MINISTRY OF ENERGY AND MINERAL RESOURCES
Mineral Status and Future Opportunity

FELDSPAR

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Feldspar

1. Introduction

Feldspar is the most important single group of rock forming silicate minerals. The mineral name feldspar is derived from the German words field + spar. The word (field) 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 Moh` Scale of Hardness and perfect to good cleavage (plane of breakage) in two directions.

There are four chemically district groups of feldspar; Potassium feldspar (KAlSi3O3), Sodium feldspar (NaAlSi3O8), calcium feldspar (CaAlSi3O8) and Barium feldspar (BaAl2Si3O8). About 90% of produced feldspar is used by the glass and ceramic industries. Soda feldspar is preferred in glass manufacture, but Potash feldspar is more popular for ceramic.

Table (1): Chemical composition of feldspar minerals.

Feldspar		**K2O%**	**Na2O%**	**CaO%**	**AL2O3%**	**SiO2%**
Microcline	$KAlSi_3O_8$	16.9	_	_	18.4	64.7
Orthoclase	$KAlSi_3O_8$	19.9	_	_	18.4	64.7
Albite	$NaAlSi_3O_8$	_	11.8	_	19.4	68.8
Anorthite	$CaAl_2SiO_8$	_	_	20.1	36.6	43.3

2. Uses of Feldspar

Feldspar is ground for industry use to about 0.85mm for glass-making and to 0.075mm or finer for most ceramic and filter applications.

Feldspar is used in the manufacture of glass products (70%), in ceramic and other products (30%).

Feldspar is an important ingredient in the manufacture of glass. The raw material for glass consists of silica sand, soda ash (sodium carbonate) and limestone (calcium carbonate). Feldspar adds certain qualities to the process. Alumina provides hardness, workability, strength, and makes glass more resistant to chemicals .NaO_2 and K_2O from feldspar are fluxes. Fluxes reduce the melting temperature so less energy is used and decrease the amount of soda ash needed. About 110 pounds of feldspar are used to produce one ton of container glass (soda bottles, e.g.), and 100 pounds are required to produce one flat glass.

In the fabrication of ceramic material, feldspar serves as a flux to form a glassy phase at low temperatures, and as a source of alkalis and alumina in glazes. It improves the strength, toughness, and durability of the ceramic body and cements the crystalline phase of other ingredients. Feldspar is also used in paint, in mild abrasives, urethane, latex foam, and as a welding rod coating

3. Locations

In Jordan, the feldspars deposits are found in the alkali granite rocks, leucogranite,feldspar pegmatites,and alkali-rich granite, which occurring as medium and coarse-grained, light coloured igneous rocks such as aplites and alaskite respectively which have a granite composition but are characterized by low levels of mafic (iron-bearing) minerals. These deposits located in the following areas (as shown in figure 1):

- **Al-Jaishieh Area, 6km south of Aqaba.**

E: 162500 - 167500 **N : 0877000 - 0887500** (Palestine belt)

- **Wadi Sader Mulghan Area, 25km north of Aqaba and 8 km to the west.**

E: 163500 - 164800 **N: 0899000 - 0900300** (Palestine belt)

- **Ayn Al Hashim Area, 45km south-east of Aqaba.**

E: 175800 **N: 0872700** (Palestine belt)

- **Other Minor Feldspar Localities:**

    1. Wadi Almahlabe, 5km north east of Aqaba. The estimated reserve of feldspar is 0.4 million tones.

    2. Jabal Alghufran, 18km north east of Aqaba,in the high way between Aqaba city and Maan city, the estimated reserve of feldspar is 0.6 million tones.

Fig. 1:
Location map for the feldspar ore deposits in Jordan

4. Geological Setting

Feldspar ore deposits are a part of the basement rocks of southwest Jordan that represents the northern extension of the Arabian Nubian Shield (ANS), which is separated by the Red Sea Rift zone. They are considered as the northeast segment of the crudely U- shaped string of Pan African belts that girdle the African Carton.

The exposed basement rocks in Jordan comprise igneous and metamorphic Suites predominantly of late Proterozoic age, classified into two lithostratigraphical complexes, the Aqaba Complex (older) and Araba Complex (younger). The complexes are separated by a regional unconformity represented by the Saramuj Conglomerate Formation (Table 2).

The Aqaba Complex consists mainly of calk-alkaline plutonic igneous rocks and a metamorphic rock of an age ranges between 570 and 800 Ma, whereas the Araba Complex comprises the Safi Group, Feinan Granitic Suite, Qirenifat Volcanic Suite and Ahaymir Volcanic Suite (the youngest igneous rocks in the southwest Jordan). The Yutum Granites and Urf Porphyritic suites forms the source rocks for the feldspar ore deposits, The granitic rocks which belong either to Abu Jadda granite (582±4Ma), or the Imran Monozogranite (589±5Ma) units which belong to Yutum GraniticSuite and the Mulghan Granodiorite unit (630-570 Ma) are the source rocks for the feldspar ore deposits.

