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EVALUATION OF BENTONITE IN LIBYA

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ABSTRACT

Large consumption of bentonite in Libya due to increase in drilling activities in the Mining and Petroleum industries. Therefore, mining processing and treatment of this clay, the major mud forming compound, has been subject of this study.

In Libya large quantities of clay have been explored. In Umm Ar Razam alone about 79,756 **kt** of clay has been estimated.

Grinding, drying temperature, chemical treatment and blending are the main variables consider in this study. It has been found that the particle size distribution of the clay has direct effect on the engineering properties. Fair results are obtained using mixer and drying at 50 C°.

The addition of 2% Soda ash (Na2COs) with 2.5% carboxy methyl cellulose (CMC) improved the properties to required values

Blending is another method of improving engineering properties. A blend of 60% local clay and 40% Magcogel with addition of 1% Soda ash and 1% CMC gave yield of 20 m^3/ton and filtrate loss of 14 ml which meets to OCMA specification

CHAPTER I

INTRODUCTION

INTRODUCTION

The mining, and petroleum industries, like most other, use a large number of raw materials in the production of its finished products. As is the case with many of these industries, some of these raw materials are classed as industrial minerals. These minerals, or more properly rocks, are used in all stages of petroleum production and refining. They vary from bentonite and mica used in the muds, essential for drilling, though the silica sands used for formation fracturing and production enhancement to bentonite and lime used in the final refining of various products. Bentonite, calcite, mica and sands that could be of potential use to the industry.

These different materials should be studied to determine the amounts used annually by the industry (not only in Libya, but in the immediate geographical area), the cost of importing these commodities, and the potential for local production.

During the drilling of an oil (or deep water) well, mud slurry is constantly circulated in the hole to assist in drilling. The purposes of this mud include cooling and lubricating the bit, preventing entry of formation fluids (and gases) into the hole, preventing loss of drilling fluids to the formations being drilled, and brining cuttings to the surface. In order to enable the mud to perform these tasks, a variety of mineral and synthetic compounds are added to the water used for drilling.

Bentonite, the major mud forming compound has been the subject of this study, the properties of muds used in drilling must be varied according to the formation being drilled. This is especially true when drilling is likely to encounter salt, gypsum or anhydrite, or clay beds and shales that exhibit swelling properties.

There are many drilling problems. Some are controlled by using water base drilling muds. Others may be controlled by using oil base drilling muds with all the attendant hazards (fire... etc). Otherwise, the only solution is to alter the chemistry of the muds to control the severity of these problems.

Commonly the chemistry of muds is controlled by the addition of one of several compounds. The materials used' include gypsum, anhydrite, soda ash and lime. These materials control the flocculation of the mud due to the presence of excess calcium and sodium in the mud by saturating the mud with the Ions to begin with. A mud may then be produced having desirable properties that will not be affected by addition of more sodium or calcium.

In this study about two hundred kilograms of bentonite were collected for testing from the Umm Ar Razam area shown in Fig – 1.1
Evaluation tests will include:

1- Chemical analysis.

2- Analysis of physical properties.

Large amount of bentonite is consumed in the Great Jamahiriya in the oil industry and in other sectors of the economy Table-1.1. And since the great Jamahiriya is rich in clay deposits therefore it seems natural to exploit such deposits.

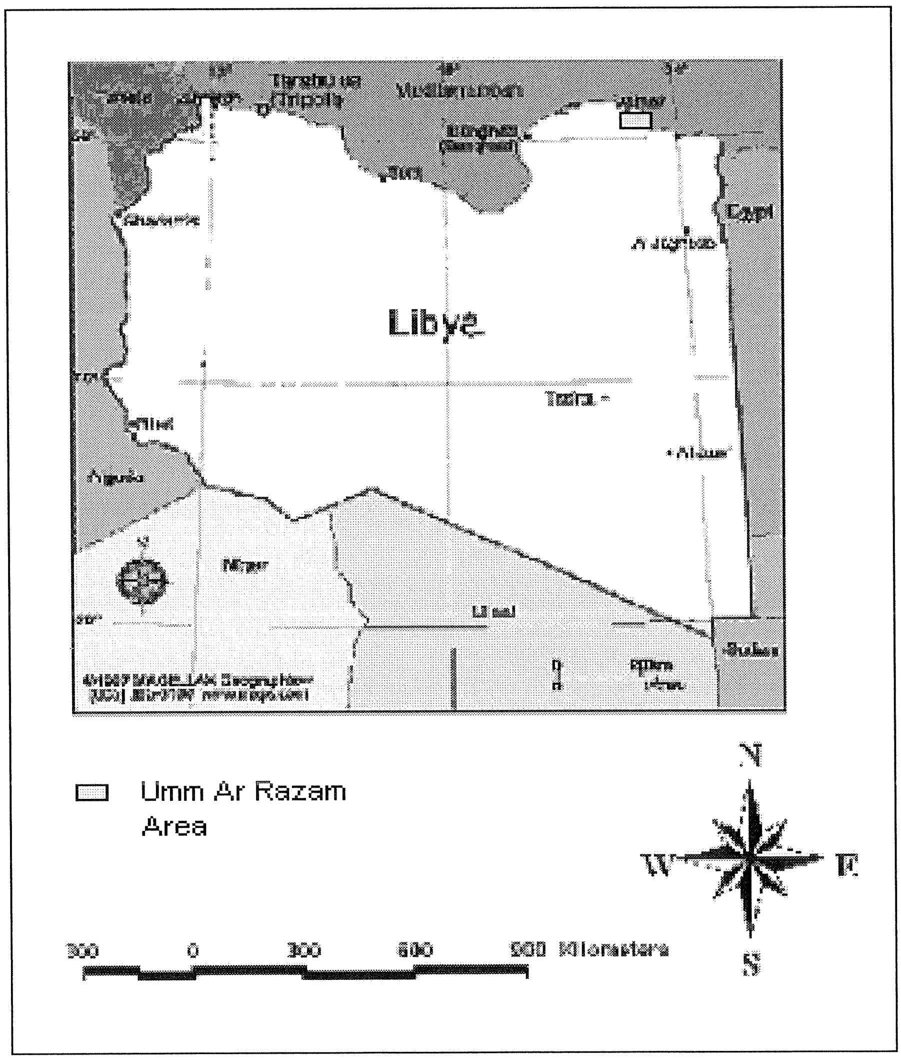
The Umm Ar Razam area is one of the sites rich in clay. This research aims to study the effect(s) of drying temperature and grinding mode on the physical properties of this clay.

These properties are: apparent viscosity, plastic viscosity, yield point, gel strength, filtrate, and yield

Drying to natural drying Pulverizing was made by ball mill, rod mill, and mixer.

It has been found that the types of grinding have direct effect on the behavior of this clay. The chemical analysis of Umm Ar Razam is slightly different from the chemical analysis of bentonite clay.

The second objective of this study is the reserve estimation of the deposit. Data from sixteen boreholes were analyzed for the computation. The total reserve is estimated at 79,756 **kt.**



Umm Ar Razam area shown in Fig 1.1

Table – 1.1 Consumption of bentonite in the Libya

YEAR	QUANTITY (ton)	VALUE (L.D)
1972	14,676	136,183
1973	7,763	60,171
1974	21,617	273,799
1975	28,993	659,845
1976	13,433	298,315
1977	20,587	563,272
1978	12,146	353,242
1979	33,101	1,622,198
1980	30,212	1,353,451
1981	25,484	1,208668
1995	30,083	1,245,439
1996	40,006	1,656,252
1997	45,056	186,532
1998	37,949	1,571,068
1999	36,639	1,156,852
2000	39,437	1,632,690

National Oil Corporation

DEFINITION OF THE PROBLEM

Large consumption of bentonite in Libya due to increase in drilling activities in the Mining and Petroleum industries. Therefore, mining processing and treatment of this clay, the major mud forming compound, has been subject of this study.

Clay minerals play very important role in various field, especially in ceramic, agriculture, as drilling fluid.

Drilling of large mining openings, drilling of blast holes, drilling of water wells, and drilling for oil and gas wells require significant quantities of clay.

Clay improves the drilling rate, reduces cost (by reducing ware), and maintain the stability of the borehole.

Sodium montmorillonite, or bentonite, is the most important viscosity in fresh-water muds, and is probably the most important fluid-loss control agent. It exhibits high swelling properties.

Calcium montmorillonite, sometimes called sub-bentonite, swells two to four times its dry volume in fresh water.

Clay samples from Al Faidiyah Formation do not show in any case typical foam structure and variety in colours as the known Na-bentonite of a good quality, due to the relative and clear oxidation of clay strata in the upper part of the deposit.

For this reason the engineering properties of this clay showed very poor performance. Previous studies indicated that the physical properties of local clay is below the international standards (OCMA), Therefore, in this study the processing techniques of clay have been investigated to improve the physical properties by controlling the drying temperature and the mode of grinding.

PROJECT PARAMETERS

During a project's life, management of it focuses on three basic parameters:

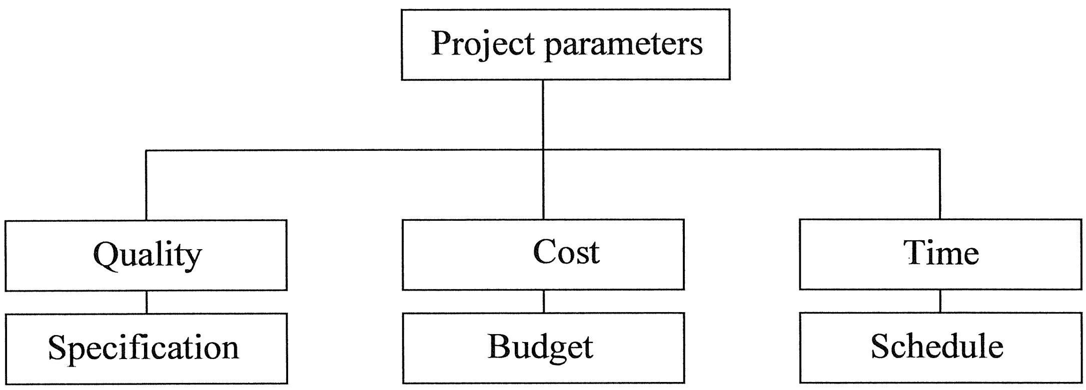
1- Quality

2- Time

3- Cost

A successfully managed project is one that is completed at the specified level of quality, on or before the deadline, and within budget.

Each of these parameters should be specified in detail during the planning phase of the project. These specifications then form the basis for control during the implementation Phase



Quality **(Specifications)**

Planning for quality requires attention to detail. The goal of quality planning is to assure that the output of the finished project will do what it is supposed to do. A quality plan also establishes the criteria by which the project output will be evaluated when the project is finished.

Planning the qualitative dimension includes specifications for the quality and types of materials to be used, the means of verifying quality, such as testing and inspection.

The objective of this study is determining the quality (specification) of the Umm Ar Razam clay and determines whether it meets the international specifications or not.

Time (Schedule)

The objective when planning the time dimension is to determine the shortest time necessary to complete the project.

The duration of each step

The earliest time at which a step may be started

The latest time by which a step must be started

This study will attempt to focus on the quality of bentonite in Libya and compare it with international standards. In this content, the thesis airs to contribute to on of the basic parameters of project management, namely '**quality** '.

Assessment of the quality of bentonite will hopefully he of benefit to the project management processes utilizing bentonite as an input , as bentonite is one of the basic materials of the mining and petroleum industries.

CHAPTER II

LITERATURE REVIEW

LITERATURE REVIEW

One of the earliest studies made on Umm Ar Razam clay was made by the industrial research center in which they have indicated the presence of large quantities of clay.

Then Rahomas, S, of EL Alami, M. from the Petroleum Research Center, reported about this clay in 1981.

Self, M., In April, and May 1982 the water well drilling authority used the clay from Umm Ar Razam area to drill a water well number T/I/0262/0/8I in the Ghyrane area, near Zanzur.

The well is drilled up to 683 m of depth, dia 8 1/2". They concluded that the mud used is made from natural clay of Umm Ar Razam and is very good for drilling. All mud properties were reported well.

Gent. M., In February 1985. From the Petroleum Research Center studied this clay in detail. He concluded that the clay of Umm Ar Razam is very good exploration target, requiring geophysical surveying and drilling to be economically evaluated. The extent of the clay is considerable (several kilometers), and the limestone cap rock is thought to be minimal but the thickness of the clay which is thought to be far more than other commercially operated deposits, remains unproven.

