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ON THE PETROGRAPHY OF THE LANCARA FORMATION FROM THE SIERRA DE LA FILERA (SPAIN)

BY

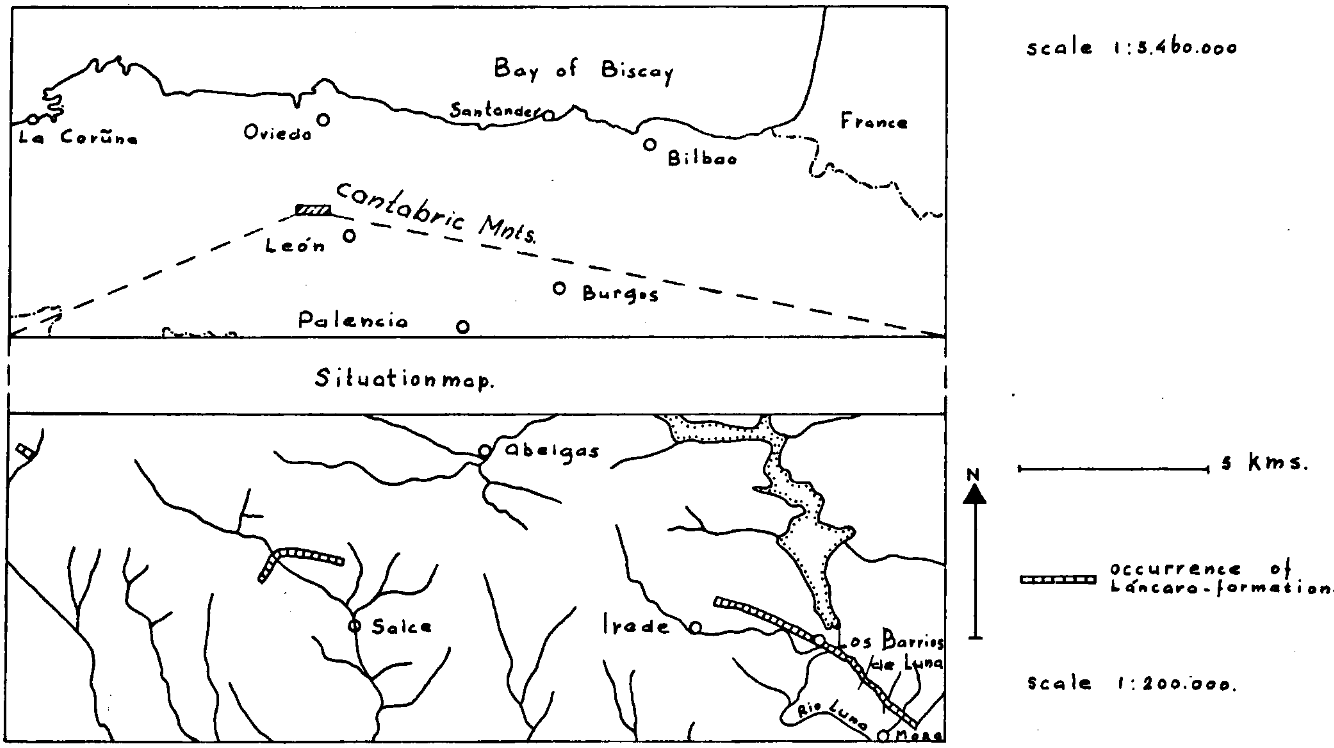
C. G. VAN DER MEER MOHR
G. A. N. H. SCHREUDER

ABSTRACT

The sediments of the, Cambrian, Lancara Formation show features which suggest their deposition in a shallow marine environment. The occurrence of stromatolites might indicate that some sediments were deposited in an intratidal environment. The gradual change, upward in the stratigraphic section, from stromatolite deposits via calcarenites to argillaceous limestones and shales is being interpreted as a transgressive marine sequence. The possibility of a penecontemporary dolomitization of the lower part of the formation followed by secondary, post Namurian?, dolomitization is suggested.

