BLOQUE DIAGRAMA ESQUEMATICO DE LA ESTRUCTURA DEL YACIMIENTO DE BAMA

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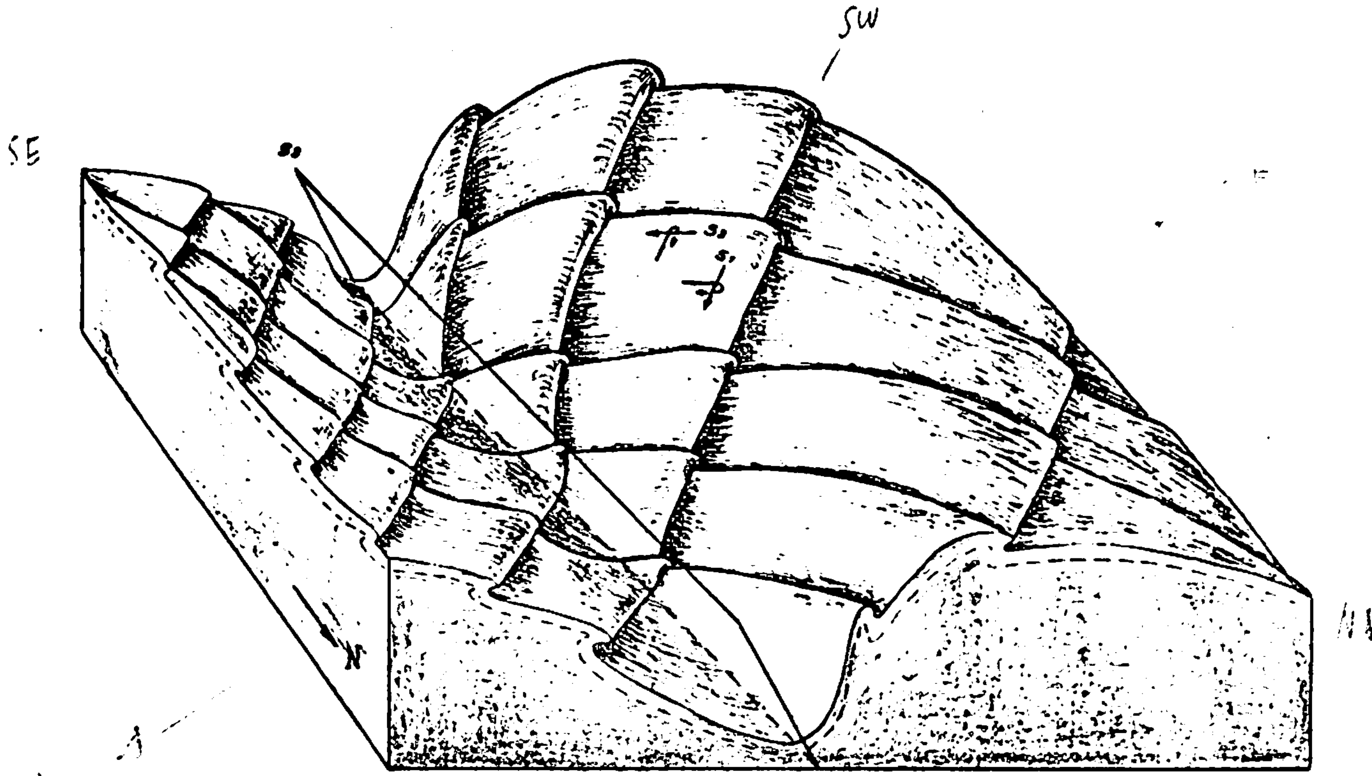

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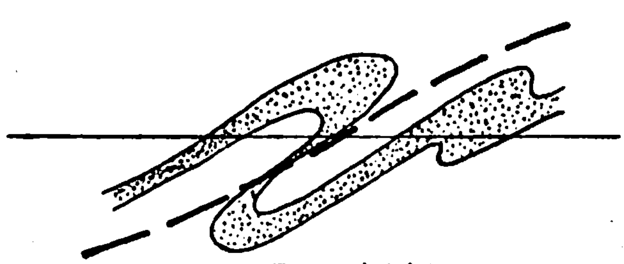
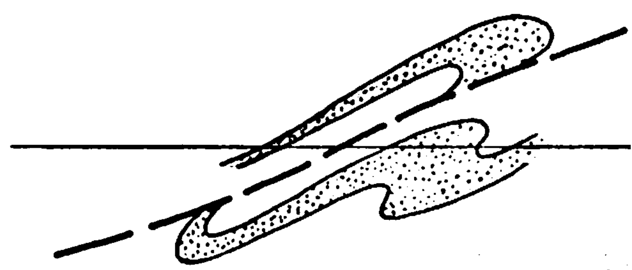


Etapa inicial



Etapa final

FORMACION DE LOS PLIEGUES-FALLA (ESCAMAS)

Description of samples from core no. 40 from Arinteiro, prov. La Coruña.

Abstract.

The core contains above the ore-bearing zone rather homogeneous amphibolites with some concordant or accordant segregation veins; below the ore-bearing zone occurs a sequence of about 6 m. containing amphibolites and gneisses with discordant, hydrothermal ore-bearing veins and sporadically with concordant quartz veins; this sequence is followed downwards by garnet--kyanite-staurolite gneisses with regularly interspersed, concordant quartz veins.

The gneisses have probably a horizontal schistosity; the amphibolites are steeper inclined, probably up to 50°. Folding is observed only in the amphibolites. A distinct (blasto-)mylonitic structure occurs in a large part of the samples.

From the mineral associations in amphibolites and gneisses it is concluded, that these rocks passed through a high-grade metamorphism, belonging to an ante-Hercynian orogenic cycle, and that a Hercynian metamorphic retrogradation has only partly destroyed the former high-grade mineral association and structures.

This implies, that the oldest structures present, to wit blastomylonitic structures, and probably also a susequent coarser blastesis belong to an ante-Hercynian orogeny.

Introduction.

The core contains:

Down to 1.2 m. soil and strongly altered amphibolites;

1.2 - 18.0 m. rather homogeneous amphibolites with usually concordant segregation veins;

18.0 - 33.5 m. ore-bearing zone, not sampled;

33.5 - 39.5 m. a variable sequence of amphibolites, amphibole-garnet gneisses, garnet-biotite gneisses, concordant segregation veins and discordant ore-bearing veins;

39.5 - m. garnet-kyanite-staurolite gneisses with concordant quartz veins.

Sample numbers, mentioned further on, correspond to the depth in cm., where the sample has been taken.

The schistosities of amphibolites above the ore-bearing zone make an angle

of 40°- 60° with the axis of the core; an exception is found in sample 1350 where this angle is 80°. The schistosity of the amphibolite sequence below the ore-bearing zone has more variable angles, 40°- 75° with the core axis. The garnet-kyanite-staurolite gneisses have schistosities about normal to the core axis, 80°-90°.
Meso-scale folding is present in the samples 450 (open fold (?)), 3680 (shear fold) and 3740 (isoclinal fold (?)).
The examined samples will be discussed in three groups: the amphibolites above the ore-bearing zone, the amphibolite sequence below that zone and the garnet-kyanite-staurolite gneisses. The modal compositions are found in the tables 1, 2 and 3; every modal analysis has been calculated from 800 counted points and the values have been rounded off at a half percent; for sample 3740"vein" only 300 points have been counted and the rounded-off value here is one percent. Where two thin sections have been made from a same sample, the "A" is from the upper part and the "B" is from the lower part of the sample.

Amphibolites above the ore-bearing zone.

These amphibolites are fine-grained to microcrystalline, only sample 760 is slightly coarser than 1 mm. (see fig. 2, 4, 6, 7 and 8); the rocks are often inequigranular due to the presence of phenoclasts or phenoblasts of amphibole, plagioclase, garnet and/or epidote (samples 540, 640, 750, 850, 880, 1500, 1630 and 1650; see fig. 10, 11 and 12). The sequence is rather homogeneous and only interrupted by concordant or accordant, often irregular segregation veins; this homogeneity can be appreciated in table 1; sample 760B in this table represents approximately the composition of a segregation vein. Banding on a macroscopical scale is not obvious. In some thin sections an indistinct banding is due to a depletion of plagioclase beneath a segregation vein; this basification is directly obvious in thin section 540 (see fig. 1) and it is demonstrated by the modal compositions of 640A, taken above a segregation vein, and of 640B, from below this vein.
Discordant veins, although seldom absent, are inconspicuous due to their narrowness; they contain some of the following minerals: greyish-or bluish-green amphibole, epidote-zoisite, chlorite, titanite, carbonate and opaque material; this mineral association is almost comparable to that found in the segregation veins.

Folding on microscale is present in several thin sections; the types of folds are divided in an older group and a younger group, although the mutual relations between the fold types are not disclosed. Isoclinal similar folds with an axial plane parallel to the major schistosity belong to the older group; such folds are usually present in fragmentary form and often their presence can only be guessed, as in the case of the form and distribution of aggregates of opaque minerals and titanite in the samples 540 and 1100 (see fig. 2). A probable fold-hinge occurs in an aggregate of plagioclase grains (640B, see fig. 5), wherein the alignment of amphibole grains follows the form of the hinge. More distinct folds are present in sample 760B (see fig. 8), wherein a post-tectonic recrystallisation of amphibole, plagioclase, titanite and opaque minerals follows the trend of an older isoclinal fold. It seems likely that these folds are shear folds, that have been fromed during a phase of extensive tectonic movement. The younger types of folds are more obvious, because they fold the major schistosity; this group includes:

- flexures in the samples 880 and 1350;
- crenulations in the samples 745, 880 (see fig. 9) and 1100;
- similar S-folds, that are perhaps a further development of flexures, in sample 640 (see fig. 3 and 4).

