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DEVELOPMENT OF A FLOW SHEET FOR BENEFICIATION ZINC-LEAD OXIDE ORES OF UM GHIAG LOCALITY, CENTRAL EASTERN DESERT, EGYPT.

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ABSTRACT

This study deals with separation of zinc-lead concentrate from Wadi Um Ghiag region , Central Eastern Desert, Egypt using screening, the froth flotation and gravity separation as beneficiation methods and studying the different factors affecting on its. Froth flotation, using 8 hydroxyquinoline as a collector, to be the most efficient reagents for the flotation of *smithonite*, in addition to a subsequent series indicated the approximate pH range, a concentration of chelating agent and concentration of pine oil. The flow sheet developed was designed to treat economically of a low grade dump ore containing zinc and lead values in the oxide form,as well as some gangue minerals . Due to varying specific gravities of the values . Gravity concentration in addition to froth flotation was indicated. Generalized flow sheet design for the alternative concentration were suggested, based on laboratory results .

INTRODUCTION

Zinc- lead ores occur in Egypt at a few localities distributed along the red Sea coast between Quseir and Ras Banas (between latitude 26^{O} and 24^{O}) as shown in Figure(1). The Zn-Pb ore deposits of Wadi Um Ghiag region have the same general character as many world-wide occurrences Asran, (1991). Aref et al.,(1983) wrote monograph series on zinc lead minerals deposits in Egypt. They showed that formation of the ore was related to erosion surfaces and controlled by the physicochemical conditions of the ground water. The important literature for this argument included in Bogacz (1973), Bernard

(1976) Dzulynski (1976) and Bogli (1978) publications. Methods of separation of zinc and lead from their ore were presented by Bushel et al. (1985). It was found that flotation of lead minerals was usually justified as compared to gravity separation. Pickett (1985) reported different circuits for flotation and separation of lead and zinc from their ore concentrates. Xingyuan (1992) showed that mono- or poly –metallic sulphide belonging to the pyretic massive ore were often fine to ultra fine grained and mineralogical more complex than the non pyretic varieties . Das et al. (1995) found that the grinding of zinc –lead to very fine size was the most important parameter affecting zinc –lead plant performance. Abd-El Rahman and Rabah (2001) stated that beneficiation of Um Ghiag Egyptian ore and separation of lead –zinc metals .This paper reviews some of these trends in concentrate composition , and the different physical dressing which will be study to develop a flow sheet for beneficiation zinc-lead of Um Ghiag locality.

