Volume 2 No.2, February 2012 ISSN 2224-3577
International Journal of Science and Technology

http://www.ejournalofsciences.org

Geochemical Classification of Sediments and Environment of Deposition of Marble from Igarra and Ikpeshi Areas, Southwest, Nigeria

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ABSTRACT

Twenty marble samples were geochemically analysed using the Inductively Coupled Plasma-mass spectrometry (ICP-MS) analytical method. Major oxides resulting from the analyses are used to calculate the Log ratios of SiO_2/Al_2O_3 and Fe_2O_3/k_2O and which are subsequently used to plot on sand class system adopted by schlumberger. An interpretation of the plottings show that most sediments are classified into the sand class group belonging to greywackes, litharenite and arkose and falling within the range of 0.643-0.89 under SiO_2/Al_2O_3 and of -0.5-0.6 under Fe_2O_3/k_2O respectively. The textural maturity of sandstone and clay matrix reflects the environment of deposition. Lithic greywackes are associated with shallow marine basal deposition. The occurrence of low matrix and high carbonate ($CaCO_3$) content admixed with the greywacke, Litharenite/arkose sediments are evidences of a probable deposition of the parent marble in a marine environment.

Keywords: *Geochemical, classification, sediments, environment and deposition*

1. INTRODUCTION

Igarra and Ikpeshi areas form part of the Basement Complex of Southwest Nigeria. The major rock units in these areas are; the gneiss complex, the schist (metasediments), older granite and late intrusives (Odeyemi, 1988). The schist is distinguished by their composition of pelitic to semipelitic rock, psammite, polymict conglomerate, calcerous rocks and mafic to ultramafic rocks (Rahaman, 1976, 1992; Elueze, 1980; Turner, 1983). Carbonate sediments are formed insitu, some are transported from shelf to basin, but the majority of limestone accumulates where the component grains are formed. The limestone (carbonate) with mineral impurities such as clay, silt, sand and iron oxide originally present as grains are now mobilized and recrystallized during the metamorphism that produced marble. These component grains (or sediments) that make up marble and their depositional environment are what this study attempts to classify geochemically. It is important to study the component sediments that admixed with the parent marble since they are sources of impurities that can impede the use of marble.

2. MATERIALS AND METHODS

Ten marble samples each were collected from Igarra and Ikpeshi areas. These samples were pulverized and sent to ACTLAB, Ontario Canada for a geochemical analysis using the inductively coupled plasma. Mass spectrometry (ICP-MS) analytical method. Major oxides such as SiO_2, Al_2O_3, CaO, MgO, Fe_2O_3, k_2O and LOI were obtained (Tables 1 and 2). These Oxides were used to calculate the log ratios of SiO_2/Al_2O_3 and Fe_2O_3/k_2O

3. DISCUSSION

The sediments admixed with marble during diagenesis are geochemically classified using a sand class system adopted by schlumberger in Fig.1. The log ratios of Fe_2O_3/k_2O are plotted against that of SiO_2/Al_2O_3 and CaO values on the sand class. The results of the log ratios and the plotting are matched with the standard pairs of points (Table 5) that define the sand class field boundary line (Heron, 1988).

The plotting of log ratios of Fe_2O_3/k_2O against Sio_2/Al_2O_3 in Fig. 1 show that the Igarra marble contain sediments that fall within the greywackes, litharenite and arkose classified boundary and range values of 0.643-0.89 under SiO_2/Al_2O_3 and 0.5 – 0.6 under Fe_2O_3/k_2O. Other plots fall into the Fe-sand class field boundary.

Greywackes are lithic fragments that are commonly of fine-grained sedimentary and metasedimentary rocks such as mudstone, shale and siltstone and slate, pelite and mica schist (Morton, 1987).The presence of greywacke (Lithic fragment) shows that they are derived from supracrustal rock consistent with granitic basement. The presence of arkoses in the Litharenite class boundary suggests that these sediments that intermingled with the marble are derived from wildly chemically weathered crystalline rocks.

The Log ratio of Sio_2/Al_2O_3 indicates mineralogical maturity of sediment (Pethjohn, et-al, 1972).

It also distinguishes between quartz-rich high ratio sandstone and clay-rich low ratio shale. Fe_2O_3/k_2O

ISSN 2224-3577
International Journal of Science and Technology

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ratio is an indication of the mineralogical stability of the sediment (Heron, 1988). This distinguishes the lithic fragments from feldspar in a variety of sandstones. The data in Tables 3 and 4 show that SiO_2/Al_2O_3 log ratio is low a reflection that the sediment contain quartz-poor sandstone and an evidence of low proportion of silt mainly quartz to clay. The clay matrix consists of silt and clay-sized quartz, illite and montmoriIlonite intermingled with carbonate.

