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Petrographical Study of Ewekoro Carbonate Rocks, in Ibese, South Western Nigeria

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ABSTRACT

Limestone deposits can be found in every system of the geologic column since the Precambrian. In classifying this rock, various attempts have been made and notable among them is the classification scheme based on three components: allochems, cements and matrix. Another classification divided limestone on the basis of texture into grainstone, packstone, mudstone, wackestone and boundstone. Texturally, limestone ranges from fine to coarse grained with aragonite and calcite as the most common minerals. This work was aimed at identifying and describing both the allochemical and orthochemical components of the limestone deposits in order to classify and deduce their depositional environment.

Eight core samples of limestone deposits representing the Ewekoro Formation of the Dahomey Basin were studied petrographically.

The result of the analysis carried out on the samples showed that the Ibese limestone is composed of the following allochems: sponges, echinoids, bivalves, coralline algae, and pelecypod which represent the skeletal content and intraclasts, pellets and ooids which represent the non skeletal grains. The orthochemical constituents include the carbonate mud matrix and the sparry calcite cement.

These constituents observed from the slides indicate that the Ibese limestone belongs to the class of wackestone and could have been deposited in a quiet and low energy environment.

Keywords: Carbonate, Depositional, Environment, Petrographic, Allochems, Micrite and Fossiliferous.

RESUMEN

Los depósitos de Caliza se pueden encontrar en todo sistema de la columna geológica a partir del Precámbrico. Para su clasificación se han hecho varios intentos y entre ellos es notable el sistema de clasificación basado en alo-químicos, cemento y matriz. Otra forma de clasificación es según la textura. Texturalmente, la caliza va del grano fino a grueso con Aragonito y Calcita como los minerales más comunes. Este trabajo permitió identificar y describir los componentes alo-químicos y ortho-químicos de los depósitos de Caliza con el fin de clasificar y deducir su ambiente de deposición. Se estudiaron petrográficamente ocho muestras de núcleos de depósitos de Caliza representativos de la Formación Ewekoro en la Cuenca Dahomey.

Los resultados de los análisis mostraron que la caliza Ibese está conformada por los siguientes alo-químicos: esponjas, equinodermos, moluscos, algas coralinas, y pelecípodos e intraclastos, pellets y ooides . Los componentes ortho-químicos incluyen carbonato en la matriz y cemento de calcita espática.

Estos componentes observados en las secciones delgadas indican que la caliza Ibese es de la clase Wackosa y podría haber sido depositado en un ambiente tranquilo y de baja energía.

Palabras clave: carbonato, deposicionales, medio ambiente, petrográfico, aloquímicos, micrita y fosilíferas

Record

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Introduction

Approximately 20% of the sedimentary rocks is made up of carbonate rocks especially Limestone and dolomite (Chilingar et al. 1972). The Dahomey Basin (Fig.1) is a marginal pull-apart basin (Klemme, 1975) or Margin sag basin (Kingston et al., 1983), which was initiated during the early Cretaceous separation of African and South American lithospheric plates. The eastern flank of this basin is delineated by the Okitipupa high, while the Western flank extends as far as into Togo and Ghana. The Dahomey Basin contains piles of sediments that have been found to be about 3000m and thickens offshorewards. Studies (geology, stratigraphy, textural and geochemical) on the eastern Dahomey Basin have been undergone by previous authors some of which include Jones and Hockey, 1964;Reyment, 1965; Omatsola and Adegoke, 1981 Coker and Ejedawe, 1983; Billman, 1992; Elueze and Nton, 2004 and Akinmosin et al, 2005.

In classifying limestone, various attempts have been made, notable among them are the classification scheme of Folk (1959,1962) which was based on three components: allochems, matrix and cements. The classification of Dunham, 1962 divides limestone on the basis of texture into grainstone, packstone, mudstone, wackestone and boundstone.

This work is aimed at identifying and describing both the allochemical and orthochemical components of Ibese limestone deposits based on petrographic studies and to deduce the depositional environment.

Stratigraphy

The area of study covers Ibese, Ogun State, Southwestern Nigeria. It is within the Eastern Dahomey Basin of Nigeria. (Fig. 2). Ibese lies at the southern edge of the Ewekoro depression and is overlooked by the escarpment capped by the Ilaro Formation which forms a prominent feature in the area. Ibese quarry is located along Ilaro-Idiroko road and it lies between latitudes $6^{0}9^{1}$N and 7^{0}N and longitudes 3^{0}E and $3^{0}3^{1}$E. Ibese quarry is operated by the Dangote cement company.

