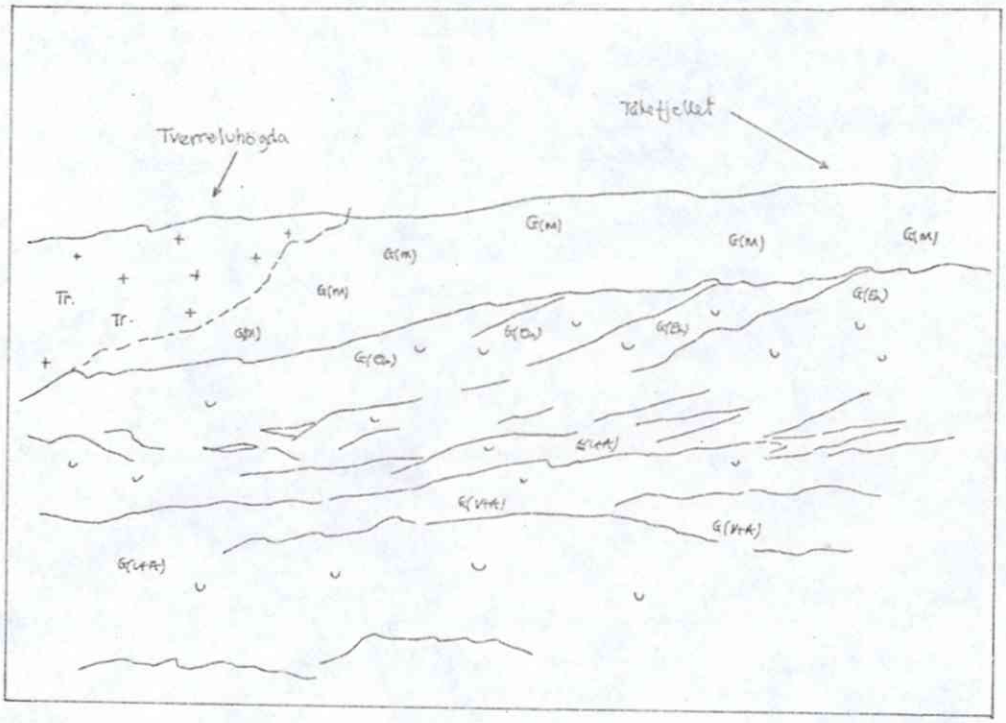

FIG.I.3. Diagram of Plate IV.3. showing the major rock types and the contact between the massive trondhjemite and the massive greenstones. The epidote rich and the vesicular greenstones both contain many minor intrusive bodies of keratophyre, quartz feldspar porphyry and albite-trondhjemite. They are mineralized, mainly along zones of weakness.

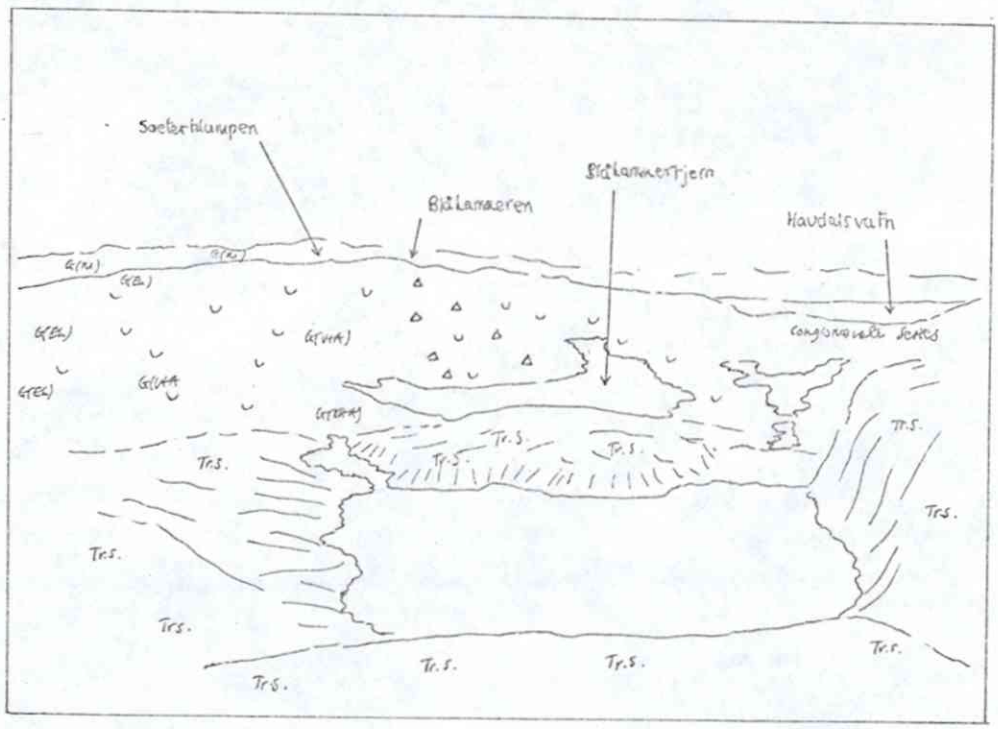

FIG.I.4. Diagram of Plate IV.4. showing the major rock types. The Conglomerate series outcrops around Haudalsvatn in the right distance. The epidote rich and vesicular greenstones contain felsic intrusive bodies and are mineralized in part. Note the greenstone agglomerate facies on the SE. front of Bråkamaeren, which occurs amongst pillow lavas. Please note distortion of the perspective in this + Plate IV.4 – actual Trondhjemite solist does not outcrop at western side of Bråkamaertjern.

