التعدين في المملكة العربية السعودية

Mineral Resources and Mining

http://www.saudinf.com/main/e7.htm

Geological surveys and mineral exploration have revealed that, in addition to vast oil reserves, the Kingdom of Saudi Arabia possesses large deposits of various minerals, including bauxite, copper, gold, iron, lead, silver, tin and a number of non-metallic minerals.

On 23rd March 1997, in order to coordinate projects and promote efficiency in the mining industry, the Saudi Arabian Mining Company (Maadin) was created, with an initial capital of more than $1 billion. Maadin is responsible for regulating mineral exploration and overseeing its progress. Mining projects which are owned by the Government or in which the Government is participating are to be consolidated and rebuilt commercially. Maadin will also provide sufficient basic infrastructure for mining projects located in remote areas. MAADIN owns Mahd adh-Dhahab and as-Sukhaibirat mines and has obtained exploration licences for the gold deposits in Wadi Bidah, Al-Hajar, Ad-Duwaihi, Samran, Sheban, Zalm and Hamdah, for phosphate ore in Wadi Al Sarhan and Turaif, for magnesium in Zargat, Jabal Abt and Jabal Al Rukham, for zinc in Al Khnaiguiyah, as well as licenses for exploration of industrial metals in Jabal Sodah. The company's articles of association stipulate that it will be reorganized as a joint stock company within five years of establishment

For the address of the Directorate General for Mineral Resources, click here.

- Saudi Arabian Mining Company Web Site

Mineral Resources

In addition to its vast oil and gas reserves, the Kingdom is rich in mineral deposits. Gold mining began in Saudi Arabia some 5,000 years ago. Since then, there have been periods when gold mining has been pursued vigorously (e.g. in the Islamic Abbasid period between the 8th and 13th centuries CE). Three thousand years ago, the mine known as the Cradle of Gold (Mahad Al-Dhahab), some 180 miles north of Jiddah, was a rich source of gold, silver and copper.

According to the Fourth Five Year Plan, gold had been discovered at some 600 sites around the Kingdom and a total of 29 prospects have been drilled. The Mahad Al-Dhabab gold mine was re-opened by Petromin with the intention of developing a high-grade underground gold mine with a capacity of 400 tons of ore per day. This venture encouraged further exploration for gold elsewhere in the Kingdom.

All known gold deposits in the Kingdom are located in the Pre-Cambrian rocks of the Arabian Shield which lies in the western region of Saudi Arabia.

Silver and base metal deposits (bauxite, copper, iron, lead, tin and zinc), as well as non-metallic minerals (bentonite, diatomite, fluorite, potash and high-purity silica sand) have all been discovered, attesting to the wealth that remains, still largely unexploited, beneath the Kingdom's soil.

Metallic resources

Non-metallic resources

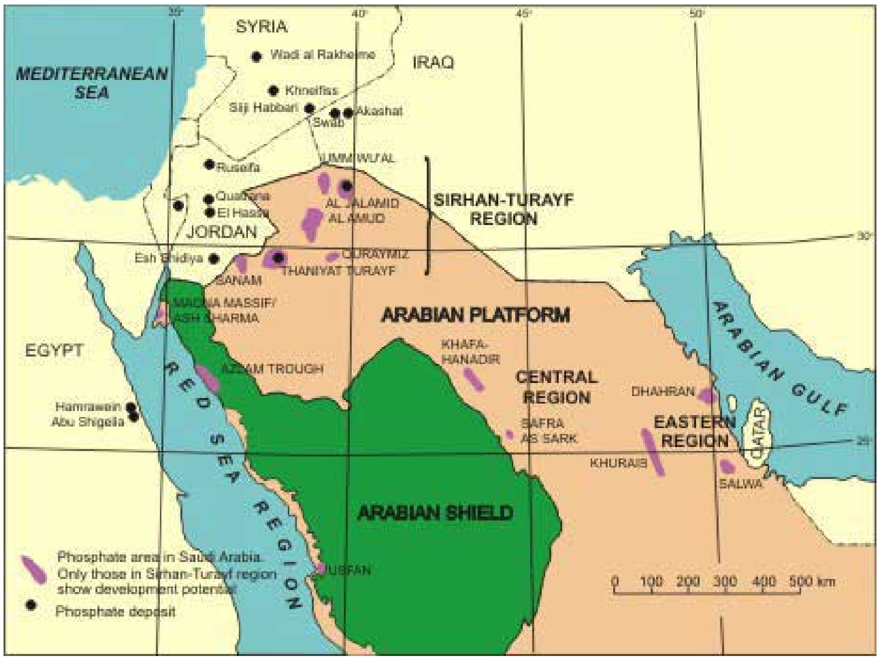
1- Phosphate

Phosphate is the main ingredient in fertilizers and as such is an essential material for the economy and health of the world. Although Saudi Arabia has no production at the present, it has a vast phosphate resource in the Sirhan-Turayf region in the northern part of the Kingdom and is potentially a major supplier to the world market.

- the best explored and largest deposit is at Al Jalamid, which has measured reserves of 213 Mt averaging 21% P_2O_5 and a stripping ratio of 2.3:1. Indicated resources amount to a further 187 Mt, 19.7% P_2O_5, stripping ratios 5:1 or less

- the Umm Wu'al North area has a demonstrated and inferred total resource of 537 Mt averaging 19.35% P_2O_5 with a stripping ratio less than 5:1
- the Al Amud area has a demonstrated resource of 24 Mt averaging 21.03% P_2O_5
- the Sanam prospect has a calculated resource of 23 Mt averaging 16.91% P_2O_5, both with stripping ratios of less than 5:1

Phosphate occurrences elsewhere in the Kingdom are small and of little concern.



Known Phosphate occurrences is Saudi Arabia and adjacent areas

2- High-grade silica sand

Major unconformity between Lower Paleozoic sandstone (above) and Neoproterozoic greenstone (below), Al 'Ula area

High-Grade Silica Sand and Sandstone

High-grade silica sand (>97.5% SiO_2) is an essential raw material in many industries and is used in Saudi Arabia in the manufacture of container glass, glass fiber, chemical products, and silicon metal; as filler for rubber, plastics, and ceramics; and in the construction business.

Worldwide, the commodity occurs both in rock and granular forms as sandstone and unconsolidated sand. Saudi Arabia has a surplus of eolian and alluvial sand, but silica in the form of sand is normally contaminated by iron oxide and other impurities and, in Saudi Arabia, does not meet the basic chemical specifications for industrial applications. Fortunately, however the country contains large volumes of quartz-rich sandstone, which after crushing and processing provide silica sand of high quality and great abundance.

Cliff-forming Saq Sandstone overlying Neoproterozoic greenstone, Al 'Ula area, northern Saudi Arabia

