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CONCENTRATING OF FELDSPAR FROM Al-SAMAWA SAND DUNE

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Abstract: This study was carried out to determine the possibility of upgrading feldspar from Al-Samawa sand dune deposit containing about 2 % Na_2O and 1 % K_2O. Two samples from the same location was tested by screening, employing, washing and disliming followed by magnetic separation then froth flotation by tallow amine acetate as a collector with poly propylene glycol and Ethyl diamine tetracetate (EDTA). The experimental results shows that a concentrate of commercial grade can be obtained in percent 5.54 % Na_2O and 2.41 % K_2O with a recovery of about 76.2 % and 77 % respectively.

Keywords: *Feldspar, Sand dune, Flotation, Magnetic separation, Concentration*

تركيز الفلدسبار من الكثبان الرملية لمدينة السماوة

الخلاصة: ان هذه الدراسة قد اجريت لغرض معرفة امكانية فصل وتركيز الفلدسبار من الكثبان الرملية لمحافظة المثنى والتي تحتوي على صوديوم بنسبة Na_2O= 2 % و K_2O= 1 %. في اثناء العمل تم دراسة نموذجين لنفس الموقع باستخدام طريقة الغربلة ,الغسل ,الفصل المغناطيسي والتعويم الرغوي، حيث استخدمت مادة Tallow amine acetate وEthyl diamine tetracetate كمادة مجمعة للأول ومادة ملطفة للثاني، النتائج التي تم الحصول عليها بينت امكانية الحصول على ركاز فلدسبار يحتوي على Na_2O = 5.54 % و K_2O = 2.41 % وبنسبة استرجاع 76.2 % و 77 % .

1. Introduction

Feldspar is the most common rock-forming mineral (about 60 % of the earth's crust) [1]. The mineral name feldspar is derived from the German words feld + spar. The word ″feld″ is ″field″ in German and ″spar″ is a term for light colored minerals that break with a smooth surface. Feldspar minerals are usually white or very light in color, have a hardness of 6 on the Moho Scale of Hardness and perfect to good cleavage (plane of breakage) in two directions. Feldspar occurs in igneous, metamorphic and sedimentary rocks and thus can be found throughout different geological environments.

Feldspar weathers to kaolin which is the main clay mineral used in ceramics and fine pottery [2]. Feldspar is one of the basis minerals used to prepare various types of ceramics, e.g. tiles, sanitary wares, table wares, etc. [3].

Feldspar consists essentially of aluminum silicates combined with varying percentages of potassium, sodium, and calcium, and it is the most abundant mineral of the igneous rocks. The two types of feldspar are soda feldspar (7 percent or higher Na_2O) and potash feldspar (8 percent or higher K_2O) [4].

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A sand dune is a topographic feature of Aeolian origin composed of sand grains transported by wind from a natural source. The size and shape of dunes display much variation. They develop in the dry and semi dry environments in which loose particles of sand size are exposed to wind action. The sand dunes in Muthana Governorate consist of small size dunes, deposited in the depressions, which run parallel to the contact between the southern desert and the mesopotamian plain [5]. The most common type of these dunes is barchans, in addition to the longitudinal dunes particularly in the north part of Muthana Governorate. The dunes in the study area are isolated or close forming sand dunes field extended to hundreds of square kilometers in area. Generally, the dunes height′s does not exceeding a few meters, while in some places reach up to 15 meters.

2. Location

The area of Bassaya / Al-Samawa sand dune deposit is located in the eastern part of the sand dunes area in Al-Muthana Governorate with the following coordinates:
46° 21' 15.3″ Latitude and 30° 22' 52.3″ Longitude [5]. Fig. 1, shows the location of the sand dune deposit .

