Economic and Environmental Sustainability of Mineral Resources in Sindh, Pakistan.

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Abstract.

Pakistan lies between longitudes of 60°-70' East and latitudes 20°N and 37°N. In its north it have Himalayas, which have boundary with Russia and China. On its west is Afghanistan and Iran. South -West have Arabian Sea and Persian Gulf on to south-east have Indian territories. Pakistan is having 41 districts. From agro-geographical point it is divided into following regions.

- Mountainous north and north western region.
- The plateau of Quetta city and Kalat.
- The plains of Indus basin.
- Sand and sand dune tracts of Cholistan and Thar.
- Marsh lands and delta region.

Major minerals of Pakistan are: gypsum, barite, magnesite, soap stone, fluorite, marble, China clay, fire clay and fullers earth.

Mineral Resources Found in Sindh.

The gas, Chromite, coal, gypsum ,limestone and salt were discovered long time ago, with more intensive exploration, petroleum and other mineral have been found. The rich deposits of copper, iron, chromite, lead, zinc are discovered in large quantity, as well as a good quantity of coal has also be found in Thar in the province of Sindh. the production of barite, bentoite, various types of industrial clays ochre and silica sand has also found in recent years. Lead and zinc deposits are found in Lasbela area in province of Balochistan, chromite deposits in Khuzdar, coal deposits in Thar and iron ore in Punjab province. Large number of Antimony deposits are found in Balochistan, chromite found in Peshwar. Iron ore deposits are located in Kalabagh, Lengrial, Chilghazi and Chiniot area. around 14 million tonnes of lead and Zinc deposits are discovered in Balochistan.

The large number of useful mineral and raw elements are found in Thar are as under.

- Germanium (Ge)
- Gallium (Ga)
- Uranium.
- Humic acid.
- Benzene Extract.

(Ref. World Bank)

Introduction.

The mineral wealth of Sindh is very limited due to the nature of sedimentary rocks and lack of igneous rocks.

Survey In 1984 showed the mineral reserves as under:

- Chromite was large reserves.
- Iron ore was 430 million tons.
- Bauxite was 74 million tons.
- Copper was 412 million tons.
- Antimony was 21,000 tons.
- Molybdenum - large reserves.
- Sulphur was 800,000 tons.
- Lime stone - large quantity.
- Marble, sand, rock, salt, clay for ceramics, very large quantities.

Copper ore, iron ore, sulphur, gold, silver and molybdenum found in large quantities in Balochistan.

General.

Minerals are naturally formed chemical elements or compounds having a definite range in chemical composition and usually a characteristic crystal form.

Minerals are natural chemical elements or compound having a limited range in chemical composition, distinctive properties and form which reflects its atomic structure. Minerals crystal-system and identification is studied by X-ray diffraction method. But common minerals are recognised by their physical properties like: colour, lustre, cleavage, crystal shape and form, hardness, specific gravity and magnetism.

Since the oxygen and Silicon form 75% of earth surfactant rocks, it means silicates is the important part of rock-forming minerals. The Silicate mineral structures is a tetrahedral arrangement of four oxygen ions around silicon ion. The tetrahedral is jointed by a chemical bounds to form chains, sheets, or three-dimensional frame work, these three structures causes many of specific properties of minerals. The silicate minerals such as biotite, augite, hornblende and olivine that are rich in iron and magnesium have black or green colour are designated ferro- magnesia minerals. Non-silicate rock-forming minerals are the carbonates (calcite and dolomite) evaporites (gypsum and halite), iron oxide minerals (nematodecite, limonite, and magnetite).

Mineral fuel and iron are basic need of the country. Copper, lead and zinc are mostly used in industries. While mineral used as fertiliser are phosphates, potash, nitrates and sulphur. While gold and silver is used in industrial development. nickel, manganese, fluorspar, vanadium, tungsten, asbestos, mica, mercury, graphite, antimony a tin used in various industries. There are between 2000 to 2500 mineral species , but only about 150 are considered common.

Coal Resources in Sindh

Per capita energy consumption in Pakistan is 180 kg coal equivalent. Its production in the year 1970/71 was 12, 87,000 tons. But this coal is a very poor quality, lignite to sub-bituminous, present at lower territory sequence, and is around 50-60 million years old. It contain high ash volatile matter and sulphur, having low heat value. Although coal is one of principal minerals, its total reserves are 400 million tons. Coal mines exist in Sindh, Balochistan and Salt Range (Cis-Indus and Trans-Indus). Coal is used in brick and lime burning, ceramic industry, chemical industry and steam locomotives. This coal is lignite to sub-bituminous of Territory Age.

In 1983 the coal reserves were 640 million tons. But it had low calorific value, with high ash and sulphur content.

Coal in Sindh.

Sindh province has total coal resources of 184 billion tonnes. The quality of coal is mostly lignite-B to sub-bituminous A-C.
The five coal reserves fields in Sindh , including Lakhra coal field, Sonda, Thar, Badin, Metting-Jaimpir coal field are estimated more than 96.297 billion tonnes. Thar deposits relate to 40% of total cover area and total reserve in the area are above 200 billion tonnes. Lakhra coal field in the Dadu cover an area of 500 square kilometre exploration carried out less than 200 square .km. Sonda coal field cover an area of 1500sq.km out of which only 635 sq. km have been explored.

Instituted arrangements to develop Sindh coal (Ref. World Bank)

- Mines and mineral development department, Sindh established on 22-08-2001.
- Sindh coal Authority established under the Sindh coal Authority Act, 1993 governs through a Board headed by Ministry for mines and Mineral Development, Sindh.
- Task Force headed by the Prime minister, Islamic Republic of Pakistan

Coal Resources of Pakistan in the Province of Sindh.