Furthermore, a regional, reconnaissance exploration of Libya for bentonite is warranted.

Watson, D., In August 1986. From the exploration-exploitation department studied the sources of raw material for the petroleum industry in Libya. He proposed that Libyan bentonite should be used in petroleum industry as well as other industries for example clarifying and decolorizing, vegetable oils ... etc.

Jowfe Company In July 1991 made a very comprehensive study on this clay. They studied the lower member of Al Faidiyah formation. Ten exploration boreholes were drilled into different stages. Chemical and mineralogical analyses were made on samples from these boreholes. In addition determination of engineer properties was made.

They concluded that the local bentonite contains carboniceous and sulphate Impurities. Therefore the results don't display the characteristics of a good bentonite.

Prof. Eng. Vitezslav zamarsky, Prof. Eng. J. La't, Dr. Eng. Bek Derna. A, up on the request of the Petroleum Research Center in May 1992, and a group of researchers from the Petroleum Research Center drilled two boreholes X1, X2. A complete evaluation of samples collected from these boreholes was very encouraging.
They concluded that 75000 **Kt** of bentonite is present and that bentonite can be used a substitute of the imported bentonite.

The drilling and well completion unit and the drilling fluids section at the Petroleum Research Center April 1993. Studied this local clay. They collected five samples from hole X1 and eight samples from hole X2 from Umm Ar Razam area. They have been tested for physical properties evaluation according to **OCMA** specification.

The results show that the moisture content, residue and dry screen analysis of all samples from both holes X1, X2 are within the OCMA range (satisfactory) where as the yield and API filter loss are out of range (not satisfactory) according to OCMA specification.

The samples delivered to the laboratory were all raw and no additives were added.

The Petroleum Research Center in August 1993 started anew study to evaluate the engineering properties of local bentonite. An they concluded that:-

a) Umm Ar Razam clay as raw material inadequate to be used as drilling fluid since it does not meet the international specification.

b) Additives such as Na_2CO_3 and CMC (H.V) have improved the quality of this clay and brought it to the required range of OCMA.

c) As a mixture 2% by wt. $Na_2\ CO_3$ and 3% by wt. CMC (H.V) is the optimum concentration required to treat URC. This is the lowest value ever obtained in comparison with other studies in Libya and abroad.

d) As a blend 60% URC to 40% ICC activated with 1 % by wt. $Na_2\ CO_3$and 1 % by wt. CMC (H.V), it does fulfill OCMA specifications.

e) In normal conditions the local clay when blended and activated behaves approximately the same as ICC, but at elevated temperatures and pressures the filtrate loss property value increased and in some cases almost doubled.

f) During experimentation we have noticed that the methodology of activating the clay samples with additives influenced the results dramatically.

The Most comprehensive report was unpublished in 1995 by the Petroleum Research Center it included geological evaluation reserve estimation, chemical analysis and evaluation of bentonite clay.

a) Clay samples collected by Chekoslovakian consultants from Umm Ar Razam area, holes X1and X2 during May 1992, did not fulfill bentonite specifications since these samples contain a high amount of impurities consisting of:

I- Non- swelling clay minerals- kaolinite, chlorite and elite with a ratio of 23-46%.

II-Non- clay minerals- quartz, k-feldspar, plagioclase, calcite and Ankerite, with a ratio of

8 to 29%.

b) The conclusion (a) above is further supported by the results obtained from cation exchange capacity analysis of these samples. The highest value was 66.1.meq./100g. While the requirements for a bentonite mineral to be used in drilling fluids, range, from70 to 130 meq. /100g.

c) Additives such as $Na_2\ CO_3$ and CMC (H.V) have improved the quality of this clay and brought it to the required range of OCMA. Thus a mixture of

2% by wt. $Na_2 CO_3$ and 3% by wt. CMC (H.V) is the optimum concentration required to that URC. This is lowest value ever reported in comparison with other studies in Libya or a broad.

d) On the other hand, a blend of 60% URC with 40% ICC, activated with 1% by wt. $Na_2 CO_3$ and 1% by wt. CMC (H.V), does fulfill OCMA specifications.

e) In normal condition, the local clay, when blended and activated, does behave in the same manner as ICC, but at elevated temperatures and pressures, the filter loss property value increases and in some cases almost doubles.

CHAPTER III

GEOLOGY OF AREA

3.1 General Geology

The Umm Ar Razam area is underlain by a sequence of sedimentary rocks ranging in age from Middle Miocene to Recent (Zert, 1974) Fig-3.1 the two units found as surface exposures in the immediate area are the Al Abraq Formation of Middle Upper Oligocene age and the Al Faidiyah Formation of Upper Oligocene Middle Miocene age. Elsewhere on the Darnah map sheet. Older rocks are exposed in wadi bottoms and sea cliffs.

The contact between Al Abraq and Al Faidiyah Formation is disconformable, with the basal clay of the Al Faidiyah having a markedly transgressive character.

The exposed portions of the Al Abraq Formation consist of pale cream – yellow calcarenite with varying numbers of fossils, chiefly pectens and echinoids. Only minor occurrences of this unit are seen since it is usually exposed only in wadi bottoms where it is subject to burial by Quaternary and recent wadi deposits.

The bedding planes of both formations in the Umm AR Razam area are essentially flat lying with variations in dip of only 1 or 2 degrees. Larger apparent dips seen in some wadi banks are due to recent movement and slumping of the Al Faidiyah Formation.

In the Umm Ar Razam region many karst type features are seen and many "sink holes" are noted on the topographic map sheet (3990 III- Umm Ar Razam). It is not known at this time whether or not these features are confined to the Al Faidiyah Formation or extend lower into other formations. A possible origin of these features is discussed under the description of the clay unit within the Al Faidiyah Formation.

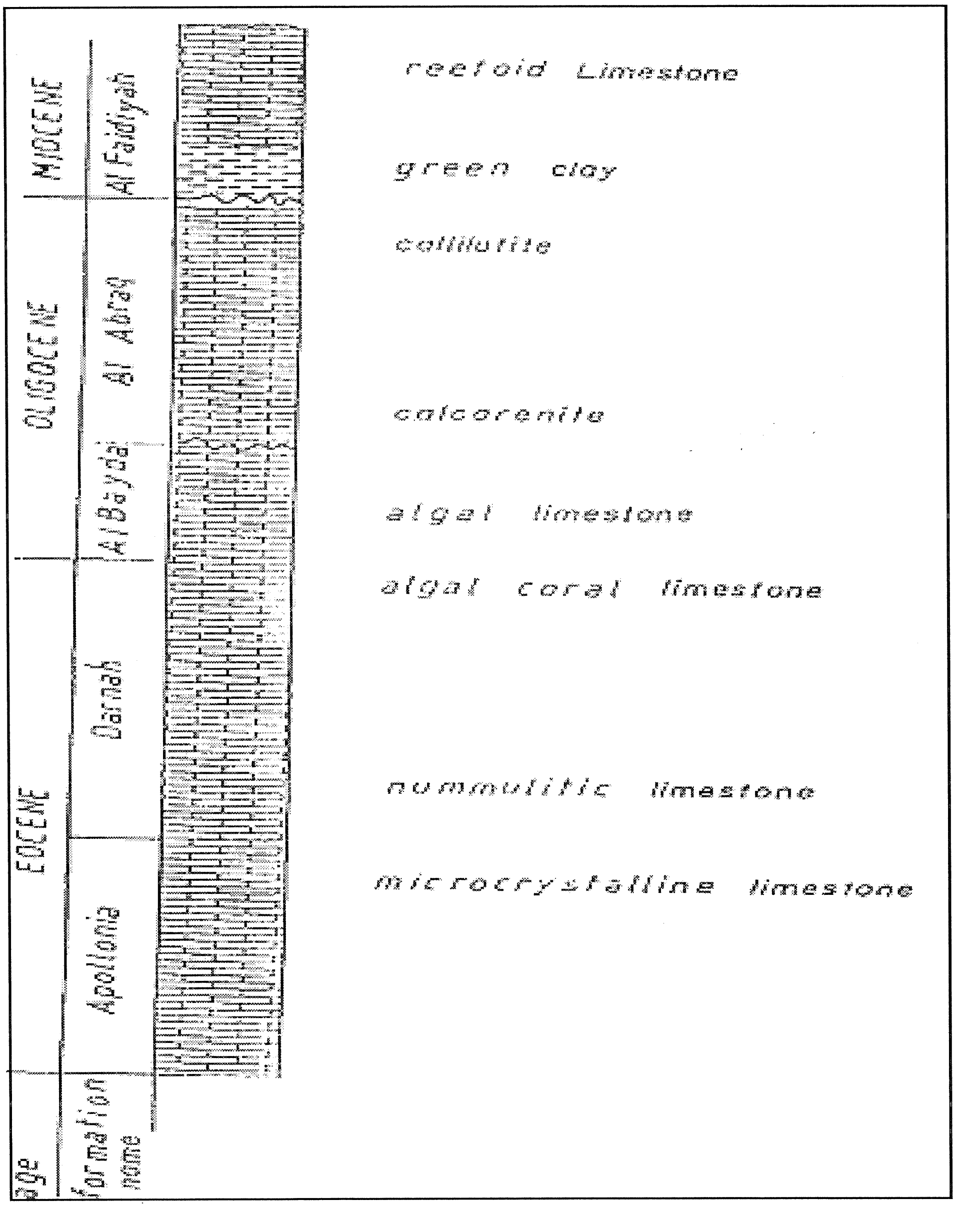


Fig- 3.1. Generalized Stratigraphy

3.2 Al-Faidiyah Formation

Al Faidiyah Formation is the unit forming the outcrop and surface material of most of the Umm Ar Razam area, the exceptions being in the bottoms of some wadis It is also theformation of interest in this study, containing, as it does, the bentonite clay unit at its base, Since for the purpose of the evaluation of the Bentonite, an examination of the entire sequence was not necessary; the following description is drawn largely from references where appropriate, they are cited.

3.3 General Description:

The name Faidiyah Formation was initially proposed by Pieteresz (1968) for a sequence of clay and carbonate rocks resting uncomfortably on the Al Abraq Formation in the area of Al Faidiyah village approximately I8km south-east of Al Bayda Originally, Pieterzs divided the formation into an "Upper Limestone Member" and a "Lower Clay Member" Fig-3.1 but this division has since been abandoned by others working in other areas since the division is not so obvious. In the Umm Ar Razam region, the distinction between these two units is very apparent and for the purposes of this study, very important

For this reason, the terms "Upper limestone" and "Lower clay" will be used herein. The lower boundary of the Al Faidiyah Formation is everywhere transgressive and disconformable. In the north, it lies on the Al Abraq Formation and this boundary although well defined in the Umm Ar Razam area is obscure in other places where the clay unit is less well defined. In the southern part of Jabal Al Akhdar, this disconformity is better developed where the basal clay lies on the Al Bayda and Al Majahir Formation (Magerisi & Mamgain, 1980).

The thickness of this lower clay unit varies from 2 to 20 meters over the limits of its occurrence although the range with in our study area is smaller. It consists mainly of gray green montmorillonitics clay with layers of glauconitic marl or clay. Microfossils have been reported by some authors (Eng. Eliagoubi, 1972) and the same unit has been declared "devoid of microfossils" by others (Eng. Zert, 1974). The composition of this unit has also been described differently by different authors, but the character is generally that of green - brown clay with minor amount of other materials.

The Upper limestone consists of white to yellowish limestone, fossiliferous, recentralized and in part, dolomitized. The thickness of the unit ranges from 130 - 150m in the central part of Jabal Al Akhdar to 60 -100m in the eastern and western parts.

Few drill holes penetrate these layers, especially in the study area. Two holes are, however described by Eliagoubi (1972) who gave litho logical as well as pale ontological descriptions.

The portion of this Upper limestone immediately overlying the clay horizon is usually yellow, soft to friable, highly fossiliferous limestone, in places coquina or lumachelle.

The main macrofossils present are pectens, oysters and echinoids. Some pellets of phosphate minerals and shark teeth are also seen in some samples.

It has been observed along the edges of some wades that in places the marly layer has been dissolved away, leaving an extensive limestone overhang, and development of a network of caves. This is probably caused by water accumulation and movement on top of the impermeable clay horizon and subsequent dissolution of the marl. Collapse of the limestone and lowering of the surface follow this process possibly this same process is the cause of the sink holes previously mentioned as occurring in the area.