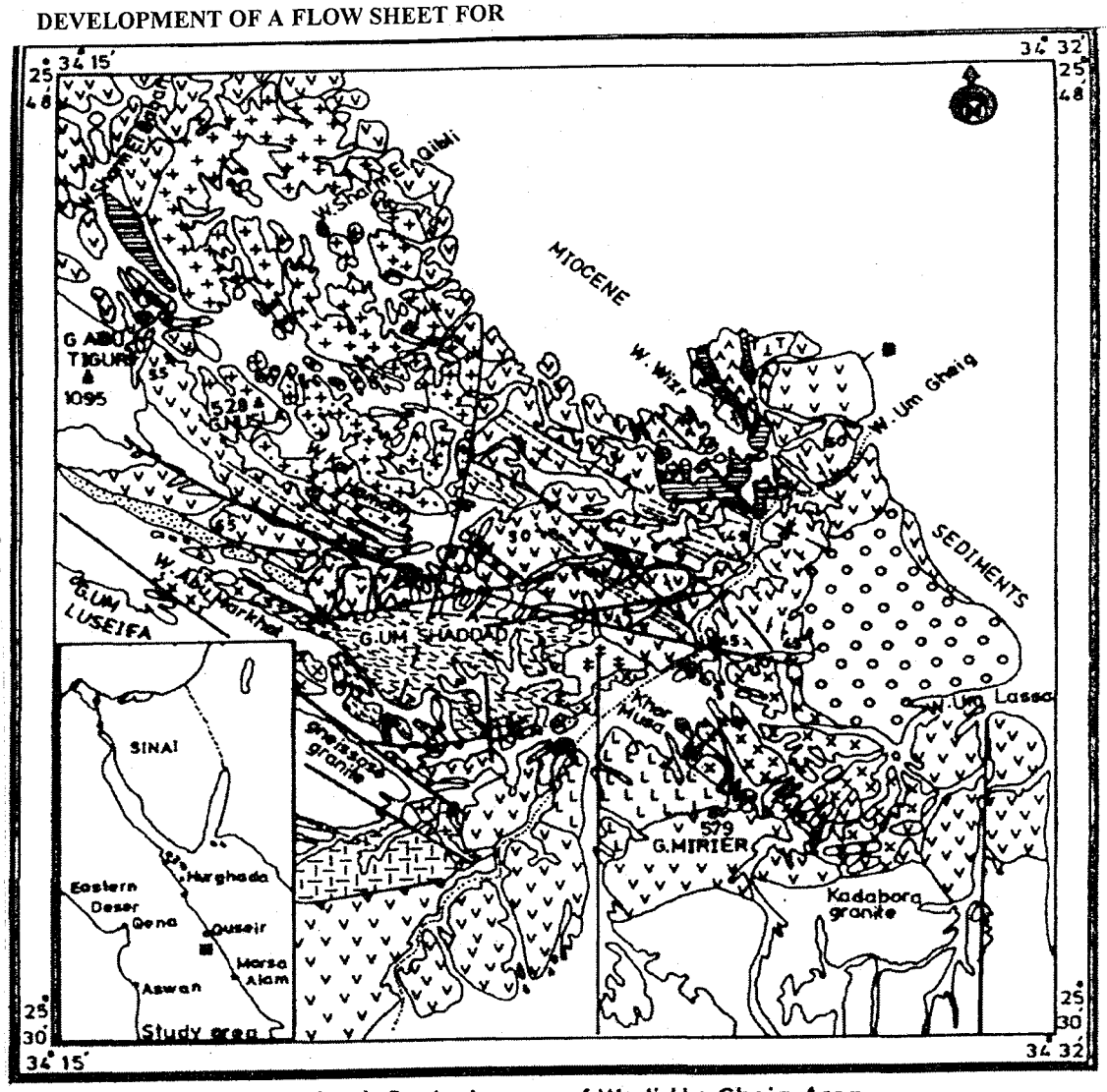


Fig.(1): Geologic map of Wadi Um Gheig Area.

EXPERIMENTAL PROCEDURE

The experimental part of this work includes the preparation of materials, the experimental facilities ,and the physico- chemical properties of starting and ending material.

Materials:

Zinc lead ore samples were supplied by "CMRDI" ,Cairo, Egypt .The samples were gig out from Um Ghiag mine located at the Red Sea cost .It is constituted of lump crudes, dirty white and weighs 4.332 kg each . Visually ,each lump has a moderate shell of lead carbonate (cerussite)with more scattered grains of zinc silicate hydrate, and a core rich in smithoniteZnCO$_3$. 8 hydroxyqunoline of technically pure grade(Oxine) was obtained from American Cyanamid Company in addition to oleic acid ,pine oil and sodium silicate.

Equipment and test facilities:

Crushing, grinding and size classification ; Jaw crusher and Ruler crushers type Denver ,Wedag rod mill fitted with 12 rods and War man & wet screening cyclosizer .

Flotation Experiments :

The lump crude (33.28 % 1.442 kg) was crushed in normal laboratory equipment and dry ground to produce a flotation feed with the following size analysis :

Fraction, μm	weight ,%
-100+74μm	13.35
-74+43.5μm	20.58
-43.5+22μm	25.57
-22+12.5μm	16.00
-12.5μm	24.50
total	100

The -10 μm fraction was removed from a portion of the ore used on the first test to ensure that slimes did not falsify the results . During final tests the ore was treated without desliming. The tests were run in a Denver laboratory cell in 500g batches . The same oxine in gasoline solution was used as was employed in the tests on synthetic mixtures of cerussite and gangue (16.7 g oxine /litre), and for comparative runs various proportions of pine oil were also added. The flotation procedure was as follows:

(1)The oxine solution was emulsified with 11 time of distilled water in the flotation cell .

(2) The ore was conditioned at a solid/liquid ratio of 1:2 for 10 minutes .

(3)Distilled water was added to bring the solid/liquid ratio of 1:4, air was introduced and flotation was continued until the froth was exhausted. Throughout these operation the impeller speed was held at 1400 rev/min. Float and tails were dried ,weighed and analyzed for Zn and Pb, recoveries being calculated on computed feed values .All tests were run at natural pH of the pulp ,which was 8.8 before addition of reagents and varied between 7 and 8.5 during flotation ,depending on the quantity of reagent used .