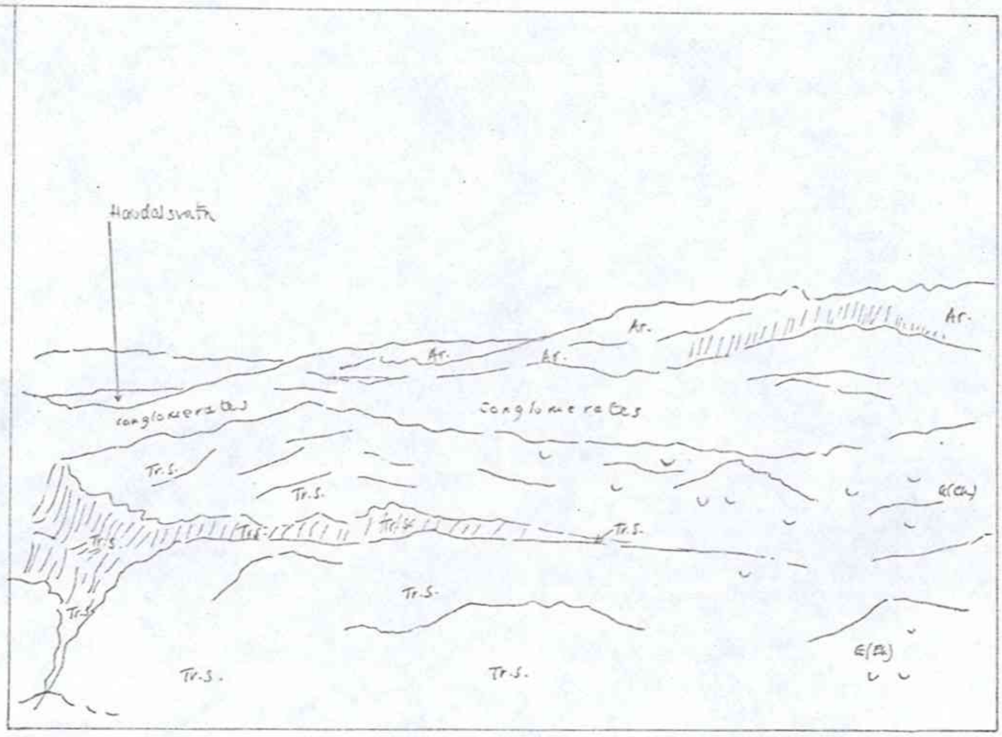

FIG.I.5. Diagram of Plate IV.5. showing the main rock types. The complete sequence of the Conglomerate Series is exposed in the area marked "conglomerates" and are in part repeated by isoclinal folding.

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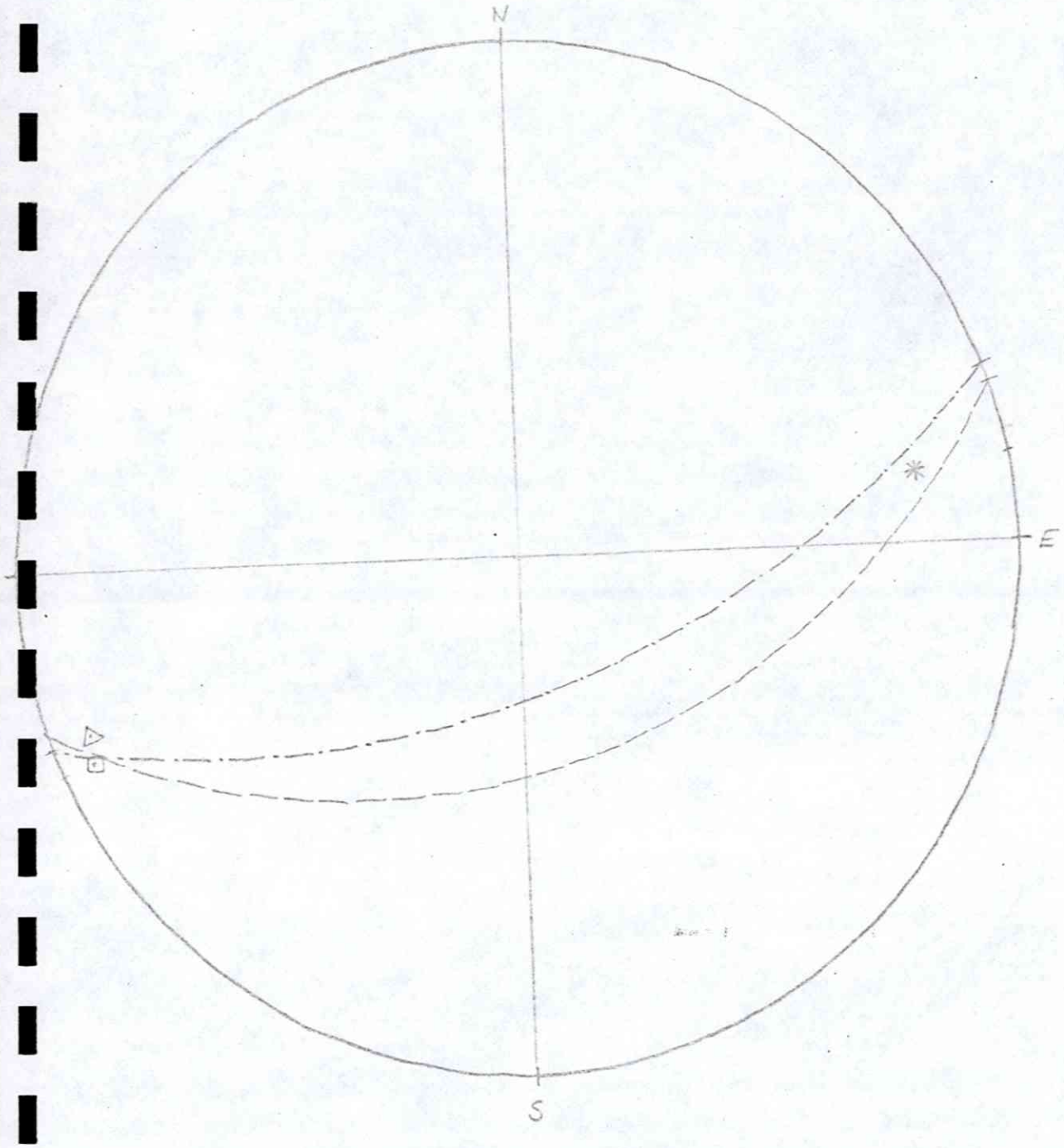
APPENDIX - Stereographic plot of structural data from the area

The Appendix contains five selected stereograms showing relevant pieces of structural data. The data are plotted on the Wulff stereographic net. In all cases, unless otherwise stated, △ is the axial trace and ⌒ is the axial plane.