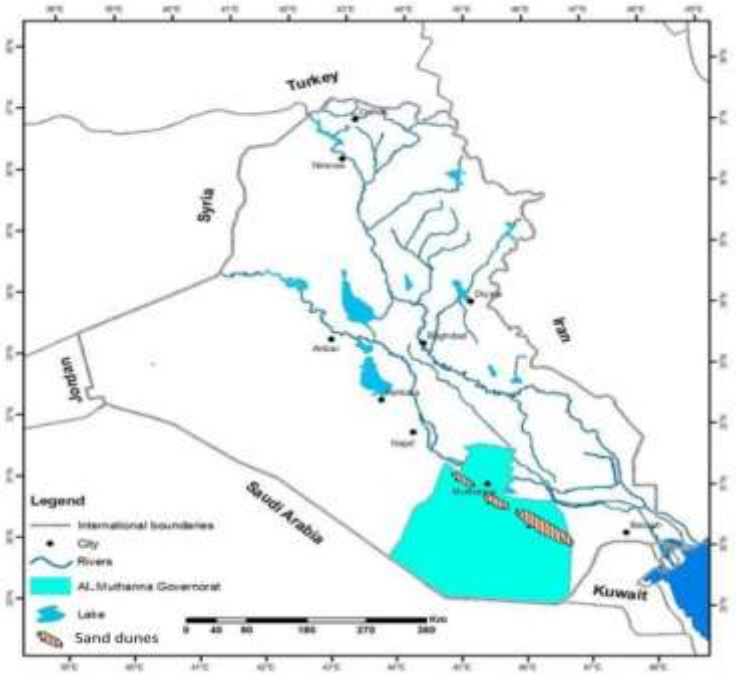

Figure 1. Location map of Bassaya / Al-Samawa sand dune deposit

3. Previous Works

Al-Ajeel was determine the possibility of separating feldspar from Al-Dibdibh sand of Al-Najaf area deposit assaying 0.9 % Na_2O and 1.65 % K_2O, samples of different locations were tested, by employing screening, washing, magnetic separation and froth flotation. The results shows that feldspar can be floated in acidic pH region (2-3) using hydrofluoric acid (HF) 48% concentration, it would be possible to obtain feldspar

concentrate containing 8.3 % K_2O, 4 % Na_2O, and 0.9 % Fe_2O_3 with a recovery about 82 % [6-7]. Al-Dahaan was arriving at the same results when studied the effects of reducing the amount of (HF) with sulfuric acid to modify the pH for floatation tests to concentrate the feldspar and use it in various industries. The feldspar concentration which achieved contains 8.5 % K_2O, 3.9 % Na_2O and 0.9 % Fe_2O_3 with a recovery of 76 % [8].

4. Materials and Methods

4.1. *Materials*

About 50 Kg of Bassaya sand of Al-Samawa area containing feldspar was received for concentration tests. The samples were mixed, and subsequently divided to about (0.5 –1Kg) by using laboratory Jones riffle sampler. A represented sample was taken for analysis and X-ray diffraction in Iraqi geosurve laboratories. The results are shown in Table 1(a) and 1(b) and Fig. 2,

Table 1(a) Mineralogical composition of the investigated sand dune

Quartz	Feldspar, Calcite

Table 1(b) chemical composition of the investigated sand dune (wt. %)

SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	SO_3	Na_2O	K_2O	Cl	L.O.I	TiO_2
65.74	1.53	8.21	10.08	2.10	<0.07	2.0	1.0	0.04	7.36	0.30

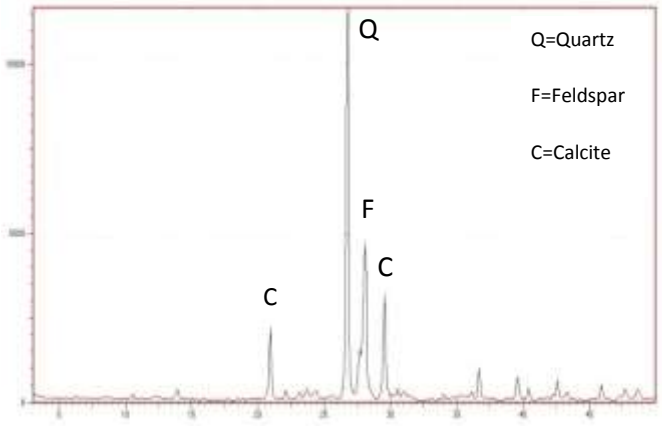

Figure 2. XRD Pattern of raw sand dune sample

4.1.1. *Sieve analysis*

The sieve analysis for raw sand was carried out using ASTM standard sieves (2011). A representative specimen from each size fraction retained on the sieve was taken for Na_2O and K_2O determination. The results of sieve analysis, percentage of Na_2O and K_2O with feldspar distribution in different fractions are given in Table 2. This table indicates that, the sand has a wide size range, about 98.9 wt. % is in the size range from

under size (-300 µm) to over size (+75 µm), and the pattern of feldspar distribution in this range being 55 %. About 0.89 % of feldspar is present in the (+ 75 µm) fraction which will be eliminate from the raw sand.