3.4 Local geology of the lower clay unit

The lower clay unit of the Al Faidiyah Formation is exposed in the Umm Ar Razam area in the lower portions of the many wadi beds. The upper boundary of the clay (against the upper limestone) appears to be relatively flat and horizontal The bottom contact with the Al Abraq Formation likewise appears to be flat.

These observations are borne out by the data obtained from the P.R.C drill holes, where the elevation of the top of the clay is nearly constant. Similarly, observation of the contact between the Al Faidiyah and the Al Abraq Formations and the relationship with the topographic contours would indicate that there is very little dip or thickness variation to the beds.

In the study area, the character of the day unit is fairly consistent. It ranges in color from gray-green too yellow-brown. Usually the two color variations are intermixed, with irregular swirls and patches of one color within the other. The differences do not appear to reflect any relic structure or real differences in composition, but may instead be due to differences in iron valence or other minor chemical variations.

The clay appears to be without macrofossils. None were found in examination o1 surface exposures of the clay, and although any encountered during drilling would have been ground to chips, these chips would have been seen during examination of the residue during mud testing.

The Al Faidiyah Formation limestones especially between Al Ghazalah and Tabruq consist of (54.49% by wt. CaO, 0.47% by wt. MgO and 0.5% by wt. SiO_2).

These limestones are very suitable for pure lime production or in some other industria branches (e.g. chemical industry, agricultural purposes etc.). It may thus be used as *c* suitable raw material in the cement production.

The most widespread clay mineral is montmoillonite. The montmoillonite clays found ir large reserves in the surroundings of Umm Ar Razam and east of Tamimi **may be used** in the production of expanded pebbles for construction industry. The preliminarily determined volume capacity is about 1.

The Al Faidiyah Formation aquifer containing a continuous clayey horizon at its base is of large extent. Except for the northwestern part of the sheet, this clay usually has a high. proportion of alkali salt and gypsum; consequently, ground water is mostly of an inferior quality. Renowned springs are, e.g., in the surroundings of Al Ghazalah. At Tamimi or Umm Ar Razam. Besides, the springs at Martuban, in the southern part of wadi Darnah, and in the wadi al Muallaq zone receive water from the Al Faidiyah Formation, as also dc the wells in the Tabruq area. Despite its various quality and low inflow, however, this aquifer is the only resource of ground water within easy reach.

Microfossils and other components found during examination of the fine fraction (plus 64 microns) are listed in Table-3.1. Their relative abundances are given in respect to eact" other. The total amount of this size fraction in any one sample was very small, ranging up to 2.4 percent.

Foraminiferal assemblages picked by the author have been examined and identified by Hulsbos of P.R.C (pers comm., Table -3.2), who gave the following interpretation:

1- The presence of Globorotalia siakensis and Globigerinoides sp. indicates an early to Middle Miocene age. The absence of Orbulina spp. in the assemblages may point to an early Miocene age.

2- The present species indicate open marine conditions. The species Nonion boueanum and Hanzaia boueana are shallow water species while the others could also be found in deeper water.

Table 3.1 Microfossils identified in 1988 samples*

Sample	Species
Le (a)	Globorotalia siakensis Globigerinoides sp. Lenticulina sp. Globigerina cf. Preabulloides Cassidulina sp. Cibicides sp. Stilostomella cfVerneuili Uvigerina cf Peregrina Bulimina sp. Bolivina sp. Globoquadrina sp. Nonion boueanum Amphicoryna sp
141	Cibicidoides sp. / Cibicides sp. Stilostomella cfVerneuili Globigerina sp. / Globorotalia sp. Hanzawaia boueana Bolivina sp.
14g	Globorotalia cf.siakensis Globigerina sp. Bulimina sp. Uvigerina cf. Peregrina Cibicides sp. Stilostomella cf. Verneuili Nonion bouean

Concentration of gypsum has been noted in the literature (Zert, 1974), and indeed were fou And in many of the surface samples. There is, however an almost complete absence of gypsum in the samples collected during the drilling program. This would indicate that the gypsum is probably forming at this time by a process of crystal growth from groundwater saturated with calcium sulphate.

The main other impurities found in the clay samples both from the surface and drill holes are glauconitic and phosphates. The glauconitic occurs as rounded green to dark green pellets reaching in size up to0.75mm. They are mainly associated with a layer of grayish clay near the top of the clay unit. The pellets have also been found associated with other horizons in the section.

The phosphate minerals occur as rounded masses, pseudo morphs after outraced, bivalves and as fillings in worm tubes and other structures. Most of the phosphate shapes found in the clay unit can also be found within the overlying limestone. There are also shark teeth and other teeth and scales in both units.

Both the phosphate pellets and the teeth have been closely examined and there appears to be no difference between those from the clay and those from the limestone layers. This would seem to indicate that the environment of deposition for both units was similar. The occurrence of these minerals, and foraminifera would indicate that the environment of deposition was probably that of a shallow and clam shelf rather than a restricted lagoon as suggested by others. The accumulations of gypsum and salt cited by others as their reasons for proposing a lagoonal environment are recent alterations and not original components of the formation.

CHAPTER IV

CLAY MINERALOGY

Clay mineralogy

Clay is the major building block of most water base drilling fluids, it exhibits a dominant role in determining the rheological and filtration properties of the mud. The clay minerals with which we are concerned can be broken down into three categories:

1-The needle-shaped, non-swelling particles of attapulgite.

2- The plate-like, non-swelling or slightly swelling clays of illite, chlorite and kaolinite.

3- The plate-like, highly swelling montmorillonite.

It s believed that the shape of attapulgite particles is responsible for its ability to build viscosity. The natural fine crystal size and needle-like shape causes it to build a brush-heap structure in suspension and thereby exhibit high stability. Attapulgite exhibits very poor filtration control and is primarily used as viscosity builder in salt water muds.

Clay particle linking processes

The various linking processes of clay particle are quite important to the theology of clay suspension. The flat, plate-like particle of clay have two different surfaces, the face surface which is negatively charged and the edge surface which may be positively charged. These electrical charge and counter ions make up an electrical force field around the clay particles. If the counter ions are dissociated from the clay surface, the repelling force between the flat negatively-charged plates is large and the plates will be dispersed from one another.

Clay particles can associate in three different ways: Face-to-face association, or aggregation, merely leads to formation of thicker plates and causes a decrease in viscosity. This is observed in the addition of gypsum to a hydrated bentonite suspension. After an initial increase in the viscosity, the suspension will thin to some value of viscosity lower than the original. Dispersion leads to a greater number of particles and higher viscosities. The degree of dispersion depends on the electrolyte content of the water, time, temperature, and the clay concentration.

Edge-to-edge or edge-to-face association is a flocculation process that forms a "house-of-cards" structure. This leads to an increase in viscosity. Certain chemicals added to mud neutralize the edge charge, with the result that the mud has deflocculated. Examples are lignosulfonates, tannates, and polyphosphates; the so-called mud thinners.

Bentonite

It is classified as sodium or calcium bentonite, depending on the dominant exchangeable cation. Correspondingly, in term of performance, bentonite is classed as "high yield " and " low yield" and in terms of geographic origin as " western" and " southern " because of the superior mud making qualities of bentonite supplied from the Wyoming and Montana deposits.

Bentonite is added to fresh water or to fresh muds for one of the following purposes:

1- To increase hole cleaning capability.

2- To reduce water seepage or filtration into permeable formations.

3- To from a thin filter cake of low permeability.

4- To promote hole stability in poorly cemented formations.

5- To avoid or overcome loss of circulation.

Approximate amount of bentonite for some applications

	Added to Fresh water (lb/bbl)	Added to Fresh water mud(lb/bbl)
normal drilling condition	**12-21**	**4-10**
stabilize caving formation	**24-35**	**9-18**
loss of circulation	**30-39**	**10-20**

Beneficiated, Super-yield Bentonite

Terms such as peptized, beneficiated and extra-high yield describe bentonite to which organic polymers (and sometimes also soda ash) have been added during processing. These products made with western bentonite are useful as starting or spud muds, in low solids muds, and applications where cost of transportation is extremely high. Less than half as much of such a material is needed compared to the amount of API-specification bentonite.

Typically, the polymer is derived from acrylic acid and that like. The selected polymer is blended whit the dried bentonite before milling. The quantity of the polymer added varies whit the type of polymer and whit its effect on the specific bentonite, but is usually between 0.1% and 2% of the weight of the bentonite. Somewhat higher concentrations of polymer may have no beneficial effect or may even be objectionable because the polymer then behaves as a flocculent.

Prehydrated bentonite in salt water muds

Before attapulgus clay came into use as a thickener for salt water, bentonite was mixed into fresh water and allowed to swell for a while. Then, the thick slurry was diluted whit salt water. This prehydrated bentonite provides only temporary suspension properties and very little filtration control. Much greater stability in the salty environment and lower filtration is obtained adding ferrochrome lignosulfonate to fresh bentonite (e.g.3Ibs/bbl lignosulfonate and 0.5Ibs/bbI caustic soda).

Attapulgite - salt gel

Is used solely for its suspending qualities. Its suspending properties are not adversely affected by dissolved salts. Usual application is in muds of higher salinity than sea water. When placed n water, it does not swell like bentonite but most be dispersed by vigorous stirring to break up the bundles of lath-like crystals. The amount of attapulgite needed to remove cuttings from the hole or to suspend barite in weighted muds range from 5 to 25 Ibs/bbI.

Sepiolite

Is stable at Is a hydrated magnesium silicate that contain less substituted aluminum than does attapulgite, which closely resembles. Sepiolite elevated temperatures.

Applications

1. As a replacement for attapulgite in brine muds

2. In a composition containing bentonite and blown asphalt

CHAPTER V

CHMICAL ANALYSIS

CHEMICAL ANALYSIS

All clay samples were subjected to wet chemical analysis, using gravimetric and flame photometric methods.

The mixtures of metals were identified as metal oxides of SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO, Na_2O and K_2O.

The methods of chemical analysis were the standard procedures reported in literature especially in **ASTM** and some relevant text- books.
A brief description for each test method is given below.

5.1 CLAY SAMPLES PREPARATION

The clay samples are wet. They were left in an open air (laboratory atmosphere) until they became air dried. The samples were then crushed and ground. The fine powder of each sample was collected in a separate bottle and labeled in a serial number, from no.1 to no.5.

These final products of all samples were subjected to chemical analysis.

5.1.1 Silica SiO_2

One gram of ground sample was fused with six grams of sodium carbonate in a platinum crucible at 1000°C in a muffle furnace until all crucible contents melted and went into solution. They were then cooled to room temperature and the crucible contents were dissolved in a beaker using hydrochloric acid. The contents of the beaker were evaporated on a sand bath until completely dried, to dehydrate the silica. This was then redissolved. Using hydrochloric acid with the volume adjusted to 150 ml by distilled water, then boiled and filtered. The filtrate collected and used for the determination of other oxides.

The precipitate collected in filter paper is silicon oxide (SiO_2) ignited in a crucible and weighed to calculate the percentage of SiO_2 in clay.

5.1.2 R_2O_3 group (Al and Fe oxides)

The filtrate from the silicate determination was boiled and treated with ammonium hydroxide with constant stirring until it became alkaline. All aluminum hydroxide and iron hydroxide precipitated were boiled for two minutes and then filtered. (The filtrate was kept for calcium determination.) The precipitate was ignited at 900°C in a crucible (to turn hydroxides to oxides) cooled and weighed as R_2O_3 (mixed oxides of Al and Fe) for calculating the percentage.

5.1.3 Calcium oxide

The filtrate from R_2O_3 group determination was acidified with HCI and evaporated to 200 ml, and then 30 ml of warm ammonium oxalate solution (50 g/l) was added, the solution heated and ammonium hydroxide added (1:1) drop wise while stirring until the color of methyl red indicator changed from red to yellow. The solution was allowed to stand without further heating for one hour with occasional stirring during the first 30 minutes so that the calcium oxalate precipitates. This was filtered and the filtrate collected for magnesium determination. The precipitate was ignited in a furnace at 900°C where the oxalate changed to oxide, cooled and weighed in a crucible. The percentage of Ca was then calculate

5.1.4 Magnesium oxide

The filtrate obtained from the determination of CaO was acidified with HCI and diluted to about 250 ml with distilled water. 20 ml of dominium hydrogen phosphate solution (250 g/1) was added and then cooled to room temperature.

