Petrography and Compositional Characteristics of Ewekoro Formation, Eastern Dahomey Basin, Southwestern Nigeria: Implications for Depositional Environment and Reservoir Characteristics

M. E. Nton and M. O Adeyemi

SUMMARY

Subsurface samples of the predominantly carbonate Ewekoro Formation, obtained from the Ibese core hole, in the eastern Dahomey Basin, were examined based on petrographic and geochemistry indices. The study aims at ascertaining the microfacies, depositional environment, as well as the reservoir characteristics. Petrography reveals sandy biomicrite, biomicrite, biosparite and dolomitic microfacies with fossil content made up of gastropods, brachiopods, ostracods, coralline algae and foraminifera. It is observed that the depositional porosity has been altered by different diagenetic pore types which could serve as conduits for fluids. Major element oxides ranges are; CaO (39.79 - 53.98wt. %), SiO_2 (1.29-25.37 wt. %), Al_2O_3 (0.43-3.77 wt. %), K_2O (0.04-0.27wt. %), Fe_2O_3 (0.74-2.35 wt. %), and Na_2O (<0.01-0.05 wt. %). Correlation coefficient shows that elements such as Na, K, Ti, Ba, Cs, Ga, Rb, Sr, Th, La, Ce, Mo and Ni have strongly correlated values with Al ($r > 0.75$). Consequently, they share siliciclastic origin with abundance of Al and their fluctuations can be linked to variation in detrital influx. The U/Th ratio (~0.25 to 2.3) and the V/Sc ratio (~6.0 to 23) suggest that the Ewekoro limestone was deposited in an oxic to anoxic setting with a strong anoxic influence.

STUDY AREA AND GEOLOGY

The Ibese corehole is located in the eastern Dahomey basin, south western Nigeria. The basin is an extensive sedimentary basin on the continental margin of the Gulf of Guinea, which extends from the Volta River Delta in Ghana in the west, to the western flank of the Niger Delta. The different aspects of the geology of the basin have been documented (Omatsola and Adegoke, 1981, Nton and Elueze, 2005) among others.

METHODOLOGY

Thirteen (13) representative limestone samples, belonging to the Ewekoro Formation, were retrieved from the Ibese corehole for this study (Fig. 1). The samples were subjected to thin section petrography by standard methods and textural features were observed under the petrological microscope in the Department of Geology, University of Ibadan.

Major elements were determined using ICP-emission spectrometry by digesting 0.2g of each sample with Lithium metaborate/tetraborate flux and fused in a furnace. A total of 11 major oxides and 2 trace elements were reported. Trace elements were determined by ICP-mass spectrometry following a Lithium metaborate/tetraborate fusion and dilute nitric digestion. These analyses was carried out at Acme laboratories, Canada.

RESULTS AND DISCUSSION

Petrographic studies of the limestone reveal sandy biomicrite, biosparite, biomicrite and dolomitic facies. The fossil constituents are mainly gastropods, brachiopods, ostracods, coralline algae and foraminifera (Figure 2 A-D). Samples from the upper sequence exhibit dolomite subhedral grains with diagenetically enhanced intercrystaline and cavernous pore types. The biomicrite facies show reduction in porosity and dominated by moldic type, whereas the biosparites are characterized by intraparticle pores. Recrystallization of sparry calcite is observed to have reduced the intraparticle conduits.

Generally, the abundance of lime mud and high spiraled gastropods suggests deposition in a protected shallow marine inner shelf setting (Reijers and Petters, 1987). The biosparite (Figure 2D) are grain supported and suggest a shoal and relatively high environment of deposition developed in a restricted inner shelf, lagoonal environment, probably proximal to the strandline (Willamson, 1972). The relative abundance of benthic foraminifera such as; *rotalia, quinqueloculina* and *textularia* (Fig 2 C and D) indicates a lagoonal (open lagoon, estuarine, marsh) for the carbonates.

Results of geochemical studies are shown in Tables 1 and 2.The ranges of major oxides are; CaO (39.79 - 53.98wt. %), SiO_2 (1.29-25.37 wt. %), Al_2O_3 (0.43-3.77 wt. %), K_2O (0.04-0.27wt. %), Fe_2O_3 (0.74-2.35 wt. %), and Na_2O (<0.01-0.05 wt. %). CaO is the most abundant and suggest biogenic input. The alumina concentration is a reflection of alumino silicate from the overlying sequence. The SiO_2 content, particularly the higher percentages in samples IB11 (18.82%) and IB 13 (25.37%) reflects terrigenous input as corroborated by the pet rography.

