



Bergvesenet

Postboks 3021, 7002 Trondheim

Rapportarkivet

Bergvesenet rapport nr BV 3765	Intern Journal nr	Internt arkiv nr	Rapport lokalisering Trondheim	Gradering
Kommer fra ..arkiv	Ekstern rapport nr	Oversendt fra	Fortrolig pga	Fortrolig fra dato:
Tittel A structural Investigation of the Rocks of the Iveland-Evje area.				
Forfatter Nixon, Frank		Dato 25.04 1968	Bedrift Sulfidmalm A/S	
Kommune Iveland	Fylke Aust-Agder	Bergdistrikt Østlandske	1: 50 000 kartblad 15123	1: 250 000 kartblad
Fagområde Geologi	Dokument type	Forekomster		
Råstofftype Malm/metall	Emneord			
Sammendrag Bakgrunnsdata for rapporten finnes i BV 3841.				

Wg

A/S Sulfidmalm Iveland-Evje Project.

A structural Investigation of the Rocks
of the Iveland-Evje area.

By

Frank Nixon.

19 April 1968

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Introduction

This investigation was undertaken by the writer at the request of Dr. Haldemann, with a view to ascertaining if possible:

- a) whether the sulphide mineralizations in the amphibolite-diorite-gabbro terrain can indeed be related to major NNE/SSW fold axes as suggested in the photogeological study by HUNTING SURVEYS LTD.,
- b) which observed fracture patterns are of significance as ore controls.
- c) which fracture patterns are post ore.

The following report attempts not only to answer the above questions, but also to give a more comprehensive structural history of the area of interest.

The Evje-Iveland area may safely be regarded as structurally complex. Previous investigators have suggested two phases of folding to be operative, and field mapping by A/S Sulfidmalm indicated this to be correct.

In the course of field mapping, quite a large amount of structural data was assembled, consisting mostly of the observable elements, of strike and dip of foliation, trend and plunge of linear structures on foliation planes, and trend and plunge of minor fold structures.

Location of linear structures in the field proved difficult, and only about 70 such structures were recorded, and in many cases they were merely recorded as "lineation", the character of the linear structure in question not being stated and thus losing valuable structural information.

As a basis for the structural analysis of the area the geological map in scale 1:25,000 (compiled by A/S SULFIDMALM 1967) was used in preference to the single 1:15,000 map units. This was done because of the fact that the compiled map shows standard geological data, such as distribution and stratigraphic relations of lithological units, location and orientation of macroscopic structures (faults etc.) and of typical mesoscopic structures, (notably s-surfaces, lineations and folds) as an entity.

All structural data was recorded in the field in the 400° scale, but was subsequently converted to the 360° scale by the writer in order to keep in line with the standard practice of using the 360° scale in structural interpretation.

Previous Work.

Tom F. W. Barth has investigated the area in question and his results were published in 1947 (N.G.U. 168a). Barth concludes that the amphibolite body is homogeneous and represents an almost completely recrystallized norite body.

Flat lying, north/south trending folds in the peripheral parts of the amphibolite indicate that this part has yielded plastically to the deforming processes. However, apart from these areas Barth is of the opinion that the central part of the amphibolite body was much more rigid than the surrounding gneisses. He describes two kinds of linear direction, one produced by striation and grooving arrangement, the other by hornblende crystals in parallel arrangement.

He regards the folds accompanying the recrystallization of the hornblende to be older than those causing the grooving. The axes of the older phase being directed NW/SE and those of the younger N/S. He states that this younger phase is the only one that is recognized in the surrounding gneisses.



Fig.1. Berths map of N. Iveland showing younger and older fold axes.

The more prominent tectonic lines and zones of mylonitization are considered by Barth to be much younger than the granitization of the area.

In a photogeological study of the Evje region by Hunting in 1966 the following historical outline is suggested.

- 5) Development of the Evje-Gunnheim fault zone (approximately E/W).
- 4) Emplacement of gneiss domes.
Folding on NNE-SSW axes.
Regional metamorphism.
- 3) Folding on ESE-WNV axes.
Regional metamorphism with development of compositional layering.
- 2) Intrusion of nickeliferous norite.
- 1) Pre-existing countryrock, ? gneisses.

Geological Considerations.

Before attempting a structural analysis of an area certain things, if possible, should be clear in the mind. It is important to know whether the system is homogenous or heterogeneous. If heterogeneous, it is important to try and establish the lithological relationships between the various members of the system.

In the case of the Iveland-Evje area, it is also of the utmost importance to determine with what rock type the nickel has been introduced into the system, and at what time in the history of the area this took place. Only when this is established can the results of the structural analyses be of direct value.

At the time of their photogeological work Hunting were under the impression (probably being influenced by Barths report) that they were dealing with a more or less homogeneous body, originally nickeliferous norite now subsequently modified to amphibolite. Most geological bodies, however, are heterogeneous and field investigations prove that this also holds true for the Evje-Iveland body. Mapping by the A/S Sulfidmalm team located many areas of massive basic rocks, the most important being, the hornblende - diorite in the vicinity of Flåt mine, and the two-pyroxene gabbro at Mölland in Iveland.

Barth regards these Mölland gabbros as unmetamorphosed "relicts" of the original norite intrusion. He takes the hornblende - diorite to be a completely recrystallized rock with a metamorphic-metasomatic mode of origin, formed from the Evje-Iveland amphibolite through recrystallization under static conditions.

Field work within the diorite body and a study of thin sections tend however to disprove Barths theory. At locality 19E5 both Wiik and the writer have seen indications that suggest the hornblende-diorite to be a younger intrusive, here a dyke-shaped body of coarse hornblende diorite cuts through a dark, medium to fine-grained gabbro/metagabbro. The dyke rock is coarse-grained and massive, whereas the gabbro has in parts a distinct foliation. Thin sections show the gabbro to be quite fresh.

If the field interpretation that the dyke rock is the younger one is correct, then locality 19E5 is a strong indication that the hornblende diorite is an intrusive younger than the gabbro and that it probably obtained its present character as a result of autometamorphic processes at the time of intrusion. Looking at this locality in the light of Barths theory it does not seem possible that a process of metamorphic-metasomatic recrystallization (as described by Barth) could produce the hornblende diorite without also altering the gabbro.

Harald Bjørlykke, who together with C. W. Carstens worked as consulting geologist to Raffineringsverket A/S at Flåt mine is also of the opinion that the hornblende diorite is a younger intrusive. In this publication Flåt Nickel Mine (N.G.U 168b, 1947) he writes:

"the Flåt ore must have been formed by segregation in a diorite magma (magma of the "ore gabbro") which was especially enriched in sulphides and has been intruded into an older amphibolite rock of nearly the same composition, which, however, was poor in sulphides".

Turning now to the Mølland gabbros we once again find evidence that disputes Barth. The gabbro is in most places extremely fresh, being classified both in the field and under the microscope as fresh norite. Strong evidence that the rocks intruded after the regional metamorphism has been put forward by Wiik in "A Petrographic description of the rocks of the Iveland-Evje area", February 1968. The writer has also seen definite evidence that at least some of the gabbro in the Mølland area is younger than, and intrusive into the surrounding amphibolite.

Thus the weight of evidence seems to indicate that both the Flåt hornblende-diorite, and the Mølland gabbros were almost certainly intruded into the amphibolite body, and are not merely derived from it. Field and microscopic evidence also indicates that they were intruded later than the main regional metamorphism.

If we now direct our attention towards the known nickel localities, it becomes evident that almost all are connected with either ultrabasics, hornblende diorite or gabbro of the Mølland type. If we regard the nickel as being entirely limited to these rock types, then we have a fairly good idea of when the nickel was introduced into the basic complex, i.e. in the case of the gabbro and hornblende diorite, after the main regional metamorphism. (as of the time of writing no accurate information is available as to the age relations of the ultrabasic).

Having now a reasonable idea of the relationship of the nickel to the Iveland-Evje basic complex in time and space, a structural analysis can be attempted.

Fractures.

"A Further result attending to the Disturbances of the surface of the Earth has been to produce rents or fissures in the Rocks which have been subject to violent movements, and to convert them into receptacles of metallic ores accessible by the labours of men".

Reverend William Buckland 1835.

There are two typical modes of failure by fracture, namely, tension and shear. Whether a rock fails by one or the other, or by a combination of the two depends on the nature of the rock and the conditions of deformation.

During the 1967 field season, fractures were located both by direct observation in the field and by photogeological studies. When preparing the 1:25000 geological map it was decided to incorporate only those fractures that had been recorded by a combination of these two methods. 378 such major fractures are shown on the geological map. (fracture embracing the three terms fault, shear, joint.)

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It should be stressed here that for the most part no detailed field observations were made of these fractures, the fracture was merely observed in situ and its trend recorded. In many cases the trends were taken directly from the aerial photographs. A more detailed examination of certain shears in the Flåt Mine area was undertaken by Dr. Haldemann. This information, together with the old documents and reports from the Flåt Mine, provide important clues as to the age relations of the shears in this area.

A cursory glance at the completed geological map indicated a fairly complex fracture system and the problem was first approached by determining the actual fracture patterns operative. This was done by taking the trend of all 378 fractures and plotting the results in the form of a rosette diagram, fig. 2. This shows three major sets of fractures to be prevalent over the area taken as a whole. One set trending east/west and two complementary sets trending roughly NW/SE and NE/SW.

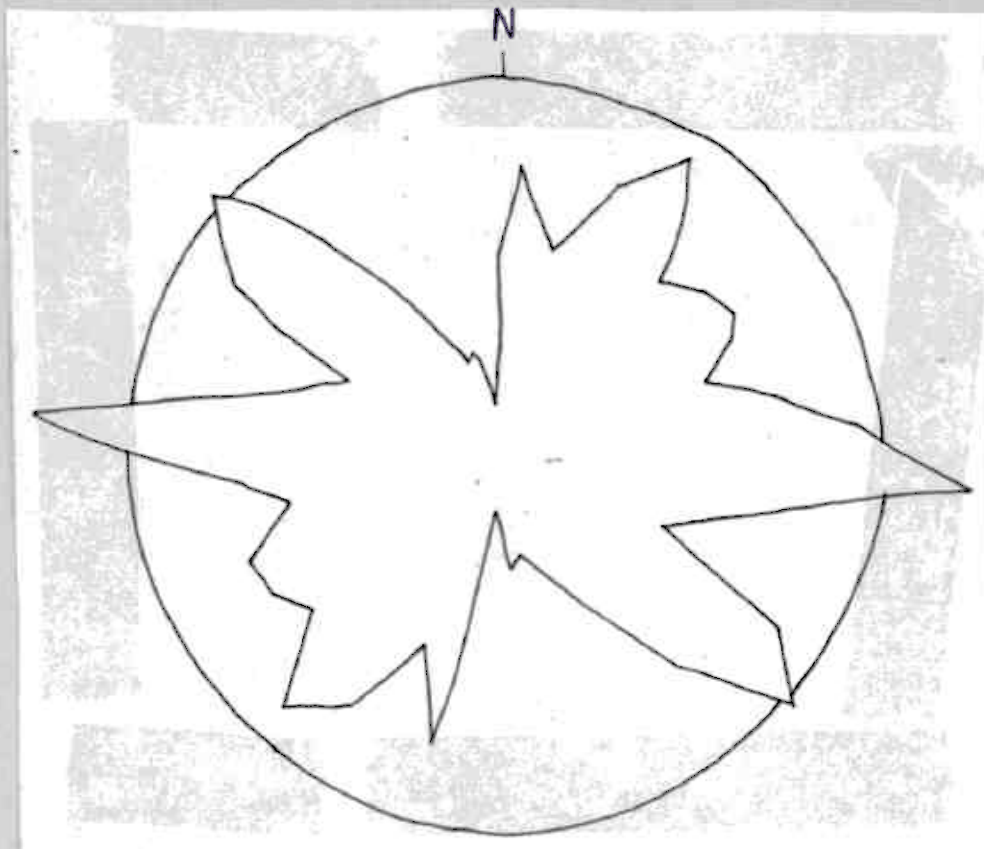


Fig. 2. Total area fracture pattern (378 fractures).

Both field and photogeological evidence seemed to indicate that the east/west trending fractures were associated with the most basic parts of the area, i.e. the amphibolite body and the surrounding hornblende gneisses. To verify this, further rosette diagrams were plotted. Fig. 3 shows a plot of the fractures occurring in granite gneiss and intrusive granite. Here one can see that the dominant directions developed are NW/SE and NE/SW. There is no indication of a strong east/west development as apparent in the total area plot.