Ammonium hydroxide was then added drop wise while constantly stirring until the solution became alkaline and magnesium ammonium phosphate began to form. The solution was left ovenight to set. Afterwards it was filtered and the precipitate ignited at 900°C, cooled and weighed as pyrophosphate. The equivalent magnesium oxide percentage was then calculated.

5.1.5 Iron oxide Fe_2O_3

One gram of the dry, sieved clay sample was treated with HCI, boiled and then stannous chloride was added. It was cooled to room temperature and 10 ml of HgCl2 and 10 ml of phosphoric acid (1:1) plus two drops of barium diphenylamine sulfonate indicator were added. It was then titrated with potassium dichromate until a purple color formed which is the end point. The percentage of iron oxide Fe_2O_3 was then calculated.

In order to determine the percentage of AI_2O_3 the percentage of Fe_2O_3 was subtracted from the total percentage of R_2O_3, the remainder being the ercentage of Ah_2O_3.

5.1.6 Sodium and potassium oxides by flame photometry

One gram of clay sample was digested with hydrochloric acid then filtered and collected in 100 ml volumetric flask and completed up to the mark with distilled water

The concentration of sodium and potassium in the prepared solution was checked by a flame photometer using proper filter of sodium and potassium, then the percentage of $K_2O$and Na_2O in the clay sample were calculated.

5.2 Moisture content, loss on ignition and crystalline water

A known weight of air-dried sample in a known weighed crucible was placed in a drying oven at 110°C for 4 hours or until a constant weight was achieved then it was cooled down in. the desiccators and weighed. The difference in weights between the sample before drying and after drying represents the moisture content of the clay sample.

Water of crystallization and loss on ignition were determined by putting the previously oven dried sample in a muffle fumace and ignited at 1000°C either for one hour or until constant weight was obtained. The ignited sample is cooled to room temperature in desiccators and weighed to determine the loss on ignition. The percentage loss calculated represents the water of crystallization of clay and other volatile matter or carbonates if present in the samples.

Table 5.1 Chemical Analysis of clay samples Collected from Umm Ar Razam

Tests	A1	A2	A3	A4	A5	Average
SiO_2	48.85	45.62	42.68	43.75	39.32	44.04
AI_2O_3	23.52	22.40	24.37	21.86	18.75	22.18
Fe_20_3	4.7	4.95	4.44	4.6	3.88	4.51
CaO	3.84	2.47	4.6	4.57	7.73	4.65
MgO	1.89	1.6	1.73	1.48	0.61	1.46
Na_2OThe Umm Ar	1.72	2,13	2.94	1.78	1.86	2.08
K_2O	0.45	0.58	0.44	0.55	0.48	0.52
Moisture content at110°C	10.3	9.53	9.33	10.14	11.18	10.09
Loss on Ignition at110°C	11.71	9,95	9.90	10.03	12.2	10.76
Total weight %	106.98	99.23	99.8	98.76	97.01	

Table 5.2 a comparison between the composition of local bentonites and other localities

Component %design	A	1	2	3	4	5
SiO_2	44.04	53.9	61.78	61.11	55.99	63.83
Al_2O_3	22.18	24.93	18.31	21.19	19.68	19.95
Fe_20_3	4.51	6.61	1.31	0.25	4.68	3.08
MgO	1.46	2.83	5.12	6.0	4.33	3.46
CaO	4.65	1.69	2.64	2.46	3.36	0.23
Na_2O	2.08	1.04	0.13	0.05	0.35	1.44
K_2O	0.5	0.32	.0.13	0.0	1.45	0.65
SO_4	-	-	-	-	-	-

A-Umm Ar Razam bentonite (average 5 samples)

1-Altered Tuff, New Mexico, USA (Weaver and Pollard)

2- Altered intrusive, New Mexico, USA (Weaver and Pollard)

3-Cretaceous shale, Colorado, USA (Weaver and Pollard)

4-Montmorillonite in sea water, Wyoming, USA (Weaver and Pollard)

5-Average of 101 analyses (Weaver and Pollard)

CHAPTER VI

RESERVE CALCULATION

1- The clay reserve was calculated using a computer program **(Surfer 7).** With the aid of this program profiles of the holes drilling logs and contour maps were generated as shown in Fig-6.1.

2- A net work of horizontal and vertical lines was constructed. The resulting grid has dimensions 100 by 100 meters as shown in Fig-6.2.

3- The coordinates of the grids within this net work were determined.

4- The coordinates of all boreholes were determined.

5- All these data were entered onto work sheet excel program.

6- By using computer program **SURFER 7** and previous data a more detailed contour map was obtained as shown in Fig-6.3.

7- From the equation

$$\mathbf{T = V\ P}$$

The reserve was estimated

Where:

T = Tonnage (ton)

V= Volume (m^3)

P = Volumetric weight (ton /m^3)

8- The reserve calculated as follows:

a) Bentonite

- Volume of bentonite = 37,979,030

- Tonnage of bentonite= 79,755,963

b) Limestone

- Volume of limestone = 4,050,960

- Tonnage of limestone = 10,137,592

c) Marl

- Volume of marl = 2,654,549

- Tonnage of marl =6,370,918

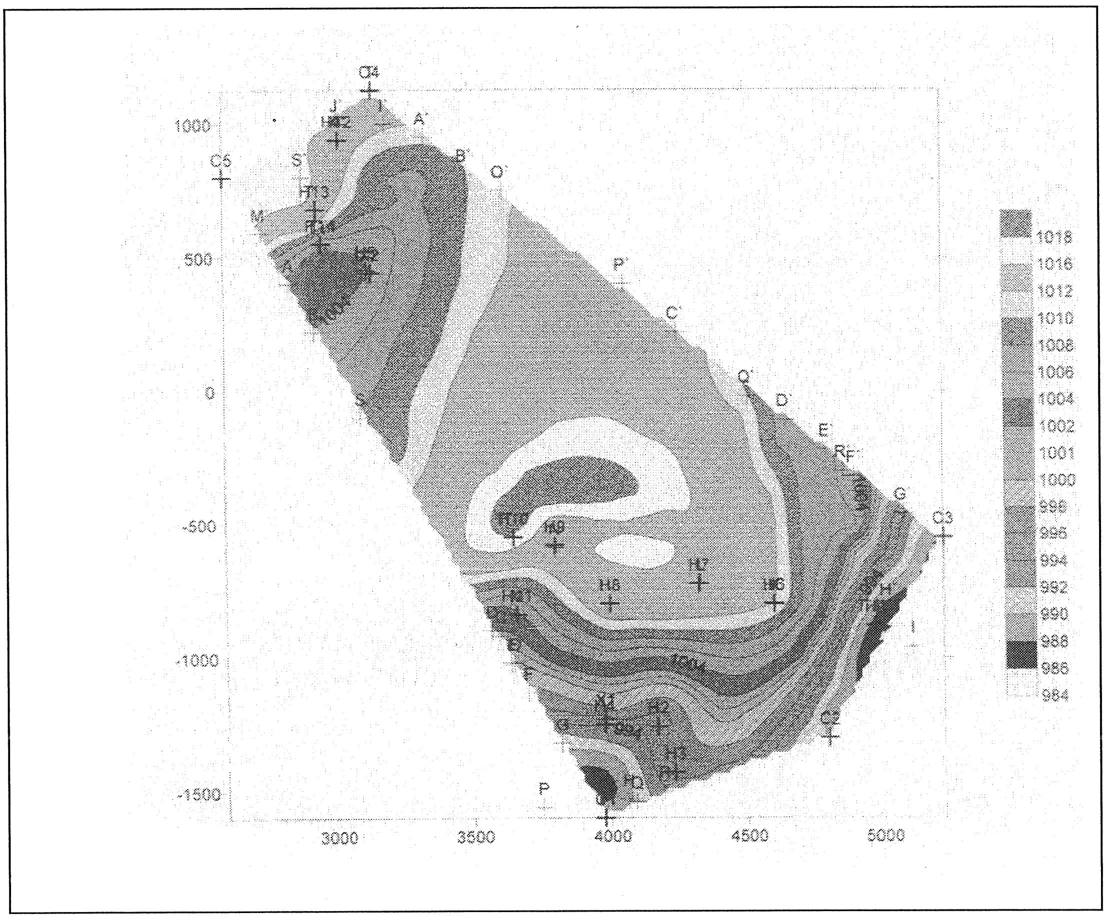


Fig-6.1 Contour with cross-section and borehole location

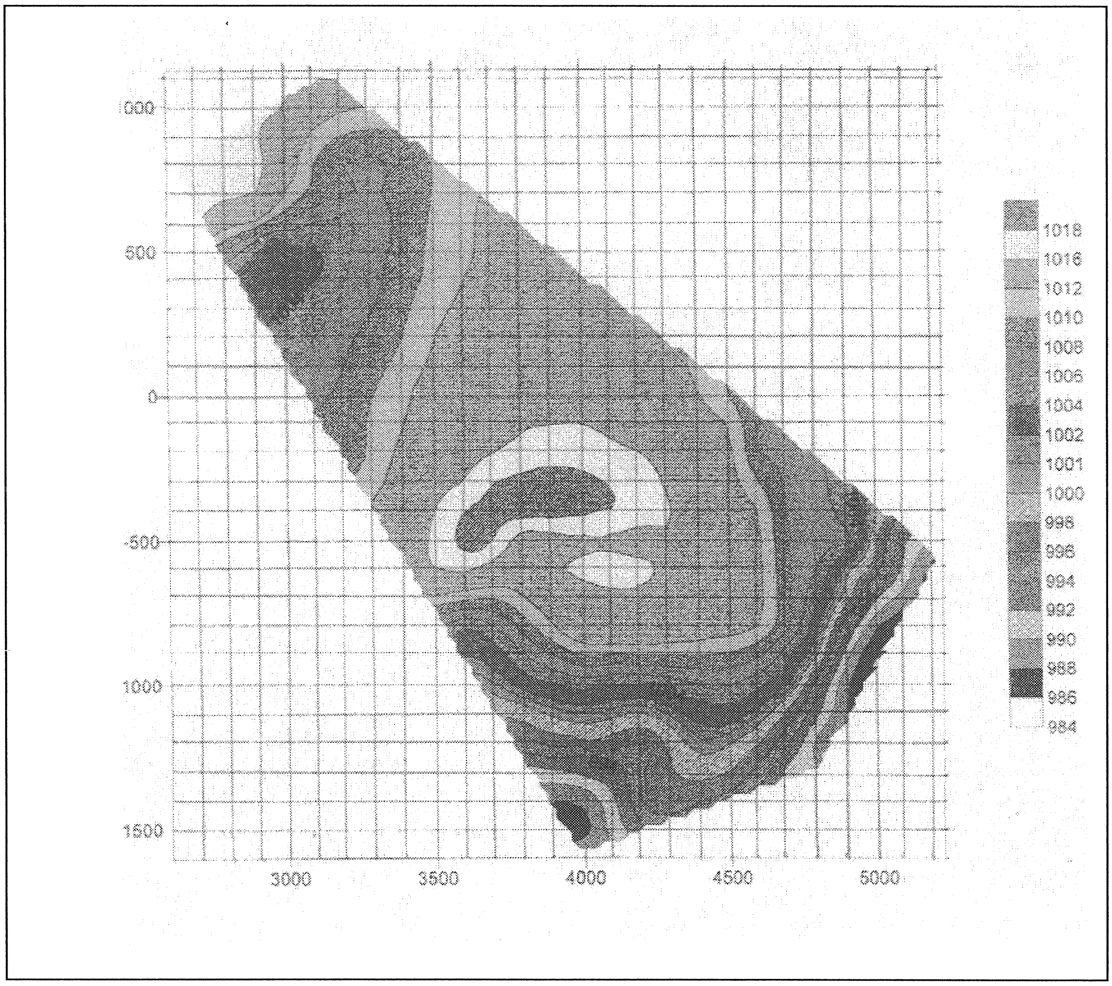


Fig- 6.2 100 X 100Grids

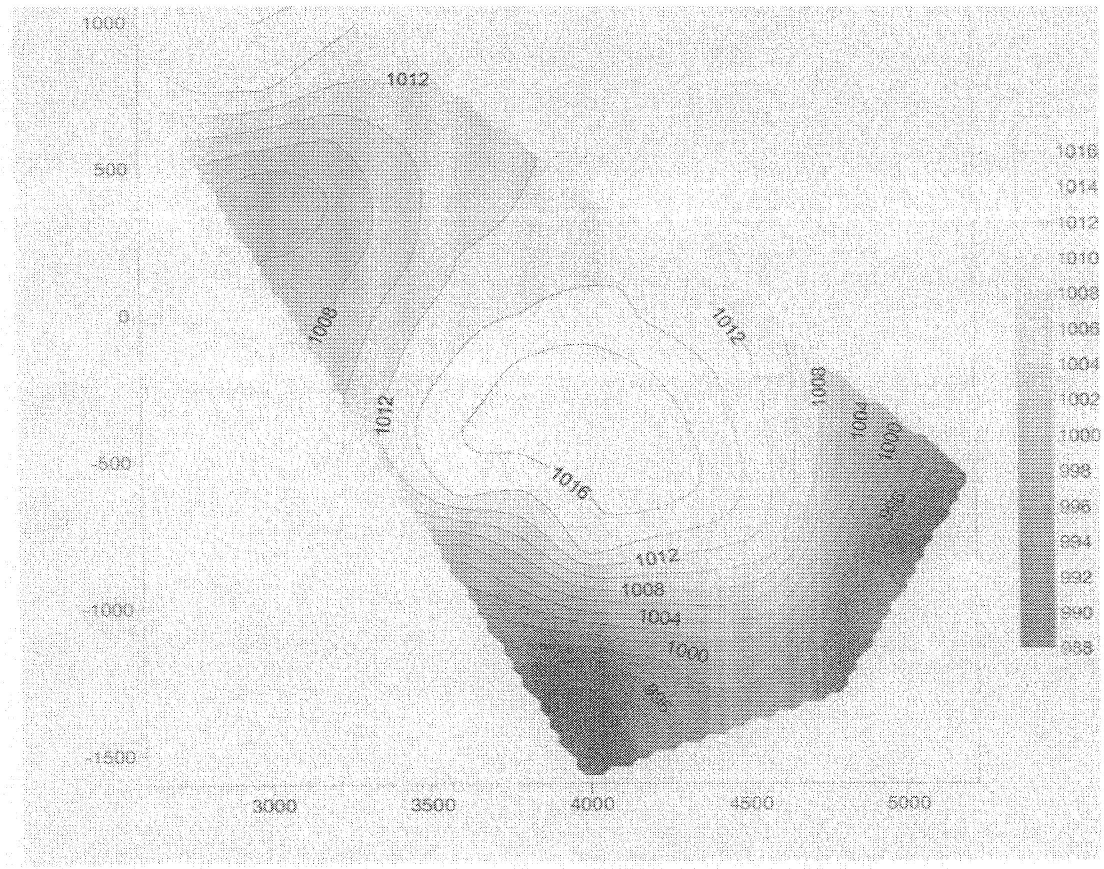


Fig-6.3 Contour map

CHAPTER VII

EXPERIMENTAL WORK

7-1 METHODOLGY

The methodology used in this study can be derided into the following phases:

1-field study

We visited the aria of Umm Ar Rzame and we collected several samples from deformation location this samples are surface samples the are covered about 18 km

2-Collect the ore for testing:

In this study about two hundred kilograms of bentonite were collected for testing from the Umm Ar Razam Evaluation tests will include:

1- Chemical analysis.
2- Analysis of physical properties

3- Geologial Analysis

The Umm Ar Razam area is underlain by a sequence of sedimentary rocks ranging in age from Middle Miocene the two units found as surface exposures in the immediate area are the Al Abraq Formation of Middle Upper Oligocene age and the Al Faidiyah Formation of Upper Oligocene Middle Miocene age.

4-Reserve calculation

The clay reserve was calculated using a computer program **(Surfer 7).** With the aid of this program profiles of the holes, drilling logs and contour maps were analyzed.

5-Chemical analysis

The methods of chemical analysis were the standard procedures reported in literature especially in **ASTM** and some relevant text- books.

6-Natural drying for sample

The water content of the clay has been determined; It was between 42-56 %. This is quite high. It must be reduced to 15 % before any tests could be performed.

7-Grinding with, mixer, rod mill, ball mill

All clay samples whether oven dried or natural dried are pulverized using:

a) Mixer Fig -7.3.

b) Rod mill Fig -7.4.

c) Ball mill Fig-7.5.

Evaluation of the physical properties was made on this clay as follows

T= Natural dry	Type of grinding = Mixer
T= Natural dry	Type of grinding = Rod mill
T= Natural dry	Type of grinding = Ball mill

8-Oven drying and grinding with mixer, rod mill, ball mil

Oven drying was made at 50 C.

T=50 C°	Type of grinding = Mixer
T=50 C°	Type of grinding = Rod mill
T=50 C°	Type of grinding =-Ball mill

(9+10) -Physical properties (natural drying) (oven drying)

- Values for apparent viscosity, plastic viscosity, yield point, gel strength of the drilling fluids are determined using viscometer
- Filtration and wall building properties of drilling mud and cement slurries are determined by a filter press

11-Calculation of the yield and filter loss

Software programs used to calculate the yield and filter loss. Log charts were utilized to obtain a linear chart

12-Classification of data

Form the previous graphs and tables for non treated clay, the best results are obtained when the clay is pulverized by mixer and at 50 C° drying temperature

13-Analysis of data

From the above table it is obvious that samples of non-treated bentonite clays do not fulfill the standard according to OCMA (oil companies' material association)

The optimum values were obtained when 2 % Soda ash and 2,5 % CMC (H.V).

The optimum values require a ratio of 60 % local clay and 40 % imported clay. The yield was 16.5 m^3 / ton (as required by OCMA). Filtrate loss remained at 22 ml (above the required values). Therefore, addition of 1% Soda ash and 1 % CMC (H.V) was necessary.

7.2 LOCATION DESCRIPTION OF SAMPLES USED IN THIS STUDY

Two hundred kilograms of clay samples had been collected from the area of Umm Ar Razam, exactly from the area shown in Fig-7.1. This area is fairly flat and gently sloping from the sea. The elevation rises from sea level to about 50m. The surface of the area is flat stony desert, in place limestone bedding surface with little or no vegetation. There are few large rocks or patches of sand.

The climate is generally dry and warm. Rainfall occurs mainly in the months of October to April, with December and February being the wettest, while June to September are precipitation free Table-7.1.

The samples are taken from trenches five meters deep or more on the average. The samples are a round borehole X1 that is drilled by the P.R.C in 1991.

This area was about one half square kilometer. The samples were saturated, very highly plastic and mainly greenish color (Fig-7.2)

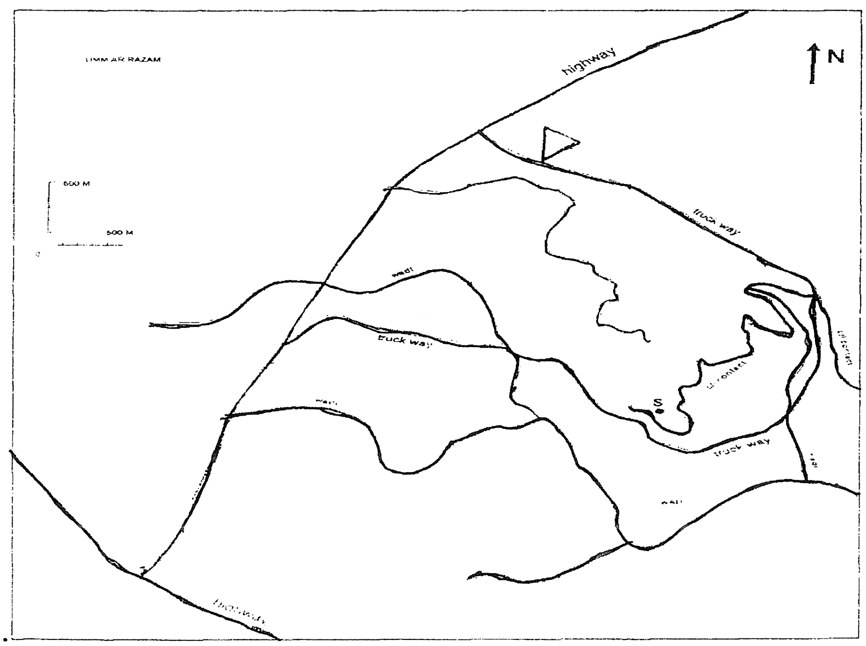


Fig-7.1 Location of samples

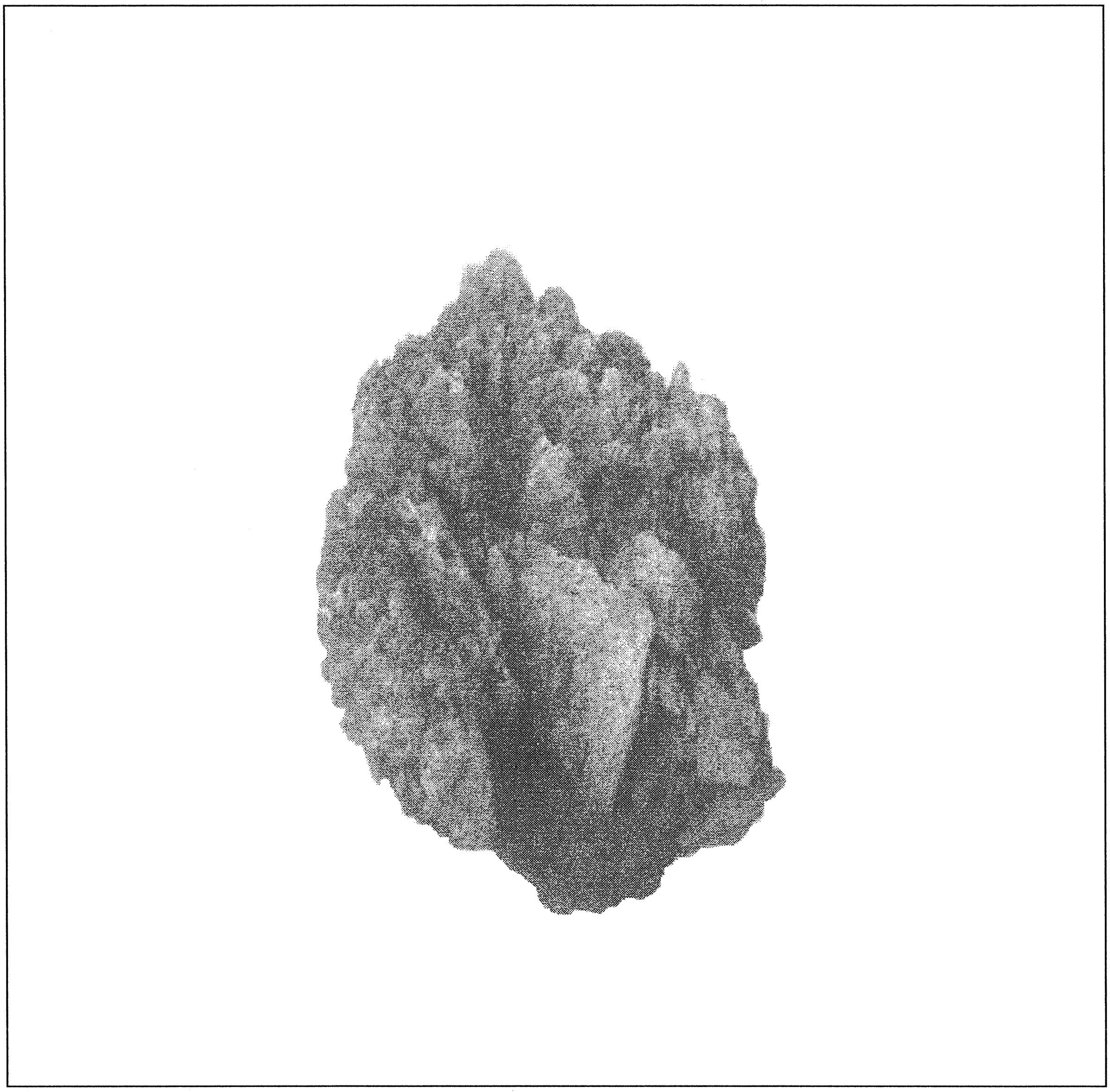


Fig-7.2 Clay sample from the study area

Table 7.1 Temperature and precipitation, Darnah region

Month	Temperature(C°)				Rain(mm)
	Extreme		Average		Average
	Min	Max	Min	Max	
January	9.5	26.5	12.2	19.1	16.6 I
February	8.5	24.5	10.9	16.7	55.6
March	8.8	24.0	11.6	18.6	6.5
April	11.5	33.8	15.3	22.3	14.1
May	12,5	26.2	16.1	22.5	2.0
June	14.6	33.0	19.6	26.3	—
July	20.4	30.6	22.6	28.3	—
August	22.2	40.8	23,8	29.7	—
September	19.9	34.4	21.7	27.9	
October	17.5	40.4	20.4	27.6	9.6
November	10.8	26.0	14.3	21.0	8.7
December	82	23.6	11.8	17.8	58,3

7.3 Drying and grinding of samples

Drying of bentonite to reduce the moisture content to international standard 15 % without adverse effect on the engineering properties, such as yield, filter loss, apparent viscosity... etc., presented a challenging problem. In addition to that pulverizing the clay was not an easy process either.

