27. "BASEMENT" ROCKS OF THE WESTERN ALBORAN BASIN

PREFACE

Metamorphic rocks were sampled from Hole 121 in the western Alboran basin. The site was located at 36° 09.65'N, 4° 22.43'W, at 1163 meters water depth, on the northern slope of a buried peak within the abyssal plain province (see Chapter 3 of this volume). The acoustic basement lay 9.0 seconds (or 850-990 m) below the seabed. Fragments of metamorphic and ultramafic rocks were recovered, in Cores 23 and 24, from 859-867 meters subbottom. In addition, a large piece, some 6 cm long, was jammed in the orifice of the drillbit.

Samples from the 121-24-CC are now recognized to be the clasts in a breccia, and are given numbers 13-121-24 CC-B1 to B5. The piece jammed in the bit has been designated 13-121-24 CC-A1. This large specimen may either represent a large cobble in the breccia or the actual basement at Site 121. A second smaller rock recovered from the drillbit above piece A1 is labeled 13-121-24 CC-A2. This Chapter gives petrographic descriptions, radiometric data, and trace-element analysis of these samples, and discusses their correlation with similar rocks on land nearby.

27.1. PETROGRAPHY OF THE WESTERN ALBORAN BASIN "BASEMENT"

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Seven samples of metamorphic rocks were examined petrographically. Samples 13-121-24 CC-A1 and 13-121-24 CC-A2 may represent the *in situ* basement. Other samples are clasts in a basal breccia (Figure 1) underlying Upper Miocene Tortonian marl oozes. The possible "basement" rock is a cordierite-biotite-feldspar hornfels. The detritus in the breccia includes altered granodiorite, biotite-plagioclase gneiss, biotite-quartz schist, and muscovite granodiorite gneiss. The mineral assemblages of all these rocks are indicative of crystallization under amphibolite-facies and retrograde metamorphism under greenschist facies conditions. It is remarkable that the detrital components of the breccia do not contain any element foreign to amphibolite-facies plutonism. This fact tends to favor the idea that the local basement, even if Sample 121-24 CC-A2 is a detrital cobble, includes only plutonic rocks of the amphibolite facies.

Detailed petrographic descriptions of the thin-sections are given in the following sections.

13-121-24-CC-A1 – Cordierite-Biotite-Feldspar Hornfels

The specimen (Figure 2) is a layered hornfel composed of cordierite (40%), potash feldspar (30%), biotite (20%), plagioclase (10%) and lesser amounts of chlorite and sericite. The anhedral potash feldspar occurs interstitially with the subhedral to anhedral cordierite. The reddish brown biotite occurs in plate aggregates and semi-parallel bands. The albite twinned plagioclase occurs in subhedral aggregates and as discrete subhedral crystals. Interlayered in the hornfels are thin stringers of chlorite-sericite aggregates accompanied by biotite, plagioclase, and magnetite. The chlorite aggregates seem to be pseudomorphs after large garnet crystals up to 5 mm in diameter.

Sample 13-121-24 CC-A2 – Micaceous Quartz-Feldspar Gneiss

The major components of this rock (Figure 3) are quartz (50%), potash feldspar (25%) biotite (8%) and muscovite (5%). Present in small amounts are plagioclase, garnet, blue green amphibole, chlorite, sericite, and opaque iron minerals. The quartz crystals are anhedral, granoblastic, with undulatory extinction. Their sizes are variable, ranging up to 1 mm. The potash feldspar is subhedral to nearly euhedral and is porphyroblastic. Twinning is present in some and minute inclusions are common. The larger porphroblasts are more than 2 mm long. The biotite is reddish brown and shows signs of being deformed. The white micas are present both as lepidoblastic flakes and as sericitic aggregates replacing potash feldspar or garnet. The plagioclase has a composition of andesine, is twinned and slightly zoned. The garnet crystals range up to 1.5 mm in size, but they were partially or wholly altered during retrograde metamorphism. A protective rim of chlorite aggregates is present around some of the altered crystals. Blue green amphibole which is a strongly pleochroic actinolite, is in slender crystals less than 0.5 mm long. The major constituents of the metamorphic rock indicate that this medium-grained plutonic rock was crystallized as a gneiss under the conditions of amphibolite-facies metamorphism. The rock was altered again during a later episode,

