# An Insight into the Sources of the Bentonite used in the Local Drilling Industry

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***Abstract*—**Bentonite is a type of clay mineral that is used in a variety of applications such as drilling, sand casting, pelletizing iron ores, in insecticides, pet-litter, pharmaceuticals and cosmetics.

In this paper, the findings from a preliminary study on the use of Bentonite in the local drilling industry are discussed. Special focus is paid on the sources of the bentonite that is used in the drilling of bore holes, geothermal wells, and coal exploration cores.

Findings from the study showed that both imported and local bentonites are used locally in drilling. Comparatively, imported bentonite accounted for upto 67.49% of the drilling industry market share as opposed to the local bentonite which takes the remaining pastry 32.51%. This drains the country's foreign exchange and leaves the local bentonites unexploited fully.

The consumption levels also appeared to be on an upward trend for both. The quantities of imported and local bentonite for drilling use increased by 55.56% and 56.29% respectively for the period between 2006 and 2010 reflecting increased demand for this clay. From the study, it was also found that none of the drilling companies involved in the study carried out routine tests on the bentonite before or during drilling, basically due to lack of standard testing equipment.

In general, formal methods for the characterization of bentonitic clays are lacking. The different venues for the standardization of the clays for drilling work are highlighted in this paper.

***Keywords*—Bentonite, Drilling, Sourcing, routine tests**.

## I. Introduction

BENTONITE is a clay mineral, largely composed of montmorillonite, which is mainly a hydrous aluminum silicate [1]. It received its name from the cretaceous *Benton* Shale, a Wyoming geological formation near Rock River,U.S.A where Wilber C. Knight found deposits of the clay in 1898 [2].

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Bentonite is used in a variety of applications such as drilling, sand casting, pelletizing iron ores, in insecticides, pet-litter, pharmaceuticals and cosmetics among others. Of these applications, drilling and foundry are the major consumers.
Research performed in the early 1990's by the Bureau of Mines of the U.S.A. showed that the sum of bentonite deposits in the world is about 1.36 billion tonnes, and the U.S.A. has more than 50.0 % of the total [3].
The world production of bentonite has averaged 12mt per year since the mid 1990's . Globally, the production is stable with annual variations of typically no more than 5 % though with significant differences in trends between regions [4].
Many countries mine and process bentonite. For instance, in 2006, U.S.A. was the top producer (4,940,000 metric tonnes,mt) with almost one third the worlds share, followed by Greece (950,000mt) and Turkey (950,000mt) compared to Kenya's 50mt [5]. Over this period, the quantity of bentonite produced in Kenya increased by only 10mt or 20% as reflected in table 1.

Table 1. Bentonite production in Kenya

| Year | Production (Metric Tonnes, mt) | Change |
|---|---|---|
| 2003 | 50 | NA |
| 2004 | 50 | 0.00 % |
| 2005 | 60 | 20.00 % |
| 2006 | 60 | 0.00 % |
| 2007 | 60 | 0.00 % |

**Source:** United States Geological Survey (USGS) Minerals Resources Program

The world demand for bentonite is forecast to rise by an average of 2.2% per year from 20 million tonnes in 2007 to 22.4 million tonnes in 2012. In the same vein, the demand for bentonite for use in drilling mud is forecast to rise by around 2.2% per year to 2012 when it will reach 2million tonnes per year compared to 1.8million tonnes in 2007 [6]

## II. BENTONITE AND ITS CHARACTERISTICS

Generally, bentonite is a rock term used to designate a naturally occurring, very fine grained material largely composed of the clay mineral montmorillonite. Chemically, montmorillonite is a hydrous aluminium silicate. Structurally, it is made of two basic building blocks, the aluminium octahedral sheet and the silica tetrahedral sheet [7].
These are shown in the Fig.1

