GLOBAL JOURNAL OF GEOLOGICAL SCIENCES VOL. 2, NO. 2, 2004: 177 - 181
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REGIONAL TECTONIC EFFECTS ON THE COMPOSITION AND MODE OF DISTRIBUTION OF BARITE MINERALIZATION IN AKPET AREA, SE NIGERIA

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(Received 26 May, 2003; Revision Accepted 17 May, 2004)

ABSTRACT

Reconnaissance geologic mapping for barite mineralization within Akpet Central and environs had been successfully done. The results of the study show that the mineralization of barite is largely structurally controlled although minor sedimentary processes have also contributed. Barite mineralization in the area therefore probably displays both metamorphic/igneous and/or sedimentary origins. Those that are derived from igneous processes occur mainly as veins and exhibit thicknesses which depend on the width of the fractures found in the rocks. On the other hand, barite mineralisation in the northeastern flank of the study area occurs as alluvial deposits and in few cases as domes. Chemical compositions for samples obtained from the northwestern and southwestern parts of the area show greater concentration of BaSO4 than in those samples from northeastern axis which exist in alluvial forms. Hence, both regional tectonic activities and the mode of occurrence of barites constitute important factors in the evaluation of barite mineralization. All the barite samples of the study areas analyzed are of high quality to stand the test of time in the world market.

KEYWORDS: Mineralization, Barite, Fractures, quality, alluvial.

INTRODUCTION

In recent times, there has been several reports on the occurrence of barite in Akpet area by local miners and undergraduate students of the Department of Geology, University of Calabar.

Field mapping exercises made within the area had engineered serious mining activities of the mineral as a better definition of the localized zones and the understanding of the mode of occurrence is now known.

Chemical analysis of barite samples from the study area gave acceptable values for the relevant elements essential in the characterization or rating of barite as an industrial material for oil production and related activities. A more realistic acceptance of the barite in Akpet area comes from the specific gravity of 4.56 glcc obtained in most samples. But of striking consideration is the variations in the mode of occurrence and composition between samples obtained from the NW and SE axes respectively. This study therefore provides much insight into this observation, which if expounded upon could serve as a useful index for mining projects in locations with well established tectonic histories. During the study which lasted for 45 days, sixteen (16) villages bordering and within the mapped area were covered. A total of about 56 km2 of land area was covered, with samples collected based on outcrop observations and pre-mined samples as well. The existence of a congenial atmosphere greatly provided the impetus for an indepth mapping in the area.

From the foregoing therefore, the following form the major objectives of the study.

- To delineate zones with barite mineralization.
- To evaluate the quality of the barite.
- To determine the regional tectonic trends in rocks of the area.
- To elucidate on the variations in the composition and mode of occurrence of barite ores in the area.

Regional Geology

Regional geological study of the area had been done and reported by Ekwueme (1987), Ekwueme et al. (1995), Adeleye and Fayose (1978), Nganje and Ekwueme (1995) amongst others. The results from these studies undoubtedly show that rocks of the area have suffered from intense magmatism, migmatisation, fracturing and folding as applicable to rocks of other basement complexes in Nigeria and other parts of the world. The average fracture width in most parts of the study area is 9.5cm.

The results of the geological mapping in the study area and its environs, by Ekwueme (2003) reveals the occurrence of many metamorphic rocks exhibiting different grades of metamorphism. According to the author, these basement rocks particularly the ones found in eastern flank of the study area and extending to Ugep, display features typical of the greenschist to lower amphibolite facies metasediments with well-developed schistosity occupying elongate, tight to isoclinal synformal remnants within the high-grade banded gneisses and migmatites. Although, there exist pockets of metavolcanics in the study area, there is a general preponderance of the metasediments (Fig.1) in the entire area.