A second cleavage or schistosity is scarcely developed by these younger folds.

The general structure of these amphibolites is due to (blasto-)mylonitisation; a more pronounced recrystallisation is obvious in the samples 745, 750, 760 and 850 p.p.; larger amphiboles in those last samples show however signs of a younger cataclasic deformation (see fig. 6 and 7).

Amphibole, the main constituent of these rocks, is always xenomorphic; several types can be distinguished on their γ-colours. The probably oldest amphibole present has a brownish-green colour and it occurs a.o. as phenoclasts with a blastic overgrowth of green or bluish-green amphibole in samples 540, 640 and 880. A younger type with a greyish-green colour is the major constituent of coarser recrystallised samples 745, 750, 760 and 850 p.p., but it occurs also in samples 880, 1100, 1350 and 1630; this type has often an overgrowth of bluish-green amphibole.

The bluish-green amphibole is the youngest type and it occurs in all samples. These greyish- and bluish-green amphiboles are present in the segregation veins. A rather light-coloured amphibole occurs sometimes as a core of larger amphiboles in the amples 540, 640, 1100, 1350, 1630 and 1650.

Plagioclase is xenomorphic and has generally an anorthite content of 25 - 30 %; scarce phenoclasts are replaced by saussurite or epidote-zoisite or they have recrystallised into a mosaic of samll grains. During recrystallisation in the greyish-green amphibole stage plagioclase blastesis is more albite-rich, 20 - 25 % An., whereby zoned crystals are produced; such zoned crystals are also present in segregation veins (see fig. 7).
Epidote-zoisite is present as saussurite and as crystalloblasts; the latter especially in veins. There is a distinct increase in quantity of this mineral group in amphibolites, going towards the ore-bearing zone. In the samples 1630 and 1650 epidote occurs as phenoblasts (see fig. 10).
Garnet is scarcely present in amphibolites 750, 850, 1350, 1500, 1630 and 1650, and in veins of the samples 760 and 1350. Garnet is xenomorphic, with the exception of those in samples 1630 and 1650, wherein it occurs as partly idiomorphic phenoblasts. Garnet looks more stable in veins than in amphibolites, again with the exception of the samples 1630 and 1650; in these two samples it shows a more stable overgrowth around a probably instable core. This leads to the conclusion of the presence of two generations of garnet: an older type, that has a sieve texture largely due to the dispersed presence of alteration products clinozoisite, amphibole and titanite, and that probably belongs to a high-grade mineral association with brownish-green amphibole, and a younger type that is syngenetic or slightly younger than the greyish-green amphibole (see fig. 12), and that probably belongs to the phase of ore concentration, on evidence found in sample 3450 from below the ore-bearing zone. The figures 11 and 12 give an idea about the difference and the relation of the two types of garnet. The neocrystallisation of garnet can explain the slight increase in the garnet content of amphibolites towards the ore-bearing zone.
Titanite occurs generally in submicroscopic, xenomorphic grains, that are often assembled in aggregates, sometimes with a core of opaque minerals; larger xenomorphic grains occur in some well crystallised amphibolites and in segregation veins.
Sulfide ore is present in small quantities in samples 640, 745, 750, 850 and 880; opaque minerals are present in all samples. Rutile seems to be absent. Carbonate occurs generally in veins, sometimes together with opaque minerals. Chlorite is a minor constituent and the same ap-

plies to a phyllosilicate with a higher birefrigence and a brownish-green or green colour (saponite (?)), that occurs associated with opaque minerals and sometimes in garnet (sample 1630); small quantities of biotite are present in sample 640A.

The amphibolite sequence below the ore-bearing zone.

This sequence is much more variable in composition and structure and can not be described as a whole.
Sample 3450 belongs apparently to the ore-bearing zone, in regard of its content of sulfide ore. This rock has the composition of an amphibole-garnet gneiss or skarn; there seems to be an associative relation of opaque minerals, garnet and quartz. The high quantity of quartz is partly due to concordant dilatation veins of coarse-grained quartz, similar to those observed in garnet-kyanite-staurolite gneisses, that occur lower in the core. Another similarity is the planar structure with a distinct linear element present in both gneiss types.
This amphibole gneiss is fine-grained and inequigranular due to partly idiomorphic phenoblasts of garnet reaching a size of 3mm.; the rock has a far better developed recrystallised structure than the amphibolites mentioned earlier and an incomplete metamorphic banding has been developed on a microscale. The partly discordant Si-patterns in garnet- a rotation of garnet made visible by aligned inclusions in garnet- and the fabric of amphibole and biotite-chlorite- -abutting bluntly against garnet (see fig. 13)- suggest a paracrystalline deformation; the "eyed" structure around garnet phenoblasts and the cataclastic textures in amphibole, biotite-chlorite and quartz indicate a younger tectonic phase of flattening.
Discordant veins are absent.
The constituent minerals are: quartz; plagioclase, that is inversely zoned with 25 - 35 % An.; a light greyish-green amphibole; garnet with cores that are more dirty than the rims; epidote-zoisite; biotite that has been altered largely to chlorite; opaque minerals (sulfides); rutile and no titanite; apatite.

The samples 3500, 3580 and 3680 are quite different from sample 3450. According to their structures they belong to a zone of intense tectonic movement; the samples 3500 and 3580 show tectonic flow structures, but also distinct indications of syn- and post-tectonic recrystallisation under amphibolite-facies conditions; in sample 3500 and to a lesser degree in sample 3580, cataclastic structures and diaphthoresis indicate a younger cataclastic phase. Sample 3680 is a mylonite with no clear indications of recrystallisation.
These phenomena make it likely, that there have been at least two distinct phases of intense tectonic movement; one phase proceeded during a high-grade metamorphic stage and affected a rather large sequence of rocks -see also the garnet -kyanite-staurolite gneisses- ; a second phase proceeded after a period of extensive recrystallisation and was probably more confined to thin horizons.

Sample 3500 is a fine-grained, distinctly inequigranular gneiss, with xenomorphic phenoblasts of garnet, that reach a size of 5mm. During and after the first deformation it recrystallised to a quartz-poor, biotite-garnet gneiss, that contained a small quantity of greyish-green amphibole; after the second deformation it changed to a chlorite gneiss with unstable remnants of garnet.
The consituent minerals are: quartz; plagioclase with 10 - 15 % An. and sparsely filled with alteration products; chlorite occurs as an alteration product of biotite and as a neocrystallised mineral; garnet with sigmoid aligned inclusions; remnants of biotite; rutile; opaque minerals; apatite.
The gneiss is dissected by veins containing opaque minerals (sulfide), carbonate, chlorite, quarts, albite and a zeolite; the presence of a zeolite, probably laumontite, seems rather queer.

Sample 3580 is a fine-grained, distinctly inequigranular amphibolite with partly idiomorphic phenoblasts of garnet up to a size of 4mm. (see fig. 14). The recrystallised tectonic flow structure with rotated garnets, defined by their sigmoid Si-patterns, is similar to the structure observed in sample 3500.
The discordant ore-bearing veins look similar to those in sample 3500 and have introduced a saponite-like mineral in the amphibolite; zeolite seems to be absent.

The consistuent minerals are: quartz; plagioclase with 15 - 25 % An.; a light greyish-green amphibole; garnet with sigmoid aligned inclusions; epidote-zoiste, partly as an alteration product of garnet; saponite (?); rutile and titanite; opaque minerals; apatite.
The veins contain opaque minerals (sulfides), carbonate, chlorite, saponite (?), epidote-zoisite, quartz and probably albite.

Sample 3680 is a fine-grained to microcrystalline, inequigranular, mylonitic amphibolite with small phenoclasts of plagioclase and amphibole. Shear folds are distinct in the thin section (see fig. 15). The constituent minerals are: plagioclase, greyish-green amphibole, chlorite, saussurite, sericite, titanite, opaque minerals and apatite.
The amphibolite is dissected by various types of veins; concordant veins of quartz with mortar structure are probably the same type of vein as those occuring in sample 3450, but here tey have been affected by a later deformation; accordant dilatation veins developed as an after-effect of the mylonitisation and these veins contain quartz, chlorite, epidote and adularia; a small discordant vein contains carbonate, chlorite, saponite and opaque minerals.

The samples 3740, 3760 and 3850 are almost similar to the more recrystallised amphibolites occurring above the ore-bearing zone. These amphibolites are also fine-grained to microcrystalline and slightly inequigranular, but they show a more developed recrystallisation especially in their segregation veins. In such a vein (sample 3740, see fig. 16), that has probably been folded before the recrysallisation, plagioclase developed a mosaic structure and phenoblasts, accompanied by needles of bluis-green amphibole, while garnet probably became instable; a younger tectonic phase has deformed some plagioclase crystals. The composition of this vein is given in Table 2; biotite is only present in the vein and has been formed at the expense of opaque minerals and probably before the formation of phenoblasts of plagioclase; the other minerals are the same as those occurring in the neighbouring amphibolites. Amphibole in these rocks is greyish-green, sometimes with bluish-green rims; plagioclase has an anorthite percentage of 25 - 30 and is sometimes zoned and elsewhere slightly altered; garnet, xenomorphic, has a sieve structure and looks instable even in veins; titanite occurs often in xenomorphic recrystallised grains and rutile is absent.

