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PRELIMINARY RESULTS OF THE INVESTIGATION OF THE CENTRAL GALICIAN SCHIST AREA (PROV. OF ORENSE AND PONTEVEDRA, NW SPAIN)

BY

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ABSTRACT

Probably Lower Paleozoic quartzo-pelitic schists with bands of feldspathic schists, white and black quartzites, graphite schists and amphibolites have been folded twice. Hercynian regional metamorphism led to porphyroblastic growth of chlorite, albite, biotite, garnet, staurolite mainly between F_1 and F_2. Andalusite porphyroblasts are related to Hercynian granite intrusions of varying age with respect to F_2. An isograd map of biotite, garnet, staurolite and andalusite is presented. Structures elucidating the relations between deformation phases and metamorphic mineral growth are discussed.

RESUMEN

Esquistos cuarzo-pelíticos con fajas de esquistos feldespáticos, cuarcitas blancas y negras, esquistos graphíticos y amphibolitas, de edad probable Paleozoica Inferior, han sido plegados dos veces. El metamorfismo regional Hercínico ha causado el crecimiento de porfiroblastos de clorita, albita, biotita, granate y estaurolita, sobre todo entre F_1 y F_2. Porfiroblastos de andalucita están en relación con intrusiones de granitos Hercínicos de edad variable con respecto a F_2. Se presentan un mapa de los isogrados de biotita, granate, estaurolita y andalucita y algunos ejemplos que aclaran las relaciones entre las fases de deformación y el crecimiento de minerales metamórficos.

INTRODUCTION

A general outline of the geology of the NW part of the (Hercynian) Hesperian massif of the western Iberian peninsula has been given in several publications (den Tex & Floor, 1972; Capdevila, 1969; Matte, 1968; Ribeiro, 1970). The reader is referred to this literature for further information.

The central Galician schist area, of which a Lower Paleozoic age is supposed, is roughly situated between Forcarey (NW), Lalín (NE), Carballino (SE) and Avión (SW) in the provinces of Orense and Pontevedra.

To the north the schists are tectonically overlain by the Lalín unit characterized by the presence of polymetamorphic metagreywackes with numerous basic and acid intercalations (Hilgen, 1971). To the east, west and south the area is bounded by several types of Hercynian intrusive granite (Fig. 1).

Petrographically, the rocks are mainly quartz-rich biotite-muscovite or chlorite-sericite schists with intercalations of quartzo-feldspathic schists, micaceous quartzites, impure quartzites, graphite schists, black cherts and amphibolites. The rocks were repeatedly folded and underwent epi- to mesozonal Hercynian metamorphism and some influence from the intruding granites. The porphyroblasts observed are mainly of chlorite, albite, biotite, garnet, staurolite and andalusite; the parageneses found vary, depending on the conditions necessary for their formation and on the rock-composition.

The intrusive granites belong to both Hercynian granite series established by Capdevila & Floor (1970). The calcalcaline series of mainly biotite-oligoclase granites is represented by both its early, regionally deformed type (the Avión granite) and by post-tectonic granite (Ribadavia granite). The alkaline series of two-mica granites is related to the Hercynian regional metamorphism (Capdevila & Floor, op. cit.) and represented by both relatively early, tectonically deformed types, and younger undeformed and unoriented granites. Migmatites are present in the southern part of the area. One of the authors (J. D. Hilgen) investigated a part of the area in connection with a regional study of an area overlapping the present one in the north and provided some of the specimens described below by the first author who, in 1969, embarked upon a regional investigation of the entire schist area.

AIM OF THE PRESENT INVESTIGATION

The investigation has several aims:

a cartography of lithological types, with establishment of standard sections in order to facilitate correlation with rock-sequences of known age elsewhere in the northwestern Iberian peninsula;

the unraveling of the tectonic history of the area;

a cartography of the isograds of the Hercynian metamorphism;