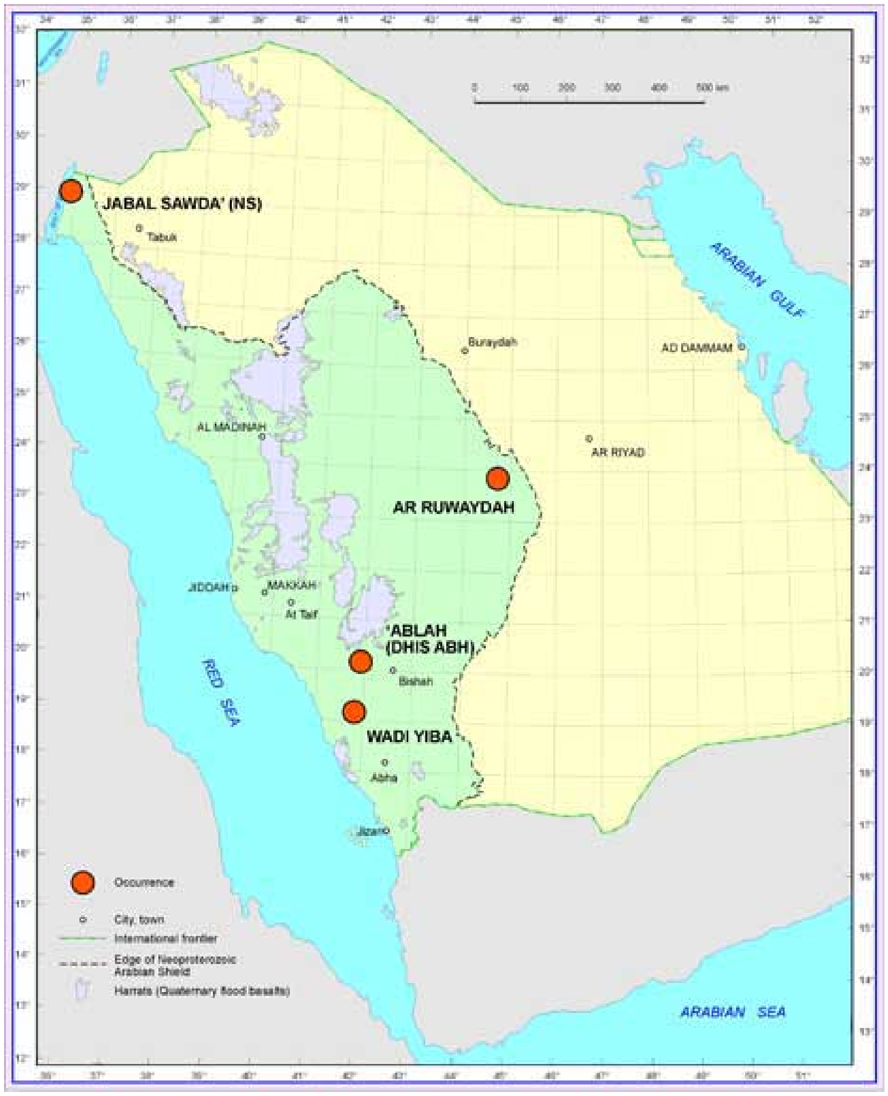
Regional targets

To date, exploration for high-grade silica sand in Saudi Arabia has focused on slightly indurated, well-sorted, quartz-rich sandstone formations in the Phanerozoic sedimentary succession of the Arabian Platform in the central and northern parts of the country. Such formations crop out close to urban and industrial centers in Riyadh, Qasim, Tabuk, Al Jawf, and Ha'il, and require only a minimum of processing (screening, washing, and magnetic separation) to meet most industrial specifications

3- Feldspar and Nepheline syenite

Feldspar and nepheline syenite in Saudi Arabia

The most suitable rocks in Saudi Arabia for feldspar/feldspathoid concentrations are feldspar-rich, nepheline-bearing plutons of the Arabian shield, and pegmatites, especially pegmatites associated with posttectonic granite that has an alkalic or aluminous trend and forms batholiths with rounded or lobate contours.



Feldspar and nepheline syenite occurrences in Saudi Arabia

Pegmatite dike in Wadi Yiba

Pegmatite dike in Wadi Yiba work area No.1

Feldspar (orthoclase and microline) pegmatite in Wadi Yiba   Pegmatite dike showing feldspar crystals

Feldspar in Wadi Yiba

Feldspar pegmatite dikes occurs in Wadi Yiba, about 560 km southeast of Jiddah on the Red Sea, and 200 km northwest of Abha, in the southern part of Saudi Arabia. The dikes are Precambrian in age and intrude the Precambrian granite and metavolcanic rocks of the Arabian shield. The dikes extend over an area of 20 km2, and comprise 20 pegmatite bodies with dimensions of 100-500 m long and 3-6 m wide. The dikes are conspicuous features of the landscape and project 5-20 m above the surrounding surface. Mineralogical study shows that the dikes contains 3.8-11.5% K-feldspar (orthoclase and microcline), 3.3-6.5% plagioclase feldspar (albite), 66-75% quartz, 0.1-1% biotite, and 0.1-0.6% iron oxide. Chemical analysis results yield an average of <74% SiO_2, 15% Al_2O_3, <0.5% Fe_2O_3, and >10% K_2O +Na_2O. Preliminary test indicates that the pegmatite dikes are suitable for use in the manufacture of ceramics and glass, and have a measured resource, above the ground level, of 1.5 Mt.

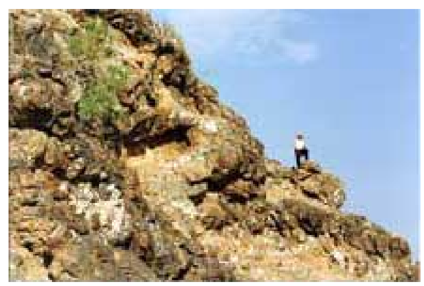
Feldspar in 'Ablah (Dhis Abh)

The 'Ablah (Dhis Abh) occurrence consists of orthoclase-muscovite-fluorite pegmatite that intrudes a predominantly tonalitic complex. The pegmatite crops out over an area of 500 by 100 m and has been explored for fluorite, resources of which are estimated at 30,000 tonnes of acid-grade fluorite to a depth of 50 m. Feldspar resources could be as high as several thousand tonnes.

Feldspar in Ar Ruwaydah

The Ar Ruwaydah pegmatite dikes occur in Abt schist and appear to have been affected by metamorphism and deformation related to the post-Murdama granite intrusion of Jabal Za'abah. However, the preferential location of the pegmatite dikes around the granitic massif could indicate that some, at least, are the differentiated products of this intrusion. The volume of resources for the four main dikes, grouped together within a radius of 2 km, is estimated at 25,000 m3. The dikes consist of microcline, essentially with quartz (easy to remove) and some tourmaline. Preliminary analysis results give compositions suitable for use in the manufacture of ceramics.

Pegmatite, mostly comprising microline and quartz, capping a hill at Ar Ruwaydah, south of Ad Dawadimi



Orthoclase feldspar cropping out on the orthern slope of the 'Ablah hill, northeast of Al Bahah

Nepheline syenite in Jabal Sawda'

The Jabal Sawda' pluton is about 2 km in diameter and ranges in composition from alkali-feldspar syenite to nepheline syenite, with marked variations in the content of ferromagnesian minerals. The main minerals are perthitic alkali feldspar (60-90%) and nepheline (0-40%), with sodalite, very minor plagioclase, ferro-hastingsite, aegirine, augite, biotite, and opaque minerals in various proportions. Hydrothermal alteration with zeolitization occurs locally. The K_2O content of the pluton ranges from 4 to 6%, the Na_2O content from 6 to 8%, and the $FeO+Fe_2O_3+MnO+MgO+TiO_2$ content from 2 to 13%

4- Kaolin

Kaolin in Saudi Arabia

Kaolin is one of the most important of the industrial minerals and finds widespread applications as a filler and coater in the paper industry and, to a lesser extent, as a filler and extender in the production of rubber, plastic, and paint. It is of paramount importance as a raw material for ceramics of all kinds, and is also used in the manufacture of structural clay products. Various kaolinitic clays are highly refractory. Kaolinitic clays are widespread in the clastic Phanerozoic rocks of Saudi Arabia. Potential economic deposits of kaolin are located in the Ar Riyad-Al Kharj area, particularly at Khushaym Radi, and in the vicinity of Buraydah.

OVERVIEW

Kaolinitic clays are almost entirely restricted to areas of Ordovician to middle Cretaceous clastic formations north and east of the Arabian Shield. No kaolinitic deposits are known on the Shield with the exception of a few isolated examples of weathered granite. Tertiary clays of the Red Sea coastal plain are mainly smectitic.

Kaolinitic deposits in the vicinity of Ar Riyad are located at Khushaym Radi and Darb Sid. The deposits belong to the Lower Cretaceous Biyadh Sandstone and, particularly, the Upper Cretaceous Wasia Formation. Lenses of white kaolin occur in the middle part of the Biyadh Sandstone and layers and lenses of kaolinitic clay and pure kaolin interbedded with sandstone occur in the Wasia. The kaolinitic clay facies of the Wasia Formation are exposed intermittently for several hundred kilometers from the Al Jawf area in the north of the Kingdom to the Al Kharj area east of Ar Riyad.