The reviewed work of Omatsola and Adegoke (1981) on the Cretaceous stratigraphy of the Dahomey Basin has recognized three formations belonging to the Abeokuta Group. These are: the Ise Formation, consisting essentially of continental sands, grits and siltstones, overlying the basement complex. Neocomian to Albian age has been assigned to this formation. Overlying the Ise Formation is the Afowo Formation, which consists of course to medium- grained sandstones with variable interbeds of shales, siltstones and clay. The sediments of this formation were deposited in a transitional to marginal marine environment Turonian to Maastritchtian age has been assigned to this formation. The Araromi Formation consists essentially of sand, overlain by dark-grey shales and interbedded limestone and marls occasional lignite bands. The formation conformably overlies the Afowo Formation and Maastrichtian to Paleocene age has been assigned (Omatsola and Adegoke, 1981).

Overlying the Abeokuta Group conformably is the Imo group, which comprises of shale,limestone and marls. The two-lithosratigraphic units under this group are: Ewekoro Formation and Akinbo Formation. Adegoke (1977) described the formation as consisting of shaly limestone about12.5m thick which tends to be sandy and divided it into three microfacies. Ogbe (1972) further modified this and proposed a fourth unit. It is Paleocene in age and associated with shallow marine environment due to abundance of coralline algae, gastropods, pelecypods, echinoid fragments and other skeletal debris. Akinbo Formation lies on the Ewekoro

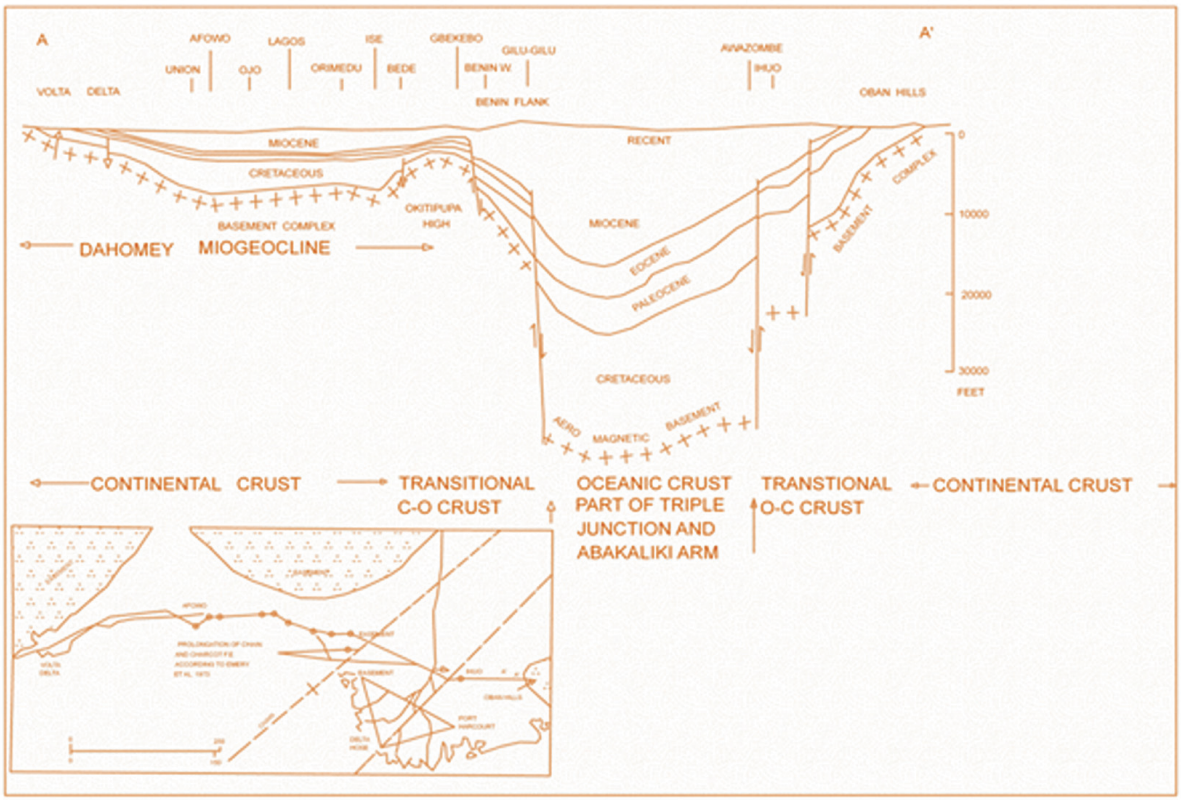

Figure 1: East-West geological section showing the Dahomey Basin and upper part of the Niger Delta (After Whiteman, 1982).

