# DIAGENETIC REPLACEMENT OF MICAS BY CARBONATES

## A PRELIMINARY NOTE *)

BY

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ABSTRACT

In the Ordovician sandstones of the Cantabrian Mountains a replacement of the micas by carbonate minerals could be observed. The absence of metamorphic minerals suggests a diagenetic replacement. This is supported by the finding of the same type of replacement in some undisturbed Pliocene sediments of an intramontane basin in the French Pyrenees. It seems that replacement can occur at any stage during diagenesis.

## INTRODUCTION

Replacement of quartz and some silicate minerals by carbonates during diagenesis has been described by several authors. At first this has been done in regard to quartz and feldspars, but Pfefferkorn & Urban (1957) and Walker (1960) already mention the same phenomenon regarding glauconite, the latter author even going so far as to state that "most of the common silicate minerals in sedimentary rocks appear to be susceptible to replacement by carbonates...". Though this may be true, to my knowledge up to now descriptions of replacement have been given only of the three minerals mentioned above.

In the Ordovician sandstones of the Cantabrian Mountains (Spain) a replacement of those minerals occurs, but moreover muscovite and biotite appear to have been attacked by solution, and replaced by calcite. Having found this in the slides of these palaeozoic sandstones I studied a thin section of a caliche of Upper-Pliocene age in which biotite is one of the detrital constituents. Here also there is a strong indication for replacement of the mica by calcite.

Before briefly describing the replacement features I shall give some information on the sediments.

## GENERAL DESCRIPTION OF THE SEDIMENTS

### *The Lower-Palaeozoic sediments*

1. *Macroscopical description:* The layers, in which the replacement can be observed, form the lower part of the Oville formation, which is Ordovician in age (Comte, 1959). The formation consists of alternating sandstones and

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shales. The total thickness is about 300 metres. The shales in the lower part contain abundant calcareous nodules, suggesting a gradual transition from the underlying Cambrian limestones to this more clastic deposit.

Several kinds of sedimentary structures are present, though infrequent. They are ripple-marks, gullies, load casts, and in a single outcrop slumpballs in several layers.

As to the environment of deposition the sedimentary structures lead us to suppose it was marine and shallow.

2. *Microscopical description:* The sandstones are rather fine-grained. The median values of the grainsize-distributions lie around 100 $\mu$. The sorting is fairly good. The four principal constituents are quartz, clay, carbonates, and limonite. Minor constituents are feldspars, muscovite, biotite, and glauconite. Quartz grains have very irregular outlines. Some show a secondary overgrowth. Only in such a case the original outline can be observed. Using the roundness-scale of Pettijohn (1957) we may classify the primary detrital grains as subangular to subrounded. Pitting of the grains occurs as well. In some instances I could notice authigenic glauconite in the pits. The grain contacts are straight, zig-zag or sometimes concavo-convex. Most of the grains do not touch, separated as they are by the clayey matrix or the carbonaceous cement. The matrix is built up by quartz and sericite. It fills only a part of the pores. The carbonate cement is mainly calcitic. Small amounts of dolomite and siderite are present. They form irregular crystals as well as fine-grained aggregates. Part of the calcite seems to be syndepositional. Limonite is distributed through the sediment in irregular patches. An alteration of carbonates into limonite, as suggested by Carozzi (1960) seems to be improbable here. Occasionally feldspar grains are met with. They show corrosion features at the edges. Partly they have been altered into sericite, partly they have been replaced by calcite.

The most important minerals of the mica group are muscovite and biotite. Their shape is sometimes elongated. Glauconite is always present, but only in small amounts. Replacement by calcite as described by Pfefferkorn & Urban (1957) is clearly visible.

### *The Upper-Pliocene sediments*

1. *Macroscopical description:* In the French department Pyrénées Orientales there are some small intramontane basins, which have been filled up during the Late-Pliocene. The sediments undoubtedly reveal a terrestrial environment of deposition. Studying the sediments of the basin of Prades, Sluiter discovered between the sand beds and conglomeratic layers several beds, which were much more cemented by calcite. He considered them to be calcareous crusts. The texture and mineralogical composition as seen in the thin section supports this idea.

2. *Microscopical description*: The detrital constituents are mineral grains as well as rock fragments. All of them show corrosion features and have irregular outlines. Quartz grains do not have secondary overgrowths. The feldspars are sometimes disintegrated by solution along fractures and their fragments rotated by calcitic growth. The grains do not touch and are floating in the cement, though the distance between them seems rather small in relation to the grainsize.

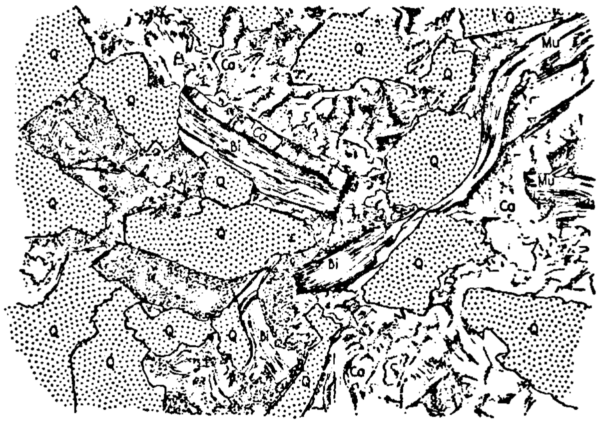


Fig. 1 Carbonate, lying against biotite in the centre of the picture, showing pseudomorphism after biotite ( × 200, crossed nicols)

