MINISTRY OF ENERGY AND MINERAL RESOURCES

Mineral Resources in Jordan

Investment Opportunities

2020

Ministry of Energy and Mineral Resources

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Ministry of Energy and Mineral Resources

Introduction

Mining and exploitation of mineral resources is recognized to be the economic nerve of both developing and developed countries alike, by enhancing the potential for economic growth and for social progress that mining projects, especially in the remote areas of these countries, contributes to their development.

It is expected that the global mining sector will continue to grow throughout the coming decades in order to meet the increasing demand for products of the industrial sectors of all levels and types, products of the agricultural sectors, as well as the most advanced sectors that specialize in advanced technologies in this era.
Jordan is considered rich in valuable mineral resources, especially Phosphate, Potash and Bromine, in addition to a group of industrial rocks such as Silica Sand, Feldspar, Kaolin, and promising quantities of some Strategic Minerals such as Gold, Copper and Rare Earth Elements in the south of the Kingdom region, in addition to the huge quantities of Oil Shale resource over the Kingdom various areas.

Some of these mineral resources have been exploited and exported during the past years, while others have been used mainly in the fields of local manufacturing, but there are many mineral indications that has not yet been evaluated or explored, Jordan relies on the private sector for the detailed evaluation studies of the strategic minerals for the purpose of proving their economic feasibility and proceeding in executing investment projects according to the Jordanian laws and regulations in force.

Based on previous exploration studies of the mineral resources in Jordan, we review in this bulletin the most important mineral resources available and open for the commercial exploitation investment projects, which includes a description of these mineral resources, the geological environment of their deposits, locations, and a review of the most important chemical and physical specifications of these minerals related to their industrial uses and the estimated geological resources for each mineral in order to investigate its economic potential.

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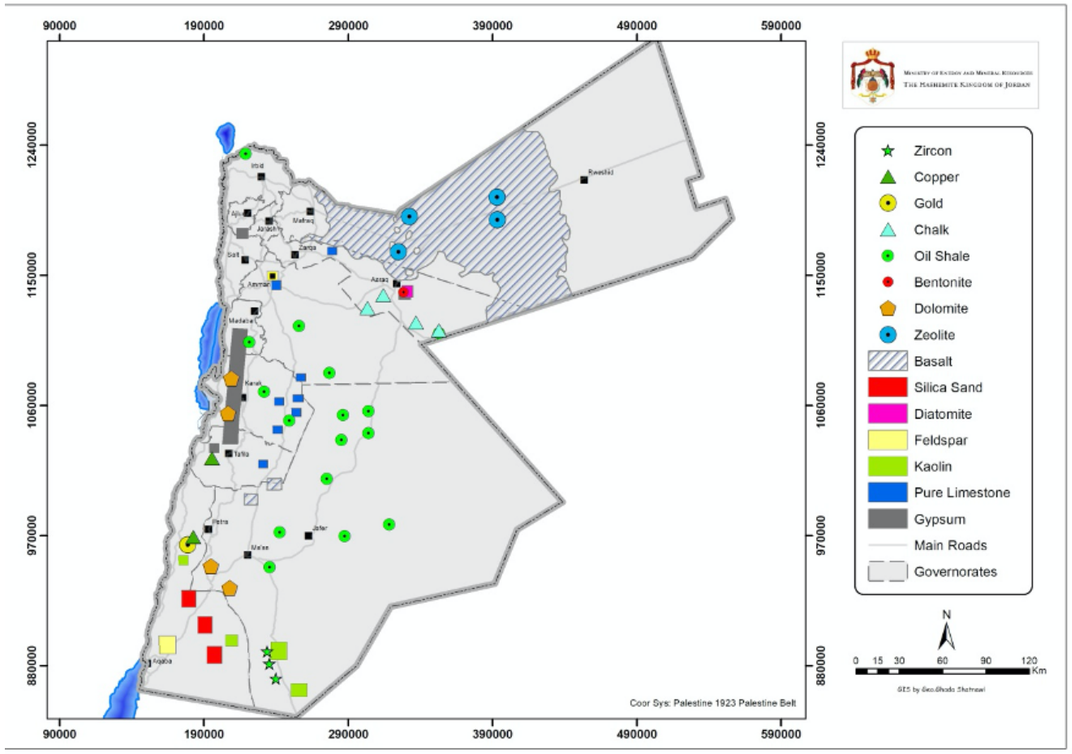
Fig. 1: Minerals and Industrial Rocks Deposits in Jordan



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Basalt

Basalt in Jordan is part of the North Arabian Basaltic Plateau and covers an area of about 11,000 km^2 in the northeast of Jordan and extends northwest into Syria and southeast into Saudi Arabia. Also, a group of small continental volcanic rocks are present in Central Jordan.

Basalt is a shallow base volcanic rock resulting from the solidification of lava flowing from the earth. It consists mainly of the minerals of Olivine, Plagioclase and Pyroxene.

Geological Setting

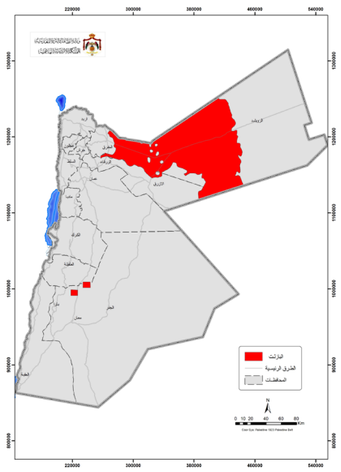
It is believed that the Basalt rocks in the northeastern region resulted from eruptions of volcanic flows or debris that emerged from long fractures in the form of Basaltic eruptions or through specific volcanic caves, where the Basalt eruptions came in three stages, and in central and southern Jordan, the Basalt eruptions were in two stages of widespread Volcanic activities during the Neogene period through the Quaternary era.

The oldest Basalt eruptions in northeastern Jordan are located to the north of the Hashemiya area in the Zarqa governorate, where it is partly covered by recent Pleistocene deposits. While the oldest Basalt eruptions in central Jordan is the Basalt of Mount Shihan, and it is 6-5 million years old.

Locations

Basalt rocks in Jordan can be roughly divided into three groups:

-Plateau Basalts Harrat Al Sham in north eastern Jordan (Azraq, Safawi and East Mafraq) and covers 11000km^2.
-Basalts relating to the Dead Sea rift, Jabal Shihan, Ma'en, Mukawer and Zara. Isolated Basalt effusions in central Jordan, mostly bound to deep faults.
-Basalt are also known in other places in the form of dykes or sills and other minor bodies, Basalt occurs in different localities in Jordan, however, the most important locations are Tall Burma and Jabel Uneiza, about 170km south of Amman.