Formation and it comprises of shale, glauconitic rock bank, and gritty sand to pure grey and with little clay. Lenses of limestone from Ewekoro Formation grades literally into the Akinbo shale very close to the base. The base is characterized by the presence of a glauconitic rock. The age of the formation is Paleocene to Eocene.

Overlying the Imo group is the Oshoshun Formation. It is a sequence of mostly pale greenish-grey laminated phosphatic marls, light grey white-purple clay with interbeds of sandstones. It also consists of claystone underlain by argillaceous limestone of phosphatic and glauconitic materials in the lower part of the formation. Eocene age has been assigned to this formation (Agagu, 1985). The sedimentation of the Oshoshun Formation was followed by a regression, which deposited the sandstone unit of Ilaro Formation (Kogbe, 1976). The sequence represents mainly coarse sandy estuarine deltaic and continental beds, which show rapid lateral facies change.

The coastal plain sands are the youngest sedimentary unit in the eastern Dahomey Basin. It probably overlay the Ilaro Formation unconformably, but convincing evidence as to this is lacking (Jones and Hockey, 1964). It consists of soft, poorly sorted clayey sand and pebbly sands. The age is from Oligocene to Recent.

Methodology

Samples used for this work are core samples retrieved from a well in Ibese. Eight Samples were selected at an average vertical interval of 1.5m. Part of the field work included thorough optical examination of the samples. Afterwards, the selected samples were clearly labeled and kept in sample bags for laboratory analysis.

Prepared slides from the collected samples were closely examined under plane polarized light.The stage of the microscope was rotated continuously to attain different views of the slides. Photomicrographs of each slide were taken under crossed nicols and comparison was made with carbonate photomicrograph catalogue to ascertain the compositional features.

Results and discussion

Lithology

The limestone samples from Ibese quarry are medium grained with colour ranging from light brown to cream. Dark brown stains were also observed on