From these plots can be seen the trends of the main phases of folding.

G.II.1 F_1 fold features of cherty materials in the lavas.



REFERENCE	MATERIAL	AXIAL TRACE	AXIAL PLANE
Y0080'X68055	Folded jaspellite	△	
0400'X68700	Folded jaspellite	⊡	
Y0220'X68860	Dirty material in lavas	*	

FIG.II.2 F_3 Folds in schistose greenstones along a thrust plane (Y0640X67825)

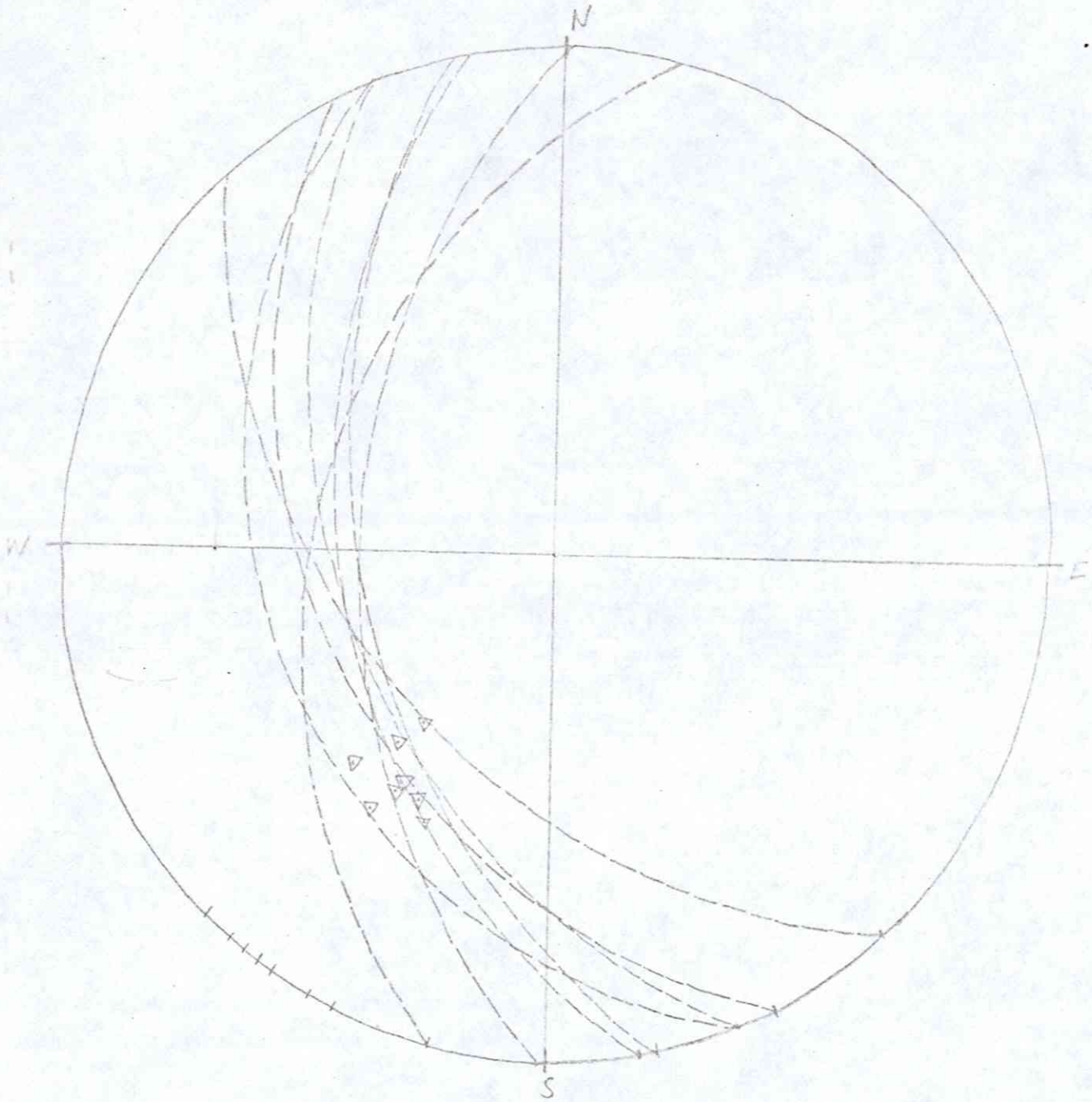


FIG.II.3 F_3 Folds in the Trondhjemite Schist, near a thrust plane (Y0640X67825)