KHUSHAYM RADI DEPOSIT

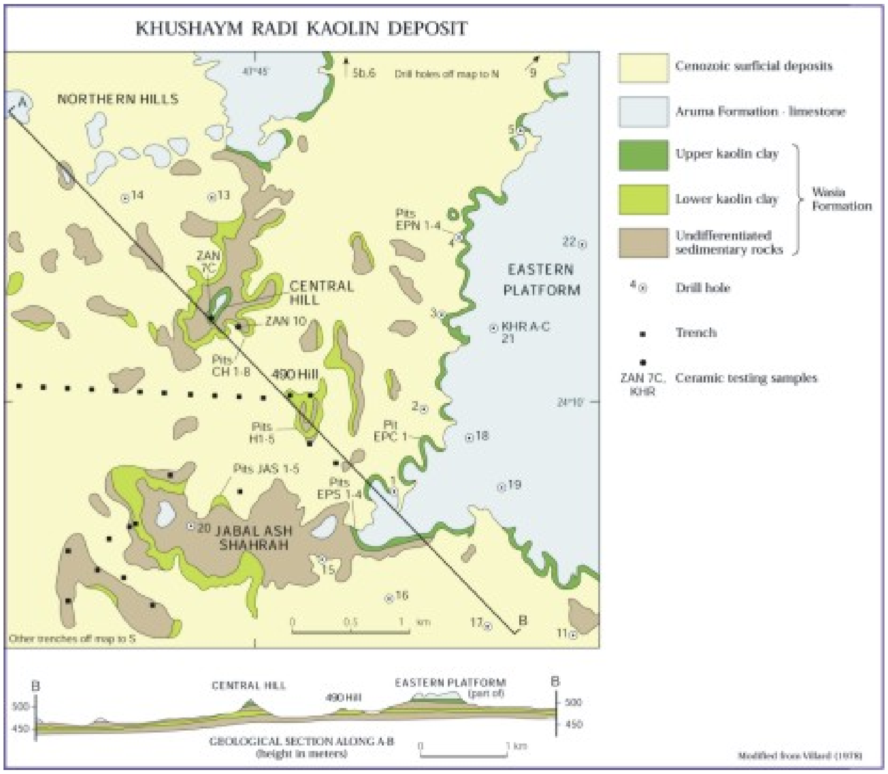
The Khushaym Radi kaolin deposit (24°10'N., 47°46'E.) is in the southeastern part of the area of the Ar Riyad 1:250,000-scale geologic map (sheet 24I; GM-121). The deposit is about 120 km east-southeast of Ar Riyad, 45 km east of Al Kharj, and 10 km south of the Al Kharj-Harad road.

The investigated area consists of isolated hills to the west and southwest of an extensive limestone plateau. The plateau, or Eastern Platform, is as much as 30 m high with scarp faces formed by an erosion-resistant limestone of the Aruma Formation. Kaolinitic clay and sand of the Wasia Formation are exposed on gentle slopes beneath the limestone.

The white kaolinitic clay in the lower member and at the top of the upper member of the Wasia Formation contains 47.00-55.75 percent total SiO_2; 25.00-29.40 percent Al_2O_3; 2.40-2.60 percent Fe_2O_3; 1.26-2.05 percent TiO_2; 0.40-1.26 percent K_2O+Na_2O; and 0.90- 2.85 percent CaO+MgO. The CaO+MgO content is too high for the clay to be used as a raw material in the manufacture of silico-aluminous refractory products, although the alkali content is acceptable. It is not suitable as a filler. Ceramic-aptitude tests made on samples taken from pits in the lower kaolinitic clay and upper white clay at the southern end of Central Hill indicated the samples have a high proportion of coloring impurities and soluble salts, especially Fe_2O_3 and

NaCl. The material is suitable for earthenware (whiteware) but needs the addition of a flux to provide for development of vitreous phases during firing, and of an inert material to reduce drying and shrinking when fired. It is being quarried for the manufacture of sanitaryware,
The colored kaolinitic clay of the upper and lower members consists of 80-90 percent kaolinite and 10-20 percent illite plus smectite in the clay fraction. It contains 48 percent total SiO_2 (36.71 percent free SiO_2), 22.14 percent Al_2O_3, 1.23 percent CaO, 0.38 percent Cl, and 0.17 percent SO_3.
Ceramic tests made on core from the entire thickness (14.85 m) of the upper-member clay showed that it has a high proportion of colored impurities, especially Fe_2O_3 and TiO_2, and of MgO and CaO, and is unsuitable for manufacture of tiles. Firing tests showed that the lower-member clay as a whole is suitable for the manufacture of bricks and other structural-clay products.

The estimated resources are 17 Mt of beige to gray kaolinitic clay and 3.4 Mt of pale colored kaolinitic clay.



5- Basalt and Scoria

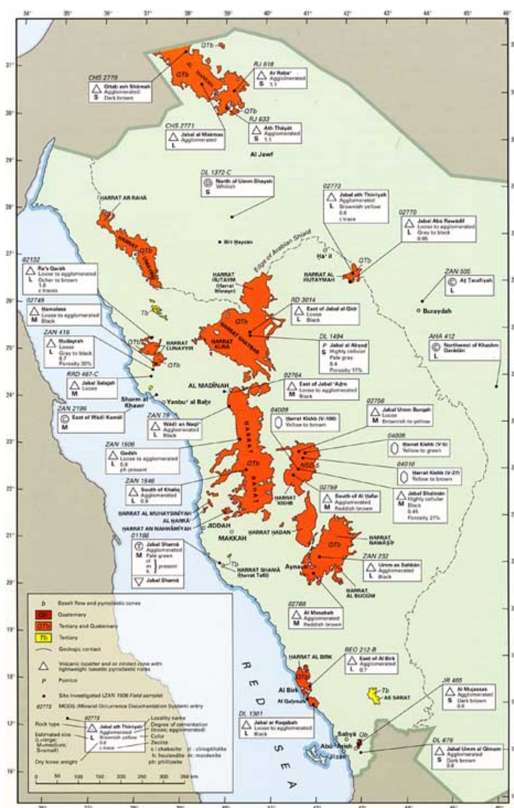
Quarry in volcanic ash at Harrat Rahat, near the Al Madinah highway

Industrial uses of basalt and scoria in Saudi Arabia

Volcanic activity that accompanied the opening of the Red Sea from the Miocene (25 Ma) to the present, resulted in the formation of vast fields of subaerial basaltic flows in the western part of Saudi Arabia, referred to by the Arabic term 'Harrat'. These harrats cover an area over about 90,000 km2, and extending over parts of the Proterozoic Arabian shield and adjacent Phanerozoic rocks of the Arabian Platform and Red Sea basin. The principal harrats are Harrat Rahat, Harrat Uwayrid, Harrat al Hutaymah, Harrat Kishb, Harrat Khaybar, and Harrat al Birk. The lava flows are commonly composed of picritic to ankaramitic basalt and may contain peridotite nodules.

Several hundred eruptive centers are distributed on the basaltic fields, and are characterized by pyroclastic cones, shield volcanoes, and phreatomagmatic craters. The pyroclastic cones consist of black or red, lightweight, loose to agglomerated scoria, and minor amounts of olivine nodules.

Currently in Saudi Arabia, basalt is used in manufacturing rock wool and road aggregate. However, it has the potential for use in the manufacture of cast basalt tiles, pipes and other corrosion resistant ceramic applications. Scoria is also used for pozzolan cement production. Preliminary results on the horticultural applications of scoria are encouraging. Scoria is an excellent medium, which holds water in its pores and allows air circulation to the root zone of the plants.



PRINCIPAL OCCURRENCES

Comprehensive exploration for basalt and scoria suitable for many uses have been carried out on harrats Kishb, Rahat, Habiash, Al Hutaymah, Khaybar, Al Harrah, Nawasif, Al Birk, and Lunayyir.

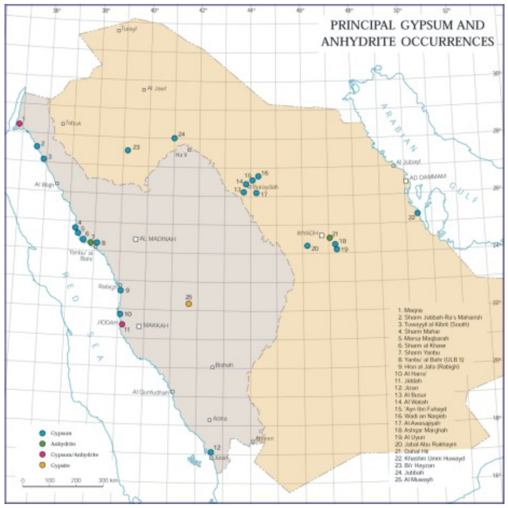
The investigations focused on the search for accessible and easily exploitable basaltic flows and scoria cones, that have properties that satisfy their intended industrial applications. Investigations to date, indicate that most of these harrats contain enormous quantities of material suitable for the production of rock wool, lightweight aggregate, and floor tiles, and that harrat Al Hutaymah, Kishb, Rahat, and Al Birk have moderate amounts of material suitable for pozzolanic cement.

Saudi Arabia currently produces rock wool from basalt at two factories in Al Madinah and Riyadh. Lightweight aggregate concrete blocks are produced in one factory in Jiddah using loose lapilli scoria as lightweight raw material. Pozzolanic scoriaceous material is used by some Portland cement plants; gem-quality olivine is recovered from nodules, volcanic bombs, and wadi sand at Harrat Kishb.

