THE GEOLOGY OF THE RIO GRANDE REGION (GALICIA, SPAIN)

BY

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SUMMARY

The metamorphic rock sequence, ranging from micaschists to migmatites, and the intrusive rocks, granites and various dykes, of a coastal region of Galicia are described. A map and a general section give their distribution.

INTRODUCTION

During the feild season of 1955 and 1956 an area in the NW part of the province of La Coruña has been mapped as a part of the mapping program of the Structural Geology Department of Leiden University under the direction of Prof. de Sitter. To the north the area is delimited by an E—W line running through Cabo Villano; its eastern boundary is formed by a N—S line, passing somewhat east of Torelo and Castro; the southern boundary is formed by an E—W line passing south of Figueiroa, Anobres and Bouza.

In 1955 Dr. I. Parga-Pondal, who has been working for many years on the geology of Galicia, organized several excursions in order to familiarize the author with the rock types and geological problems of this region.

In 1956 Professor de Sitter and Professor Shackleton from Liverpool visited the area.

The area to the east of the present one has been investigated by L. Th. Schoon in 1955.

For mapping purposes the topographic sheets 67-Mugia and 68-Camerinas, 1 : 50.000 of the Spanish topographic service, were used.

In the present paper I will restrict myself to a rock description only, the area being too small to come to a trustworthy conclusion about the relation between the various rock types.

For a general description of the geology of this part of Galicia we refer the reader to Parga-Pondal, 1956.

MORPHOLOGY

The area is well exposed along the coast, further inland exposures are few and poor. Except for the gently sloping banks of the Ria Camerinas, the coast is formed by steeply rising barren cliffs.

The Traba-, Mugia- and Leis granites have a typical weathering, and especially the Traba granite shows summits built up of rectangular blocks. The rocks belonging to the Lage series have exfoliation weathering. The resistant rocks of the Lage series form hills, the valleys mainly follow the micaschists zones. The lower parts are used for cultivation or have pineforests, at higher levels gorse, in spanish called "tojo", is very common. Watercourses are nearly all directed N 30° E, following the general structural trend.

The rocks show strong and deeply penetrating weathering and alteration, especially kaolinisation, as the region has never been glaciated.

DESCRIPTION OF THE MAIN ROCK TYPES

The following rock-units have been recognized:

The Traba granite

The Lage series
- aplitic rocks
- porphyritic rocks
- migmatite
- Bartolomé and Faro granite-gneiss
- augengneiss
- mica (biotite) schist

These rocks are quite similar in composition, as indicated by the Point-counter diagrams (± 600 grains counted in each thin section), prepared from 70 representative samples. Only the augengneiss, which has less quartz, and the strongly varying migmatite showed distinctive compositions.

The micaschists

Micaschists occur especially in the valleys of the rio Ogas and the rio Castro. Much smaller are the micaschist zones of Sandia and Leis, where micaschists alternate with gneiss, as can be seen clearly along the coast.

In the western part of the Faro massif and more frequently in the migmatite zone many small exposures of micaschists occur. They all show similar orientations and the contact with the surrounding rocks is usually not sharp.

The schists consist of small, round quartz crystals (size ± 5 mm) concentrated in bands of about 2 mm, alternating with bands of long (3—5 mm) biotite and muscovite crystals. Graphite is mixed with the mica-crystals.

The biotite has been strongly altered into penninite and sericite. Especially in or near the migmatites the schists consist mainly of chlorite and sericite. Microfolds can be seen in the sericite and biotite bands.

The general orientation of the schists in the valleys of the rio Ogas and the rio Castro and of the schistose inclusions in the migmatite is N—S, but the orientation of the strike and dip is strongly varying.

In the schists concordant quartz-, applite-dykes and lenticular quartz bodies are common. Discordant rhyolitic (up to 200 m thick) and basic dykes (up to 50 m thick) are present especially near the contact with the granites.

Quarzites (quartz percentage 50—90 %) with thin layers of biotite, muscovite, quartz and feldspar occur within the micaschists and have a banded appearance. The feldspar crystals (size 1—2 mm) have changed into albite.

Near the contact with the gneiss hydrothermal tourmaline has been formed. The columnar crystals are parallel to the sometimes visible foldaxes of the schists. Adularia occurs locally.