5. Previous Studies

Detailed mineral processing using magnetic and floatation processes were carried out by Mineral Processing Division Division (AL-Rawashdi, et. al.1996, Tahat, et al.1999, Tahat, et al.2000, Tahat, et al.2000 and AL-Abtah, et al.2002). Barjous (1995, 1997 and 2000) carried out a study on beneficiation of Jordanian feldspar from unique tectonically crushed granite. Haki (1971 and 1976) has been discovered anew localities of feldspars in south-east Jordan. During the geological mapping survey for the Aqaba sheet map Rashdan et al. (1985) found that the crushed granite could be as a source of feldspar. Haddad, et al.(1976 and 1988) carried out a beneficiation studies on the medium grained alkali granites of the Aqaba-Quweira area .Technostone S.P.A. 1984 produced a final report on feldspars in El Quweira Area.

Recently (2005 up to now) NRA has carried out a systematic exploration studies for the exposures of feldspar in Wadi Sader Mulghan area.

Table (2): Field Established Hierarchy of the Aqaba Complex, Southwest Jordan (Ibrahim, K., 1991).

Units and Suites of Aqaba Calc- alkaline Complex (after Ibrahim, K., 1991)			
Units	**Suites**	**Ages/Ma**	**Important Features**
Main Dyke Phase			
Sammaniya Micro-granodiorite	Yutum Granitic	Late Proterozoic 630-570	Calc-alkaline Rocks
Mubarak Monzogranite			
Humrat Syenogranite			
Ar Rashidiya Aplite			
Abu Jadda Monzogranite			
Imran Monzogranite			
Sahaqi Granodiorite			
Minshar Monzogranite			
Ghuwayr Volcanics			
Mulghan Granodiorite	Urf Porphyritic	Late Proterozoic 630-570	Calc-alkaline Rocks
Huneik Granodiorite			
Abyad Granodiorite			
Filk Monzogranite			
Rubeiq Granodiorite			
Muheirid Granodiorite			
Marsad Monzogranite			
Barraq Granodiorite			
Qara Granite	Rumman Tonalitic		
Ishaar Monzogranite			
Sabil Granodiorite			
Hubayra Diorite			
Wa'ara Granodiorite	Darba Tonalitic		
Muhtadi Quartz Monzodiorite			
Huwar Two Mica Granite	Rahma Foliated Suite		
Umm Rachel Quartz diorite			
Taba Monzogranite			
Es Sadra Granodiorite			
Um Saiyala Granodiorite			
Turban Granodiorite			
Abu Radmar Granodiorite			
Naba'a Monzogranite			

6. Mineral Properties

The investigation methods that used through this study were XRF, petrography examinations using both stereo-microscope and polarized microscopic techniques, in addition to X-Ray diffraction were carried out for mineralogical studies purposes.

Twenty samples have been collected from different feldspar ore localities within the basement of the Aqaba Complex to investigate the distribution and the quantity of the feldspar quartz and mafic minerals in the three different localities of deposits of the feldspar areas (Wadi Al-Jaishieh, Ayn Al Hashim and Wadi Sader Mulghan). All the collected samples were analyzed in the laboratories of Natural Resources Authority.

6.1. Chemical Properties

6.1.1. X.R.F Analysis of Feldspar in Wadi Al-Jaishieh

Four representative samples were collected from the three parts of the Wadi Al-Jaishieh Feldspar Deposit (north, middle and south areas).

Results of the major elements presented in Table (3) indicate that the K2O percentage varies from 2.30 to 4.34, Na2O 3.92 to 5.54, SiO2 71.33 to 74.49 this variation is due to the heterogeneous distribution of the feldspar minerals that present in the original granitic rocks.

The iron oxides occurred in a low quantity in the analyzed samples. The percentages vary from 0.81 to 2.28 which are thought to be produced from the alteration of the mafic minerals that present in the rock.

Table (3): Chemical analysis of feldspar ore deposit in Wadi Al-Jaishieh.

Area	SiO_2 %	CaO %	MgO %	Fe_2O_3 %	Al_2O_3 %	TiO_2 %	Na_2O %	K_2O %	MnO %
Al-Jaishieh/ North	71.46	1.05	0.35	1.02	13.98	0.88	5.53	4.29	0.02
Al-Jaishieh/ Area 1	71.72	1.04	0.50	1.37	13.63	0.92	5.34	4.34	0.03
Al-Jaishieh/ Area 2	74.49	1.62	0.01	2.28	13.25	0.09	3.92	4.28	0.04
Al-Jaishieh/ South	71.33	3.22	0.42	0.81	12.90	0.32	5.54	2.30	0.03

6.1.2. X.R.F Analysis of Feldspar in Ayn Al Hashim

Two samples have been analyzed from Ayn Al Hashim Feldspar Deposit. One sample (Ayn Al Hashim/1) was collected from pegmatites that exposed in the area, the other one collected from the adjacent rock. The results are shown bellow in (Table 4).

