Available online at www.elixirpublishers.com (Elixir International Journal)

Geoscience

Elixir Geoscience 67 (2014) 21226-21229

ISSN: 2229-712X

A Comparative Assessment of the Quality and Industrial Applications of Lessel and Korinya Baryte Deposits, Benue Trough, Nigeria

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ARTICLE INFO

Article history:
Received: 20 December 2013;
Received in revised form:
20 January 2014;
Accepted: 1February 2014;

Keywords
Atomic Absorption Spectrophotometer (AAS),
Beneficiation,
Baryte,
Filling materials and specific gravity.

ABSTRACT
An assessment of the quality of Lessel and Korinya baryte deposits was carried out by analyzing their geochemical properties using the Atomic Absorption Spectrophotometer (AAS). The results shows that the mean concentrations of BaO, FeO, Cao, MgO, Al_2O_3, Fe_2O_3 and SiO_2 of Lessel baryte were 77.22, 0.07,1.03, , 0.03, 0.03, 2.25 and 19.08% respectively while at Korinya, the mean concentrations of these parameters were 83.96, 0.04, 2.24, 0.02, 0.03, 2.35 and 11.25% respectively. The result also show that the mean specific gravity of Lessel and Korinya barite depositswere 4.25 and 4.31 respectively. Although the two baryte deposits exhibits close chemical relationship, the Korinya baryte is relatively better in quality in terms of BaO, FeO , SiO_2 and specific gravity values. On the basis of BaO,FeO and specific gravity, the two baryte deposits can be used as a weighting material in oil and natural gas drilling. The two barytes are also suitable for glass, paint, and paper production on the basis of their Bao and Al_2O_3 contents. However, in terms of FeO and SiO_2, the two baryte deposits would require beneficiation before being used for glass production. The two barytes would also require beneficiation in terms of FeO contents before being used forfor paint and paper production. The results also indicates that the Lessel and Korinya barytes can be used in the cosmetics, construction and pharmaceutical industries as well as filling materials in the ceramics industry.

Introduction

Lessel and Korinya are located about 20 and 40 kilometers respectively southward of Gboko, Kogi State of Nigeria (Figure 1).The two mining sites lies within the Benue Trough which was formed in the Early Cretaceous times as an abandoned arm of trilete (rrr) rift system that failed to develop into a Proto-Continenet. The Trough contains about 5,000 meters of sediments comprising of immature argillites, carbonates and volcanic rocks which have been structurally deformed during the Early Cenomanian (Ukpong, 1981). Mineralization (lead-zinc, baryte, gypsum and salt) in the fractured or sheared zones which were formed during the deformational episodes (Bogue and Reynold, 1951; Farrington, 1952; Orajaka, 1965; Olade, 1976). In early 60,s, mining activities in the Benue Trough focused mainly on lead-zinc and coal which occurs in commercial quantities in the basin. However, in recent times, exploration activities in the basin has been extended to baryte. This may be probably due to the high cost of baryte especially for oil drilling activities. Since the early 1980, most oil drilling companies operating in Nigeria have been purchasing barytes locally for their drilling activities. the inferred reserve of barytes in the Benue area of which the study area is about 305, 657 metric tones based on mean specific gravity of 4.0 and 20 meters depth of vein (Maritz, 2010).

Apart from being used as a weighting material for oil and gas well drilling, baryte has other other industrial purposes (Painting, plastics, paper, cosmetics, pharmaceutical, rubber, ceramics and glass industries). Although baryte occurs in commercial quantities in Kogi, Nassarawa, Cross River, Taraba, Kogi, Plateau, Adamawa and Gombe States, the quality of these deposits varies from one mining site to the other. Studies (Ene and Okogbue, 2012; Maritz, 2010; Ayim and Enoch, 2009) has been carried out on some baryte deposits in Nigeria. However, there is paucjty of information on the geochemical properties of most baryte de[posits mined on a small scale. An assement of the quality of such deposits can be of immense benefit to local industries. Lessel and Korinya barytes are operated on small scale and their geochemical properties are yet to be investigated.