Bench–scale tabling of the ground ore:

A "Wilfley" shaking table was used for the gravity concentration of the ground ore from -2mm to +0.25mm (about 65 wt %) . Optimizing of the process includes the following operating parameters: rate of feed. water flow rate -table inclination --and length of the stroke.

PHYSICO -CHEMICAL PROPERTIES

Determination Of Metal Content Either Zn Or Pb:

This was performed by atomic absorption spectrometer type Perkin Elmer 2380 .Percentage of metals in the ore $(Wt_m)_o$ and in the sized fraction $(Wt_m)_f$ was gravimetrically computed . Partition weight percentage of metal content in sized fraction (PWP) was computed from the relation :

$$PWP = (Wt_m)_f \; X \; (W\,t_f)_O / (Wt_m)_o$$

Where $(Wt_f)_o$ is the weight percent of sized fraction of concern in the feed ore sample. For trace elements analysis, pressed powder pellets were prepared by filling an alumina cup (diameter 4cm,height 1.2 cm and weight 3 gm) with 9 gm of boric acid covered by one grounded sample ,(-200 mesh grain size), and then pressed under 12 tons using semi-automatic hydraulic press model HERZOGHTP-40. The X-ray fluorescence technique,(XRF) was used to determine the trace element contents using PHILIPS X ,unique-II spectrometer with automatic sample changer PW1510, (30 positions) (Norrish and Chappell 1967).

Petrographic Examination of the Ores:

This carried out by X-ray Diffraction analysis method and ore microscopy . A Philips X-ray diffractometer model"PW3710131"with scintillation counter (PW 3020) and Ni filter.The XRD unit was used at 40 k v and 30 ma.

RESULT AND DISSCUSSIONS

Complete Characterization of the ore:

Table (1) shows the composition of the zinc lead ore specimen used in this work as follows.

Table (1) Composition of Um Ghiag zinc lead ore

Zinc				subtotals		lead		others
Smithonite		hemimorphite				cerussite		
Wt %	metal	Wt %	metal	Wt %	metal	Wt %	metal	Wt %
47.2	36.6	31.00	8.48	78.20	45.08	15.35	13.35	6.4

Results of the routine chemical analysis for all resultant size fractions are shown in Table (2). It is clear that the ore is a low grade zinc and moderate lead. The analysis of zinc and lead oxides are 1.75 % and 0.55 % respectively . Grade analysis of the different size fractions does not show any mineral segregation in the coarse sizes ≥ 2mm. On the other hand, it is noticed that there is an increase in the percentage of zinc oxide in the finer size fractions below 0.5 mm.However, it was decided to grind the ore to – 0.045 mm as a suitable grain size feed for the beneficiation experiments for all either gravity separation or froth flotation . The x-ray analysis reveals that the sample contains hemimorphite $Zn_4(OH)_2\ Si_2O_7.H_2O$, cerussite $PbCO_3$, smithonite $ZnCO_3$, zircon, barite ,celestite, dolomite, calcite ,quartz and kaolinite minerals as shown in Table (3) and Figure (2 a b c). They illustrate the three major lines of Hemimorphite $Zn_4(OH)_2\ Si_2O_7.H_2O$ (3.11 A^o, 6.59 A^o ,3.29 A^o), cerussite $PbCO_3$ (3.59 A^o, 3.50 A^o ,2.49 A^o), smithonite $ZnCO_3$(2.75 A^o,3.56A^o,1.70A^o)

Table (2) : Routine chemical analysis for all size fractions for the selected sample of Um Ghiag locality

