THE GEOLOGY OF THE AREA BETWEEN CORME AND BUNO
(GALICIA)

BY

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The area to be discussed is bounded N and W by the Atlantic Ocean; in the S it reaches as far as the Rio Allones; its eastern boundary is formed by the Malpica-Buño and Buño-Agualada roads. For mapping sheets 43 and 44, Lage and Carballo respectively, of the Spanish 1 : 50.000 topographic maps were used.

THE LAGE GROUP

Rocks belonging to this group were studied near Lage and on the Corme- and Cabo San Adrian peninsulas. Within the Lage group occurs a leucocratic two-mica gneiss (the Lage gneiss s.s.) and also migmatites and augengneisses. The migmatites are well exposed along the coast NW of Playa de Traba and show strongly folded mica bands. Augengneisses occur at the contact with the schist zone and on the San Adrian peninsula.

The Lage gneiss s.s.

Over large areas this granitic gneiss show little variation in composition and structure. Local variations for example have been observed in the Corme peninsula. On the whole the rocks there are very uniform in composition, near Corme harbour, however, they are much finer grained and rich in biotite.

The gneissic texture is often vague and only visible on the weathered surface. Sometimes there is no schistosity and the rock is granitic. Mylonites occur along shear zones; these shear zones form conjugate systems; but generally one shear zone predominates. One of these shear zones is marked by the occurrence of concordant schist bands.

The main components of these rocks are quartz, potassium feldspar (mainly microcline), plagioclase, muscovite and varying percentages of biotite; accessories are tourmaline, apatite, zircon and ore. Quartz is often recrystallized and shows undulose extinction. Microcline has been observed to replace plagioclase; the average percentage of anorthite in the plagioclase is 10 %. Potassium feldspar, plagioclase and biotite show transformation into kaolinite, sericite and chlorite. The weakly pleochroic muscovite occurs also as pseudomorphic replacement of biotite. Tourmaline shows pleochroism from colourless to yellow-green and green-blue.

Pegmatites were observed near Lage and Corme, either in concordant, plate- or lenslike forms or in irregular bodies. Contacts with the gneiss are vague; gneissic structures sometimes continue into or — in the case of thin veins — through the pegmatite. In the border zones the pegmatites are often coarser than towards the center. In composition they are equal to the Lage gneiss, which seems to indicate a replacement or metamorphic origin; the continuity of structures from the gneisses into the pegmatites confirms this.

Fig. 1. Migmatite in Lage group; north of Playa de Traba.

Fig. 2. Pegmatite dyke in Lage gneiss; west of Corme.

Large feldspars up to several cms long have been found in the Lage gneiss. They occur either as idiomorphic and single crystals making an angle with the schistosity which bends around it, or as rows parallel to the schistosity and then deformed. Similar feldspars have been seen in the augengneiss of Cabo San Adrian.

Discordant basic dykes, with a NW-SE strike occur along the coast from Playa de Traba towards the mouth of the Allones river. These younger rocks are easily eroded by the sea and small bays and inlets often indicate their presence.

North of Playa de Traba two such basic dykes occur in folded migmatites. The axes of the anticlines have a NW-SE direction, plunging to the E. Such folds are only known within the migmatites.

The augengneisses

These rocks form the transition between the Lage gneisses and the mica schists, the Lage gneiss gradually becomes coarser and aquires an augengneiss texture. The boundary between the augengneisses and the schists is marked by a migmatite zone with folded aplitic bands. These coarse grained rocks are best exposed N of Barizo and on Cabo San Adrian. The feldspar augen can attain a diameter of several