Next to the segregation veins occur other veins, both discordant and concordant, with opaque minerals, carbonate, quartz, plagioclase, adularia, chlorite, epidote and prehnite (in sample 3760).

Garnet-kyanite-staurolite gneisses.

The lower part of the core contains gneisses; sample 4190 is a diaphthoritic gneiss, wherein kyanite and staurolite have been fully destroyed, but remnants of garnet and biotite still occur. The other samples contain both garnet and kyanite; staurolite is irregularly distributed and only present in thin sections of the samples 4000, 4130 and 4250.
The more conspicuous properties of the gneisses are:

an incoherence of the gneissose structure due to frequent, concordant veins and lenses of coarse quartz, that are sometimes ½ cm. wide;

a textural contrast between the distinctly cataclastic structures of clusters and streaks containing kyanite, and the non-cataclastic structure in the surrounding recrystallised part of the gneiss (see fig. 17);

irregular, discordant veins with carbonate, adularia and quartz.

The gneisses are inequigranular and contain phenoblasts of garnet and staurolite up to 2½ mm. and clusters of medium-grained muscovite in a fine-grained groundmass. The gneisses are inhomogeneous on the scale of a thin section due to the above mentioned veins and lenses of quartz and to streaks with kyanite, micas and staurolite.
Folding is absent, except for fold-like shear structures of the streaks containing kyanite.

Staurolite occurs as xenomorphic grains often with straight rows of opaque inclusions (see fig. 18), that are sometimes discordant to the foliation. The grains are embedded in clusters of kyanite and although kyanite shows often textures of a strong deformation, the staurolite looks undisturbed. The increase of opaque material and the continuation of the above mentioned rows of opaque inclusions in the clusters of kyanite give the impression that staurolite has been replaced by kyanite.
Kyanite is largely xenomorphic and occurs in clusters of more or less randomly oriented grains and in streaks with strongly aligned grains;

A large part of the grains are bent and broken. Small hypidiomorphic crystals often in random orientation -and as such enclosed in garnet- make it probable, that kyanite occurs in two generations, pre- and post-tectonic. Kyanite is replaced by garnet, by muscovite and perhaps also by biotite.

Garnet occurs in xenomorphic and hypidiomorphic porphyroblasts; it encloses opaque minerals, rutile and tourmaline, often in sigmoidal patterns, and kyanite needles, both in sigmoidal and more random patterns. These inclusion patterns in garnet give some indications in regard to the history of the gneisses; there are S_i-patterns discordant to the external schistosity (see fig. 20) in a similar way as found for staurolite, indicating the presence of garnet before the mylonitic phase; other S_i-patterns are concordant with the mylonitic structures of kyanite (see fig 17 and 19) indicating a second generation of garnet, that sometimes formed as a rim on an older core. Although kyanite has been a stable phase during a part of the post-tectonic recrystallisation of garnet, there are clear indications that garnet has replaced kyanite and also biotite during its recrystallisation. During the decline of metamorphism garnet has been replaced on a minor scale to biotite and more intensely to chlorite in the diaphthoritic rock (4190).

The micas are seldom deformed, even in sample 4190, and had evidently every opportunity for a posttectonic recrystallisation under less stress induced circumstances, because a part of the micas show a non-oriented growth pattern. Muscovite has replaced a part of kyanite grains.

Chlorite is an important component in sample 4190.

Plagioclase with 20 - 25 % An, quartz and biotite constitute the fine-grained groundmass of the gneisses.

Accessory minerals are: xenomorphic apatite, xenomorphic zircon, hypidiomorphic, zoned, bluish-green tourmaline, rutile (sometimes idiomorphic) and opaqe material.

The gneisses show a distinct lineation in the plane of foliation.

Conclusions.

The mylonitic structures in amphibolites and gneisses, and the difference in the dip of the schistosity between gneisses and amphibolite, make it unlikely that there should be a normal stratification, that has been folded on a macroscale.
It is evident that these amphibolites and gneisses have been affected by a strong mylonitisation under high-grade conditions and by a subsequent recrystallisation under amphibolite-facies conditions. Arguments for an ante-Hercynic alter of this orogeny with an inter-mediate to high pressure metamorphismcan be found in the theses of Vogel (1967) and van Zuuren (1969).
There is also evidence for a younger mylonitic phase, that affected more confined horizons.
The first mylonitisation fits the F2 folding phase of the deformation scheme of van Zuuren. The second mylonitic phase is less easily placed in this scheme, but it belongs probably to the aftermath of the Hercynian orogeny. It is possible that between these mylonitic phases a phase with large scale folding on subhorizontal axial planes took place, but sofar we have found no evidence for this in Western Galicia. According to me it is more likely that the sequence in this core is an imbricate structure due to overthrust wedges.
It is likely that the major ore concentration took place during the metamorphic stage, that belongs to the above mentioned F2 phase of tectonic movement, but much younger remobilisations are not excluded on the evidence of the low-temperature veins occurring in sample 3500.

References.

Vogel, D.E., 1967. Petrology of an eclogite- and pyrigarnite-bearing polymetamorphic rock complex at Cabo Ortegal, NW Spain. Leidse Geol. Med., 40, pp. 121 - 213.
Zuuren, A. van, 1969. Structural petrology of an area near Santiago de Compostella, NW Spain. Leidse Geol. Med. 45, pp. 1 - 71.

Leiden (Holland), 24 november 1969.

Table 1: MINERAL CONTENT in volumetric percentages.

Sample no. (1)	540	640A	640B	745	750	760B	850B	880A	1100
Minerals									
Quartz							+		+
Plagioclase	23	14	5	31½	32½	40½	25½	16½	22½
Amphibole	61½	73	78½	57½	56½	24½	62	71	64
Epidote-zoisite	3½	2	2	2	+	20½	2½	1	2½
chlorite (2)	+	+	+	+	+	5	+		1
Garnet					+	+	+		
Titanite	8½	5	11	7	6	4	5	6½	5
Opaque material	3	6	3	2	4	5	4½	5	5
Biotite		+							
Apatite	+	+	+		+	+	+	+	+
Zircon				+					
Carbonate					½	+	+	+	+

Sample no. (1)	1350B	1500	1630	1650A
Minerals				
Quartz	+	+		+
Plagioclase	24	19	19½	20
Amphibole	52½	57½	58½	54½
Epidote-zoisite	9	10	11½	14
Chlorite	2½		1	2
Garnet	1	+	1	1½
Titanite	7	10	6	4½
Opague material	3	3	2	2
Apatite	+		+	
Carbonate	1	½	+	1

(1) sample no. = depth in cm.

(2) chlorite and other phyllosilicates occurring as alteration products.

Table 2: MINERAL CONTENT in volumetric percentages.

Sample no. (1)	3450	3500	3580	3680	3740	3740 vein	3760	3850
Minerals								
Quartz	13	8½	4½	7½				3½
Plagioclase	20½	24½	13½	10½	36½	77	19	23
Amphibole	36	3	43½	52½	53	15	62	61
Epidote-zoisite	1		+	14	+	+	6	5
Prehnite							3	
Chlorite (2)	2½	46½	12	1½	+	+	1	+
Biotite	+	1½			+	+		+
Muscovite/sericite		½	½	1½				
Garnet	15	7	13	+	+	+		+
Rutile-titanite	1½	1	2	8	3½	+	5½	7
Opaque material	10½	5½	9½	3	6	4	2½	1
Apatite	+	+	+	+	+	1	1	+
Zircon	+							
Carbonate		2	1	1½	+	+	+	

(1) sample no. = depth in cm.

(2) chlorite and other phyllosilicates occurring as alteration products.

+ = mineral is present in a quantity smaller than ½ %.

Table 3: MINERAL CONTENT in volumetric percentages.

Sample no. (1)	4000	4060	4130	4190	4250
Minerals					
Quartz	22	21½	7	24	28
Plagioclase	27	26½	17½	37	31
Muscovite-sericite	17	22	23½	12	9½
Biotite	21	20	20½	1	21½
Chlorite		½	+	21½	
Garnet	4½	6	7	3½	6½
Kyanite	7	1	17½		1½
Staurolite	+		3½		+
Rutile	+	+	+	+	½
Opaque material	+	1	2½	1	1
Apatite	+	+	+	+	+
Tourmaline	+	+	+	+	+
Zircon	+	+	+	+	+
Carbonate		1		1	+

(1) sample no. = depth in cm.

+ = mineral is present in a quantity smaller than ½ %.

Fig. 1. Lower segregation vein in sample 540: 1 nicol, 50x; from left to right: amphibolite almost depleted of plagioclase;
vein containing plagioclase, amphibole, epidote-zoisite and opaque minerals;
amphibolite almost depleted of plagioclase and containing granular titanite and opaque minerals in aggregates;
normal amphibolite with plagioclase.