The schists of the rio Ogas valley east of the road from Vimianzo to Berdoyas show bands of biotite and muscovite intercalated with bands of fine grained quartz and thin bands of staurolite, garnet and andalusite. The staurolite (up to 5 mm) with rims of andalusite has been partly changed into muscovite along cracks. The garnet shows rims of sericite. Biotite and muscovite occur as small crystals lying in the schistosity. Larger mica crystals (up to 3 mm)

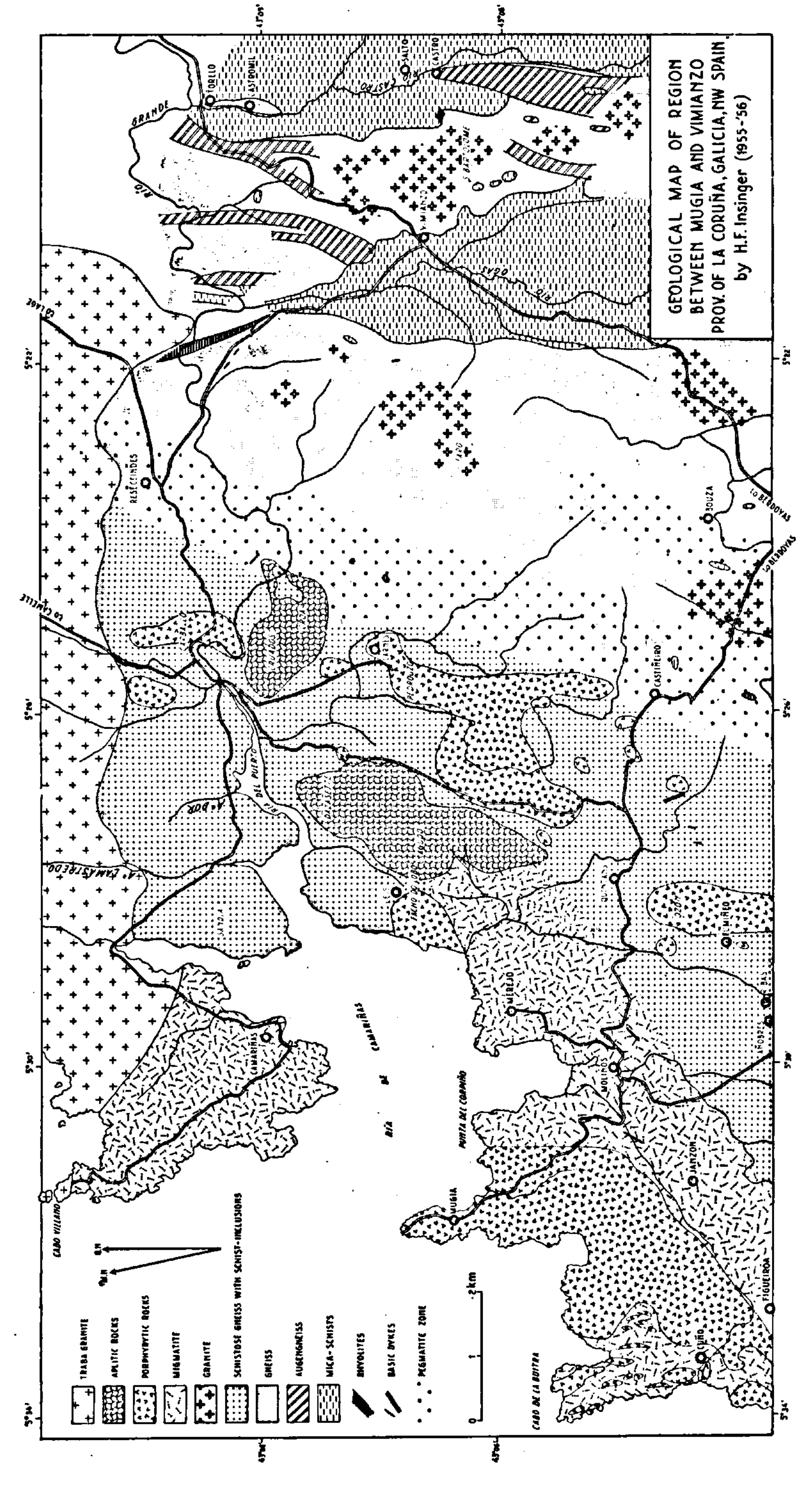
GEOLOGICAL MAP OF REGION
BETWEEN MUGIA AND VIMIANZO
PROV. OF LA CORUÑA, GALICIA, NW SPAIN
by H.F. Insinger (1955-'56)
TRABA GRANITE
APLITIC ROCKS
PORPHYRYTIC ROCKS
MIGMATITE
GRANITE
SCHISTOSE GNEISS WITH SCHIST-INCLUSIONS
GNEISS
AUGENGNEISS
MICA-SCHISTS
RHYOLITES
BASIC DYKES
PEGMATITE ZONE