Occurrence of baryte deposits

Baryte is the most common barium minerals, occurring mainly as gangaue mineral in metalliferous hydrothermal veins which have formed at moderate or low temperatures. In rare cases, baryte occurs as a major constituent of the vein. It occurs often in association with fluorite, calcite, siderite, quartz, galena , shalerite, magnetite, stibinite and celestite (Olade and Morton, 1985). Lessel and Korinya barite deposits occurs as vein deposits. The Lessel deposits occurs in association with galena,quartz, pyrite and anglesite while that of Korinya occurs in association with quartz, siderite, pyrite and minor quantities of calcite. The veins in Lessel and Korinya located 20 and 40 kilometers respectively from Gboko respectively runs in NE-SW and NW- SE directions respectively. Minor baryte, however, occurs in veins running in E- W diirections. Veins exposed do not persist over a long distance; the width of the veins in both mines range from 0.50 to 3.0 meters. The barites in the two mines occur as white, reddish-brown and clear The depth of the Lessel and Korinya mines are about 12 and 15 meters respectively.

Physiography and Climatic conditions

Lessel and Korinya lies on an elevation of 110 and 122m above sea level respectively. The annual rainfall of the two areas is between 1500 and 2500mm while the vegetation cover is the moist Woodland Savanna. The vegetations includes shrubs and trees; most of the vegetation have been removed through

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agricultural and mining activities thus creating a kind of desertification.

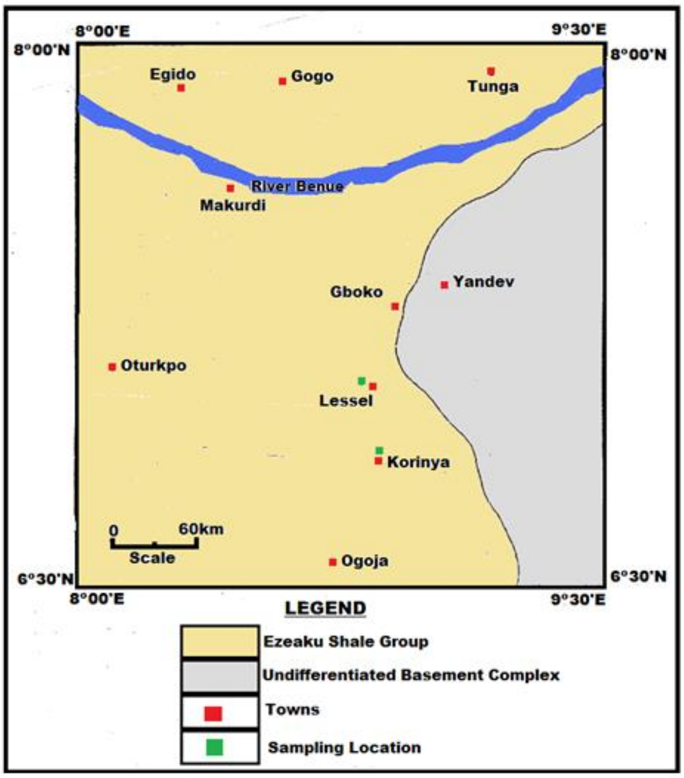

Figure 1. Geological mapof the study area

Geological setting

Lessel and Korinya are underlain by the Ezeaku Shale Group (Figure 1). The Formation consists of flaggy calcareous shale and siltstone,grey or black in colour with frequent impressions of Inoceramus. The shale also contains minor bands of sandstone and shelly limestone.Locally the Ezeaku Shale pass into The Ezeaku Shale is overlain byconsists of massive sandstone with thin beds of arenaceous and calcareous shale. The shelly sandatone pass laterally into a shale-limestone sequence (Reyment, 1965). Although the maximum thickness os the sandstone is unknown, the Ezeaku Shali is known to attain a maximum thickness of about 1220m (Reyment, 1965). The Ezeaku Shale is overlain by the Agwu Shale and underlain by the Undifferentiated Basement Complex.