Table (4): Chemical analysis of feldspar in Ayn Al Hashim.

Area	SiO2 %	CaO %	MgO %	Fe2O3 %	Al2O3 %	TiO2 %	Na2O %	K2O %	MnO %
Ayn Al-Hashim/1	66.78	0.03	0.25	0.22	18.83	0.02	4.06	11.03	0.01
Ayn Al-Hashim /2	69.06	0.60	0.34	1.45	14.88	0.23	2.64	8.68	0.06

6.1.3. X.R.F Analysis of Feldspar in Wadi Sader Mulghan

Three representative samples were brought from the feldspar area in Wadi Sader Mulghan and sent to N.R.A Laboratories to identify the major oxides by X.R.F.The results revealed that the total alkalis (Na_2O + k_2O) are varies from 9.77 to 10.24%. Copared with the total alkalis in the other countries; for example in Sweden 8.83%, Norway 8.9% and Japan the total alkali are 7.44%. All the results are presented in Table 5.

Table (5): Chemical analysis of feldspar in Wadi Sader Mulghan area.

Area	SiO2 %	CaO %	MgO %	Fe2O3 %	Al2O3 %	TiO2 %	Na2O %	K2O %	MnO %
Wadi Sader Mulghan/1	72.99	0.617	0.074	0.651	14.29	0.06	4.13	5.64	0.02
Wadi Sader Mulghan/2	72.9	1.20	0.23	0.58	14.2	0.05	5.25	4.99	0.03
Wadi Sader Mulghan/3	73.69	1.37	0.03	0.30	13.02	0.04	6.05	3.73	0.01

Table (6): Chemical analysis of the feldspars in the other countries.

Oxides %	Sweden	Norway	Japan
MgO	0.5	0.0	0.8
Na_2O	4.25	4.3	3.39
K_2O	4.58	4.6	4.05
SiO_2	75.50	75.30	77.14
P_2O_5	0.0	-	-
CaO	-	0.9	0.5
TiO_2	-	-	-
Al_2O_3	15.17	14.90	14.12

6.2. Mineralogical Properties

6.2.1. Mineralogy of Feldspar in Wadi Al-Jaishieh

- **X-Ray – Diffraction (XRD) Analysis**

A mineralogical study was performed on representative samples for Wadi Al-Jaishieh Feldspar Deposit, the results are shown bellow:

Primary minerals:

The main essential minerals found to be Orthoclase, plagioclase, microcline and quartz.

Accessory minerals:

- Biotite altered to chlorite.

- Zircon.

- **Petrography Analysis**

Orthoclase texture is subhedral and tabular highly altered to Kaolinite. The grain size ranges 0.8-3.5mm. The mineral forms about 18 % (by volume) of the rock.

Plagioclase Texture is subhedral and tabular. The grain size ranges 0.5-3.5mm. The mineral forms about 26% (by volume) of the rock.

6.2.2. Mineralogy of Feldspar in Ayn Al Hashim

Two representative samples were collected from the pegmatites of the Ayn Al Hashim deposit; the results revealed that the main minerals are feldspars, as shown in Table 7.

Table (7): XRD analysis of some samples from Ayn Al Hashim

SNO.	Q	Al	Mi	M	Cc	F
F11	*	***	***	*	--	
F31	*		***			***

Q=Quartz
Sm=Smectite
Al=Albite
Cc=Calcite
Mi=Microcline
F = Felspar

Major: ***
Minor: **
Trace:*

6.2.3. Mineralogy of Feldspar in Wadi Sader Mulghan

- **X-Ray – Diffraction (XRD) Analysis**

The resoles of three representative samples collected from the area showing that the major feldspar minerals were microcline and albite. For more details see Table 8.

Table (8): XRD analysis of some samples from Wadi Sader Mulghan

SNO.	Q	Mi	Al	Sm	Cc
F76	***	***	***	*	--
F77	**	**	***	*	--
F78	**	**	***	*	*

- **Petrography Analysis**

A- Textures:
Perthitic & microperthitic, Poikilitic, Micrographic intergrowths (rare), Consertal texture (local) and Myrmekitic texture (local).

B- Mineralogy:

1- Quartz: occurs as medium-grained, anhedral with suture outlines giving consertal texture or irregular boundaries. In some places occurs as fine-grained like rods enclosed by feldspar. It forms about 25%.

2- Plagioclase: occurs as large to medium grains, euhedral to subhedral elongated crystals showing well-developed albite twinning forms about 45%. The crystals partially altered to sericite (at the center).