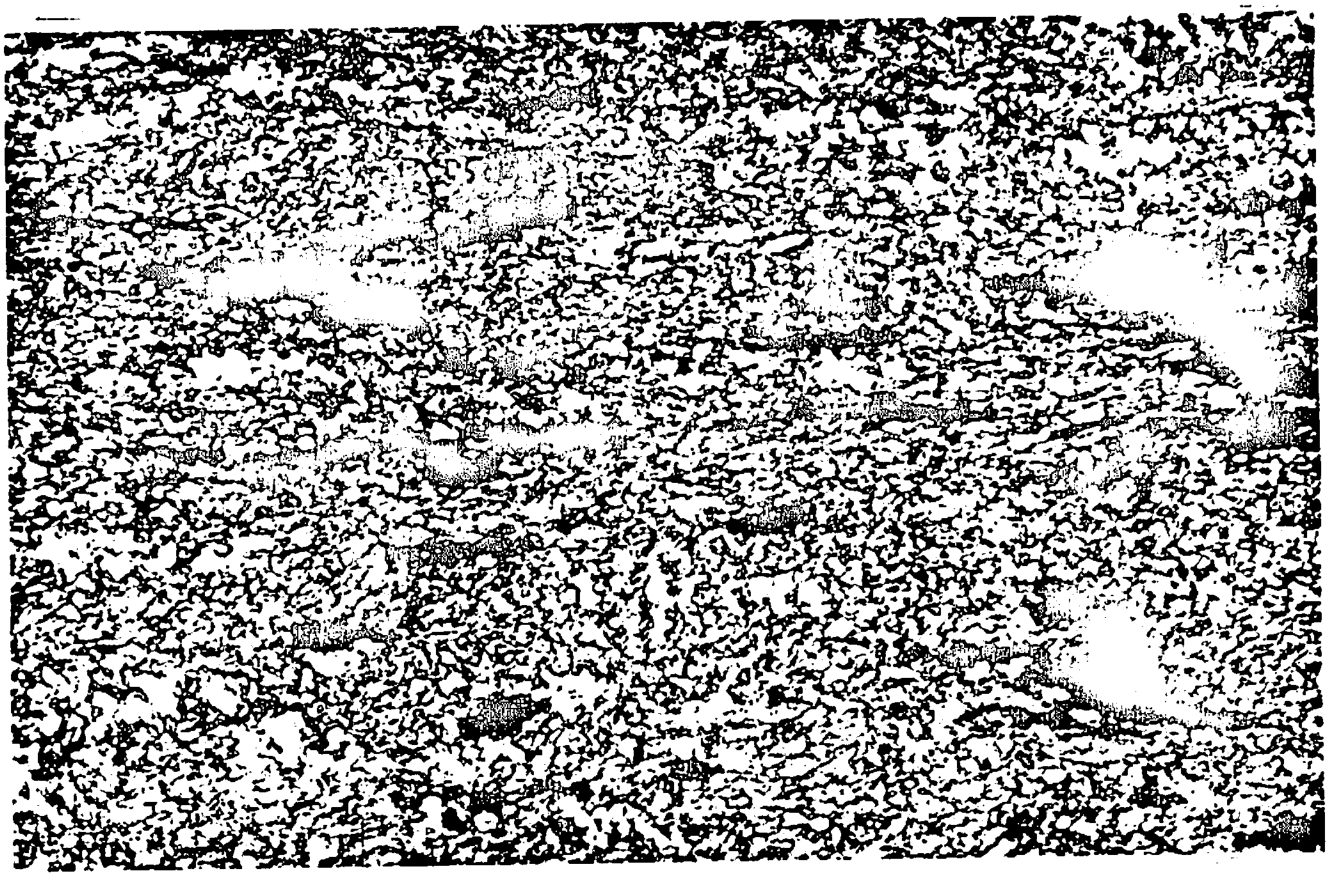


Fig. 2. Amphibolite of sample 540; 1 nicol, 50x; the form and distribution of aggregates of opaque minerals (core) and titanite (rim) suggest isoclinal microfolding.

Fig. 3. Similar S-fold in sample 640: 1 nicol, 50x.

Fig. 4. Flexure-fold in sample 640: 1 nicol, 50x; the axial planes of this fold and the fold of fig. 3 are approximately parallel.

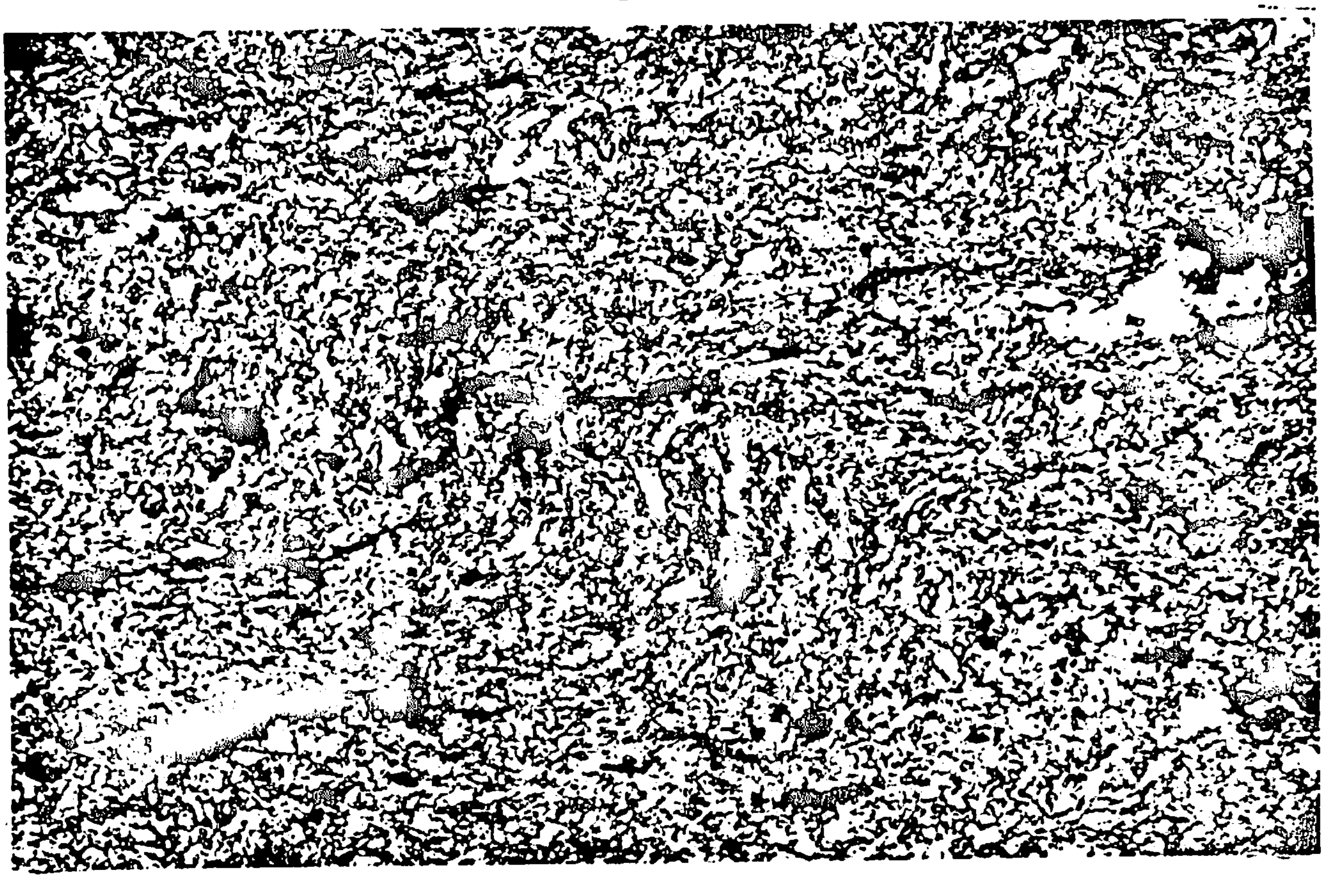


Fig. 5. A probable fold-hinge, closing to the left, in sample 640B: 1 nicol, 50x; this fold belongs to an older tectonic phase than the folds of fig. 3 and 4.