A general northeast - southwest orientation (Fig.2) of the measured fractured and lineation planes

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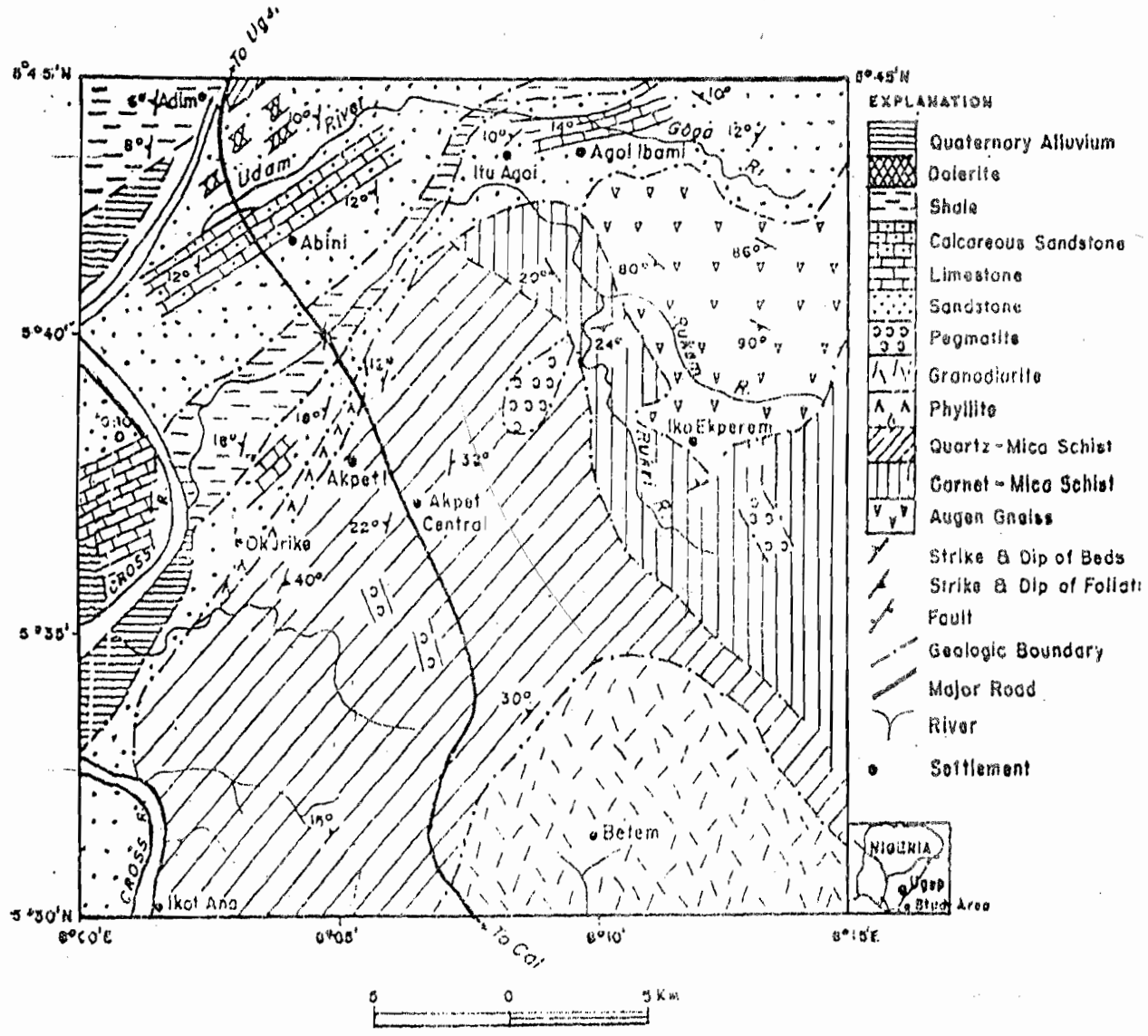


Fig. 1: Geological map of soulthwest Ugep southeastern Nigeria (after Ekwueme 1990a)

based on data of Table 1 is indicative of the Pan African event (Oden, 1995) while relicts of Pre-Pan African event is slightly represented mainly in areas further south of the study area. The fold angles vary between 18 and 200 with the thickness of the limbs being averagely 2.8cm in the schist at the eastern axes of Ibogo, Igbofia, Ugbem and Okurike areas.