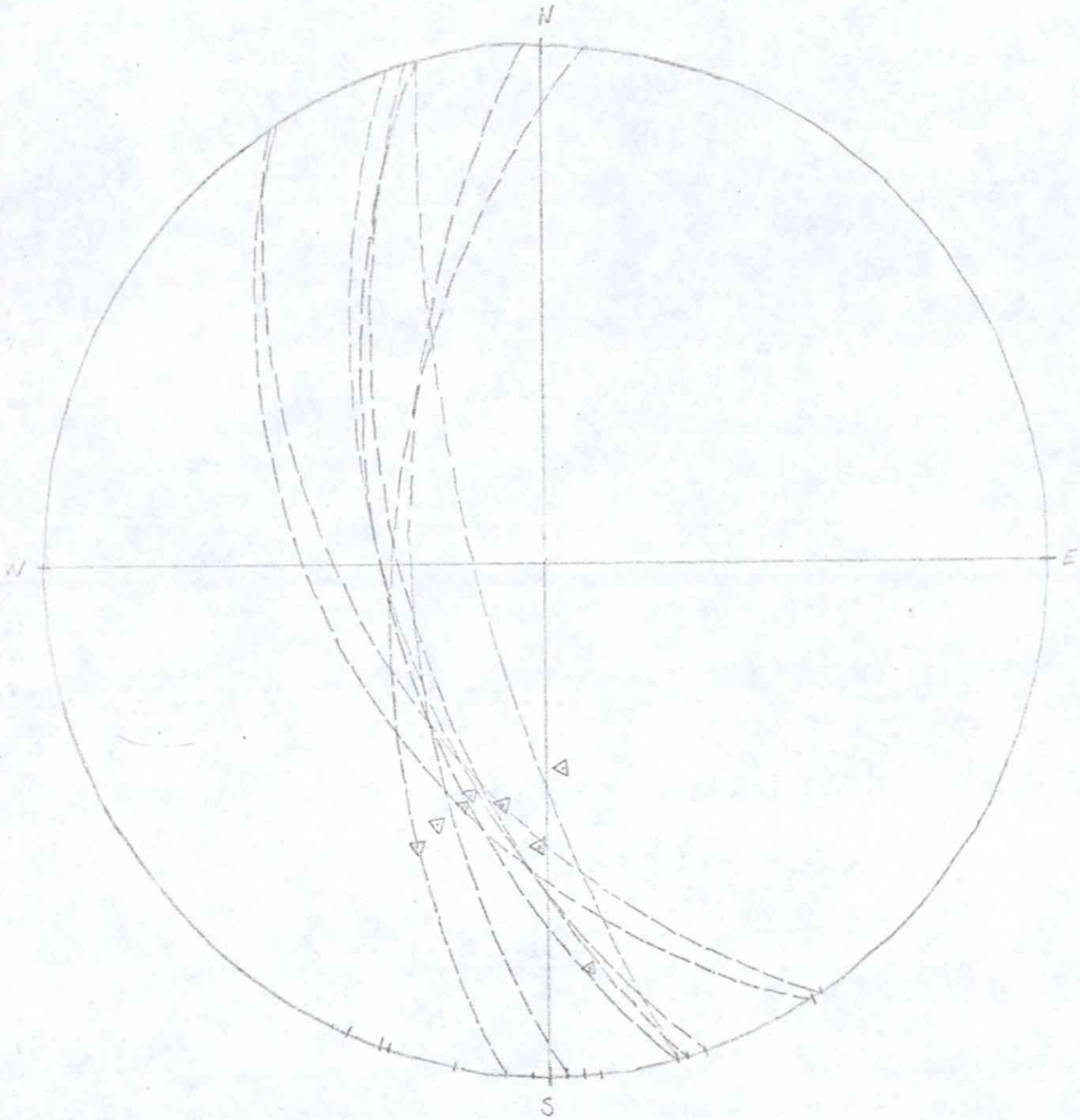
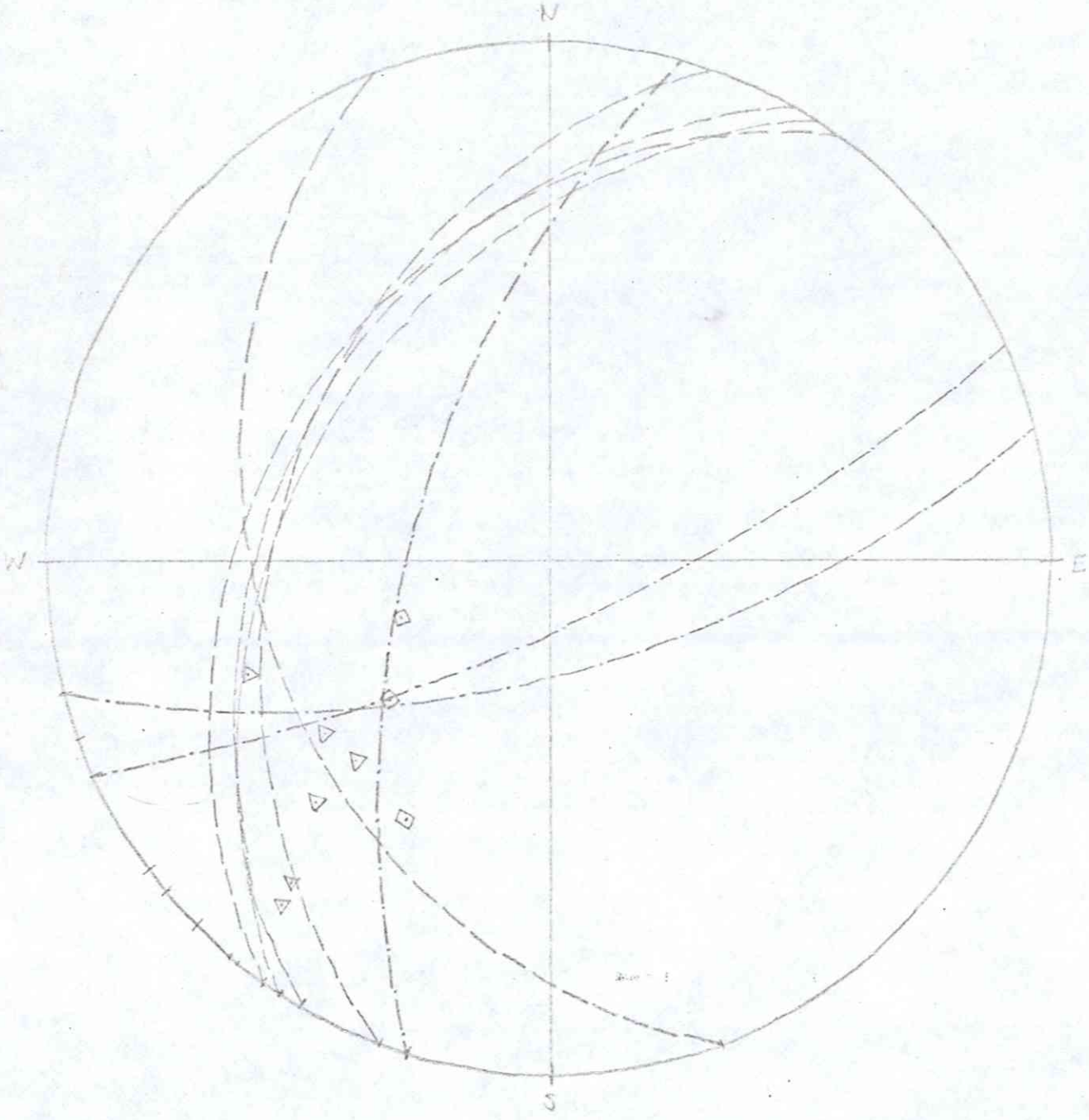


FIG.II.4 F_3 Folds along a thrust plane near Blahammertjern in schistose greenstones (Y0560X68560). The plot also shows the development of a crenulation cleavage observer at this locality.