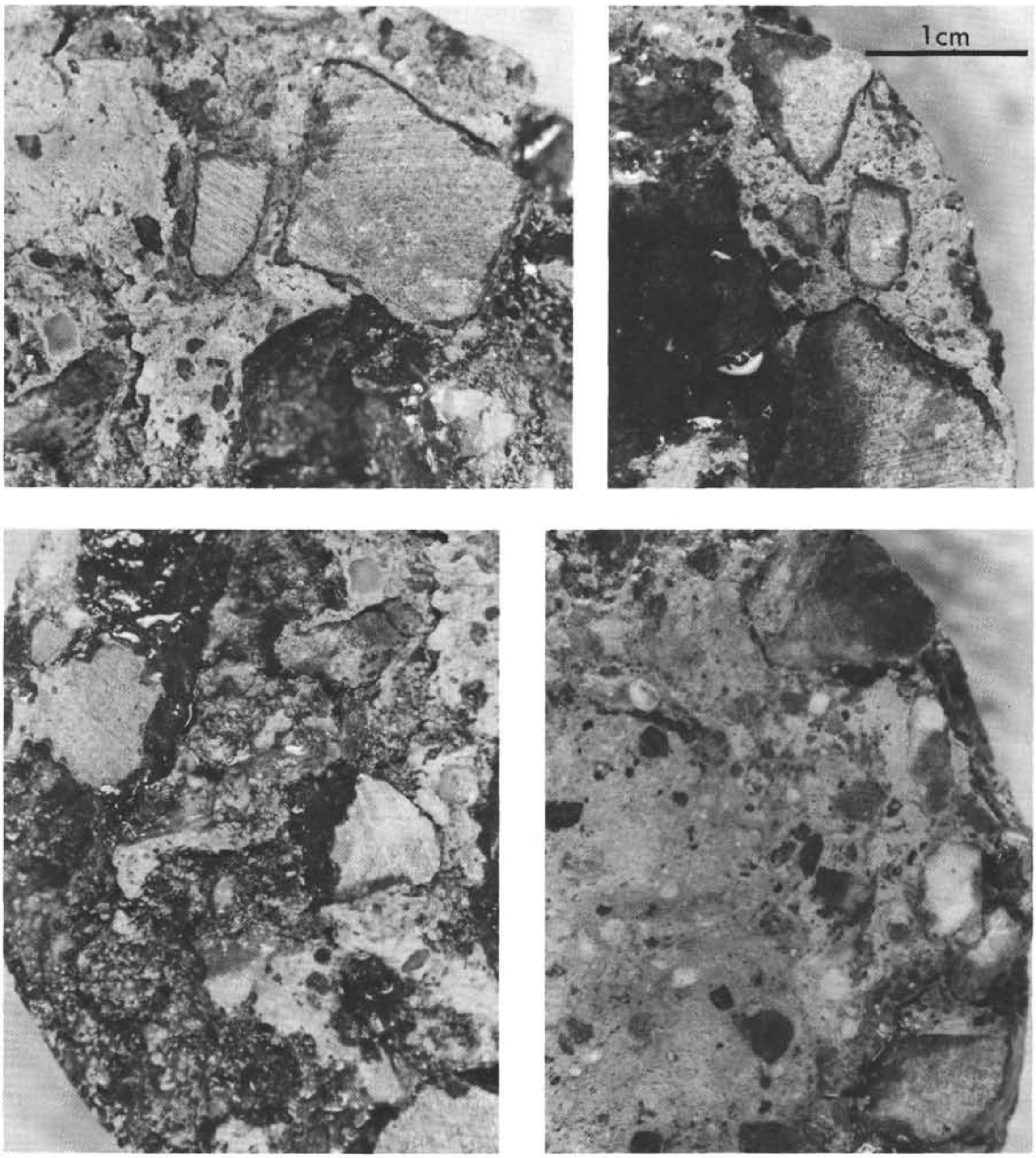

Figure 1. *Slices through the basal breccia in the Core Catcher sample of Core 24, Site 121 in the western Alboran Basin. Several of the rock fragments have been thin-sectioned and are designated in the descriptions of the test with the prefix B. The mineral assemblages of all these rocks are indicative of crystallization under amphibolite-facies and retrograde metamorphism under greenschist facies conditions. The light colored marl matrix has not been baked and contains marine microfossils of Tortonian age and flakes of serpentinite.*