Resource

There are huge resources of Basalt in Jordan; the estimated resource is calculated from data obtained from boreholes in Tell Burma to be approximately about 310 Million tons.

Mineral and Chemical Properties

X-ray analysis indicates a major content of Augite and Feldspar. Heamatite, Calcite and Zeolite occur as a minor quantity. The petrographical analysis indicates the presence of following:

Olivine
occurs as a major mineral

Feldspar
Occurs as plagioclase

Pyroxene
Occurs as Clinopyroxene

Calcite and Zeolite:
As secondary minerals

Chemical analysis for the Basalt in Tall Burma area indicates the following:

Oxides	Concentration %
Fe_2O_3%	13.2 - 14.3
MnO%	0.19 - 0.22
TiO_2%	2.8 - 3.3
CaO%	9.9 - 11.8
K_2O%	0.53 - 1.3
SiO_2%	40 - 43
Na_2O%	0.62 - 2.5
Al_2O_3%	11.8 - 12.7
P_2O_5%	0.57 - 0.65
MgO%	9.8 - 9.15

Uses

Basalt can be used as an input raw material for the manufacturing of Rock Wool for insulation. Basalt can be used as Aggregates and Building Stones for construction works due to its' good physical engineering specifications and in molds casting.

Investment Opportunities

Basalt in Tall Burma area has been studied for its' suitability for establishing specialized industries, such as manufacturing Basalt molds, in plumbing systems, pipes, rods and others, the study showed positive results. Basalt was used in Rock Wool industry and in construction works in Jordan.

The investment opportunities are open for Basalt exploitation, whether for the domestic consumption or for the external export, or in the manufacture of casting molds, pipes and rods for construction works and other uses.

In investing in Basalt, the Government adopts an approach of granting the interested investor an exploration license and a mining right, in accordance with Jordanian laws and legislations. To learn more information about licensing mechanisms for the various mining activities, please visit the following link:

http://www.emrc.gov.jo/Pages/viewpage?pageID=175&CategoryID=5

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Pure Limestone

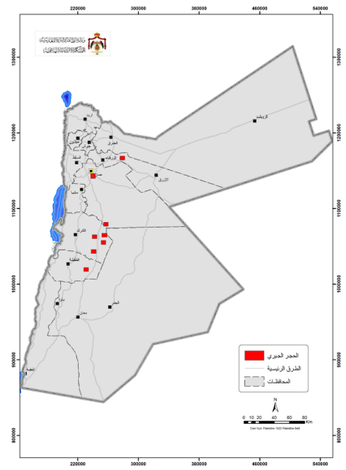
Pure Limestone is one of the most important non-metallic raw materials used for industrial and agricultural purposes.

Geological Setting

Pure Limestone exposures can be found within of the Upper Cretaceous Bahiya Coquina Member of Al Hisa Phosphorite Formation (Campanian-early Maastrichtian). Bahiya Member is up to 40m thick.

Location

Pure Limestone is found in commercial quantities in the regions of: Al-Qatrana, Al-Sultani, Al-Hasa, Al-Hallabat, Jurf Al-Darwish, Al-Abyad, Swaqa and Al-Damkhi.



Resource

The following table shows the distribution of geological resource and Calcium Oxide percentage.

Area	Location	Resource (million ton)	CaO %
Qatrana	85 km south of Amman	31.5	> 54.3
Sultani	100 km south of Amman	460	> 52.2
Al Hasa	140 km south of Amman	69	> 54.19
El-Hallabat	75 km northeast Amman	286	> 52.56
Jurf Al Darawish	150 km south of Amman	90	> 53.0
Al Abyad	120 km south of Amman	11	> 53.5
Swaqa-Al Damkhi	70 km south of Amman	388	> 53.3

Investment Opportunities

Currently, Pure Limestone is being mined, produced and exploited from Halabat Area by the local companies for White Cement and Calcium Carbonate industries.

Investment is open for Pure Limestone in different localities in Jordan to produce Calcium Carbonate and in White Cement industry or other uses. In investing in Pure Limestone, the Government adopts an approach for granting an interested investor an exploration license and a mining right in accordance with Jordanian laws and legislations. To learn more information about licensing mechanisms for the various mining activities, please visit the following link:

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Mineral and Chemical Properties

Pure Limestone has the following chemical composition:

1. $CaCO_3$ > 93%
2. SiO_2 < 3%
3. MgO < 1.2% (and higher for certain products)
4. Fe_2O_3 < 1.5 (and lower for certain products)
5. Alkaline salts are low

The following table shows the chemical properties of the Pure Limestone according to the location, where high-quality pure Limestone is concentrated in the Qatrana, Hasa and Sultani regions in southern Jordan, which are suitable for pharmaceutical, Carbonates and fillers industries, while other types of Pure Limestone in the rest of the sites are suitable for Cement Industries, mining industries and Lime production.

Area	CaO%	Fe_2O_3%	MgO%	Al_2O_3 %	SiO_2 %	Whiteness%
Qatrana	50.9-54.3	0.09-1.14	0.15-2.08	0.02-0.6	1.5-3.8	75.9-95.7
El-Hallabat	53.0-53.6	0.2-0.5	0.3-0.8	0.01-0.5	1.7-1.9	----
Al-Hasa	48.2-54.9	0.02-0.5	0.2-2.7	0.1-1	0.02-9.9	75.6-97.4
Siwaqa-Damekhi	47.6-53.9	0.1-0.5	0.1-0.5	0.1-1	1.5-3.2	82.1-90.3
Sultani	52.6-54.1	0.2-0.3	----	----	0.3-4.0	93.7-95.5
Al Abiad	51.2-53.8	0.1-0.4	0.1-0.2	0.1-1.1	1.3-4.3	64.0-87.8
Jurf Ed Darawish	42.3-53.7	0.1-0.3	0.2-3.5	0.1-0.6	1.7-5.9	70.7-85.9

Uses

Pure Limestone can be used:

-In the metallurgical industry as a fluxing agent for the smelting and refining of Iron, Aluminum and Copper.
-In the chemical industry in the production of Lime, Calcium Carbonate, Alkali compounds, Calcium Carbide, Magnesium Oxides and Soda Ash.
-In the industries of white cement, iron and steel, glass, paper, sugar-refining, water purification, sewage and waste treatment, and gas de-Sulphurization.
-Agricultural uses in soil conditioning, fertilizers and animal feeds.
-As filler material in paints, rubber, paper, ceramics, floor tiles, tooth pastes and medicine.

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Zircon

Zircon mineral consists of Zirconium Silicate ($ZrSiO_4$) and Hafnium in addition to some Rare Earth Elements which usually are Heavy Minerals associated with Zircon such as Titanium minerals (Rutile, Ilmenite) Monazite and others.