Coal Field	Coal Resources (Million Tonnes)				
	Measured	Indicated	Inferred	Hypothetical	Total
Lakhra	244	629	455	-	1,328
Sonda-Thatta	60	511	2197	932	3,700
Jherruck	106	310	907	-	1,323
Others	82	303	1881	-	2266
Thar	3,407	10,323	81,725	80,051	175,506
Sub-Total	3,899	12,076	87,165	80,983	184,123

(Ref. World Bank)

Coal Deposits in Sindh

Lakhra District. Dadu.	1.328 billion tonnes.
Sonda- Jherruk. District- Thatta	5.512 billion tonnes.
East- Indus. Distrct. Thatta	1.5 billion tonnes.
Jhimpir- Metting District- Thatta	0.161 billion tonnes
Badin	0.0161 billion tonnes
Thar	175.506 billion tonnes

Sindh coal Fields.

These are located in lower part of Indus plans .Divided into many sub-groups.

In Sindh at Lakhra in Distric Dadu, huge deposits of over 218 billion tonnes of coal have been identified also small deposits are found in Sonda, Metting, Jhimpir in Thatta Distict.

1) Lakhra coal field.

Is found in District Dadu, 16 km to the West of the Khanot railway station on Kotri- Dadu section of Pakistan Railways. It cover an area of 200 sq .km. It show variation in thickness from 0.75 meter to 2.5 meters. Average thickness 1.5 meter. Coal rank of lignite-A to Sub-Bituminous -C. The coal is dull black contain amber resin flakes and about 30% moisture. It tend to crumble longer exposure to atmosphere and often susceptible to spontaneous combustion. The analysis results are as under:

Lakhra Coal field (Ref. -World Bank)

Distance from Karachi	193 km
Area	1309 sq. km
Coal Reserves	1.328 billion tonnes.

Chemical Analysis of coal.

Moisture (AR)	28.9 %
Ash (AR)	18.0 %
Volatile Matter (AR)	27.9 %
Fixed Carbon (AR)	25.2 %
Sulphur (AR)	4.7 to 7.0 %
Heating Value (Average)	4,622 to 7,554 Btu/lb

- Lakhra coal has high content sulphur and ash for cement use low ash, low sulphur coal is pre-requisite, so this coal is not suitable for this purpose.
- Thar coal has calorific value 11.10 to 17.64 MJ/kg. Average 13.22 MJ/kg belong to low-medium calorific value, easily grinned, poor thermal stability, strong reactivity to CO^2 , strong clinker, rich Tar and high humic acid, other used are gasification, liquefaction, power generation and humic acid extraction. (Ref. World Bank)
- The total reserves of the deposit have been estimated to be 1328 million tonnes with 244 million tonnes measured 629 indicated and 455 tonnes inferred. Its annual production is more than one million tonne.

Lakhra coal Project in Sindh, Statistics.

Location	176 km North of Karachi or 65 km North West of Hyderabad
Coal Field	Lakhra coal field.
Geological Horizon	Palaeocene
Type of coal	Sub- Bituminous to Lignite.
Calorific Values	2,570 to 4,260 k. Cal.
Working system	Room and Pillar method
Leased area (Two leases)	5,096.49 acres
Total coal resources production	38.82 million tonnes
year 2001 to year 2002	176,228 tonnes.

2) Thar Coal Field.

It have resources of 175 billion tonnes. Thar is located 400 Km South -East of Karachi. The coal field extend 9,000 Sq .km out of which 356 Sq .km are studied by Geological Survey of Pakistan. Providing 9 billion tonnes coal in four blocks. The main coal bed thickness range from 12 to 21 meters, at an average depth of 170 meters upper 50 meters being lose sand. The coal sample results show as under:

Thar Coal Field (World Bank)

Thar Desert Area (Approx.)	22,000 sq .km
Coal Field Area	9,100 sq. km
Total Drill holes.	217 nos.
Coal deposits.	175.506 billion .tonnes.
Coal reserves	Billion tonnes
Thar coal analysis	Thar coal analysis
coal quality	Lignite A-B
Moisture (AR)	46.77%
ash (AR)	6.24 %
Volatile matter (AR)	23.42 %
Fixed carbon (AR)	16.66 %
Sulphur (AR)	1.16%
Heating value (AR)	5.774 Btu/lb
Heating value (dry)	10,898 Btu/lb
* AR-as received.	-

Thar Coal Finding Chinese Report (World Bank)

- Gas- Analysis not reveal availability of Methane gas.
- Coal dust- each coal bed possess explosive natural dust explosion.
- Self combustion trial of coal- all the coals are of self-combustion type.
- Stripping Ratio - 5.30 upward.

3) Indus-East coal Field (World Bank)

Explored area	616 sq. km
Drill holes	16 nos.
Coal reserves.	1.5 billion tonnes
Coal rank	Lignite-B to sub .Bit-B
Ash (AR)	15.2%
Sulphur (AR)	2.6%
Calorific value (AR)	6,300 to 8000 Btu
Thickest coal bed.	2.40 meters
Moisture (AR)	33.1%
Volatile Matter (AR)	27.7 %
Fixed carbon (AR)	23.9%

4) Sonda- Jherruk coal field.

This contains over one billion tonnes reserves of lignite quality.

5) Thatta- Sonda- Jherruk Coal Field (World Bank)

Distance from Karachi	150 km approx.
Identified Area	1206 sq. km
Shallow West coal Bed	37.8 m
Deepest coal Bed	265.28 m
Coal reserves	7.112 Billion tonnes
Chemical Analysis	Chemical Analysis
Moisture (AR)	31.23 - 34.72%
Volatile Matter	27.9 %
Fixed carbon	25.2 %
Ash (AR)	7.69 to 14.7 %
Sulphur (AR)	1.38 to 2.82 %
Heating value (AR)	6,780 to 11,029 Btu/lb

6) Meting Jhimpir Field.