Given the generalized classification scheme applicable to the Nigerian basement complexes, the study area is considered to be situated within the Oban massif, which is part of the Nigerian basement complex. The Oban massif is flanked on the southeast by the Cameroon volcanic line and on the northwest by the Benue Trough. The Oban hills according to Fitton (1978) could be a complimentary rifts or aulacogen made up of Cretaceous-Tertiary sedimentary and igneous rocks. The joint patterns in the area are those which falls on the Q-type of Hobbs et al. (1976) while minor cross joints also exist. All these structural elements point to the fact that regional paleotemperature effect could have greatly affected the components of any recrystallized melts during magmatic flows and/or stoppings in the area. It is however, fascinating that rocks further northeast and extending to the lower Benue Trough do not accentuate the effect of this regional stress as much as their counterparts in the western flank of the area (Aniekan, 2000). The most affected rock types include schists, gneisses, granodiorites, phyllite, migmatitic rocks and basalts, (Akpeke, 2000; Ekwueme, 1994; Nganje and Ekwueme, 1996).

METHODOLOGY

The entire study area (Figure 1) was subjected to an intensive surface/outcrop mapping for possible evidence of the presence of barite. Outcrops elevations were documented using a portable GPS. Traversing was made based on the initial reconnaissance mapping exercise made by these authors. Soil/rock stratifications as seen in some abandoned quarry sites were usefully employed in the analyses of subsurface geology to the nearest 15 meters. During the mapping exercise, structural elements preserved in the rocks of the area were noted. Their orientations and magnitudes dimensions taken. Rock samples with barite mineral embedded in them were taken and subjected to A

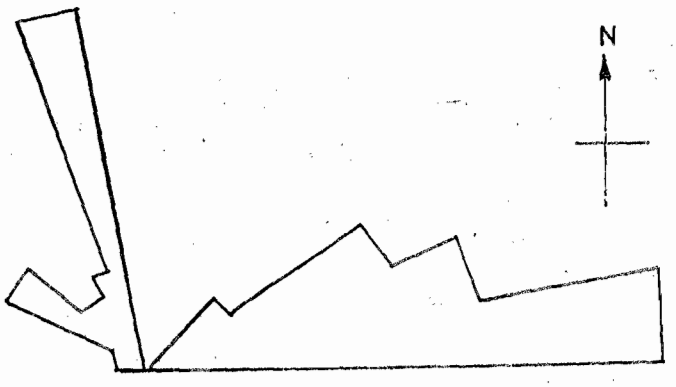


Fig. 2: Rose Diagram of lineament in Akpet area

analysis as well as specific gravity determination. By correlation of the general trends of these tectonic elements from all the areas suspected to be rich with this mineralization in addition to the variation in the elemental composition of the various samples analyzed, it was then possible to adduce reasons for the variations in the mode of occurrence and composition of the barite ore. To ensure accuracy of results, many measurements were made on the observed linear structures and the data plotted into a rosette (Fig.2) for proper definition of the regional stress system in the area.

RESULTS AND DISCUSSION

Plates 1-8 represents barite samples from the area while table 2 is the elemental compositions of some of the selected/representative samples based on electron microscopic study. It is also evident from structural geologic mapping in the area that microscopic folds and faults as well as minor and major joint system are more prevalent in the crystalline part (NW-SW) flank than in the northeastern flank where Cretaceous and younger sediments predominate. These deformational elements could be easily seen imprinted on the rock outcrops at Ugbem, Okurike, Akparavumi and Akpet Central villages. The attendant result of the development of these structures is the recrystallization and segregation of an uprising magmatic fluids believed to be the progenitor for the formation and development of barite as an infilling bodies within the structures. It is therefore evident that barite bodies in these areas exist mainly as veins and in minor cases as domes. Hence, fractures and joint patterns in the rocks found in the western axis of the study area as well as the accommodation space within the limbs of the folds directly guided the vein-type mode of occurrence of the barite bodies in the affected areas. In terms of compositional changes, it is clear from tables 2 and 3 that the composition of BaSO4 (the main component of barite) is relatively higher (80-95%) in most samples from the northwestern axis of the study area. The results obtained for the samples from the northeastern flank of the area particularly in places like Agoi Ibami, Ibogo and Iko Essai rather contrast greatly with those from the far western regions in the study area.