Therefore in this study the anther has chosen to study these two variables hopping to reach to the optimum level of temperature and size which will finally give good physical properties when mixed with water.

The step by step experimental procedure is as follows:

1-The water content of the clay has been determined, and it was from 42-56 %. That is very high. It must be reduced to 15 % before any tests can be performed.

2- The clay has been divided into two parts:

a) For natural drying.

b) For oven drying.

3-Oven drying was made at 50 C.

4- All clay samples whether oven dried or natural dried are pulverized using:

a) Mixer Fig -7.3.

b) Rod mill Fig -7.4.

c) Ball mill Fig-7.5.

5- Evaluation of the physical properties was made on this clay as follows:

a)	T=50 C°	Type of grinding = Mixer
	T=50 C°	Type of grinding = Rod mill
	T=50 C°	Type of grinding =-Ball mill

d) T= Natural dry Type of grinding = Mixer

T= Natural dry Type of grinding = Rod mill

T= Natural dry Type of grinding = Ball mill

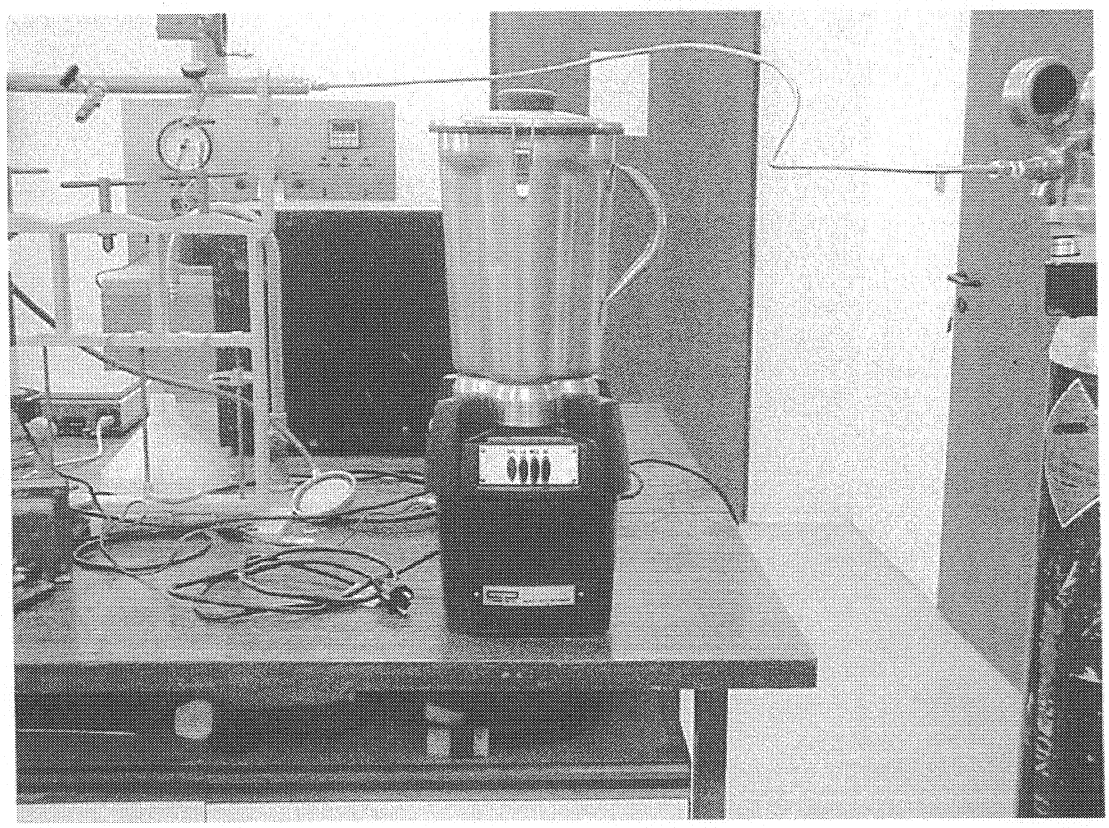


Fig -7.3. Mixer grinding

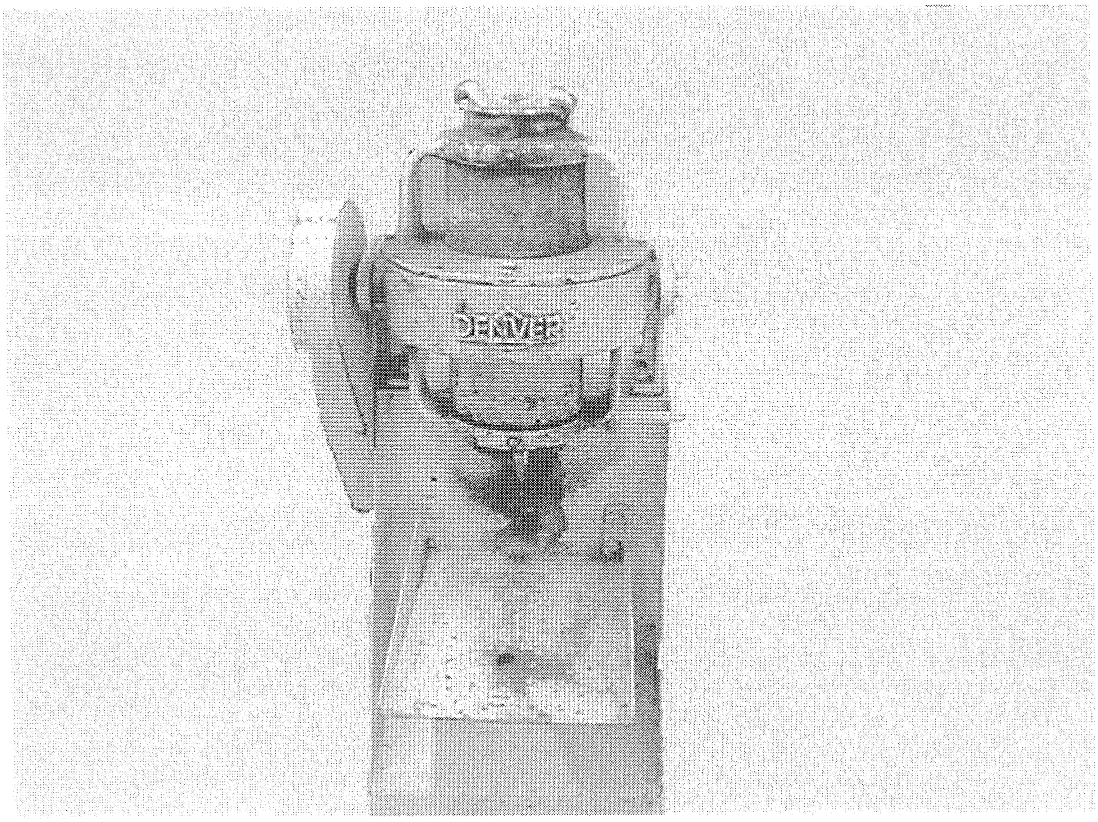


Fig -7.4 Rod mill grinding

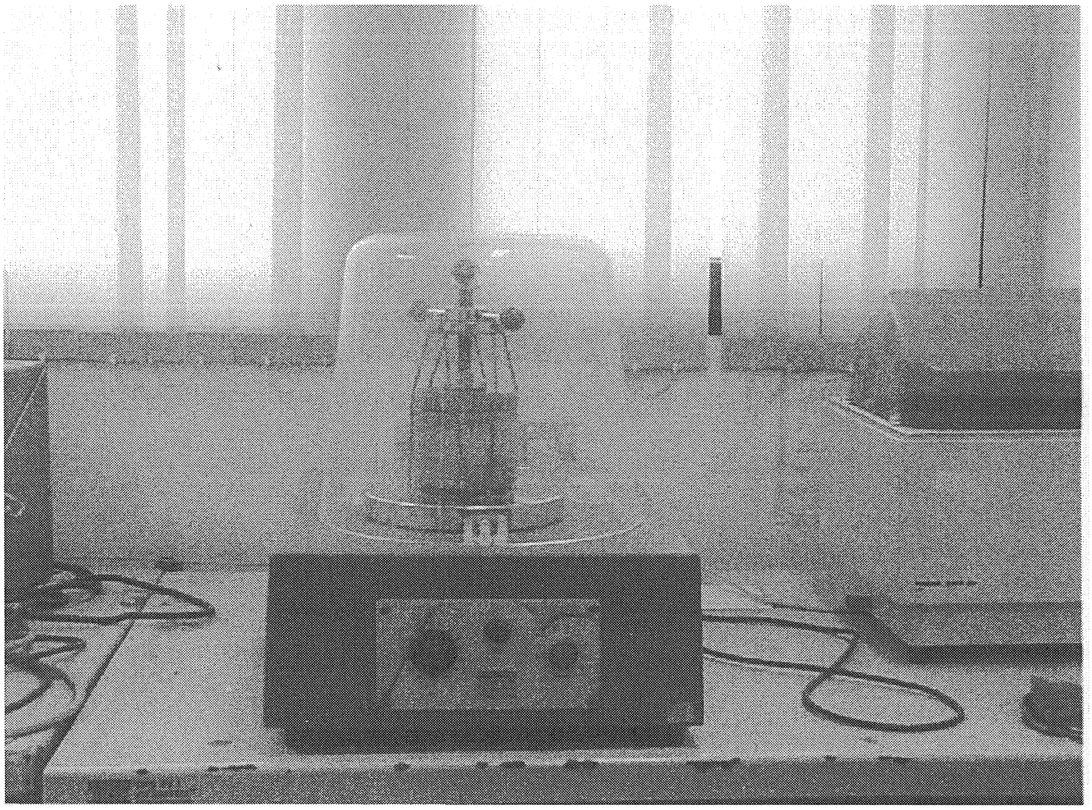


Fig -7.5 Ball mill grinding

6- Preparation of suspension:

a) Different suspensions with different concentrations (14g/350ml, 24.5 g/350 ml and 35g/350 ml) were prepared, after aging for 24 hours the physical properties were measured by the viscometer.

FAN VISCOMETER

Values for apparent viscosity, plastic viscosity, yield point, gel strength of the drilling fluids are determined using viscometer Fig-7.6. The viscometer is rotational viscometer whereby of shearing rates of 300 and 600 rpm can be determined. Speed of 300 and 600 rpm are selected by shifting the gear.