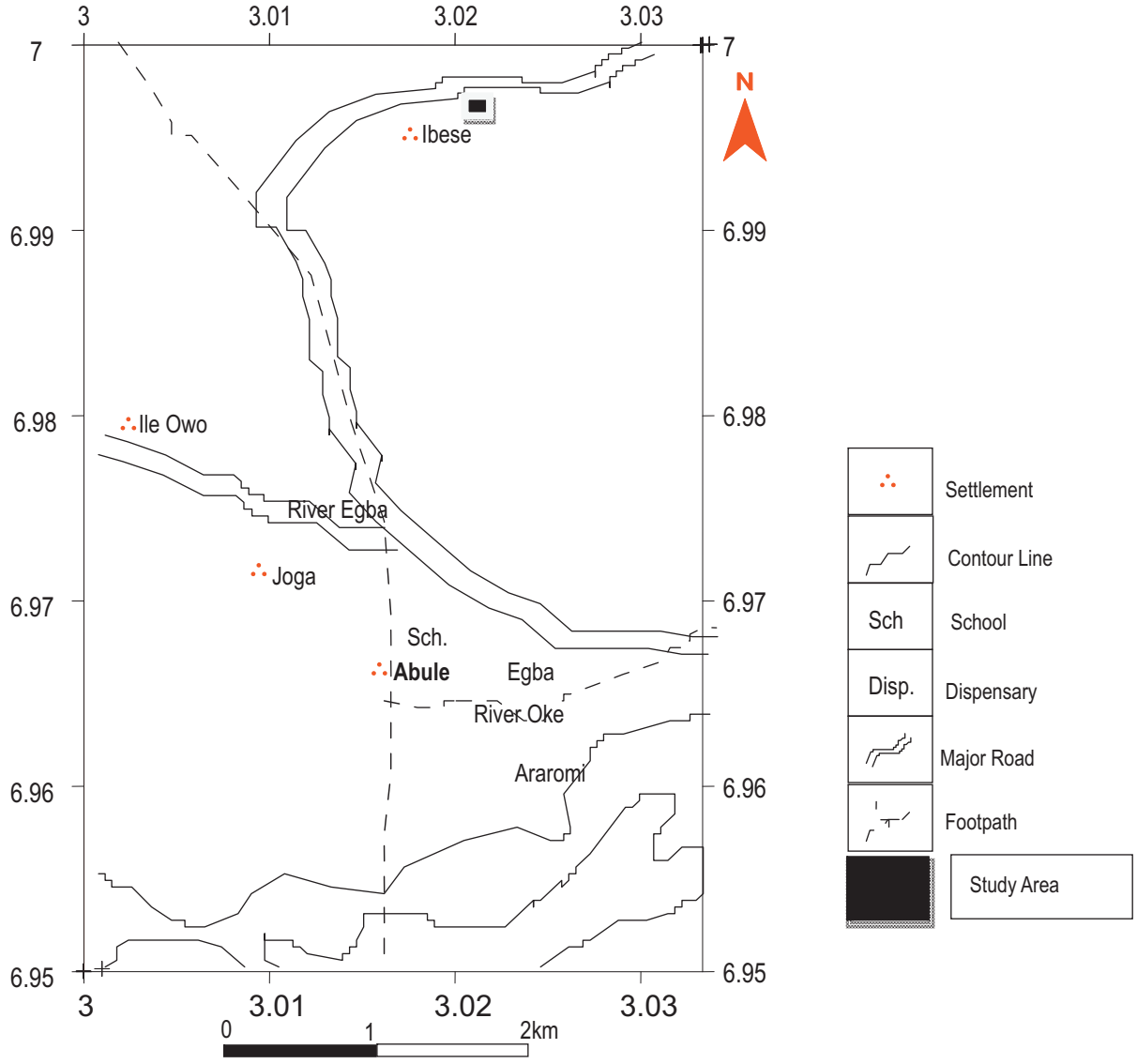

Figure 2: Location map showing the study area

Table 1: Summary table of components of ibese limestone

Plate	Depth (M)	Fossil	Intraclast	Ooid	Pellet	Support	Sparry Calcite
1	23.0	Sponge Spicules	v	X	v	MUD/GRAIN	v
2	24.5	Sponge Spicules	v	v	v	MUD	v
3	34.0	Echinoid Sponge Spicules Bivalves	X	X	X	MUD	X
4	37.5	Pelecypod	X	X	X	GRAIN	v
5	38.5	Pelecypod	v	v	v	MUD/GRAIN	v
6	40.0	Sponge Spicules	X	X	v	MUD	X
7	47.5		v	X	v	GRAIN	v
8	48.5	*Globorotalia* Cerroazulensis	v	X	v	MUD	v

some of the exposed samples which is an indication of oxidation of the iron content. The samples were observed to be highly fossiliferous.

Petrographic Description

Allochemical constituents, carbonate mud matrix (micrite) and sparry calcite cement are the major components of carbonate rocks, Folk (1959, 1962). The petrographic description of Ibese limestone was based on these three parameters. The term "allochem" is applied to carbonate grains greater than 0.062mm Rich, 1964.

Discussion

Allochems

The non skeletal grains identified from the petrological study are intraclast, pellets and ooids while the skeletal grains represent the fossil content.

Skeletal Grains (Fossil Content)

For the identification of the fossil content of the Ibese limestone, the following points were noted: shape, internal micro-structure and presence of spines or pores. The following were identified with varying depth: Sponges, echinoderms, pelecypods, bivalves, coralline algae and foraminifera *Globorotalia cerroazulensis.*

Sponges

The sponge spicules are composed of silica or calcite. Sponges were identified in Plates 1 and 6 at depths 23m and 40m respectively. They serve as source of silica for the formation of chert nodule and the silicification of the limestone.

Echinoderms

It was observed that sparite cement crystal had grown syntaxially around the echinoderm fragment identified in the Ibese limestone deposit. (See Plate 3a).

Bivalves

Bivalve shells identified in the deposit consisted of several layers of specific internal microstructure composed of micron-sized crystallites. (See Plate 3b).

Non Skeletal Grains

Intraclasts

These are fragments that have been reworked within the area of deposition thereby forming new sediment. Sizes of identified intraclasts ranged from sand size to pebble or boulder size. Sub-angular or subrounded types were rare and some of them were identified to possess irregular protuberances. Some have complex internal structure and contain fossils, pellets, quartz silt as seen in Plates 1, 2, 5, 7 and 8.