Sr content ranges from 359.6 to 893.1 ppm (av. 640 ppm) similar to the average values given for lithospheric carbonates (Sr = 610 ppm; Turekian and Wedepohl, 1961. About 31% of the rocks have U/Th ratio of < 1.25 (oxic) while 69% is > 1.25 (suboxic to anoxic). Arising

Department of Geology, University of Ibadan, Ibadan

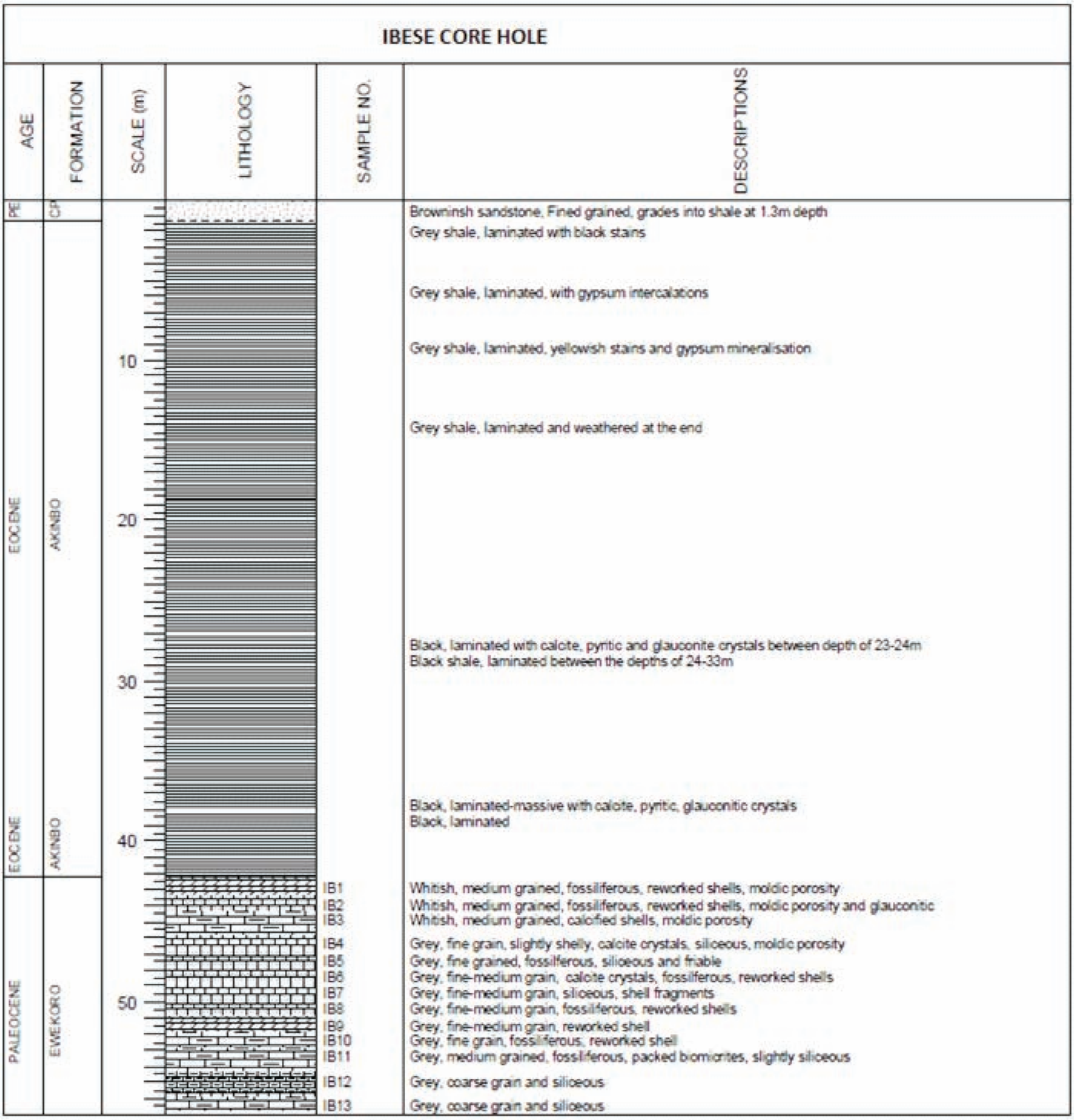

Fig. 1: Litholog description of the Ibese corehole

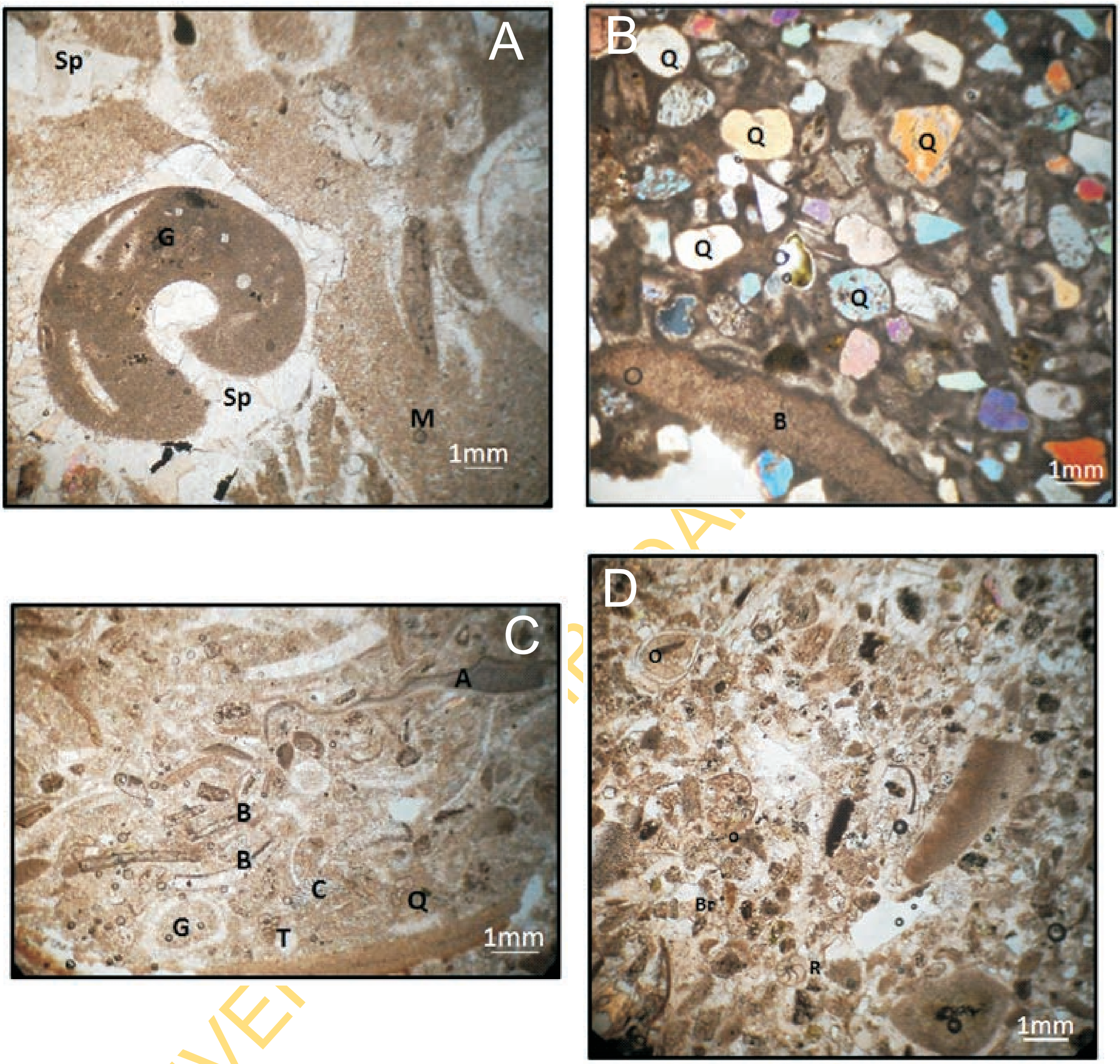

Fig. 2: Photomicrographs of Ewekoro Limestone. **A) Biomicrite** showing gastropod mould in a median section. **B) Sandy biomicrite** showingbroken shell fragments and quarts grains. **C) Biomicrite,** highly fossiliferous, B- Brachiopod shells, *T-Textularia, Q- Quinequeloculina, G-gastropod.* **D) Biosparite** showing highly fossiliferous and cleanly washed grain supported. R- rotalia, Br- brachiopod, O- ostracods

Table 1. Result of Major Oxides (w. %)