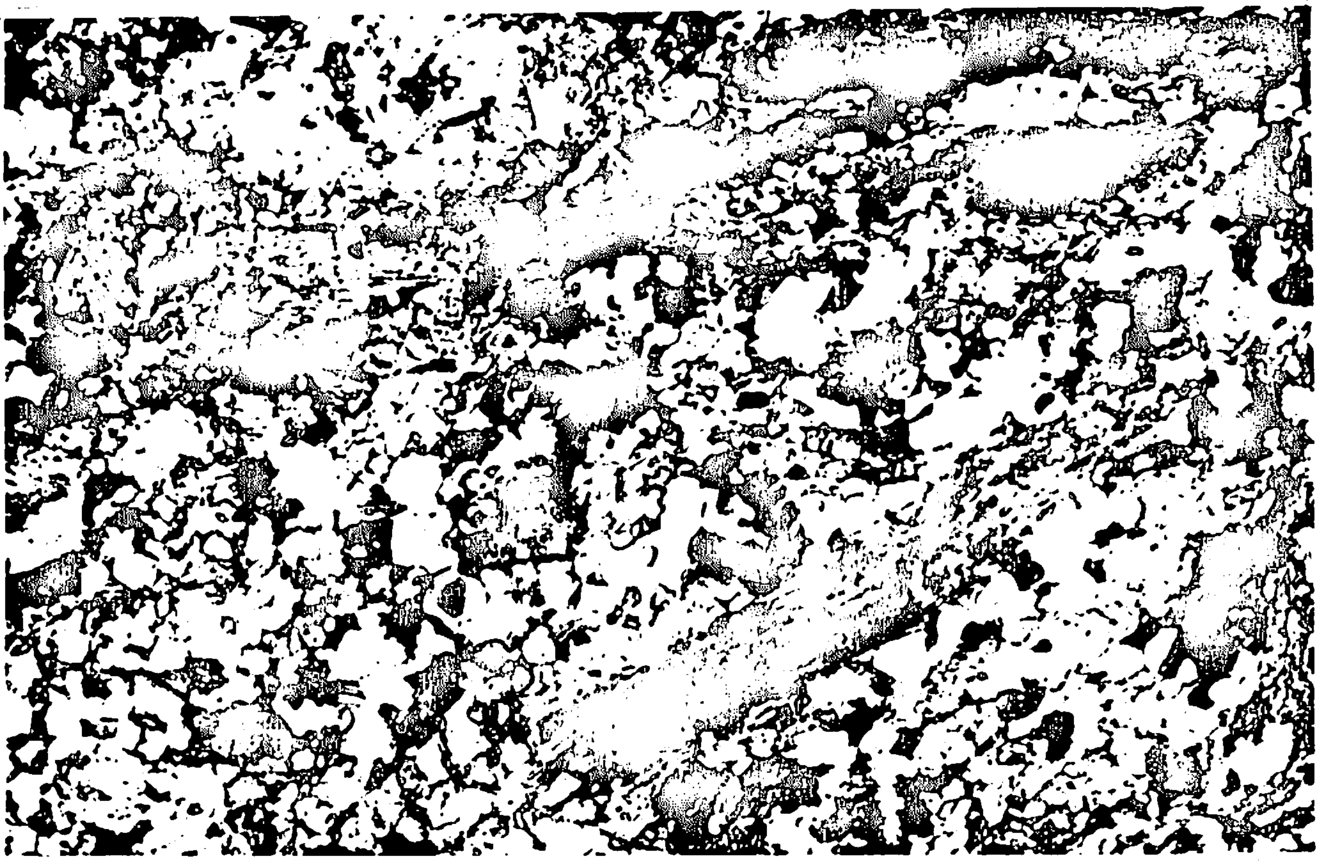


Fig. 6. Amphibolite of sample 750: x nicols, 50x; a recrystallised fabric of greyish-green amphibole and zoned plagioclase; a younger cataclastic deformation of amphibole is evident.

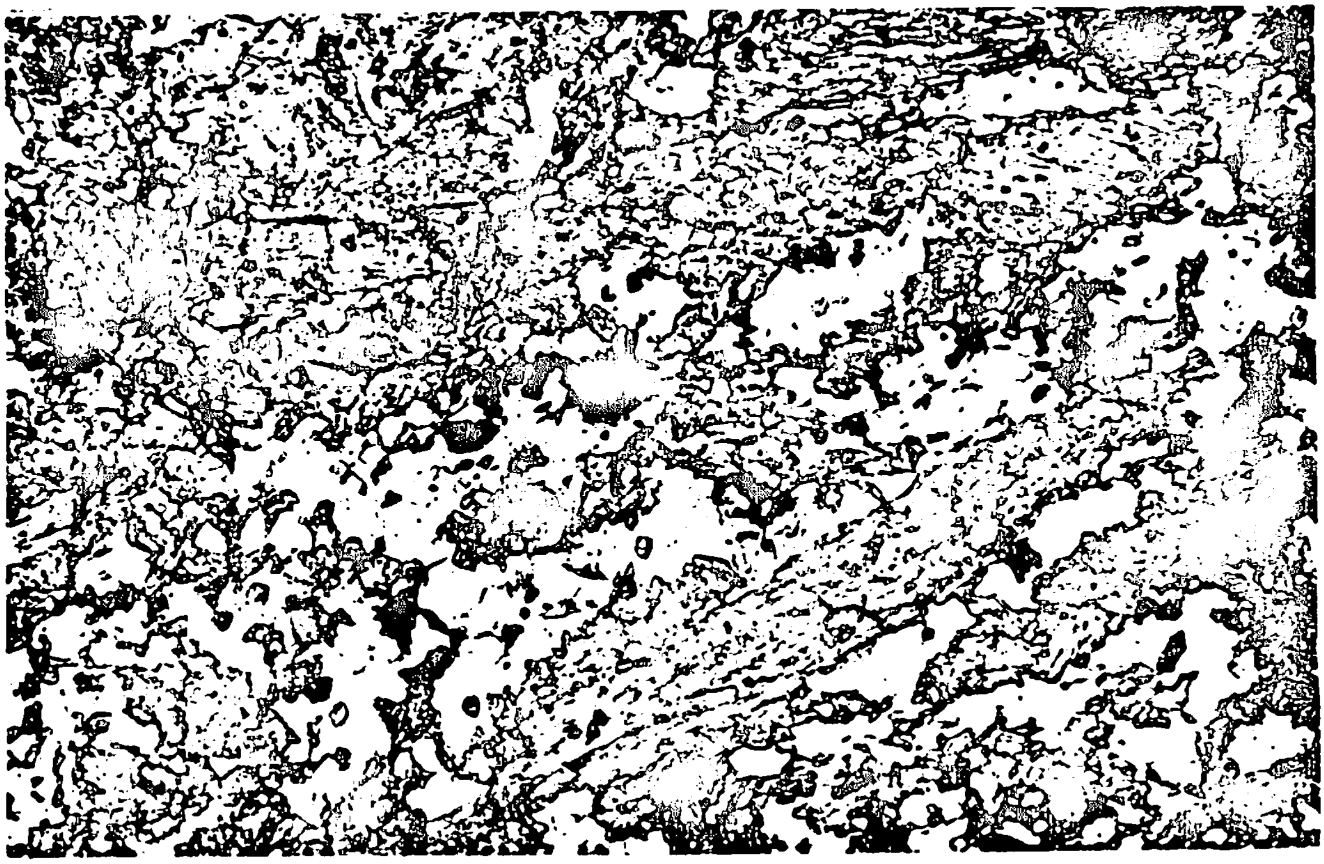
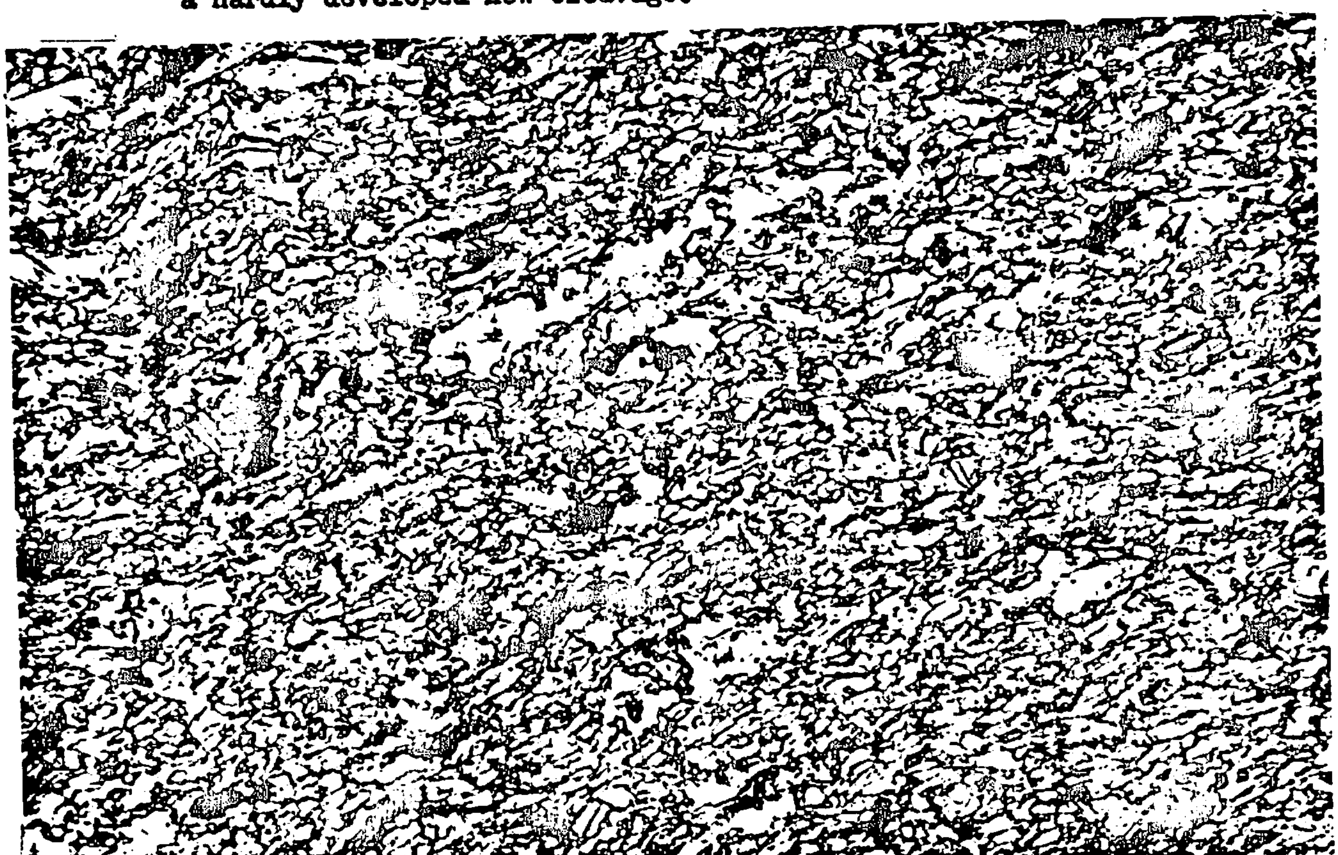


Fig. 7. The same as fig. 6, with 1 nicol.