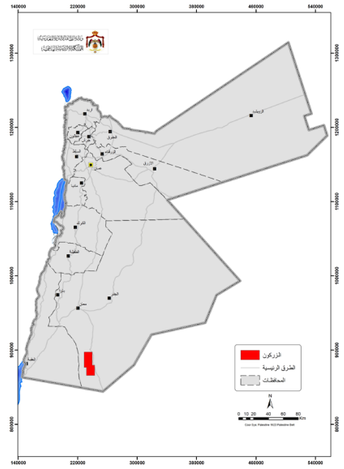
Zircon has a high temperature resistance (melting point of 2500°C), acid corrosion resistance, high heat conductivity and low thermal expansion.

Geological Setting

Zircon occurs in the middle member of Dubaydib Sandstone Formation (DB2) of Middle Ordovician age. This member consists of very fine-grained sandstone, brown to dark brown in color. The thickness of the bed bearing Zircon ranges from1.5-4.2m.

Location

The area is located about 350 km south of Amman and 100 km northeast of Aqaba.



Resource

Prospecting studies carried out in (Wadi Al-Mezrab) area had demonstrated a high potential mineralization of Zircon; the estimated resource is about 96000 metric tons.

Mineral and Chemical Properties

Quartz mineral is the main constituent of the Zircon bearing bed, with the presence of small amounts of Feldspar, and Heavy Minerals (Zircon, Rutile, Brookite, Epidote and Monazite) are present.

The chemical properties can be summarized as follows:

Mineral	Composition	Grade
Zircon	$ZrSiO_4$	0.67-3.75 %
Cerium	Ce	499-2168 ppm
Lanthanum	La	224-1065 pmm
Titanium	TiO_2	1.61-4.91 %

Uses

Zircon is mainly used in casting molds to increase the metal's resistance to penetration, and ground Zircon is also used in thermal coatings and it is also used in polishing medical lenses and in control sensors and other uses.

Investment Opportunities

As Zircon mineral (Zirconium Silicate ($ZrSiO_4$)) exists with Hafnium and associated with some Rare Earth Elements and Heavy Minerals as Titanium minerals (Rutile, Ilmenite), Monazite and others, the exploitation of Zircon is open for investment and will be dealt with in parallel with the Rare Earth Elements and Heavy Minerals exploitation projects, by which a memorandum of understanding will be signed with the interested investor for executing exploration activities and for concluding a preliminary feasibility study, upon which a special agreement will be signed according to the Jordanian laws and legislations to develop the project on a commercial scale.

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Silica Sand

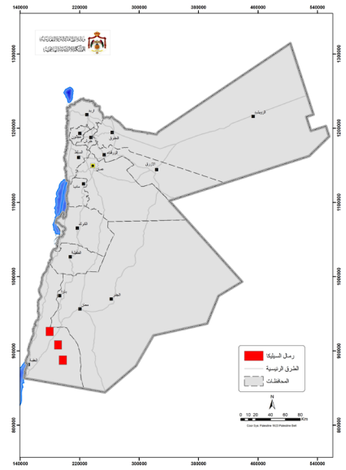
Silica Sand is defined as a high purity industrial mineral in which the Sand grains are made entirely of Quartz. Impurities are very minor. The term Silica Sand is applied to Quartz Sand that conforms to the specifications of which the main composition is SiO_2 > 99% with very little impurities of less than 0.1%.

Geological Setting

White Silica Sand deposits are exposed on the surface and belong to Disi formation of the early Ordovician Kurnub formation of the Lower Cretaceous in south of Jordan.

Locations

Area	Location
Ras En Naqb	70 km north of Aqaba
Qa' Ad Disa	50 km NE of Aqaba
Ein El Bayda /Petra	North of Petra city
Wadi Es Siq-Wadi Rakiya area	65 km north of Aqaba
Al Jayshia	6 km east of Aqaba



Resource

Area	Geological Resources (million ton)
Ras En Naqb	>10000
Qa`a Disi	>10000
Wadi Es Siq-Wadi Rakiya	120
Al Jayshia	Not determined

Uses

The most important industrial uses of Silica Sand can be summarized as follows:

1. Building materials and ceramics.
2. Electronic industries.
3. Super-Fast Connectors.
4. Silicon-based chemicals
5. Glass industry
6. Filler material

Chemical Properties

Major Oxides	Resource%		Wet sieved (%)		Scrubbed for (%)		Glass Sand Grade-A* (BS: 1988 ,2975)
					8 minutes	6 minutes	
	Ras En Naqb	W. Es Siq	Ras En Naqb	W. Es Siq	Ras En Naqb	W. Es Siq	
SiO_2	98.7	95.23	99.41	99.36	99.62	99.65	99.70
Al_2O_3	0.52	2.57	0.16	0.22	0.04	0.04	0.20
Fe_2O_3	0.04	0.04	0.03	0.03	0.01	0.01	0.01-0.013
TiO_2	0.09	0.09	0.04	0.04	0.02	0.02	0.02 (*)
CaO + MgO	0.08	0.22	0.02	0.12	0.01	0.01	0.02 (*)
$Na_2O+ K_2O$	0.11	0.17	0.09	0.09	0.02	0.02	0.02 (*)

* Sibelco Company Grade (A) stands for optical and ophthalmic glass.

Area	SiO_2 %		Al_2O_3 %		Fe_2O_3 %		TiO_2 %	
	Raw	Refined	Raw	Refined	Raw	Refined	Raw	Refined
Qa' Disi	96.59	98.36	1.43	0.24	0.025	0.019	0.13	0.04
Jayshia	95.21	98.93	2.97	0.32	0.028	0.013	0.14	0.04

Mineralogical investigation of raw Sand and Glass size fraction indicated that they are consist mainly of Quartz as a major mineral with minor amounts of Kaolin, whereas mineralogical investigation of fine fraction (<63 micron) reveals that the fine fractions of the Glass Sand consist mainly of Kaolin and Quartz as the major minerals with traces of Heavy Minerals such as Rutile, Illmenite,... etc.

Investment Opportunities

The easy accessibility, low content of impurities and low content of Heavy Minerals are advantages for exploitation of Silica Sand in Jordan.

There are many quarries operating in the Ras al-Naqab area for Silica Sand uses in building materials, Ceramics and treated Silica for exporting purposes.

Investing in Silica Sands in Jordan is an attractive investment opportunity due to its quality, purity, abundant quantities, and the feasibility of its exploitation.

In investing in Silica Sand, the Government adopts an approach that grants the interested investor an exploration license and a mining right, in accordance with Jordanian laws and legislations.