This field is located 80 miles north of Karachi near Jhimpir and Meting railway station. It cover an area of 350 sq. miles .Reserves are 28 million tonnes.

Sindh Coal authority (Ref. World Bank) function are explain as under.

Exploration of coal includes:

- Exploration.
- Development.
- Mining.
- Processing.
- Utilisation.
- Research and Development.
- Co-ordination of Infrastructure Development.
- Conduct problem oriented research.
- Development of indigenous technology.
- Promotion of investment Sector.

In Pakistan five regions are rich in minerals. These are as under:

1. The salt range and Makarwal region - rich in, rock salt, gypsum and coal.
2. The Potwar Plateau - rich in oil.
3. The north-east Balochistan and adjacent part of Waziristan - rich in coal, Chromite and marble.
4. The lower Indus Plain - rich in natural gas and coal.
5. The Chitral area - rich in Iron.

Pakistan is poor in metallic minerals and power resources, but has rich deposits of few non-metallic minerals. Although Pakistan have many mineral deposits which are yet not expedition and explored. So we have big future for export of these minerals

Mineral Potential in Sindh .Pakistan

On the basis of tecto- megmatic environments and associated metallic mineralization, following metallogenatic provinces in Pakistan are delineat.

1) Shield slopes Area (Industrial and Non- Metallic Minerals)

   The eastern shield slope zone has vast reserves of limestone, gypsum and rock salt along with commercially exploitable resources of dolomite and Cis-Indus salt range. In the northern marginal mass of Indo-Pakistan large reserves of magnetite, soapstone, phosphate and marble of various type occur.

2) Shield Area.

   Major part of the provinces of the Punjab and Sindh comprised of the shield rocks of Precambrian age, famous to host world class precious and recently, in Chinnot, a large oxide zone having hematite has been discovered to cap a sulphide zone having anomalous values of precious Meta indicate possibility of a larger base-precious metal deposit in the area. Regional geophysical survey has also defined much bigger an area of exploration.

3) Island Arc Environment.

   - Porphyry and Epitherma-deposits hosting copper-molybdenium-iron-gold deposits in Chagai District, in the Balochistan province.
   - Copper, iron, lead zinc, and other base metals in Kohistan district, NWFP.

4) Ophiolites and Ophiolitic Melanges.

   - Chromite deposits in parts of Lasbela, Zhob in Balochistan, Kohistan, North Wazirstan, Mohmand and Malakand Agencies in the provinces of Northern Areas.
   - Manganese in Lasbela and Northern areas.

5) Collisional Granitoids and Associated Rocks.

   - Antimony, arsenic, copper, lead, zinc, silver, mercury, gold, etc., as hydro-hermal veins, fissures and cavity fillings in Citral District, NWFP
   - Tin and tungsten in anatectic granites and contact carbonate rocks in Chitral, Hazara, Kohistan in NWFP and Northern Area.
   - Lithium in younger pegmatite in Chitral.

6) Rifiting.

   - Rare earth and radioactive minerals in carbonates in NWFP.
   - Copper, tin, lead, gold, etc. in Paleozoic sediments in the salt range, Punjab, and Abbottabad-Sherwan and other areas in Hazara, NWFP.
   - Antimony and mercury in the Chaman transform zone in Balochistan.

7) Shelf Carbonates.

   Barite-flourite associated lead-zinc-silver deposits in Khuzdar and Lasbela areas in Balochistan.

Reserves of principal minerals in Pakistan.

-	Marble (a ragonite/onyx).	Very large deposits.
-	China clay.	4.9 million tons.
-	Chromite.	Fairly large deposits.
-	Coal.	580 million tons.
-	Crude oil.	139 million US barrels.
-	Fire clay.	Over 100 million tons.
-	Fuller's earth.	Fairly large deposits.
-	Gypsum/Anhydrite.	350 million tons.
-	Iron ore.	Over 430 million tons.
-	Lime stone.	Very large deposits.
-	Rock salt.	Over 100 million tons.
-	Silica sand.	Very large deposits.
-	Copper.	412 million tons.
-	Dolomite.	Very large deposits.
-	Dauxite/laterite.	Over 74 million tons.
-	Barite.	5 million tons.
-	Soap stone.	0.6 million tons.
	Source: Pakistan Economic Survey, Year 1986-87, Table 8.1	

The Minor Minerals sources found in Sindh are as under:

Alum

It is found in Kirthar Nits.

Antimony.

The chief source in stibnite. Its reserves are 12,000 tons. The alloy is used in chemical industry. It is located in krinj (Kamalgol), Qila Abdullah, and Pishin It is also found in Kamalgol mines in Chitral. Its production is 33% per year. Traces of radioactive minerals found in N.W.F.P and D.G .khan District.

Asbestos.

Found in north of Hindubagh.

Barite.(Baryte).

It is Barium Sulphate. It is used in oil-well drilling, manufacture of plants, glass, insecticide and barrium compound. In the year 1964-65 its annual production in Pakistan was 10,000 tons, the year 1974-75 it was 20,000 tons. In the year 1985-86 it production was 42,000 tons. Its deposit located 10 miles south-west of Khuzdar at Gunga, which is about 1.4 million tons. The deposit at Kundi about 40 miles north-east of Bela is 13,000 tons. At Kohala deposts are 130,000 tons, small deposits are located at Bankhiri,, 10 miles east of Bela and Faquir Muhammad at 22 miles east of Haripur.

Bauxite.