6- Gypsum and anhydrite

Gypsum And Anhydrite In Saudi Arabia

Gypsum in Saudi Arabia occurs in Cenozoic rocks of the Red Sea Rift Basin, in Mesozoic strata of the Arabian Platform near Buraydah and the Ar Riyad area, and in Cenozoic formations on the Arabian Gulf coast. Sandy and clayey gyspiferous deposits too impure for exploitation are present in sabkhahs throughout the Kingdom.

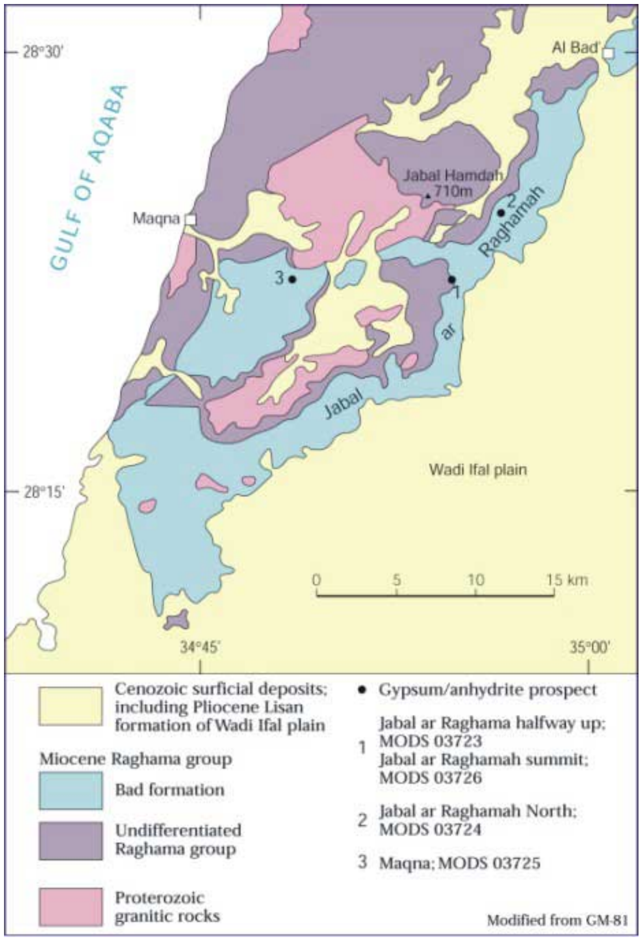


MAQNA AREA

The ***Maqna area,*** at the junction of the Red Sea basin and Gulf of Aqaba, contains large gypsum deposits exposed over an outcrop area of about 270 km^2. The principal deposit is on Jabal ar Raghamah about 20 km south-southwest of Al Bad' and another important occurrence is inland from Maqna on the Gulf of Aqaba coast. The area is part of the Maqna massif, which is bounded to the west by steep cliffs along the Gulf of Aqaba and to the east and south by the Wadi Ifal plain. The massif has a steep and spectacular relief of several hundred meters and is incised by numerous wadis. The highest point is Jabal Hamdah at 710 m above sea level.

Maqna gypsum deposit area

The deposits are part of the thick evaporite, carbonate, and clastic sedimentary Miocene Raghama group and consist of gypsum at the surface that gives way to anhydrite at about 15 to 20 m depth. Along-strike correlation of the evaporite beds is difficult due to the rapid variation in gypsum/anhydrite ratios. This weakens the reliability of the resource estimation, but four areas appear to have economic potential. These area contain high-purity gypsum/anhydrite with less than 0.05 percent SiO_2, and very low Al_2O_3, Fe_2O_3, Na_2O, K_2O, MnO, MgO, and Cl. Total identified resources are 33.6 Mt grading between 83.63 and 90.5 percent gypsum with a thickness of as much as 17 m. Potential resources of gypsum and anhydrite are considerably greater. Although the Maqna gypsum deposits are handicapped by their remoteness from consumption centers, the potential exists for the export of gypsum or the local manufacture of gypsum products.



Geology of the Maqna massif

7- Limestone and Dolomite

Limestone and Dolomite Rocks in Saudi Arabia

Saudi Arabia is richly endowed with limestone and dolomite. Deposits are currently worked for crushed stone and as raw material for cement. Limestone and dolomite resources are chiefly in Phanerozoic rocks that flank the northern and eastern sides of the Neoproterozoic Arabian Shield; they are particularly abundant in the central region of the Kingdom. Quaternary raised coral-reef limestone of the Red Sea coastal plain is the principal source of cement-grade limestone in the west of Saudi Arabia. Jurassic limestone is worked for cement in the Jizan area, in southwesternmost Saudi Arabia.

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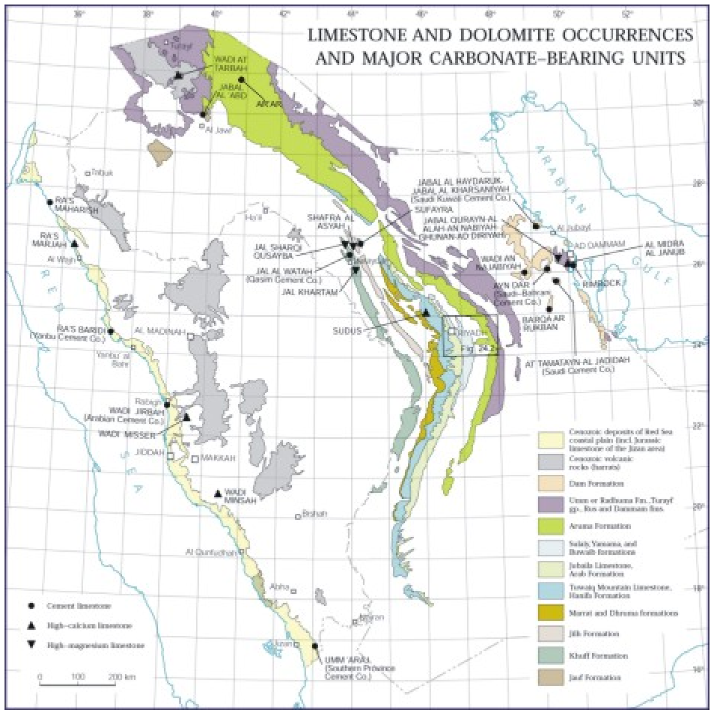
Overview

Carbonate rocks area abundant in Saudi Arabia, particularly in the curved belt of gently dipping Phanerozoic strata on the northern and eastern flanks of Arabian Shield. Limestone is present particularly in Upper Jurassic and Lower Cretaceous strata. Dolomite is well represented in Upper Cretaceous and Paleocene-Eocene formations and to a lesser extent in Upper Jurassic units.

Carbonate rocks, commonly dolomitic limestone, are also present in the narrow strip of Tertiary (and minor Jurassic) strata in the Red Sea basin that fringe the western edge of the Arabian Shield, and as Quaternary raised coral reefs. Within the Arabian Shield, variably metamorphosed limestones form relatively small beds of crystalline limestone and marble.



Cement-grade limestone

1.-Red Sea coastal area

The most favorable, and currently exploited, cement-grade carbonates are Quaternary coral limestone present as raised reefs discontinuously exposed from the Farasan Islands in the south to Haql in the north, and Jurassic limestone located in the Jizan Area. Known occurrences include:

- Ra's Baridi
- Wadi Jirbah
- Ra's Maharish
- Umm 'Araj

2.-Riyadh area

The Ar Riyad area has enormous reserves of cement-grade limestone in the Lower Cretaceous Sulaiy Formation and the Permian Tuwaiq Mountain Limestone. The Sulaiy Formation is worked by the Yamama Cement Company SE of Riyadh where the formation has a maximum thickness of about 170 m and an outcrop width east of as much as 30 km. The Tuwaiq Mountain Limestone is not yet worked but contains massive, fine-grained, and generally soft cement-grade limestone in its upper two thirds.

Outcrop of upper Tuwaiq Mountain Limestone suitable for use in white cement, Sudus, west of Ar Riyad

High-calcium limestonein the Umm al Ghirban district, east of Al Kharj

3.-Qasim (Buraydah area)
Limestone for cement in the Buraydah area is contained in the Permian Khuff Formation and the Jurassic Marrat Formation. The Khuff Formation has low magnesia calcarenite 20-25 m thick and is used in the Qasim Cement Company's plant at Jal al Watah, 18 km north of Buraydah. Fine-grained limestone of the Marrat Formation is also low in magnesia and is a potential raw-material source for the manufacture of high sulfate-resistant cement.