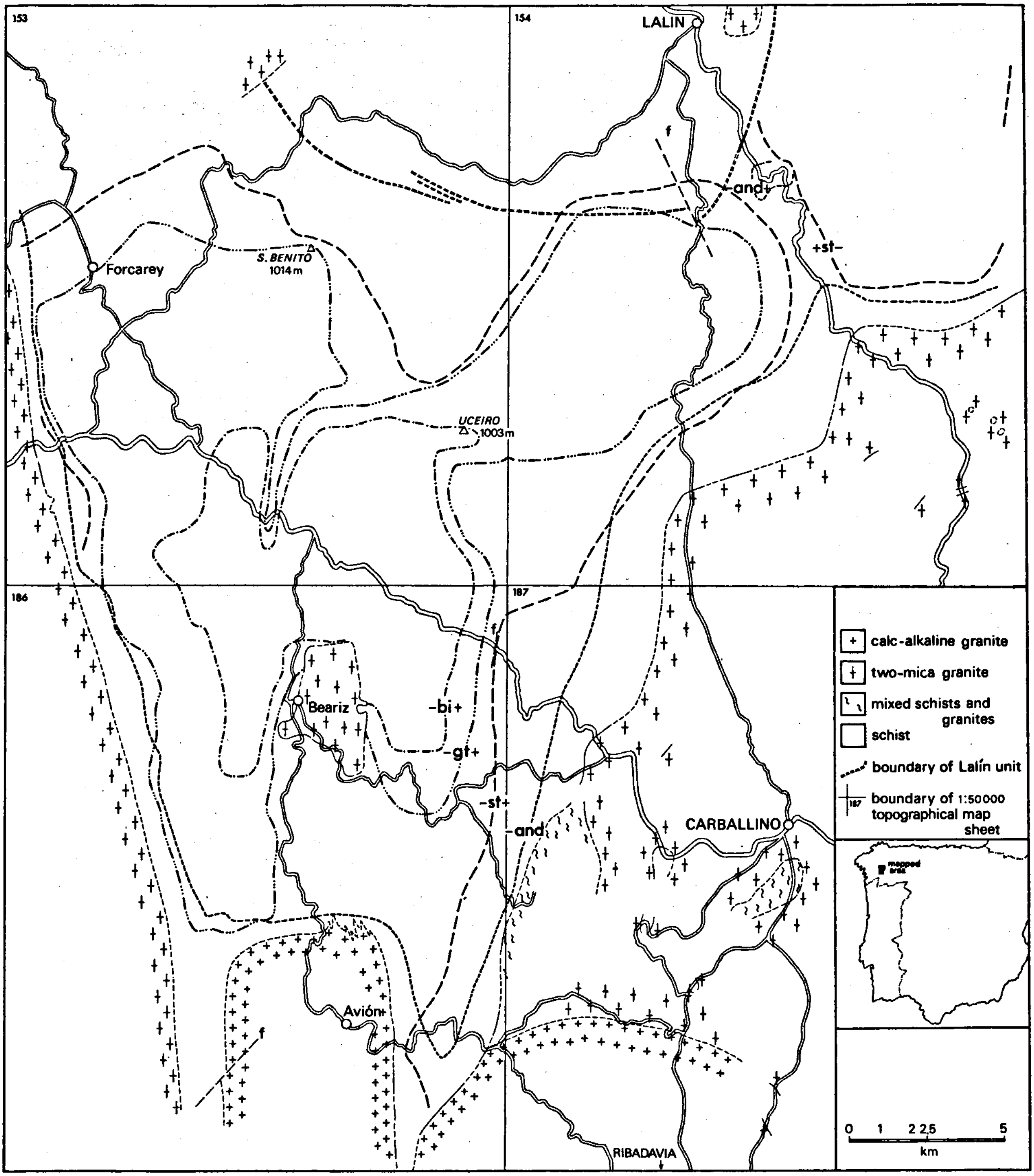


Fig. 1. Geologic sketch map of the investigated area showing approximate location of metamorphic isograds (after van Meerbeke, 1972).

the establishment of the order of tectonic, metamorphic and plutonic events from a study of the influences upon the investigated rocks from tectonic phases, regional metamorphism and granite emplacement and their interrelations.

A similar study of the schist belt along the NW Spanish coast between Portugal and the Ria of Muros and Noya was also started in 1969. These schists are an immediate continuation of those in NW Portugal which are of Cambrian to Silurian age (A. Ribeiro, pers. comm.).

It is hoped that a comparison of the results of the investigation in the two schist areas mentioned with other regions of the NW Iberian peninsula will reveal the relations in space and time of Hercynian tectonic, metamorphic and plutonic events in the NW part of the Iberian Peninsula.

