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LABORATORY BENEFICIATION TESTS OF THE RAW PHOSPHATE OF WADI HIRRI AL-GHARBI (AREA I), WESTERN DESERT, IRAQ

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ABSTRACT

A high grade phosphate concentrate , with P_2O_5 content about 31% and less than 0.7% MgO was successfully obtained from Wadi Hirri Al-Gharbi dolomitic phosphorite deposit (Area I) using simple sizing and classification processing. The yield (about 59%) and phosphate recovery (about 80%) are good as compared with those gained previously from other phosphate localities.

تجارب مختبرية لتركيز خام فوسفات وادي الهري – الغربي (المنطقة الأولى) في الصحراء الغربية، العراق

المستخلص

تتناول هذه الدراسة التي أجريت في مختبرات الشركة العامة للمسح الجيولوجي والتعدين إمكانية تركيز خام فوسفات
، وقد أمكن الحصول على فوسفات MgO و 4.7% P_2O_5 وادي الهري الغربي (المنطقة الأولى) الذي يحتوي على 22%
التكسير إلى حجم حبيبي اقل من 4 ملم ومن ثم [مركزة وبمواصفات مقبولة ومطابقة للمتطلبات الصناعية وبطريقة بسيطة
في الفوسفات المركزة بحدود 31% P_2O_5. بلغ تركيز]الغربلة الرطبة وإهمال الشوائب بحجم حبيبي اقل من 0.106 ملم
وبنسبة مئوية للاسترجاع تصل إلى 80%.

INTRODUCTION

The exploratory work of GEOSURV has reported an extensive phosphorite deposit in Wadi Hirri Al-Gharbi locality (Fig.1). The deposit was categorized into areas namely I and II. Area I is located about 15-20 Km ENE of Akashat mines. The phosphorite deposit belongs to the Akashat Formation (Paleocene) and consists of medium to coarse grained friable dolomitic phosphorite.

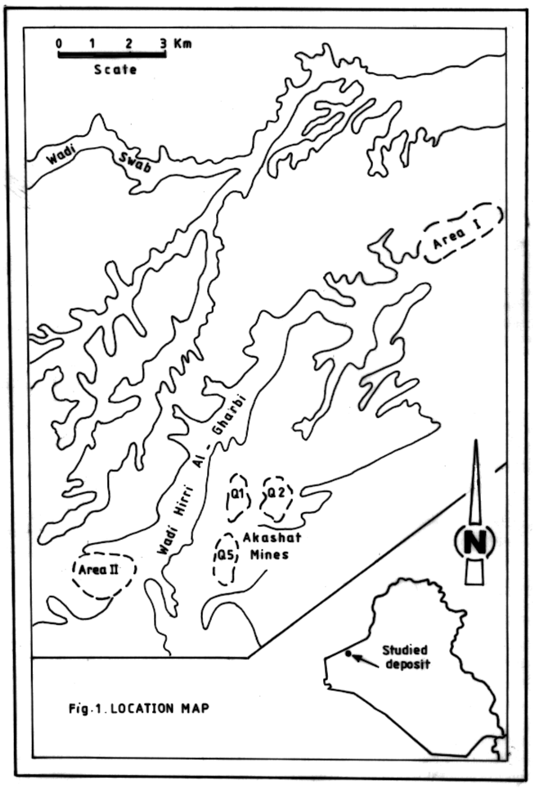

Fig.1. LOCATION MAP

Area II is located about 6-7 Km to the SW of Akashat mines. The phosphorite deposit belong to Akashat Formation and it is considered to be a high grade phosphorite deposit (Al-Bassam and Saeed, 1989), suitable for fertilizers

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industry, while that of area I is of a lower grade and contain high amount of MgO (≈ 4.7%). Therefore, beneficiation of the phosphorite in Area I is required prior to milling (Hammodi, 1989).

This investigation is based on preliminary laboratory tests with the aim of producing high quality phosphate concentrate from this phosphorite deposit using simple sizing and classification techniques. It is worth mentioning that the Akashat phosphorites, presently mined to produce phosphate fertilizers, require crushing, calcination and desliming to achieve a phosphate concentrate with about 30-31% P_2O_5 and less than 1% MgO (State Organization for Minerals, 1975).

ORE CHARACTERISTICS

PETROGRAPHY

The petrographical analysis of the studied phosphate deposit (Area I) is as follows (Al-Bassam and Saeed, 1989):-

The industrial bed consists of poorly sorted to moderately sorted phosphate grains which are mostly bioclasts (bones, shark teeth and fish scales) and intraclasts of phosphomudstone. The grains also include considerable amounts of phosphochems (coated and noncoated) which are usually oval or flattened discs.