3- K-Feldspar: occurs as well-developed crystals showing perthitic texture and Carlsbad twinning, perthite exhibits alteration along the albite lamellae. Microcline, also present and showing cross-hatching twinning altered to clay minerals. It forms about 25-30%.

4- Biotite and muscovite are present as flakes and forms about 2%, Biotite is altered to iron oxides.

5- Inclusions of opaque minerals in feldspar and quartz.

6- Secondary mineral of iron oxides filled veins.

7. Evaluation and Investment Opportunities of Feldspar Ore Deposits in Jordan

The source of the feldspar is only found in the granites of Aqaba Proterozoic complex which covers about 2000 km^2 of the south-west corner of the Jordan country. A total of 15 promising localities or areas have been identified. 13 of these localities have been inspected and sampled. Other two localities are inaccessible. The feldspar areas can be seen on map sheets of 1: 50,000 scale 3048/IV Jabal al Mubarak, 3048/I Ayn Al Hashim, 3049/II Umm Ishrin, 3049/ III Aqaba and 3049/ IV Wadi Rahma, (Figure 2).

On the basis of the results technological and dressing tests it has been noted that the most convenient areas for feldspar productions were Al Jaishiah within Jabal al Mubarak and Aqaba sheet maps and Wadi Sader Mulghan within the Aqaba sheet map, because they are more accessible and also more suitable from the extraction viewpoint.

According to the existing known realities the hope to find deposits of pegmatite feldspars in Jordan is rather minimum. Even when the lenses shaped bodies of orthoclases with quartz core are known as in the Ayn Al Hashim area, they are very small with reserves in the order of a few tens to hundreds of tons and therefore not suitable for industrial mining.

7.1. Evaluation of the Most Promising Feldspar Deposits in Jordan

7.1.1. Al Jaishiah Feldspar Ore Deposit

The deposit is located 6km south of Aqaba within Jabal al Mubarak and Aqaba sheet maps (Figure 3).

The area is restricted between two major faults, almost parallel to each other. This area is largely affected by the tectonic movements and caused of many minor faults on the intersection zone (crushed zone). The deposit is characterized by easy accessible, lack in dykes, has high alkali consent and low costs of mining and beneficiation.

The area was divided along the crushed zone strike to three parts (sub-areas), northern, central and southern part, due to their accessibility and the nature of the alkali granite rocks

(Haddad, M. 1988).The investigated area consists of the Abu Jadda and Imran Monzogranites which belong to the Yutum Granitic Suite. It varies in composition from monzogranite to alkali feldspar granite and coarse - grained equigranular to aplite in texture. The biotitic Abu Jadda Granite is distinguished from Imran Granite in color index and presence of spars hornblende.

The crushed zone has a length ranging from 8 to10 km, and is 0.5 to 1.0 km in width. It covers an area of approximately 8.0 km2. The estimated Reserve was found to be 115 million tones according to Haddad (1988).

Haddad also dealt with feldspar raw material in model scale from the processing viewpoint. He found out that when mining 60,000 tons of raw material per year it would be possible to gain 19,200 ton of K-feldspar, 15,600 ton of Na- feldspar and as a by product 15,600 ton of quartz and 9,600 ton of dusty mica.

Owing to the fact that the area belongs to a private prospecting company (General Mining Company Limited), which owns the mining license for respective mining. The company extracting the feldspar from the area since 1998 to 2005 as seen in Table 9.

Table (9): Jordan mining production of feldspar (General mining company /Al jaishieh)

Year	Mine production /ton
1998	4008.26
1999	1000
2000	11112
2001	611
2002	530
2003	13057
2004	13063
2005	1000

The intended production would be about 200 tons per day, i.e. at 300 working days approximately 19000 ton of K-feldspar and 15000 tons of Na-feldspar (GIS Geoindustry, Praha Czech Republic 2000). The dressing would have to be done by flotation which would have to face a lack of water. Water demand would be approximately 60 m3/ hour with loss of only 4m3/ hour. Such project would require huge investment of 30,000,000 USD.

7.2. Mining Aspects

7.2.1. Mining of Al Jaishiah Feldspar Ore Deposit

The most suitable mining method in Al Jaishiah ore deposit should be applied for exploitation the crushed granite in the studied area is the selective open pit mining method (Haddad, 1988).The reasons for Appling the mentioned method are the following:

1) The northern part is very extensive traversed with dykes.
2) Distribution of the mafic minerals content along the crushed granite is variable.
3) The alkali- group in the ore is variable.
4) The compaction of crushed Granite is variable as follows:

- Surface crushed granite is coarse-medium blocks.
- Surface crushed granite is medium-grained blocks.
- Interior crushed granite is fine-grained blocks (friable).

5) Silica content in the Al Jaishiah feldspar ore deposit is also changeable

• Current Situation

Nowadays the area of Al Jaishiah feldspar ore deposit is located in side the Aqaba Economic Zone Reservation.