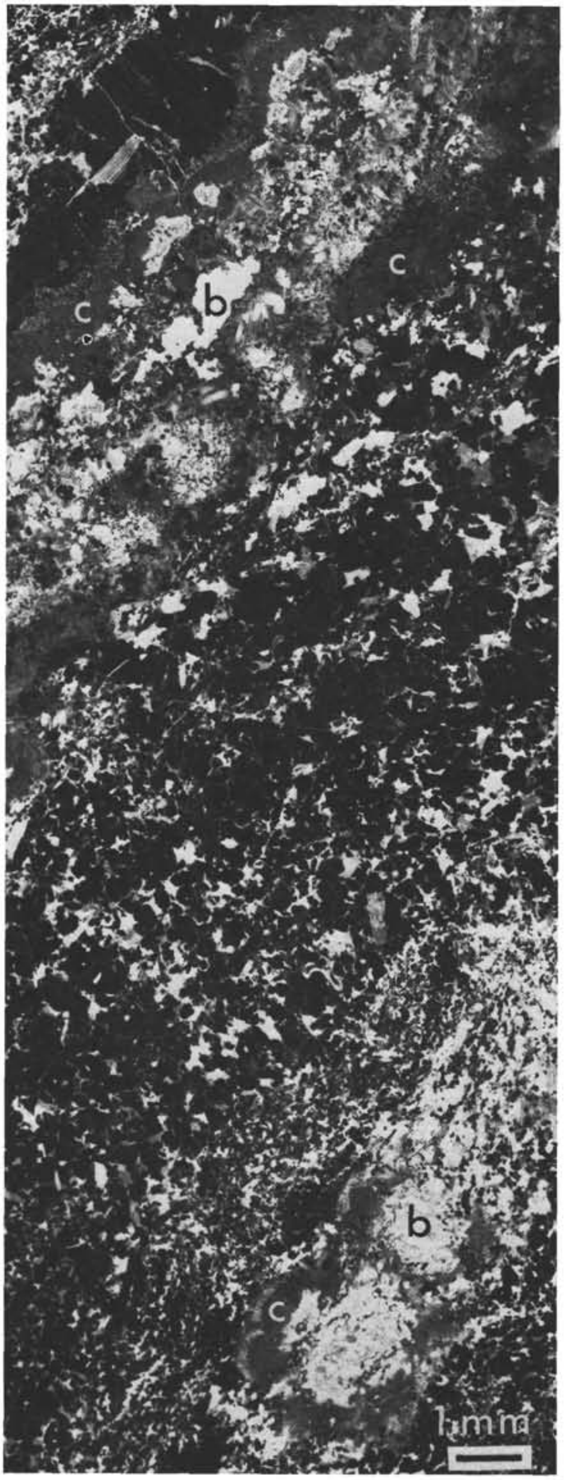

Figure 2. *Sample 13-121-24 CC-A1 is a cordierite-biotite-feldspar hornfels. This coarse-grained irregularly banded rock is dominated by equidimensional grains of cordierite (a) and potash feldspars. It is particularly rich in biotite (b) occurring in elongate patches (light colored) rimmed by sericite-muscovite and chlorite (c). Reverse print, plane-polarized light.*

producing the actinolite-chlorite-sericite assemblage. This is indicative of retrograde changes under the conditions of the greenschist-facies.