The grain size of the phosphorite range mainly from 0.1 to 0.5 mm, larger fragments (mainly bones and teeth) are present, but not common. The cementing material consists of micrite and dolomicrite.

MINERALOGICAL AND CHEMICAL ANALYSIS

The average phosphate in the industrial bed (Area I) contains about 65% carbonate fluorapatite ,16% dolomite, 17% calcite and 2% quartz(Al-Bassam and Saeed,1989). A representative sample was taken from the prepared head sample and chemically analyzed for it's components .The results are shown in Table 1.

Table 1: Chemical composition of the raw phosphorite

Component	P_2O_5	Fe_2O_3	Al_2O_3	CaO	MgO	Na_2O	K_2O	IR	SO_3	Cl	F	L.O.I
Wt%	22.00	0.32	0.32	48.4	4.68	0.76	0.06	0.32	1.47	0.17	2.93	17.32

SAMPLE PREPARATION

Representative samples were taken from 50 boreholes drilled in Wadi Hirri Al-Gharbi raw phosphate deposit (Area I). The samples were mixed and crushed to minus 10mm particle size.

SIZE ANALYSIS

In order to identify the behavior of the phosphate bearing minerals and the associated impurities with respect to particle size, representative samples of the phosphorite (crushed to -10mm particle size) was subjected to dry and wet sieving. Each size fraction obtained was weight (dry) and analyzed in terms of P_20_5 and MgO. The distribution percentages of P_20_5 and MgO were calculated accordingly. The results obtained are tabulated in Tables 2,3and 4.

Table 2: Particle size distribution of the studied phosphorite

Dry sieving

Fraction (mm)	Weight %	P_2O_5 Cumulative% Distribution	
		Passing	Retained
+4	3.62	96.38	3.62
+2.36	3.09	93.29	6.71
+1.18	3.81	89.48	10.52
+0.6	7.40	82.08	17.92
+0.3	24.36	57.72	42.28
+0.15	25.77	31.95	68.05
+0.125	12.95	19.00	81.00
+0.075	13.88	5.12	94.88
-0.075(Base)	5.12	0.00	100.00

Wet sieving

Fraction (mm)	Weight %	P_2O_5 Cumulative% Distribution	
		Passing	Retained
+4	1.84	98.16	1.84
+2.36	1.58	96.58	3.42
+1.18	1.61	94.97	5.03
+0.6	5.64	89.23	10.67
+0.3	20.32	60.00	31.00
+0.15	26.86	42.32	57.68
+0.125	3.00	39.32	60.68
+0.075	5.48	33.84	66.16
-0.075(Base)	33.84	0.00	100.00

Table 3: P_2O_5% size distribution in the studied raw phosphorite

Dry sieving

Fraction (mm)	Wt %	P_2O_5%	P_2O_5 Distribution %	P_2O_5 Cumulative% Distribution	
				Passing	Retained
+4	3.62	17.75	2.97	97.03	2.97
+2.36	3.09	18.25	2.61	94.42	5.58
+1.18	3.81	26.25	3.56	90.86	9.14
+0.6	7.40	26.00	8.94	81.91	18.08
+0.3	24.36	28.75	32.32	49.60	50.40
+0.15	25.77	26.75	21.85	17.75	82.25
+0.125	12.95	12.75	7.63	10.17	89.88
+0.075	13.88	11.50	7.34	2.78	97.22
-0.075(Base)	5.12	11.75	2.78	0.00	100.00

Wet sieving

Fraction (mm)	Wt %	P_2O_5%	P_2O_5 Distribution %	P_2O_5 Cumulative% Distribution	
				Passing	Retained
+4	1.84	18.00	1.48	98.52	1.48
+2.36	1.58	18.00	1.29	97.23	2.77
+1.18	1.61	25.75	1.82	95.41	4.59
+0.6	5.64	30.50	7.59	87.82	12.18
+0.3	20.33	31.50	28.20	59.62	40.38
+0.15	26.68	30.75	36.15	23.47	76.53
+0.125	3.00	25.75	3.41	20.06	79.94
+0.075	5.48	18.25	4.39	15.67	84.33
-0.075(Base)	33.84	10.50	15.67	0.00	100.00

Table 4: MgO % size distribution in the studied raw phosphorite

Dry sieving

Fraction (mm)	Wt %	MgO%	MgO Distribution %	MgO Cumulative% Distribution	
				Passing	Retained
+4	3.62	4.85	5.20	94.80	5.20
+2.36	3.09	4.81	4.43	90.37	9.63
+1.18	3.81	4.80	5.47	84.90	15.10
+0.6	7.40	2.68	6.00	78.90	21.10
+0.3	24.36	1.53	11.22	67.68	32.32
+0.15	25.77	1.63	12.71	54.97	45.03
+0.125	12.95	7.23	27.96	27.01	72.99
+0.075	13.88	8.47	12.76	14.25	85.75
-0.075(Base)	5.12	9.07	14.25	0.00	100.00