7.2.2. Wadi Sader Mulghan Feldspar Ore Deposit

The deposit is located 25km north of Aqaba and 8km to the west of the Amman-Aqaba highway. The studied area is located in Aqaba sheet map scale 1:50,000 (Figure 4).

Natural Resources Authority (NRA) studied the area in full exploratory program during (2005-2006) by Shakkor, et al. (In press) and dug about 20 exploration trenches in the feldspar ore deposit. They collected about 50 samples in order to estimate their alkali contents and the mineralogical components. The feldspar ore deposits are present in an area of about 5.0 km^2. The ores are present in Mulghan Monzogranite to Granodiorite Unit and the thickness is ranging from 10-25 m. The reserve of the deposit is not estimated yet.

The Mulghan Monzogranite to Granodiorite Unit is considered as a part of the Urf Porphyritic Suite. The rock of Mulghan unit is the only source for the feldspar in the Wadi Sader Mulghan area that forms prominent highly weathered whitish grey rounded isolated hills, typically crossed by a few dolerite dykes.

• Mining of the feldspar ores in Wadi Sader Mulghan

Comparing with the Al Jaishiah feldspar ore deposit the feldspar in the Wadi Sader Mulghan area is more favorable for exploitation for the following reasons:

1) Less in Ferro-magnesium minerals
2) Higher alkali content
3) Less iron content
4) Less dykes
5) Easier exploitation
6) More accessible
7) Easy for mining

So, the open mining method was found propose to be the cheapest and gave the highest recovery and safest method; besides, it would permit almost a 100% recovery.

7.2.3. Ayn Al Hashim Feldspar Ore Deposit

The deposit is located 45km southeast of Aqaba (several kilometers east of Titten Village).The studied area is located in 3048/I Ayn Al Hashim (Figure 5).

The Natural Resources Authority (NRA) studied the area during (2005) by Abu Baker. Several samples were collected from the pegmatite exposure which hosted by the Sabil Granodiorite Unit that belongs to Rumman Tonalitic Suite and analyzed in the NRA laboratories. Unfortunately the exploration activity in the project was stopped. So, further exploration activities would be needed (drilling boreholes and dug trenches) to give more information about the depth, quantity and quality of the pegmatite exposure in the studied area.

The surface studies that performed by Abu Baker (2005) indicate that the length of the pegmatite intrusion is about 26m,with 16m width and 8.0m thickness. Depending on the previous diminutions of the ore, the estimated reserve will be ranges from 10,000 to 12,000 to including small pockets of pure quartz that present in the core of the pegmatite exposure.

7.3. Production and Prices of Feldspar in the World

The industrial Revolution led to a greater demand for the feldspar because of the increased use of glass and ceramics. This gave the feldspar producing industries a major boost worldwide and today the use of feldspar is extensive in many countries in the world. Today there are many countries that mining and producing the feldspar with the major ones being the Italy, U.S.A., France, Thailand and Spain. The world mine production of feldspar is illustrated in Table10.

The prices of the feldspars in the world are illustrated in Table 11.

Table (10): World mine production of feldspar (U.S. Geological Survey, Mineral Commodity Summaries, 2012).

Country	Mine production (kt)*		Reserves
	2010		2011
United states	670	United states	NA
Argentina	215	Argentina	NA
Brazil	115	Brazil	NA
Bulgaria	80	Bulgaria	NA
China	2.100	China	NA
Colombia	85	Colombia	NA
Czech republic	388	Czech republic	28.000
Egypt	355	Egypt	5.000
France	650	France	NA
Germany	150	Germany	NA
India	400	India	38.000
Iran	500	Iran	NA
Italy	4.700	Italy	NA
Japan	650	Japan	NA
Korea, republic	600	Korea, republic	NA
Malaysia	360	Malaysia	NA
Mexico	399	Mexico	NA
Poland	450	Poland	10.600
Portugal	315	Portugal	11.000
Saudi Arabia	500	Saudi Arabia	NA
South Africa	95	South Africa	NA
Spain	550	Spain	NA
Thailand	600	Thailand	NA
Turkey	5.000	Turkey	NA
Venezuela	200	Venezuela	NA
Other countries	450	Other countries	NA
World total (rounded)	**26.600**	World total (rounded)	**Large**