Fig. 8. Isoclinal fold-hinge, closing to the left, in sample 760B: 1 nicol, 50x; the post-tectonic recrystallisation of greyish-green amphibole, plagioclase and titanite follows the pattern of an older fold.

Fig. 9. Amphibolite of sample 880A: 1 nicol, 50x; crenulation with a hardly developed new cleavage.



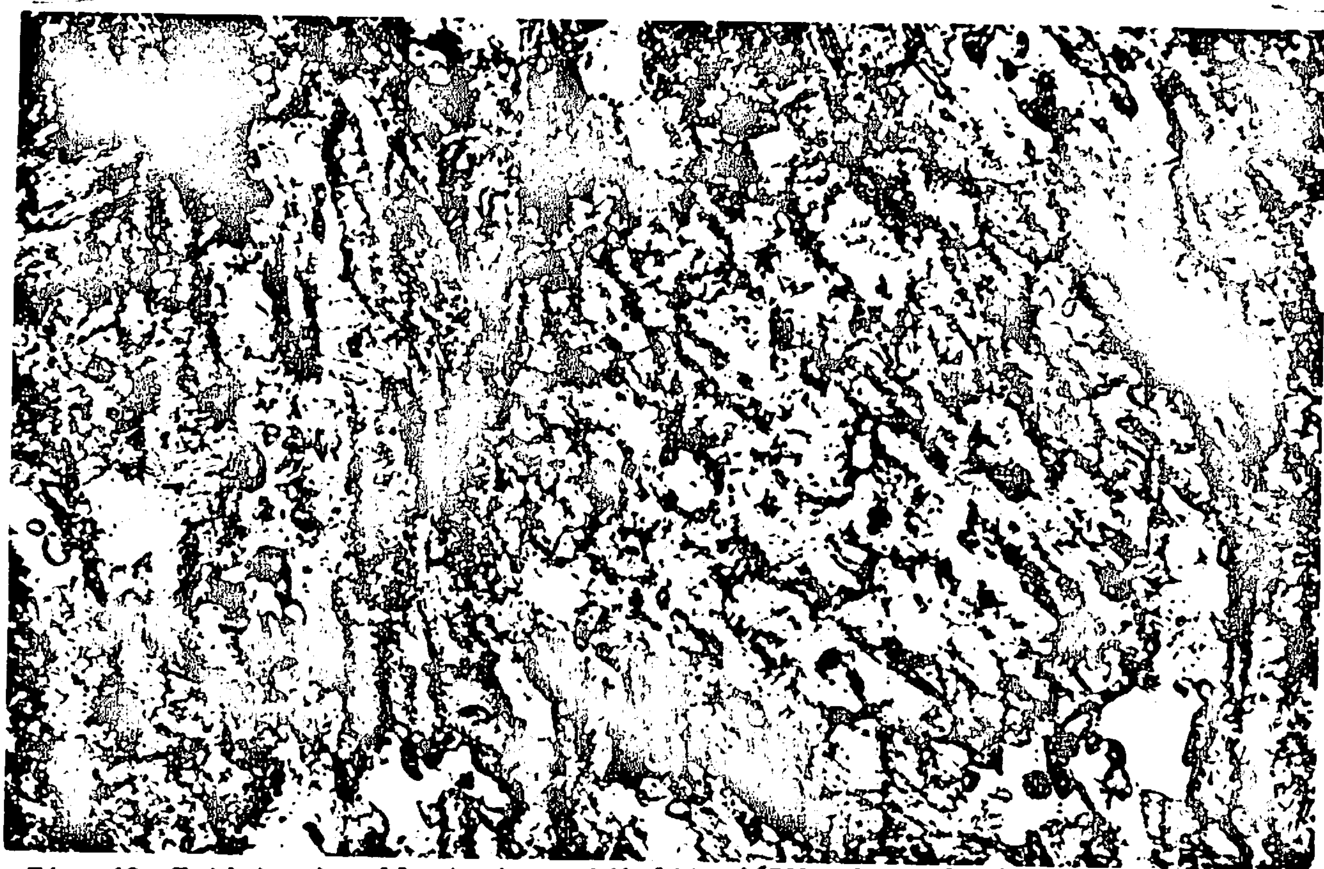


Fig. 10. Epidote phenoblasts in amphibolite 1650B: 1 nicol, 200x; the phenoblast has a discordant Si-pattern.

Fig. 11. Instable garnet phenoclast in amphibolite 1500: 1 nicol, 200x; garnet is replaced by amphibole, clinozoistite and titanite.

Fig. 12. Garnet phenoblast in amphibolite 1650B: 1 nicol, 200x; garnet has an instable, dirty core and an almost clean rim, that encloses partly a greyish-green amphibole.

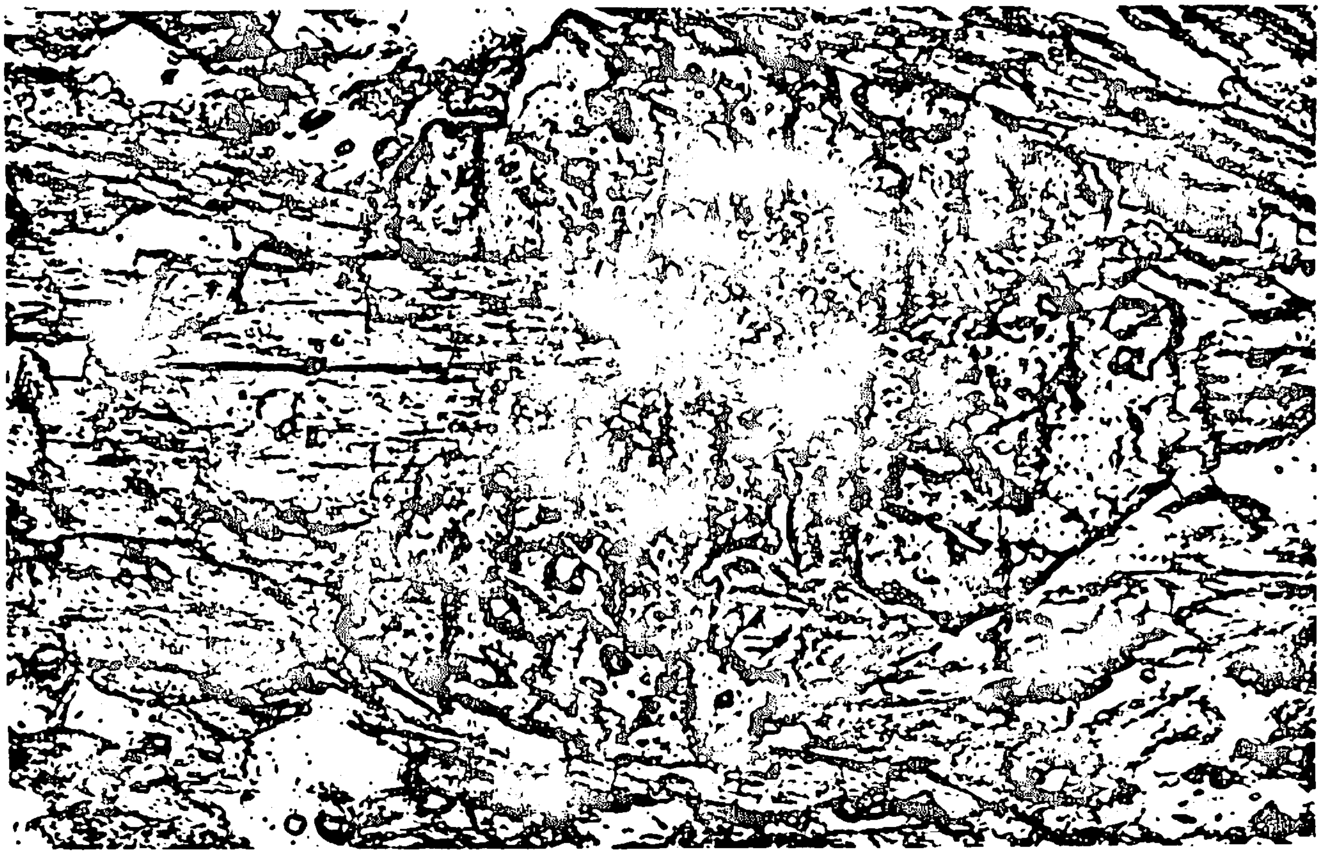


Fig. 13. Amphibole-garnet gneiss of sample 3450: 1 nicol, 50x; a mineral association of sulfide-ore, garnet, light greyish-green amphibole, biotite-chlorite, plagioclase and quartz.