Wet sieving

Fraction (mm)	Wt %	MgO %	MgO Distribution %	MgO Cumulative% Distribution	
				Passing	Retained
+4	1.84	2.34	1.11	98.89	1.11
+2.36	1.58	2.28	1.43	97.46	2.54
+1.18	1.61	1.39	0.61	96.85	3.15
+0.6	5.64	0.63	0.97	95.88	4.12
+0.3	20.33	0.48	2.54	93.34	6.66
+0.15	26.68	0.61	4.48	88.86	11.14
+0.125	3.00	1.79	1.47	87.39	12.61
+0.075	5.48	4.62	6.99	80.40	19.60
-0.075(Base)	33.84	8.68	80.40	0.00	100.00

It is clearly seen from the results obtained (Tables 3 and 4) that the dry screening cannot improve the quality of the phosphate (i.e. all the size fractions contained less than 30% P_20_5 and more than 1.5% MgO). On the other hand, the wet sieving revealed a significant improvement in the ore especially in the size range – 1.18 mm + 0.15 mm at which more than 30% P_20_5 and less than 0.65 % MgO (as an average) was achieved. Furthermore, this size range represents 52.65% of the total phosphate weight with a P_20_5 recovery of about 72%.

However, this result, although is convenient, but it can be improved to a higher level.

UPGRADING TESTS

Regarding wet sieving results, (Table 3) attempts were made to improve the P_20_5 recovery and grade. Seven tests were carried out at feed size of –10mm, -4mm and –2.36 mm. Since washing has a significant influence on the impurity (MgO) removal, these feed fractions were subjected to intensive washing at a screen aperture of 0.106 mm and 0.125 mm.

At the end of each test the product gained was analyzed for P_20_5 and MgO content and the P_20_5 recovery was determined accordingly. The results obtained are listed in Table 5. All the tests show incorrigible results for both grade and recovery and especially for the size fractions (–2.36 mm +0.125 mm) and (-2.36 mm +0.106 mm). The chemical compositions of all the test products are shown in Table 6.

Table 5: The effect of crushing and sizing on the specification of the Upgraded phosphorite

Test No.	Particle size of feed(mm)	Particle size of product (mm)	Yield %	P_2O_5 recovery %	P_2O_5 %	MgO%
1	-2.36	+0.125	56.69	74.00	31.50	0.61
2	-2.36	+0.106	58.07	79.99	31.75	0.63
3	-4	+0.125 −2.36	57.01	78.46	32.00	0.59
4	-4	+0.106−2.36	59.63	80.38	31.37	0.70
5	-4	+0.106	59.53	80.33	31.00	0.64
6	-10	+0.125−2.36	55.58	76.20	32.5	0.57
7	-10	+0.106−2.36	57.33	78.83	31.15	0.66

Table 6: Chemical composition of the upgraded phosphorite

Component %	Test No.							Industrial standard*
	1	2	3	4	5	6	7	
P_2O_5	31.50	31.75	32.00	31.37	31.00	32.50	31.15	≥30.00
Al_2O_3	0.07	0.11	<0.03	<0.03	0.10	0.14	<0.03	-
Fe_2O_3	0.16	0.18	0.18	0.16	0.21	0.17	0.13	-
IR	1.22	0.91	0.77	1.03	0.73	1.22	0.92	≤2.6**
CaO	53.20	52.59	52.64	52.57	52.50	52.13	58.74	≤56
MgO	0.61	0.62	0.59	0.70	0.64	0.58	0.65	≤1.0
Cl	0.05	0.04	0.04	0.05	0.09	0.04	0.04	≤0.08
F	3.76	3.76	3.94	3.84	3.72	4.03	3.86	≤4.0

* Ref. (Al-Ajeel and Dayk, 1989) for Al-Qaim fertilizer plant.

** SiO_2 %

The analysis show that the products were upgraded to more than 31% P_2O_5 and the MgO content was reduced to less than 1%. However, it should be mentioned here that for industrial application separation of the fine fraction can be achieved by using cycloning (Pryor, 1965 and Taggart, 1954) since sieving is not applicable on such scale.

CONCLUSIONS

High grade phosphate of acceptable industrial specification can be successfully prepared from the raw phosphate of Wadi Hirri Al-Gharbi (Area I) by crushing to particle size less than 4mm followed by wet screening to reject the - 0.106mm.

The technological approach in this work is much easier and less costly than the process adapted for the Akashat phosphorite deposit currently applied in the Al-Qaim fertilizers plant.

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