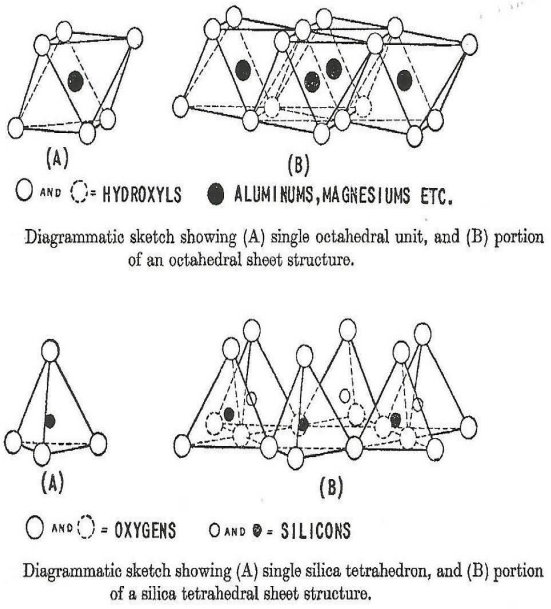



Fig.1. Structures of alumina and silica sheets

A single unit cell of montmorillonite consists of two silica tetrahedral sheets, between which is an aluminium octahedral sheet [7] as shown in Fig. 2

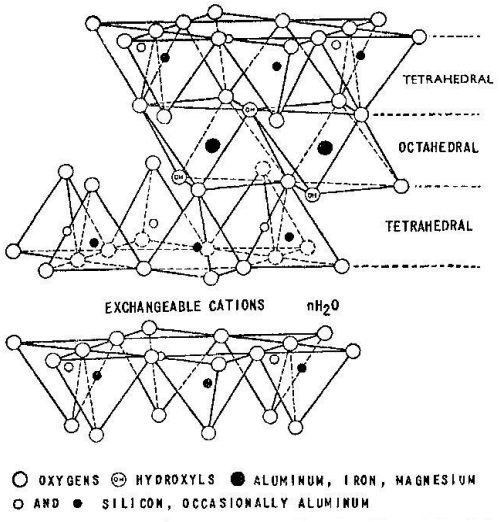



Fig.2.Montmorillonite Structure

The montmorillonite lattice has a negative charge, owing primarily to isomorphous substitution of ions within the structure. This negativity is balanced by cations which are held on the surface of the flakes. Cations held in this fashion by the clay can be readily exchanged, the most commonly found in nature being sodium and calcium. The exchangeable cations, both by type and amount that are associated with the montmorillonite are of great importance since they largely control its physical properties [7]. For drilling purposes, the rheological properties of the bentonite need to be determined and these include: viscosity, yield value, gel strength and filtrate loss.

## III. BENTONITE OCCURRENCE IN KENYA

GEOLOGICAL reports by the Kenya's Department of Mines and Geology indicate the presence of bentonitic clays in different parts of the country, such as Athi river basin, Timau, Meru and Namanga among others [8-10]. The quality of the bentonites in these and other deposits require to be fully determined in order to provide the requisite information to mining investors. Consequently, the available bentonite, once mined and processed could possibly satisfy the local demand for drilling and other uses as well as earn the government the much needed foreign exchange through cross border trade.

## IV. OBJECTIVES OF THE STUDY

IN Kenya, the demand for drilling bentonite is likely to increase now and in the near future on account of the increasing need to drill boreholes, geo-thermal wells as well as for coal and oil exploration wells. The purpose of this study was thus to determine the sources and quantities of the bentonites currently used in the local drilling industry. This would in turn form the basis of searching for local alternative sources to meet the current and future bentonite demand not only for drilling, but also for other applications in the country and beyond.

## V. USE OF BENTONITE IN DRILLING

Bentonite is usually mixed with a measured quantity of water to form drilling mud which is then pumped into the bore during the drilling process.
The use of bentonite as drilling mud serves the following important functions [11, 12].
a) Removal of cuttings
b) Control subsurface pressure.
c) Suspend drilled cuttings.
d) Cool and lubricate the bit.
e) Wall building.
f) Drill string and casing support.
g) Formation evaluation.
h) control corrosion.