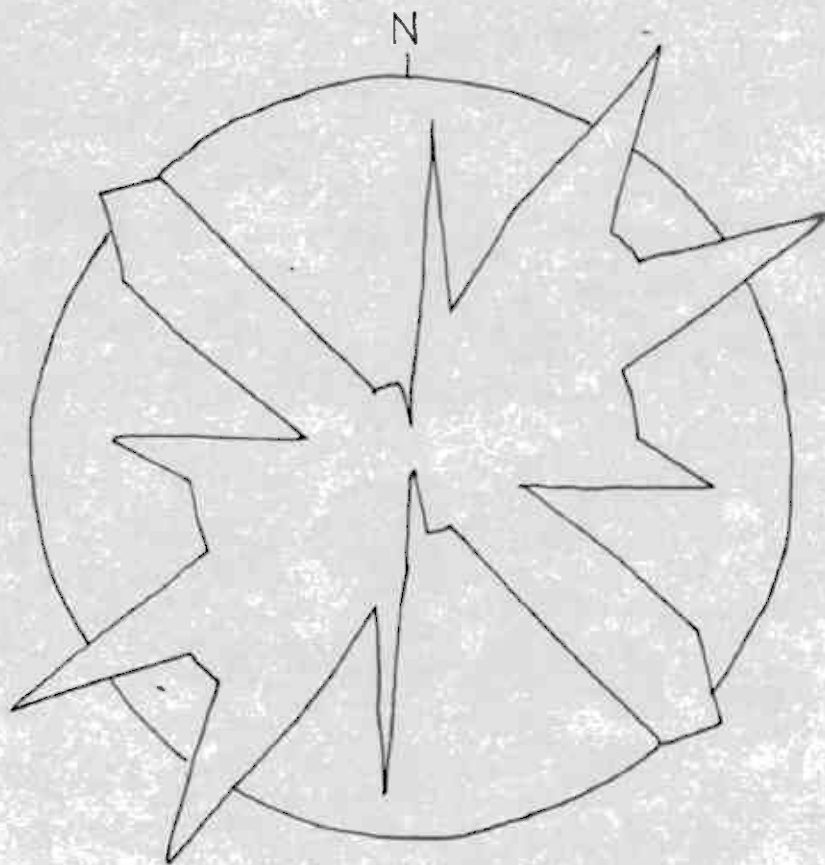


Fig. 3. Fractures in intrusive granite
and granite gneisses. (128 fractures)

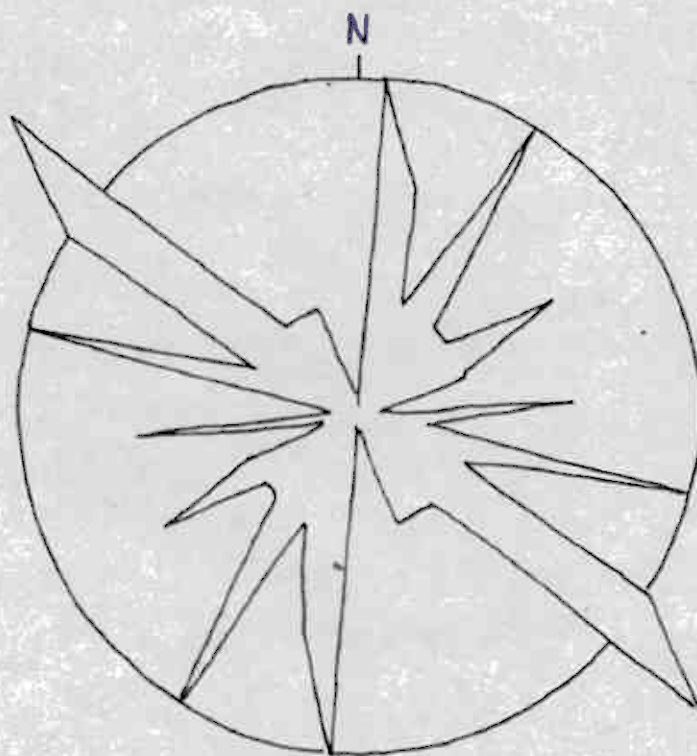


Fig. 4. Fractures in intrusive granite.
(31 fractures)

This subdivision of the total area was further subdivided, insofar as that the fractures in intrusive granite and the fractures in granite gneiss were plotted separately from one another. Fig. 4 is a plot of the fractures in intrusive granite. Here the observed pattern gives a dominant NW/SE set of fractures, and a spread of fractures between N-NE and S-SW. No significant east/west fracture patterns is developed.

The plot of the fractures confined to granitic gneisses (fig. 5) gives more or less the same picture as fig. 4: -two complementary sets NE/SW, NW/SE with very little indication of east/west fracture development.

The rosette diagram for the basic complex (amphibolite gabbro and hornblende gneiss) was then plotted (fig. 6). It can readily be seen that there is a very strong east/west development overshadowing a NW/SE and a NNE/SSW set of fractures.

Thus we have established that in the amphibolite and surrounding hornblende gneiss an east/west set of fractures predominates. These fractures are not to any great extent present in the granitic gneisses. Both areas possess a NW/SE and NE/SW sets of fractures.

The most detailed information on the fractures in the Iveland-Evje region comes undoubtedly from the Flåt Mine area. In the vicinity of a mine major fractures can be a mere nuisance, or they can spell disaster for the mine. It is therefore not surprising to find that quite an amount of time was spent on the study of these fractures.

During the last ten years or so that the Flåt Mine was operating, much time was spent on trying to locate the almost mythical "storsleppen". This is a fault which was suspected of cutting and displacing the ore. It is a roughly N/S striking fault dipping about 70 to the west, it has been described from a number of levels in the mine, notably 163, 184, 282 and 402.

At different times in the investigations of this fault different theories have been advanced. In 1939 W. C. Carstens postulated that it could possibly have a horizontal displacement in the region 250-300 mt. Geological and drilling evidence failed to substantiate this however, and subsequent investigations now seem to indicate that although there seems to have been a relative sinking on the eastern side, the movement along the fault must have been negligible, and that no ore of any importance has been displaced.

Other examples of small faults have been recorded from the mine. According to Bjørlykke some of these local faults seem to be contemporaneous with the granitization, for in the mine one can see a vein of pegmatite two inches wide continue uninterrupted across a fault. Frankly, this I find hard to believe, firstly I am of the opinion that the faulting in this area is later than the granitization. Secondly, even if the pegmatite is later than the fault then I find it impossible to understand that the pegmatite did not make use of this fault and follow in part its line of weakness.

Another interesting observation was made by Bjørlykke in 1940. On level 163 he finds several small shears which are more or less parallel to the storsleppen. The ore is not cut off by these faults, but continues on the east side of them actually bordering against a small zone of fine grained dark rock. I do not think that this is definite evidence to say that the ore is pre-faulting or shearing. It seems reasonable to assume that some of these small shears and

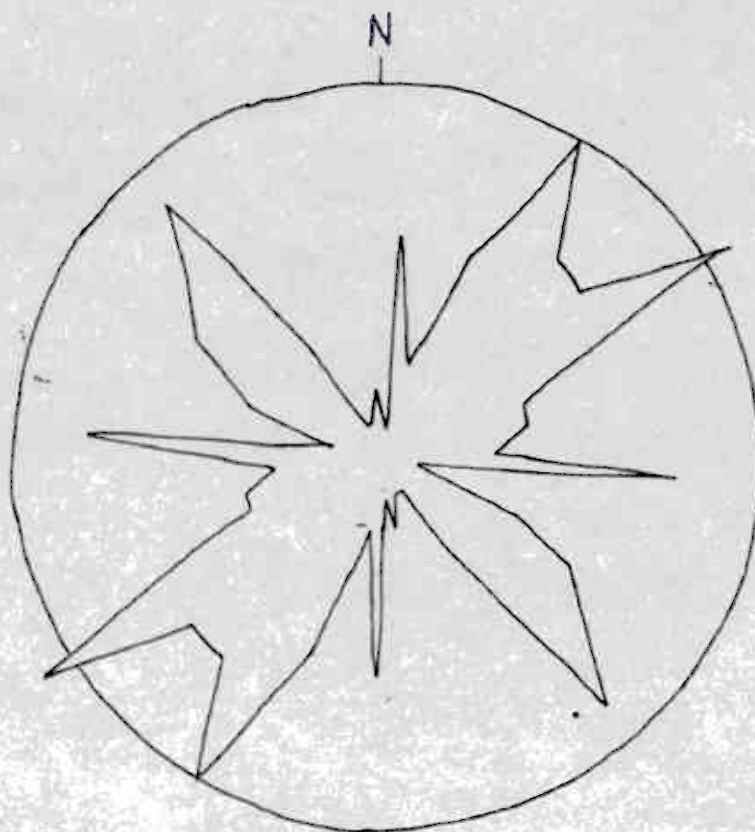


Fig. 5. Fractures in granitic gneisses.
(97 fractures)

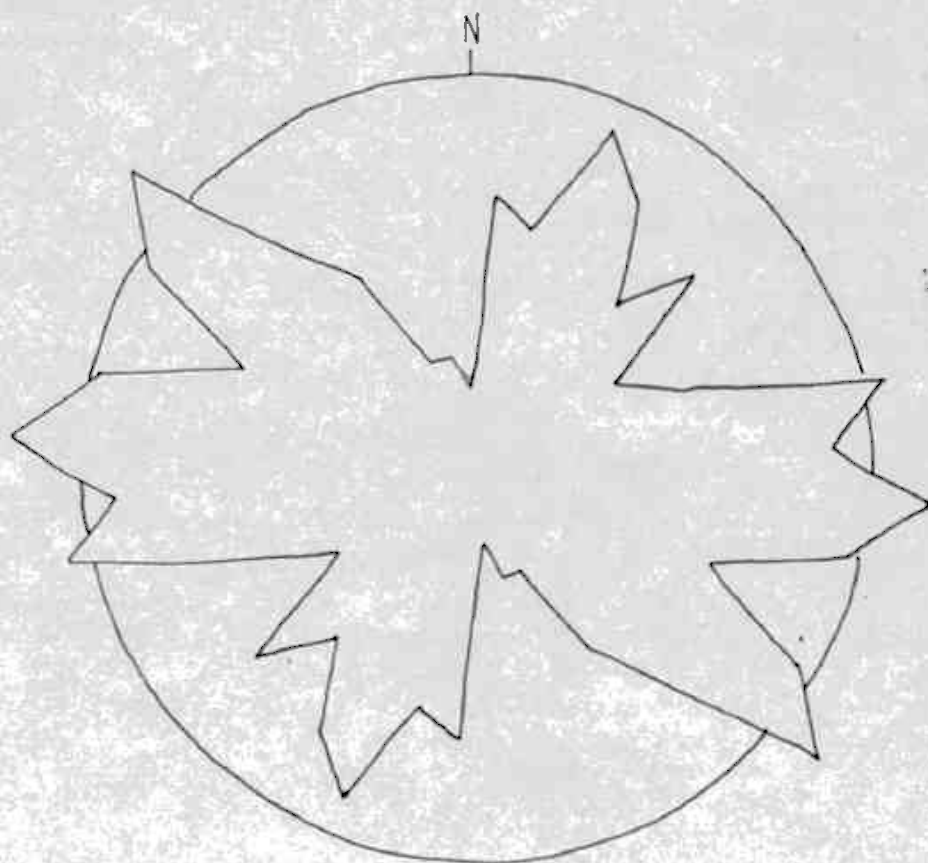


Fig. 6. Fractures in amphibolite/gabbro
and surrounding hornblende gneiss.
(250 fractures)

faults found in the mine probably represent border faces between slightly different rock types within the "ore diorite", and that movement along them is negligible.

The majority of the major faults and shears in the ore diorite and around the Flåt Mine are predominantly NE/SW shears together with a smaller proportion of NW/SE fractures. This NE/SW shearing zone fits into the regional system of faults intersecting Eastern Sörlandet, and this in itself is an indication that these faults are of a distinct later age. Other indications also point to the fact that this shear system is of a late age. One of the most convincing pieces of evidence is to be found at locality 21Dc, where a NE/SW shear is seen to cut and brecciate a pegmatite.

These shears belong to the NE/SW-NW/SE pattern of fractures which is developed over the entire area. During this period of mylonitization and regional fracturing the amphibolite and the surrounding gneisses must have been much cooler than during granitization. They acted as brittle rocks and were at a much higher level in the earth's crust. It thus seems reasonable to assume that mylonitization and granitization are in no way geologically connected, all the evidence points to the fact that the mylonitization occurred at a much later stage in time.

The motivating forces that cause fracturing may be either local or regional. When explaining fracture systems it is very easy to fall back onto local forces as a cause, especially those depending on the energy of igneous intrusion. It would be very plausible when thinking of the Flåt diorite and the central gabbros of the Mölland area, to conceive a magma entering and supplying the solutions to traverse the cracks that its own entry and cooling have created. The uncritical acceptance of this is likely to obscure not only the origin of the fractures, but also the source of the ore solutions.

However, if we look critically at the evidence that has been presented above we have many factors that indicate that we are dealing with regional forces. Both the development of the NE/SW-NW/SE pattern over the entire area and the fact that many of the fractures are shears testify to failure under regional compression.

If we consider the entire fracture pattern, we can on a regional scale explain the pattern as a result of an east/west compression and a corresponding north/south tension. (See fig. 7.)

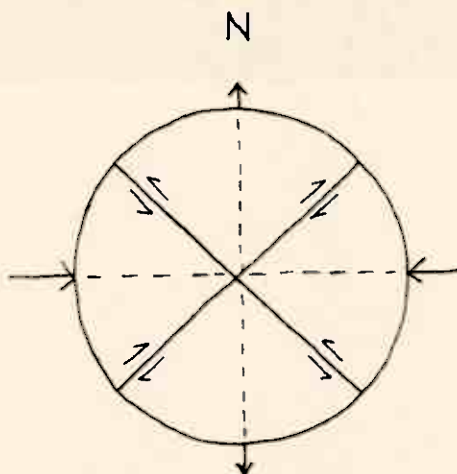


Fig. 7. Stress diagram of the regional fracture pattern.

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Compression in an east/west direction resulted in shearing along surfaces approximately parallel to the planes of maximum shearing stress (approx. NE/SW-NW/SE) and making an angle somewhat less than 45 to the planes of maximum normal stress. The east/west fractures could then be explained as being tension fractures normal to the plane of the minimum normal stress.

The fact that these east/west fractures only occur in the amphibolite could be due to the difference in mechanical properties between the basic amphibolite and its more acid surroundings. It is true that to a certain extent some of these east/west fractures extend into the gneisses flanking the amphibolite. This is very evident on the west flank of the amphibolite body. Local forces could be the cause of these extensions, for once a fracture has been formed, relatively small deformation forces are required to cause an extension of the fracture.

This theory then places all the fractures into a regional system formed as a result of regional forces, all the fractures being post-ore.