* 1kt= 1000 ton

Table (11): World prices of the feldspar

Year	**2007**	**2008**	**2009**	**2010**	**2011**
Price, USD/ ton	60	62	65	65	63

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Appendices

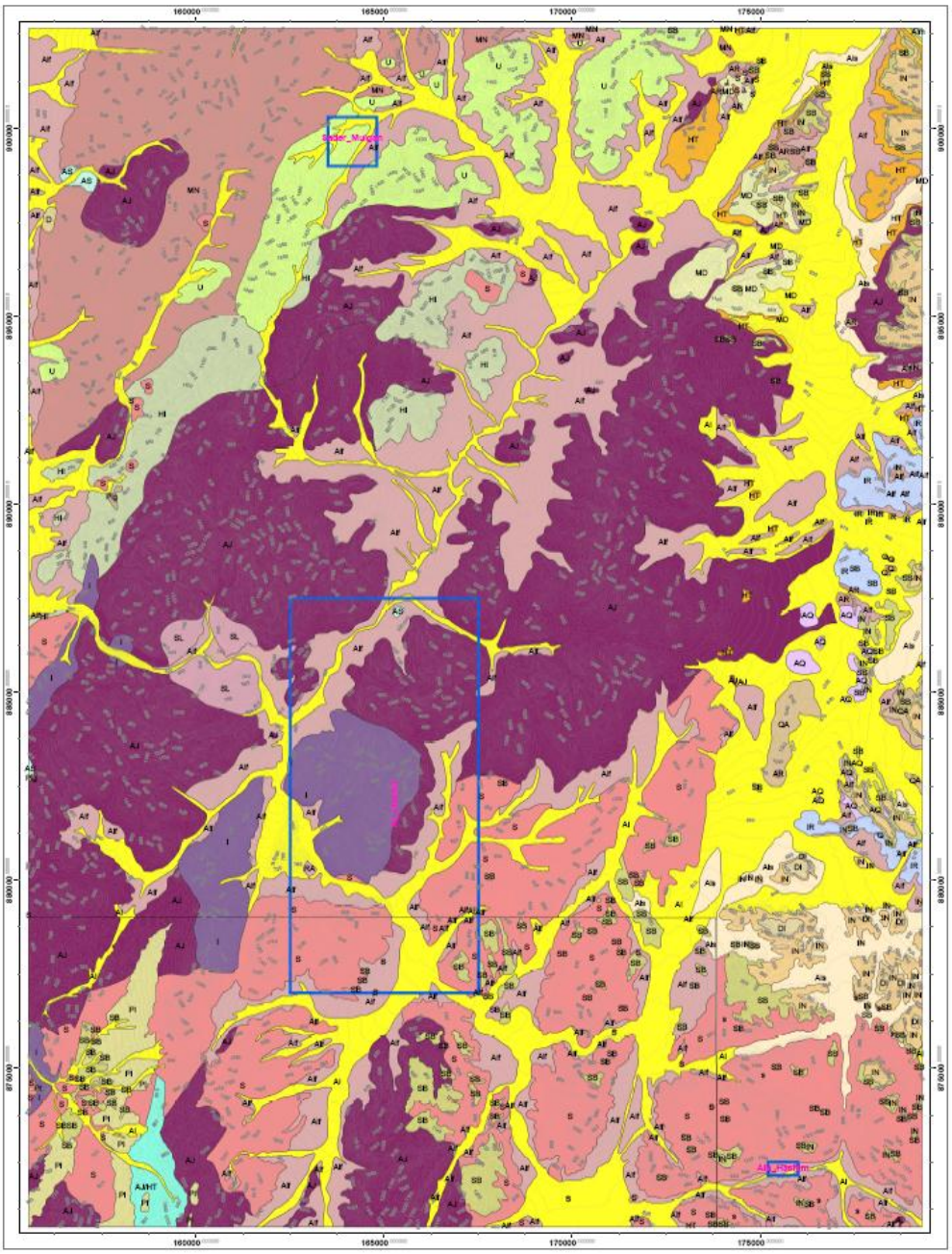

Figure (2): Compiled Geological Map Showing The Distribution Of Feldspar Ore Deposits

Legend

Geological Formation:

- Umm Ishrin sandstone
- Abu Jadida granite
- Azraq /Qara granite
- Ar Rashidiyya Aplite
- Abu Saq'a schist
- Alluvium And Wadi Sediments
- Alluvial fan
- Mudflat
- Aeolian Sand and Sand Dunes
- Duhella Hornblendic
- Disi Sandstone
- Lake Deposit
- Humrat granite
- Imran Monzogranite
- Irkheim/ saham /Ishaa monzogranite
- Janub metamorphic
- Marsad porphyry
- Ma'in Sandstone
- Fluviatill and Lacustrine Gravels
- Quraynifat volcanic
- Azraq /Qara granite
- Rahma Foliated
- At Tayan siltstone
- Salib Arkusic Sandstone
- Silal
- Urf.porphyritic
- Study Area
- Railroad
- Track Road
- Road < 5 m
- Road > 7 m
- Contour

Natural Resources Authority
Administration Of Geological Survey
Information Diroctority
GIS Division
GIS Processing By: Ayman EL-Banna
December 2006