Fig. 1

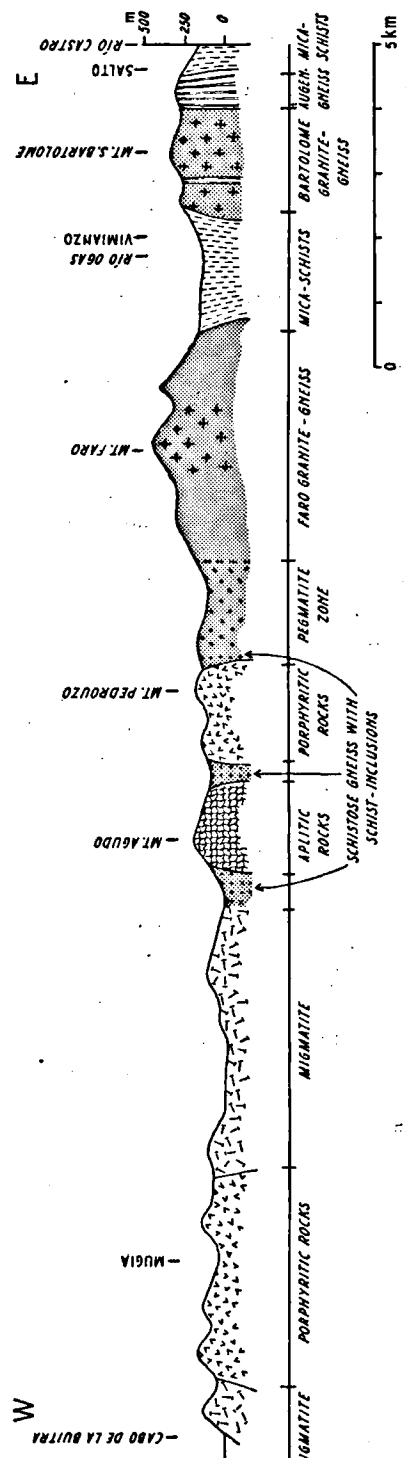
m
500
250
0
E
W
RIO CASTRO
SALTO
MT. S. BARTOLOME
RIO OBAS
VIMIANZO
MT. FARO
MT. PEDROUZO
MT. AGUDO
MUGIA
CABO DE LA BUITRA
MIGMATITE
PORPHYRITIC ROCKS
MIGMATITE
APLITIC ROCKS
PORPHYRITIC ROCKS
PEGMATITE ZONE
FARO GRANITE-GNEISS
MICA-SCHISTS
BARTOLOME GRANITE-GNEISS
AUGEN. MICA-GNEISS SCHISTS
SCHISTOSE GNEISS WITH SCHIST-INCLUSIONS
5 km
0

Fig. 2

of a second generation have been formed at angles cutting across the schistosity. Small ore grains and dark graphite schlieren are common.

The micaceous bands curve around the staurolites and garnets, which probably are syn-tectonic.

Near contacts of the schists with the Faro- and Bartolomé granites, zones of leucocratic, medium grained granite, rich in quartz and with only little biotite, have been observed. The contact with the Faro gneiss is usually sharp. On the contact occur large muscovite crystals and concordant quartz lenzes and veins. The contacts with the Bartolomé massif may locally be gradual and less sharply pronounced. The schists and the adjacent gneiss remain orientated in the same direction.

A section of the contact between the augengneiss and the schists in the rio Castro valley, east of Pedra Longa, shows a 50 m wide zone of fine grained slightly schistose granite with inclusions of schistose xenolites. Then follow schists containing a concordant granite- (size up to 30 cm) and quartz-veins. Intersecting this same zone are discordant rhyolites, having large (1 cm) potassium feldspars and much smaller (2 mm) albite crystals. The biotite has been altered into chlorite. Surrounding the albite are radiate intergrowths of alkali feldspar and quartz.