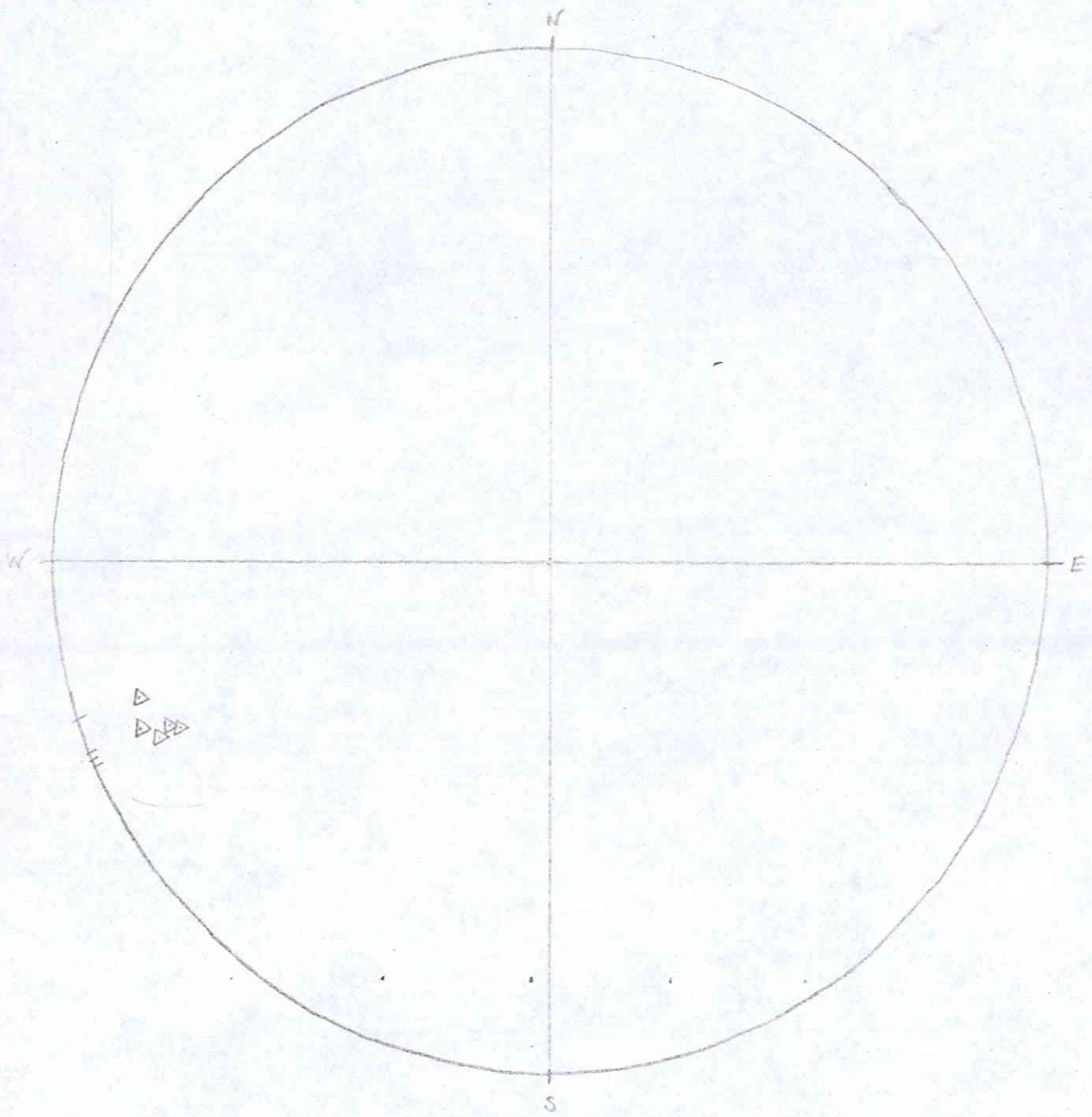
AXIAL TRACE

AXIAL PLANE

F_3 Folds

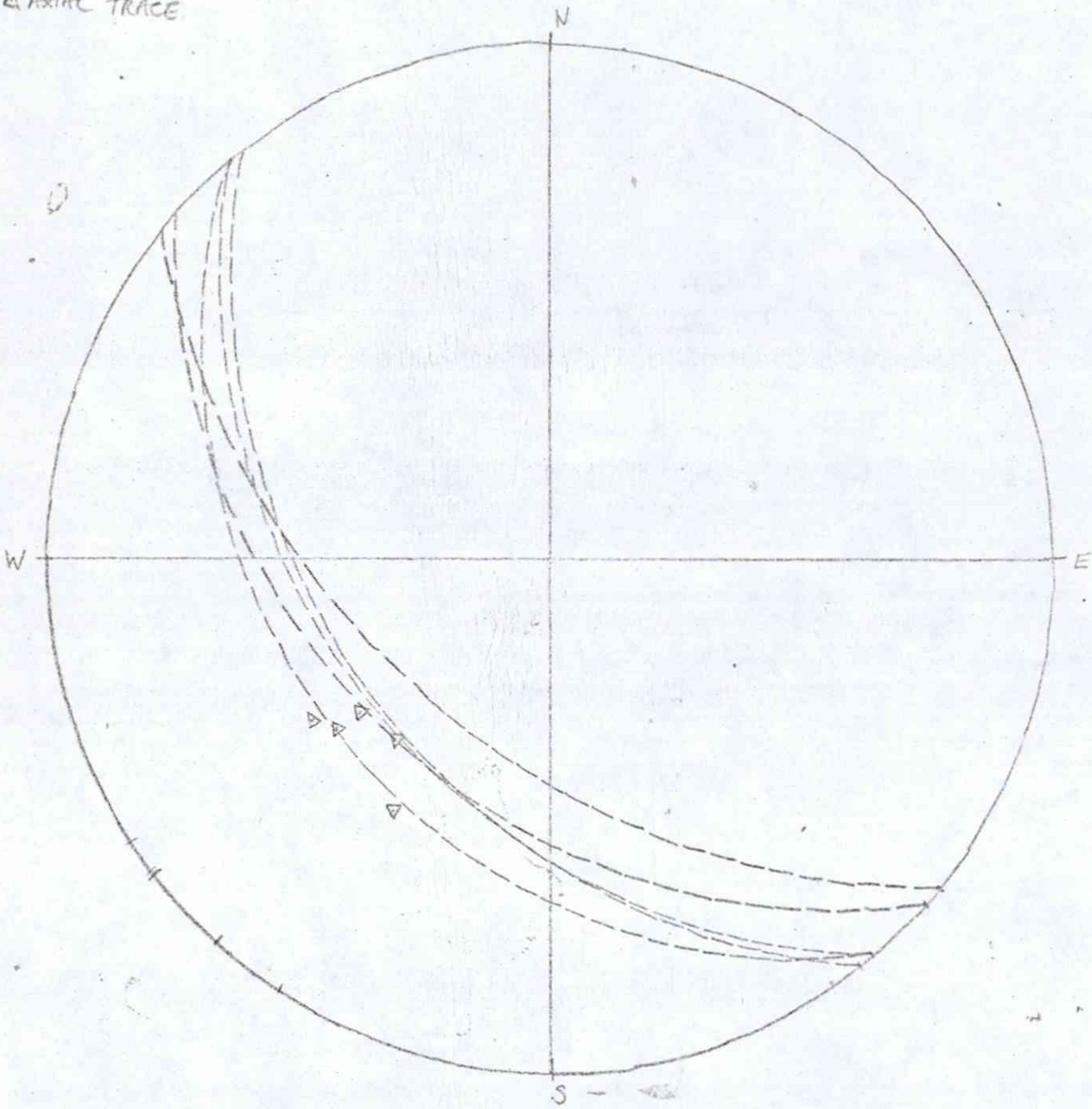
Crenulation Cleavage

FIG.II.5 Plot of the Plunge of Conglomerate Pebbles defining the limbs of the late opne style F_4 Folds (Y0685X67950).