To learn more information about licensing mechanisms for the various mining activities, please visit the following link:

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Copper

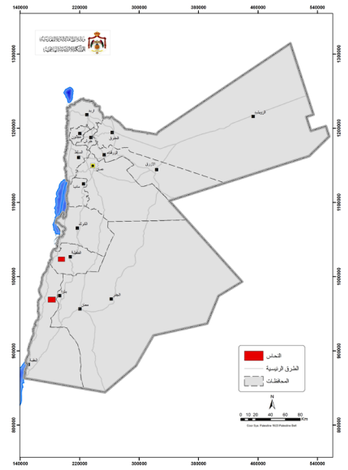
The first discovery of Copper mineralization in Jordan was in the fifties of the 20th century in Wadi Dana/ Wadi Araba area. In ancient times, there were many mining activities for extracting Copper as indicated by the slags and the old mines in Khirbet El-Nahas, Wadi Jaryia and other localities.

Geological Setting

Copper mineralization occurs within the Palaeozoic Cambrian sediments in two formations; Abu-Khushayba Sandstone and Burj Dolomite Shale formations. The mineralized areas are characterized by rugged, high and steep topography, and traversed by deeply incised valleys with their drainage lines mainly following the faults patterns westward, towards the Rift Valley.

Location

Copper mineralization is located, in areas that extend approximately 70 km in length and 15 km wide, along the eastern side of Wadi Araba from the southern end of the Dead Sea to Wadi Abu-Khushayba area.



1. Khirbet El-Nuhas-Jaryia Area

The area is located in the northern part of Finan area and the Copper mineralization in both formations covers an area of about 61 km^2. The mineralized layer is 2 m thick. Within the area, Jabal Marzuka-Jaryia area, which covers an area of 8-10km^2, is a promising area for exploration and evaluation of Copper and the associated minerals.

2. Finan Area (Wadi Khalid, Dana and Ratyia)

The area is located in the central part of Wadi Araba. The Copper mineralization in Finan area is present in the two formations and with an average thickness of 2m.

3. Abu Khushayba Area

The area is located in the southern part of Wadi Araba. The Copper mineralization exists in the Abu-Khushayba Sandstone formation. The thickness of the mineralization zone is 1–3m.

Resource

Area	Resource (million ton)
Khirbet El-Nuhas – Wadi Jaryia	Not determined
(Finan (Wadi Khalid, Dana, Ratya	19.8
Abu-Khushayba	8

Mineral and Chemical Properties

Copper minerals are Malchite, Chrysocolla, Atacamite, Cuprite, Blancheite and others, which are mostly exist as Oxides and Silicates.

The concentrations of Copper in the areas of its existence are as follows:

Area	Copper %
Khirbet El-Nuhas – Wadi Jaryia	2-2.3
(Finan (Wadi Khalid, Dana, Ratya	1.37
Abu-Khushayba	0.65

Uses

Copper is mainly used in the following:

1. The manufacturing of electrical wires due to its high electrical conductivity, moreover, it is also used in the manufacturing of many electrical and electronic devices and tools, such as: transformers, power generators, television, mobile phones, and other devices, Copper is used in the electricity sector in wired communications, where special fine wires are made for internet lines relevant to local networks, in addition to making use of Copper in the field of renewable energy, specifically in the manufacture of wind turbines, photovoltaics, and other devices associated with renewable energy technology.

2. In the field of construction, through its use in building domes and building decoration; It has been used in the manufacture of door handles, locks, lighting tools, and faucets, and it is also used in hospital interior design due to its property to inhibit the growth of bacteria and germs, which reduces the possibility of disease spread.

3. In vehicles manufacturing because of its efficiency in thermal and electrical conductivity, as it is used in the manufacture of the basic components of all means of transportation, including cars, airplanes, ships, boats, and trains…etc.

Investment Opportunities

Abu-Khushayba is an open area for Copper investment for interested local and international mining companies, the Government's policy in Copper exploitation starts by signing with the interested investor a memorandum of understanding for executing exploration activities and for concluding a preliminary feasibility study, upon which a special agreement will be signed according to the Jordanian laws and legislations to develop the project on a commercial scale.

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Feldspar

Feldspar is the most important single group of rock forming Silicate minerals. There are four chemically district groups of feldspar; Potassium Feldspar ($KAlSi_3O_3$), Sodium Feldspar ($NaAlSi_3O_8$), Calcium Feldspar ($CaAlSi_3O_8$) and Barium Feldspar ($BaAl_2Si_3O_8$).

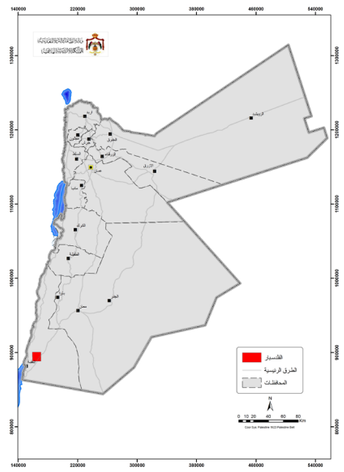
Geological Setting

Igneous rocks, which form part of the Feldspar ore body, are part of the Yutum Granite Suite from the Aqaba complex. The age of these rocks range from approximately 610–630 million years. The source of the Feldspar is the Granitoides of Abu Jadda granite and/or Imran Monozogranite units.

Location

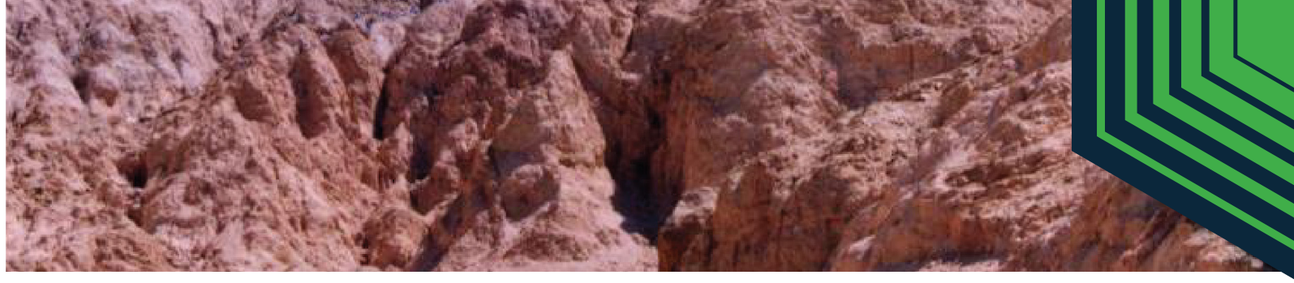
Feldspar is found in the following locations:

Area	Location
Wadi Al Jayshia – Al Yutum	6 km south of Aqaba
Wadi Al-Mahlabah	5 km north east of Aqaba
Jabal Al-Gufran	18 km NE Aqaba along Aqaba-Maan Highway
Wadi Sader Mulgan	25km north of Aqaba and 8km to the west



Resource

Area	Resource (million ton)
Wadi Al Jayshia – Al Yutum	115
Wadi Al-Mahlabah	0.4
Jabal Al-Gufran	0.6
Wadi Sader Mulgan	22



Chemical Properties

Chemical analysis for Feldspar in south of Jordan are as follows:

Area	SiO_2 %	CaO%	MgO%	Fe_2O_3 %	Al_2O_3 %	TiO_2 %	Na_2O%	K_2O%	MnO%
Wadi Al Jayshia	71.46	1.05	0.35	1.02	13.98	0.88	5.53	4.29	0.02
Ain Al-Hasheem	70.37	1.29	0.52	2.21	14.95	0.37	2.02	6.27	0.37
Wadi Sader Mulgan	72.99	0.61	0.07	0.65	14.29	0.16	4.13	5.64	0.02

Uses

About 90% of produced Feldspar is used for glass and ceramic industries. Soda Feldspar is preferred in glass manufacture, but Potash Feldspar is more popular for ceramics.

Investment Opportunities

One of the known Feldspar deposits, Al Jayshia Feldspar Ore Deposit, Al-Jayshia site has undergone successful extraction operations by a local Mining Company due to the presence of crushed rock and the ease of the mining in the area.

There are also open investment opportunities to extract and exploit Feldspar in other regions, as the Government adopts an approach for investing in Feldspar by granting the interested investor an exploration license and a mining right in accordance with Jordanian laws and legislations.

To learn more information about licensing mechanisms for the various mining activities, please visit the following link:

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Kaolin

Kaolin is a commercial name for a big group of lamellar minerals originally made of Aluminum Silicates, It is white, soft clay mainly composed of the fine-grained platy mineral Kaolinite; a white Hydrous Aluminum Silicate, $Al_2Si_2O_5(OH)_4$, containing 39.5% Aluminum Oxide, 46.54% Silica Oxide, and 13.96% water.

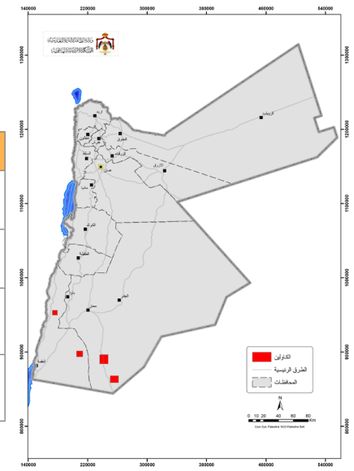
Geological Setting

Kaolin deposits are exposed in four main locations in south Jordan; Batn El-Ghul, Al Mudawwara, Al-Hiswa and Umm Sahm areas. Both Batn El-Ghul and Hiswa have been exploited in few quantities. Kaolin is still not exploited in Mudawwara and Umm Sahm areas. The four deposits are of Ordovician age. Locally, both Batn El-Ghul and Al-Mudawwara deposits belong to Batra Mudstone Member of Mudawwara Formation and Al-Hiswa deposit belongs to Al-Hiswa Sandstone Formation.

Location

Kaolin is found in the following locations:

Area	Location
Batn El-Ghul	70 km SE of Ma'an
Al Mudawwara	120 km SE of Ma'an
Al Hiswa	45 km east of Al-Quwayra town
Um Sahm	40 km southeast of Ad Disa town



Resource

Area	Resource (million ton)
Batn El-Ghul	1100
Al Mudawwara	9700
Al Hiswa	54
Um Sahm	1090

Chemical Properties

Area	$Al_2O\%_3$		$SiO\%_2$		$Fe_2O\%_3$	
	max.	min.	max.	min.	max.	min.
Batn El Ghul	25.37	14.01	68.32	47.79	8.37	4.05
Al-Mudawwara	27.54	13.36	70.20	41.87	10.54	4.54
Al-Hiswa	29.27	12.94	78.88	49.04	9.09	1.15
Dubaydib/Um Sahm	24.70	17.0	61.97	49.04	11.04	3.5

Uses

It is used in the manufacturing of white-ware ceramics and in coating of paper. It is also used as filler in paints, rubber, plastics and many other productions.

Investment Opportunites

The Ceramic industry in Jordan is the least expanding among the Middle East countries. Nevertheless, Kaolin producers have strengthened their position due to the continuous expansion in the local market and their adoption of product improvement programs.

The Cement industry is also one of the most important industries in the Jordanian mining sector, which depends on local mineral resources as raw materials. There is also a rapid growth in the local Cement market due to the increase in construction industries in Jordan and neighboring countries.

Investment in Kaolin is open in areas that contain large quantities such as Batn Al Ghoul, Al Muwdawwara, Dubaydib and Um Sahm.

In investing in Kaolin, the Government adopts an approach for granting the interested investor an exploration license and a mining right in accordance with Jordanian laws and legislations. To learn more information about licensing mechanisms for the various mining activities, please visit the following link:

http://www.emrc.gov.jo/Pages/viewpage?pageID=175&CategoryID=5

Ministry of Energy and Mineral Resources

Gold

Gold is considered a precious metallic mineral which is present in nature in the form of a free metal crystallized in eight facets, or in the form of granular or lamellar.

Geochemical studies previously conducted by the Natural Resources Authority (NRA) have detected anomalous Gold concentrations over the northern extremity of the Arabian-Nubian Shield in South Jordan. The best anomaly, sited over felsic volcanic rocks in Wadi Abu Khushayba area, returned Gold concentrations up to 40g/t in Heavy Minerals concentrations collected from stream sediments. Visible Gold was observed in Heavy Minerals concentration.

Geological Setting

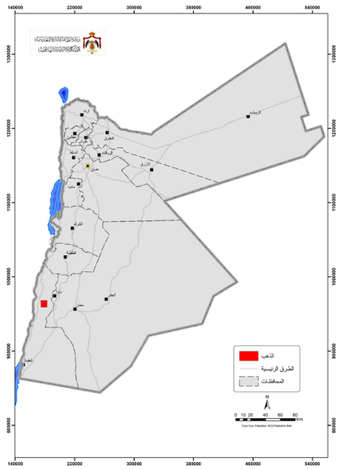
The Araba Complex is dominated by the Ahaymir Volcanics Suite, which has been identified as the main exploration target in the Pan African Jordanian basement for precious metals. The suite trends north-northeast and crops out in a belt of 2 to 4km wide over some 70km long. The Ahaymir Suite is dominated by alkaline, effusive and extrusive Quartz and Feldspar-quartz Porphyries with subordinate Andesite. Volcanic activity is considered to have ceased by 540 million years.

