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**Case Study:**

# An Appraisal of Locally Processed Barite for Use as Weighing Material for Oil and Gas Well Drilling In Nigeria

By

**F. M. Ayim** and **E. Enoch**
Nigerian Petroleum Development Company Limited
Benin City
Nigeria.

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***Abstract***

*This study shows one of the many ways the Nigerian Petroleum Development Company Limited (NPDC) promotes the Nigerian Content Development initiative. The experiences gained as a result of using locally processed barite supplied by providers of drilling fluid chemicals and services in oil well drilling is presented. The study also explains the importance of standardizing the production processes and procedures of locally produced barite with a view to meeting acceptable quality standards.*

*Results of quality assurance tests carried out on locally processed barite are presented for the purpose of comparison with international standards. While our investigation shows that many of the barite deposits in Nigeria are of high quality and of right specific gravity, the quality of the end products of processed barite sold to the consumer are often below the oil industry set standard for the product. This study also outlines the adverse effects which substandard products have on the consumers. Suggestions on how acceptable quality of the product can be achieved by the local processors are also presented.*

## Introduction

Nigerian Petroleum Development Company Limited (NPDC) is a wholly owned subsidiary of the Nigerian National Petroleum Corporation (NNPC), an integrated oil and gas national corporation. NPDC as a national oil and gas exploration and production company has been a vanguard of the Nigerian Content Development initiative through manpower development and patronizing local contractors in the provision of exploration and production materials and services. This probably derives from the company's mission statement which states that "NPDC is to profitably operate a petroleum exploration and production business both nationally and internationally using indigenous manpower and current technology".

Right from its inception in 1988, NPDC have patronized local contractors in the provision of as much as 90% of the various services required in the area of its operations. One of such services is the provision of drilling fluid chemicals. The chemical of special interest to us in this case study is barite. This is because of its importance as a weighting agent vis-a-vis the role it helps the drilling fluid to play in containing the high pressures encountered in the formations as a well is drilled deeper.

Prior to the advent of the Nigerian Content Development initiative in the oil and gas industry, the source and origin of Barite was not an issue of concern as long as it meets the minimum standard. The industry was therefore flooded with barite imported from Europe, United States and other parts of the world in spite of the occurrence of huge deposits of the mineral in Nigeria. However, with the Federal Government of Nigeria's ban of the importation of barite in order to encourage the production of the mineral locally with a view to empowering Nigerians to develop capacity and actively participate in the Nigerian Oil & Gas Industry, there has been a marked difference in the quality of the imported barite and the locally processed product with the former being of better quality. The difference in quality, we believe, is a result of the way in which the product is being processed in Nigeria as shown by our study.

## Barite Deposits in Nigeria

Barite which is simply barium sulphate ($BaSO_4$) occurs in large deposits in the Benue Trough. Geological and geochemical studies of the barite mineralisation in the Azara area, middle Benue trough, show that the barite belong to two grades: grade 1 containing the smoky and whitish varieties

with a minimum of 92% $BaSO_4$, and grade 2 containing the pinkish variety with 77% $BaSO_4$.[1] The mineral is also found in the Abakaliki-Ishiagu mining district of Nigeria, mainly in the Albian carbonaceous rocks and the Asu River Group of the lower Benue trough.[2] Over 7.5 million tonnes of barite have been identified in Taraba and Bauchi States of the upper and middle Benue troughs.[3] The Nigerian barite has specific gravity of about 4.3 (35.8ppg).[4] It meets the minimum requirement of 4.2SG (35lb/bbl) as per international specification. Spirited efforts have been made to mine and process this mineral for industrial use, especially in the petroleum subsector. There are many companies involved in this under the auspices of the Association of Miners and Processors of Barite in Nigeria. One German company (Projekt-Consult GmbH) also claims to have designed a study for a pilot project on the development of barite mining under the World Bank mining sector project in Nigeria.[5] In spite of the efforts enumerated above, the barite produced in Nigeria to a large extent, is yet to meet the standards specified globally, based on NPDC's experience. This is explained in the following below.

**Use of Locally Processed Barite – NPDC's Experience**

Barite is normally delivered in big bags of 1.5 metric tonnes. They are also delivered as bulk material in trucks or vessels, depending on the terrain of operation. The local processors here also package them in 50kg sacks. The experience we would like to share was on an onshore location where the product was delivered in 1.5 metric tonnes bags. At NPDC, if, for example, we want to determine the quantity of barite required to raise the mud weight from $MW_1$ to $MW_2$, we use the generalized weight-up formula for barite:

**Weight-up formula (barite) in U.S. units:**

Barite (lb/bbl) = $1{,}470 \times [(MW_2 - MW_1)/ (35 - MW_2)]$.....(1)

**Weight-up formula (barite) in metric units:**

Barite (kg/m3) = $4{,}200 \times [(MW_2 - MW_1)/ (4.2 - MW_2)]$.....(2)

Where $MW_1$ = initial mud weight

$MW_2$ = desired mud weight

4.2 is the specific gravity of barite (equivalent to 35lb/bbl in US units)

From the 2 equations above, it can be seen that the major factor which determines the quantity of barite to be added to a mud to achieve a higher weight is the specific gravity of the product.