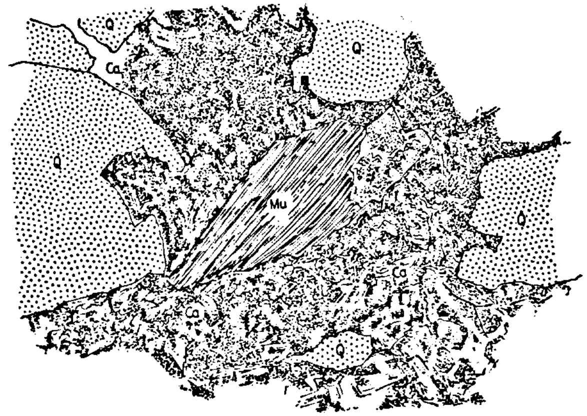


Fig. 2 Muscovite corroded along the edges. At the extremity a zone of calcitic grains resting on the mica ( × 400, crossed nicols)

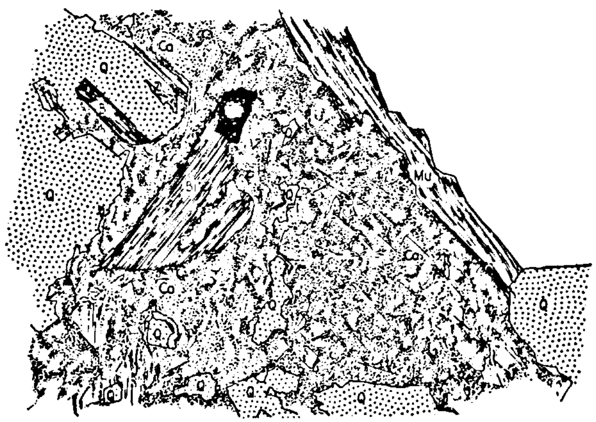


Fig. 3 Central part of biotite grain having been replaced by calcite ( × 300, crossed nicols)

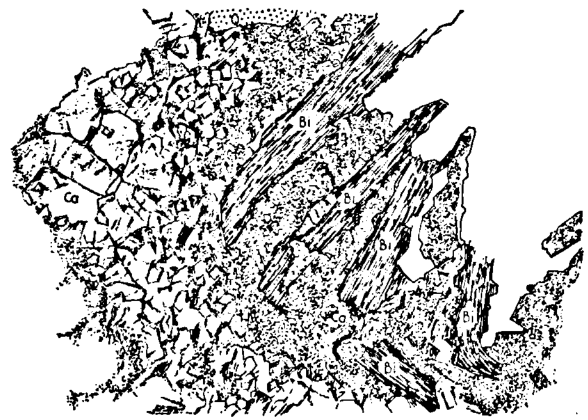


Fig. 4 Biotite grains, partly replaced by calcite ( × 150, uncrossed nicols)

Q = quartz, Bi = biotite, Mu = muscovite, Ca = carbonate, To = tourmaline.

The cement is calcitic. Nearly all of the detrital grains are surrounded by a rim of a crypto-crystalline aggregate of calcite, not unlike an oölitic texture. The rim may be discontinuous and it follws the outlines of the grain. Outside the rims the calcite forms subhedral crystals. In some cases I could notice a zone of finely-crystalline calcite between the crypto-crystalline rim an the detrital grains. In such a case there is a sequence in accordance with the description given by Nicholas (1956), who assumes the finely-crystalline calcite to be replacing material. Also there is a strong resemblance with the pisolitic limestones described by Swineford, Leonard & Frye (1958). This is not surprising since the origin of the two sediments is similar (Oele, Sluiter & Pannekoek, in press).

## REPLACEMENT OF THE MICAS

At first the replacement was suggested by the presence of calcitic bars, which are pseudomorphic after micas (fig. 1). Upon closer examination a zone of transition between the extremities of some mica blades and the carbonate cement could be seen. In this zone no sharp boundary between the mica and the carbonate can be traced, calcitic grains and the relics of mica being mixed up. More convincing is the corrosion along the edges of the micas, analogous to that of etched quartz in a carbonaceous cement (fig. 2).

Both muscovite and biotite can be replaced. Fig. 3 gives an example of a partly replaced biotite grain. In its present form the grain could not have been transported. Because of their size an authigenic origin of the micas is not likely. A pushing apart of the mica blades seems highly improbable, the grain lying parallel to the bedding plane. Moreover in the middle part there are some relics of biotite, which unfortunately do not show clearly on a photograph. Fig. 4 gives a picture of the replacement of biotite in the caliche. The original outline of the grain is still visible.

At the moment it is impossible to say if the replacement takes place along certain planes of preference. A further examination may bring this to light. Another question arises from the presence of unattacked micas. It may be that conditions varied within short distances as has been suggested by Walker (1960).

As to the time of replacement the examples given above support the idea that it can occur at any moment during diagenesis. This is in accordance with the replacement of quartz by carbonates, which can take place in an early diagenetic stage, for example in the case of the pisolitic limestone mentioned above or of the Pliocene sediments described by Alimen & Deicha (1958), as well as in later stages, according to the conclusion by Heald (1956).

The author should be very grateful to be informed when other investigators find the same replacement phenomenon especially as to the environment, in which it is suggested to have been occurred.

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