INTRODUCTION

The Sierra de la Filera forms the SW part of the Cantabrian Mountains (fig. 1a). Paleozoic sediments of pre-Westfalian age are folded here to an EW striking syncline, the Abelgaz syncline, and this fold is cut in a NS direction by the Rio Luna. Along the eastern side of the Luna valley one can find a continuous section of Paleozoic rocks ranging in age from the Precambrium to the Devonian (fig. 1b). The Lower Paleozoic strata of the Cantabrian Mountains are mainly quartzites and shales with the exception of the rocks of the Lancara Formation. This formation is formed of limestones and dolomites with near the base and near the top, some shale intercalations. The type section of the Lancara Formation is near the inundated village of Lancara de Luna (Plate 1A) north of the area that is discussed in this paper. The type section is poorly exposed and the strata have been intensely folded. Therefore a detailed study of



Distribution of the Láncara-formation in the Sierra de la Filera

Figure 1a

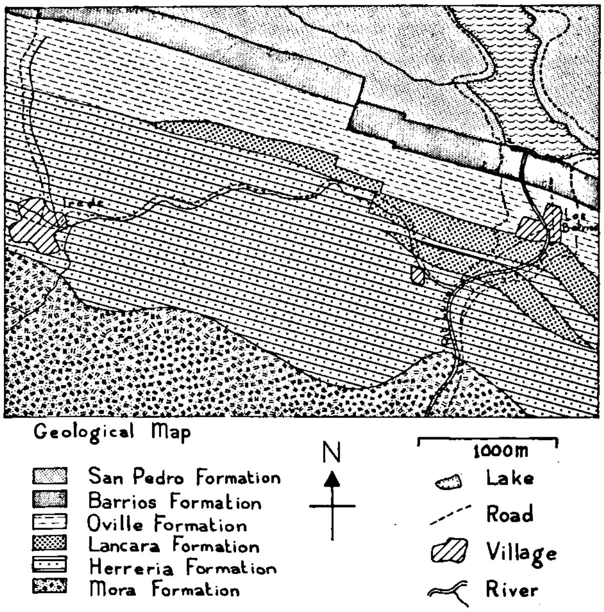


Figure 1b

the Lancara Formation could be much better carried out in the road cuts near Los Barrios de Luna (Plate 1B).

Near this last village the Lancara Formation can be divided into three, distinct, members (fig. 2) which was already mentioned by Lotze & Sdzuy (1961). From a structural point of view the Lancara Formation is very important since the base of the formation coincides with thrustplanes in the Cantabrian Mountains. This might be due to a difference in response to folding between the basal dolomites of the Lancara Formation with their shale intercalations and the underlying sandstones of the Herreria Formation.

Another point to be mentioned is that W of Los Barrios the upper member of the Lancara Formation, the griotte member, disappears without a noticeable change in thickness of the formation. Whether this is due to a facies-change or is caused by folding and faulting is yet an unsolved question.

Previous work on the Cambrian strata of NW-Spain dates as far back as 1860 (Casiano de Prado). From the other geologists who came after de Prado we should like to mention Comte (1959), Lotze & Sdzuy (1961), Oele (1964) and de Sitter and his collaborators who mapped the Cantabrian Mountains in detail. Schreuder (Leiden University) mapped the area, discussed in this paper, for his M. Sc. thesis in 1964 and 1965. The petrographic part of this article and the interpretation of the data were done by the other author. Further research on the formation is carried out by him.