Two possibilities now present themselves as possible ore controls. The first and most obvious being the fact that any one of these faults could have displaced ore lying at depth. The other possibility is one of reworking and reintroduction of a sulphide melt. The newly formed fracture planes represent areas of decreased pressure and increased permeability, and thus present an ideal passageway for ascending fluids. From the available evidence however, it seems unlikely that this second possibility has been operative. An examination of thin sections of mylonitic and sheared rock from some of the fracture zones in the Flåt area indicate that a crushing and partial recrystallization has taken place. The rocks formed being in the Greenschist metamorphic facies. In none of the slides were calcite or sulphides noted. It is the writers opinion that recrystallization took place only to a limited extent and probably in closed systems. It seems highly unlikely that any noteworthy remobilization took place at depth, and that any ore has been reworked and introduced into these fractures.

Only at one locality are nickel mineralizations geographically associated with a fracture. This is at Bekken, north of Birkeland (map unit F9). Here three small nickel prospect pits associated with ultrabasic rocks lie on either side of a small stream which occupies the fracture. This might have some geological significance or it may be a total coincidence. Detailed investigations planned for this summer will help to clear up this problem.

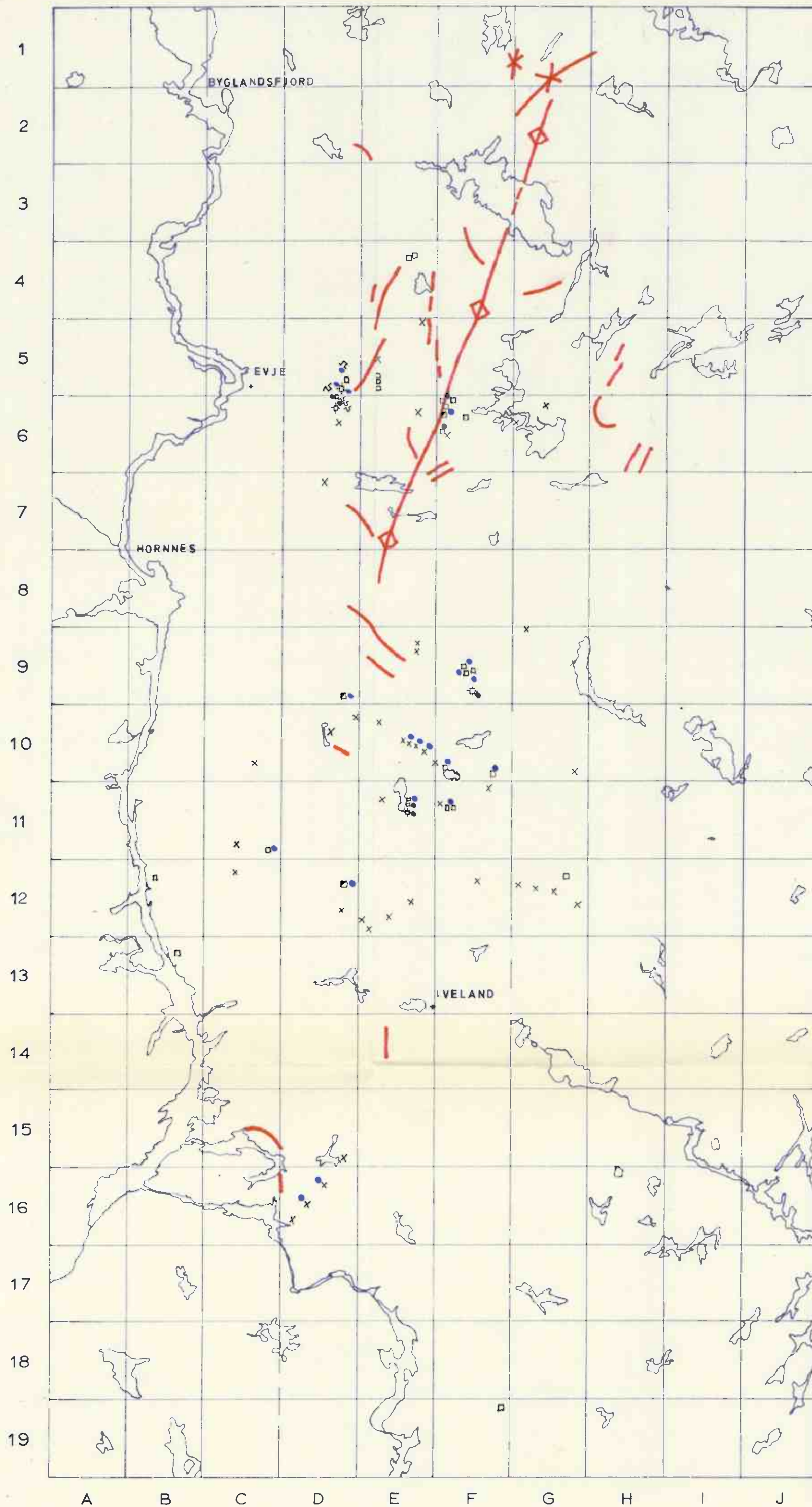
To return a little to the mine at Flåt.
Recent work in the area by Haldemann has led to the discovery of a new shear to the east of the actual mine. This shear, named the Mykleåsen shear, could possibly be of importance with regard to the question of ore displacement in the mine.

Folding.

Of first priority in trying to relate ore to fold structures is to determine the date of the folding with respect to the ore deposition, that is, whether the object of search is a folded ore deposit, or ore that has been deposited in folded rocks. Ore that was present before the folding will naturally have been deformed along with the enclosing rocks. Ore that has been introduced into rocks that are already folded, may show no relationship to the folding, but usually it reflects folded structure in one way or another.

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Fig. 8.

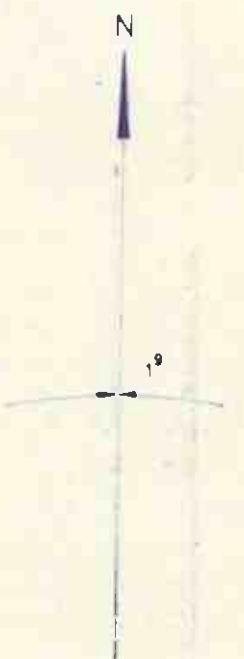


- ⊕ Old mine working
- Exploration shaft
- Exploration adit
- Prospect pit, trench or open cut
- x Mineralization discovered by Sulfidmalm

Red lines indicate fold axes suggested by Hunting Geology and Geophysics Ltd..

• Main nickel localities.

Scale 1 : 100 000
0 1 2 3 4 5 KM



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Considering the question: - "Can the sulphide mineralizations be related to major NNE/SSW fold axes as suggested by Hunting Surveys Ltd.?" We must first determine if such a system of fold axes exist, and if so are they pre or post-ore.

Because of the very nature of such a photogeological study Hunting, were led to assume certain important points without having a field check to verify or dispute these. They begin their section on structural features with the sentence, "The most obvious feature is the Hövringsvann gneiss dome". Field evidence however, points to the fact that this so-called dome is in fact a basin. They also state that the nickel localities described in Barths publication can be seen to form elongate zones in a NNE/SSW direction. This was a correct observation at the time but the discovery in 1967 of new localities makes the picture much more complex. (See fig. 8).

These however, are obvious and accepted pitfalls of photogeology and do not discredit Hunting in any way. However, the stereographic plots and interpretations presented in this report are based entirely on an evaluation of field data and are in no way influenced by Huntings report.

Stereographic projections were made from three main areas

- a) the central gabbro area (map units F11, E10, F10, D10, F9, E9,)
- b) an area of gneisses to the west of the gabbro area (C8, C7, - C11, C12, C9, B11, B12)
- c) an area to the north-east of the gabbro area (F7, F8, G6, G7, G8, H5, H6, H7, H8)

Plots were also made of the total area lineations and the total area minor folds.

All the stereographic plots from the map units mentioned above are of poles to foliation planes and these are contoured.

All contouring was done after the **Mallis** or circle method. This is most suitable for diagrams with few points -- 150 or less, for weak concentrations, and especially for drawing the contour of minimum density. The contours show a density of points per 1 per cent area.

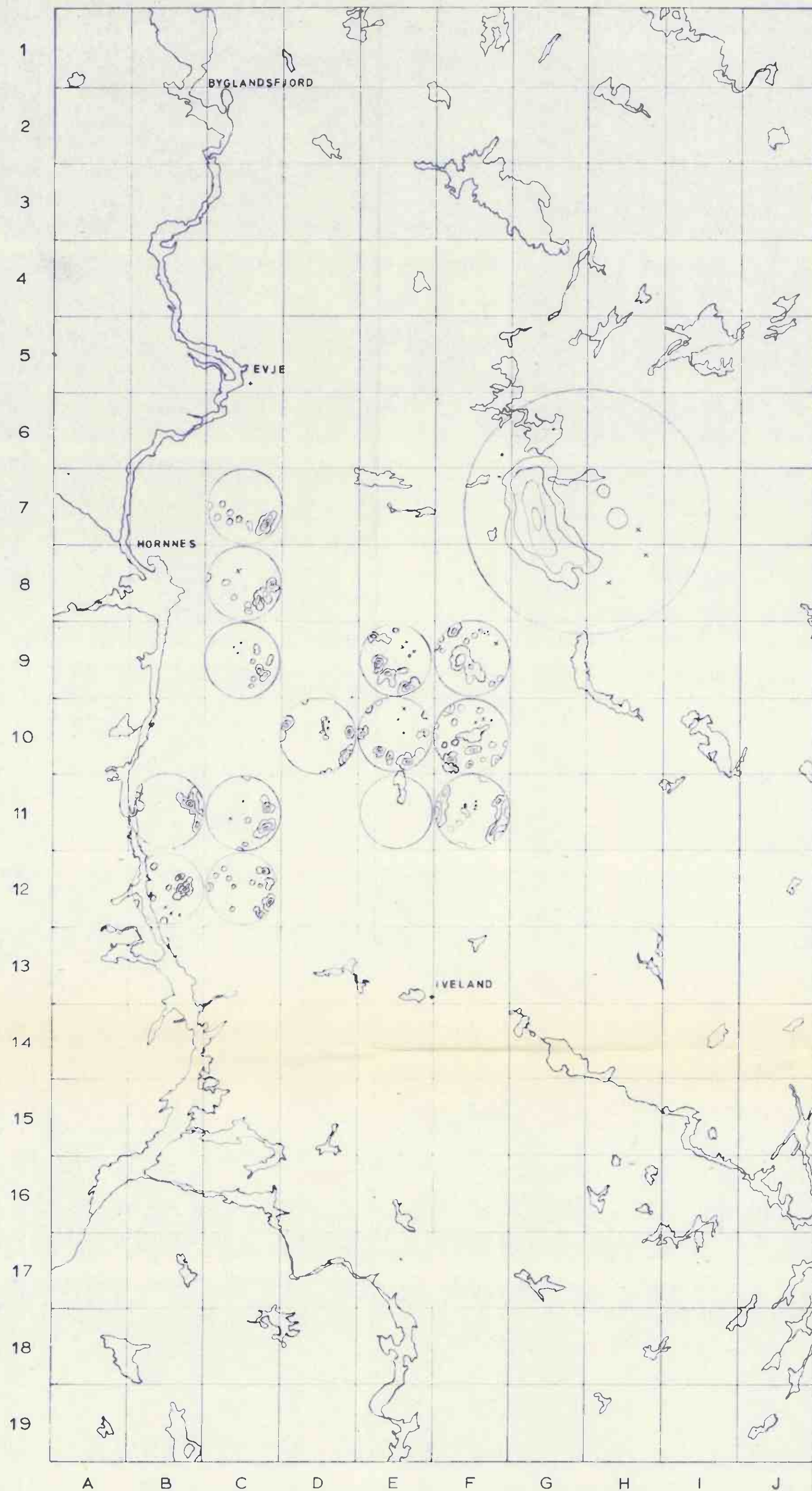
Considering first the total area minor folds. The plot shows two main concentrations, a well defined concentration of folds plunging very gently in a northern direction, and a not so well defined group, plunging fairly gently towards south-west. Although this plot suggests that at least two phases of folding have been operative in the area, it is by no means a conclusive plot. Many of the folds are no doubt drag folds and ptygmatic folds, and these complicate the final plot. This, however, was unavoidable as no information was available as to what type of folds the writer was dealing with during the analyses.

The total area lineation plot shows a marked concentration plunging steeply southwards. These can be interpreted as lineations in "c" to the N/S fold axes. Again the picture is probably somewhat complicated by slickensides and entirely local phenomena.

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Fig. 9.

Map showing the stereographic patterns obtained from the various map units.



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An examination of individual plots did not reveal a tremendous amount of data. In very few of the plots could a girdle pattern be seen, and in many cases plots were complicated by superimposition of various local phenomena, such as fault zones, and areas around intrusive bodies.

The individual plots viewed as a whole present a more clear picture (See fig. 9) a picture of a wide synclinorium with the Mölland gabbro area more or less in its centre. This confirms the interpretation put forward by Wiik in his petrographic report. The form of the synclinorium is by no means uniform, stereographic plots from the westerly map units suggest that the western limb of the synclinorium is made up of steeply dipping almost isoclinal folds with the fold axes trending roughly north-south. Plots from the area to the east suggest that here the rocks are affected by much broader folds, trending in a west-south-westerly direction.

All the seven map units investigated in the west are remarkably uniform. They all show maxima of concentrations in a belt from SE to NE and all the planar elements are steeply dipping. This then is an area where the deformation has been uniform and of one type. It is the writer's opinion that a possible interpretation of such stereographic patterns could be a series of overturned isoclinal folds the axes of which trend roughly north-south. Six minor folds and four lineations are recorded from the area, and of the folds, three, are in accordance with a north-south fold pattern. The lineations are all steeply dipping and can all be regarded as "c" lineations to north-south folds.