4.-Eastern Province
Carbonate rocks in the Eastern Province are commonly magnesia rich or excessively siliceous, but favorable areas for cement manufacture are known in at least four areas:

- Al Hufuf area
- Wadi an Najabiyah
- Ad Dammam
- Jabal al Haydaruk

5.-Northern Region
Cement-grade limestone is not common in the northern part of the Kingdom but deposits are known at:

- Jabal al ‘Abd, near Al Jawf
- Wadi at Tarbah, an inlier of limestone in the Al Harrah lava field

8- Ornamental stone

Ornamental stone in Saudi Arabia
Ornamental stone in used widely within the Kingdom of Saudi Arabia and several varieties of granite are exported.
Commercially exploitable deposits of plutonic igneous rocks, mostly granite but also quartz monzonite, anorthosite, and gabbro, occur in the Arabian Shield, mainly in the southern, western and eastern parts.

Deposits of marble also occur in the Shield, notably in the western and east-central areas. Jurassic oolitic limestone (“Riyadh stone”) is worked extensively to the west of Riyadh. Deposits of Cenozoic coral-reef limestone are present along the Red Sea coast; they were exploited in the past for building stone but have a more restricted use today.

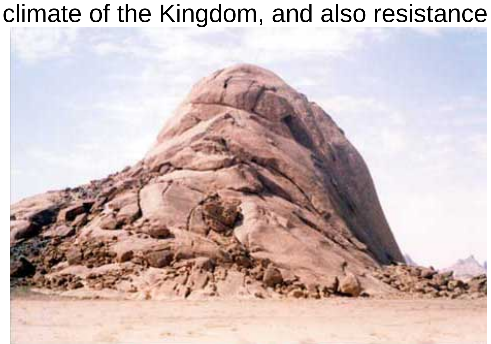
Overview
Evidence of an early use of natural stone for masonry can be seen in the defensive structures and ancient dams of the western and southern parts of the country. Notable examples are the watchtowers and fortified grain stores of the Asir mountains where roughly dressed dark-gray and greenish schists have been used with white quartz to create a distinctive local architecture. Near Khaybar, about 130 km north of Al Madinah, a large ancient dam (now breached) was constructed from blocks of columnar basalt. Coral-reef limestone, an excellent natural insulating material, was used extensively to build the large old houses of Jiddah, Yanbu‘ al Bahr, Umm Lajj, and Al Wajh.

Types of Ornamental stone
Almost any kind of rock can be used as ornamental stone provided it possesses aesthetic and decorative appeal, can be polished, and is sufficiently resistant to weathering. In practice, the main Saudi Arabian rocks used as ornamental stone are igneous rocks, marble, and limestone.

Igneous rock
In commercial terms, the name “granite” is applied to a wide range of igneous rocks extending from true granites (in a petrologic sense), through diorite, monzonite, and syenite, to gabbro and anorthosite. The granites have a visible crystalline texture but, whereas the true granites are composed essentially of feldspar and quartz plus mica or hornblende, the gabbro end of the range is darker in color and contains little or no quartz. Granites have properties that make them suitable for such applications as:

- Curtain wall or facing stone for exteriors and interiors, floors and stairs.
- Monument construction
- The manufacture of curbstones and paving stones

The quality of granites are best shown by polishing, but all finishes, such as honed or flame-cut finishes, (which give a paler color) are suitable. Split surfaces can be given to steps, curbstones, and paving slabs. The finished products have a high resistance to weathering, particularly in the dry, hot, or humid climate of the Kingdom, and also resistance to acid pollution and frost action.



Massive granitic rock in Ranyah area

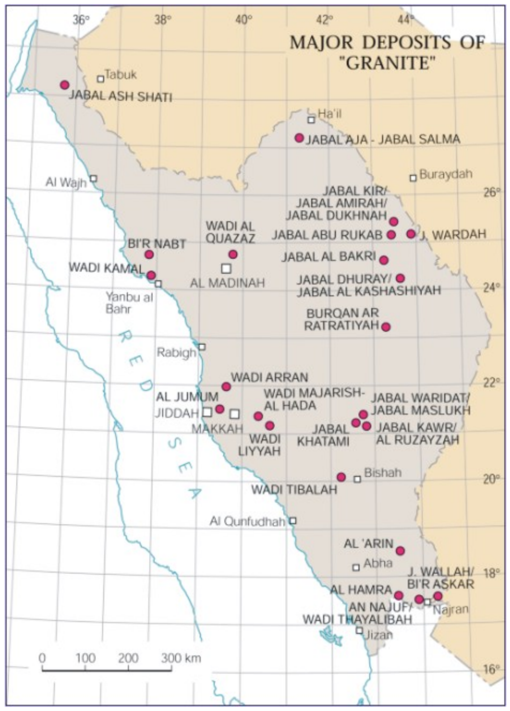
Saudi Arabia has abundant resources of igneous rock suitable for the production of high-quality ornamental stone. About 40 occurrences have been identified (all commercially called “granite”) that are suitable for exploitation by the ornamental stone industry. The most favorable areas are the Najran, Ranyah, southern Ar Rass, Ad Dawadimi, Jiddah-At Ta’if, and Yanbu‘ al Bahr-Al Madinah districts. Many sites have been investigated and some are being quarried commercially or on a pilot scale.

All the igneous rocks used as ornamental stone in the Kingdom are from the Proterozoic Arabian Shield. The true granites are commonly gray or pink, but range from red, through red-brown and brown, to black. In addition, red and brown quartz monzonites, black and blackish-brown anorthosites, and black gabbros occur. In general, the exploited igneous rocks are holocrystalline and medium to coarse grained but some, used for special effect, are fine grained.

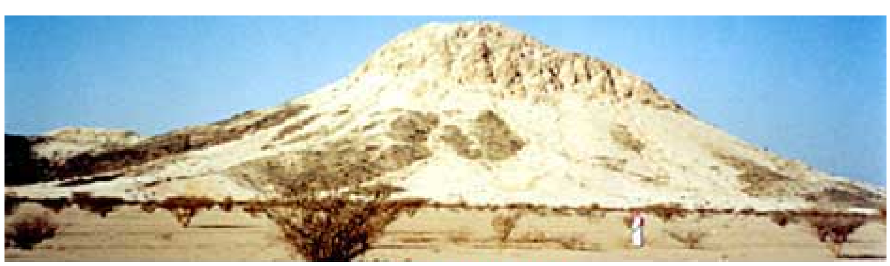
Name/District	Description
Najran district	
Al 'Arin	Reddish-pink porphyritic monzogranite
Al Hamra	Red-brown porphyritic monzogranite
Jabal Wallah *	Brown monzogranite
Bi'r Askar *	Brown granite
An Najuf *	Carmine-red granite
Wadi Thayalibah *	Blackish anorthosite
Ranyah district	
Jabal Waridat *	Pale-gray granite
Jabal Maslukh *	Reddish-pink monzogranite
Ar Ruzayzah	Reddish-pink monzogranite
Jabal Kawr *	Green granite
Jabal Khatami *	Beige to brownish monzogranite
Wadi Tibalah	Gray gneiss
Southern Ar Rass and Ad Dawadimi districts	
Jabal Kir *	Gray fine-grained syenogranite
Jabal 'Amirah	Pink to pale-gray porphyritic granite
Jabal Dukhnah	Pink granite
Jabal Wardah	Brown to beige porphyritic granite
Jabal Abu Rukab *	Gray porphyritic granite
Jabal al Bakri *	Milky pink granite
Jabal Dhuray *	Pink porphyritic granite
Jabal al Kashashiyah *	Gray granodiorite
Jiddah-At Ta'if district	
Wadi 'Arran (Ghuran)	Gray granite
Al Jumum *	Pink monzogranite
Wadi Majarish-Al Hada *	Pale-pink monzogranite
Wadi Liyyah	Pink to buff granite
Yanbu' al Bahr-Al Madinah district	
Bi'r Nabt *	Gray fine-grained granite
Wadi al Quazaz *	Blood-red granite
Wadi Kamal *	Brown anorthosite
Miscellaneous	
Jabal ash Shati	Pink granite
Jabal Aja'-Jabal Salma	Reddish-pink granite
Burqan ar Ratratiyah	Dark-blue gabbro

* Working quarries

Domestic use of ornamental stone is growing in Saudi Arabia and there is an international demand for certain types of Saudi granite. In an attempt to search for new areas and possibly new types of rocks for quarrying, a general reconnaissance was carried out in the northwestern part of the Arabian Shield, roughly from Duba in the north, to Umm Lajj in the south. The zone under investigation (about 85,000 km2) covers seven quadrangles (Umm Lajj, Wadi Al 'Ays, Al Wajh, Sahl al Matran, Al Muwaylih, Shaghab, southern part of Al Bad) at 1:250,000 scale. The presence of port facilities in both Duba and Yanbu is a favorable factor for possible exports of commercial blocks or manufactured products.