Found in Hazara .District. The total reserve in Pakistan are 74 million tons. The rocks are Aluminous rather than bauxite. These are found in Muzaffarabad, Kotli in Azad Kashmir, Central Salt Range, Lorali District in Balochistan. The mine at Khakhan-China spring in Lorali Distrct its production is 2,000 tons annually.

Bentonite.

Its annual production is 1,000 to 1,500 tons. It is used in oil drilling, foundries, steel mills, clarifying , sealing reservoirs. Its deposits found in central salt range at Qadirpur Bhilmor and Bhadrar, in eastern salt Range at Rohtas Dariala, at foothills of Azad Kashmir at Bhimber Mawa Kanch and Samwal-Pothi-Kharota..

Calestime.

It is present in stone hills of Kohistan, is used in manufacturing fire works.

Carbonate Soda.

Present in large quantity in Nara Taluka of Khaipur State, in Nawabshah, Umerkot and Shah Bandar.

Celestine.

The estimated reserve is 300,000 tons. It contains about 83% Strontium Sulphate. In the year 1984-85 it was 650 tons. Celestite is used in signal rockets and flares, tracer bullets, transportation warning fused and fire-works. It also used in Strontium compound Ceramics, luminous paints, plastics industries. Its deposits are found in Thano Bula Khan, is also found in Daud Khel in the Western Salt Range.

China clay (Kaolin).

Kaolin found in Nagar Parkar, in Tharparkar Distect Ahl in Hazara Distrct and Shah Deri in Swat. It composed of hydrous aluminium Silicate minerals. Is used in cement, paper, rubber filter. It contains 16-31% Clay . In the year 1984-85 its production in Pakistan was one thousand tons.

Fire clay.

Its total reserve is 100 million tons .In the year 1984/85 its production in Pakistan was 77,000 tons. It .Is mainly used in refractories, in potteries, chemcials and fillers. It reserve are located in Surghar Range, Kishore Range , Trans-Indus area. It also found in Eastern and Western Salt Range.

Chromite.

In the year 1976/77, its production in Pakistan was 5,000 tons. In the year 1970/71 its deposit was 27,300 tons. These are located at Lasbela in the South and South Waziristan in Hindubagh in Zhob valley, Chagai, Kharan and Ras Khoh range north of Hari Chand Village in charsadda District , and Muslimbagh at north east of Quetta. Chromium is used in stainless steel, high speed tools, precision instruments, dyes and photography.

Copper.

Its deposits are located in the Eruptive Zone of Western Balochistan about 25 miles north of Koh-i-Tuftan Railway station. Iranian border is 25 km(15 miles) to its west and the Afghan border 42 km(26 miles) to its north. Copper deposits called Sulphide valley.

Fluorite.

It reserves are 95,500 tons. Which are located at KohiI-Maran and Koh-i-Dilband about 50 miles south of Quetta. Fluorite used in glass, steel, chemical and enamelling cooking utensils.

Fuller's earth.

Is found in soft yellowish clay form, mostly present in Ranki and Sebdi Nodasin Southern Sulaiman Range. Thano Bula Khan , Lakhi range, Kot Diji and Padhrar deposits. Ganjo hill, Iherruk, Thatta and Rohri hills. It is used for cleaning purposes. Also used in oil drilling, foundries, steel mills, oil filtering calrifying and sealing reservoirs. Annual production is 15,000 to 20,000 tons.

Gemstones.

Emerald, occur in sea green and transparent, is a costly stone. Found in Charbagh-Alburani near Mingora, Swat. Ruby is transparent deep red found in Hunza. Aquamarine blue to sea green in colour, topaz white colour and tourmaline blue found in Dassu, Skardu and Katlong in Mardan.

Gypsum.

They are white or pink in colour. The salt is overlain by gypsum, dolmite and clay. It total production in the year 1977 was 164,000 tons. It is located in Rakhi Mumh in foot hills of Sulaman Mountains, west of Dera Ghazi Khan, Khewra, Dandot, Daud Khel. Also at Saiyiduwali in Kishori Range and Chamalong in Marri-Bugti hills. They are mostly light grey, white and reddish pink in colour. It is mostly used in cement, plaster of Paris, prefabricated construction board and fertiliser marking, paints and rubber. The total reserve are 350 million tons.
It is found in Kirthar mountains and the Banks of Nai Gaj. It is found in abundant quantity in the form of lime stones..

Extraction of Main Minerals.

Items	1994-95	1995-96	1995-96	1996-97	%CH
Coal	3010	3465	2358	2448	3.86
Natural Gas	17.2	18.89	15.03	14.80	-1.53
Crude Oil	19.86	21068	15.75	16.10	2.22
Marble	46.7	458	308	360	16.88
Chromite	13	27	17	20	17.65
Dolomite	227	185	144	166	15.28
Gypsum	620	420	290	425	46.55
Limestone	9680	9740	6012	7289	21.24
Magnesite	5227	14981	20702	4652	-77.53
Rock Salts	890	958	739	816	10.42
Sulphur	510	20	30	-	-
Barvet	20	14	12	21	75.00

Figures of gas in thousand million cubic meter, crude oil in million barrels, magnesite in tonnes sulphur in tonnes and other in thousand tonnes. (Source Federal Bureau of Statistic Government of Pakistan)

RESERVES AND EXTRACTION OF PRINCIPAL MINERAL (2002-03)