Sample 13-121-24 CC-B1 – Altered Granodiorite

The specimen (Figure 4) consists of euhedral crystals of altered feldspar (45%), quartz (40%), plagioclase (10%) and muscovite (5%). The euhedral feldspar crystals are almost completely altered to very-fine-grained sericitic aggregates. They may have been potash-feldspar. The largest crystal is more than 2 mm. Quartz is anhedral, with undulatory extinction and fractures; the largest grain is about 3 mm. Muscovite, present as 1-mm-long flakes, is probably a primary mineral. On the other hand, sericitic aggregates are obviously replacement products during secondary alteration. Traces of chlorite and magnetite have also been recognized.

This rock belongs to a gneiss basement. The secondary alteration may have been related to a later orogenic event.

Sample 13-121-24 CC-B2 – Biotite-Plagioclase Gneiss

The slide consists mainly of twinned plagioclase (60%) and reddish brown biotite (40%). The plagioclase is a calcic andesine or labradorite. Traces of apatite and sphene are present. This specimen is a metamorphic rock of amphibolite facies.

Sample 13-121-24 CC-B3 – Diopsidic Biotite-Quartz Schist

The specimen (Figure 5) consists mainly of fine-grained quartz (65%) and biotite (25%). The biotite-flakes are mostly 0.1-0.2 mm long and are considerably finer than those in 121-24-B2. Present in small amounts are diopside (5%) and potash-feldspar (5%). Relic garnet crystals, broken and replaced by biotite have also been identified.

The metamorphic assemblage is typical of the amphibolite facies.

Sample 13-121-24 CC-B4 – Altered Granodiorite

This sample consists of anhedral quartz (50%), anhedral potash feldspar (30%), plagioclase (15%) and muscovite (5%). The euhedral plagioclase has been almost completely altered to very-fine-grained sericite aggregates. The quartz has undulatory extinction and is thoroughly fractured. The sericite aggregates appear to be replacement products produced during secondary alteration.

Sample 13-121-24 CC-B5 – Muscovite-Granodiorite Gneiss

The rock (Figure 5) consists mainly of potash-feldspar (30%), quartz (40%), and white micas (20%). The potash-feldspar is characterized by its Carlsbad twinning; subhedral crystals range up to 2 mm. The quartz is, as usual, anhedral and shows undulatory extinction. The white micas include both muscovite flakes up to 1 mm long and very-fine-grained sericite aggregates. The latter are common alteration products of feldspars. Plagioclase is present in small amounts (5%) and slightly zoned. Traces of epidote, magnetite, sphene and chlorite are present.

This rock, either an orthogneiss or a paragneiss, belongs to a part of an amphibolite-facies crystalline complex.