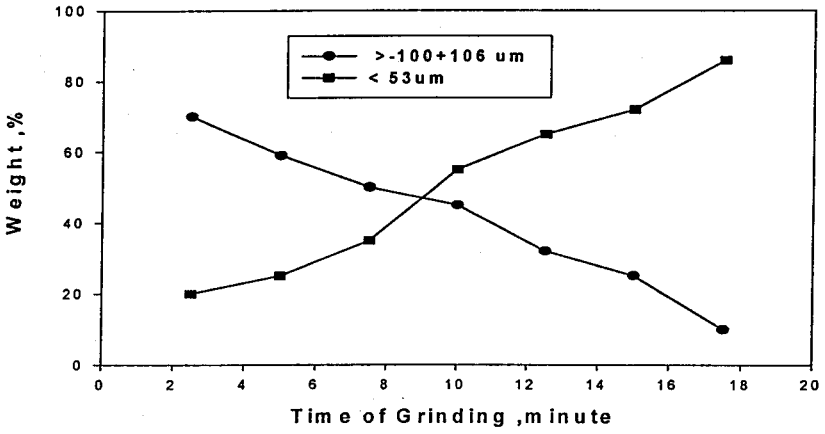
Size, mm	Weight %	Oxide assays %		Recovery %	
		ZnO	PbO	ZnO	PbO
+2	3.59	1.73	0.263	3.55	1.71
-2 +1	16.53	1.79	0.282	16.90	8.47
- 1 + 0.5	21.93	1.654	0.5831	20.73	23.24
- 0.5 + 0.35	10.85	1.77	0.492	10.97	9.71
-0.35 + 0.25	13.85	1.78	0.478	14.08	12.04
-0.25 + 0.106	9.36	1.525	0.825	8.15	14.04
- 0.106 + 0.063	7.25	1.459	0.456	6.044	6.01
- 0.063	16.67	1.850	0.505	17.62	1.70
Calculated	100	1.750	0.55	98.1	75.21

BENEFICIATION ALTERNATIVES

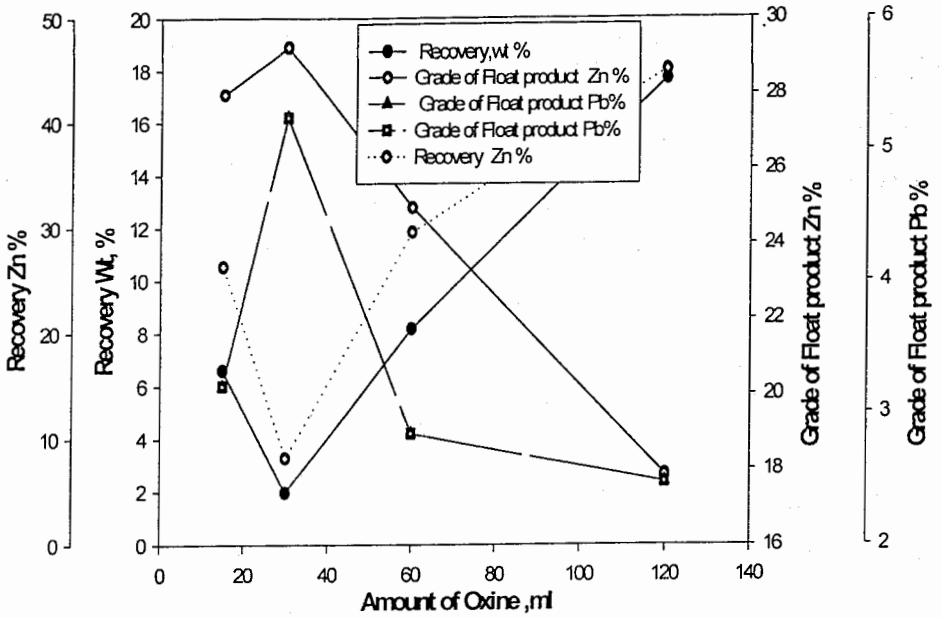
Flotation tests of deslimed ore:

Figure (3) shows weight % of ground products having > -100+ 106 μm (> 140 mesh)and < 53 μm (<200 mesh) as a function of grinding time. It is clear that the weight % of fine fraction increases with grinding time

attaining a value of >86 % after 20 minutes. Figure(4) shows that the flotation tests on deslimed ore (effect of varying amounts of oxine) .Since an initial series of tests was run to ascertain approximately how much oxine would be required for good flotation .Also the chelating agent was fed in gasoline solutions and the results of the use of 2g oxine (120 ml solution) ,1g oxine (60ml) ,0.5 gm (30) and 0.25 g (15ml) .Conditioned time for all experiments was reduced to 5 minute. The results are presented in Figure(4): Although the grade of the concentrate is higher with the smaller quantity of oxine (better selectivity), recovery is low . Figure (5) shows the effect of pH on the flotation process of the suggested sample since at pH 8.5 ,it is obtained better concentrate with high grade and considerable recovery. All these tests are carried out in presence of pine oil about 60ml .