Materials and methods

Ten barite samples (five from each location) were obtained with the aid of geological and analzed for thir geochemical contents (BaO, CaO, FeO, MgO, Fe_2O_3, Al_2O_3, SiO_2 using the Atomic Absorption Spectrophotometer (AAS). The sampling interval was 10m and sampling was restricted along the major barite veins. The specific gravity (S.G) of the barite samples were analyzed using digital S.G equipment while the elevation 0f two mining sites was obtained with the aid of the Global Positioning System (GPS).

It is imperative the barite samples were first pulverized using standard grinding machine before being digested and subsequently subjected chemical analysis using AAS.

Results and discussion

The result of the geochemical characteristics of Lessel and Korinya baryte samples is presented in Table 1 while the standard for industrial applications of barite is shown in Table 2.

BaO

The concentrations of BaO varies from 74.50 to 78.20% with a mean value of 77.22% at Lessel mine while the BaO concentrations at Korinya varies from 82.60 to 84.00% with a mean of 83.96% (Table 1).The mean BaO concentration at Korinya is relatively higher than that of Lessel (Figure 2) and thus of a better quality. The mean concentrations of BaO at Lessel and Korinya is consistent with BaO concentration range of some barytes in the Benue Trough of Nigeria (Ene and Okogbue, 2012; Ayim and Enoch, 2009).

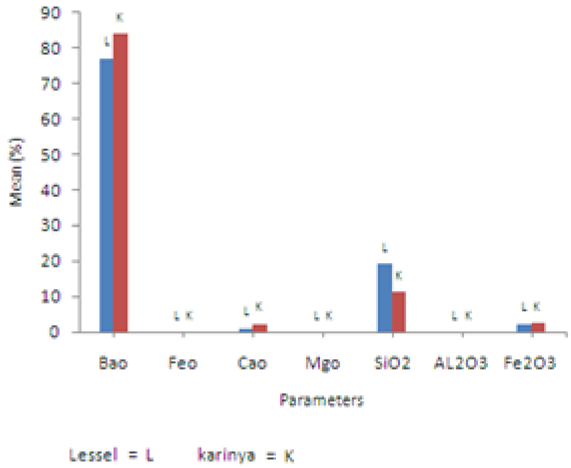

Figure 2. Chemical relationship of Lessel and barytes

Although the Korinya baryte is better than that of Lessel, both of them satisfied the industrial requirements (BaO% content of >60%) for oil and natural gas drilling (Leford, 1983). The two baryte deposits are also suitable for glass, paint and aper production on the basis of their BaO concentrations (Leford, 1983).it is estimated that about 90% barites produced in the World is used only for oil and natural gas drilling (Maritz, 2010).In Nigeria, there is growing demand for locally processed barite for use as a weighting material for oil and natural gas drilling (Ayim and Enoch, 2009).

FeO and Fe_2O_3

The concentrations of ferrous iron (FeO) at Lessel varies from 0.05 to 0.09% with a mean of 0.07% while at Korinya, it varies from 0.02 to 0.06% but with a mean of 0.04% (Table 1). Howeve, the concentrations of ferric iron (Fe_2O_3) varies from 1.95 to 2.94% with a mean of 2.25% at Lessel and from 1.95 to 2.94% with a mean of 2.35% at Korinya (Table 1). The pyrite (FeS_2) associated with the Lessel and Korinya barytes is partly responsible for the formation of insoluble ferric iron (iron 111) in both mines (equation 1).

$2FeS_2 + 4H_2O + 15/20_2 = 4H_2SO_4 + Fe_2O_3$ ………(Equan.1)

Pyrite Haematite (ferric iron)

The ferrous iron (FeO) is the stable iron oxide in two sites and hence the one employed in the assessment of barytes for industrial purposes. Ferric iron (Fe_2O_3) is easily converted to ferrous iron (FeO) under aeration process (equan. 2).