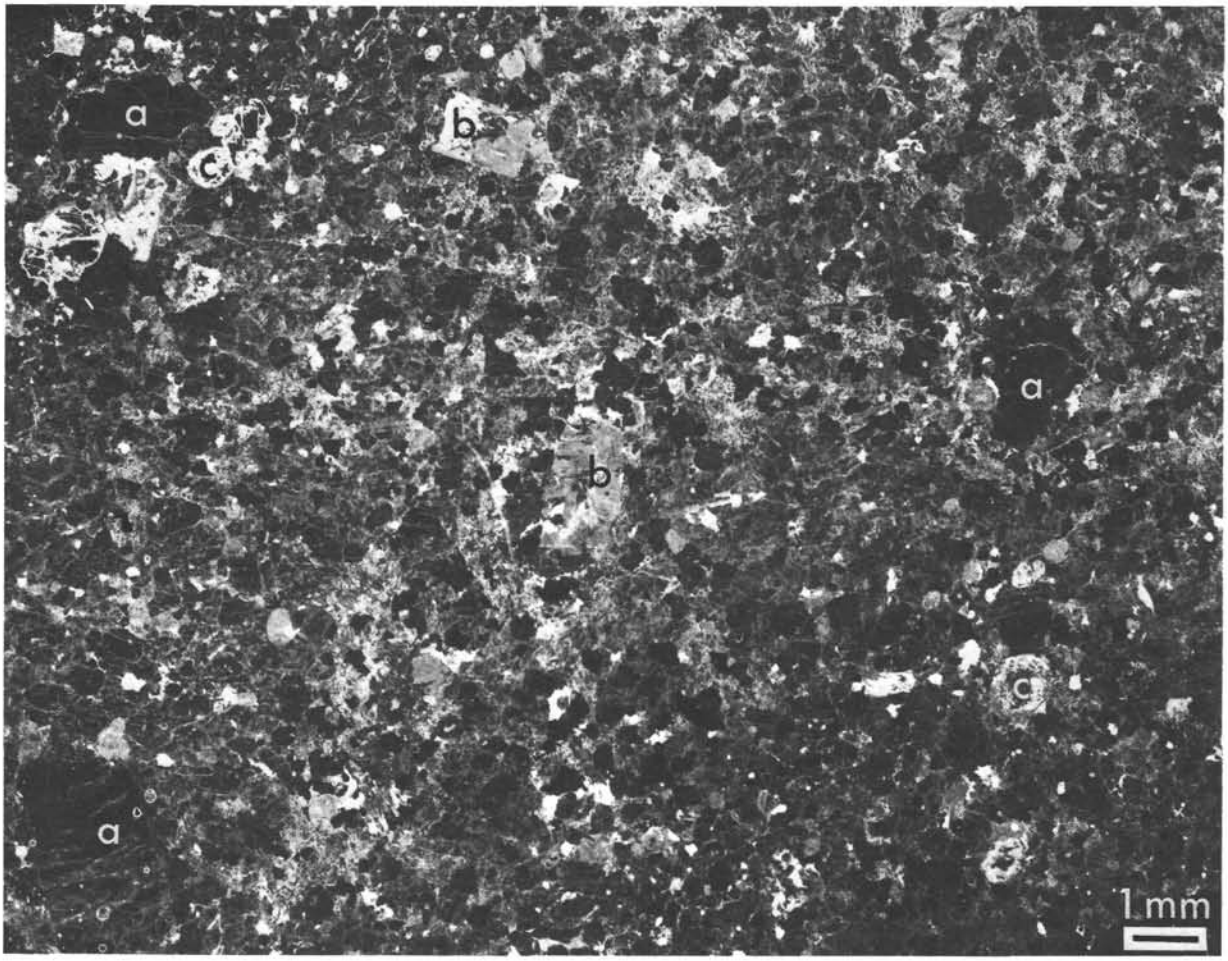

Figure 3. *Sample 13-121-24 CC-A2 is a micaceous quartz-feldspar gneiss. The dominant mineral, quartz (a), is anhedral and granoblastic with undulatory extinction. The potash feldspars (b) are occasionally nearly euhedral and are porphroblastic, some reach 2 mm in length. Garnet crystals (c) are partially or wholly altered during retrograde metamorphism. Reverse print, plane-polarized light.*