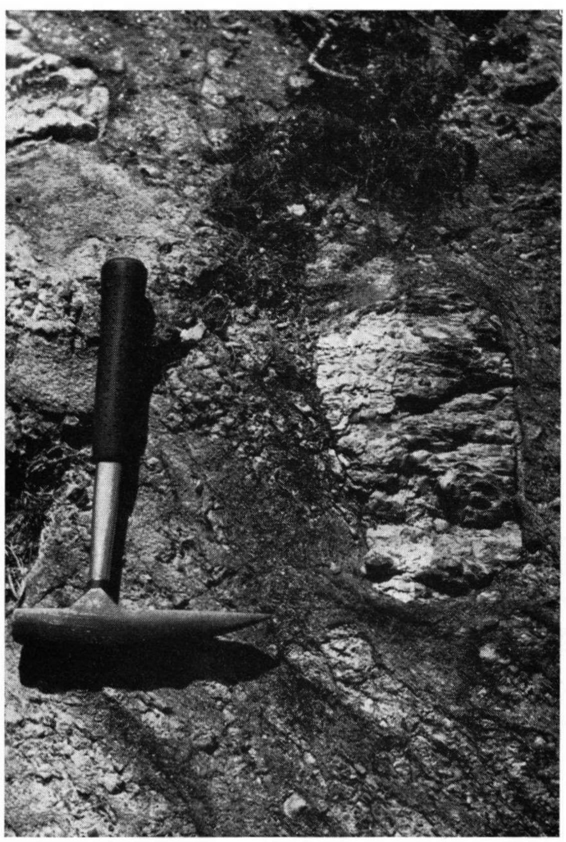

Fig. 3. Feldspar megacryst in Lage gneiss east of Lage.

centimeters. The augen are defined by two oblique shear directions, which are marked by thin mica bands. These shear directions make angles of 15—20° with the schistosity and the longer axes of the eyes are in the direction of schistosity.

Apart from these deformed feldspars there occur also a number of more idiomorphic feldspars, their longer axis being in the same direction as one of the shear directions. In many instances these crystals seem to have been rotated as is suggested by the disturbed glimmer bands around them. Such a rotation may have been caused by later shearing.

Along cracks in the feldspars quartz crystals have formed. The augen consist of both potassium feldspar (microcline) and plagioclase (oligoclase), both showing signs of albitization.

THE SCHISTZONE

The schistzone between the Lage gneisses and the gneiss of the Central complex consists of weathered, isoclinally folded micaschists. The schists contain bands of Lage gneiss and aplitic gneiss; to the E the schists are cut by basic, boudinaged dykes and have inclusions of schistose gneiss, all of these parallel to the schistosity. The boundary between the gneisses of the Central complex and the schists is ill defined.

The schistosity in these rocks is practically vertical; lineations coincide with the direction of micro fold axes, which plunge gently both to the N and the S. These micro folds are folds of the schistosity. Near Beo a divergent fold axis has been recorded, the strike of the axis being N 75° E and plunging 10° to the W. This direction may be due to movements along a nearby fault.

Pegmatitic and aplitic dykes in the schist are generally boudinaged; this can be seen very well W of Cabo San Adrian. The boudins are arranged lengthwise or "en echelon" as a result of oblique shearing. Shearing is strongly developed here,

Fig. 4. Folded aplite veins in migmatite zone between Lage gneiss and schistzone.

both dextral and sinistral. Similar phenomena can also be observed on the E bank of the Rio Allones, where this river enters the Ria de Corme y Lage. Boudinaged tourmaline veins and rotated quartz crystals can be seen here in the schists. The tourmaline boudins show tension cracks, which have been filled with quartz.

The occurrence of microfolds in the schists is best seen from the bent mica bands in thin sections. Biotite has often been sheared to dark schlieren and is partly

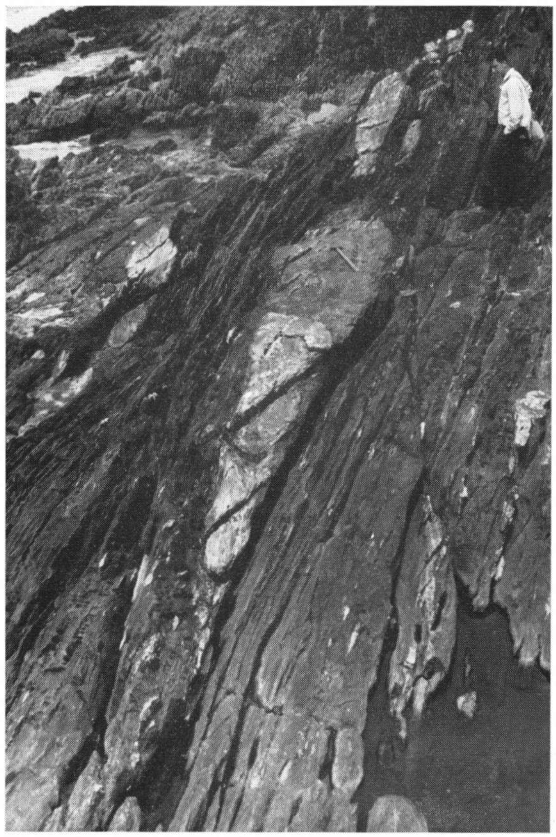

Fig. 5. Aplite vein with boudinage structure in micaschists of Cabo de San Adrian.

or completely chloritized. Other constituents are: muscovite, showing undulose extinction; undulose quartz; some feldspar; cataclastic garnet; black tourmaline and accessories.