As the central area is approached the same kind of structures seem to prevail. Map units D10 and F11 both suggest north-south isoclinal folding although not of an overturned nature. In D10 the fold axes seem to be swinging more towards the northeast. Other plots from this central area are very complex and extremely difficult to interpret. Map unit F10 is complicated by superimposition of entirely local phenomena such as igneous intrusions and a NW/SE trending shear zone.

Three plots from the eastern gabbro/gneiss border area (E9, E10, F9) give good undisturbed girdle patterns and, in most cases, with minor folds and lineations clustered around the corresponding girdle axes. These folds are much broader than the ones to the west and they trend roughly in a southwest direction (E9: - $W32^{\circ}S$, F9: - $W20^{\circ}S$, E10: - $S28^{\circ}W$). Thus we have on the eastern border zones of the gabbro relatively undisturbed folds forming the eastern limb of the synclinorium.

The gneisses to the east of the gabbro area although giving a more or less elongated maximum of points also follow the same tendency and a fold axis trending $W16^{\circ}S$ can be extrapolated.

Summary of Results.

Essentially, the results obtained dismiss certain areas of investigation as unfruitful, and earmark others for further study.

The fault and fracture patterns are in the writer's opinion unimportant and at the present state of investigation require no further detailed study.

The evidence stated shows these fractures to be late in age and almost certainly post-ore.

From the available evidence it has been established that the area has been disturbed by at least two phases of folding and that it seems as if the Evje-Iveland amphibolite body has been intruded into a synclinal structure.

The directions of the two phases of folding identified agree quite closely to those suggested by Hunting, and some comparison can be seen between alignment of certain nickel localities and the NE/SW fold axes.

Barth also identified the N/S phase of folding and he considered this to be the youngest phase present. Hunting consider the NNE/SSW (our more WSW/ENE) phase to be the younger and this is more in line with the views of the writer. The writers opinion however, is based on scanty evidence and more on intuition than any definite proof.

In conclusion therefore and in answer to Dr. Haldemann's question it is the writers opinion that all the fracture patterns are post-ore and that they are not important as ore controls except in the case where they may cut and dislocate potential ore bodies.

With regard to the folding, two phases are present in the area but their age relations both to each other and to the ore, and their influence as ore controls has not been established and in the writers opinion can not be established before further detailed field investigations have taken place.

Recommendations for further study.

This report has attempted to draw conclusions from the available data. It is clear that in order to determine more accurately causes and series of events much more detailed data is required, and it is suggested that more detailed structural investigations be made in the field.

The field procedures of structural analysis are additional, and they in no way replace routine field methods. These additional procedures should concentrate on accumulating orientation data for structures that on the mesoscopic or the macroscopic scale are penetrative. Of particular importance in such detailed studies are age relations of different structures.

Lineations etc. should not merely be measured but also given a short description, for example, the lineation measurements from a single exposure might read

	trend	plunge	notes
L1	28	55	fine stiation parallel to fold axis B and to intersection of S1 and S2
L2	248	58	crenulation on S2 parallel to intersection of S2 & S3

(Taken from Structural Analysis of Metamorphic Tectonites
Turner & Weiss, McGraw-Hill 1963.)

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It is suggested that the above mentioned detailed studies be directed
towards a more clear understanding of the fold structures in the area.

FN/kt
April 25, 1968.

Appendix.

A short description is given of most of the stereographic plots accompanying this report.

Stereo. plot C12.

The vast majority of the points in this plot dip steeply to the east, five or six points dip fairly steeply west. The general strike is roughly north/south. This pattern can be explained as resulting from fairly isoclinal folds being slightly overturned westwards, the westerly dipping elements being either a disturbed part of this system or perhaps being related to some kind of drag fold.

Stereo plot C11

This plot presents much the same kind of picture as C12. The lineation present is in "c" to north/south folds. The minor fold falls out of both the pattern and theory and might possibly be a minor drag fold.

Stereo plots B12, B11, C7, C8, C9.

These plots fall into the same general group as plot C12.

Foliations in gabbro.

This plot shows more or less what one might expect- the planar elements are steeply dipping and show no preferred direction. Most of the foliations were probably observed in the border zones of the gabbros, the foliation being parallel to the contact.

Map unit F11

This plot indicates fairly tight folding, the fold axis trending about 5° west of north.

Map unit D10

Again tight isoclinal folding is suggested by the plot. The limited number of points suggest the fold axis to be trending some 20° east of north.

Map unit E9

This proved to be one of the few plots to give a reasonable

girdle pattern. The extrapolated fold axis trends 32° south of west.

Map unit E10

This unit gives an incomplete girdle pattern but interpretation of the available pattern gives the fold axis as trending south 28° west.

Map unit F9

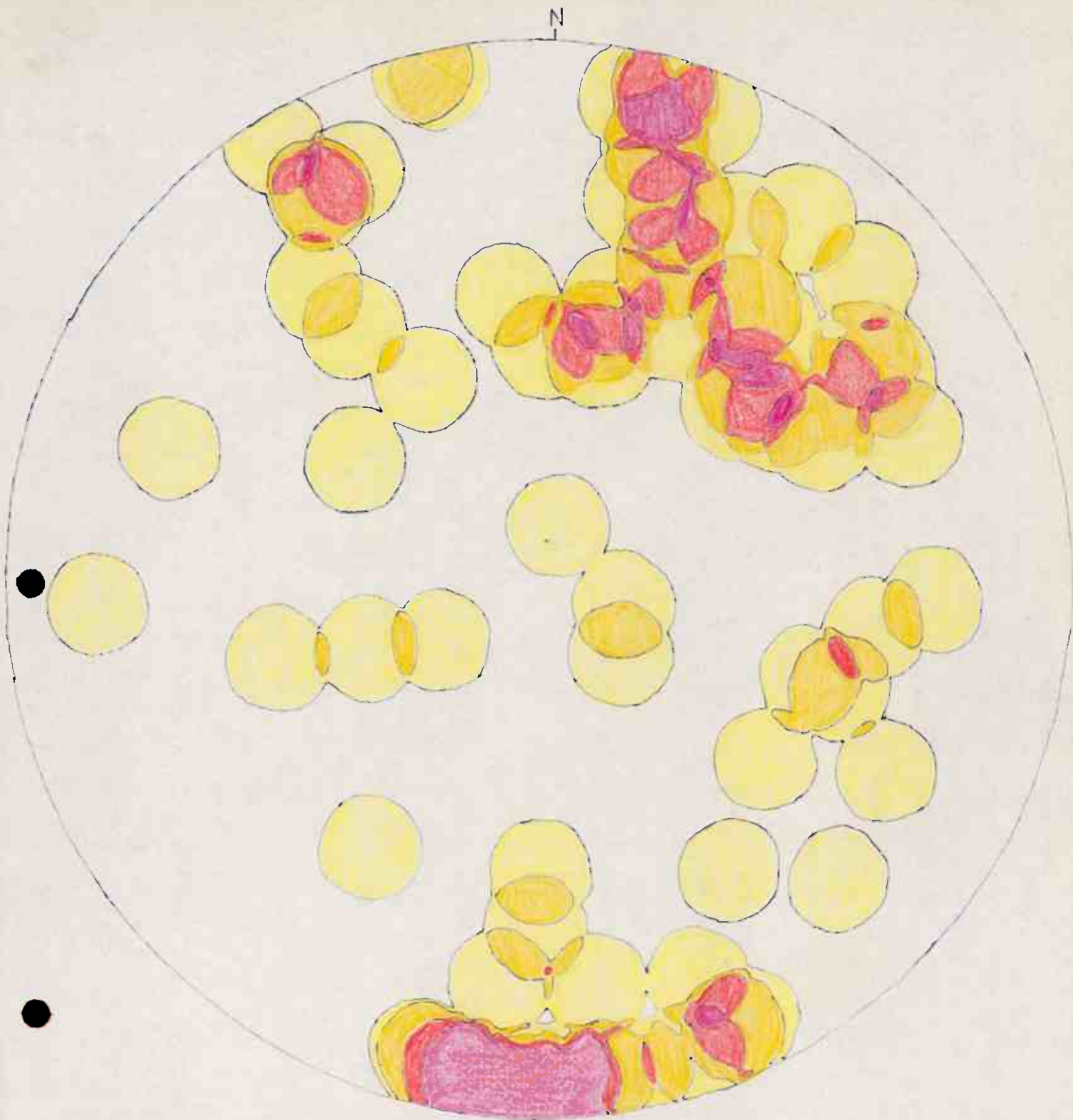
Again the same general pattern as the two previous plots. Fold axis trends 20° south of west.

Map unit F 10

This plot appears very complex. The relatively disturbed pattern is due to local phenomena such as a NW/SE trending shear zone, and various igneous intrusions.

Map unit F7,F8,G7,G8,H5,H6,H7,H8

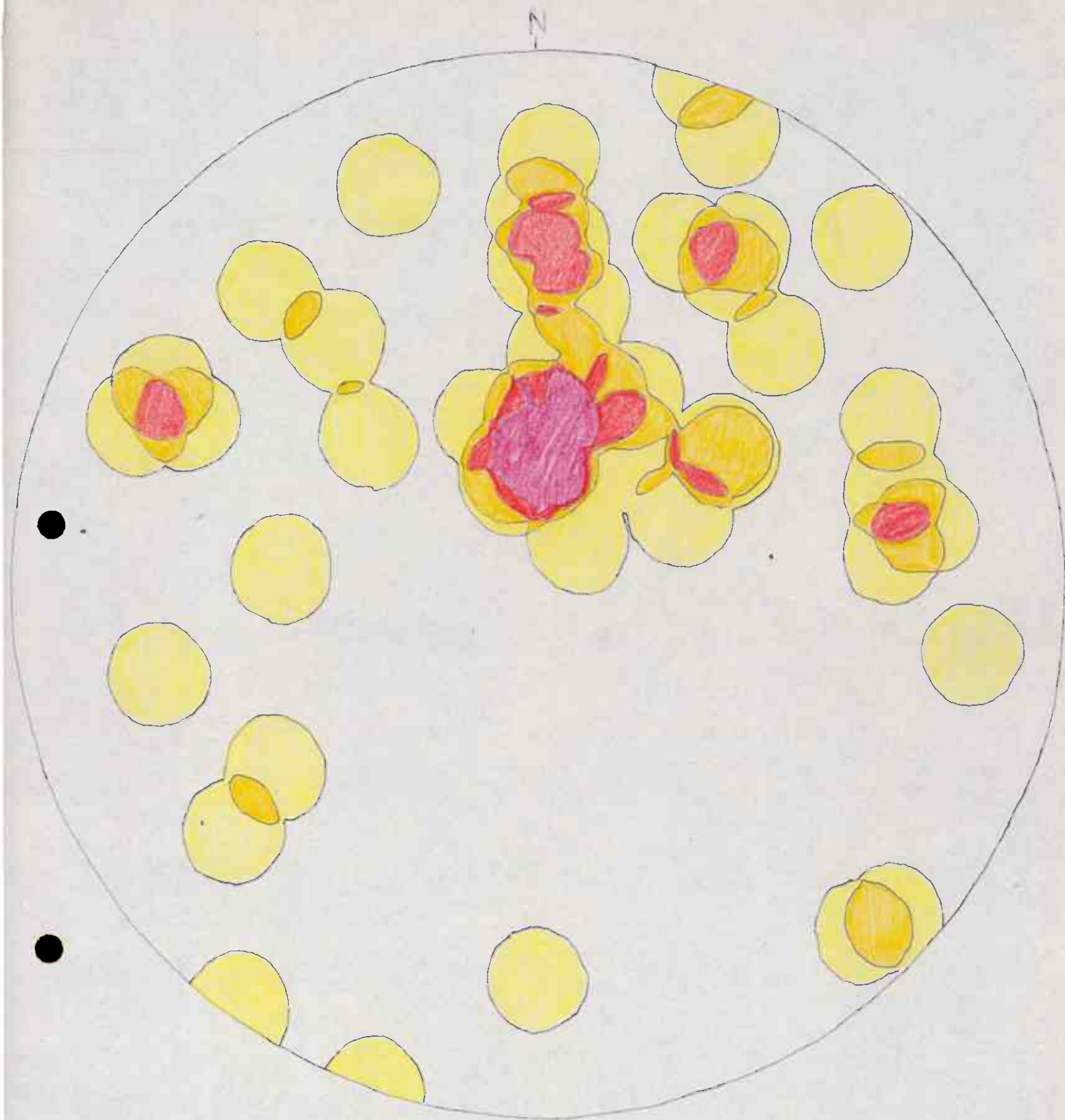
This area gives a slightly elongated area of maximum density. Although it does not give a complete girdle pattern it follows the same general trend as the other easterly units and gives a fold axis trending 16° south of west.



Total area minor folds. (77 points)

Schmidt net upper hemisphere.