MAJOR DEPOSITS OF
"GRANITE"
36°
38°
40°
42°
44°
26°
24°
22°
20°
18°
16°
Tabuk
JABAL ASH SHATI
Ha'il
JABAL AJA - JABAL SALMA
Buraydah
Al Wajh
JABAL KIR/
JABAL AMIRAH/
JABAL DUKHNAH
JABAL ABU RUKAB
J. WARDAH
WADI AL
QUAZAZ
BI'R NABT
WADI KAMAL
AL MADINAH
JABAL AL BAKRI
JABAL DHURAY/
JABAL AL KASHASHIYAH
Yanbu al
Bahr
BURQAN AR
RATRATIYAH
Rabigh
RED SEA
WADI ARRAN
AL JUMUM
WADI MAJARISH-
AL HADA
JABAL WARIDAT/
JABAL MASLUKH
JIDDAH
MAKKAH
JABAL
KHATAMI
JABAL KAWR/
AL RUZAYZAH
WADI
LIYYAH
Bishah
WADI TIBALAH
Al Qunfudhah
AL 'ARIN
Abha
J. WALLAH/
BI'R ASKAR
AL HAMRA
AN NAJUF/
WADI THAYALIBAH
Najran
Jizah
0
100
200
300 km

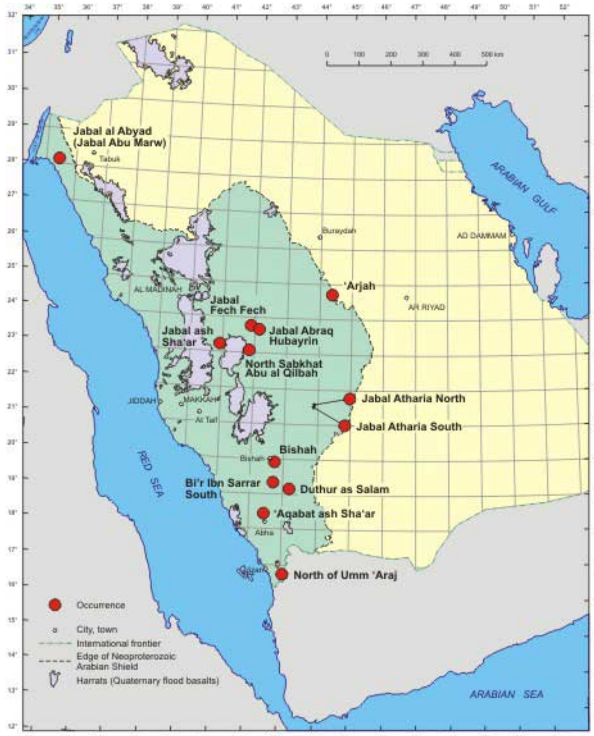
9- Quartz



Jabal as Sayirah al Bayda

Quartz In Saudi Arabia

Quartz veins and pegmatite occur through out the Arabian shield where they are related in pact to granitic intrusive. Most of the quartz veins are mineralized but some occurrences are barren. These veins are suitable for industrial applications especially in the for the production of silicon, ferrosilicon, piezo-electric quartz, and electronics. For these application the quartz raw material must contain (> 99 % SiO2, < 0.1 % Al2O3, < 0.1% Fe2O3).



Quartz occurrences in Saudi Arabia

The following occurrences deal principally with some of the larger quartz veins.

AD DAWADIMI AREA

Jabal Abraq Hubayrin

Quartz veins occur with gray syntectonic granite and are abundant over an area of approximately 10 km² around Jabal Abraq Hubayrin.

They range in length from several meters to 300 m with an average thicknesses of 1-5 m, and in places are between 20-50 m wide.

Arjah

A dense system of *en echelon* east-striking veins crops out in an area 2.5 by 0.2 km near Arjah, partly in granite and partly in Abt schist. The veins hewe a 99.2 % SiO2, 0.05 % Fe2O3, 0.05 % Al2O3.

Other quartz veins occurrences occur 32 km southeast of Arjah contain good-quality quartz but the veins are small, with an average outcrop area of 400 m². They hewe appositive relief of 3-5m above the surrounding plain.

NORTH ARABIAN SHIELD

Jabal Al Abyad (Jabal Abu Marw)

The two hills of the Jabal Al Abyad occurrence are formed by quartz veins with in a quartz monzodiorite. The veins are not extensive; the larger of the two occurrences is about 70 m long, 10 m wide, and fises 8-20 m above the plain. The second is 50 m long, 5 m wide, and contains with feldspar.

Central Arabian Shield

Jabal Atharia

Quartz veins associated with small plugs and dikes of red, fine-grained, granophyric granite, occur north and south Jabal Atharia. The swarm at Jabal Atharia South is 3,000 m long and 20-100 m wide.

North of Sabkhat Abu Al Qlibah

North of Sabkhat Abu Al Qilbah (Quraynah) (32 km south-southwest of Ad Dafinah), a group of quartz veins cropout over an area (1,000 m long and 20 m wide).

Jabal Fech Fech

A vein, 1,000 m long and 20 m wide, composed of milky-white quartz cuts a complex of banded schist and gneiss of the Mughais complex. The quartz appears almost pure and contains no other mineralization.

Jabal ash Sha'ar

The Jabal ash Sha'ar occurrence is a very large, white, reddened, and jointed quartz vein that stretches for more than 1 km and continues southward sporadically, for yet another kilometer particularly abundant quartz veins that occur at the edge of a granodioritic and granophyric intrusion up to approximately 400m wide.

Jabal as Sayirah al Bayda

SOUTHERN ARABIAN SHIELD

Aqabat ash Sha'ar

Numerous quartz veins cut schist and phyllite at Aqabat ash Sha'ar, and other barren quartz veins cut schistose rock about 5 km north-northeast of this occurrence. The inferred resources are considerable up to .

Bi'r Ibn Sarrar South

Pegmatite at Bi'r Ibn Sarrar South cuts a posttectonic granodioritic to tonalitic complex. The pegmatite is composed mainly of orthoclase and quartz, and the outcrop is about 100 m in diameter, with an inferred resource of 71,000 tones.

Duthur as Salam

Between 1.0 and 2.5 km west of Wadi as Salam, large barren masses of platy milky quartz (up to 500 m long and 200 m wide) form hills and coalescent aprons of white scree in diorite and gabbro.

-

Bishah Quartz

Several milky-white quartz veins occur 58 and 8 km southeast of Bishah in Jibal Lumaiz Rak and in Jabal as Sayirah al Bayda & Jabal Arfajan respectively.

1. At Jibal Lumaiz Rak, numerous, highly fractured, milky-white quartz veins cross cut granitic rocks over an area of approximately 20 km². Their average dimensions range between 12–40m long, 2–5m wide, and have a positive relief of between 5–15m.

Chemical analyses for 7 samples are shown below. The rough estimate of the reserve for this area is 0.02Mm³.

Sample#	SiO2 %	Al2O3%	Fe2O3%	TiO2%
REX-116	99.60	0.06	0.16	0.02
REX-117	99.00	0.06	0.19	0.03
REX-118	99.35	0.05	0.13	0.01
REX-119	99.40	0.05	0.31	0.04

Chemical analysis results for quartz veins in Jibal Lumaiz Rak

Environmental geology and geohazards

SGS surveys and monitors occurrences of natural and man-made geohazards, maps susceptible areas, assesses the likely impacts, and advises on management and mitigation strategies to minimize risks to life, property and the economy. In the Kingdom, the most serious geohazards arise from:

Human activity, such as ground collapse and subsidence caused by the abstraction of groundwater, and ground instability, water and soil contamination caused by mining and waste disposal activities.

Natural environmental processes, such as flooding and rise of water tables, sand movement, desertification, environmental radiation, landslides and rockfalls, limestone and evaporite dissolution, and movement of salt plugs.

Earthquakes and volcanic activity, including secondary effects such as fissuring, ground liquefaction and ground motion amplification.