Analyte	IB1	IB2	IB3	IB4	IB5	IB6	IB7	IB8	IB9	IB10	IB11	IB12	IB13
Depth (m)	39.5	40.5	42	43.5	45	46.5	48	49.5	51	52.5	54	55.5	57
SiO_2	2.84	2.19	1.29	5.48	4.16	9.22	4.36	4.44	3.54	9	18.82	2.68	25.37
Al_2O_3	0.84	0.72	0.43	2.02	1.56	3.77	1.56	1.58	1.28	2.58	0.73	0.84	0.47
Fe_2O_3	1.01	0.94	1.01	0.95	1.13	1.59	1.25	1.39	1.96	2.35	0.76	0.95	0.74
MgO	3.2	2.63	0.97	1.48	1.59	1.55	1.78	2.05	5.49	1.91	1.13	1.26	0.84
CaO	48.84	50.18	53.98	48.47	49.16	43.88	49.18	48.9	45.11	44.74	42.88	51.48	39.79
Na_2O	0.02	0.02	0.02	0.03	0.03	0.05	0.04	0.04	0.02	0.03	0.01	<0.01	0.01
K_2O	0.15	0.12	0.06	0.15	0.11	0.27	0.11	0.11	0.09	0.18	0.07	0.04	0.05
TiO_2	0.03	0.02	0.02	0.1	0.06	0.16	0.07	0.06	0.05	0.1	0.08	0.03	0.12
P_2O_5	0.18	0.14	0.1	0.09	0.14	0.2	0.17	0.17	0.11	0.19	0.13	0.1	0.15
MnO	0.04	0.04	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.02	0.01	0.02
Cr_2O_3	0.009	0.008	0.013	0.006	0.007	0.011	0.008	0.008	0.007	0.016	0.007	0.005	0.005

Table 2: Result of Trace Elements (PPM)

Analyte	IB1	IB2	IB3	IB4	IB5	IB6	IB7	IB8	IB9	IB10	IB11	IB12	IB13
Depth (m)	39.5	40.5	42	43.5	45	46.5	48	49.5	51	52.5	54	55.5	57
Ba	19	5	6	15	13	23	12	11	8	15	6	5	7
Be	<1	<1	<1	1	<1	1	<1	1	<1	<1	<1	<1	<1
Co	0.2	0.6	1	2	1.7	2.9	1.8	1.6	1	5.4	0.8	0.8	1.2
Cs	0.4	0.3	0.2	0.6	0.4	1.1	0.4	0.4	0.4	0.7	0.3	0.2	0.2
Ga	0.8	<0.5	<0.5	1.7	1.2	2.9	1.1	1.2	0.9	2.5	<0.5	<0.5	<0.5
Hf	0.2	0.2	<0.1	0.9	0.3	0.7	0.4	0.5	0.2	1.1	2.4	0.2	2.6
Nb	2.1	1.9	1.6	1.6	1.2	2.5	1.5	1	1.2	1.8	4.5	1.4	31.3
Rb	5.4	4.1	2	6.6	4.9	11.4	4.3	4.3	3.3	7.3	2.4	1.7	1.7
Sn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	<1	2
Sr	371.3	418.3	532.5	840.8	881.6	870.5	966.4	893.1	593.2	768.7	378.2	448.9	359.6
Ta	3.3	5.9	5.1	1.2	1.2	0.9	1.4	1.4	1.6	0.9	10.5	5.6	22.1
Th	1.8	1.5	2	2.2	2.8	4.5	2.8	3.1	1.8	3.7	1	1	1
U	3	3.3	0.5	1.8	2.8	2.9	2.7	2.4	2.4	2.4	1.5	2.3	1.1
V	21	19	23	12	18	21	15	17	14	31	8	10	<8
W	<0.5	<0.5	3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zr	5.5	4.2	3.4	28.1	10.3	26.1	14.1	14.7	8.4	37.8	90.9	4.3	97.9
Mo	<0.1	0.5	0.2	1.5	2.4	4.1	2.2	2.3	1.2	2.7	0.2	0.4	0.1
Cu	5.2	1.6	1.4	2	2.5	3.7	2.1	2.2	1.6	2.7	1.2	1.3	1.2
Pb	2.5	2.4	3.8	3.5	5.2	7	5.4	4.8	2.5	5.5	1.8	1.7	1.7
Zn	19	19	23	20	40	45	50	53	40	121	20	30	24
Ag	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ni	3.1	4.3	2.2	5.6	8	12.9	8.3	9.2	6.9	22.6	2.8	2.5	5.1
As	2.3	4.2	4	5.2	9.7	9.1	8.6	7.2	6	16.2	1.4	4.4	1.9
Au	3.8	2.5	86.8	4.4	2.4	2.5	2.1	2.1	<0.5	1	1.4	4.1	1
Cd	0.7	0.7	0.5	0.3	0.5	0.5	0.6	0.5	0.3	0.9	0.2	0.3	0.2
Sb	0.1	0.1	0.2	<0.1	0.3	0.1	0.3	0.2	0.2	0.3	<0.1	0.2	<0.1
Bi	0.5	0.7	0.8	0.3	0.2	0.2	0.2	0.3	0.2	0.2	0.9	0.8	1.8
Hg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tl	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Se	<0.5	1	0.9	0.7	1.7	1.5	1.7	1.3	0.9	2.3	<0.5	0.6	<0.5

from the concept of Jones and Manning, 1994, it can be deduced that the Ewekoro Limestones were deposited in an oxic to anoxic setting with a strong anoxic influence.

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