The bentonite drilling mud is normally recycled as the drilling process continues.
A typical circulation system for bentonite drilling mud is shown in Fig. 3.

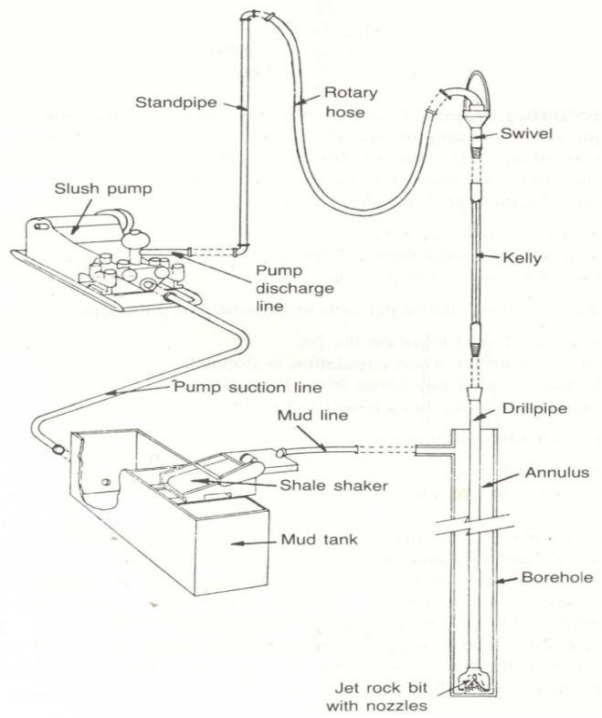



Fig. 3 Bentonite drilling mud circulation system.

## VI. DATA COLLECTION SURVEYS, VISITS AND INTERVIEWS

IN this study, a questionnaire was designed to best suit the information intended to be gathered by developing simple, clear and straight forward questions. These questions sought to provide information relating to the following:

- The estimate of the quantity of bentonite used annually in drilling between 2006 and 2010
- The source of the bentonites used by each of the respondent companies
- Other alternative sources of bentonite known to the respondents
- The tests, if any carried out on the bentonite before and during the drilling activities.
- The drilling standards adopted by each of the drillers

The questionnaires targeted 30 drilling companies. Amongst these, 6 claimed not to use bentonite while 4 others totally declined to respond to the questionnaire citing privacy in their operational policies. Thus, overall 20 drilling companies provided the information /data discussed in this study.
The administration of the questionnaire involved making an initial visit in which the questionnaire was delivered followed by at least one more visit to collect the assumedly filled questionnaire, make some clarifications , conduct related interviews and obtain some bentonite samples where possible.

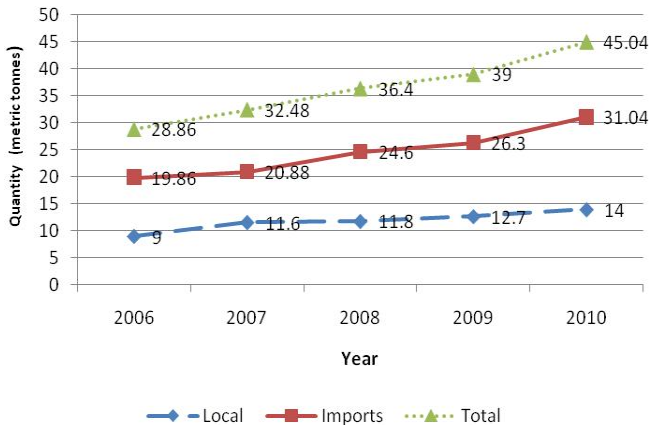
## VII. RESULTS, ANALYSES AND DISCUSSIONS

THE results of this study relate only to bentonites used in drilling as per the information/data gathered from respondents in the local drilling industry.