F_2 folds in schistose greenstones (foliated)
at ref. 0750'67670

/ AXIAL PLANE
△ AXIAL TRACE

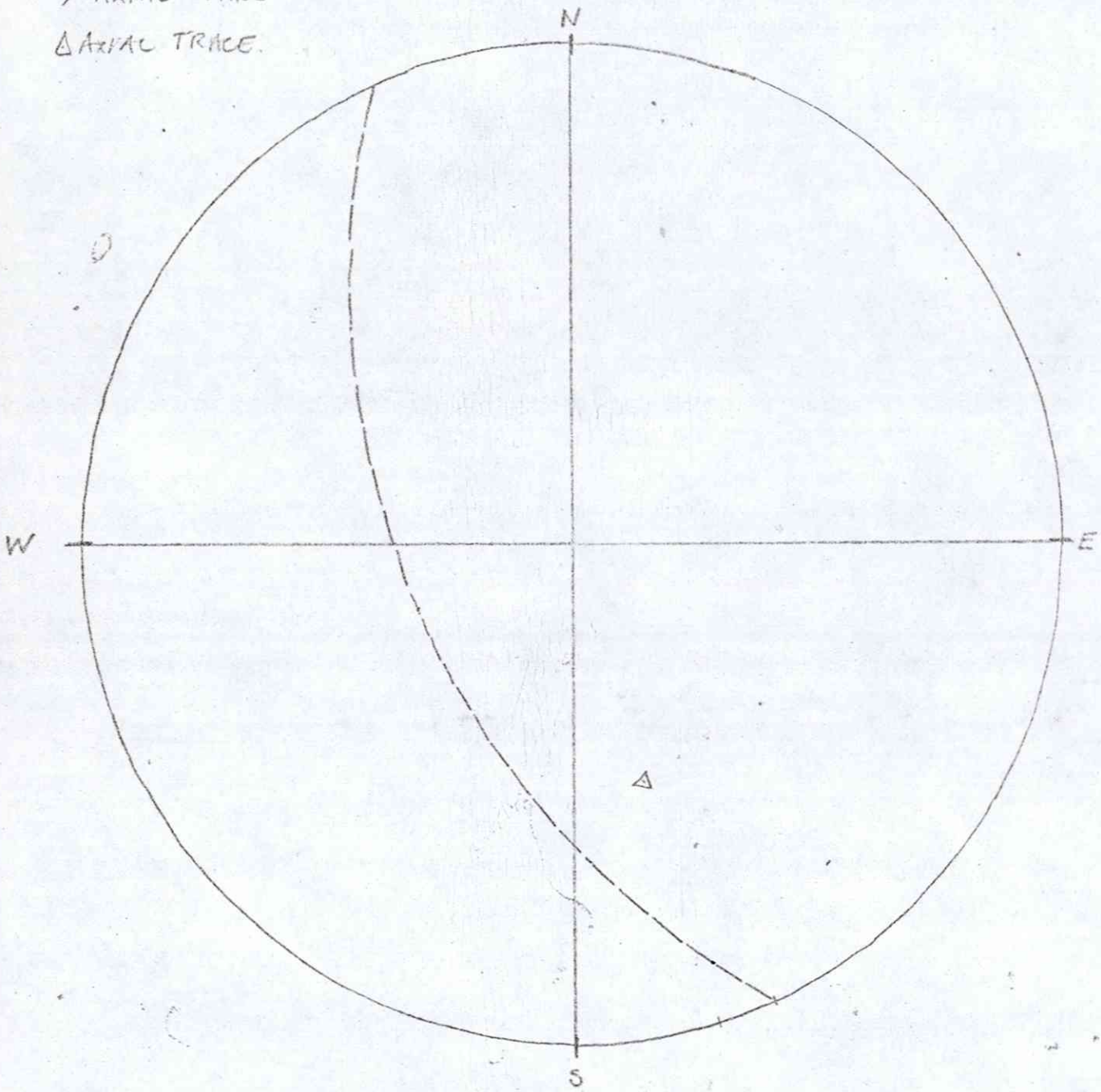


F_2 folds in aphyric felsic dyke

Ref: 0120' 68500

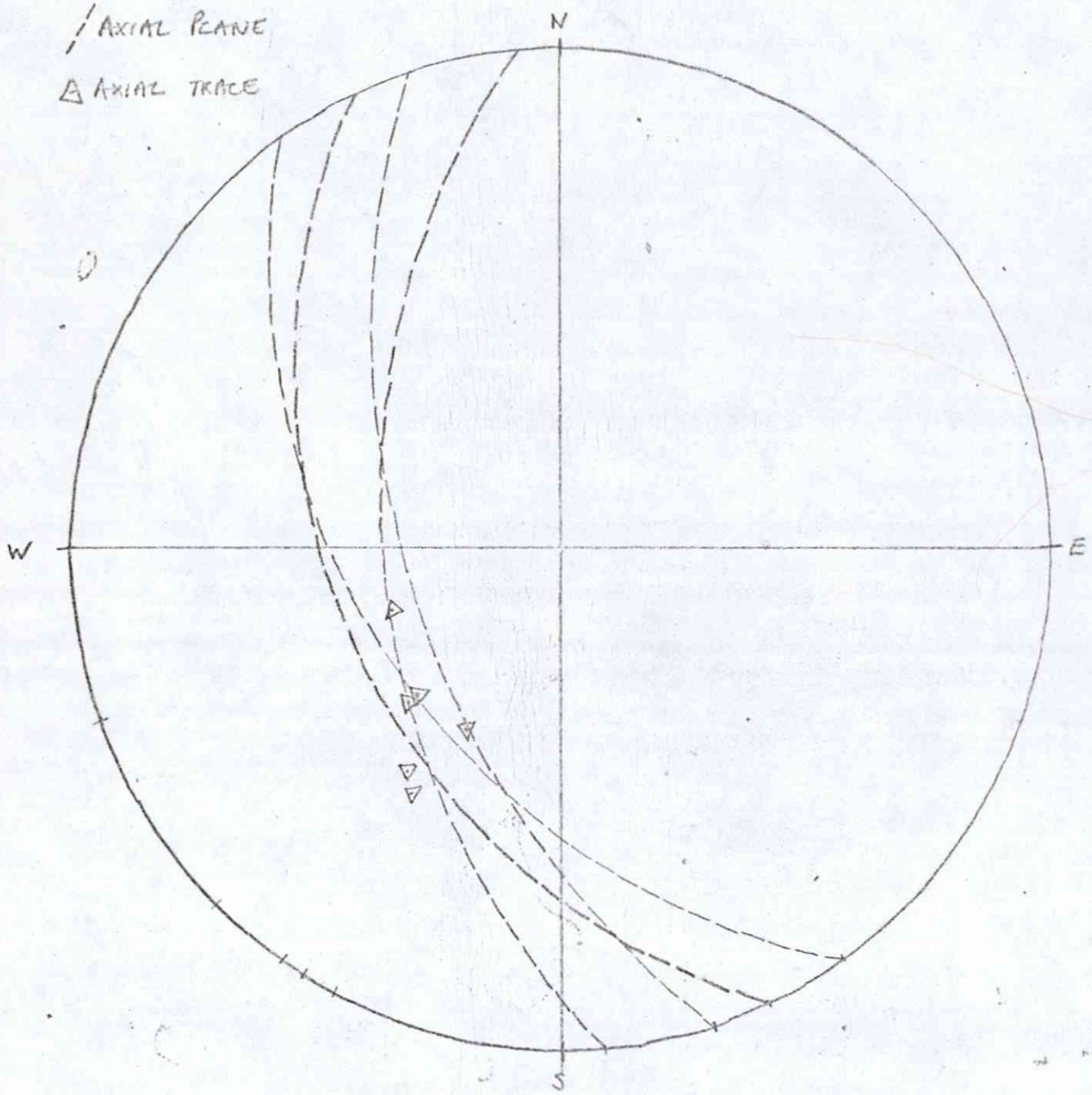
/ AXIAL PLANE

Δ AXIAL TRACE.