In the present contribution mainly some preliminary results of microtectonic investigation of the specimens collected are given.

MICROTECTONIC OBSERVATIONS

A main schistosity (s_1), composed mainly of muscovite and to a smaller extent of green and brown biotite is recognizable in the whole area and is the axial plane schistosity to isoclinal folds in quartz veins, which are found in nearly every kind of schist, and to folds in bands of contrasting composition. Generally, however, compositional banding in the present region is (sub)-parallel to s_1 and the actual observation of F_1 fold hinges is a rare feature.

In thin section, remnants of an older surface (s_0) are visible either as a schistosity crenulated by s_1 or as polygonal arcs. s_0 is formed by small muscovite and chlorite flakes. Examples of s_0 and s_1 are given in Figs. 2, 3B, 4.

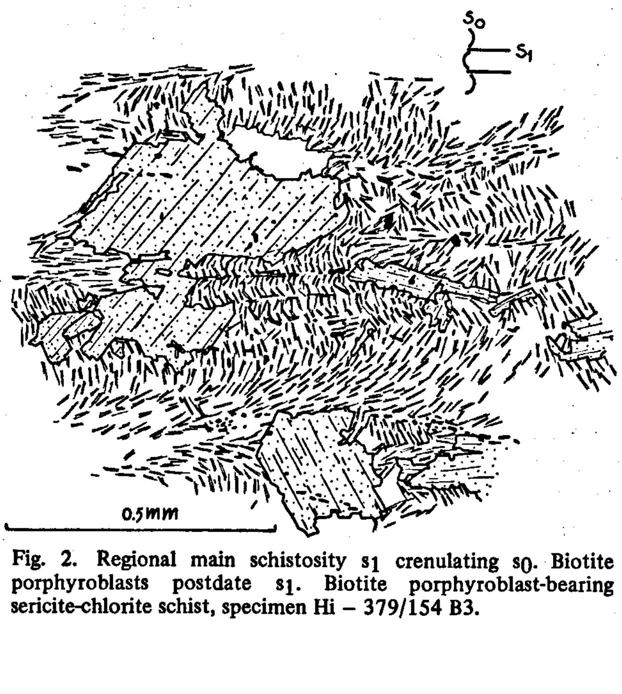


Fig. 2. Regional main schistosity s_1 crenulating s_0. Biotite porphyroblasts postdate s_1. Biotite porphyroblast-bearing sericite-chlorite schist, specimen Hi – 379/154 B3.

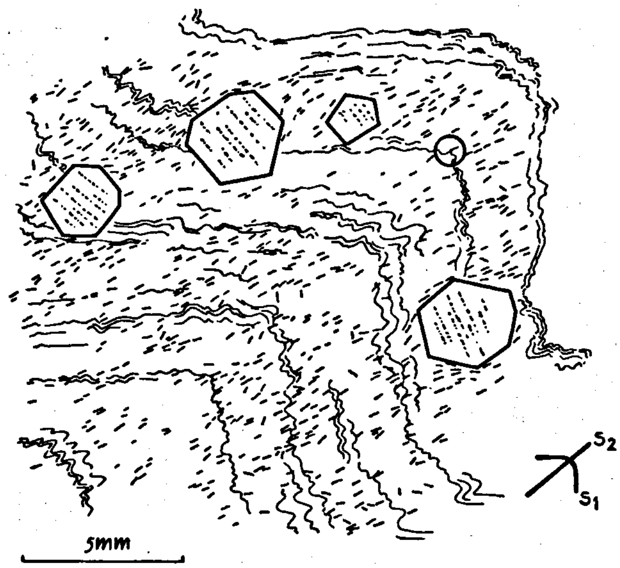
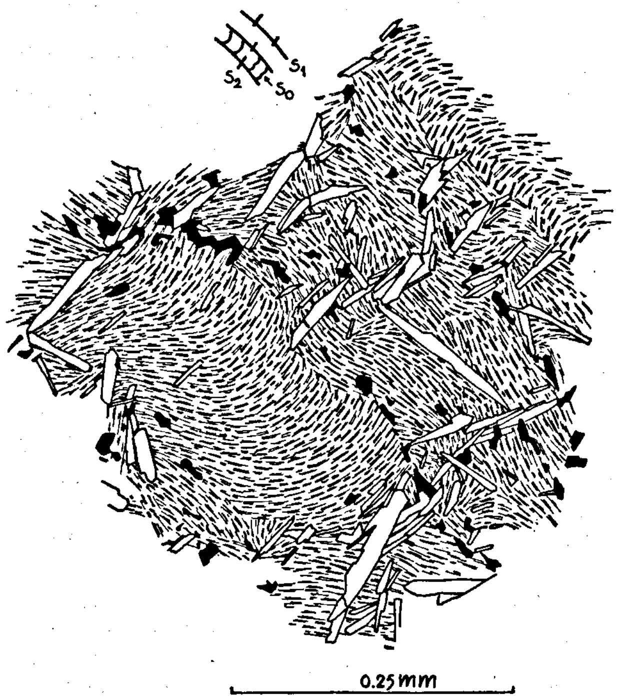