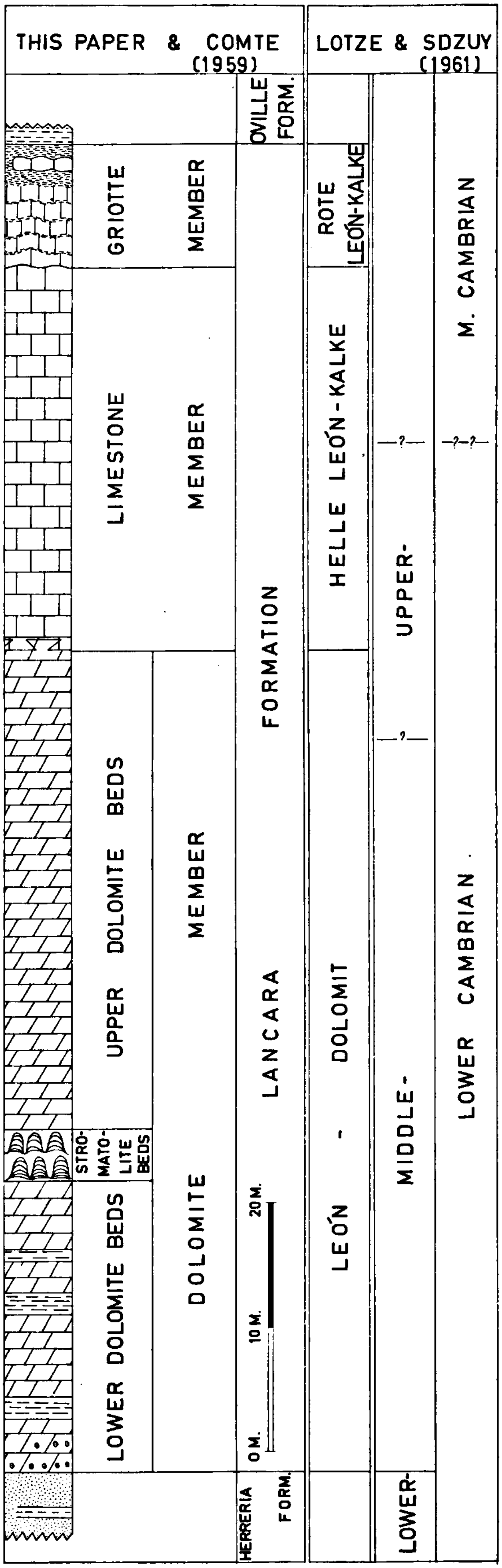


Figure 2: Stratigraphic column of the Lancara Formation.

DESCRIPTION OF THE STRATA

The most basal member of the formation is the dolomite member (fig. 2). It has a yellowish-brown weathering color and can be subdivided into

c) the upper dolomite beds
b) the stromatolite beds
a) the lower dolomite beds

(pending further work on the Lancara Formation we do not intend to give these beds an official stratigraphic rank yet).

The lower dolomite beds are about 23 m thick with chertified, oolitic dolomites as their most striking part. Between the oolites (which are 1—1,5 mm in diameter) are fine to medium sized (Wentworth-Udden scale), well rounded fossil fragments. Chert lenses occur near the top of the oolitic dolomites. Higher up in the section are finely crystalline, calcareous, dolomites which show small-scale cross bedding (Plate IIA) and sometimes a varve-like lamination (Plate IIB). Thin sections of this dolomite showed, after coloring with Alizarine Red S., that the rock consists of alternating layers of finely crystalline dolomite and calcite. The sediments were probably devoid of fossils since none were found in them. In the lower dolomite beds are also some layers of greyish-brown weathering, dark grey, calcareous shales.

The stromatolite beds form a 3 to 4 m thick unit following on the lower dolomite beds. The stromatolites consist of a combination of *Collenia* and *Cryptozoon* structures (Logan et al., 1964) and are not higher than 50 cm (Plate IIC). Generally they are about 2 to 5 cm in diameter and 5 to 20 cm high and give the impression of having been rather delicate forms. Thin sections show that they are made of finely crystalline calcite and stringers of dolomite parallel to the dome shaped bedding of the stromatolites. Between and in the stromatolites are pink nodules of sparry calcite (Plate IIC). The stromatolite beds are cut off abruptly by cross bedded, dolomitized fragmental limestones (Plate IID). They grade upward into another series of dolomites which are about 40 m thick. The lower part of these dolomites consists of yellowish-brown finely crystalline dolomites which are identical to the finely crystalline dolomites described above. Small scale cross bedding and intraformational breccias (Plate IIIA) are common in this interval. Higher up in the section the dolomites become very coarsely crystalline and porous and their weathering color changes to reddish-brown.