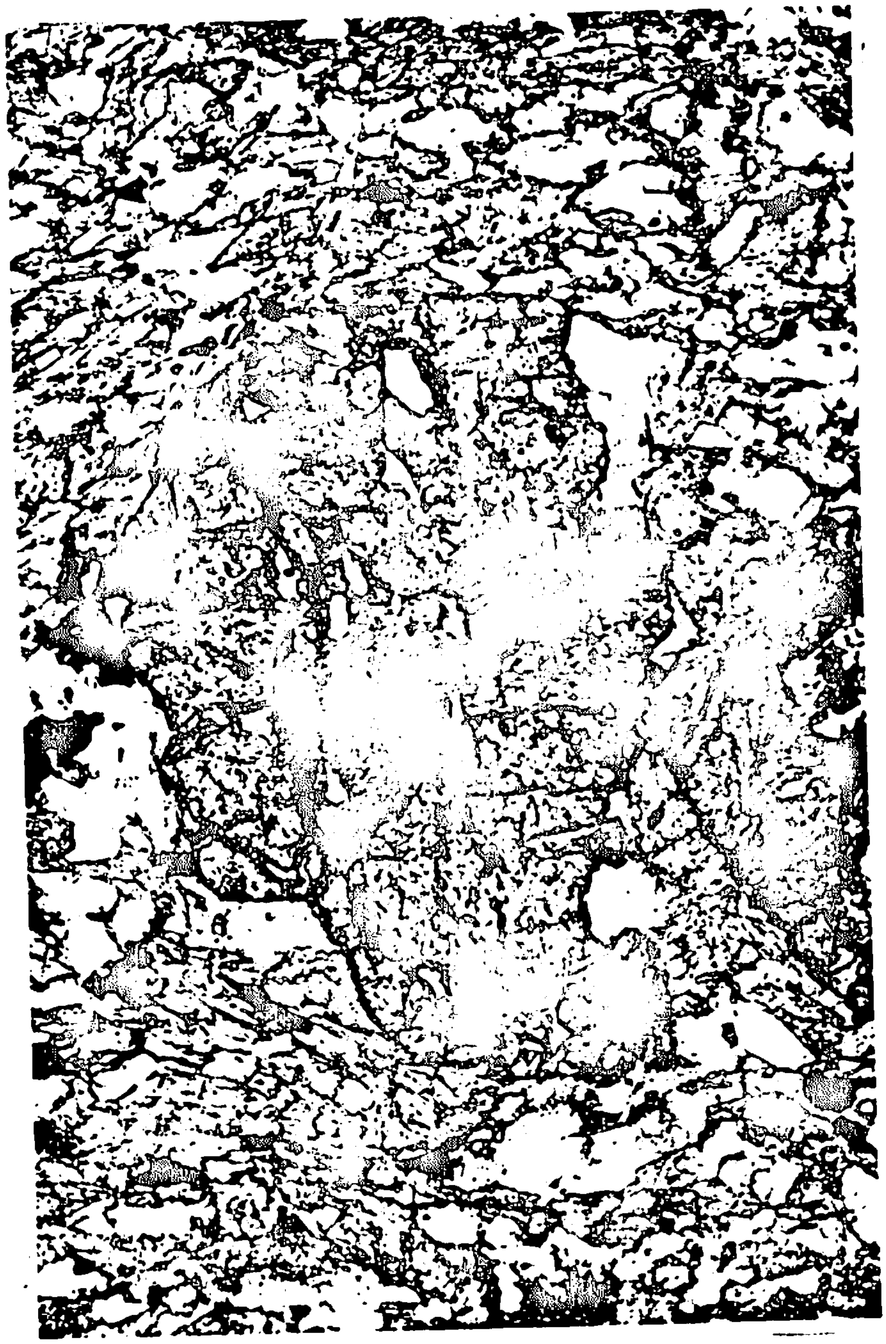


Fig. 14. Garnet phenoblast in amphibolite 3580: 1 nicol, 50x; the sigmoid inclusion pattern in this garnet is discordant to the external structure of the amphibolite.

Fig. 15. Isoclinal similar fold in amphibolite 3680: 1 nicol, 50x.

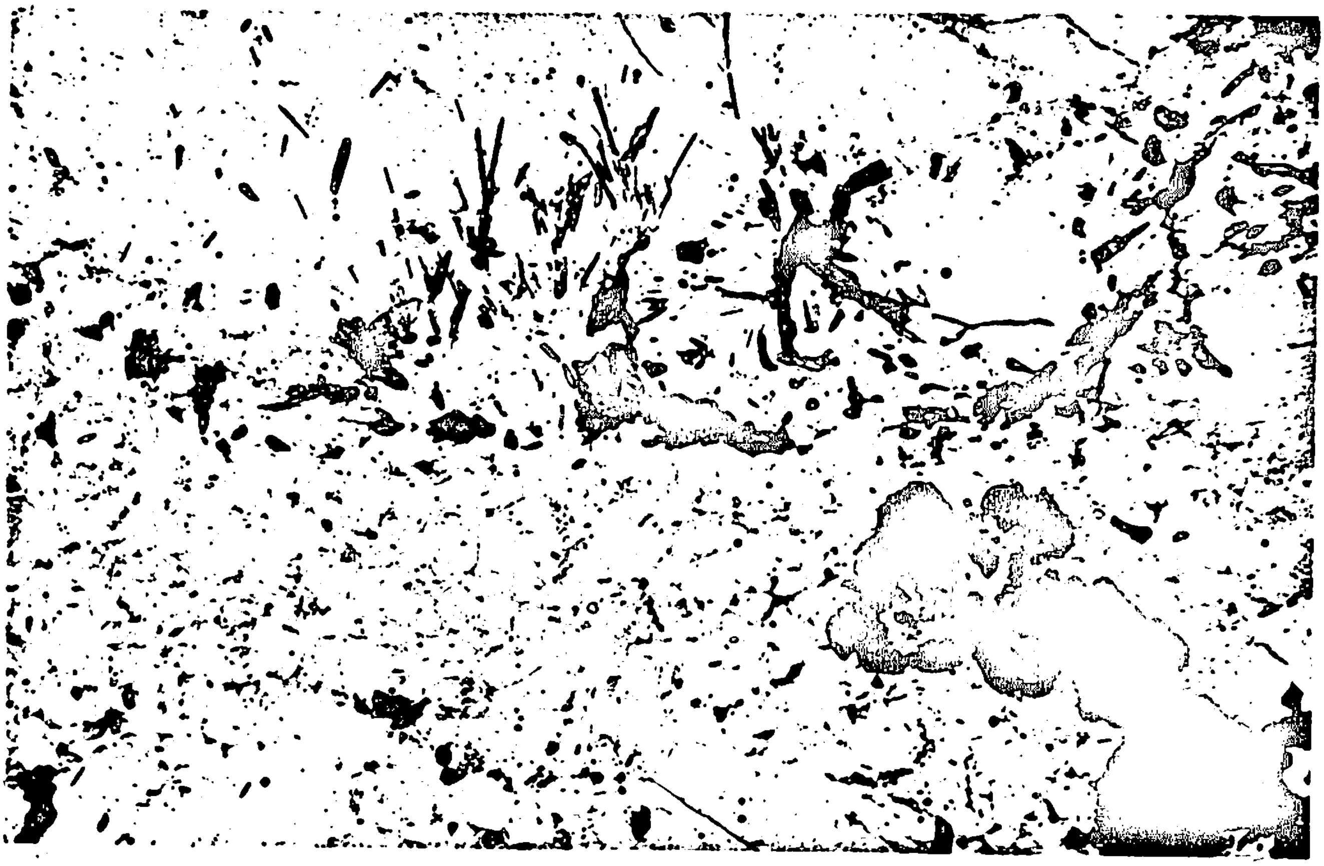
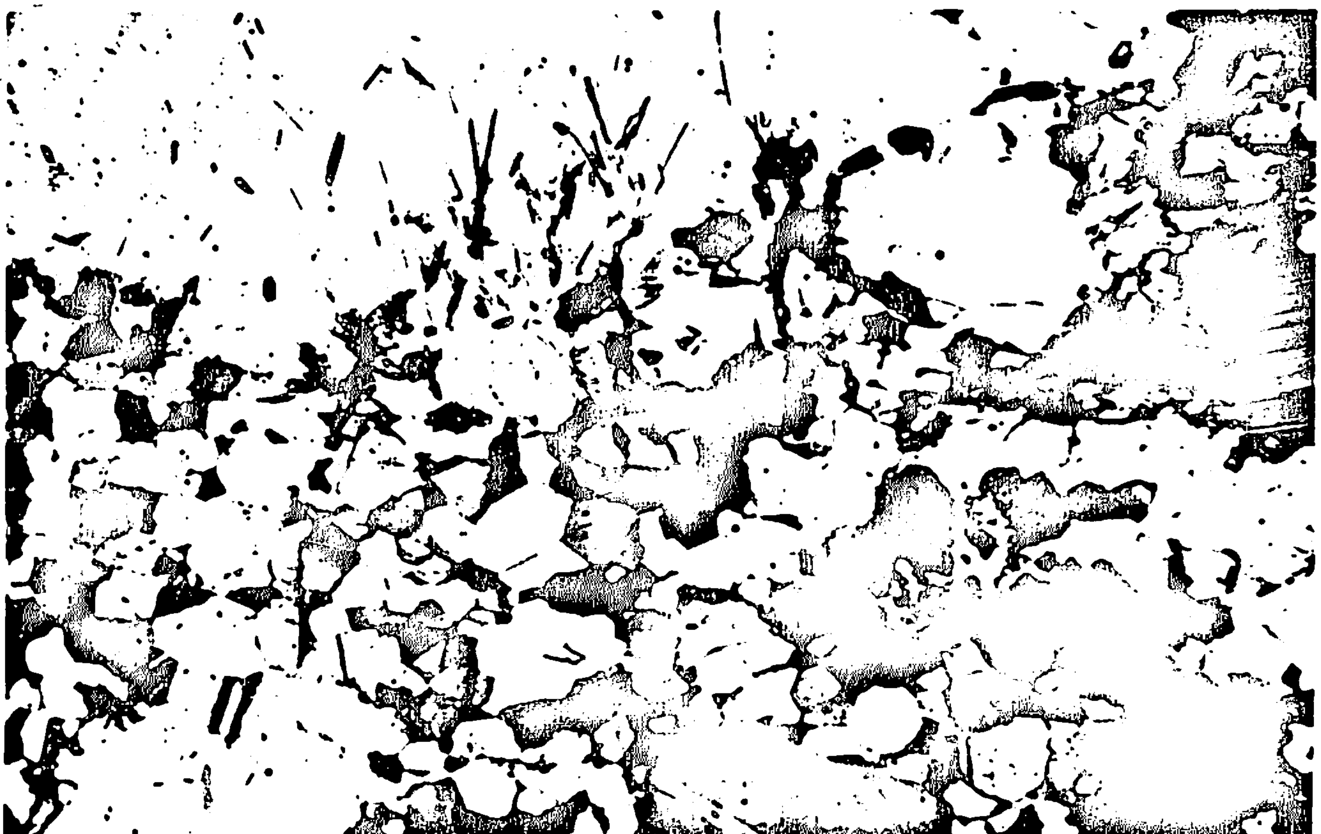


Fig. 16. Mosaic strucutureand part of a phenoblast of plagioclase in a segregation vein of sample 3740: 1 nicol and x nicols (below), 50x; in the phenoblast occur needles of bluish-green amphibole.