$Fe^{3+} =$ Fe^{3+} ……………………………………….(Equan. 2)

Ferric Ferrous

The measured FeO concentrations in two baryte mines conformed to the mean concentrations of barytes in the Benue Trough (Ene and Okagbue, 2012; Ayim and Enoch, 2009). On the basis of FeO contents, the Lessel and Korinya baraytes are suitable are suitable for oil and gas drilling, glass, paint and paper production (Table 2). In dope and painting, baryte is used as filling material and can the place of some expensive materials such as basofor, crypton, titanium dioxide, activity and monox. It is also used to control the viscosity of the paint compatibility to make the products with bright colour and good stability. In paper making, barite is used to improve the whiteness of paperboard as well as coverage (Meritz, 2010).

Table 1. Some geochemical properties of Lesseland Korinya baryytes Concentration (%)

LOCATION	BaO	FeO	CaO	MgO	SiO_2	Al_2O_3	Fe_2O_3	S.G
Lessel- 1	78.00	0.08	1.00	0.03	17.95	0.02	2.42	4.25
" 2	76.40	0.05	1.02	0.04	20.49	0.05	1.95	4.26
" 3	74.50	0.06	1.06	0.03	19.38	0.03	2.94	4.25
" 4	77.00	0.09	1.03	0.03	18.92	0.02	2.01	4.26
" 5	78.20	0.05	1.06	0.04	18.65	0.05	1.95	4.25
Mean	77.22	0.07	1.03	0.03	19.08	0.03	2.25	4.25
Korinya- 1	85.70	0.04	2.00	0.01	10.27	0.02	2.41	4.30
" 2	84.00	0.05	2.20	0.02	10.76	0.02	1.95	4.35
" 3	83.50	0.06	2.40	0.03	11.05	0.02	2.94	4.32
" 4	82.60	0.03	2.20	0.03	12.64	0.03	2.47	4.30
" 5	84.00	0.02	2.40	0.03	11.54	0.03	1.98	4.30
Mean	83.96	0.04	2.24	0.02	11.25	0.03	2.35	4.31

Table 2. Industrial Requirements of Barytes

INDUSTRY	BaO	FeO	MgO	Al_2O_3	SiO_2	S.G
Oil Drilling	>60%	0.09%max				At least 4.20
Glass	>60%	0.02%max		0.15%max	1.50%max	
Paint &paper	>60%	0.03%max		0.03%max		
Construction						4.20

Source: Leford ((1983)

CaO

The concentrations of CaO at Lessel varies from 1.00 to 1.06% with a mean of 1.03% while it varies from 2.00 to 2.40% with a mean of 2.20% at Korinya (Table 1). The relatively higher CaO concentrations at Korinya (Figure 2) compared to Lessel is due to the presence of thin bands of shelly limestone at Keroinya mine. The range of CaO concentrations at Korinya mine is relatively higher than that of barytes in Abakiliki basin (Ene snd Okagbue, 2012). On the basis of CaO concentrations, the Lessel andKorinya barites are suitable for use as fillers.