Pellets

These are rounded, spherical to elliptical or ovoid aggregates of microcrystalline calcite ooze which are devoid of any internal structure. They show a uniformity of shape and size (See Plate 6).

Ooids

These are particles that show either radical or concentric structure (Plates 2 and 5). Ooid typically form in agitated waters.

Carbonate Mud Matrix (Micrite)

It is considered as forming very largely by rather rapid chemical or biochemical precipitation in sea water settling to the bottom and at times undergoing some later drifting by weak currents. Micrite was identified in most of the samples studied (Plates 2,3,4,7 and 8)

Sparry Calcite Cement

This type of calcite generally forms grains or crystals 10 microns or more in diameter and is distinguished from microcrystalline calcite by it's clarity as well as coarser crystal size. Large coarse grains of sparry calcite which were white and grey in colour were observed to be dominant in Plates 1 and 7.

Environmental Interpretation

This is based on the fossil content and the dominant support of the Ibese limestone (Table 1). The fossil contents include sponges, echinoids, bivalves, coralline algae, pelecypod which are typical of an open shelf environment. The presence of echinoid indicates deeper waters. The dominant support is mud and muddiness is generally a property of rocks deposited in quiet water and a low energy environment. The absence of shell fragments is indicative of this.

Conclusion

Petrographic studies of Ibese limestone deposit have shown that the rock is highly fossiliferous with the identified fossils indicating deposition in an open shelf environment. Moreover, the limestone deposit was equally observed to be principally mud supported which is indicative of rocks deposited in quiet water and a low energy environment.

From the aforementioned textural characteristics, Ibese limestone deposits can be classified as Wackestone according to Dunham, 1962.

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Appendix 1

S = Sponge
I = Intraclast
P = Pellet
C = Calcite

Plate 1: Photomicrograph of Ibese limestone (Depth 23m).

O = Ooid
I = Intraclast
C = Calcite
M = Micrite

Plate 2: Photomicrograph of Ibese limestone (Depth 24.5m).