The coarsely crystalline dolomites are followed by 30 to 40 m of grey limestones of the limestone member. All limestones in this unit are dolomitized fragmental limestones. The size and nature of the fragments vary, mostly the fragments are fine to medium sized. In some outcrops limestones which look similar to the birdseye limestones described by Ham (1952) dominate the section (Plate IIIB). Thin sections show that they are well stratified intrasparites-intrasparudites (see for these terms Folk, 1959). In other outcrops algal remains such as algal balls, algal mats and stromatolites are abundantly present. The stromatolites in this interval are of a much sturdier looking type than those described previously. They are surrounded by algal debris in which fragments of algal mats up to 6 mm in diameter can be found (Plate IIIC). Sparry cement is the dominant matrix in these limestones.

Towards the top of the limestone member the limestones gradually become pink in color. These pink limestones are recrystallized fragmental limestones (Plate IIID) containing fragments of brachiopods and trilobites.

The griotte member, around 15 m thick, follows gradually on the pink limestones and consists of reddish-brown shales and argillaceous limestones. Most of these limestones are more or less recrystallized biomicrites and biosparites. The fossil fragments are pieces of trilobites and brachiopods. The uppermost part of the Griotte Member becomes very argillaceous and red shales dominate the picture. At the top of the Lancara Formation the red shales suddenly change to the brown shales of the overlying Oville Formation. This change takes place in a few meters but no distinct anomalous contact is visible between the Lancara Formation and the Oville Formation.

CONCLUSIONS

Although our investigations into the Lancara Formation are not in a final stage we like to make some suggestions as to the possible environmental picture. It is fully realized however that this interpretation is heavily based on comparisons with data from areas with recent carbonate deposition. The following points are believed to be the most important facts.

1. The Lancara Formation is a unit of carbonate rocks overlying sandstones of the marine Herreria Formation (Oele, 1964). The contact between the two formations is sharp and conformable.
2. The lower member of the Lancara Formation consists of dolomites. At their base they are oolitic and contain a stromatolite bed. The top of the dolomites is coarser crystalline.
3. The limestone member consists of calcarenites, and calcirudites and shows in some places abundant algal remains. The unit changes via pink calcirudites and calcarenites into the Griotte Member.
4. The griotte member is the most argillaceous member and goes conformably over into the overlying Oville shales.

Our conclusions are that, following the deposition of the sandstones of the Herreria Formation shallow marine carbonates were deposited. The first carbonates, the oolites, were probably still deposited in a