Figure(3)Weight % of ground products having >106 um and <53 um in diameter as a function of grinding time



ɟure (4) The effect of addition of the amount of oxine to float the zinc or

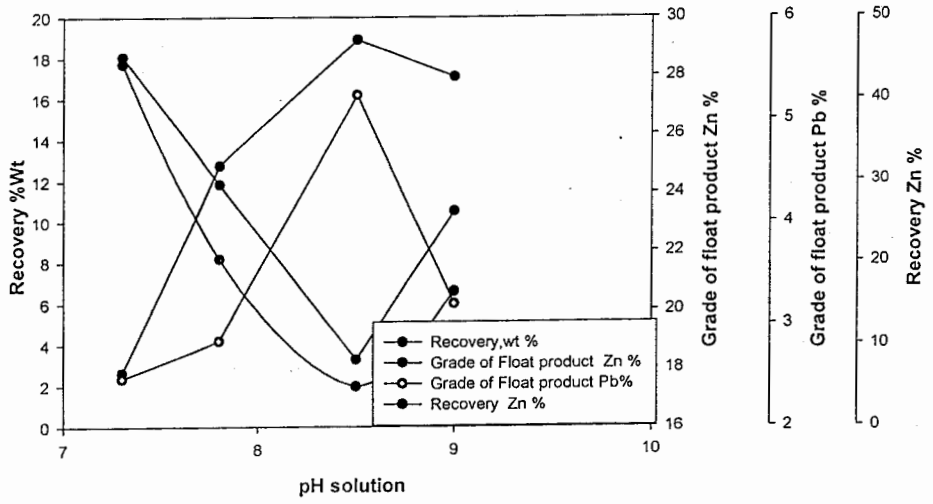


Figure (5) Effect of pH on the flotation tests of the selected sample

Table (3) Distribution of Minerals in Um Ghiag area by XRD

Name of mineral	Chemical formula	No of ASTM card
Hemimorphite	$Zn_4 (OH)_2 Si_2 O_7.H_2O$	5 - 0555
Cerussite	$Pb CO_3$	5- 417
Smithsonite	$Zn CO_3$	8- 449
Zircon	$Zr SiO_4$	6- 266
Baryte	$Ba SO_4$	5- 0448
Celestite	$Sr SO_4$	5- 0593
Dolomite	$Ca Mg (CO_3)$	11- 78
Calcite	$Ca CO_3$	5- 586
Kaolinite	$Al_2Si_2 O_5 (OH)_4$	6- 0266
Quartz	$Si O_2$	5- 0490

Tabling of the ground ore (-1mm+0.25 µm):

The use of the tabling technique, as a gravity separating method, was mainly devoted to clean the bulk heavy mineral fraction from most of the quartz and associated silicates. Such separation depends on differences in the specific gravity, shape and grain size (Taggart 1945).

Effect of changing table inclination:

By increasing the table inclination from 3 to 8° from the horizontal position , more ore escape to the middling side .At a rate of feed of 5 kg/hr, water flow rate of 4 l/min., stroke length of 10 mm and an optimum table inclination of 8°, a concentrate having 72.10 % ZnO was obtained with 19.91% wt, Table (4).

Table(4)Effect of changing table inclination on quality of concentrate:

Inclination degree ,°	Concentrate		Middling		Tailing	
	% Wt	% ZnO	% Wt	% ZnO	% Wt	% ZnO
3	18.91	52.74	41.36	15.83	31.73	12.25
4	18.74	62.84	34.72	13.54	14.54	10.67
5	21.54	64.56	29.64	10.08	19.82	14.52
8	19.91	72.10	32.42	8.72	13.67	15.34

Effect of stroke length:

Table (5), shows that by decreasing the stroke length from 20 to 10 mm, stratification of ore particles deteriorates .This leads to improper separation. A maximum stroke length of 18 mm is determined under the aforementioned experimental conditions.

Table (5) Effect of stroke length:

Stroke length, mm	Concentrate		Middling		Tailing	
	% Wt	% ZnO	% Wt	% ZnO	% Wt	% ZnO
20	9.29	76.50	70.46	20.64	21.25	10.72
18	14.52	69.12	65.74	23.50	20.74	12.43
15	9.76	65.80	76.31	18.18	14.93	8.53
10	7.91	62.10	70.42	23.26	22.67	7.34

Effect of feed rate :

Increasing the rate of feed on the table from 2 to 5 kg/hr impairs separation, Table(6).At an inclination of 8° stroke length 18 mm, an optimum feed rate of 5 kg/hr corresponding to a concentrate having 80.63 %ZnO and 16.47% wt.,