The schists at the contact with the granite-gneiss E of Calo appear to have been partly pushed up. These schists are orientated differently from the orientation of the surrounding schists.

300 m South of Vimianzo the contact is rather sharp, the schistosity is parallel to the contact, which dips 45° to the east.

In the valley of the rio Castro near Castromil occurs a strongly schistose paragneiss, which shows a gradual transition to the schists. The gneiss is leucocratic with bands and schlieren of biotite.

The Bartolomé massif

The massif consists of unoriented homogeneous granite, bands of augengneiss and well oriented gneiss. Transitions between granite and gneiss are gradual and are visible macroscopically. Apart from thin quartz veins (1 cm), which formed in fissures, no veins or dykes have been encountered in this massif.

The large idiomorfic-carlsbad twinned-potassium-feldspars (up to 1,5 cm) have been recrystallized for the most part into perthite, microcline and albite. The albite (5—10 % anorthite) shows fine lamellar twinning. The gneiss has fine grained zones of biotite, quartz and feldspar. This medium grained gneiss has been recrystallized; second generation feldspars and micas originated and the fine grained zones between the orientated feldspars disappeared.

The generally intergrowing muscovite and biotite crystals carry thin sillimanite needles.

The augengneiss

Bands of augengneiss occur in the Bartolomé massif. They are especially common near the contact between the granite and the schists, but they also occur in the centre of the massif. The orientations of the large potassium feldspars show the same variations as the lineations of the gneiss. Gradual transitions from the schists or from the strongly linear gneiss to augengneiss are frequent. Leucocratic gneiss and aplitic bands are often intermixed with the augengneiss.

The pointcounterdiagrams show a very low quartz percentage of the augengneiss.

South of mount San Bartolomé a small fault forms the contact between the augengneiss and a mediumgrained granite. Movement in the faultzone has caused bending of the porphyroblasts.

The large (up to 2 mm) in orientation considerably varying idiomorfic feldspar crystals, twinned according to the carlsbad law, can be easily identified macroscopically. The strong recrystallization makes it difficult to recognize them microscopically. As a result of the recrystallization many small (2—3 mm) secondary, xenomorfic albite and kalifeldspar crystals have been formed. The feldspar porphyroblasts show no sharp boundaries and contain at their edges many inclusions of plagioclase, quartz, biotite and muscovite.

Small plagioclase crystals, their centre completely altered into sericite and with an outer rim of albite, occur also as inclusions in the kalifeldspars. Surrounding the feldspar eyes are crystals of biotite, muscovite and quartz (1—3 mm), which are bent and arranged in schlieren. Micaceous schistosity planes even curve round. Those porphyroblasts which are perpendicular to the schistosity indicate that all porphyroblasts belong to the same generation.

The Faro massif

The Faro massif consists of muscovite-biotite gneiss and pegmatites. It occupies the area between the schists in the rio Ogas valley and the migmatite zone. In the same area occur aplites and porphyritic granites, which will be dealt with separately. The contact of these intrusives with the surrounding gneiss is sharp.

The gneiss is very homogeneous, generally more schistose than the Bartolomé type and shows many faults (general direction 30—40° E. The Bartolomé type granite with large unoriented potassium feldspar occurs here more locally.

The transitions between the schistose gneiss and the Bartolomé type granite-gneiss are gradual.

Schists laying in the gneiss generally have similar lineations; occasionally, however, small schist bodies may have quite different directions. Often the schists have been broken and moved, e. g. near Vilarseco.

Rhyolites and basic dykes occur, but are generally small. One more important rhyolite (size 125 m) near Calo fingers out into the schists.

The pegmatite zone appearing on the map indicates the area where pegmatites, quartz lenses and aplites are most common. This area has no sharp boundaries and such features may also be found elsewhere in the gneiss. The general orientation of the pegmatites is N—S, many are however divergent. They form narrow, branching dykes or lenses with varying width and limited extension.

East of Carnes occur N—S pegmatite dykes, quartz veins and lenses (up to 1 m thick), the latter show similarly directed biotite zones. SE of mount Croa pegmatite zones (up to 100 m thick) have been observed, containing very large (up to 5 cm) feldspars. Pegmatites in the same area are formed by rows of idiomorphic potassium feldspars. Parallel displacement of these feldspars probably resulted from small movements in the surrounding rocks. Some of the pegmatite dykes are flanked by quartz dykes.

Near Resecindes an aplite cuts through the gneiss and a somewhat linear pegmatite.