In the feldspathic schists, which have an intermediate composition between the mica schists and the biotite gneisses of the Central complex, occur lenticular albite porphyroblasts, which can also be noticed macroscopically. These contain rows of inclusions, arranged at an angle to the schistosity. Mica bands curve around these albite porphyroblasts.

It seems likely that the porphyroblasts inherited an older s-plane: the schistosity plane. In a later kinematic phase which caused folding of the schistosity and possibly also later shearing, they were deformed and rotated. These porphyroblasts are scarce in the micaschists of the schistzone, but occur commonly in the schists included in the gneisses of the Central complex. In the latter also synkinematic albite porphyroblasts have been observed. As the central inclusions underwent more rotation than the peripheral ones, their arrangement is sigmoidal.

The synkinematic albite crystals include small idioblastic garnets; elsewhere in these rocks and also in the late kinematic albite crystals the garnets are usually cataclastic. In some samples both types of porphyroblasts occur together, showing that albitization started already in the synkinematic phase and continued in late kinematic time.

Andalusite bearing pegmatites occur in the schists of Cabo San Adrian.

THE GNEISSES OF THE CENTRAL COMPLEX

These rocks have been subdivided as follows:

1. planar gneisses
2. linear gneisses
3. augengneisses
4. granites.

Furthermore a few schists, hornfelses and basic dykes occur in this complex.

Rather than on mineralogical composition, these four groups are distinguished by their structural properties. The mineral association of these rocks corresponds to the epidote-amphibolite facies of Eskola; epidote, clinozoisite and albite are common; garnet occurs as relicts.

The petrographic investigation was hampered by the deep weathering of these rocks and the frequent alterations of many minerals.

As a result of recrystallization the gneissic structure has in some cases been partly obliterated. The main constituents are quartz, potassiumfeldspar, plagioclase (albite-oligoclase), biotite, muscovite, chlorite, epidote-clinozoisite, garnet and accessories. Amphibole, with negligible exceptions, is restricted to the hornblende gneisses.

The muscovite content may vary considerably. Quartz is often recrystallized and undulose, with irregular crystal boundaries. Potassiumfeldspar (microcline) shows differentiation into quartz and albite. In the augengneiss the microcline is perthitic.

The biotite occurs often as dark schlieren, generally quite strongly chloritized and with rims of ore. Green biotite has been observed occasionally.

The muscovite is weakly pleochroitic; sometimes this mineral is formed as fine grained crystals under static conditions.

Epidote-clinozoisite and garnet are often found in the mica bands. Epidote-clinozoisite occur as alterations of garnet and biotite. Cataclastic garnet is a relict, showing transformation into chlorite along cracks.

Accessory minerals are: titanite, apatite, zircon and ore.

Transformation of several minerals into those of a lower grade metamorphism indicates — at least for the latter stage — the retrograde character of the metamorphism, and is connected with phyllonitization.

The planar gneisses

These rocks of varying, but generally small grain size, predominate in the Central complex. The schistosity has been folded, as can be deduced from its changing attitude. In the central part of the Complex the schistosity is rather flat, steepening in the outer parts and even vertical in the schist zones.

Later shearing caused mylonitization; one ultra-mylonite has been observed, in this rock only quartz, feldspar and epidote could still be recognized.

According to their composition the planar gneisses can be subdivided as follows:

a. muscovite-rich gneisses

b. leptynitic gneisses

c. hornblende gneisses.

The hornblende gneisses differ from the other two types by the occurrence of a dark green to blue green amphibole, ferro hastingsite according to Geul. This mineral alters into biotite and epidote; as inclusions it contains titanite, garnet and ore. This type of rock forms the northern extension of the hornblende gneisses in the area studied by Geul and is only exposed in one locality in the Rio Allones valley. The schistosity is flat; from the general appearance it seems as if the hornblende gneiss forms a shallow syncline.

Dark hornblende, pink feldspar and pyrite characterize the handspecimen. On joints secondary epidote has developed.

In the field the leptynitic gneisses are difficult to distinguish from the muscovite-biotite gneisses, which also have light weathering colours. They are best known from outcrops, N of Puente-Ceso on Mount Mezquita in the western part of the Central complex. The gneissic structure has been partly obliterated as a result of rather strong crystallization. Muscovite is lacking completely.