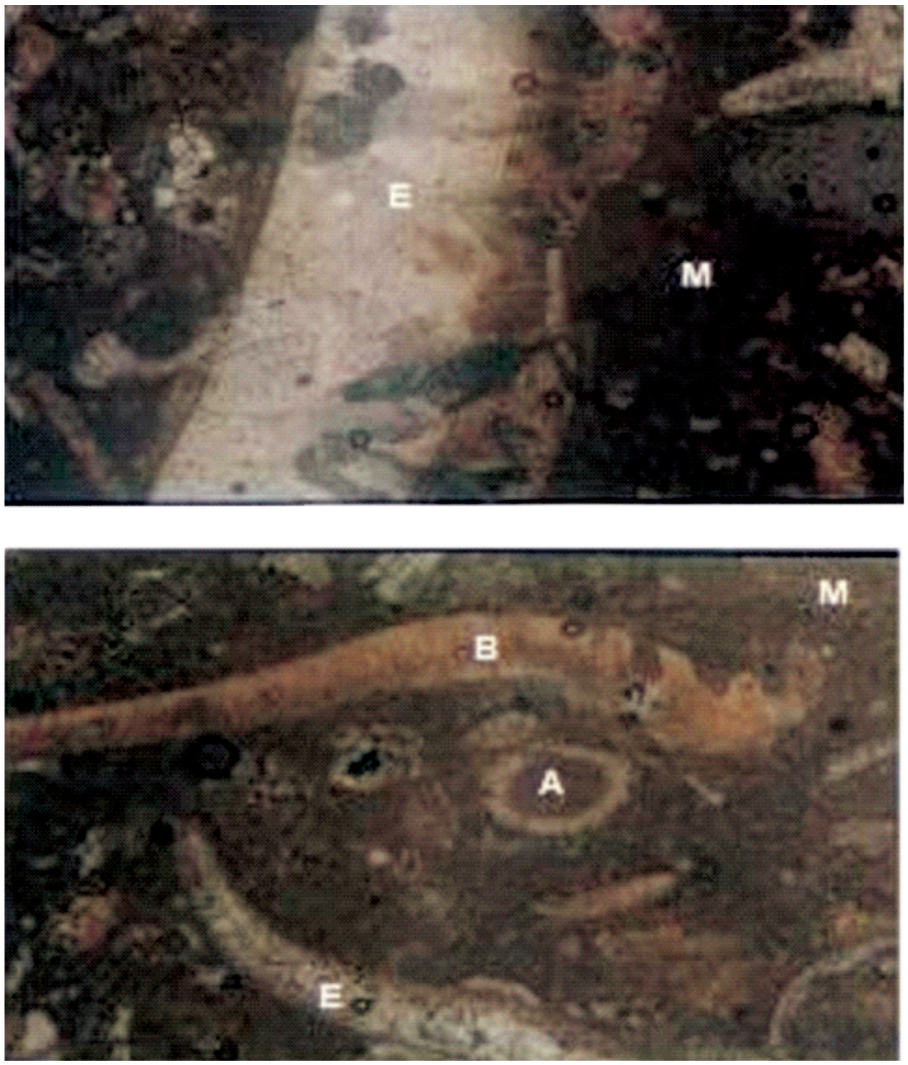
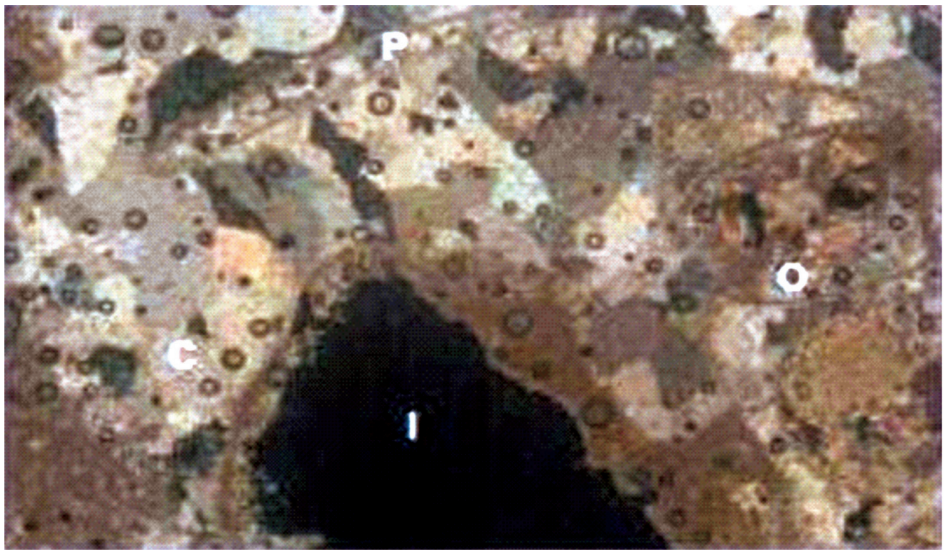


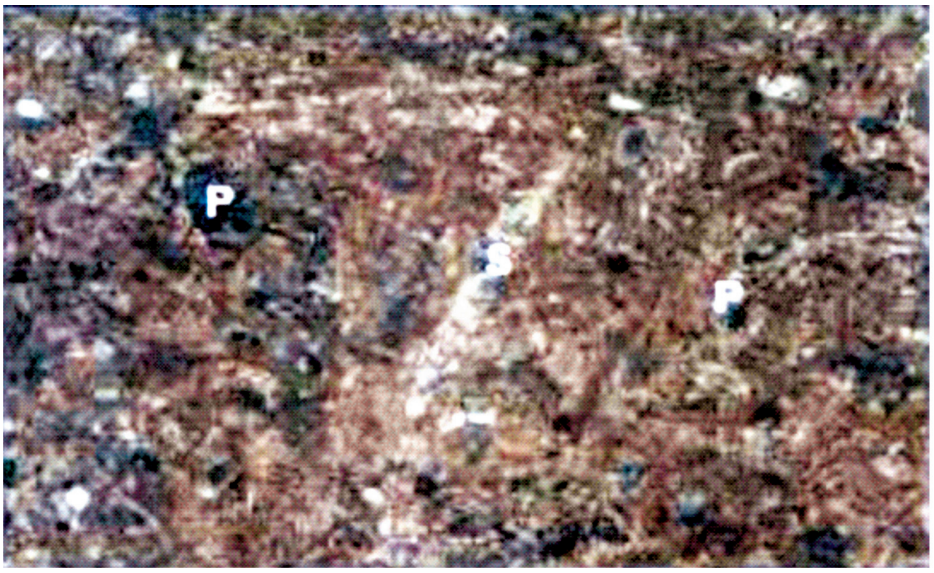
Plate 3: Photomicrographs of Ibese Limestone (Depth 34.0m)

Plate 4: Photomicrograph of Ibese limestone (Depth 37.5m)



P = Pelecypod
O = Ooid
C = Calcite
I = Iron mineral

Plate 5: Photomicrograph of Ibese limestone (Depth 38.5m).