Especially the schistose parts are rich in quartz and pegmatite lenses. The

quartz veins contain some ore; e. g. the coast of the Sandia peninsula, the valleys of the arroyos de Lamaestredo and Dor. The schists generally show intensive chloritization. Along the coast of mount Sandia and mount Leis long (2 cm) potassium feldspars have developped in the schists. Thus an augengneiss has been formed, which is, however, quite different from the Bartolomé augengneiss. This type of rock is richer in quartz than the Bartolomé augengneiss and its porphyroblasts can be distinguished clearly macroscopically. It is generally associated with pegmatite and quartz lenses, its contacts are gradual. The same phenomenon can be seen near Anobres and Ribas.

In the neighbourhood of Cereijo occurs a medium grained, homogeneous, unoriented granite, which is very rich in biotite. Such granites are characteristic for the migmatite zone.

Transitions between schistose and more homogeneous types of gneisses are marked by biotite zones, continuing over long distances; they form a planar parallel structure.

The Faro granite-gneiss changes very gradual to the migmatites, the intermediate zone being at least 200 m broad.

The migmatites

The migmatite zone adjacent to the Faro massif occupies the western part of the area under discussion. Locally the migmatite may loose its character, changing into — usually small — granite bodies. These do, however, still contain schlieren and nests of biotite.

From the point counter diagrams the large variety in composition can be read. The granitic parts, however, are always similar in composition to other rocks of the Lage series.

The migmatites show alternation of schistose and granitic parts. These granites vary in grain size and composition, they show flow structures and have nests and schlieren of biotite and also unoriented schistose inclusions. In contrast to the Faro massif only small schist bodies occur within the migmatite. Flow structures generally incorporate the vaguely delimited schist bodies. Anorthite percentages vary from 5—20 %, thus the migmatites are somewhat more basic than the gneiss. Frequently potassium feldspars of varying sizes recrystallized as porphyroblasts, as is also the case in the schistose parts of the Faro massif.

A fibrous sillimanite, (fibrolite) — size up to 3 cm — originated in the coastal zone from Cabo de la Buitra to mount Matamao in the schistose parts of the migmatite.

The orientation in the schists and schistose gneisses is not constant, however, E—W strikes and horizontal positions are frequent. Near cabo Villano occur alternating and folded layers of schist and granite. The strike of these structures is E—W, the dip horizontal.

Large schistose and well delimited inclusions in the migmatite mark the contact with the Traba granite.

Near the porphyritic granite of Mugia, between Figueiroa and Janzon, pegmatitic, rhyolitic and quartzitic dykes (13—10 m) have been observed.

The contact zone with the Faro granite is also marked by pegmatites, quartz-lenses and dykes.

The porphyritic granites

Porphyritic granites occur in various massifs: Mugia, mount Facho do Lobo, mount Carballo, mount Pedrouzo, mount Ozon and a few smaller outcrops.

These rocks are very homogeneous, without dykes or veins. The individual massifs vary somewhat from each other in lineation and the size of the phenocrists. The perthitic kalifeldspar phenocrists show twinning according to the carlsbad law. Small idiomorphic plagioclase crystals occur as inclusions in the large kalifeldspars, they are arranged more or less parallel to the crystal boundaries. Somewhat smaller albite phenocrists occur also. They are idiomorphic, not zonal and contain 5—12 % anorthite. The size of the phenocrists varies from 1—3 cm, still larger ones are especially common in the neigbourhood of Mugia and mount Facho do Lobo. The massif of mount Ozon is without lineation and contains more biotite, especially near Fuente Raposa.

East of Fumiñeo dykes of fine grained porphyritic granite with irregular boundaries cut the porphyritic granite and the medium grained gneiss of mount Ozon.

In mount Pedrouzo the contact with the gneiss is marked by quartz lenses (up to 1 m thick) and by basic dykes.

The Mugia massif shows on its western side a very gradual contact with the migmatite, the transition zone reaches up to a 100 m in width. The groundmass changes into migmatite, the amount of phenocrists gets less but they are still visible within the migmatite.

In the Mugia massif phenocrists are concentrated locally in zones with more or less circular boundaries.

N. of Cuño a very homogeneous medium grained migmatite with nests and schlieren of biotite is in contact with the porphyritic granite. The general orientation of the feldspar phenocrists is 40° E, except near the contact with the migmatite. There the phenocrists appear to have been deflected during the intrusive phase of the porphyritic granite.