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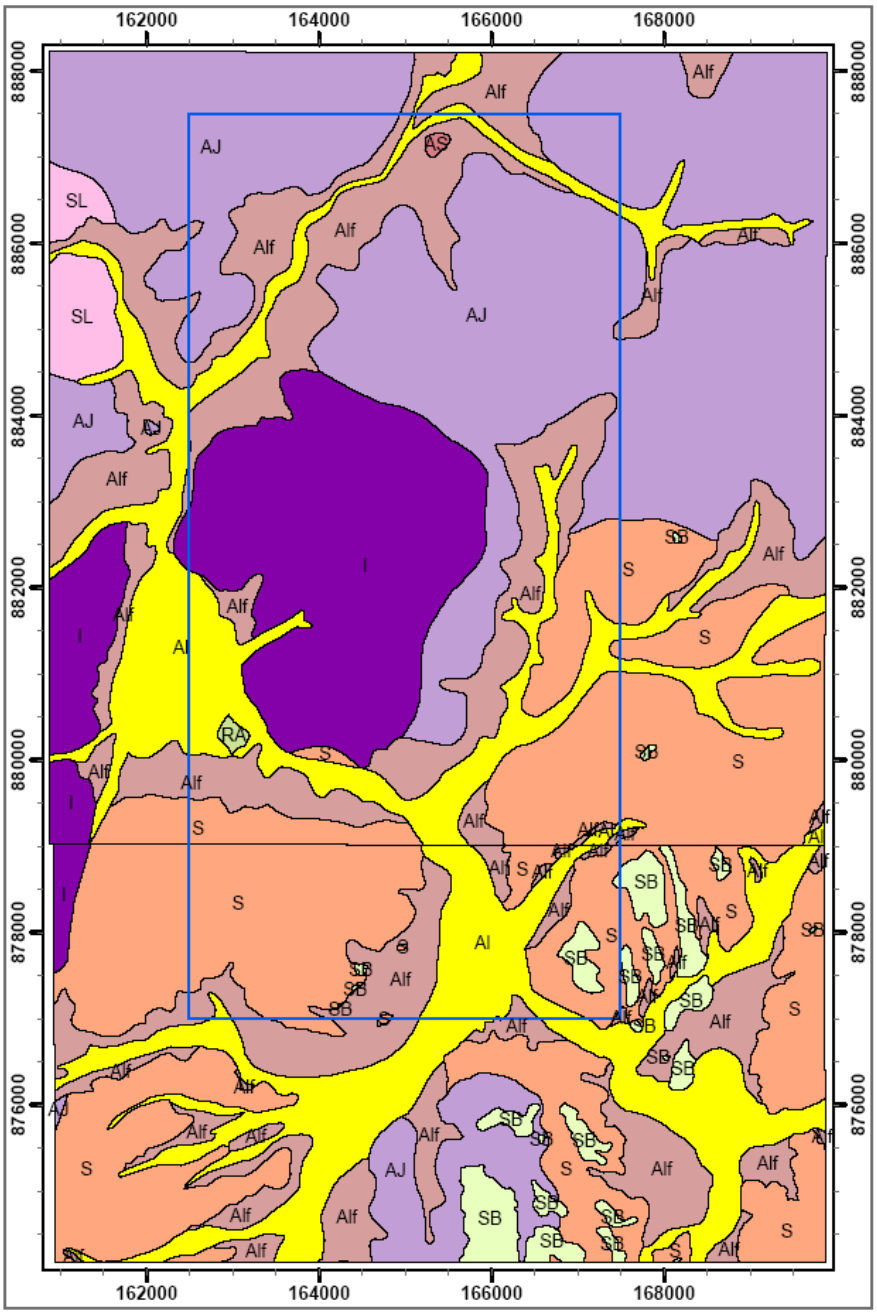

Figure (3): Geological map of Al_Jaishia Area

Legend

Geological Formation

AJ	Abu jadda granite
AS	Abu saq'a schist
Al	Alluvium And Wadi Sediments
Alf	Alluvial fan
I	Imran Monzogranite
RA	Rahma Foliated
S	At Tayan siltstone
SB	Salib Arkusic Sandstone
SL	Silal
	Al Jaishieh Study Area