Environmental and geohazard events can occur with little warning and may affect large populations. An important role of the SGS is to reach out to local communities and increase public awareness of environmental and geohazards issues. Following any such event, teams of SGS specialists are ready to respond at short notice to advise on remediation measures and to collect data on impacts to inform future risk assessments. SGS also carries out engineering geological mapping of the Kingdom's major cities to identify resources, constraints and hazards for safe and effective development, and a geoconservation program to preserve the nation's heritage of world-class geological sites for education, research and tourism.

Surveys, research and services in Environmental Geology and Geohazards are carried out by the following SGS departments:

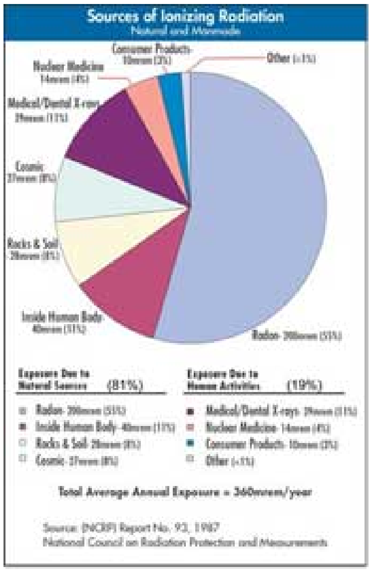
Geohazards and Engineering Geology
Environmental Geology
Seismic Centre
Desert Studies

Learn more about Geohazards and Earthquakes in Saudi Arabia

Environmental geology

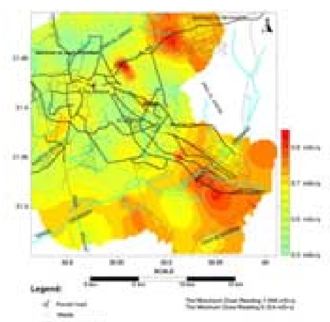
SGS project work in Environmental Geology

The SGS Environmental Geology department focuses on the hazards posed by natural or man-made contamination of the environment. Our projects and services identify potential sources of contamination, investigate the pathways for contaminant movement and potential human or environmental exposure, and recommend solutions to mitigate or eliminate the associated risks. As part of the Applied Geology Program of SGS, we also collaborate extensively with other SGS groups, notably the Hydrogeology, Geohazards and Engineering Geology departments, to provide integrated risk management assessments of engineering and waste sites.



Sources of environmental radioactivity

Current SGS strategic programs in environmental geology concentrate on mapping the hazards associated with natural radioactivity. The mapping is based largely on existing airborne radiometric surveys carried out in the 1960s, 1970s, and 1980s that were originally intended to support mineral exploration and geologic mapping objectives, Reinterpretation of these data, supplemented by new ground checking using portable spectrometers in selected areas, is used to produce maps showing potential dose levels and the magnitude of the associated hazards.



Dosemetry Map For Makkah Al Mukkarramah City
(Report No. SGS-TR-2004-4)

A key aim of the department is to raise public awareness of the occurrence and significance of low-level radioactivity, ionizing radiation and electromagnetic fields in the environment. An educational citizen’s guide to radon is currently in production and similar publications on other themes are planned for the future.

Our current projects are:

Natural radioactivity map of Saudi Arabia
Radon potential maps of Saudi Arabia

Geohazards and Engineering Geology

SGS programs in Geohazards and Engineering Geology

Stages of cavern collapse associated with subsurface dissolution

Current SGS programs in the department focus on delivery of strategic information and solutions to underpin planning, development and management of the environment and hazards in the Kingdom. Current emphasis is on risk assessment and remediation of floods, rock falls and fault movements, and on engineering geological mapping of major cities.

Our current projects are:

Flood hazards along the coastal area between Jeddah and Jizan
Stability analysis of high risk slopes at the Al Baha descent
Evaluation of engineering properties and industrial uses of scoria
Engineering geology and land-use planning for Saudi Arabian cities
Recent fault movements in the Haql coastal area, Gulf of Aqaba

Services to the community

The Geohazards and Engineering Geology department can perform, on request, a wide range of advisory and consultancy services including geohazard assessment, mapping and mitigation, engineering geological mapping and site investigations, and rock physical properties analysis. Specific services include:

SGS site investigation services

Investigating geohazards and their environmental impacts, mapping of susceptible areas, and advising on mitigation methods. The department offers a rapid response service to investigate and ameliorate rapid-onset, geodynamic events such as floods, ground collapse and rockfalls

Site investigations of major civil and military major installations, including dams and waste sites

Engineering geological mapping of both hazards and resources in cities and for other major installations at various scales

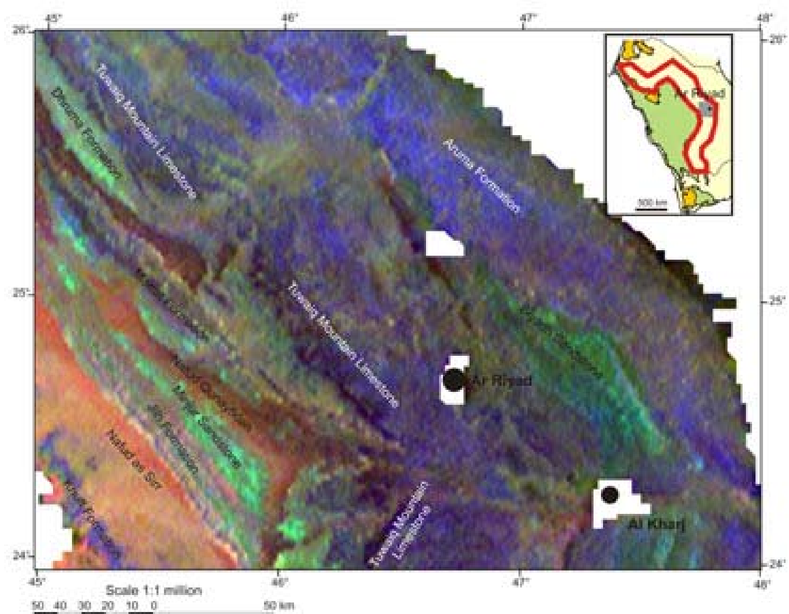
Analysis of the engineering properties of construction materials, including rocks, soil, aggregate, concrete and dimension stones.

Our services are commonly provided in collaboration with the Hydrogeology and Environmental Geology departments in SGS, and make extensive use of our Engineering Geology Laboratory and Drilling Services teams.

For more information about our services in Engineering Geology and Geohazards, please [contact SGS Business Development Services]

Geophysics in Saudi Arabia

Geophysics is the study of the Earth by quantitative physical methods – principally by measuring the gravitational, magnetic, electrical, and seismic-velocity properties of the Earth's surface and interior.



Different rocks have different properties. Measuring these differences provides information about the distribution and the structure of the rocks on the surface and at depth, and gives a 3-dimensional picture of the earth's crust. Scientists use this information to better understand the evolution and structure of the

Earth and to more effectively explore for mineral, hydrocarbon, and water resources. >>>Read More

- What is geophysics?
- Aeromagnetic surveys in central and western Saudi

What is geophysics?

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What are the most common types of surveys?
These include:

- Gravity surveys
- Magnetic surveys
- Electrical surveys
- Electromagnetic surveys
- Radiometric surveys
- Seismic surveys
- Radar surveys
- Downhole electrical and caliper surveys

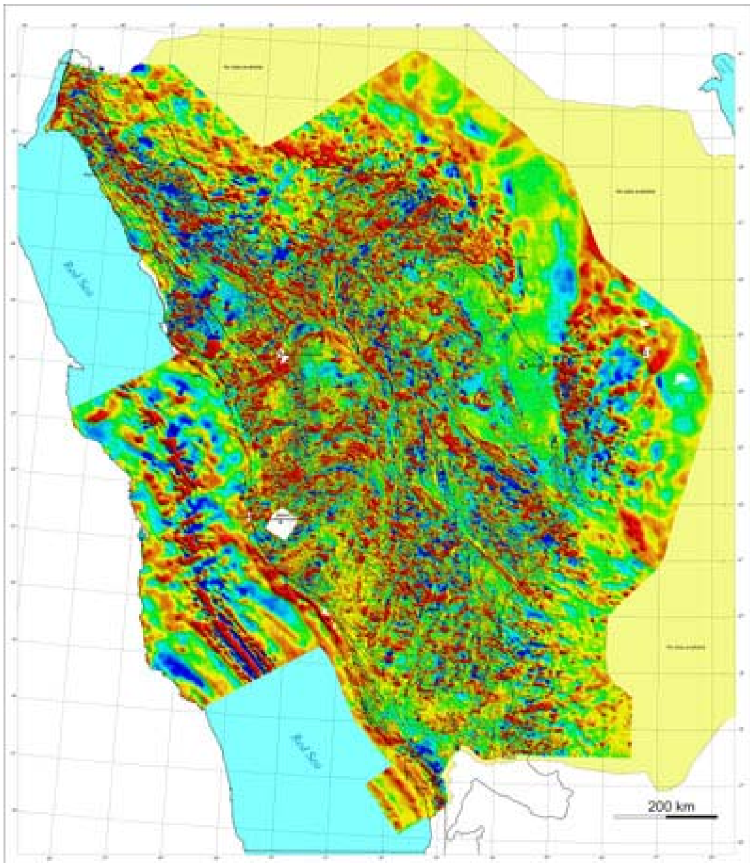
Surveys are done, for different purposes, at regional scales (covering large areas, both on the ground and from aircraft) and at local scales (covering specific sites such as mineral prospects, again on the ground or with airborne instruments, or done from within drillholes deep in the ground).