Therefore, to weight up 1,000 bbl (159 $m^3$) of 14.0 lb/gal (1.68 kg/l) to 16.0 lb/gal (1.92 kg/l), the following material is required:
1,548 sacks of barite or 70.2 mt (1 mt = 1,000 kg)
The final volume is 1,105.3 bbl (175.7 $m^3$).

Since the product comes labelled with claims to have met the required specifications, the next thing to do is to instruct the rig crew to bring out the quantity calculated (in 50kg sacks or 1.5MT bags) and mix it. However, our experience with the locally processed barite has cost us a lot in terms of

[1] Joseph I. OMADA and Echefu C. IKE "On the economic appraisal and genesis of the barite mineralization and saline springs in the middle Benue trough, Nigeria". Journal of Mineralogy, Petrology and Economic Geology Vol. 91, 109-115 (1996).
[2] M. A. Olade and R. D. Morton "Origin of Lead-Zinc mineralization in the southern Benue Trough, Nigeria – Fluid inclusion and trace element studies" Mineral Deposits 20, 76-80 (1985)
[3] NIPC Internet reference "Solid Mineral Deposits in Nigeria". http://www.nipc.gov.ng/deposit.html
[4] NIPC Internet reference "Solid Mineral Deposits in Nigeria". http://www.nipc.gov.ng/deposit.html
[5] Projekt-Consult. "Mining and Environmental Protection" http://www.projekt-Consult.de/pc-mining-en.htm

non-productive time and also exposed us to great risks when, after mixing the calculated quantity, the final weight obtained was far below the expected in spite of the margin of error normally tolerated. The major problem became how to determine the right quantity of barite to achieve the desired weight as it became very clear that the specific gravity claimed by the supplier was incorrect.

As a result of the above, we decided to take a random sample from each delivery with a view to confirming its properties (especially specific gravity) and the average results from ten (10) tests are presented below.

| **CHEMICAL: BARITE** | | **SAMPLING LOCATION: ONSHORE (OML 111)** | | |
|---|---|---|---|---|
| **S/N** | **PROPERTY** | **UNIT** | **REQUIRED** | **AVERAGE RESULT** |
| 1 | Density | g/ml | 4.20 minimum | 3.69 |
| 2 | Wet Screen Analysis | | | |
| | Retained by #200 Sieve | % by Weight | 3.0 maximum | 2.17 |
| | Retained by #325 Sieve | % by Weight | 10±5 maximum | 10.17 |
| 3 | Concentration of Soluble Alkaline Earth Metal as Calcium | mg/l | 250 maximum | 29.68 |

The minimum density ever encountered was 3.63 while the maximum was 3.78 from the locally processed barite.

It can be seen that the specific gravity of the barite is below the recommended acceptable standard of 4.2. Since Nigerian barite is said to have a specific gravity of 4.3, the results obtained above raises questions on the manner in which the product is being processed. It would have been appropriate here to dwell into barite processing with a view to detecting which aspects of the process need improvement.

The Association of Miners and Processors of Barite recently decried how Nigeria looses over ₦6.2 billion annually to incessant granting of waivers for the importation of barite.[6] They lamented how imported barite is posing a barrier to the development of the Nigerian mining sector. Uncontrolled importation, they claimed, was done through waivers in spite of the ban by the Federal Government. While appreciating the concerns of the miners and processors of barite in terms of jeopardizing the growth of the solids mineral industry in Nigeria, they should also have regard for the end users of the product like NPDC that incurs substantial NPT (non productive time) as a result of the time it took to mix so many bags of barite where just a few would have been adequate if they were processed to the required standard. Again the product is being sold to us at a rate that is not commensurate with its quality. There is therefore the need for standardization of processes so that local processors can meet the acceptable standards.

**Recommendations**

In the spirit of the Nigerian Content Development initiative and to ensure that the consumers of barite get value for resources spent in patronizing Nigerian miners and processors of barite, we would like to recommend as follows:

[6] Toba Agboola "Nigeria loses N6.2billion annually to imported barite" The Nation Newspaper, April 13, 2009

1. The Ministry of Solid Minerals Development which is involved in the promotion, exploration and development of Nigeria's non-fuel minerals should work closely with the Nigerian Content Division of NNPC towards working out modalities for establishing world-class barite processing industries in Nigeria for the purpose of developing the solid mineral sector in-line with what is obtainable in the oil and gas sector.
2. The Nigerian Content Division of NNPC should, along with the Standards Organization of Nigeria, encourage the current small-scale enterprises that are into mining and processing of barite to achieve a certain acceptable standard quality which should be clearly labelled on the products in order not to misguide consumers.
3. The Ministry of Solids Mineral Development should be encouraged to understudy the running of the Department of Petroleum Resources with a view to introducing some of the incentives used in the oil and gas sector to attract reputable Nigerian investors into the non-fuel mineral sector.
4. Set up business alliance with oversees producers who will provide the technical support in terms of know-how and machineries to be installed in Nigeria.
5. Arrange for purposely built machineries in-country for small scale producers.

## Conclusion

Based on the need to have a fair playing ground for both processors and consumers of barite in Nigeria, it is important that the product is processed to the required standards. Uncontrolled importation of barite poses a serious threat to the development of the local mining industry. The very laudable efforts of the government efforts in developing the local industry may be undermined if a favourable environment for the local production of barite is not created. Regarding production, one of the objectives of the Local Content Policy which is to promote a framework that guarantees active local participation without compromising standards should be the watch word of the local processors.