Table 2. Sieve analysis for raw sand

Sieve opening	wt. %	Cumulative pass %	Feldspar %	Na_2O %	K_2O %	Feldspar distribution %	Fe_2O_3%	Feldspar distribution cumulative pass %
300 µm	3.3	96.7	4.6	0.15	0.55	0.65	0.23	95.94
250 µm	8.08	88.62	9.3	0.61	0.69	3.29	0.42	92.65
150 µm	21.65	66.97	24.7	2.24	0.98	23.44	1.08	69.21
125 µm	48.93	18.04	24.4	2.22	0.95	52.34	1.45	16.87
75 µm	16.96	1.08	21.5	2	0.77	15.98	2.56	0.89
Base	1.08	0	18.8	1.64	0.83	0.890	4.09	0

4.2. *Methods*

4.2.1. *Screening*

According to the results that obtained from the sieve analysis and the distribution of feldspar in the particle size the raw sand was prepared by using two methods:

1- Screened the raw sand at (300 µm) and (75 µm) screen to remove (+300 µm and the -75 µm) fractions because of the low percent of feldspar in these fractions. Then the fraction (-300 +75 µm) was mechanically attrition scrubbed with water at (70 %) solid in a laboratory Denver scrubbed cell for (15 minute), at (1500 rpm). Subsequently the pulp was deslimed by screening on (75 µm) and washed and then washed on the sieve (75 µm), the results of this method represent by the sample no. (A) in Table 3.

2- The raw sand was mechanically attrition scrubbed with water by using the same conditions in the above method and also the pulp was deslimed on (75 µm) and washed and then washed on the sieve (75 µm), the result of this method represent sample no. (B) in Table 3. The results of these two methods are given below :

Table 3. The results of the prepared samples

Sample No.	Na_2O %	K_2O %	Fe_2O_3 %	Feldspar %
A	1.90	1.18	1.78	23.1
B	1.7	1.22	1.53	21.58

The results above indicated that there are very little differences between the raw sand and the scrubbed sand according to the low concentration of feldspar in the fine fractions as shown in Table 2.

4.2.2. *Magnetic separation*

For studying the possibility of removing the iron oxide (Fe_2O_3) from the sand containing feldspar. Dry high intensity magnetic separator device type (OUTOTECH) is

used, with a magnetic field intensity of about (1.2 and 14.3) Kilogauss for two stages. The results for the samples (A and B) represented in Table 4.

Table 4. The results of the magnetic separation

Sample No.		Na_2O %	K_2O %	Fe_2O_3 %	Recovery of feldspar %	Loss in Feldspar %	Feldspar %	Loss in Fe_2O_3 %
A	Mag.	2.96	1.19	4.33	-	8	33.16	
	Non mag.	1.82	1.16	0.78	88.69	-		56.2
							22.24	
B	Mag.	3.67	1.41	3.44	-	5	28.86	

From the table above the results indicated that the loss percent in Fe_2O_3 for the two samples (A and B) is (56.2 % and 65.8 %) and the loss percent for feldspar in the magnetic parts is (8 % and 5 %), by using the polarized and reveres microscope the iron oxides presence as colors and grains and also contains feldspar grains and this is the reason by losing feldspar with iron oxide.

4.3. *Flotation Process*

The industry insists on high quality raw materials with exacting specifications. Modern mineral processing technology, such as flotation has enabled inferior feldspar to be upgraded to an acceptable level and with based on the previous work [6-7], exhaustive flotation tests were performed by using cationic collector tallow amine acetate to determine the best condition for flotation of feldspar, the effect of adding various amount of collector reagent, and the number of flotation stage in floating feldspar were studied. The experiments have been carried out in laboratory Denver flotation cell of 1liter capacity (using 300 gm. feed sample), with agitation speed of 1500 rpm, the pulp uses conditioned at 75 % solid with 10ml of hydrofluoric acid to the pH=2 of the pulp for depressing quartz [9-10], prior to the addition of collector in stages (for each flotation stage) on feldspar flotation and frothing reagent the pulp was conditioned with the acid for five minutes, then for another five minutes with tallow amine acetate, polypropylene glycol, ethyl diamine tetracetate (EDTA). Duplicate samples were tested for each experiment. The feldspar concentrated floated from the two stages was mixed and analyzed for Na_2O, K_2O and Fe_2O_3, the amount of the addition reagents in the flotation process is indicated in the Table 5.

Table 5. The amounts of the addition reagents in the flotation process

The addition reagent	The amount gm. / kg
Tallow amine acetate	0.8 and 0.4 gm. / kg
TA (floated amine)	0.8 and o.4 gm. / kg
Ethyl diamine tetracetate (EDTA)	33 and 16 ml
Poly propylene glycol	0.155 gm. / kg

We can see from the Table above the amounts of the addition reagent in the flotation process according to the results that obtained from the study of separation of feldspar from quartz using EDTA as modifier [11], therefore the results of the concentrated feldspar from the flotation process is illustrated in the Table 6.