Clearly, the regional magnitude of the structural elements mapped on the more crystalline rocks in the western flank diminishes northeasterly and finally extinct further east in the areas adjourning the southern Benue Trough. Accordingly, the topography in the area falls from 270-350m documented in the western arm to 80-120m in the region. Hence, rather than the barite occurring as veins or domes, they exist as alluvial deposits within the thick siliclastic rocks. Again, a cursory examination of the samples represented by Plates 5-8 (samples B1-B4 of table 3) show clearly that the composition of BaSO4 is relatively lower. From the foregoing therefore, it is clear that genetically, both metamorphic/igneous and sedimentary origins of the barite found in Akpet area and environs is plausible.

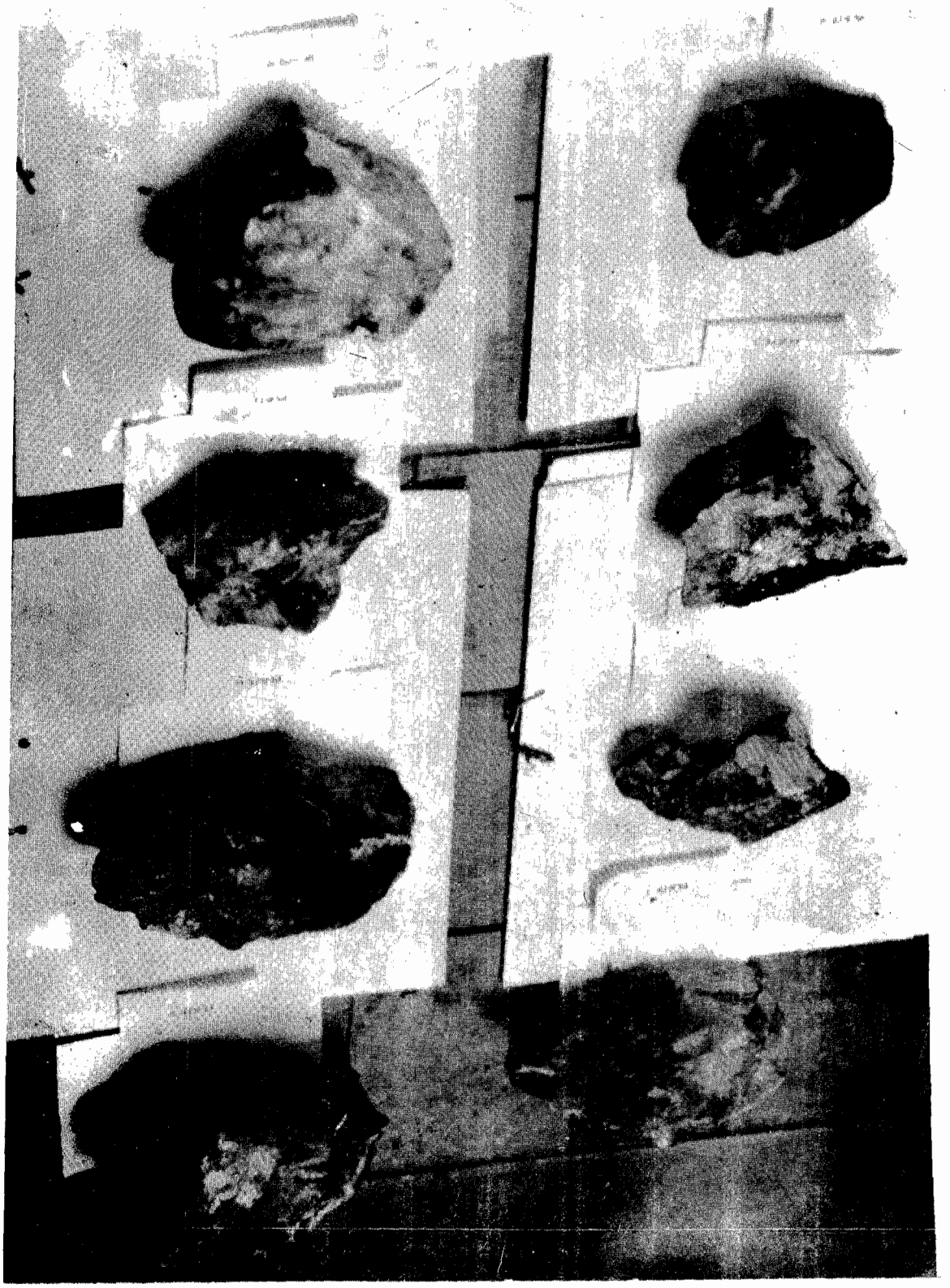
Compositional variation may therefore be directly linked with the recrystallization process which greatly depends on the dimensions of the available space (fractures and faults), fluid compositions at the time of magma injection and other post depositional effects. Generally therefore, barites which are tectonically produced appeared to be of higher grade and hence of more economic value than those with sedimentary origin. Apparently, being of sedimentary origin, it is very likely that intensive denudational processes would have produced a horrendous impact on the deposited barites and thus changing them from what would have otherwise be acceptable as high quality barites to low grade ones. In addition, the alluvial mode of occurrence of the barite will imply more than usual