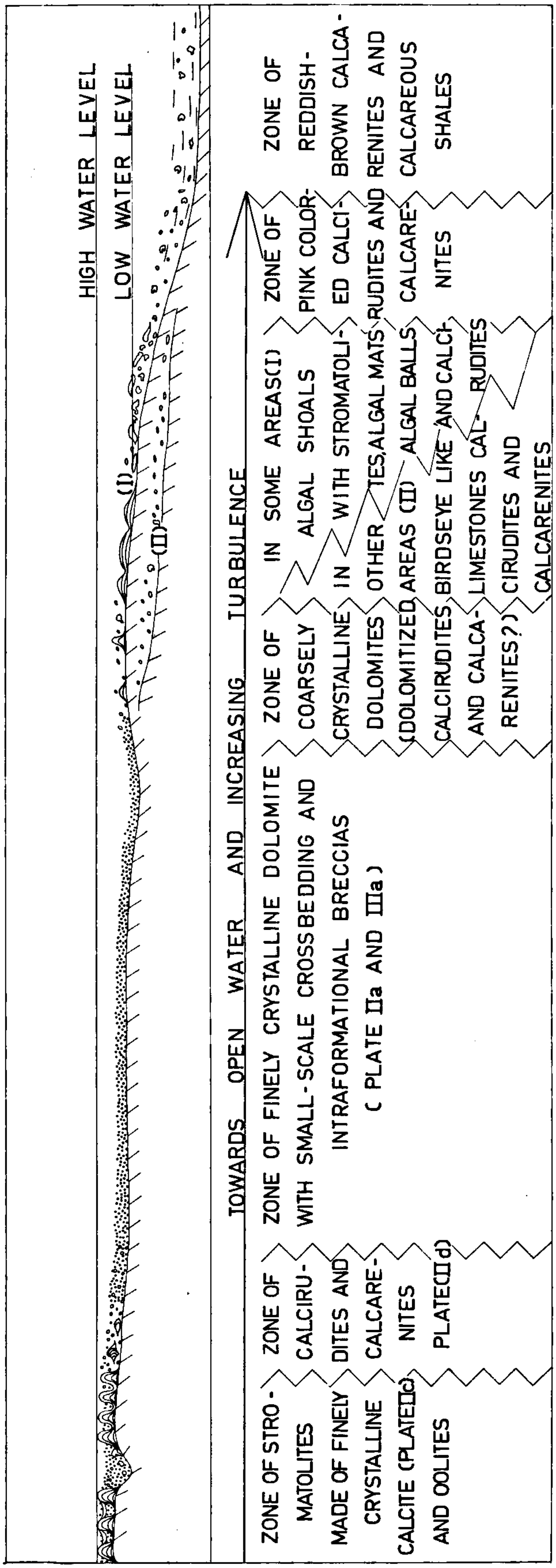


Figure 3: Cross section showing the possible lateral environmental relationships of the sediments forming the Lancara Formation.

relatively agitated environment. Later on more tranquil conditions prevailed, during which carbonate mud was deposited. This carbonate mud changed later into the finely crystalline, calcareous dolomites. The stromatolite beds in the dolomite member represent an intratidal environment. The carbonate mud surrounding the stromatolites provided the material for the construction of the stromatolites. Therefore we find today that the stromatolites are also composed of finely crystalline calcite and dolomite. Since we did not find any fossils in the dolomites we can assume a very scarce fauna in this environment. The fragmental limestones overlying the stromatolites represent the only deposits in this interval which formed under slightly more agitated conditions. They were probably deposited in an area just below low water mark where no stromatolites flourished and where the waves provided the necessary agitation to winnow the finest carbonate particle away. The thick section of finely crystalline dolomites overlying the fragmental limestones were also deposited as carbonate mud in a sheltered area (lagoon?) that might have looked somewhat similar to the "sebkhas" described by Illing et al., (1965). The small scale crossbedding and the size of the fragments in the intraformational breccias indicate very tranquil conditions. In contrast to these finely crystalline dolomites stand the coarsely crystalline, porous dolomites. Intensive dolomitization has obliterated most of the characteristics of the original sediment. However, since they lie between the finely crystalline dolomites and the fragmental limestones of the Limestone Member we assume that they are a dolomitized version of the fragmental limestones. The limestones in the limestone member give the impression of being formed in a much more agitated environment. The sturdier built stromatolites, the brecciated algal mats and the other algal debris together with the absence of any micrite as cement point at a "higher energy-level". Those parts of the limestone member which contain predominantly stromatolites and coarse algal debris could represent algal shoals surrounded by fine to coarse calcareous sands containing a high amount of intraclasts. Seaward of these shoals and sands were sediments deposited which form today the limestones and shales of the griotte member. The abundance of trilobites and brachiopods together with the higher amounts of micrite and shale suggest a quieter, deeper?, open marine environment.

In this interpretation (fig. 3) we have placed the different overlying lithotopes in environments which we suggested to be present laterally from each other at the same time. If this assumption is correct and the vertical succession of these strata is a reflection of their horizontal occurrence one can draw the conclusion that the sediments of the Lancara Formation represent a transgressive marine sequence. An almost similar transgressive sequence was reported by Textoris & Carozzi (1966) from the SE margin of the Michigan Basin. As for the dolomitization of the sediments our conclusions have as yet to be very tentative. Studies of Recent carbonates have shown that penecontemporary dolomites do occur in areas of high evaporation. Sometimes these dolomites occur together with evaporites as is described by Illing, Wells & Taylor (1965) from the Persian Gulf and by Deffeyes, Lucia & Weyl (1965) from Bonaire, Shinn, Ginsburg & Lloyd (1965) found dolomitization occurring on supratidal mud flats around Andros Island, but did not find any evaporites preserved in the mud. Applying this knowledge to our observation on the Lancara Formation we feel that some of the finely crystalline dolomites might have formed out of carbonate mud early after deposition of the mud under conditions that might have been somewhat identical to those around Andros Island. However this does not at all exclude the possibility that much later secondary ("late diagenetic") dolomitization also took place. Most of the Lancara outcrops North of Los Barrios de Luna are situated along thrust faults and in those outcrops often only the Griotte Member is not fully dolomitized. Since the Namurian limestones of the Escapa Formation in the Cantabrian Mountains show distinct evidence of post-orogenetic dolomitization a secondary (post — Namurian) dolomitization of the Lancara Formation can have been superimposed on the penecontemporary dolomitization discussed above.