Textural maturity of sandstone and clay matrix are linked with the environment of deposition (Folk, 1974). Lithic greywackes are commonly associated with shallow marine basal deposition. The occurrences of low matrix and high carbonate ($CaCO_3$) contents in the greywackes, Litharenite /arkose sediments are evidences of a probable deposition in a marine environment.

Similar plot of the log ratios for the Ikpeshi marble is shown in Fig. 2, The result reveals that the sediments belong to the class group of greywacks and Litharenite/arkose. Some sediments however, plotted on the Fe-sand boundary suggesting that the mixture of silt and clay-sized quartz, illite and montmorillonite may have intermingled with Fe derived probably from Lamprophyre intrusion during the metamorphism of the rocks around Ikpesi area.

4. CONCLUSION

Marble samples were geochemically analyzed in order to classify the component sediments that admixed with the original limestone formation. The results show that the sediments belong to greywackes, Litharenite and arkose sand class system as adopted by Schlumberger. The presence of greywackes indicates their derivation from supracrustal rock (Schist) consistent with the source area geology. The presence of arkose in the Litharenite suggests its derivation from mildly chemically weathered crystalline basement rock. Lithic greywackes are commonly associated with shallow marine basal disposition.

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Table 1: Log ratios for Fe_2O_3/k_2O and SiO_2/Al_2O_3, CaO concentrations (vol %) for Igarra marble

Sample	SiO_2	Al_2O_3	Fe_2O_3	k_2O	Log SiO_2/Al_2O_3	Log Fe_2O_3/k_2O	CaO	LOI
1	1.84	0.31	0.18	0.050	0.77	0.56	51.35	43.0
2	2.11	0.45	0.35	0.11	0.67	0.50	53.06	40.95
3	1.89	0.16	0.12	0.03	1.07	0.60	52.76	43.38
4	2.79	0.54	0.14	0.07	0.74	0.30	52.24	42.00
5	4.33	0.52	0.32	0.23	0.92	0.14	48.68	42.61
6	4.83	0.31	0.58	0.28	1.19	0.32	47.89	42.25
7	1.90	0.18	0.08	0.01	1.02	1.30	47.82	44.26
8	3.69	0.61	0.26	0.15	0.78	0.24	50.66	41.08
9	3.53	0.45	0.33	0.18	0.89	0.26	50.12	41.36
10	4.26	0.36	0.52	0.29	1.07	0.25	46.51	43.65

Table 2: Log ratios for Fe_2O_3/k_2O and SiO_2/Al_2O_3, CaO values for Ikpeshi marble

Sample	SiO_2	Al_2O_3	Fe_2O_3	k_2O	Log SiO_2/Al_2O_3	Log Fe_2O_3/k_2O	CaO	LOI
1	1.73	1.46	1.23	0.52	0.82	0.374	46.05	41.98
2	1.94	0.31	0.18	0.05	0.79	0.56	51.35	43.5
3	1.83	0.04	0.04	0.05	1.66	0.09	33.95	44.66
4	0.44	0.11	0.08	0.07	0.60	0.06	33.64	45.75
5	2.12	1.04	0.05	0.05	0.31	0.00	50.08	44.53
6	1.18	0.40	0.23	0.03	0.47	0.89	50.30	43.32
7	7.56	1.86	0.77	0.64	0.61	0.08	45.83	45.30
8	1.88	0.33	0.16	0.08	0.76	0.30	48.36	45.61
9	4.07	1.08	0.47	0.29	0.58	0.21	53.02	40.7
10	6.54	0.29	0.26	0.01	1.35	1.46	46.59	44.23

Table 3: Pair of points defining the sand class field boundary line (After Heron, 1988)

Field boundary	Log SiO_2/Al_2O_3	Log Fe_2O_3/k_2O
Quartz-arenite order	1.6 1.8	-1.0 1.5
Fe-sand: Fe shale	0.71 0.71	0.6
Ferruginous Nonferruginous	1.72 0.0	0.6 0.6
Shale: Greywacke	0.55 0.71	-0.1 1.5
Greywacke: Litharenite/arkose	0.643 0-89	-0.5 0.6
Feldspathric: lithic	0.7605 1.68	0.05 0.05
Subarkose/sublitharenite Litharenite/arkose	1.0 1.1375	-1.0 0.6