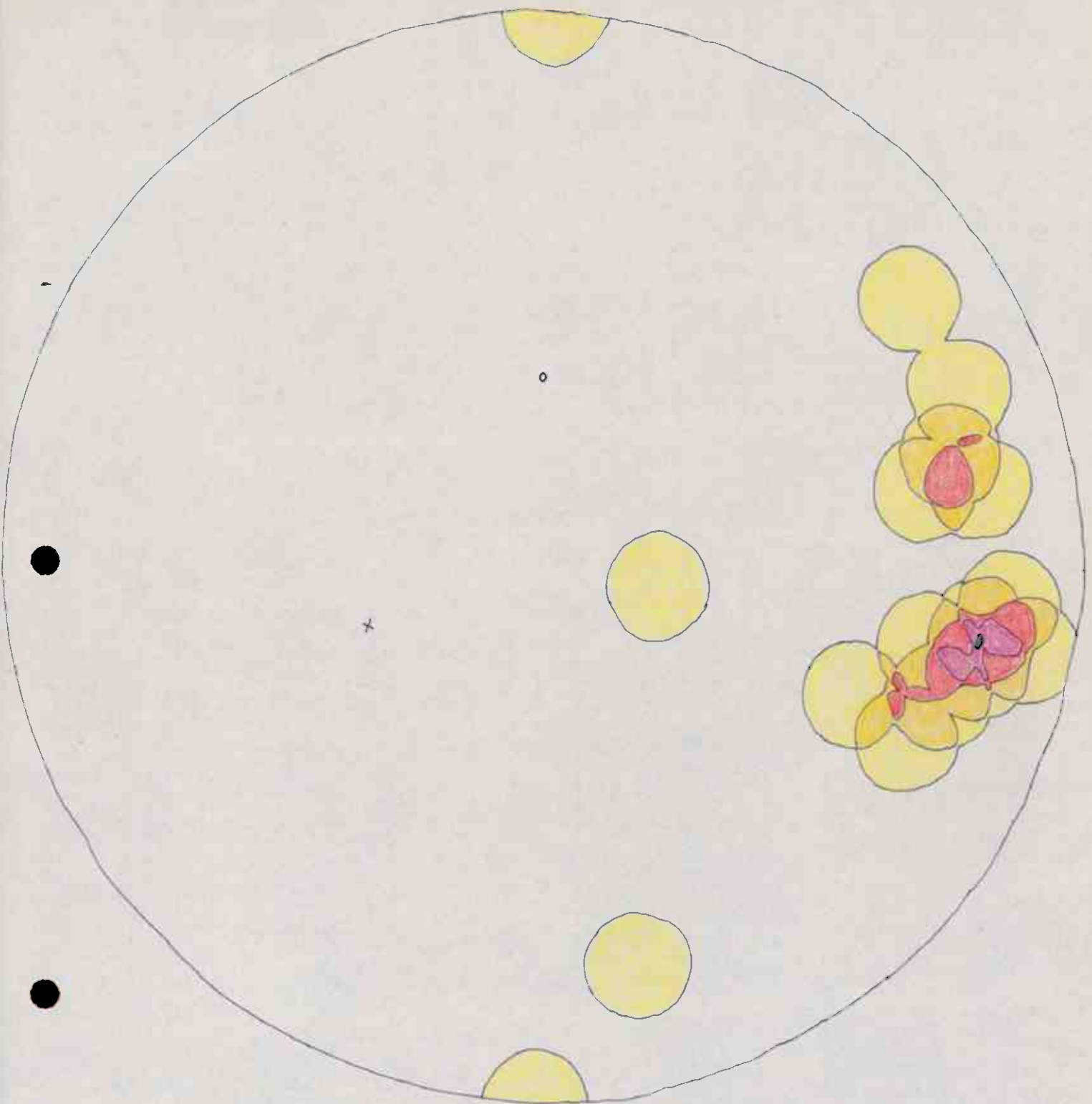
Contours 1,2,3,4,5 points per 1% area. (after Melli)



Total area lineations. (64 points)

Schmidt net upper hemisphere.

Contours 1,2,3,4 points per 1% area. (after Melli)



Map unit C11. Poles to foliation planes.

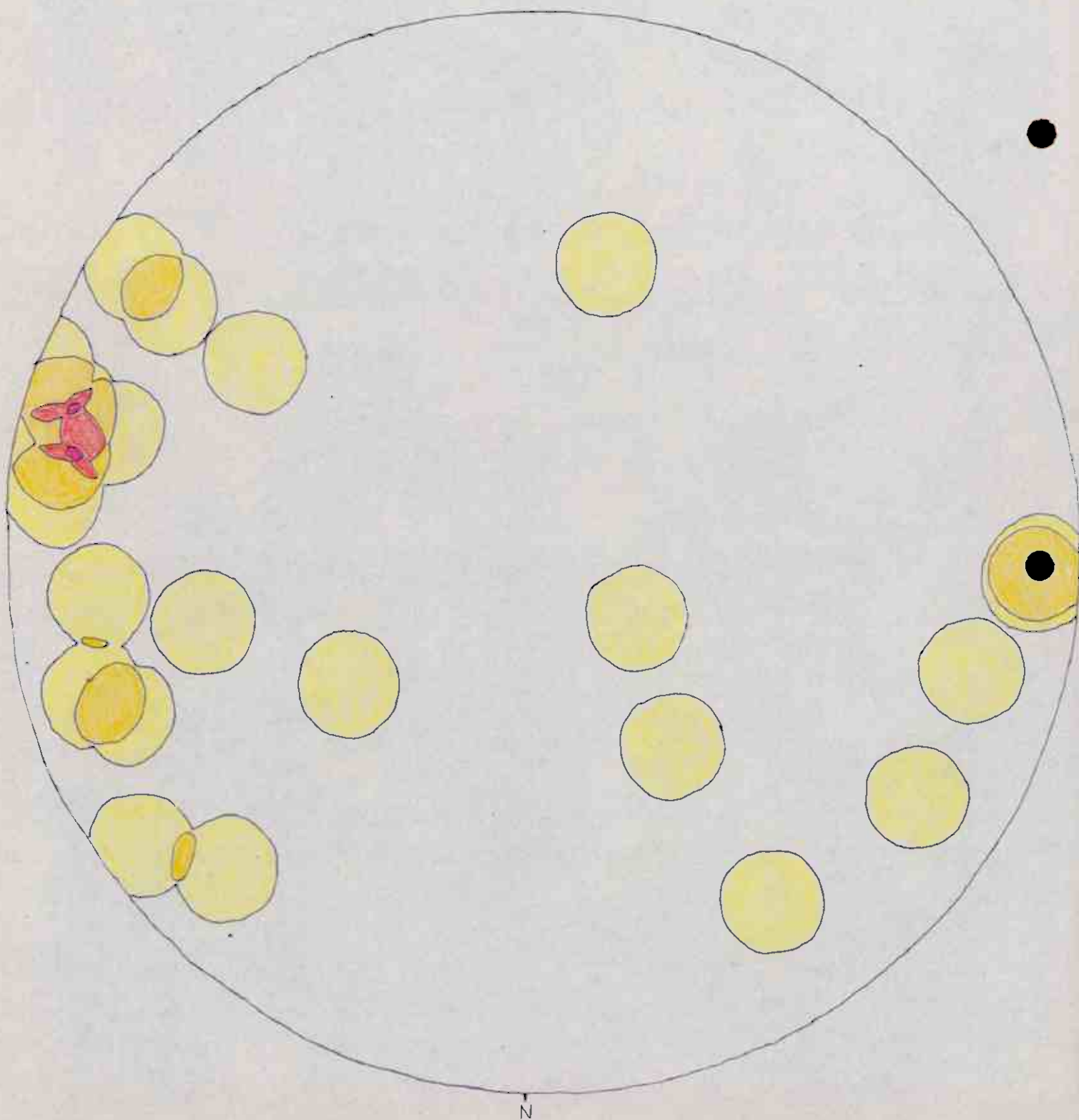
Schmidt net upper hemisphere.

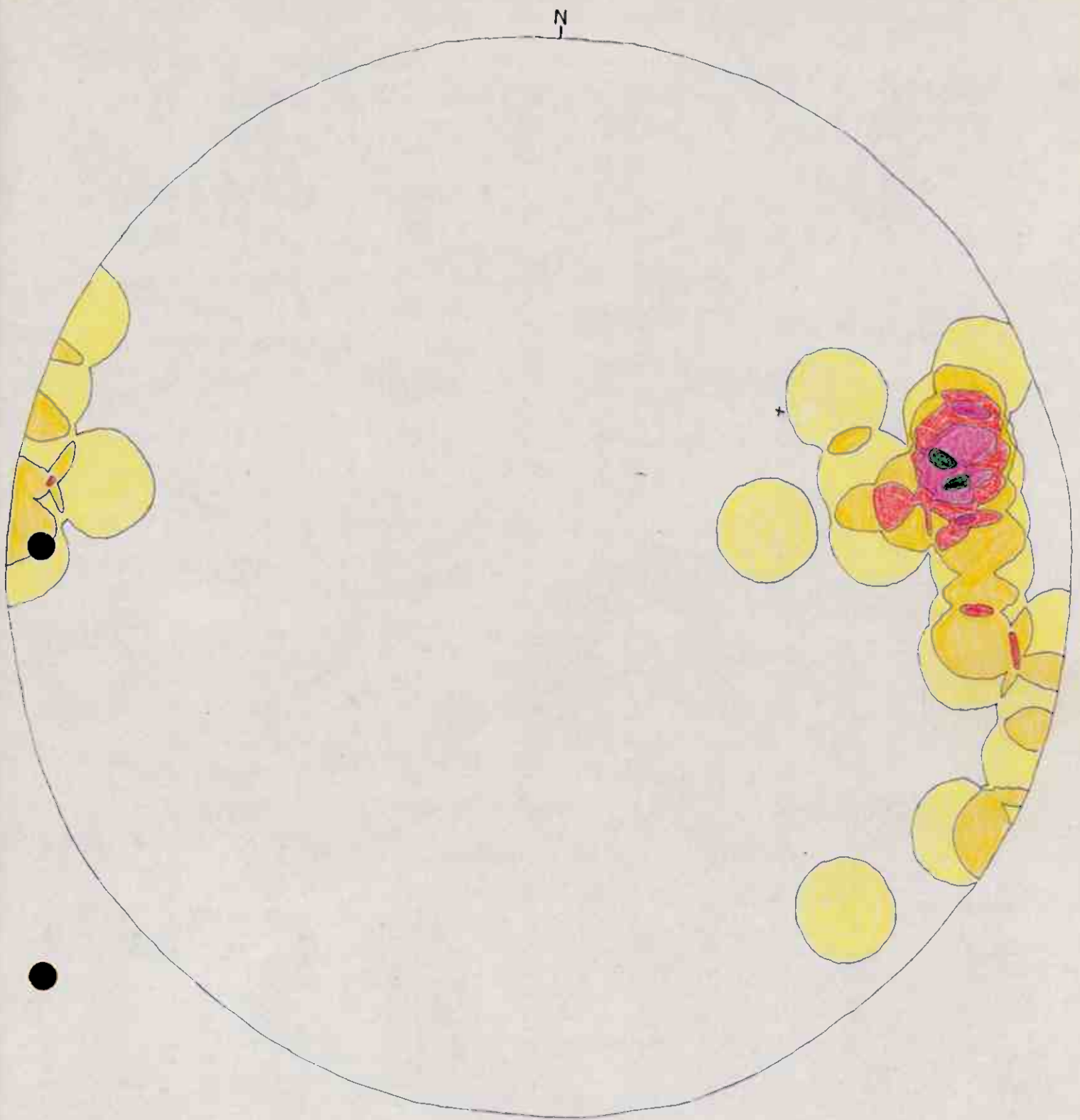
Contours 1,2,3,4,5 points per 1% area .(after Melli) Total points 16.

x minor fold.

o lineation.

Map unit C12. Poles to foliation planes.
 Schmidt net upper hemisphere.
 Contours 1, 2, 3, 4 points per 1% area. (after Wells) Total points 22.



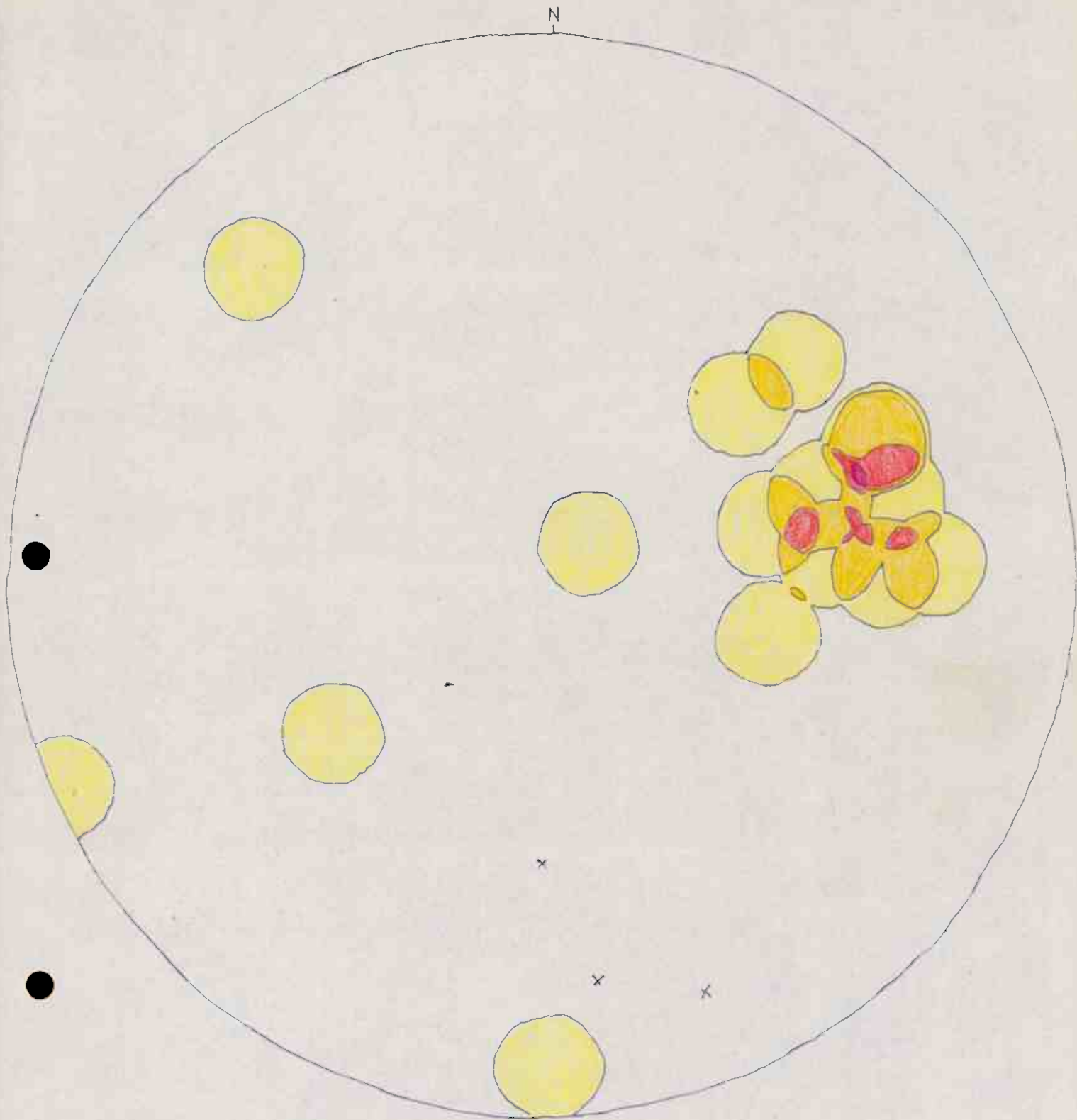


Map unit B11. Poles to foliation planes.