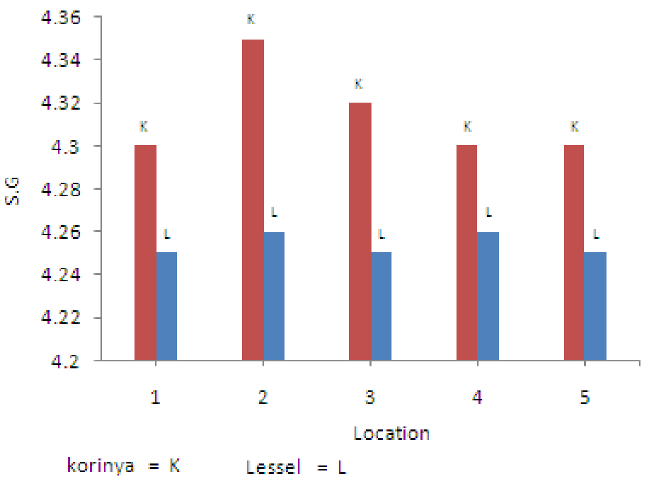

Figure 3. Variations of specific gravity of baryte at Lessel and Korinya

MgO

Mgo concentrations at Lessel varies from 0.03 to 0.04% with a mean of 0.03% while at Korinya it varies from 0.01 to 0.03% with a mean of 0.02% (Table 1). It should be noted that the Mgo concentrations at Korinya is slightly lower than that of Lessel.

SiO_2

The SiO_2 concentrations varies from 17.95 to 20.49% with a mean of 19.08% while the range at Korinya is from10.27 to 12.64% with a mean of 11.25% (Table 1). Ayim and Enoch (2009) observed that barites of Benue Trough has a silica content of up to 21%.The Lessel and barytes can be used for glass making on the basis of SiO_2 content if beneficiated.

Al_2O_3

The concentrations of Al_2O_3 at Lessel varies from 0.02 to 0.05% with a mean of 0.03% while at Korinya, it varies from 0.02 to 0.03% with a mean of 0.03%(Table 2 and Figure 2). On the basis of Al_2O_3 contents, the two barite deposits are quite suitable glass, paint and paper productions (Table 2).

Specific Gravity (S.G).

The specific gravity of pure barite is about 4.5. the barytes at Ibi in Taraba State has a mean specific gravityof about 4.4. At Lessel, the specific gravity varies from 4.25 to 4.26 with a mean of 4.25 while at Korinya it varies from 4.30 to 4.35 with a mean of 4.30 (Table 1 and Figure3). Ene and Okugbue (2012) observed that the specific gravity of barytes in some parts of Benue Trough varies from 3.1 to 4.5.The Korinya barytes is best in terms of specific gravity. Oil and gas drilling companies prize barytes intended for use asa weighting material on the basis of their specific gravity (Ayim and Enoch, 2009). The higher the specific gravity, the higher the cost of the barite. On the basis of specific gravity, the two barite samples are suitable for construction, oi and natural gas drilling (Table 2).

Chemical relationship

Except for BaO and SiO_2 concentrations that vary slightly in the two sites, othe measured parameters shows close chemical relationship (Table 1 and Figure 2). The chemical trend in two baryte mines depends on the geological setting of the area. The relatively higher concentrations of SiO_2 at Lessel compared to Korinya is due to the occurrence of quartz at Lessel. The variations of chemical parameters at various sampling points in both Lessel and Korinya are shown in Figures 2 and 3 respectively while the relationship in the mean concentrations of the chemical of the Lessel and Korinya barytes is shown in Figure 2.

Conclusions

The Lessel and Korinya barites are quite suitable for oil and natural gas drilling on the basis of their BaO, FeO concentrations and specific gravity.However, the Korinya is best for oil and natural gas drilling because its relatively higher BaO, FeO concentrations and specific gravity compared to that of Lessel. The two barytes are also suitable for glass, paper and paint making on the basis of BaO, FeO and Al_2O_3 concentrations. However, on the basis of SiO_2 contents, the two barites would require beneficiation before being used for glass production. The Lessel and Korinya barytes are quite suitable for construction purposes on the basis of specific gravity although the Korinya is the best.

Acknowledgements

The authors are grateful to Engr. Tony Anyiam-Osigwe of Pedmacgrek Ltd for his contributions. Gratitude is also due to Mr. H. Abu of Federal Ministry of Solid Minerals Makurdi as well as Obioma Nosiri of the Federal University of Technology Owerri for their technical assistance. The author is also grateful to Mrs Adaku Ahiarakwem for contributions.

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