P = Pelecypod
S = Sponge

Plate 6: Photomicrograph of Ibese limestone (Depth 40.0m)

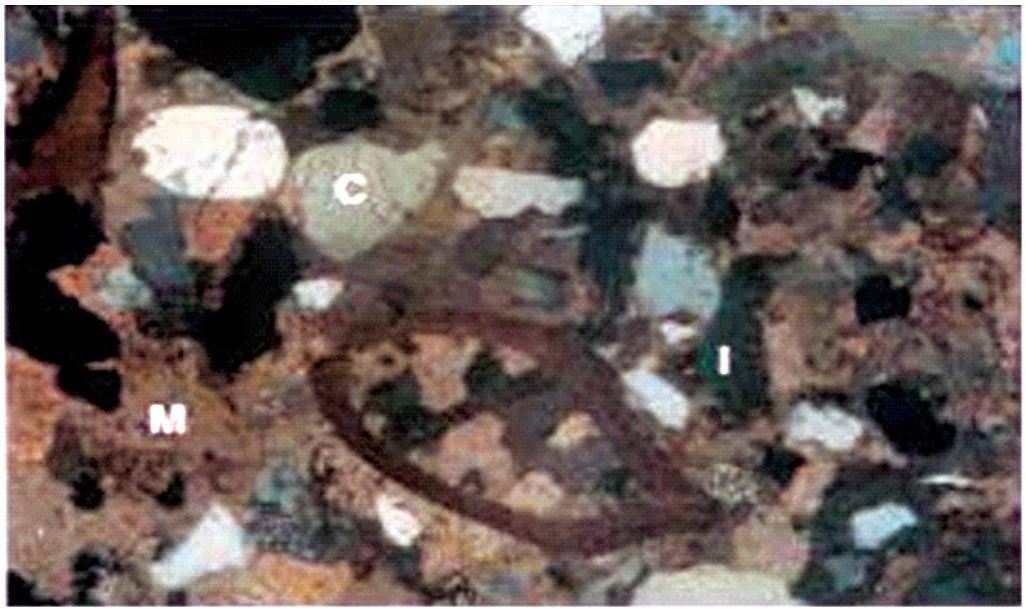


Plate 7: Photomicrograph of Ibese limestone (Depth 47.5m).

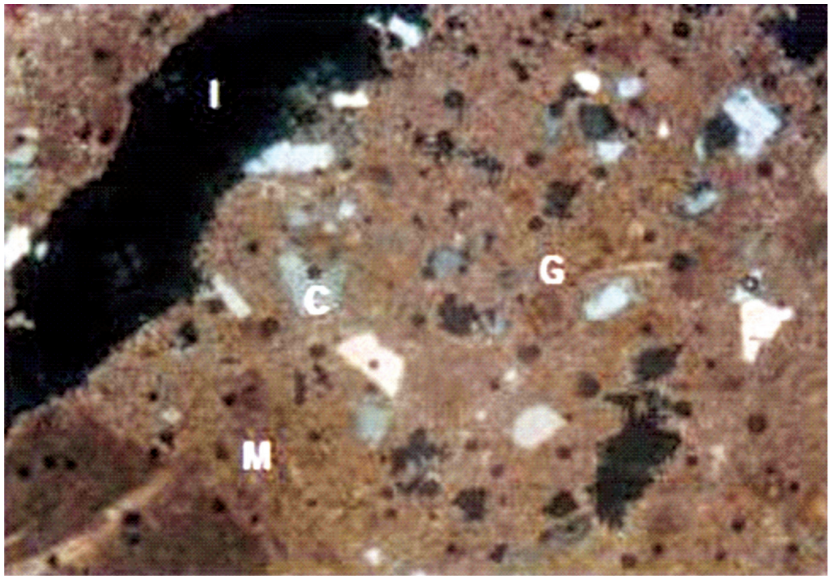


Plate 8: Photomicrograph of Ibese limestone (Depth 48.5m)