Name of Minerals	Reserves	Unit	Production, 2002-03
Antimony	-	Tonnes	-
Marble	Very large deposits	000 Tonnes	1066
China clay	4.9 million tons	"	40
Celestite	-	Tonnes	402
Chromite	Fairly large deposits	000 Tonnes	31
Coal	185 Billion Tonnes	"	3609
Dolomite	Very large deposits	Tonnes	340864
Fire Clay	Over 100 million tons	Ooo Tonnes	117
Fuller's Earth	Fairly large deposits	"	15
Gypsum	350 million Tons	"	424
Lime Stone	Very large deposits	"	11880
Magnesite	-	Tonnes	2645
Rock Salt	Over 100 million tons	000 Tonnes	1426
Slica Sand	Very large deposits	"	185
Ocher		Tonnes	6733
Sulphur	0.8 million tons	"	19402
Soap Stone	0.6 million tons	000 Tonnes	66
Barytes	5 million Tons	"	41
Bauxite/Laterite	Over 74 million Tons	Tonnes	67536
Iron Ore	Over 430 million Tons	"	11483
Crude Oil	184 million Barrels	M.Barrels	23.46
Natural Gas	492 Billion cu.metre	000 MCU mtrs	28.11

1. Enegy Suppies in Pkaistan (2002-03) = 47060706 TOE
2. Production of Crude Oil in Pakistan (2002-03) = 23458000 Barrels
3. Domestic Production of Petroleum in Pakistan) = 8888340 Tonnes (2002-03)
4. Total Petroleum Energy Products Consumption) = 16451954 Tonnes (2002-03)

PRODUCTION OF SELECTED MINERALS IN SINDH, 1997 TO 2001

MINERAL	1997	1998	1999	2000	2001®
(In "000" Kgs.)					
Bentonite	1,210	2,530	2,750	..	615
Celestite	345	595	701	470	509
China Clay	17,508	20,305	18,335	14,565	11,769
Clay (Shale)	417,304	415,606	331,119	356,149	424,083
Coal	1,005,116	1,227,175	1,189,398	1,229,057	961,276
Chalk	4,207	6,863	7,036	7,331	7,703
Dolomite	112,868	74,112	129,817	178,396	147,058
Fuller's Earth	9,845	13,393	18,568	10,423	9,497
Flint Stone	111	119	52	..	..
Fire Clay	..	..	..	..	..
Gravel	1,856	..	19,062	..	..
Lake Salt	7,277	16,079	13,887	12,771	15,875
Lime Stone	2,221,358	2,315,397	2,204,292	2,385,480	1,641,449
Laterite	7,280	14,497	14,791	10,733	16,740
Marble	..	2,728	7,284	1,206	3,947
Silica Sand	77,375	40,342	46,324	55,016	55,903
Trona	3,323	3,300	3,561	3,325	3,863

Source: Directorate of Mineral Development Government of Sindh.

Source: UNCTAD yearbook

Gems and Precious Stones found in Pakistan.

S. No	Name	S. No	Name	S. No	Name
1	Actinolite	11	Hessonite	21	Rodingite
2	Agate	12	Idocrase	22	Rutile
3	Aquamarine	13	Jadeite	23	Ruby
4	Amazonite	14	Kunzite	24	Serpentine
5	Azurite	15	Kyanite	25	Spressartine(gamet)
6	Beryl	16	Marganite	26	Spinel
7	Emerald	17	Moonstone	27	Topaz
8	Epidote	18	Pargasite	28	Tourmaline
9	Garnet(alamandine)	19	Peridot	29	Turquoise
10	Garnet (green, grossular)	20	Quartz(citrin & others)	30	Vesuvianite.

Note. No reliable estimates of reserves and production are available. Estimated export of raw and cut/polished gemstones (mostly emeraid, ruby, topaz, aquamarine, peridot and tourmaline) are stated to be in excess of U.S $ 200.00 million per annum.

Industrial Usage of Minerals.

Minerals	Uses
Coal	Brick kilns, power generation.
China Clay	Ceramics, electrical insulators and white cements.
Celestine	Paints ,optical glasses, drilling mud and military usage.
Dolomite	Metallurgical flux, paints and pigments.
Fire clay	Fore brick and refractors
Fuller's earth	Textile, cooking oil , pesticide, soap, leather.
Granite	Decorative and building material
Gypsum	Cement, soil re-conditioner and plaster of pares.
Lime Stone	Building material, cement, steel mill, chemical, sugar factories, and soil conditioner.
Silica Sand	Glass, abrasives and furnaces.
Chalk	Paints and modelling
Flint Stone	Rolling mills and refractors
Lake salt	Tanneries, household, chemical, soap and dyes.
Laterite	Sulphate resistant cement, pigments and colours
Marble	Decorative building material
Sand Stone	Cement and pottery.
Gravel	Construction material.

In order to exploit mineral resources in Pakistan. Government has established following agencies.

Pakistan Mineral Development Board.

- Resource Development Co-operation establish in 1974, it function to investigate and develop copper mines.
- Gemstone Corporation of Pakistan Ltd, establish in 1979 to develop gemstone sector.
- Mineral Development Board at provincial level. To co-ordinate the work of various federal and provincial agencies.
- Mineral Co-operation Board at federal level.

Pakistan Mineral Corporation establish in 1974, its function is exploration and marketing of all minerals.

Pakistan contains some Metallic minerals like, Iron, Chromate and Antimony.

Iron Ore deposits.

Hematite ore contain 40-45% iron. The largest deposit in Pakistan are found in Mazari Tang, Marai Bela and Samana Range in Kohat area. Which is around 300 million tons are found near Kalabagh in the Surghar range and near Sakesar in the Salt range. This iron is mostly Chichali and Kutch type having only 30-35% iron in it. Some 3 million tons deposit having 55-65% iron in it , found in Southern Chitrl. Total reserves in Hazara District are about 100 million tons. Small amount is also found in Langrial Village in Haripur tehsil about 20 miles south of Abbotabad. These are have iron content 9-50% . Small amount also found in Galdanion about 10 miles north-east of Abbottabd. This contains only 14-46% iron in it. About 3 million tons better iron ore having 55% iron in it found in Chagai District near Dalbandin. Limonite and Siderite deposit having 31% ion located at Marwat range near Pezu. In the year 1980-81 its production was only 1,000 tons. It is mostly found in Kotri Taluka and around the Jherruk hills.