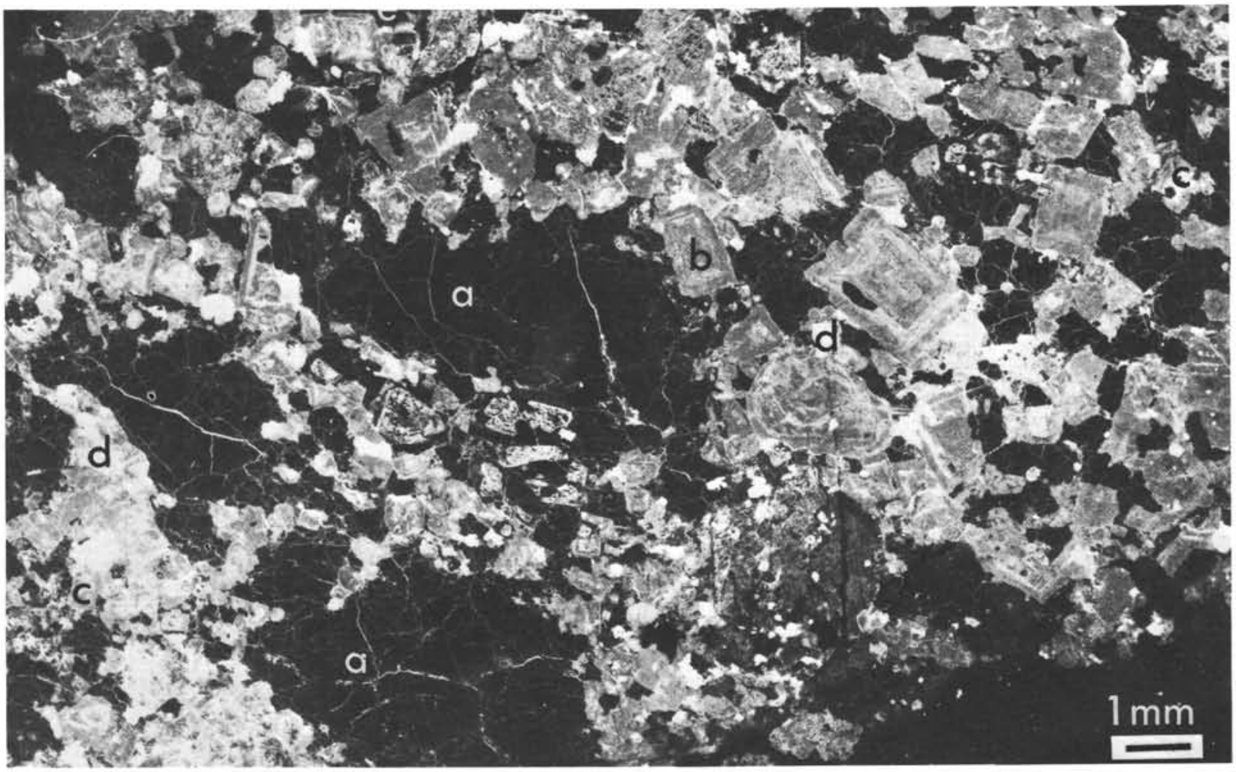

Figure 4. *Sample 13-121-24 CC-B1 is an altered granodiorite. The quartz grains (a) are very large, heavily fractured, and show undulatory extinction. The euhedral feldspars (b) are almost completely altered to sericite and chlorite. Some muscovite (c) is present in elongated flakes along with opaque inclusions of ilmenite-magnetite (d). Zoned plagioclase (e) with anhedral cores of sericite and chlorite are, according to T. Loomis (personal communication), identical to hornfel occurrences around the Ronda ultramafic massif. Reverse print, plane-polarized light.*