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PLATE I

A) View of the Lancara Formation near Lancara de Luna.
The base of the formation is at B and its top at T.

B) The Lancara Formation West of Los Barrios de Luna.
The finest section present is indicated by BT. DM is the dolomite member, LM is the limestone member and GM the griotte member.

PLATE I

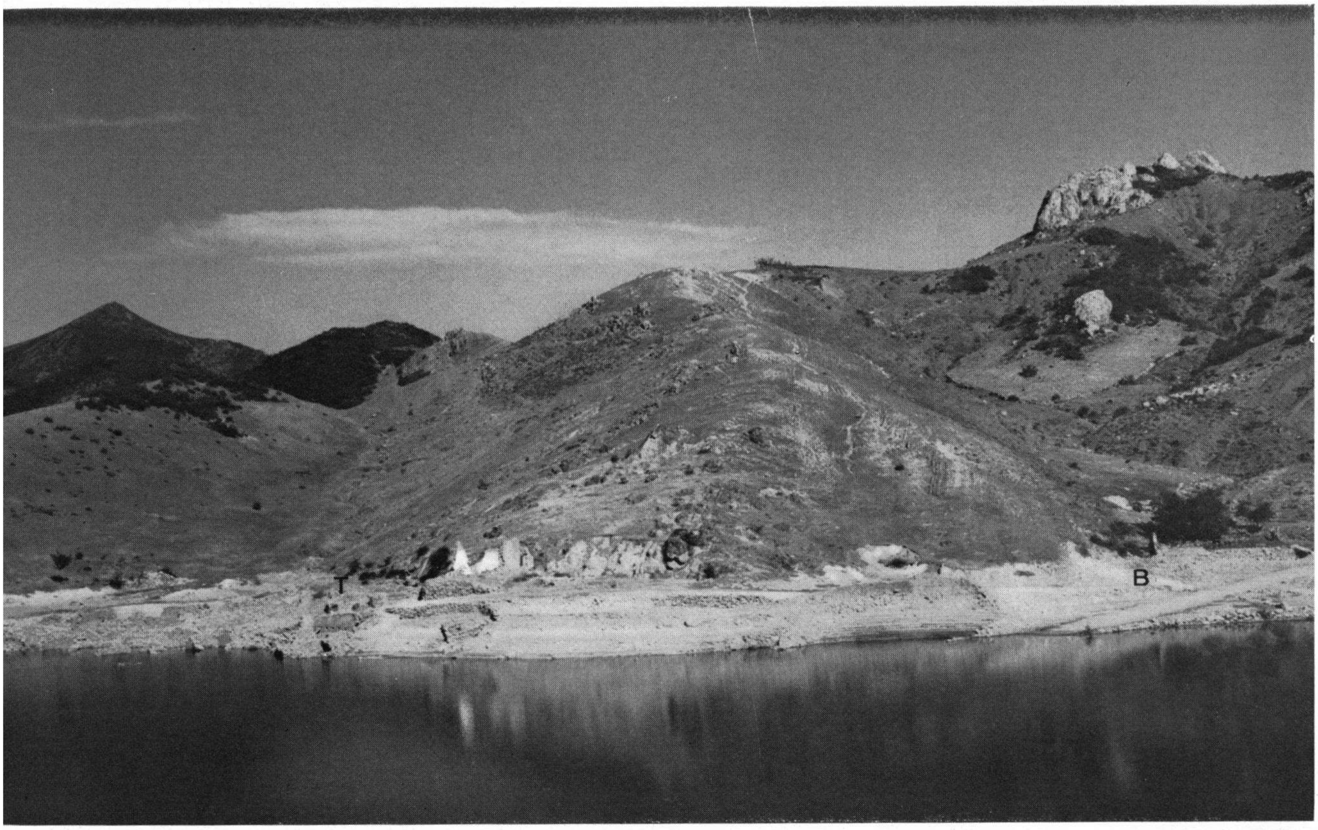
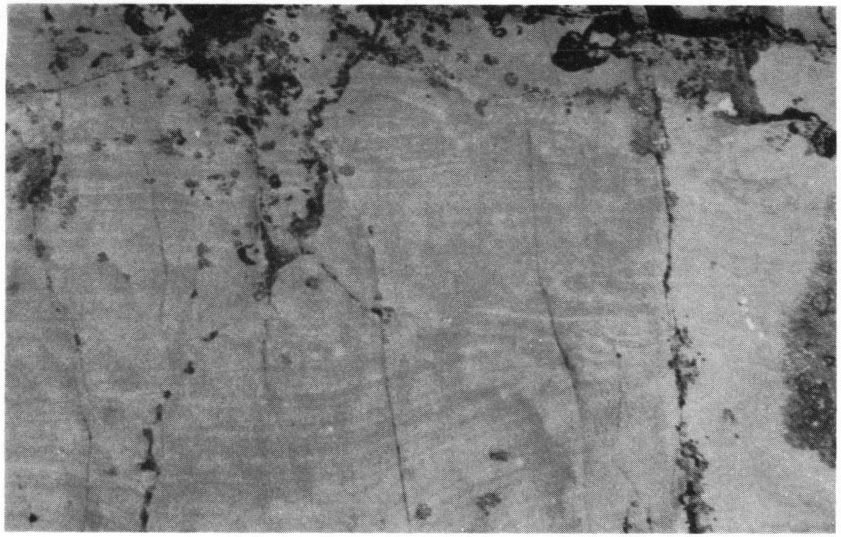
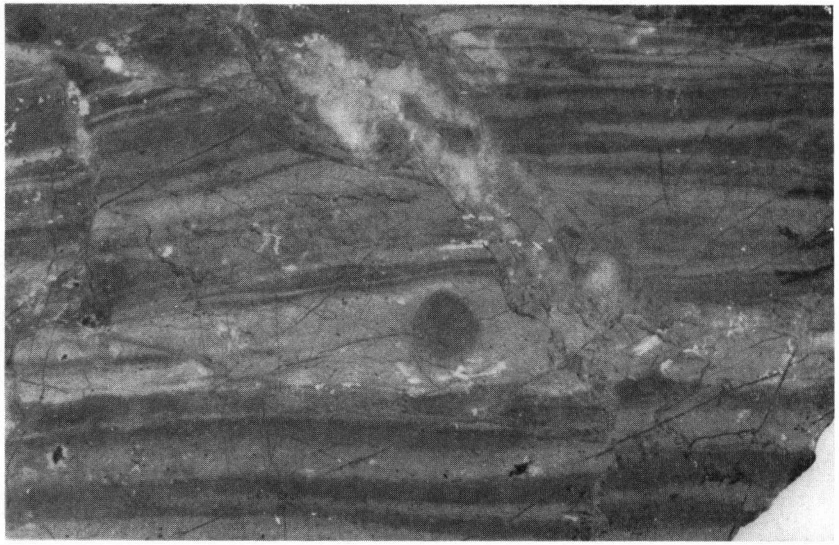