F_2 folds in schistose greenstones

Ref: 0750 67680

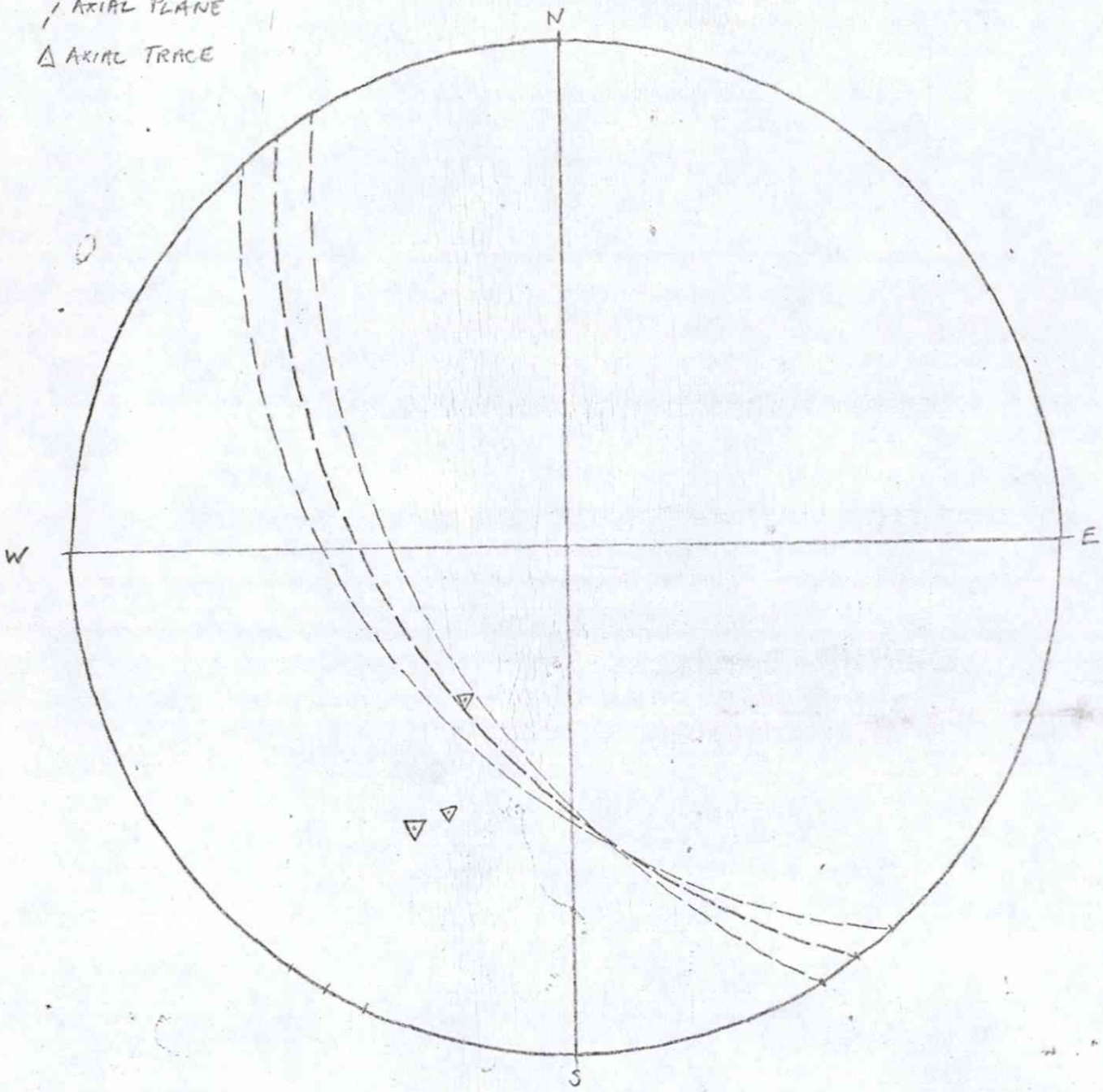


F_2 folds in foliated greenstones

Ref: 0400'68700

/ AXIAL PLANE

△ AXIAL TRACE