Schmidt net upper hemisphere.

Contours 1,2,3,4,5 points per 1% area.(after Malli) Total points 23.

x minor fold.

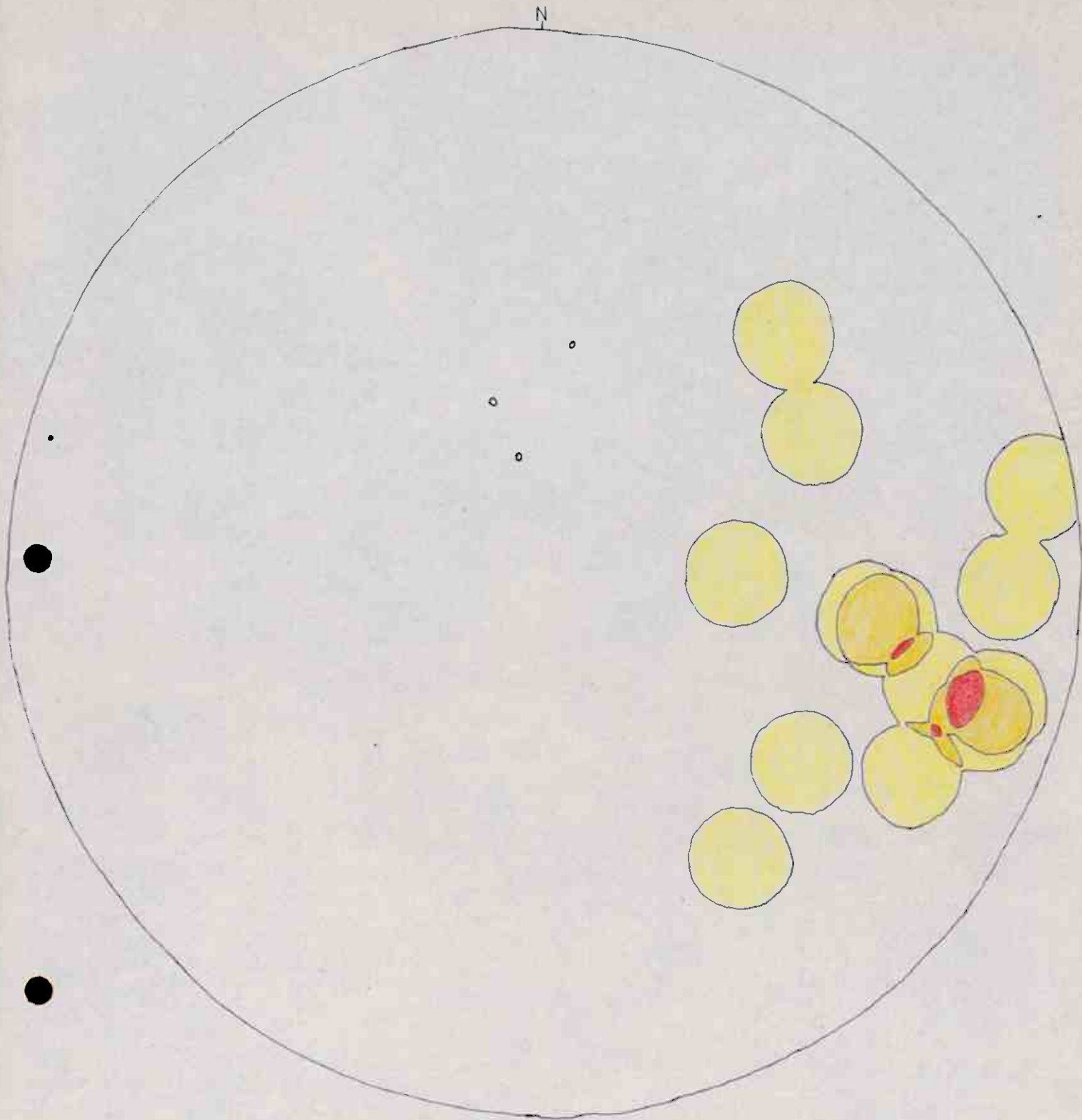


Map unit B12. Poles to foliation planes.

Schmidt net upper hemisphere.

Contours 1,2,3,4 points per 1% area. (after Melli) Total points 15.

x minor fold.

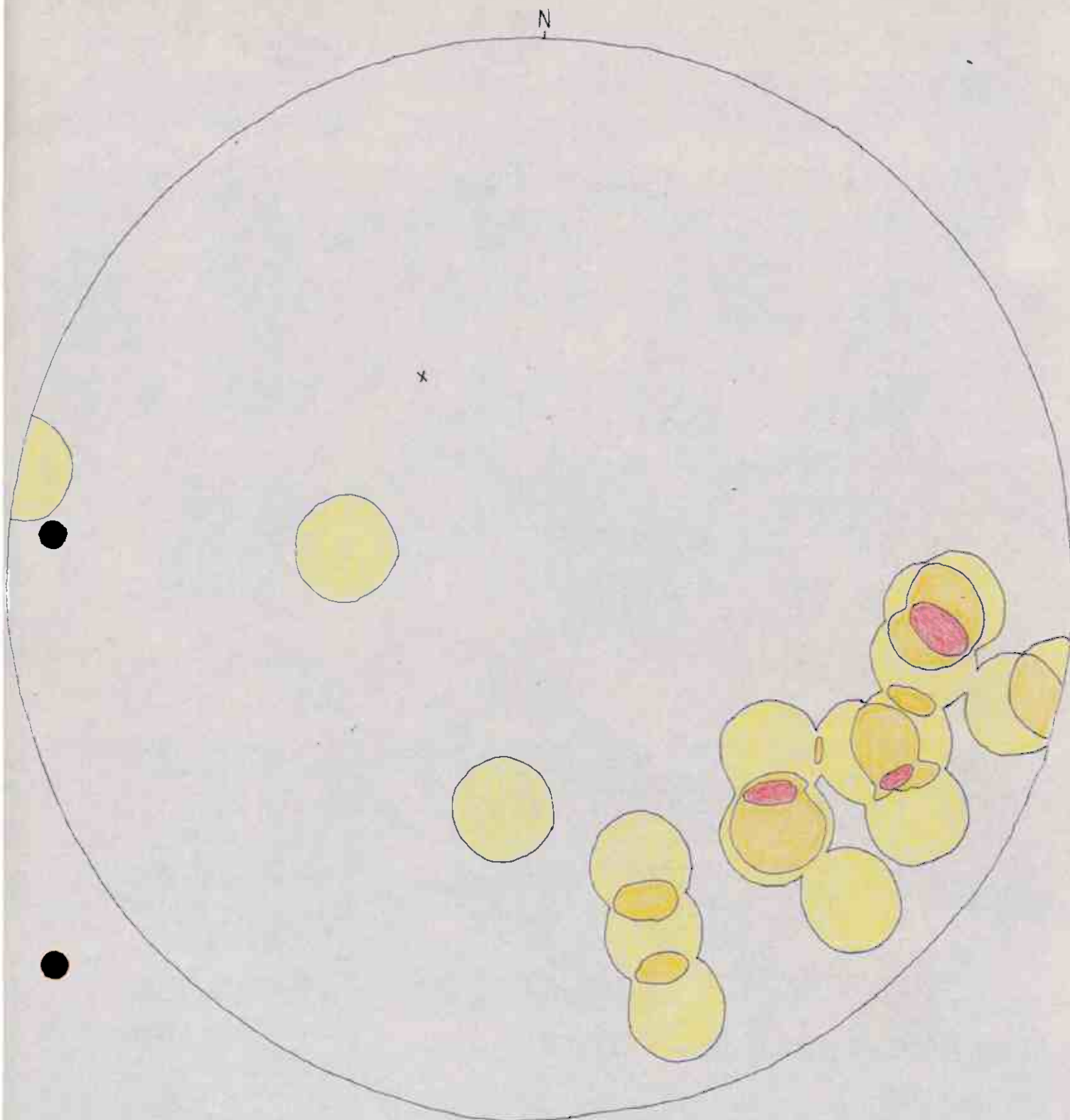


Map unit C9. Poles to foliation planes.

Schmidt net upper hemisphere.

Contours 1,2,3 points per 1% area.(after Melli) Total points 12.

• lineation.

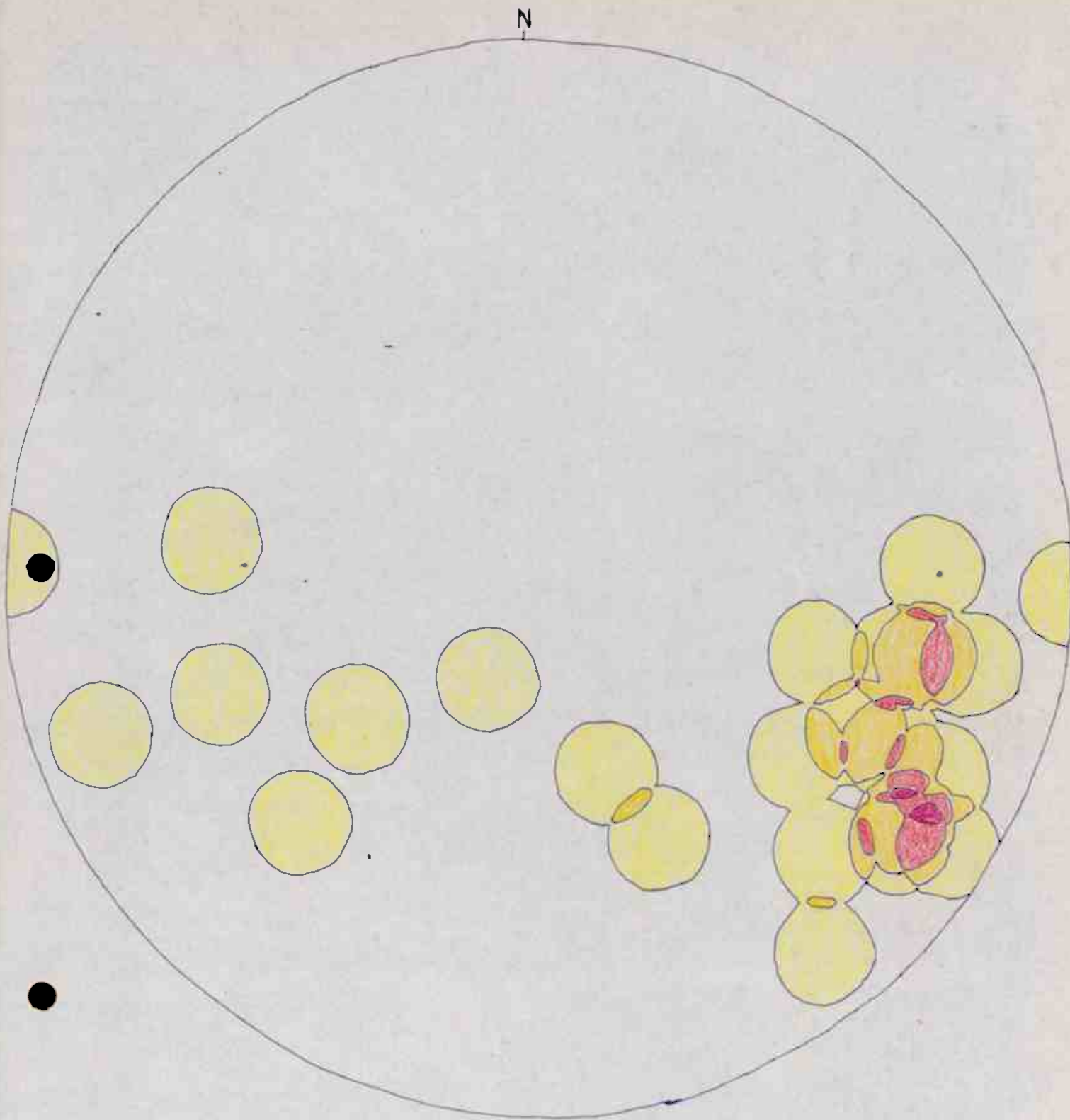


Map unit C8. Poles to foliation planes.

Schmidt net upper hemisphere.

Contours 1,2,3 points per 1% area. (after Melli) Total points 17.