Location

- Wadi Abu Khushayba Area

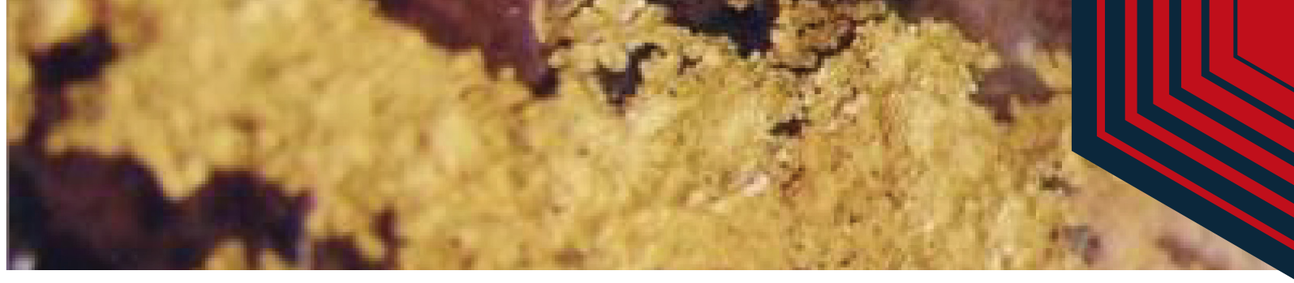
Wadi Abu Khushayba area is located 90 km north-northeast of Aqaba in South Jordan, located some 4 km east of the Dead Sea-Aqaba highway in Wadi Abu Kushayba in Wadi Araba area.

Abu Khushayba Gold occurrence is sited within Quartz Porphyry and Quartz Feldspar Porphyry volcanic rocks of the Ahaymir Volcanic Suites of Wadi Araba Complex. Visible Gold was detected in a number of Heavy Mineral concentrates up to 40g/t. concentrations up to 15g/t of Gold were obtained from the vein and the highly silicified weathered rock in alteration zones.



- Wadi El Huwar and Wadi Sabra Areas

The two areas are located south and southeast of Abu Khushayba occurrence. Semi-detailed geochemical exploration was carried out in Wadi El Huwar and Wadi Sabra. The two areas were characterized by relatively high Gold anomalies.



Resource

Further works is still required to be conducted in Wadi Abu Khushayba prospect area so as to ascertain the true surface extent of the Gold anomalies and the distribution of Gold presence in width and depth.

Uses

Gold is known for its high economic value and its importance in many of the electronic industries, the development of high efficient conductors and the Jewelry industry.

Investment Opportunities

The Government's policy in Gold exploitation starts by signing with the interested and qualified investor a memorandum of understanding for executing exploration activities and for concluding a preliminary feasibility study, upon which a special agreement will be signed according to the Jordanian laws and legislations to develop the project on a commercial scale.

And since there are companies currently interested in Gold exploration in one of the sites, there is an open investment opportunity for the remaining areas to explore gold within.

Chalk

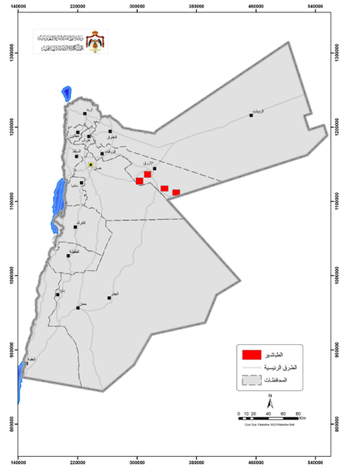
Chalk is a fine-grained white Limestone or Micrite. On average, it consists of 97.5-98.5% Calcium Carbonate. Clay and Quartz are the most common impurities. Most Chalk is soft friable rock that does not require explosives in mining.

Geological Setting

Chalk occurs in rocks at different stratigraphic levels and can be found throughout Jordan within the Muwaqqer Chalk Marl Formation (Maastrichtian-Palaeocene) and Wadi Shallala Chalk Formation (Eocene). Wadi Shallala Formation is considered the most important source of chalk due to the high thickness of chalk and broad distribution.

Location

Area	Location
Al-Umary-Dahikiya	45 km southeast of Al Azraq
Wadi Al-Ghadaf	35 km south of A Azraq
Qasr Al-Harrana	50 km east of Amman
Wadi Al-Dabi	60 km east of Amman



Resource

Area	Resource (million ton)
Al-Umary-Dahikiya	1325
Wadi Al-Ghadaf	161
Qasr Al-Harrana	976
Wadi Al-Dabi	3364

Uses

Chalk is a form of Carbonate rocks containing high Calcium Carbonate that can be used in many industrial applications such as paint, cement, agriculture…etc.

Mineral and Chemical Properties

Calcite is the main mineral in Chalk. Other rare minerals are Kaolinite, Dolomite, Quartz, and Halite.

Area	CaO %	Brightness %
Al-Umary-Dahikiya	38.9 - 49.6	74.8 - 81.7
Wadi Al-Ghadaf	43.6 - 52.6	79.5 - 81.4
Qasr Al-Harrana	47.9 - 52.6	76.6 - 83.5
Wadi Al-Dabi	51.59 - 53.15	76.6 - 85

Investment Opportunites

Chalk deposits are soft to medium hard and exposed on the surface, almost without overburden, so it is easily removed by open – pit mining and without using explosives. The ease of access to the sites of Chalk reserves and its proximity to the main roads in the Kingdom in addition to its distance from populated areas and agricultural areas are among the advantages of the Jordanian Chalk that encourages its exploitation.

In investing in Chalk, the Government adopts an approach for granting the interested investor an exploration license and a mining right in accordance with Jordanian laws and legislations. To learn more information about licensing mechanisms for the various mining activities, please visit the following link:

http://www.emrc.gov.jo/Pages/viewpage?pageID=175&CategoryID=5

Ministry of Energy and Mineral Resources

Dolomite

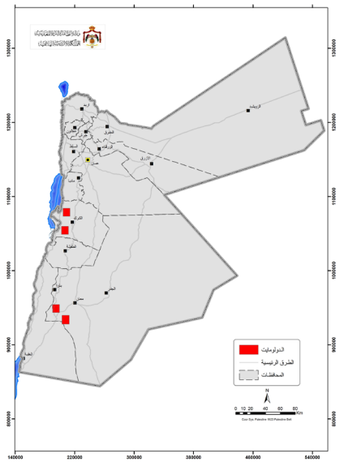
Dolomite $CaMg(CO_3)_2$ is a sedimentary rock occurs as a sedimentary deposit similar in nature to Limestone. Most Dolomite deposits are as a result of replacement of Mg instead of Ca during the recrystallization of Limestone, whereas some Dolomite precipitates directly from sea water. The Dolomite rocks contain more than 50% of both Calcite and Dolomite minerals in which Dolomite is more abundant than Calcite.
Impurities in Dolomite include clay minerals.