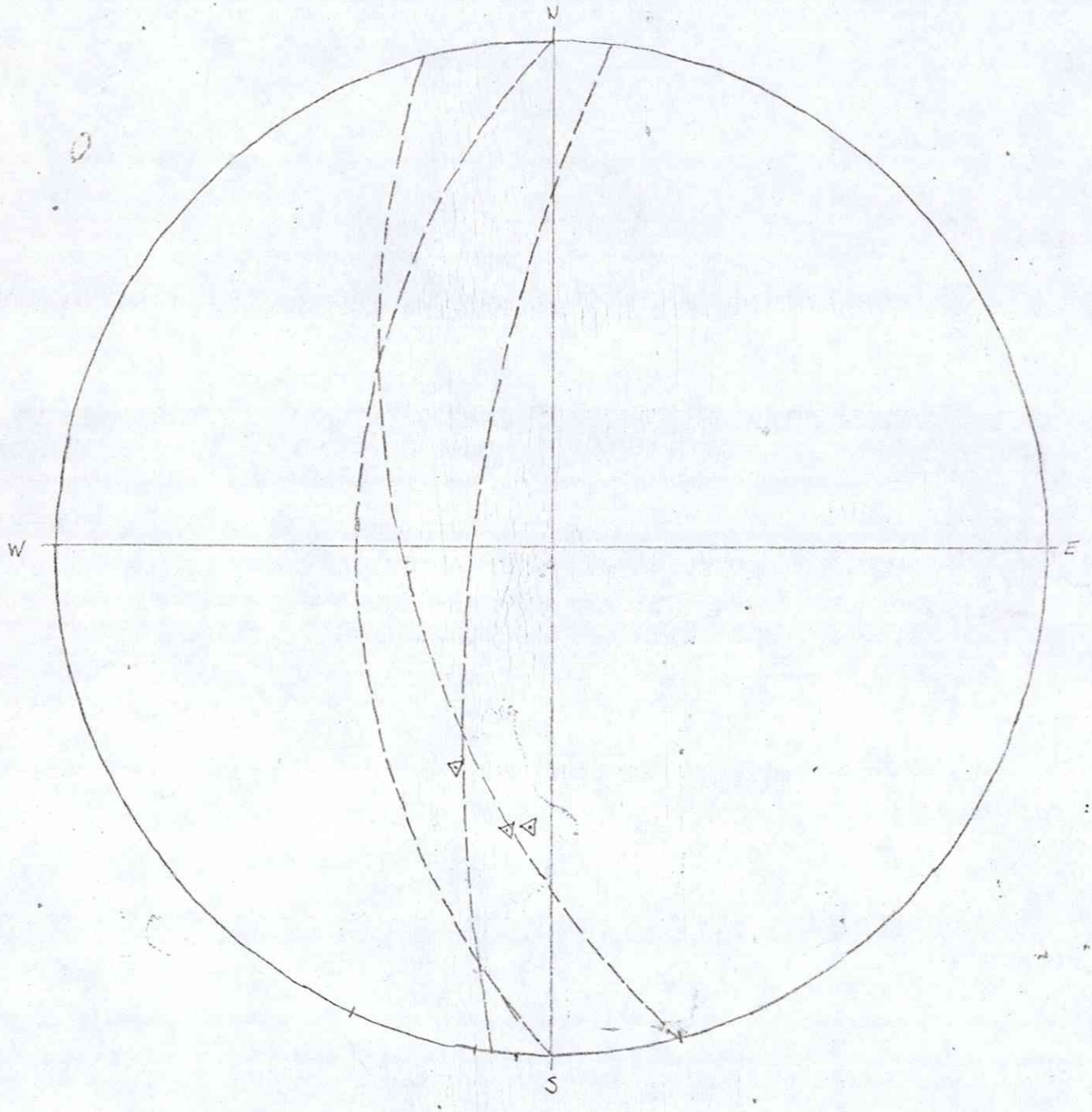


F_2 folds in schistose greenstones (chlorite schist)

Ref: 0810'67730

/ AXIAL PLANE

△ AXIAL TRACE



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