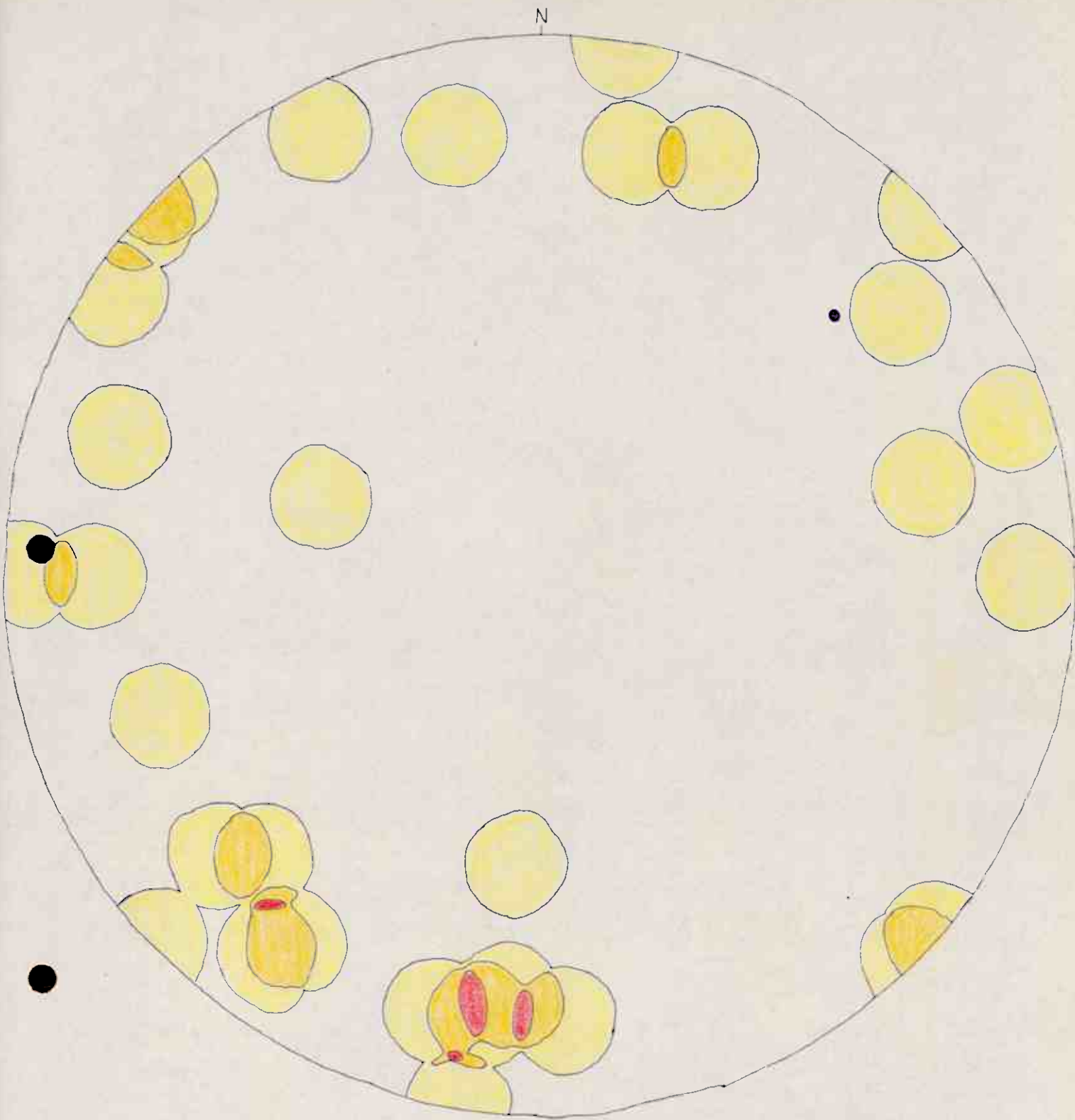
x minor fold.



Map unit E7. Poles to foliation planes.

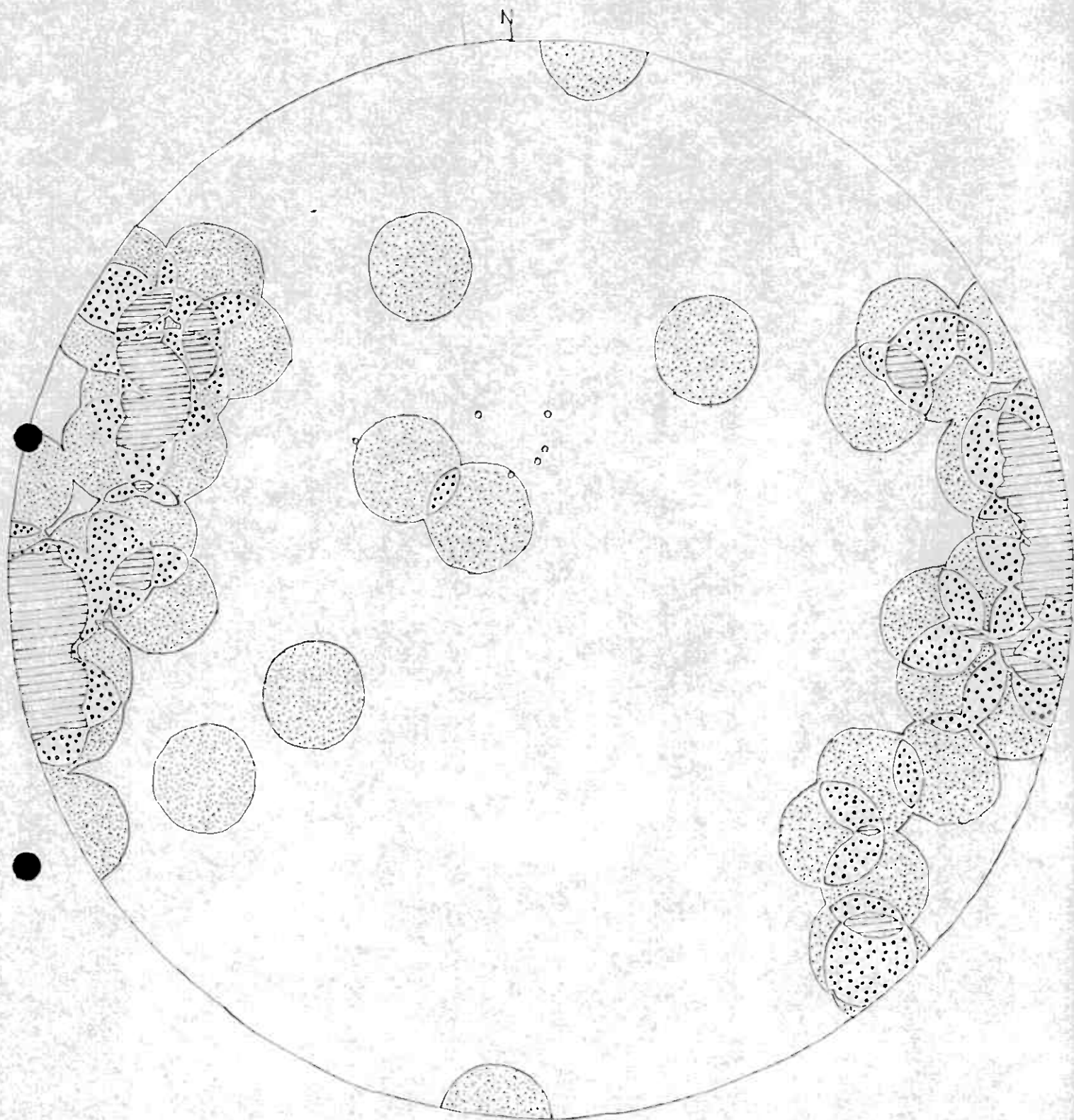
Schmidt net upper hemisphere.

Contours 1,2,3,4 points per 1% area. (after Nelli) Total points 24.



Poles to foliation planes in gabbro from the Central Iceland area around Melland-Friksted-Li.

Contours 1,2,3 points per 1% area. (after Melli) Total points 20.

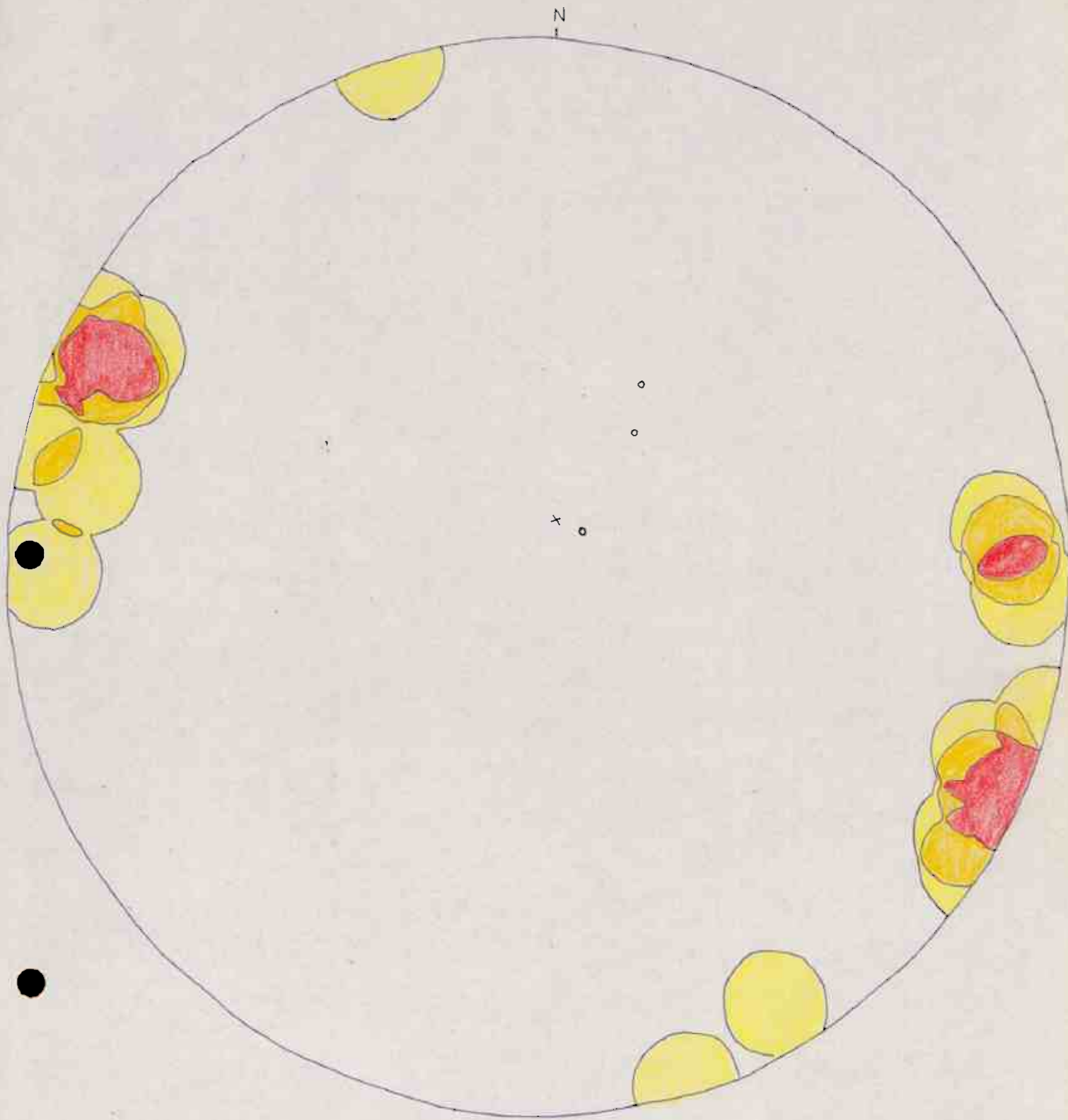


Map unit F11. Poles to foliation planes. (50 points)

Schmidt net upper hemisphere.

Contours 1,2,3 points per 1% area. (after Melli)

• lineation.



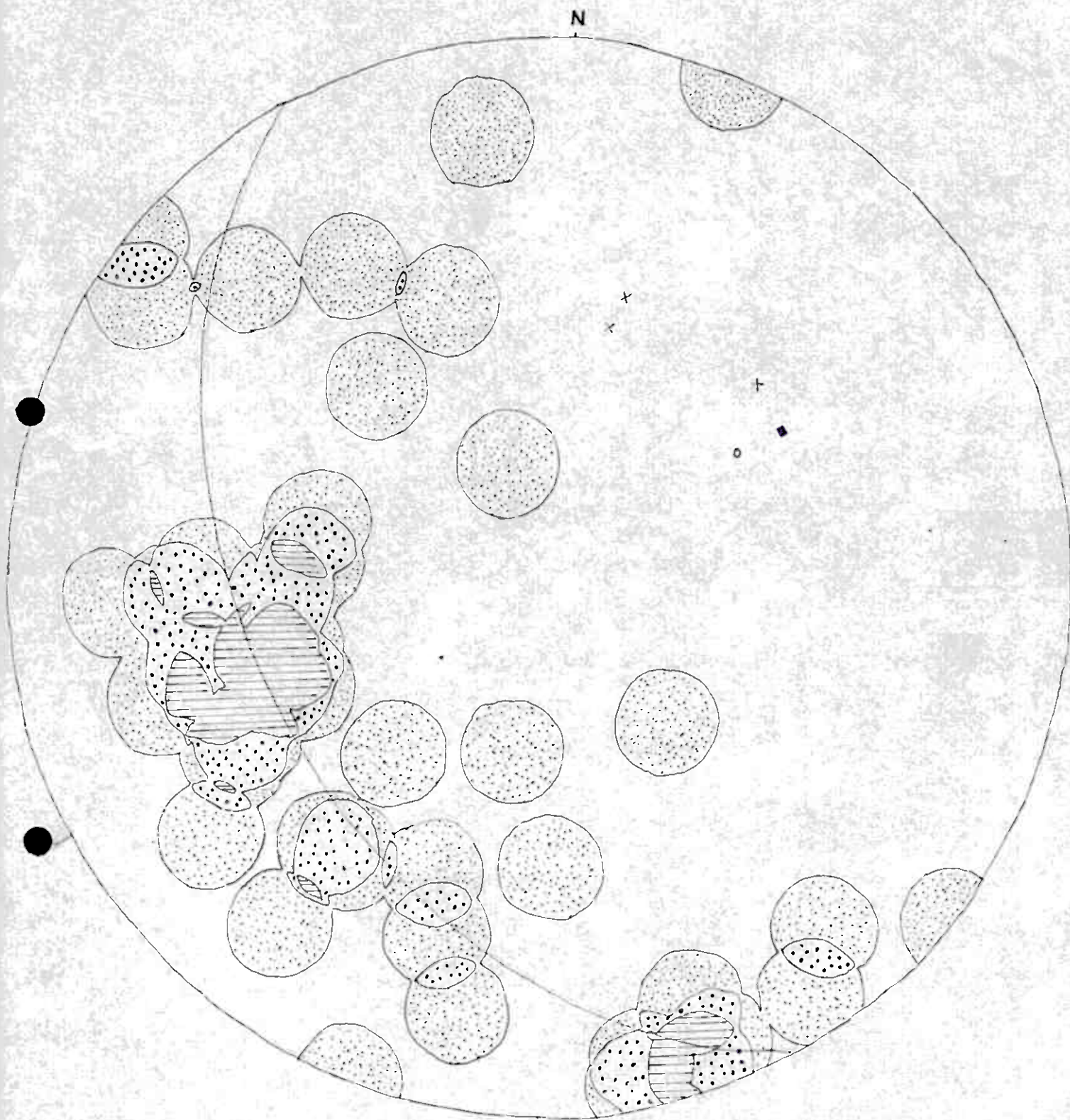
Map unit D10. Poles to foliation planes.