What has been done in Saudi Arabia?
Geophysical surveys have been done in Saudi Arabia since the 1920s.

- In the east, they include airborne and ground-based magnetic and gravity survey, seismic surveys, and downhole surveys and have been done for oil exploration. The data are held mainly by Saudi Aramco.
- In the central and western parts of the country, airborne magnetic and radiometric and ground-based gravity surveys have been done for regional studies of the structure of the Precambrian Arabian shield and adjacent Phanerozoic sedimentary rocks. Many other surveys have been done for mineral exploration purposes, and the data are held by the Saudi Geological Survey.
- Other types of important geophysical investigations include those done by Universities and other agencies that focus on elucidating the deep crustal structure of the Arabian Plate and Red Sea.

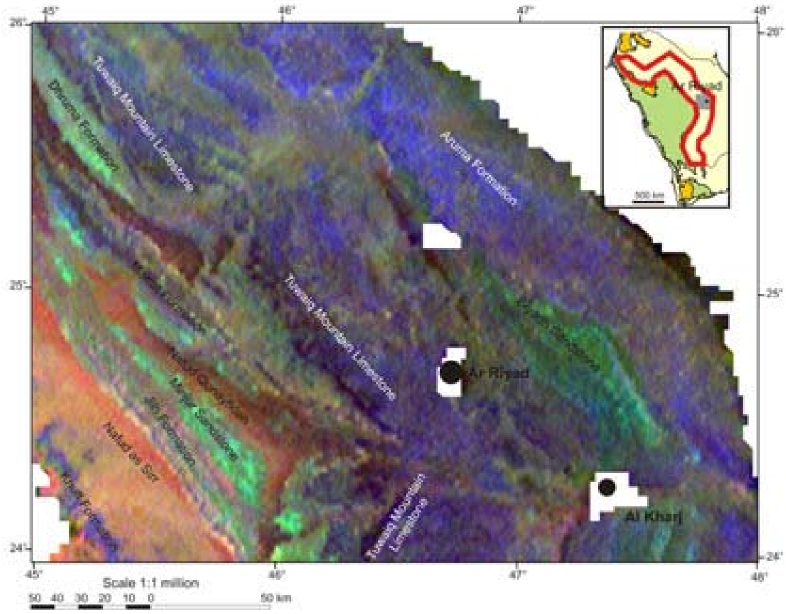
Aeromagnetic data
Airborne regional magnetic surveys cover outcropping Precambrian rocks in the western part of Saudi

Arabia (the Arabian Shield), Phanerozoic sedimentary rocks east and north of the shield (the "Cover rocks"), and parts of the Red Sea basin.



Magnetic data (reduced to the pole) for parts of central and western Sadui Arabia--an example of a type of magnetic anomaly map available for SGS

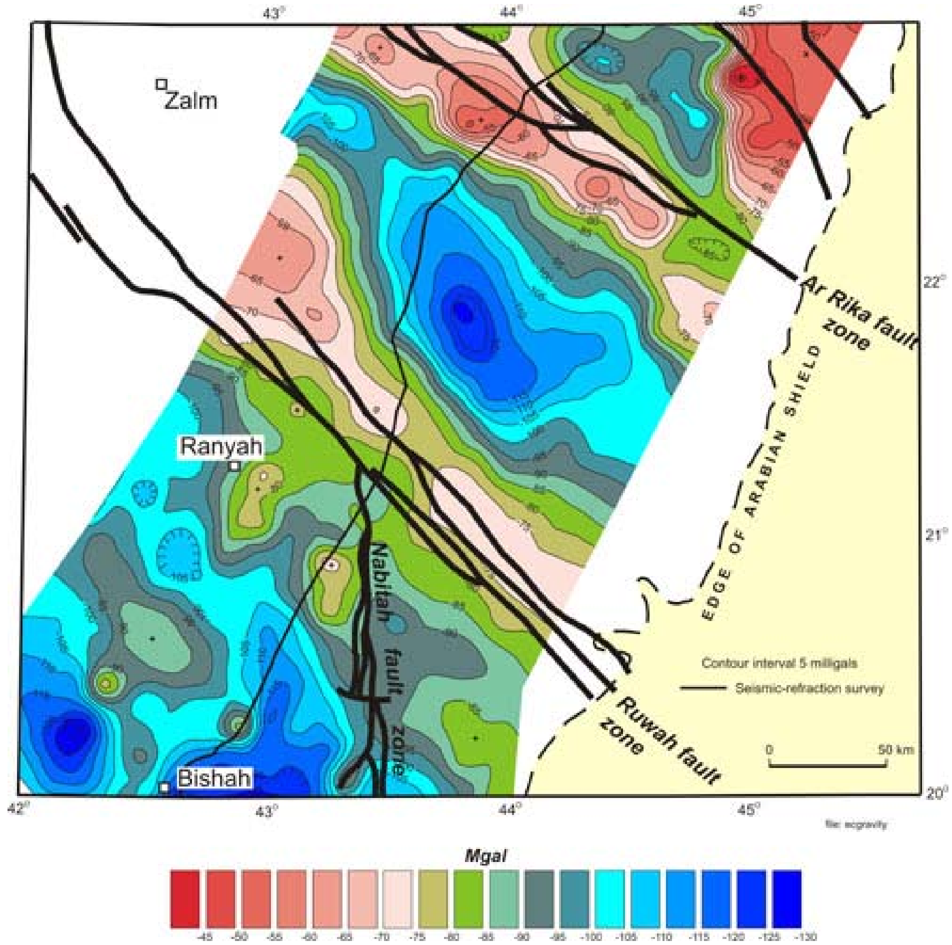
Radiometric data
SGS has radiometric (U, K, Th) covering part of the Phanerozoic rocks adjacent to the Arabian shield, and U,K, Th data for parts of the shield. The data reveal subtle changes in the lithologies of the Phanerozoic rocks and help to clarify the succession.



Composite false-color image of U, K, and Th data for the Ar Riyad area

Gravity data

Gravity data were acquired in the 1980s by the predecessor of SGS for the southern and smaller northeastern parts of the shield and for some areas adjacent to the Red Sea. Because of the wide spacing of data points, the data are only applicable to regional interpretation but, nonetheless, provide an important picture of the structure of the Arabian shield and Red Sea coast and, in conjunction with aeromagnetic data, are useful for metallogenic interpretations.



Applications of geophysics by SGS

Geophysical surveying is one of the important functions of the Saudi Geological Survey and has applications in many aspects of work by the Saudi Geologic Survey. It is used to locate small physical targets such as pipe-lines and concentrations of metallic ores; to locate more subtle targets such as zones of clay alteration around mineral deposits or the boundaries and thicknesses of underground water reservoirs; and to investigate large-scale phenomena such as the potential movement of magma in the Earth's crust, the drift of the Arabian Peninsula as it moves away from Africa, and the sources and intensities of earthquakes that affect the region.

In exploration geophysics, the main objective is to map structures that are of potential economic importance, such as those that control the location of ore deposits and petroleum reservoirs or to define the character of an aquifer. In geologic mapping, geophysics is commonly used to differentiate rock types and characterize their contacts. In the fields of geohazards and the environment, geophysics is used to measure features such as the magnitude and location of earthquakes and earthquake epicenters, and the levels of naturally occurring radiation. During the past seven decades, geophysical methods contributed significantly to geologic mapping and exploration for hydrocarbons, minerals and aquifers in Saudi Arabia, and aided the discovery of several ore deposits of economic significance in the Arabian shield.