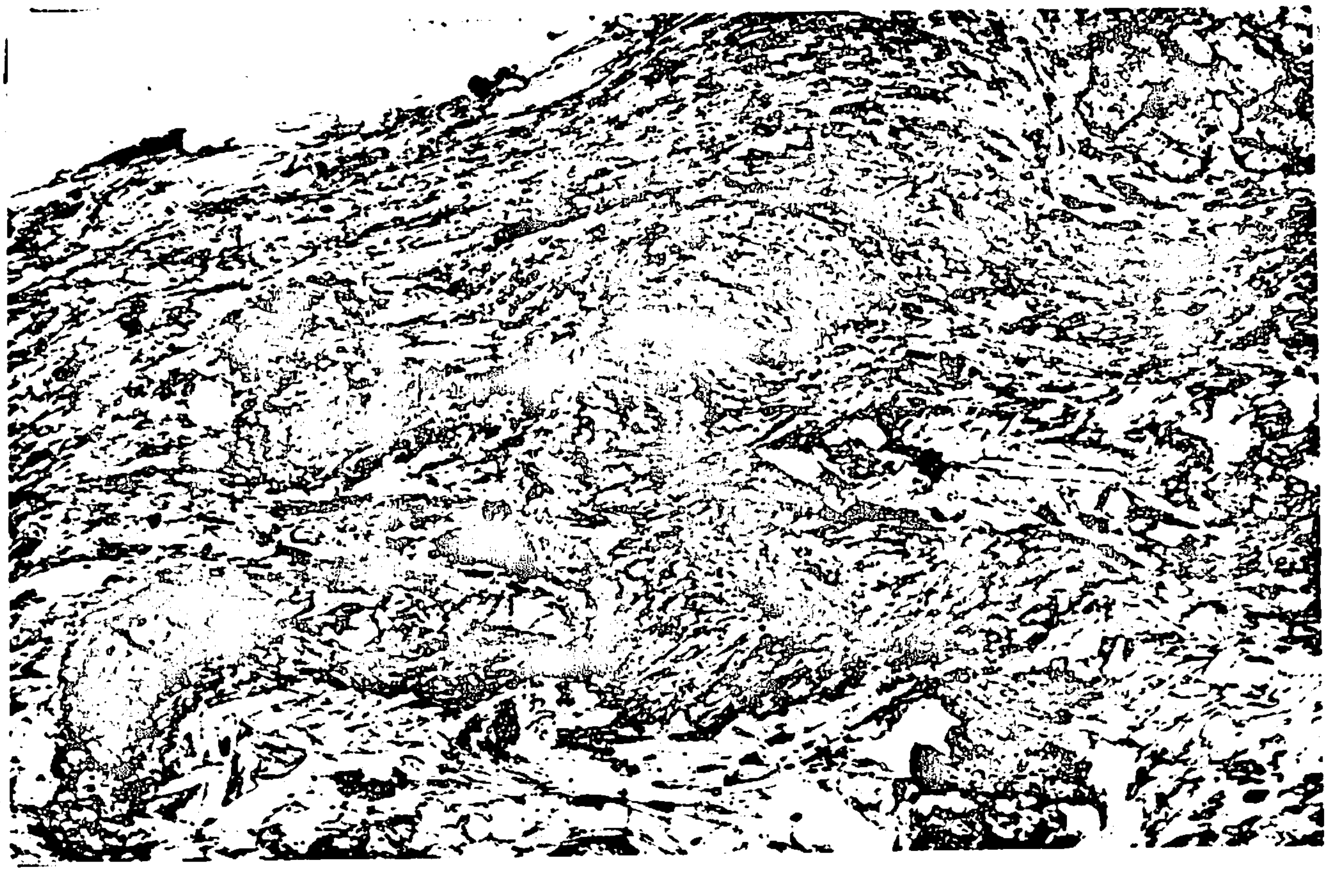


Fig. 17. Mylonitic structure of kyanite in sample 4250: 1 nicol, 50x; in the lower left corner a garnet that replaces kyanite.

Fig. 18. Staurolite phenoblast replaced by kyanite in sample 4130: 1 nicol, 50x; opaque inclusions of staurolite continue partly into the rim of kyanite crystals; kyanite is strongly cataclastic.

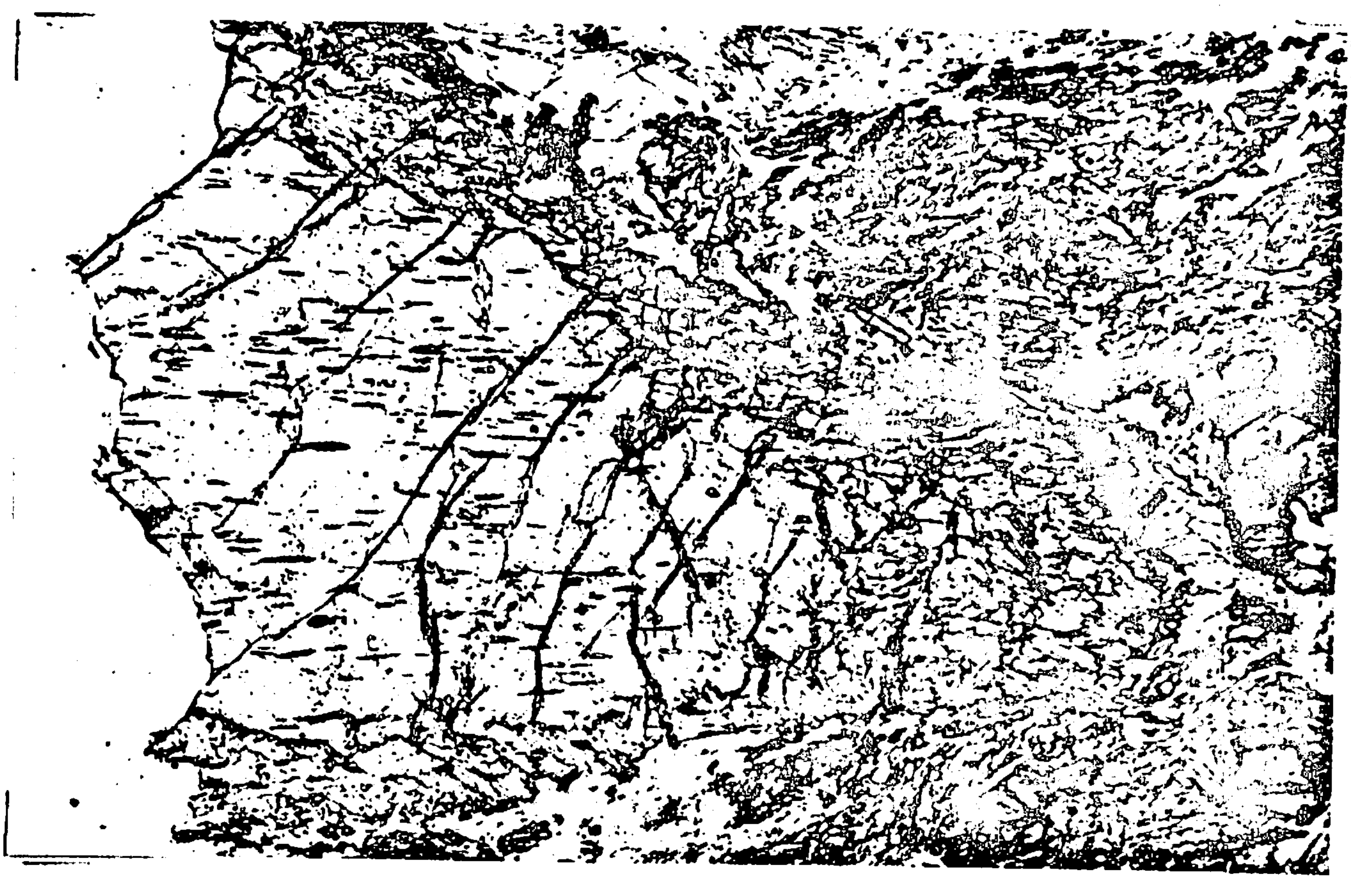


Fig. 19. Si-pattern of garnet in sample 4250: 1 nicol, 200x; the inclusion pattern in recrystallised garnet follows the trend of a samll shear fold, that deformed kyanite- in upper right corner- .

Fig. 20. A discordant sigmoid inclusion pattern in garnet of sample 4130: 1 nicol, 50x.