Table 6. The results of the concentrated feldspar

Sample No.	Stage No.	Collector gm./kg	Concentrate Na_2O % K_2O %		Fe_2O_3 %	F % ave.		R % ave.
A	1	0.8	5.54	2.41	0.93	61.1	57.89	76.2
	2	0.4	4.89	2.26		54.68		
B	1	0.8	3.19	1.94	0.57	38.4	41.8	77
	2	0.4	3.74	2.29		45.2		

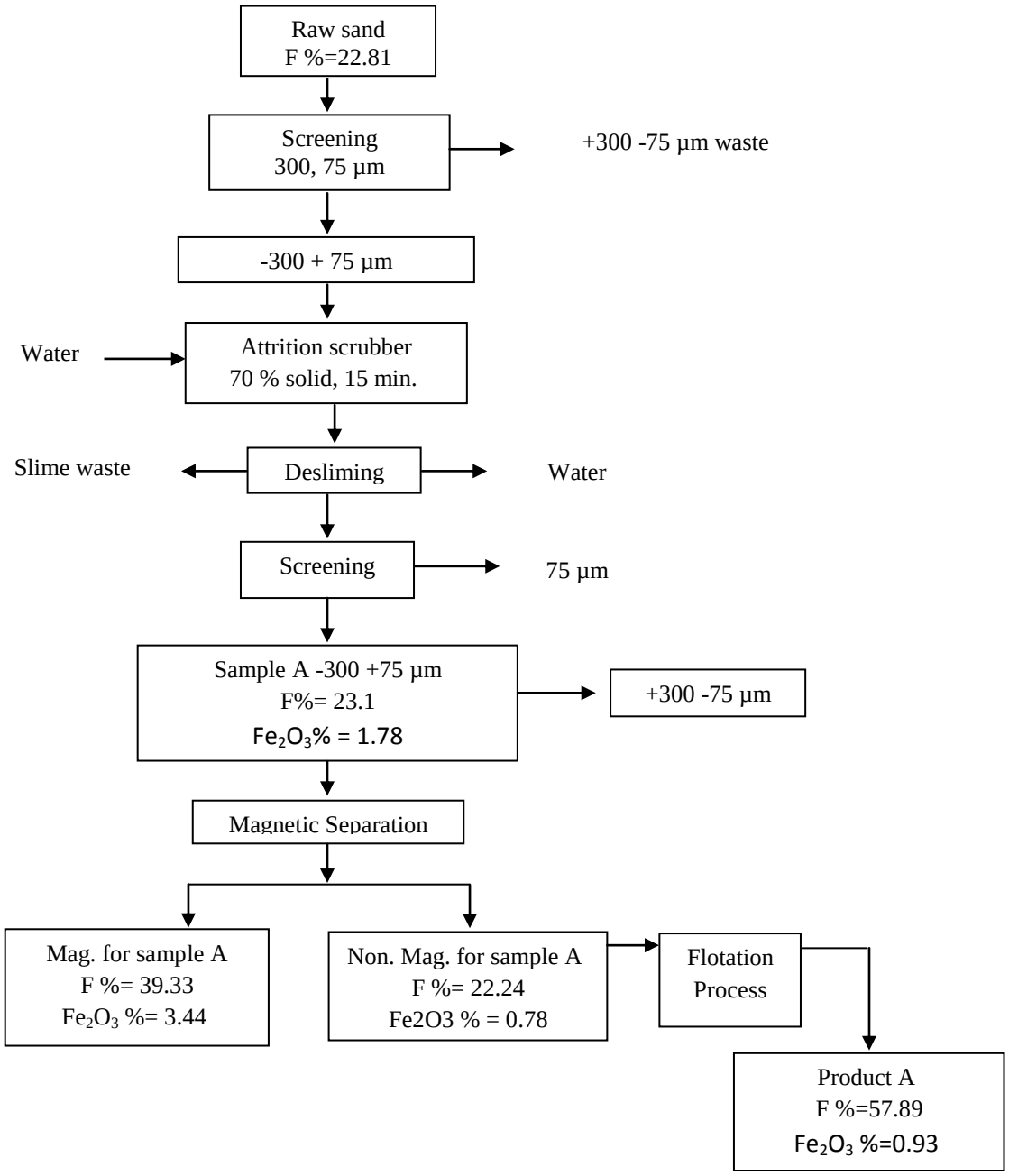

Figure 3. Feldspar flotation process

5. Results and Discussion

5.1. *Characterization of the Concentrated Feldspar*

Fig. 4, indicated the XRD pattern for the concentrated feldspar from the sand dune, which is clearly observed from this figure the peak of the feldspar, increased against that one of the quartz and calcite almost decreased too comparably with the results given in the Fig. 2, for the raw sand, and according to the chemical composition that illustrated in Table 1 (b), the type of feldspar is plagioclase feldspar which is contain sodium / calcium aluminum silicates. While from the Table 7. the chemical composition for the beneficiated feldspar indicated that the feldspar contains sodium and potassium which is means alkali feldspar.