Fig. 3. A. F_2 fold crenulating s_1 with formation of muscovite flakes parallel to s_2. s_2 micas bend around garnet porphyroblasts with flat $s_i = s_1$, which have grown between F_1 and F_2. Encircled portion is shown enlarged in Fig. 3B. Garnet porphyroblast-bearing muscovite-chlorite schist, specimen M – 171/186 E1.



B. Detail of A showing the presence of s_0 crenulated by F_1, and some larger s_2 muscovites.

The main schistosity s_1 has been folded by a subsequent folding phase (F_2), sometimes generating s_2 crenulation cleavage planes (Fig. 3A). In most cases only few biotites or muscovites occur as newly formed crystals parallel to the F_2 axial planes (Fig. 4). The axial planes of F_2 are more steeply inclined than s_1. The fold

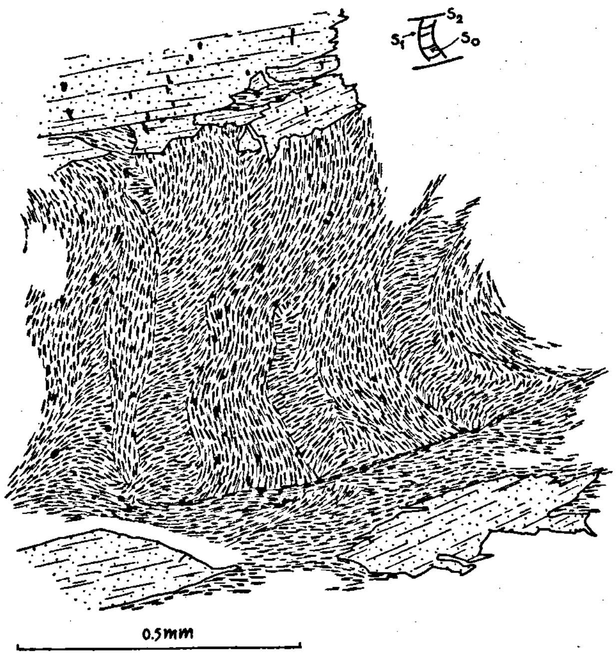


Fig. 4. Remnants of s_0 between s_1, crenulated by F_2. Biotite porphyroblasts have grown parallel to s_2. Biotite porphyroblast-bearing sericite-chlorite schist, specimen Hi – 685/154 A3.

axes of both phases trend roughly N–S and are sub-horizontal.

METAMORPHIC INDEX MINERALS

The metamorphic index minerals biotite, garnet, staurolite and andalusite generally have a porphyroblastic habit. The biotites started to grow between the first and second phase and continued to do so during F_2, for biotite parallel to s_2 has sometimes been observed. Some biotites even seem to be younger than F_2, since they are not deformed by it.

The growth of garnets must have largely taken place between F_1 and F_2 for in thin section a planar inclusion fabric (= s_1) is clearly visible while s_2 bends around garnet crystals (Fig. 3A). Only in a few cases the enclosed fabric is somewhat curved. Garnets have also been rotated by F_2.