Hematitic clay stone and silt stone occur at Kakul, Galdanian and Chure Gal, it contain 20% iron. At Langrial, low grade Oolitic hematic contains 9-30% iron. At Rakhimunh in Dera Ghazi Kahn, limonite and Siderite deposits are found, having 37% iron. At Dommel Nissar located about 20 miles south of Drosh in Chitral contain 45% iron. Chakuli Bakht area in Zarimure Mountain contain 45% iron. Chilghazi and Baluchap Kundi near Dalbandin. Thhe North Chagai Arch. The Ore is magnetitite it contains 33-55% iron.

Limestone.

Pure limestone is Calcium Carbonate. In the year 1977 its production in Pakistan was 3 million tons. It present as a Sedimentary rock part located in Pezu, Moghalkot, Kohat, Nowshera in N.W.F.P, Lorali, Harani in Balochistan, the salt Rang, Potwar Plateau, Margalla Hills, Zinda Pir in D.I.G.khan, Ganjo Takkar, Murli Hills, Mango Pir, Cape Monze , Kot Diji and Ranipir in Sindh. It also found in Trans-Indus salt range at Daudkhel and lower Indus Plain near Hyderabad. Limestone used in chemical and glass factories also as an ingredient in cement manufacturing, bleaching powder, soap, paper and paint industries. In the year 1985/86 it production in Pakistan was 6.3 million tons. It is us used for lime and building making.

Manganese.

It is found in Axial Belt at Lasbela, in Chagai District of the Eruptive Zone and at Galdanian. In the year 1980-81 its production in Pakistan was 84 tons.

Marble.

It is one of the country foreign exchange earning. In the year 1980/81 its production in Pakistan was 114,000 tons, In 1985/86 its production in Pakistan was 122,000 tons. In the year 1970/71 its production in Pakistan was 26,000 tons. Its name is Aragonite. The white crystalline, with uniform texture can be compare with Carrara, marble of Italy. It is also present in grey, yellow, green, red ,brown and in various colour patches . It deposits are found in Mullagori, area of Khyber Agency, Maneri in Mardan Distrct, Swat , Dalbandin Hills of Campbellpur Distrct, Muzaffarbad, Mirpur, Azad Khasmir, Multagari road in Peshwar. The Ghaudai Tarko marble deposits are located at the boundary of Swabi, Mardan District and Swat.Onyx (Travertine) found in Eruptive zone in Chagai area.

Rock salt and Brine.

It is called Halite. In the year 1947/48 its production in Pakistan was 163,000 tons, in the year 1984/85 it increased up to 573,000 tons. Its located salt Range escarpment, from Junate to Mari Indus. Important miners are Khewra, Warcha, Kalabagh and Jatta. At kewra its production was 220,000 tons. The worked area thickness is 60 ft. Khewra is the terminus of Makarwal branch. The Warcha is located 10 miles north-west of Gunjital railway station, its production is 40,000 tons, its having five seams, with thickness of 50 ft. The Kalabagh salt field is located at the right bank of Luni Wahan nullah. At Trans-Indus extension of slat Range, Jatta, Bahadurkhel and Karak salt deposits are located. In which Jatta and Karak rock have 100 ft, while Bahadurkhel rocks are 350 ft thickness. In 1970/71, salts derived from brine and salt lakes was 344,000 tons. Salts derived by evaporation of sea water, this practice is done in Tharparkar area, Mauripur, Makran, Lasebela Coasts, and Dharyala near Khewra. These brine and salt used in potash and fertiliser factories, soda ash, bicarbonate of Soda, caustic Soda, Soda of laundry, textile and tanning industries.

Salt.

Sindh does not have any salt rocks, but salt is available from sea-water and salt lakes.

Soap stone.

Its total reserve is 0.6 million tons, annual production is 22,000 tons. Soap Stone is Steatite, which is a variety of talc. Its deposit located in Axial Belt. In Sherwan located in Abbottabad, Zhob and Safed Koh near Parachinar. It is used in Ceramics, face powder and as a filler in soap industry.

Sulphur.

In the year 1971/72 its production was 2,750 tons, In the year 1984/85 its production left only 884 thousand tons. Its reservoir located at northern Kirthar at Sanni, about 75 miles South-east of Quetta. This reservoir is about 59,000 tons, this is about 45% grade. The other reservoir are located about 300 miles West of Quetta at Koh-i-Sultan, . This is 738,000 tons about 50% grade. Sulphur is the basic part of Sulphuric acid, is used in paints, dyes, rayon, pulp, fertiliser, refining petroleum, non-ferrous metals and explosive material.

Geological Survey of Pakistan.
Metallic and Non- Metallic Mineral Resources (in metric tonnes)

Deposit Type	Mineral	Preserve size	Annual production .Average.
Metals	Antimony	Small	35
	Chromite	Small to medium	27,458
	Iron ore	Small to medium	24,322
	Manganese	Small	655
Non- Metals	Agglomerate	Large	366
Building &	Aragonite/Marble	Large	497,317
Dimension Stones	Basalt	Large	217
	Building Stone	Large	16,011
	Conglomerate	Large	276
	Ebry Stone	Medium	209
	Granite	Large	5,676
	Gravel	Large	19,684
	Onyx marble	Large	28,780
	Ordinary Stone	Large	1,887
	Sand / Bajri	Large	92,670
	Sand Stone	Large	2,255
	Serpentine	Large	4,204
	State Stone	Large	108,182
Clay	Ball clay	Small	1,371
	Bentonite	Small	19,983
	China Clay	Small to medium	61,403
	Clays*	Large	2,934,218
	Fire clay	Medium	124,003
	fuller's Earth	Medium	18,446
Chemical, &	Asbestos	Small	60
Fertiliser &	Barite	Large	26,002
Industrial Minerals	Bauxite	Small	22,360
	Brine	Medium	55,903
	Calcite	Small to medium	15
	Celeste	Small	838
	Chalk	Small	7,945
	Dolomite	Large	276,668
	Field Spar	Small	32,012
	Flint Stone	Small	73
	Fluorite	Small	579
	Gypsum	Large	384,513
	Lake Salt	Small	16,035
	Laterite	Small	21,532