*a) Quantities of bentonites used*

For the 20 drilling companies involved in the study, the annual quantities (in metric tonnes) of bentonite used for drilling were tabulated and plotted to show their trends as shown in Fig. 4.

Fig.4 Trends of local and imported bentonite for local drilling(2006-2010)




From the graph, it is clear that the quantities of both the local and the imported bentonites have been on the increase from 2006 to2010. However the increase in the imported quantity increased faster than the local one as can be inferred from their gradients.

*b)Sources of bentonite for local drillers*

Different drilling companies obtain their bentonite from different sources. Countries quoted by the respondents as being sources of bentonites included Australia, India, America, South Africa, China and Kenya as well. However, for purposes of this research, the sources were deliberately classified as either local or imported. On this basis, the study showed that the local drilling bentonite constituted just 32.51 % of the 181.8 mt of bentonite used in drilling compared to imported quantities taking upto 67.49% over the period considered. This disparity is despite the fact that Kenyan deposits remain grossly unexploited, a challenge which this paper seeks to explore. A major observation made during the visits was that about 85% of these drilling companies were owned by foreigners, mostly Asians who import their bentonite from their mother countries.

*c)Alternative sources of bentonite*

Most of the respondents (80%) failed to cite any alternative source of bentonite either due to lack of information about other sources or deliberately to avoid diverging company secrets. The few who responded positively on this aspect were very general about the alternatives (western, central, Kenya/Tanzania border) or made reference to their suppliers. From this observation, it is clear that the local drillers are not well informed about the availability of bentonite deposits locally or simply are keen on maintaining the status quo.

*d)Tests Carried out on the bentonite before or during drilling*

None of the drillers in the survey carried out any routine preliminary tests on the bentonite before use or even during drilling. This was mainly attributed to lack of testing equipment and the capacity to do so. The drillers thus relied on the good will of the suppliers. Generally, the drillers separately felt that the bentonite they obtained (from their suppliers) and used (for drilling) was serving their purpose, whether it was local or imported. They were thus of the view that testing or investing in testing equipment was an unnecessary expense since any complains could be referred to the suppliers.

*e) Adoption of Standards for bentonites used in local drilling.*

There are two internationally recognized standards that are acceptable in the drilling field. These are the American Petroleum Institute (API) standards and the Oil Companies Materials Organization (OCMA) Standards. The response on the adoption of either of these or any other standards by all the drilling companies involved in this study was a clear ' NO'. This could be attributed to lack of professional or legal guidelines to govern all drilling activities in the country.

## VIII. CONCLUSIONS

THE following conclusions can be drawn from the findings of this study:

1. Both local and imported bentonites are used by local drillers, the larger share(67.49%) being taken up by imports.
2. There is inadequate information or lack of access to the available information to local drillers regarding presence of potential bentonite deposits in the country
3. Testing on lcal or imported bentonite is scarcely done by local drillers. This casts doubt on the perceived performance or quality of these bentonites
4. Local drillers are generally not adherent to any drilling standards and this is likely to compromise the quality of their work.

## IX. RECOMMENDATIONS

THE following are the recommendations made from this study:

1. Bentonite users need to be sensitized on the availability of unexploited bentonite deposits in the country with the view of encouraging investors into further exploration and possibly mining and processing.
2. Similar studies on all the other possible applications of bentonite should be carried out in order to broaden the scope of the study and thus come up with more reliable findings.
3. Bentonite testing centres should be established and made available to the public with the intention of making the testing more friendly and cost effective. This would in turn make it possible to compare the qualities of bentonite from different local and foreign sources. Testing would also be used to classify different bentonites into their appropriate applications.
4. A professional body be established and empowered to streamline and coordinate all the operations of the drilling industry. This would in turn be expanded to cover all the other applications aspects inwhich bentonite is used.

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