The muscovite-rich gneisses are best known from quarries situated midway along the road from Puente-Ceso to Pazos de Abajo in the central part of the Complex, where these rocks are very well exposed. They consist of green muscovite (phengite), chlorite, quartz and light pink feldspars. Along cracks, secondary epidote has formed. The muscovite is weakly pleochroitic, from colourless (X) to light green ($Y = Z$); 2V is little over 30°. Along their rims the muscovite crystals show alteration into chlorite and inclusions of zircon and ore are common.

The chlorite shows pleochroism from light green to bright green and anomalous blue interference colours. These gneisses sometimes have feldspar augen. When weathered, the green muscovite cannot be recognized and the rock is a chlorite-rich gneiss.

Linear gneisses

These B-tectonites with a rodded appearance occur only in a rather narrow zone of the Central complex. From the schistosity dipping outwards, it would appear that they occur in an anticlinal zone.

The linear gneisses are well exposed E of Puente-Ceso, along the road to Agualada. Further E they change into augengneiss.

The lineations are horizontal or plunge gently (maximum 10°) to the S. Perpendicular to the linear structure, the rock shows no structure. Evidence of a younger shearing is present. Thin sections parallel to the lineation exhibit a banded arrange-

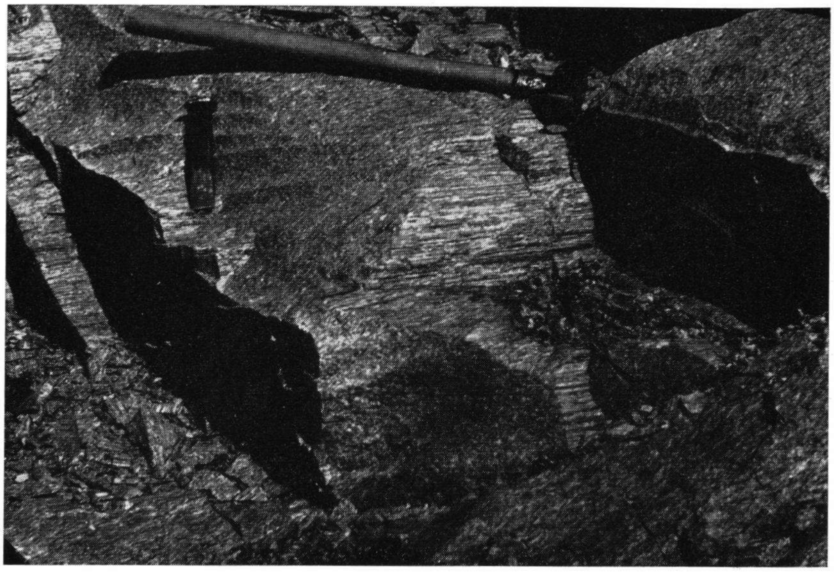

Fig. 6. Strongly linear gneiss in Central Complex; along road Puente-Ceso - Agualada.

ment of the minerals: bands of mica, epidote and garnet alternating with bands of quartz and feldspar. Biotite has been flattened to dark chlorite masses, and the rock has been partly mylonitized. Muscovite is rare. The epidote contains brown orthite grains. In thin sections perpendicular to the lineation quartz and feldspar show rims of chlorite. In general it can be stated that these gneisses are blastomylonites.

The augengneisses

These rocks have an intermediate position between the linear and the planar gneisses and sharp boundaries between these rocktypes cannot be drawn. They occur throughout the Central complex, but mainly in some zones parallel to the strike. The augen are strongly deformed microcline crystals with albite veins and rims of fine grained quartz and feldspar, bands of mica and epidote have been bent around them. Alteration of the microcline into quartz and albite has taken place from the outer rims and along cracks, also chlorite has often formed in the cracks. Sometimes the augen have been recrystallized to quartz and albite, with only a microcline relic in the centre, they can then still be recognized by the mica bands around them.

The granites

Granites are known at several localities within the Central complex. These rocks have a composition similar to the augen gneisses. Plagioclase (probably oligoclase) shows strong saussuritization. Microcline has veinlets of albite and shows alteration to the same mineral along its rims. Micrographic intergrowth of feldspar and quartz has been observed.

A granite exposed near Allones has a contact zone of hornfels. The contact between both rocktypes is sharp. The hornfels consists of quartz, biotite and muscovite with relicts of an unknown mineral (cordierite?). This rock has a fine grained, granoblastic texture.

In the schists and gneisses of the Central complex, except from the hornblende gneisses and the linear gneisses, basic rocks are common. They occur as boudinaged concordant veins, similar in composition to the blasto-mylonites of Geul. The only eclogite, occurring in the N of the area, has also been described by Collée.