Schmidt net upper hemisphere.

Contours 1,2,3 points per 1% area.(after Melli) Total points 18.

x minor fold.

o lineation.



Map unit E9. Poles to foliation planes. (41 points)

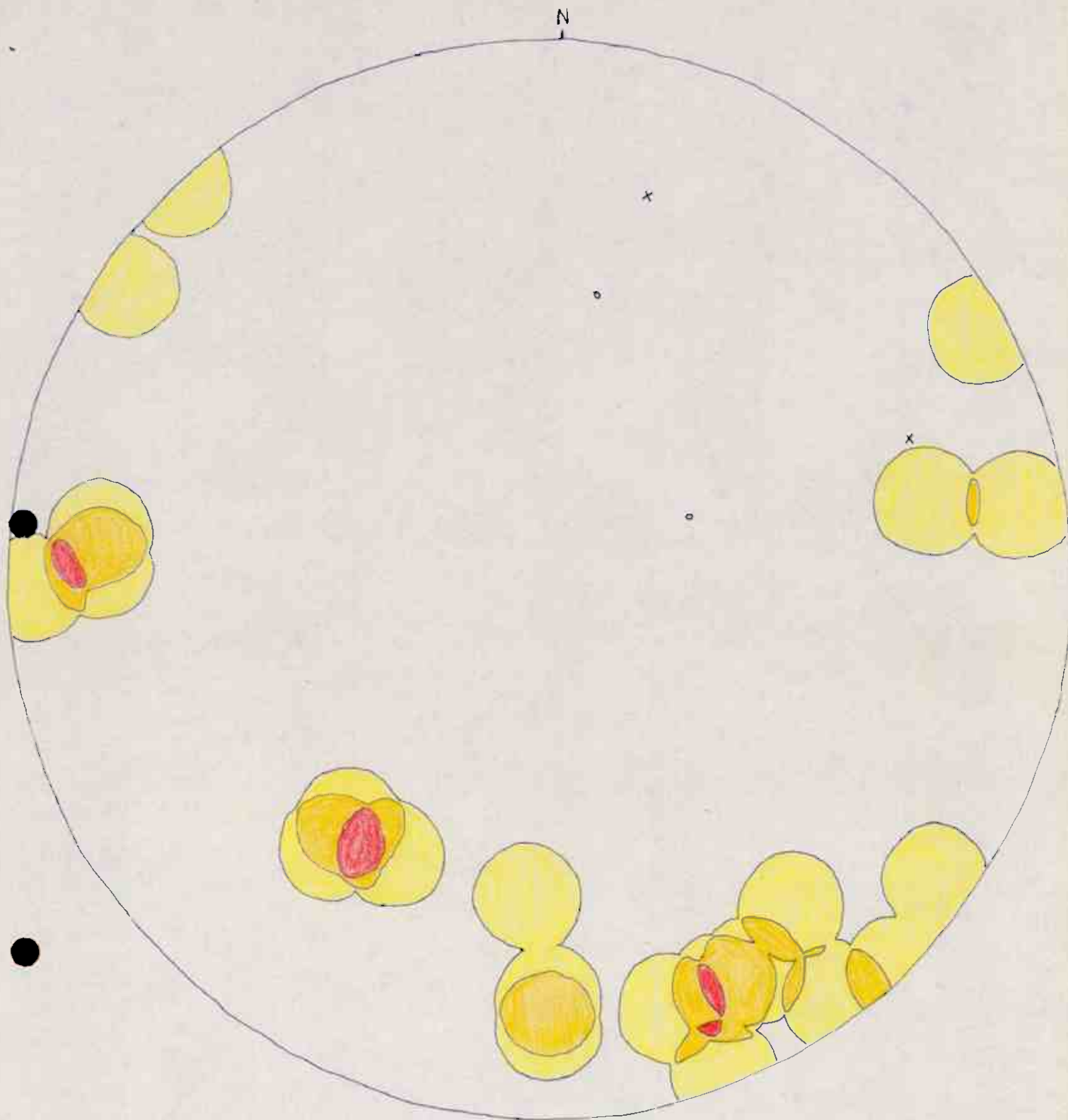
Schmidt net upper hemisphere.

Contours 1,2,3 points per 1% area. (after Melli)

x minor fold

o lineation

■ girdle axis



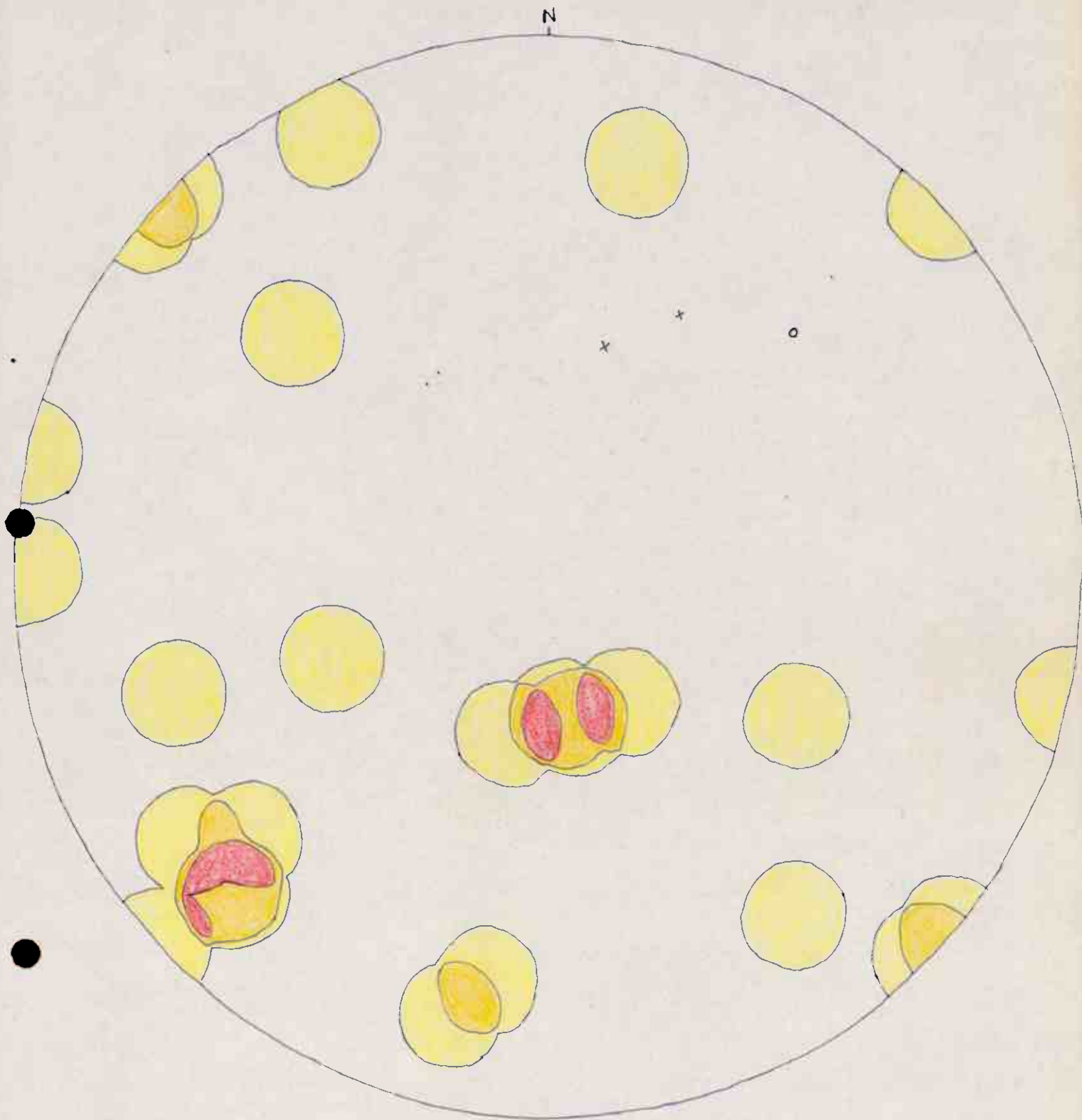
Map unit E10. Poles to foliation planes.

Schmidt net upper hemisphere.

Contours 1,2,3 points per 1% area.(after Melli) Total points 20.

x minor fold.

o lineation.



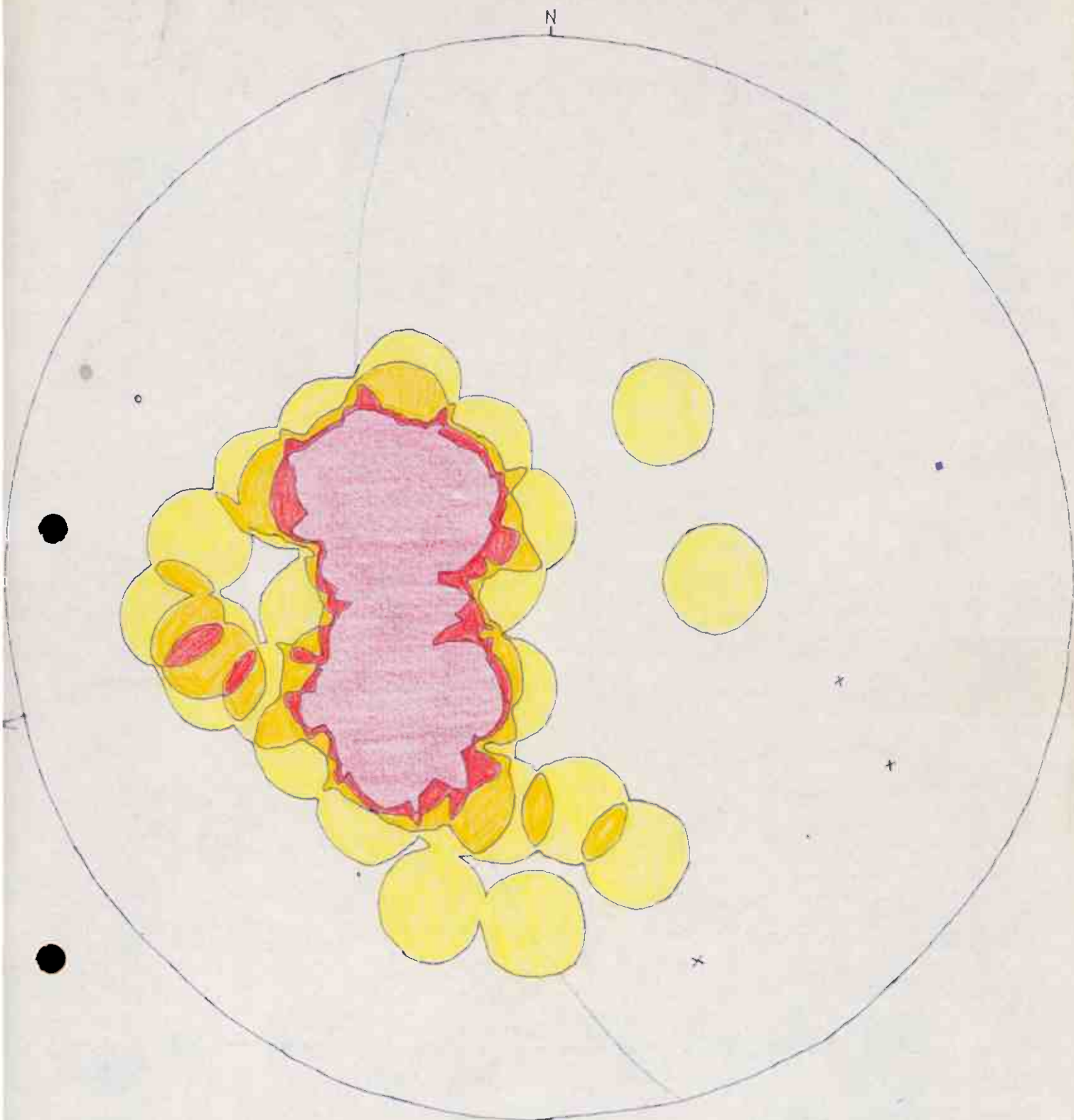
Map unit F10. Poles to foliation planes.

Schmidt net upper hemisphere.

Contours 1,2,3 points per 1% area. (after Melli) 23 points.

x minor fold.

o lineation.



Map units F7, F8, G6, G7, G8, H5, H6, H7, H8.

Poles to foliation planes. (86 points)

Schmidt net upper hemisphere.

Contours 1, 2, 3, 4 points per 1% area. (after Melli).

x minor fold

o lineation

■ girdle axis