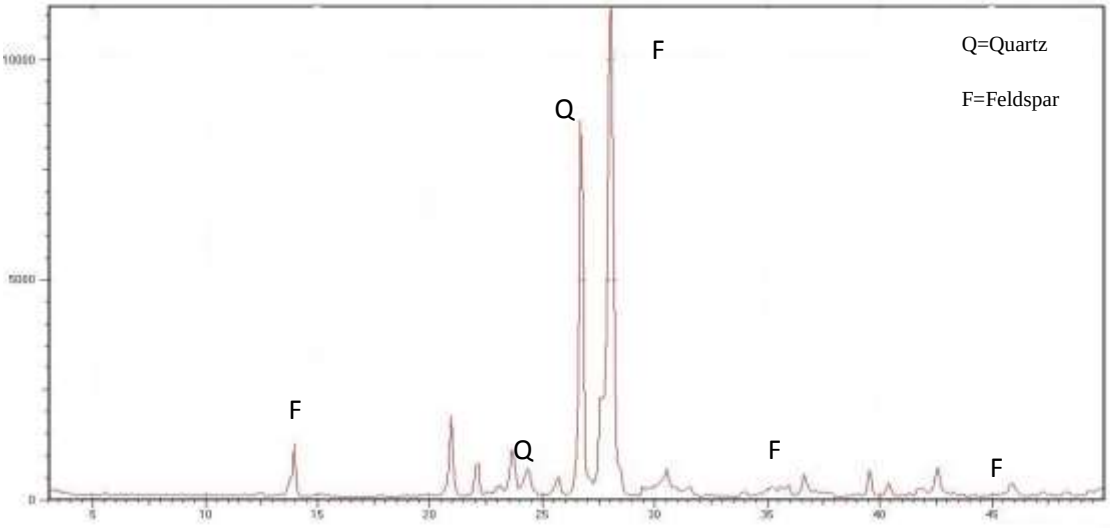

Figure 4. The XRD pattern for the concentrated feldspar

Table 7. The results of the concentrated feldspar

Sample No.	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	TiO_2	Na_2O	K_2O	SO_3
A	69.7	14.81	0.93	3.36	0.57	0.14	5.54	2.41	0.19

5.2. *Upgrading process of Feldspar*

According to the results in Table 2. the percentage of the Fe_2O_3 is low and range from 0.23 % in the +300 µm size fraction to 4.09 % in the -75 µm size fraction. Fe_2O_3 increase with decreasing of size fraction, and is concentrated mainly in the fine fraction of < 75 µm.

The aim of this work is to obtain feldspar suitable for ceramic and other industries. The chemical analysis of the sand dune indicates that it can't be used as it is in the industry. This due to its high SiO_2 content, which is exceeding 65 %. It is obvious that for producing feldspar with higher Na_2O, K_2O and lower Fe_2O_3 content, concentration and upgrading must be used. The results of the magnetic separation show that the Fe_2O_3 decrease from (1.78, 1.53 to 0.78, 0.64)
respectively.

The flotation process was employed to study the floatability of quartz and feldspar based on the previous work [6], the tests were conducted in acid medium (pH = 2) by using hydrofluoric acid (HF) during conditioning in a pulp density of (50 – 60) % solid, Ethyl diamine tetracetate as modifier and the cationic collector (Tallow amine acetate) was also used to determine the best condition for flotation of feldspar, the effect of adding various amount of collector reagent and the number of flotation stage in floating feldspar were studied and from the best conditions that obtained by the flotation process we can increase the feldspar percentage from (22.81) in the raw sand dune to (57.89) and (41.8) respectively. The results of the chemical analysis of the original sample are illustrated in table 1 (b), while the concentrated feldspar is illustrated in the Table 2.

6. Conclusions

According to the experimental work, the following points can be concluded:

1- Using screen on the sieves (300, 75μm) for the sand dune gives results better than when we used the raw sand dune.
2- Using the maximum current in the high intensity magnetic separation for gate a good results of losing the iron oxide (Fe_2O_3).
3- This feldspar which is concentrated from the sand dune of Al-Samawa area is suitable for the glass making.
4- Using Ethyl diamine tetracetate (EDTA) with the flotation reagents give the flotation process a good behavior so that we could rise in feldspar concentrate from (23.1) in the raw sand dune to (57) in the floated feldspar.

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