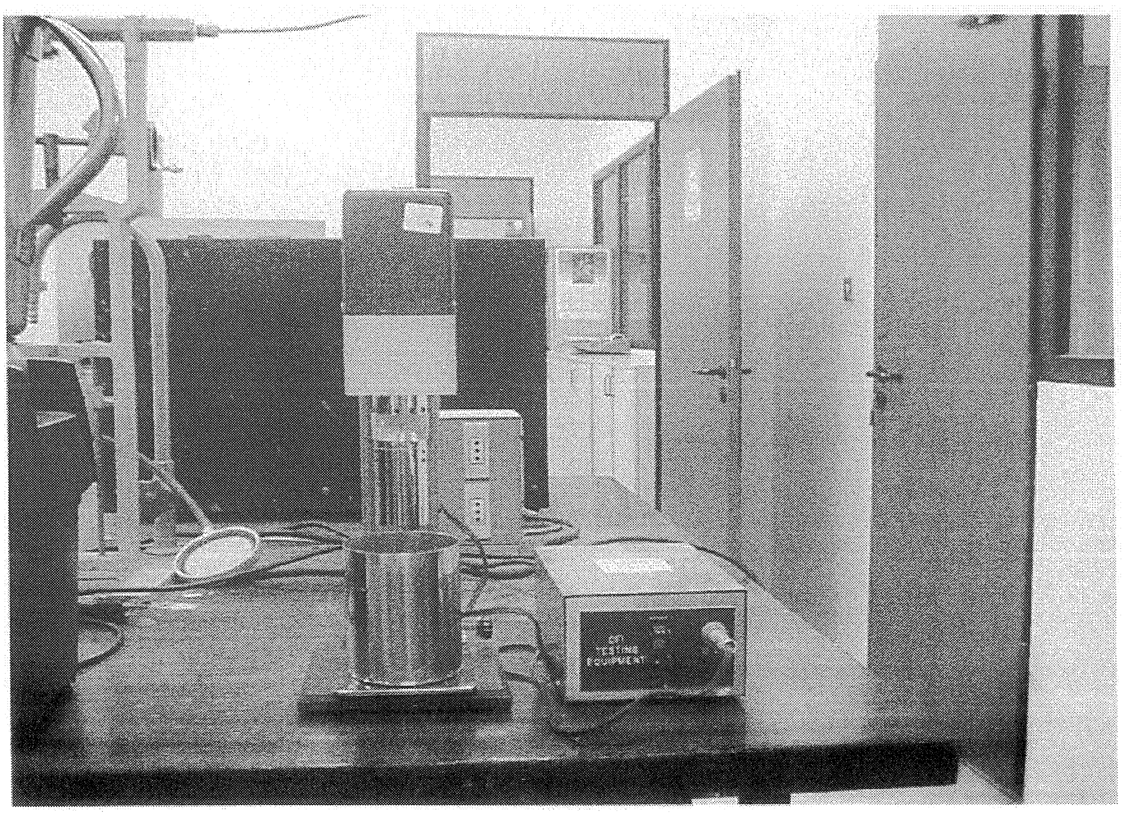


Fig-7.6. Fan viscometer

Operation

1- Sample cups have a line at the proper level to hold 350 ml. Fill with recently stirred test fluid. A scribed line on motor indicates proper immersion depth which should not be exceeded. If other sample holders are used, the space between bottom of bob and bottom of cup should not be less than 1.27cm.

2- Turn motor on. Select desired speed and read shear stress values from dial. Procedure for apparent viscosity, plastic viscosity, yield point determination

1- Place a mud sample in mud cup, adjust surface of mud to scribed line on the rotor sleeve.

2- Turn motor to 600 rpm, and record the 600 rpm reading.

3- Turn motor to low speed (300 rpm) wait for steady value and record 300 rpm reading.

4- Plastic viscosity (cp) = 600 reading - 300 reading.

5- Yield point (lb/100 ft^2) = 300 reading - plastic viscosity.

6- Apparent viscosity (cp) = 600 reading/2.

Procedure for gel strength determination

1- Stir sample at 600 rpm for approximately 15 seconds and slowly lift gear assembly to first position.

2- Shut motor off and wait for 10 seconds.

3- Switch gear to low position and record maximum deflection in lb/100 ft^2 as initial gel strength.

4- Shut motor off and wait for 10 minutes.

5- With gear at low position read maximum deflection units as 10 minutes gel.

Filtrate loss was measured by API filter press cell at 100 psi API Filter Press

Description

Filtration and wall building properties of drilling mud and cement slurries are determined by a filter press Fig-7.7. The filtration rate is a measure of fluid loss in ml under 100 psi of pressure through special filter paper for 30 minutes.

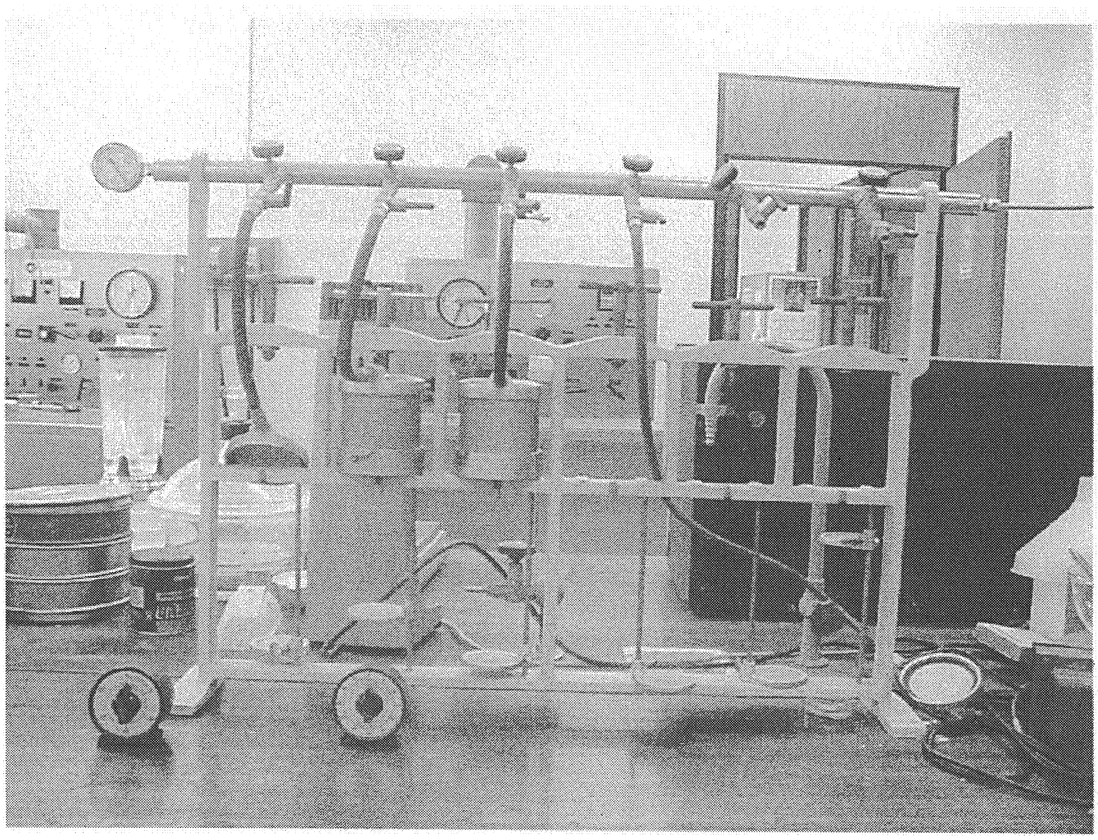


Fig-7.7 API Filter Press

The full sized filter press assemblies described in this booklet of a filter cell mounted in a frame, a pressure source, a filtering medium, and a graduated cylinder for receiving and measuring the filtrate. Procedure for filtrate loss determination

1- Assembly the dry parts of the filter cell in the following order: base cap, rubber gasket, screen, a sheet of filter paper, rubber gasket, and cell

2- Fill the cell with test sample to within approximately 1/4" of the top, (Filling the cell to this level lessens the pressure volume required from the pressure source.)

3- Set the filter press in place within the frame.

4- Chick the top cap makes sure the rubber gasket is in place. Place the top cap, already connected to the pressure source, onto the filter cell in place and secure unite in place with the T-screw.

5- Place a dry graduated cylinder under the filtrate tube, either on the support or in the clip.
6- Apply 100 psi pressure to the cell and start timing of the test. At the end of 30 min, first close the pressure valve and then open the safety bleeder valve to release pressure from the entire system.

7-Read the volume of filtrate loss collected in the graduated cylinder at the 30 minutes. Plotting the values of apparent viscosity and filtrate loss versus the clay concentration on a semi-log paper.

b) The addition of 2%, 1.5%, 2.5% and 3% by wt. Of Na_2 $C0_3$ has been done to each suspension and the physical properties were checked in order to determine the optimum range of soda-ash required to improve the physical properties of the clay, 2%, 2.5%, and 3% by wt. CMC (H.V) was added to the suspensions to obtain the optimum range that reduces the filtrate loss to the required level.

c) To improve the quality of Umm Ar Razam clay, it was blended with international certified clay a cording to following concentration:

1) 80% URC and 20% MAGCOGEL
2) 70% URC and 30% MAGCOGEL
3) 60% URC and 40% MAGCOGEL
4) 50% URC and 50% MAGCOGEL

d) A suspension of 60% local clay and 40% MAGCOGEL imported clay, 1% by wt. Soda ash and 1 % by wt. CMC (H.V) were added. After aging 24 hours the suspension was tested for the physical properties.

7- Results of physical properties are given in Tables 7.2 - 7.18.

Table 7.2

EVALUATION OF BENTONATIC CLAY-UMM AR RAZAM AREA DRYING = NATURAL DRY TYPE OF GRINDING =MIXER PHYSICAL PROPERTIES			
CLAY CONC.(g/350ml)	**14**	**24.5**	**35**
600 reading	5.5	10	16
300 reading	4.5	9	14
AV(cp)	**2.75**	**5**	**8**
PV(cp)	1	1	2
YP($Lb/100ft^2$)	3.5	8	12
Gel ($Lb/100ft^2$)	1/2	4/6	8.5/12
API Filtrate (ml)	**51**	**46**	**40.5**
Yield (in^3 /tone) = 7.9 **Cum. Filtrate loss (ml) = 45**			
Remarks: low yield and high filtration			

Table 7.3

EVALUATION OF BENTONATIC CLAY-UMM AR RAZAM AREA **DRYING = NATURAL DRY** **TYPE OF GRINDING =ROD MILL** **PHYSICAL PROPERTIES**			
CLAY CONC.(g/350ml)	14	24.5	35
600 reading	5.5	10	13.5
300 reading	4	8.5	11.5
AV(cp)	2.75	5	6.75
PV(cp)	1.5	1.5	2
YP(Lb/100ft^2)	2.5	7	9.5
Gel (Lb/100ft^2)	2/3	2/5	8/10
API Filtrate (ml)	52	42	38
Yield (m^3/tone) = 7.1 **Cum. Filtrate loss (ml) = 42.2**			
Remarks: low yield and high filtration			

Table 7.4

EVALUATION OF BENTONATIC CLAY-UMM AR RAZAM AREA DRYING = NATURAL DRY TYPE OF GRINDING =BALL MILL PHYSICAL PROPERTIES			
CLAY CONC.(g/350ml)	14	24.5	35
600 reading	3	5	7
300 reading	2	3	5
AV(cp)	1.5	2.5	3.5
PV(cp)	1	2	2
YP($Lb/100ft^2$)	1	1	3
Gel ($Lb/100ft^2$)	0/0.5	1/1.5	1 / 2
API Filtrate (ml)	57	50	43
Yield (m^3 /tone) = 5.3 **Cum. Filtrate loss (ml) = 49**			
Remarks: low yield and high filtration :			

Table 7.5

EVALUATION OF BENTONATIC CLAY-UMM AR RAZAM AREA DRYING = 50 C° TYPE OF GRINDING =MIXER PHYSICAL PROPERTIES			
CLAY CONC.(g/350ml)	14	24.5	35
600 reading	7	16.5	29
300 reading	5	14	26
AV(cp)	3.5	8.25	14.5
PV(cp)	2	1.5	3
YP(Lb/100ft^2)	3	12.5	23
Gel (Lb/100ft^2)	1/2.5	3/5	7/10
API Filtrate (ml)	48.5	37.75	30
Yield (m^3/tonne) = 10.7 **Cum. Filtrate loss (ml) = 36.3**			
Remarks: low yield and high filtration :			

Table 7.6

EVALUATION OF BENTONATIC CLAY-UMM AR RAZAM AREA DRYING = 50 C° TYPE OF GRINDING =ROD MILL PHYSICAL PROPERTIES			
CLAY CONC.(g/350ml)	14	24.5	35
600 reading	6.5	10	22
300 reading	5	8	19
AV(cp)	3.25	5	11
PV(cp)	1.5	2	3 -1
YP(Lb/100ft^2)	3.5	6	16
Gel (Lb/100ft^2)	1 / 2	3/5	6/9
API Filtrate (ml)	49	37	32
Yield (m^3 /tone) = 8.8 **Cum. Filtrate loss (ml) = 38**			
Remarks: low yield and high filtration :			