Deposit Type	Mineral	Preserve size	Annual production .Average.
	Lime Stone	Large	8,697,573
	Magnesite	Large	4,535
	Mill Stone	Small	1,257
	Nepheline syenite	Small	70
	Ochres / Red oxide	Medium	12,780
	Orpiment	Small	29
	Phosphate	Small	1,074
	Pumice	Small	1,577
	Quartz	Small	485
	Quartzite	Small to medium	1,457
	Rock salt	Large	1,212,366
	Silica Sand	Large	157,300
	Soap Stone	Medium to large	46,486
	Sulphur	Small	527
	Talc Stone(Talc)	Small	260
	Trona	Small	3,446
fuels	coal	Large	3,105,715
	Natural gas	41,978893	923,758
	(Trillion cubic feet)	26,98237	million CFT
	Crude Oil	765.237	23,195,048
	(million barrels)	300.203	US Barrels
	Uranium	N.A	N.A
**	Ochres, red ochres and	Red Oxide.	
CFT	Cubic Feet.		

Production of principal non-metallic minerals in Pakistan in selected years (thousand tons).

Minerals	1947-48	1960-61	1970-71	1980-81	1984-85
Brite.	-	-	3	21	21
Gypsum.	15	94	167	554	400
Magnesite.	-	-	648	397	3,137
Rock salt.	163	210	350	514	573
Soap stone.	-	1	4	28	17
Sulphur.	-	-	-	403	884

Source: Economic Survey of Pakistan 1986-87 Table 8.2 and other sources.

In 1970/71 mineral production contributed less than 0.5% of the G.N.P. The index of mineral production rose from 100 (1964/5) to 122 (1971/2), a slow rate of growth when compared with the industrial sector.

Natural gas.

Its production in the year 1959/60 in Pakistan was 25,750 million cubic ft. While in the year 1971/72 it was 127,075 million cubic ft. It was found in Zin , Uch, Khairpur, Kandkot , Mari, Golarchi, Khaskheli, Mazarani, Pirokoh and Laghari.,Sari , Jacobabad and Dhullian. The gas found in Pakistan having 73% content of methane. Its biggest reservoir was found in Sibi District, which cover 75 sq. miles, about 37.5 % gas production used in power generation, 19.3% in fertiliser factories, 26.0% in textile, 14.0% in other industries, only 3% used in domestic purposes.

Natural gas is located nearly 40 natural gas fields and reserves estimated over 31 trillion cubic feet. While country consumption is 7 trillion cubic feet. Country average production is 1500 million cubic feet per day. Mari gas field supply 290 million cubic feet per day, Kandh kot gas field present supply of 30 Mcfd, Pirkoh gas field daily production is over 200 Mcfd , Loti gas field producing over 40 Mcfd and Adhi gas field produce 18 Mcfd of gas and 62 Tpd of liquefied petroleum gas as well as over 300 Bpd of natural gas liquid (NGL)

Energy supply in Pakistan (percentage share).

Source	1980-81	1984-85	1985-86
Oil excluding export.	36.7	40.7	40.2
Gas excluding feed stock.	41.6	35.4	35.0
Hydroelectricity.	15.8	17.1	18.4
Coal.	5.3	5.9	5.5
Nuclear.	0.23	0.4	0.6
LPG.	0.3	0.5	0.4

Source: Economic Survey of Pakistan, 1985-86. Table 8.2, and 1986-87 Table 8.2.

The Economic survey of Pakistan in 1997 the mining growth was 6.8% ,while the out put of coal, crude oil and natural gas, which carries 79%, weight in mineral sector will grow by 3.8%, 1.9% and 8.7% respectively.

Natural oil Resources.

In the year 1971/72 the crude oil production in Pakistan was 2.9 million barrels. Pakistan have large number of sedimentary rocks. Which have petroliferous members. Few sites are explain as under:

Khaur

Is located 54 miles south-west of Rawalpindi in District, Campbellpur. The stratigraphic and structural traps consist of grey stone and red shale.

Dhulliam field.

It is located 10 miles north-west of Khaur. This is the one of the biggest oil field in the country. It is also a source of gas production. It covers about 36 sq. miles, oil is obtained from the Lani and RaniK t horizones of the basal Murree beds.

Jaya Mair oil field.

This structure is narrow anticlone oil-producing horizon, Sakesar limestone. The oil is heavy asphaltic oil.

Balkassar oil field.

Is found at west of Joya Mair in Jehelum District. The field is gentle anticline, having two Eocene limestone, oil producing horizons. But oil is rich in asphalt.

Karsal oil field.

It is located very near toward north west of Balkassar.

In Campbellpur district, Tut, Kot Sarange and Mayal oil fields are founds.

Recently large number of oil-fields are located in Sindh, where work is still under process. Nari, Tajedi, Mazari, Turk, Dhulian, Joya Maris, Meyal, Toot, Adhi and Fimkassari, Khaskheli, Laghari and Tando Alam.

Field-wise location, year of discovery and production of crude oil in Pakistan 1980-81 and 1984-85 (thousand US barrels).