Geological Setting

Dolomite occurs in rocks of all ages, and is generally associated with Limestone. In general, Dolomite can be found throughout Jordan in the Cambrian Burj Dolomite Shale Formation and the Cretaceous Naur, Hummar and Wadi As-Sir formations. Dolomites that occur in Wadi I'sal and Al-Haditha areas belong to the Wadi As-Sir formation (Turonian).

Location

Area	Location
The area between Wadi I'sal and Ahemir I'sal	30 km west of Karak
Al-Haditha area	25 km west of Karak
Ras An Naqab area	70 km north of Aqaba



Resource

Area	Resource (million ton)
The area between Wadi I'sal and Ahemir I'sal	62
Al-Haditha area	20
Ras An Naqab area	80

Mineral and Chemical Properties

Al-Haditha area: The Dolomite of this area mainly consists of Dolomite and Calcite with minor amount of Gypsum, Quartz and Kaolinite.

	Wadi I'sal and Ahemir	Al-Haditha area	Ras An Naqab
MgO %	1.77 - 18.98	1.74 - 20.2	19.06
SiO_2 %	0.95 - 6.44	0.45 - 24.2	2.6
CaO %	31.13 - 46.7	21.55 - 50.9	35.06
Fe_2O_3 %	0.12 - 1.36	0.1 - 3.57	0.69

Uses

Dolomite is used in agriculture, cement mortar, and treatment of cracks. Uses of selectively Calcined Dolomite (Magnesium Oxychloride, cement, Magnesium Oxysulphate Cement, inorganic Magnesia foams, and Silicate bricks).

Chalk is one of the primary materials in the manufacturing of glass and in the manufacturing of heat-resistant ceramics

Investment Opportunities

Investment opportunities are open to exploit Dolomite in Wadi I'sal and Ahemir I'sal, Al-Haditha area and Ras An Naqab area.

In investing in Dolomite, the Government adopts an approach for granting the interested investor an exploration license and a mining right in accordance with Jordanian laws and legislations. To learn more information about licensing mechanisms for the various mining activities, please visit the following link:

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Ministry of Energy and Mineral Resources

Zeolite (Zeolitic Tuff)

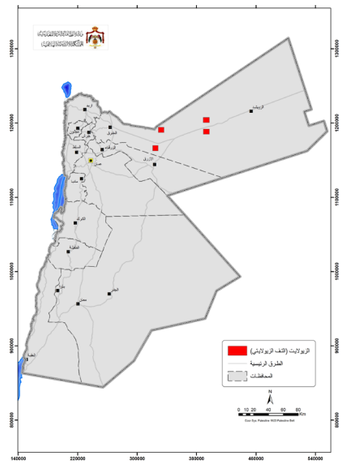
Zeolites are a chain of hydrated Alumino-Silicates of the Alkaline and earth metals principally. The minerals most found in sedimentary rocks of volcanic origin are characterized by high porosity, small size of particles, and their ability to hydrolyze; there are more than 30 types of Zeolites in nature.

Geological Setting

Zeolite minerals were generated from alteration of volcanic tuff in northeast and central of Jordan. It occurs as a cementing material to the volcanic tuff granules.

Location

Zeolitic tuffs are located in many locations: Jabal Aritayn (30 km northeast of Azraq), Tlul Al-Shahba (20 km east of Al Safawi), Tal Al-Rimah (35 km northeast of Al Mafraq) and other small deposits in central and south Jordan.



Resource

Area	Resource(million ton)
Tal Al-Rimah	46
Al-Aritayn	170
Tlul Al-Shahba	9.2
Northeast areas	472
Other areas	1340

Uses

Zeolite is used in Cement industry, Agriculture applications, waste water treatment and other Chemical industries.

Chemical Properties

Area	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	MgO %	CaO %	K_2O %	Na_2O %
Exploited							
Tal-Al Rimah	42.0	12.8	12.1	10.1	8.5	0.8	4.0
Al Aritayn	38.6	12.8	12.1	9.6	9.3	1.5	2.1
Mukawer	42.7	13.9	12.7	9.2	9.8	1.9	2.1
Not exploited							
Shihan	44.0	13.2	8.3	8.6	11.3	1.2	2.0
Tal Juhayra	35.0	10.2	11.3	7.6	20.2	0.7	2.4
Jabal Ata'atah	48.0	10.8	8.1	7.7	10.1	0.5	1.5
Tlul Al- Shahba	41.7	11.8	12.0	10.3	9.4	1.7	2.8
Jabal Unaizah	40.0	7.9	8.8	8.6	15.8	0.9	5.7

Investment Opportunities

Zeolitic tuff production in Jordan started in 1998.

Currently around 400000 ton/year of Zeolitic Tuff is consumed by Jordan Cement factories to produce Pozzolanic Cement.

Given the size of the agricultural sector in the region, it is estimated that the market potential in the agricultural application is large. In terms of Jordan's cultivated land, each 2% increase in land treated with Zeolitic Tuff would result in an increase in Zeolitic Tuff demand of 100,000 tons per annum and 50,000 tons per annum in animal feed and odor control. The total expected demand potential is 360,000 tons per annum depending on previous assumptions. Also it can be used in animal waste treatment and / or as air purification media inside animal houses.

In investing in Zeolite, the Government adopts an approach for granting the interested investor an exploration license and a mining right in accordance with Jordanian laws and legislations.

To learn more information about licensing mechanisms for the various mining activities, please visit the following link:

http://www.emrc.gov.jo/Pages/viewpage?pageID=175&CategoryID=5

Ministry of Energy and Mineral Resources

Rare Earth Elements

The Rare Earth Elements''REE'', consist of 15 elements from the Lanthanides group, in addition to the elements Yttrium and Scandium, Scandium and Yttrium are considered Rare Earth Elements because they tend to occur in the same ore deposits as the lanthanides and exhibit similar chemical properties, but have different electronic and magnetic properties.

Rare Earth Elements are divided into two groups known as Light Rare Earth Elements and Heavy Earth Elements classified according to their chemical composition, the chemical and physical properties of the Rare Earth Elements characterize them to be of significant economic value.

Rare Earth Elements are usually found accompanied by some radioactive elements such as Uranium and Thorium. Titanium (Rutile, Ilmenite), Monazite and Zircon are found with the Rare Earth Elements as well.