Table 7.7

EVALUATION OF BENTONATIC CLAY-UMM AR RAZAM AREA DRYING = 50 C° TYPE OF GRINDING =BALL MILL PHYSICAL PROPERTIES			
CLAY CONC.(g/350ml)	**14**	**24.5**	**35**
600 reading	4	6,5	9
300 reading	3	5	7
AV(cp)	2	3.25	4.5
PV(cp)	1	1.5	2
YP($Lb/100ft^2$)	2	3.5	5
Gel ($Lb/100ft^2$)	12.5	2/3	3/5
API Filtrate (ml)	78	62	51.25
Yield (m^3 /tone) = 5.8 **Cum. Filtrate loss (ml) = 60.5**			
Remarks: low yield and high filtration :			

Table 7.8

EVALUATION OF BENTONATIC CLAY-UMM AR RAZAM AREA DRYING = 50 C° TYPE OF GRINDING =M1XER ACTIVATED w/ 2 % BY wt. Soda Ash + 2 % BY wt. CMC (HV) PHYSICAL PROPERTIES			
CLAY CONC.(g/350ml)	14	24.5	35
600 reading	13	59	180
300 reading	10	56	167.5
AV(cp)	6.5	29.5	90
PV(cp)	3	3	12.5
YP(Lb/100ft^2)	7	53	155
Gel (Lb/100ft^2)	3/8	16/18	39/69
API Filtrate (ml)	20.5	17	13.5
Yield (m^3/tonne) = 17.8 **Cum. Filtrate loss (ml) = 16.2**			
Remarks: high yield point			

Table 7.9

EVALUATION OF BENTONATIC CLAY-UMM AR RAZAM AREA **DRYING = 50 C°** **TYPE OF GRINDING =MIXER** **ACTIVATED w/l,5% BY wt. Soda Ash + 2.5 % BY wt. CMC (HV)** **PHYSICAL PROPERTIES**			
CLAY CONC.(g/350ml)	14	24.5	35
600 reading	11	42	136
300 reading	8	36	132
AV(cp)	5.5	21	68
PV(cp)	3	6	4
YP(Lb/100ft^2)	5	30	128
Gel (Lb/100ft^2)	4/8	13.5/18	38.5/49
API Filtrate (ml)	18.5	15	14
Yield (m^3 /tone) = 16.3 **Cum. Filtrate loss (ml) = 15.5**			
Remarks: high yield point			

Table 7.10

EVALUATION OF BENTONAT1C CLAY-UMM AR RAZAM AREA DRYING = 50 C° TYPE OF GRINDING =M1XER ACTIVATED w/ 2 % BY wt. Soda Ash + 2.5 % BY wt. CMC (H.V) PHYSICAL PROPERTIES			
CLAY CONC.(g/350ml)	**14**	**24.5**	**35**
600 reading	13.5	54	187,5
300 reading	1 1.5	50	181
AV(cp)	**6.75**	**27**	**93.75**
PV(cp)	2	4	6..5
YP($Lb/100ft^2$)	9.5	46	175
Gel ($Lb/100ft^2$)	2/6	13/21	46/60
API Filtrate (ml)	**18**	**15**	**12.25**
Yield (m^3 /tone) = 17.9 **Cum. Filtrate loss (ml) = 14.5**			
Remarks: high yield point :			

Table 7.11

EVALUATION OF BENTONATIC CLAY-UMM AR RAZAM AREA DRYING = 50 C° TYPE OF GRINDING =MIXER ACTIVATED w/ 2.5 % BY wt. Soda Ash + 2.5 % BY wt. CMC (H.V) PHYSICAL PROPERTIES			
CLAY CONC.(g/350ml)	**14**	**24.5**	**35**
600 reading	16	79	221
300 reading	14	73	216
AV(cp)	**8**	**39.5**	**110.5**
PV(cp)	2	6	5
YP($Lb/100ft^2$)	12	67	211
Gel ($Lb/100ft^2$)	6.5/8	22/35	85/135
API Filtrate (ml)	**19.25**	**14**	**11.5**
Yield (m^3 /tone) = 19.7 Cum. Filtrate loss (ml) = 14			
Remarks: high yield point, high gel strength			

Table 7.12

EVALUATION OF BENTONAT1C CLAY-UMM AR RAZAM AREA **DRYING = 50 C°** **TYPE OF GRINDING =MIXER** **ACTIVATED w/1,5 % BY wt. Soda Ash + 3 % BY wt. CMC (H.V)** **PHYSICAL PROPERTIES**			
CLAY CONC.(g/350ml)	**14**	**24.5**	**35**
600 reading	14	46	147
300 reading	11	40	143
AV(cp)	**9**	**23**	**63.5**
PV(cp)	5.5	6	4
YP(Lb/100ft^2)	2	34	139
Gel (Lb/100ft^2)	4.5/7	12.5/26	34/47
API Filtrate (ml)	**16.75**	**14.25**	**12**
Yield (m^3/tonne) =18.3 **Cum. Filtrate loss (ml) = 13.7**			
Remarks: high yield point			

Table 7.13

EVALUATION OF BENTONATIC CLAY-UMM AR RAZAM AREA **DRYING = 50 C°** **TYPE OF GRINDING =MIXER** **ACTIVATED w/ 3 % BY wt. Soda Ash + 3 % BY wt. CMC (H.V)** **PHYSICAL PROPERTIES**			
CLAY CONC.(g/350ml)	14	24.5	35
600 reading	17	80	185
300 reading	15	75	179
AV(cp)	8.5	40	92.5
PV(cp)	2	5	6
YP(Lb/100ft^2)	13	70	173
Gel (Lb/100ft^2)	6.5/10	21.5/29	61.5/130
API Filtrate (ml)	16.5	14	11
Yield (m^3 /tone) = 20 **Cum. Filtrate loss (ml) = 13.1**			
Remarks: high yield point, high gel strength			

Table 7.14

EVALUATION OF BENTONATIC CLAY-UMM AR RAZAM AREA **DRYING = 50 C°** **TYPE OF GRINDING =MIXER** **BLENDED W/ MAGCOGEL** **80% UMM AR RAZAM & 20% MAGCOGEL** **PHYSICAL PROPERTIES**			
CLAY CONC.(g/350ml)	**14**	**24.5**	**35**
600 reading	14	39.5	79
300 reading	13	35	76
AV(cp)	7	**19.75**	**39.5**
PV(cp)	1	4.5	3
YP($Lb/100ft^2$)	12	30,5	73
Gel ($Lb/100ft^2$)	3/5	12/18	15/26
API Filtrate (ml)	**36**	**28**	**23.75**
Yield (m^3 /tonne) = 14.9 **Cum. Filtrate loss (ml) = 28**			
Remarks: high filtration			

Table 7.15

EVALUATION OF BENTONATIC CLAY-UMM AR RAZAM AREA DRYING = 50 C° TYPE OF GRINDING =MIXER BLENDED W/ MAGCOGEL 70% UMM AR RAZAM & 30% MAGCOGEL PHYSICAL PROPERTIES			
CLAY CONC.(g/350ml)	**14**	**24.5**	**35**
600 reading	14	43	95
300 reading	12	40	93
AV(cp)	7	21.5	27.5
PV(cp)	2	') .1	2
YP(Lb/l00ft^2)	10	37	91
Gel (Lb/100ft^2)	5/10	21/35	46/69
API Filtrate (ml)	32	25	21.5
Yield (m^3 /tonne) = 15.5 Cum. Filtrate loss (ml) = 25			
Remarks: high gel strength, high filtration			

Table 7.16

EVALUATION OF BENTONATIC CLAY-UMM AR RAZAM AREA DRYING = 50 C° TYPE OF GRINDING =MIXER BLENDED W/ MAGCOGEL 60% UMM AR RAZAM & 40% MAGCOGEL PHYSICAL PROPERTIES			
CLAY CONC.(g/350ml)	14	24.5	35
600 reading	13.5	44	110
300 reading	12	40	104
AV(cp)	6.75	22	55
PV(cp)	1.5	4	6
YP($Lb/100ft^2$)	10.5	36	98
Gel ($Lb/100ft^2$)	8.5/12	33/42	52/83
API Filtrate (ml)	28	22.5	18.5
Yield (m^3 /tonne) = 16.5 Cum. Filtrate loss (ml) = 22			
Remarks: high gel strength, high filtration			

Table 7.17

EVALUATION OF BENTONATIC CLAY-UMM AR RAZAM AREA **DRYING = 50 C°** **TYPE OF GRINDING =MIXER** **BLENDED W/ MAGCOGEL** **50% UMM AR RAZAM & 50% MAGCOGEL** **PHYSICAL PROPERTIES**			
CLAY CONC.(g/350ml)	**14**	**24.5**	**35**
600 reading	12	53	120
300 reading	10	49	117
AV(cp)	6	26.5	60
PV(cp)	2	4	
YP($Lb/100ft^2$)	8	45	1 14
Gel ($Lb/100ft^2$)	8.5/11	35/48	52/75
API Filtrate (ml)	**25**	**20**	**17**
Yield (m^3 /tonne) = 16.8 **Cum. Filtrate loss (ml) =19.6**			
Remarks: high yield point			

Table 7.18

EVALUATION OF BENTONATIC CLAY-UMM AR RAZAM AREA **DRYING = 50 C°** **TYPE OF GRINDING =MIXER** **BLENDED W/ MAGCOGEL** **60%. UMM AR RAZAM & 40% MAGCOGEL** **ACTIVATED w /1 % wt. Soda Ash + 1 %wt. CMC (H.V)** **PHYSICAL PROPERTIES**			
CLAY CONC.(g/350ml)	**14**	**24.5**	**35**
600 reading	12	53	120
300 reading	11	58	137
AV(cp)	7.5	31	72
PV(cp)	4	4	7
YP($Lb/100ft^2$)	7	54	130
Gel ($Lb/lOOft^2$)	5/15	37/55	76/85
API Filtrate (ml)	**19.5**	**14.5**	**11**
Yield (m^3 /tonne) = 20 **Cum. Filtrate loss (ml) = 14**			
Remarks:			

CHAPTER VIII

ANALYSIS OF DATA

Form the previous graphs and tables for non treated clay, the best results are obtained when the clay is pulverized by mixer and at 50 C° drying temperature.

PROPERTY	RESULT	REQUIRED	REMARKS
Yield (m^3 / ton)	10.7	16 min	Low
Cum. Filtrate loss (ml)	36.3	15 max	high

- From the above table it is obvious that samples of non-treated bentonite clays do not fulfill the standard according to OCMA.

Volume of yield and filtration are very far from the required values .

- Treated samples

Samples of Umm Ar Razam days were further treated by an addition of Na2C03 carboxymethylcellulose. For the purpose improving the quality of bentonite clays a high viscosity carboxymethylcellulose was added with various Na2C03 concentrations. The results of these treatment are given in Tables (7.10) and graphs in Figs-(7.24 - 7.25). The optimum values obtained when 2 % Soda ash and 2, 5 % CMC (H.V).

- Another possibility of improving quality of Umm Ar Razam clays is blending with other certified clays such as (Magcogel). Blends results are given in Tables (7.18) and graphs in figs-(7.40 - 7.41). The optimum values obtained ratio of 60 % local clay and 40 % imported. The yield was 16.5 m^3 / ton (as required by OCMA).

Filtrate loss remained at 22 ml (above the required values). Therefore, addition of 1% Soda ash and 1 % CMC (H.V) was very necessary and the result was substantial reduction in the filtrate loss and final values were as follows:

Yield = 20 m^3 / ton
Filtrate loss = 14 ml

CHAPTER X

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS AND RECOMMENDATIONS

1- The Great Jamahiriya has tremendous amount of clay in different parts of Libya for example in Umm Ar Razam the reserve is calculated 79,756 **kt.**

2- Chemical, mineralogical, and engineering properties indicated that this clay des not meet the international standard.

3- Drying temperature has direct effect on the performance of clay as a drilling fluid. Drying at 50 C° gave the best results.

4- Grinding mode which reflects the particle size distribution proved to be very important. Best results are obtained when the clay is pulverized by a mixer.

5- The addition of 2% Soda ash and 2.5 % CMC (H.V) improved the properties of this clay to the required limits.

6- Blending of 60% local clay and 40 % Magcogel, 1% Soda ash and 1% CMC (H.V) improved the properties of this clay the required limits.

7- We recommend conducting more studies and research on this clay to improve its properties so it can be utilized in various industries.

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