In the border zones of the massifs the phenocrists are oriented parallel to the contacts. This orientation is probably due to movements parallel to the contact.

The aplitic rocks

Aplitic rocks are frequent in the massifs of mount Cruados — mount Croa and mount Dazasete — mount Agudo, furthermore many smaller outcrops are known in the Lage gneiss, especially in the pegmatite zone.

The aplitic dykes are highly irregular. In many places aplitic bodies without well defined boundaries have been found, which in contrast to the sharply delimited aplitic dykes have schistose inclusions and schlieren of biotite. They are not intersected by the dykes.

The aplites do not show lineations, they are medium grained and aequigranular. The crystals are hypidiomorphic. The leucocratic rocks contain much quartz and large muscovite crystals. Biotite occurs in small and varying quantities. Locally gneiss in contact with an aplite may be richer in biotite.

On the contacts with surrounding rocks pegmatites and quartz dykes are common.

The Traba granite

The Traba granite occupies the northern part of the area. This rock consists of quartz, kalifeldspar which is often porphyritic, strongly zonal plagioclase with 20 % anorthite and biotite. Locally it may contain more basic plagioclase and some hornblende. Small quartz veins about 20 cm wide, cross the granite in all directions.

The hypidiomorphic perthites contain small idiomorphic plagioclase crystals which show parallel arrangement to the crystal boundaries. According to Frasl (Tschermaks Mineralogische und Petrografische Mitteilungen 1954) this indicates a magmatic origin for such feldspars. This phenomenon, though less clearly, was also observed in the phenocrists of the porphyritic granites.

The discordant contact with the Lage series is marked by the occurrence of large muscovite and tourmalin crystals and rocks rich in quartz. Near Calo a medium grained, not linear granite, very rich in biotite marks the contact between the Traba granite and the Lage series. North of Jabina an aplitic dyke (100 m thick) crosses the contact.

The large kalifeldspars having more resistance, protrude from the weathered surface, giving it a characteristic look.

The rhyolites and basic dykes

The rhyolites show a constant composition. Their colour may vary from white or grey to pink, black bands occur occasionally. Kalifeldspar phenocrists, biotite and quartz vary in size from 0,5—1 cm. The groundmass is very fine grained. The kalifeldspars may be altered into kaoline. Contacts with surrounding rocks are sharp and discordant. These rocks never show lineation.

An important, 125 m wide rhyolite dyke occurs in the migmatite near Calo, others mark the contact between the schists and the Bartolomé granite or between the augengneiss and the Bartolomé gneiss. Smaller ones occur near punta del Corpino and in the Mugia porphyritic granite.

Basic dykes vary in width from 10 cm to 20 m, they occur in the migmatite, the Faro massif and the schists. These dykes are strongly fractured. Some concordant dykes are known from the schists.

Due to the very fine grain size and the strong weathering their composition is difficult to ascertain; plagioclase, biotite and quartz form the main components.

The ores

Important ores are wolframite and kassiterite, which occur in mineralized quartz or lenses. Kassiterite occurs in the Bartolomé- and in the Faro regions, especially near Bouza and Castineiro, and also in small veins in the granite-gneiss and migmatite.

Wolframite occurs in quartz dykes, particularly in the peninsula of Sandia and N of Leis.

Ilmenite, hematite monazite, pyrite and chalcopyrite occur in small quantities throughout the whole area.

Small (0,01 mm) hematite crystals cause the red coloration, which can be observed W of the line mount Aranzon-Devesa-Braño and in the Traba massif. In these red zones strong albitization and alteration of biotite into chlorite and hematite has been observed.

Kaolinization

Throughout the area the feldspars have been kaolinized, generally only at the surface but in some places also at deeper levels. The occurrences at the surface are due to climatic conditions, the deeper ones may be related to hydrothermal influences. Also greisening appears to have operated locally.

Recrystallization

On the universal stage the orientation of the C-axes of quartz crystals has been measured.

Samples of well orientated quartzites and gneisses of the Bartolomé massif and in the rio Ogas and rio Castro valleys showed random orientations.

REFERENCE

Parga-Pondal, Don Isidro, 1956. Nota explicativa del mapa geológico de la parte NO de la provincia de la Coruña (with extensive english summary). Leidse Geol. Med. 21/2, p. 468—484.