Table (6) Effect of feed rate on table performance:

Feed rate, Kg/h	Concentrate		Middling		Tailing	
	% Wt	% ZnO	% Wt	% ZnO	% Wt	% ZnO
2	9.73	76.02	74.53	6.26	15.74	6.02
3	9.97	70.33	75.36	10.34	14.67	7.32
4	11.23	72.95	71.24	17.66	17.53	7.98
5	16.47	80.63	62.81	12.07	20.72	8.35

Effect of water flow rate:

Increasing the water flow rate causes flushing of the ore to the tailing and middling sides. Table (7), shows that below 8 l/min, both the grade and the weight percentage of the concentrate deteriorates. However, wet tabling of the ground ore of Zn-pb Um Ghiag, at a rate of feed of 5 kg/h, water flow rate of 6 l/min, table inclination of 8° from horizontal, stroke length 18 mm and motor speed 300 rpm led to the production of a zinc fraction having 74.00 %Zn and 10.88 %wt

Table (7) Effect of water flow rate:

Rate l/min	Concentrate		Middling		Tailing	
	% Wt	% ZnO	% Wt	% ZnO	% Wt	% ZnO
4	10.88	74.00	80.74	16.53	6.52	6.12
6	7.10	64.12	78.66	25.70	12.89	5.20
8	4.50	72.23	80.95	26.19	14.45	7.40

CONCLUSION

*The x-ray analysis reveals that the sample contains Hemimorphite $Zn_4(OH)_2\ Si_2O_7.H_2O$, cerussite $PbCO_3$, smithonite $ZnCO_3$, zircon, barite ,celestite, dolomite, calcite ,quartz and kaolinite minerals. Since the three major lines of Hemimorphite $Zn_4(OH)_2\ Si_2O_7.H_2O$ (3.11 A^o, 6.59 A^o ,3.29 A^o), cerussite $PbCO_3$ (3.59 A^o, 3.50 A^o ,2.49 A^o), smithonite $ZnCO_3$(2.75 A^o,3.56A^o,1.70A^o)

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the grade of the concentrate increased with the smaller quantity of oxine (better selectivity) but recovery is low . The effect of pH on the flotation process of the suggested sample at pH 8.5 gives better concentrate with high grade and considerable recovery .All these tests are carried out in presence of pine oil about 60 ml .

*** Wet tabling of the ground ore (from –2mm +0.0106 mm) of Zn-pb Um Ghiag , at a rate of feed of 5 kg/h, water flow rate of 6 l/min, table inclination of 8° from horizontal, stroke length 18 mm and motor speed 300 rpm led to the production of a zinc fraction having 74.00 %ZnO and 10.88 %wt

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تطوير اللوحة التوضيحية لتركيز خامات أكاسيد الزنك والرصاص بمواقع أم غيج بوسط الصحراء الشرقية ج.م.ع.

د.محمد شعبان عتريس ود.ماجدة عبد الحكيم خلف
هيئة المواد النووية

هذه الدراسة تعتني بفصل ركازات الزنك والرصاص من منطقة وادي أم غيج بوسط الصحراء الشرقية ج.م.ع باستخدام الغربلة والتعويم الرغوي والفصل بالجاذبية لطرق للتركيز الفيزيائي . وذلك بدراسة العوامل المؤثرة عليها . التعويم الرغوي باستخدام ٨ هيدروكسيد الكينولين كمجمع تكون أكفأ طريقة لتعويم اكسيد الزنك (السميثونيت) بالإضافة إلي سلسلة من العوامل الأخرى مثل مدي الأس الهيدروجيني وتركيز المادة المركبة (تركيز زيت رجيع الكون).اللوحة التوضيحية المتطورة ترسم لتعالج بشكل اقتصادي الركامات منخفضة الرتبة التي تحتوي علي قيم للزنك والرصاص في صورة اكاسيد بالإضافة إلي شوائب معدنية أخري .لذا تستخدم طرق الفصل بالكثافة النوعية مع التعويم الرغوي في تفسير النتائج.

شكر وتقدير

يشكر الباحثان السيد الدكتور محمد إسماعيل رئيس قسم التركيز الفيزيائي بهيئة المواد النووية علي حسن تعاونة معهم لإخراج هذا العمل المتواضع إلي النور من خلال توفير كل امكانتة ومعملة في خدمة الباحثون