Railroad
Road < 5 m
Road > 7 m
Contour

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Scale Map 1:75000

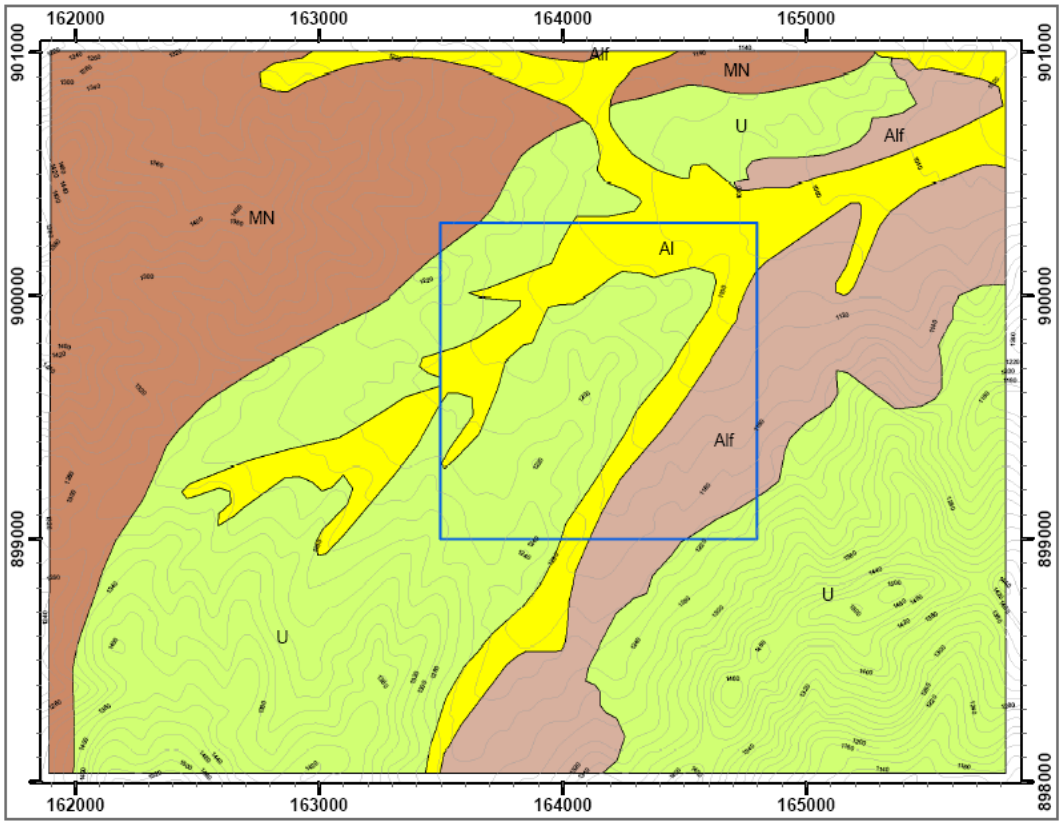

Figure (4): Geological map of Wadi Sader Mulghan Area

Legend

Geological Formation

- Al — Alluvium And Wadi Sediments
- Alf — Alluvial fan
- MN — Ma'in Sandstone
- U — Urf.porphyritic
- Wadi Sader Mulghan Study Area
- Track Road
- Contour

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Scale Map 1:25000

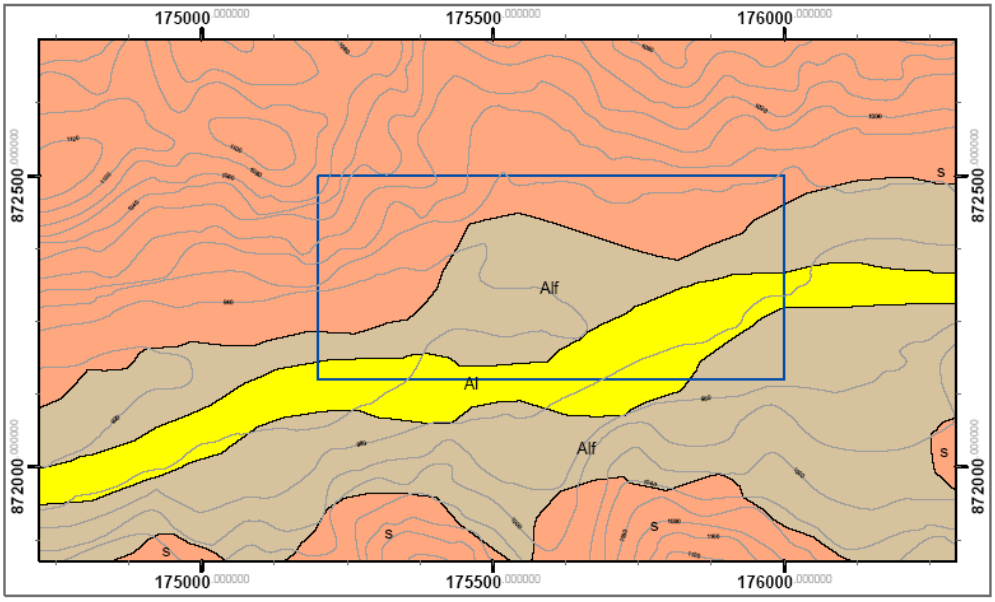

Figure (5):Geological map of Ayn Al Hashim Area

Legend

Geological Formation

Al	Alluvium And Wadi Sediments
Alf	Alluvial fan
IN	Umm ishrin sandstone
SB	Salib Arkusic Sandstone
S	At Tayan siltstone
	Ayn Al_Hashim Study Area

Contour

Track Road

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