Staurolite must have grown after the first phase and largely before the second, because it clearly encloses, like garnet, the first schistosity. Mostly, the inclusion fabric is planar and flat, but cases have been encountered in which it is slightly and in a few cases even strongly undulating, so staurolite must have continued to grow until after the beginning of the second phase. Occasionally staurolite has been observed to enclose garnet, whereas the opposite has never been seen. During F_2 staurolites were rotated (Fig. 5). Micas parallel to s_2 bend around the porphyroblasts, also around those with undulating s_i.

Most andalusites have a straight $s_i = s_1$ and therefore have crystallized between F_1 and F_2.

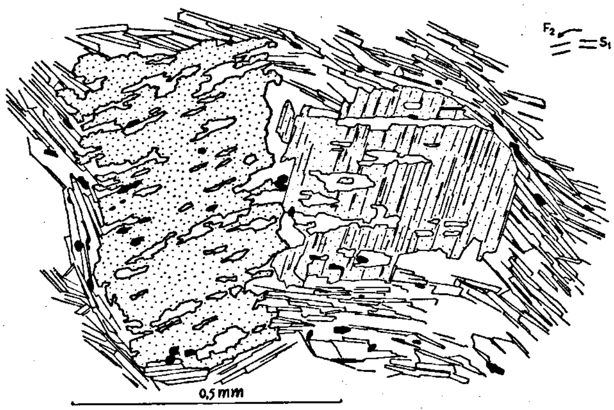


Fig. 5. Staurolite and biotite porphyroblasts enclosing flat $s_i = s_1$, and rotated by F_2. Staurolite and biotite porphyroblast-bearing muscovite-biotite schist, specimen Hi – 167/153 E3.

METAMORPHIC ISOGRADS

On the basis of field and laboratory observations, four isograds have been drawn on the geological map, characterized by the first appearance of biotite, garnet, staurolite and andalusite (Fig. 1). From the study of thin sections alone the reactions to which the isograds correspond cannot be deduced. The following data, however, may assist in deriving possible reactions:

chloritoid is only present in a few isolated localities;
biotite porphyroblasts develop in sericite-chlorite schists;
garnet porphyroblasts are found in schists with a chlorite-sericite matrix, a chlorite-sericite-green biotite matrix, and a coarser-grained muscovite-biotite matrix;
staurolite is found only in a coarser-grained muscovite-biotite matrix;
andalusite, when occurring together with garnet or staurolite, is always younger than these minerals.

The andalusite isograd closely follows the contacts of the various Hercynian granites and locally cuts across the staurolite and garnet isograds.

CONCLUDING REMARKS

1. A remarkable feature emerging from the microtectonic investigation of the Central Galician schist area is the presence of a planar structure older than the main schistosity s_1. It seems to be too well-developed to consider it as the original bedding of the sedimentary sequence or as a parallelism of micas, grown in the beddingplane during diagenesis. Since no folds were found to which it could be the axial plane cleavage no evidence is available to consider s_0 as an older schistosity generated by similar folding. However, the presence of quartz veins, isoclinally folded by F_1 and therefore older than that phase suggests the existence of low-grade metamorphic conditions prior to F_1.

These structures have not been described as such by Matte (1968) and Capdevila (1969), and the areal distribution and real importance of s_0 remain therefore to be evaluated.

2. The folding phases F_1 and F_2 and the relations between folding and the regional metamorphic growth of porphyroblastic minerals in the Central Galician schist area are very similar to those described by Matte (op. cit.) and Capdevila (op. cit.) from eastern Galicia.

3. Since most of the index minerals have grown between F_1 and F_2, the isograds must have been folded by F_2; the local continuation of porphyroblastic growth during the beginning of F_2, however, should complicate the reconstruction of their pre-F_2 position.

4. The fabric of the gneissic granites in the area suggests that they were only deformed or otherwise oriented by F_2. This conclusion is supported by the intrusive character of the granites cross-cutting s_1 of their wall-rocks, by the discordant character of the andalusite isograd with respect to the other isograds and by the observation of pre-F_2 andalusite around these granites.

Nevertheless, also the biotite, garnet and staurolite isograds show a rough relationship with the granites. Which geologic agents acted as the causes of this relationship, and which features should be considered as the results has not yet been established with certainty.

5. On a regional scale the style of the first and second phase folds can only be established when the mapping of individual rock sequences has been completed. Lack of conspicuous marker-horizons and of continuous outcrops have delayed progress on this part of the investigation.

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