PLATE II

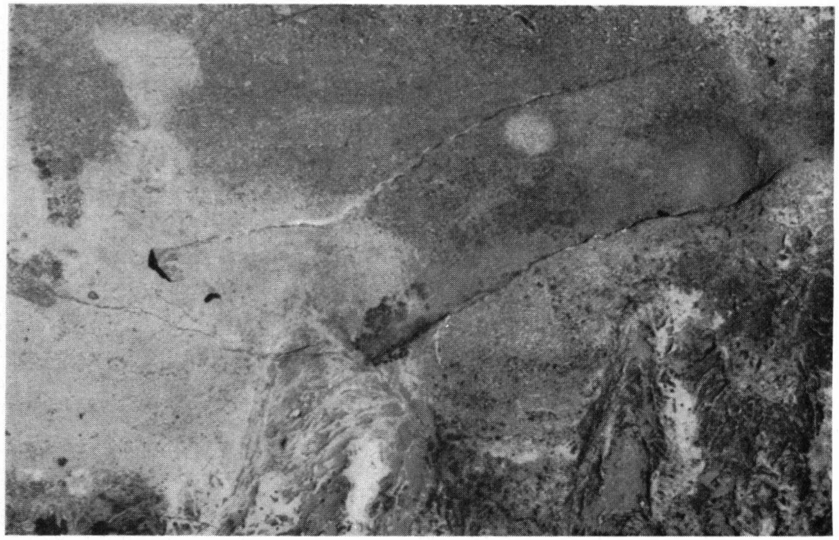


A) Small scale cross bedding in the finely crystalline dolomites.