Table 1: Chemical compositions of barite samples (from the NW part) of the study area

Component analysed (%)	IB_1	IB_1	U_{2-2} I	U_{2-1} A	U_{2-1} B
BaSO4	92.66	92.59	89.94	84.25	87.50
SIO2	0.80	0.50	1.00	6.40	7.05
Al2O3	3.43	2.99	4.40	4.83	3.41
Fe2O3	0.07	0.06	0.10	0.17	0.09
TiO2	N.D.	N.D.	N.D.	N.D.	N.D.
Na2O	0.24	0.20	0.24	0.22	0.21
K2O	0.006	0.004	0.04	0.004	0.04
CaO	1.25	1.25	1.12	1.39	0.28
MgO	0.50	0.50	0.60	0.80	1.21
L.O.I	0.40	0.30	0.80	0.10	0.15
SG	4.21	4.15	4.10	4.17	3.92

Table 2: Chemical compositions of barite samples (from the NE part) of the study area

Component analysed (%)	B_1	B_2	B_3	B_4
BaSO4	55.32	48.90	57.10	50.30
SiO2	0.35	0.60	0.46	2.15
Al2O3	1.20	0.72	1.20	1.11
Fe2O3	0.02	0.03	0.06	0.17
TiO2	0.08	0.02	0.04	0.07
Na2O	0.14	0.11	0.20	0.13
K2O	0.001	0.003	0.002	0.01
CaO	0.12	0.20	1.12	1.39
MgO	0.20	0.30	1.00	0.40
L.O.I	0.36	0.27	0.45	0.17
SG	3.25	2.25	4.10	3.25



Plates 1 - 8 Barite Samples from the study area.

cost of labour even at a higher uncertainty rate (personal communication with a local miner).

CONCLUSION

1. The steep dips (18-200) of the folds and fractures in the basement rocks of the study area greatly enhance slow migration of groundwater through the sediments thus inhibiting further flushing of barium-rich groundwater, leading to the eventual concentration of the thick barite bodies within the folded strata and fractures.
2. The most probable petrogenetic history of the barite mineralization is magmatic segregation of the constituents of hydrothermal fluids derived from either intrusive or volcanic or both sources which leached out barium from sediments to form ores.
3. Both sedimentary and tectonically-controlled processes gave rise to variations both in chemical composition and mode of occurrence of the barite deposits observed in the study area. Temperature effects on recrystallized magmatic melt during the ascend and concentration of barite-rich fluids largely depends on the dimensions of the fractures within which the final deposit is formed. Hence, compositional variation is temperature-time-space dependent. Most volatile components are easily lost to the surroundings, the greater the space and effect of wind.
4. Alluvial-concealed barites are relatively low in BaSO4 and consequently of relatively lower grade than those of metamorphic and igneous origins. However, both igneous/metamorphic and sedimentary-derived barites of the study area are of high quality to stand the test of time in the world market.

ACKNOWLEDGEMENT

The authors sincerely expressed their gratitude to Messrs R.O. Kajotoni and E.O. Akujobi of the chemical and physical laboratories of the Nigerian Mining Corporation, Jos for carrying out the chemical/elemental analysis of the test samples used in this study. We are also thankful to the chiefs of the host communities for their unconditional consent. Mr Akpeke, G.B. was of great assistance during the mapping exercise.

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