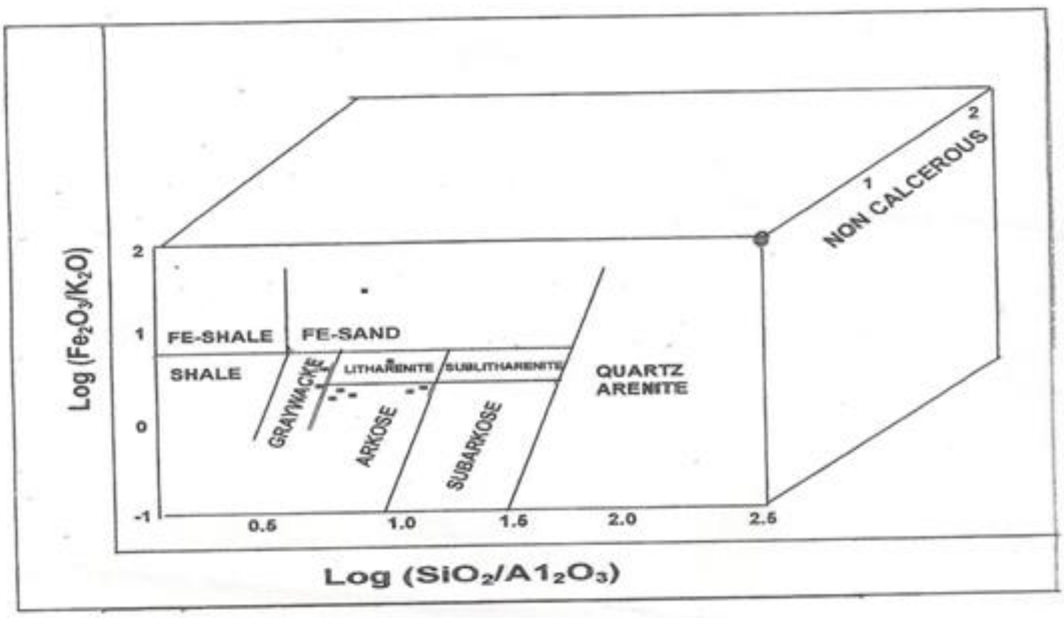

Fig. 1 Geochemical classification according to the Sand Class System for sediments from Igarra

ISSN 2224-3577

International Journal of Science and Technology

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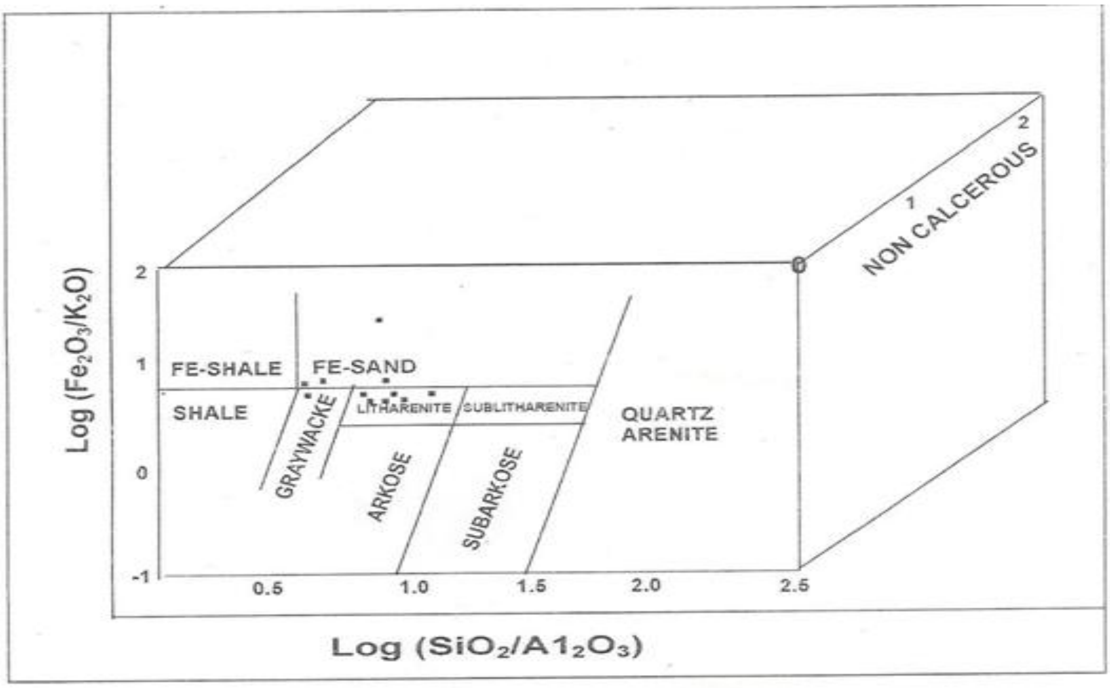

Fig. 2 Geochemical classification according to the Sand Class System for sediments from Ikpeshi.