B) Varve — like lamination in the finely crystalline dolomites. The dark circle is a lens which appears like a circle because it cuts the sedimentary layers obliquely.

C) Stromatolites from the basal part of the dolomite member. The white spots S are patches of pinkish-white sparry calcite.

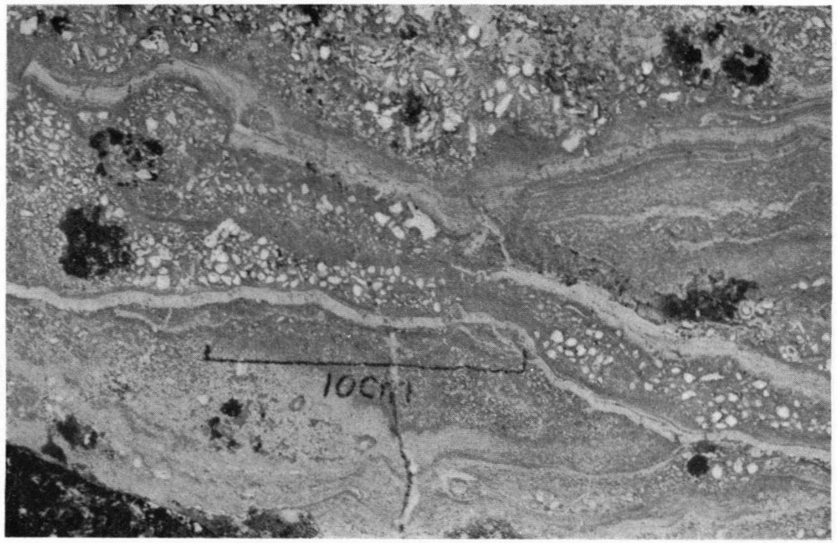


D) Picture of the stromatolites in the basal part of the dolomite member and the overlying calcirudites.

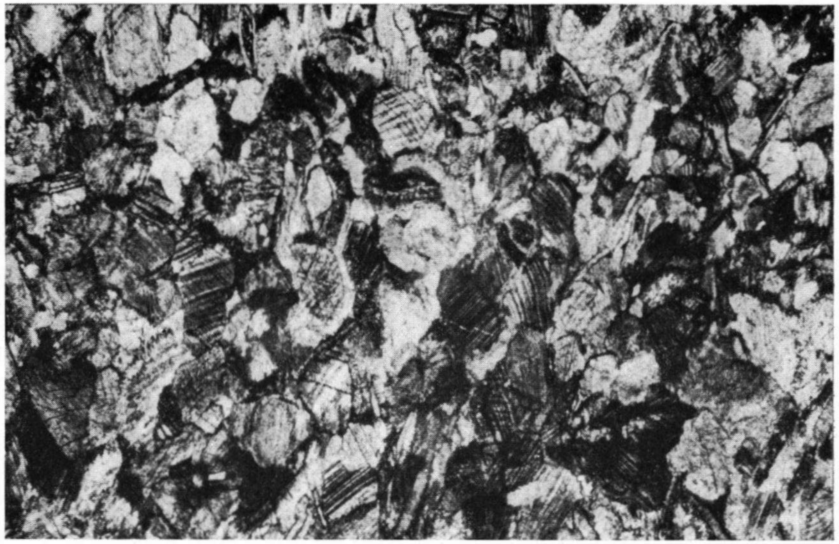
PLATE III

A) Intraformational breccia and small scale unconformity (uu′) in the dolomite member.

B) Birdseye — like limestone in the limestone member.



C) Algal mats and algal debris in the limestone member.



D) Recrystallized biosparite from the top of the limestone member.