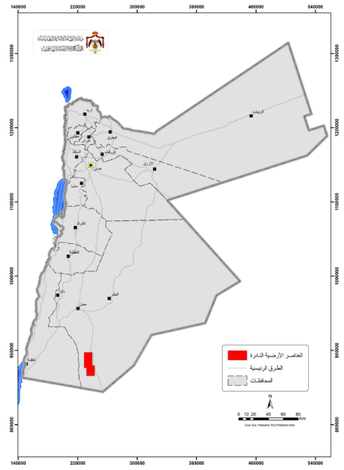
Geological Settings

The Rare Earth elements are located in the central part of the Dubaydib Sand Formation (DB2) of the Ordovician period.

DB2 is made of fine-grained Sandstone, brown to dark brown in color.

Location

The area is located 350 km south of Amman and 100 km from east to northeast of Aqaba.



Resource

Prospecting studies carried out in (Wadi El-Mzrab) area had showed high mineralization of Rare Earth Elements, Trace Elements and Radioactive Elements.

Uses

There are several uses of Rare Earth Elements due to their different optical, magnetic and chemical properties which make them of high economic value and of increasing importance for future technologies for a range of different applications in the fields of energy efficiency and renewable energy production industries, and which increases the global demand for the Rare Earth Elements every year.

Mineral and Chemical Properties

In addition to Feldspar and Clay minerals, Heavy Minerals are associated with Rare Earth Elements (Zircon, Rutile, Brookite, Epidot, and Monazite) and others.

Investment Opportunities

The opportunities of exploiting the Rare Earth Elements are open for investment for international mining companies who are interested in carrying out further exploration work to reach an accurate evaluation of the Rare Earth Elements for the purpose of concluding the feasibility studies to exploit these elements.

The Government's policy in REE exploitation starts by signing with the interested investor a memorandum of understanding for executing exploration activities and for concluding a preliminary feasibility study, upon which a special agreement will be signed according to the Jordanian laws and legislations to develop the project on a commercial scale.

Ministry of Energy and Mineral Resources

Oil Shale

Oil Shale is a sedimentary rock mostly carbonates to chalk marl and shale which contains immature organic matter that when it is heated to above 500°C, it produces oil and gas.

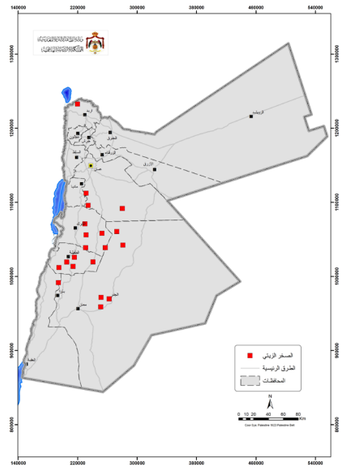
Geological Setting

Oil Shale deposits mainly occur within the lower part of Muwaqqar Chalk Marl Formation (Maastrichtian-Palaeocene). The formation consists of Limestone, Marls, Chalk and Phosphates.

Location

There are more than 18 known surface and near surface deposits. Eight of which (Lajjun, Sultani, Jurf Ed-Darawish, Attarat Umm Ghudran, Wadi Maghar, Siwaqa, Khan El-Zabib and Eth-Thamad areas) were investigated at different levels. The major deposits of commercial scale interest are located south of Amman in central Jordan and are easily accessible via Amman and Aqaba Desert Highway.

Oil Shale exists in other areas such as Wadi El Tharwa, Al-Naadyia, Isfir Mahata, Jibal Ghuzymah, Wadi Abu El-Hammam,...etc.



Resource

Area	Lajjun	Sultani	Jurf Ed-Darawish	Attarat Umm Ghudran	Wadi Maghar
Area (km^2)	25	19.23	114.5	340	625
Oil Shale Thickness (m)	1-87	2-65	157-18	21-104	13-108
Overburden Thickness (m)	7-78	34-90	33-58	36-150	33-70
Geological Resource (million ton)	1200	1180	8000	2400	13600

Chemical and Physical Properties

	Lajjun	Sultani	Jurf Ed-Darawish	Attarat Umm Ghudran	Wadi Maghar
Av. Oil Content (wt %)	10.5	9.4	7.8	8.79	7.8
Total Organic Matter (wt %)	22.1	21.5	18	--	--
Calorific Value (kcal/kg)	1590	1210	864	--	--
$CaCO_3$ (wt %)	54.3	46.96	69.11	--	--
SO_4 (wt %)	0.27-4.3	2.6-5.5	3.2-6.5	0.6-2.7	1.2-3.2
Bulk Density (g/cm^3)	1.81-2.1	1.8-1.9	1.87-1.99	1.5-1.89	1.34-1.9
Moisture (wt %)	2.43	2.6	2.8	--	--

Uses

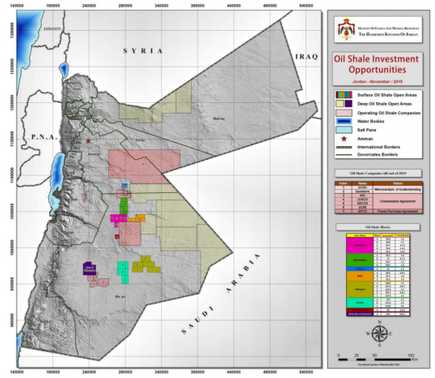
All the exploration studies that have been carried out so far, aimed at evaluating the exploitation of oil shale as a source of crude synthetic oil or electricity production using the successful technologies operating in the world, whether by retorting of oil shale through surface mining to produce oil or through the direct combustion of oil shale to produce electricity.

Investment Opportunities

The Ministry of Energy and Mineral Resources has accomplished a study with the objective to divide the potential areas for oil shale exploitation into 21 areas and produced a map for these specified areas, areas were classified according to their quantity of estimated resource, oil content, heat content, ...etc. Each area will contain sufficient resource and sufficient space for all the facilities needed in any commercial oil shale project.

The Ministry of Energy and Mineral Resources encourages investment in retorting projects by surface mining or by (InSitu) process for deep oil shale to produce crude synthetic oil, by using proven and efficient operating technologies.

The Government and the interested and qualified investors will sign memoranda of understanding according to the Jordanian standards and legislations adopted by the Ministry of Energy and Mineral Resources, in order to enable the companies to investigate the feasibility of implementing their proposed projects to exploit oil shale contained in their areas of interest, and if the feasibility is proved for any proposed project, the two parties will proceed to sign a special agreement to develop the project in a commercial scale.



MINISTRY OF ENERGY AND MINERAL RESOURCES

www.memr.gov.jo

Tel: +962 6 5803060 Fax: +962 6 5865714

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