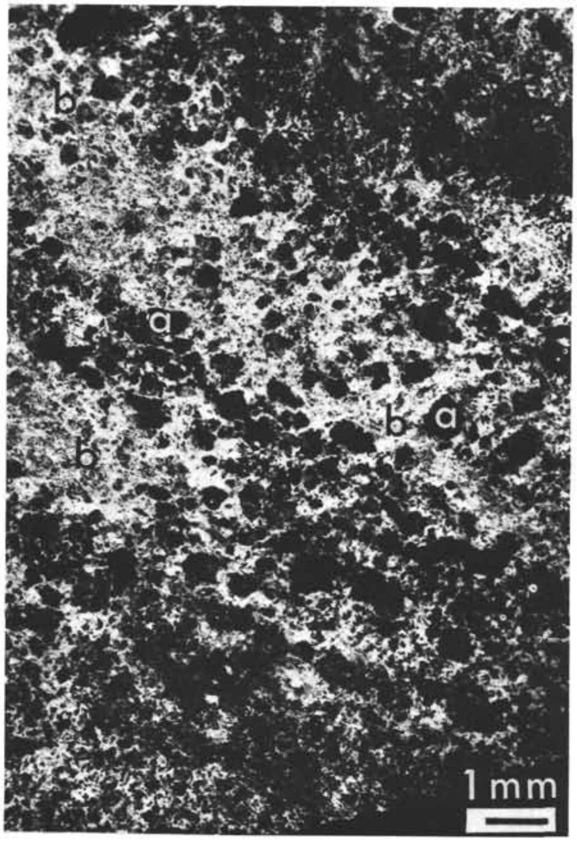

Figure 5. *Sample 13-121-24 CC-B3 is a diopsidic biotite-quartz schist. The foliation is most marked with parallel bands of quartz (a) sometimes elongated, alternating with reddish brown biotite color, (b), usually as quite small flakes. Reverse print, plane-polarized light.*

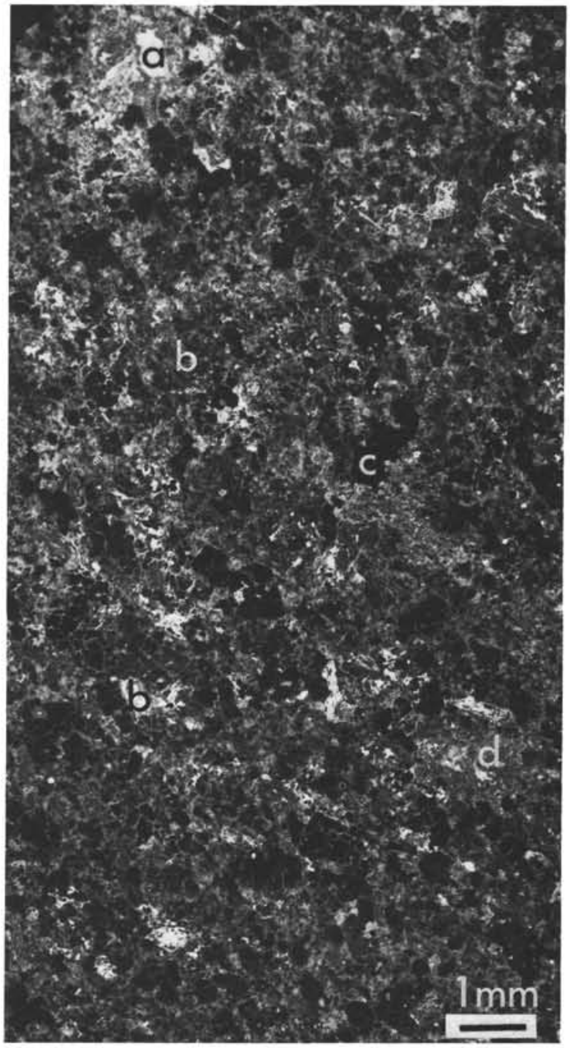

Figure 6. *Sample 13-121-24 CC-B5 is a muscovite-granodiorite gneiss. The white micas in this specimen include flakes of muscovite (a) up to 1 mm in length. The potash-feldspar (b) is characterized by Carlsbad twinning with subhedral crystals up to 2 mm in length. The quartz (c) is cataclastic and shows undulatory extinction. A large sericite clot (d) has low birefringence and is length fast with a reddish pleochroism, characteristic of andalusite left over from a lower-grade assemblage. Reverse print, plane-polarized light.*