Field	Location	Year of discovery	1980-81	1984-85
Khaur.	Potwar.	1915	2	3
Dhulin.	Potwar.	1935	123	9
Joya Mair.	Potwar.	1944	181	87
Balkassar	Potwar.	1946	280	184
Toot.	Potwar.	1968	515	925
Meyal.	Potwar.	1968	2,271	1,395
Adhi.	Potwar.	1978	57	399
Dhurnal.	Potwar.	1984	-	2,166
Fim Kassar.	Potwar.	1978	-	10
Khaskheli.	Lower Sindh.	1981	-	1,161
Laghari.	Lower Sindh.	1983	-	2,188
Tano Alam.	Lower Sindh.	1984	-	995
TOTAL	-	-	**3,567**	**9,522**

Source: Energy year book, 1985, Table 2.1 and 2.2

Domestic production and total consumption of petroleum in Pakistan and percentage of domestic production to total consumption in selected years.

Year	Consumption (thousand metric tons)	Domestic production (thousand metric tons)	Domestic production as percentage of consumption
1949-50	817	99	12
1959-60	2,413	258	11
1969-70	3,820	461	12
1979-80	4,151	479	12
1984-85	6,616	1,278	19

Source: Economic Survey of Pakistan, 1980-81 and Energy Year Book, 1985.

Lignite products are: Electricity, briquettes, pulverised, lignite, fluidized, bed lignite, coke, substitute natural gas, and fuel.

Mineral resources utilisation future work.

- Power plant to be established.
- Underground coal gasification projects.
- Use of coal by cement industry.

Strategies of work.

- Geological investigations and studies.
- Infrastructure development.
- Promote private investment.
- Appropriate co-ordination.
- Assist the investors.
- Conduct all geo-technical studies, hydro -geological studies to boost this sector.
- Determine most economic ,efficient, and reliable technology to operate the coal mines
- Exploitation of indigenous coal, which will lead self reliance.
- Contains shifting of people from rural to urban centres.
- Poverty alleviation.
- Sustainable power generation programme.
- Stop deforestation.
- Gasification, liquefaction, briquetting and pulverisation of coal.

Ministry of Petroleum and natural resources achievements.

- Foreign direct investment of US$ 1 billion in the petroleum sector.
- Gas production increased by 1 billion cubic feet per day from new discoveries.
- US$ 800 million per annum saved through replacement of furnace oil with supply of indigenous gas to power plants.
- Contribution of gas in total energy mix increased from 37 to 50%.
- 22 petroleum exploration licenses granted including 20 onshore petroleum concessions and 2 offshore sharing agreements.
- Oil and gas regulatory Authority (OGRA) established to protect consumers interest.
- 5,50,000 vehicles converted to CNG which are serviced by 500 CNG stations.
- LPG production doubled.
- Petroleum sector emerged as major contributor to national budget.

Ref.- Ministry of Petroleum and natural resources government of Pakistan.

Sui Southern Gas company Ltd. Achievements.

- System network capacity doubled (600 to 1200 MMCFD)
- Gas supplied to 125 new towns/villages in Sindh and Balochistan benefiting over 400,000 population.
- Special projects being implemented under the President's/Prime Minister's directions for supply of gas to Ziarat, Kalat , Sohbatpur Khangarh, Jaffarabad , Jacobabad, Dadu and Shakarpur.
- 90,000 new gas connections provided to domestic, commercial and industrial consumers benefiting 600,000 persons.
- Facilitating $ 32 million project of 400 tons LPG per day through private sector on build own operate (BOO) basis to enhance country 's LPG supplies by 40%.

Ref.- Sui Southern Gas Company Ltd. Pakistan.

Introduction WTA Technology to get its benefits.

- Benefits from WTA Technology.
- Energetically very efficient.
- Quasi-emission free drying.
- Self-sufficient in term of steam.
- High safety standard (inert atmosphere)
- High drying capacity (continuos process)
- Release of evaporated water as an almost solids-free condense.
- Lignite drying done due to extract water for other utilisation, nearly double the calorific value and raise efficiency of power station.

Benefits of indigenous fuel/coal industry.

- Self-reliance.
- Reliable and less expensive fuel. generation of massive economic activities.
- Direct and indirect employment and business avenues.
- A sustainable power generation programme poverty alleviation.
- Massive saving in foreign exchange, contain shifting of population from rural to urban area.

Ref.- Harnessing of coal resources of Sindh Province-Dec.12, 2003. World Bank.

The constrains in mineral Industry in Pakistan.

In Sindh due to the nature of sedimentary rock and lack of igneous rocks, so the availability of minerals is limited.

- Pakistan have only few non-metallic minerals.
- The number of major minerals are only 25-30 numbers.
- The quality and quantity of few of them is not known , their economic feasibility has yet not studied.
- The Infrastructure required for their exploitation does not exist.
- Still mining is less important sector of economy in Pakistan.
- It is 0.5% GNP and minerals plays week role in Industrial development in Pakistan.

- There is no Industry for refining Chromite Ore, so high cost of production comes its way of production., and exploitation.
- A major constrain for all development in the difficulty of finding adequate water for industrial plants their workers.
- The bulk of production comes from small privately owned mines, those are lacking funds..

Conclusion.

Since Pakistan is still is under -developed. We do not have new and advance technologies and equipment to exploits our mineral resources and use them properly in industries. We still have many source of deposits, not yet exploited, there are major hindrance is the lack of funding, non-availability of drinking water for industrial workers, the quality and quantity of these minerals need advance technologies and re-finning industries of these mineral are very few.

Results.

There are lot of scope in mineral industries development in Pakistan. Once it developed properly Pakistan improve its economic position and bring better development and Sustainable growth of the Country.

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