

A BRIEF REVIEW OF THE  
MINERAL WEALTH  
OF PAKISTAN

By  
Ali H. Kazmi  
& S. Ghazanfar Abbas



GEOLOGICAL SURVEY OF PAKISTAN

## ABOUT THE AUTHORS

**Ali H. Kazmi** received his B.Sc. degree from Lucknow, India and D.I.C. from the Imperial College of Science & Technology, London. He has been a Nuffield Fellow at the University of Cambridge and a Fulbright Fellow and a Courtesy Professor at the Oregon State University, USA. He has served as a geologist and in various other capacities for over 40 years with the Geological Survey of Pakistan, Pakistan Mineral Development Corporation, and Gemstone Corporation of Pakistan.

Pursuing geological and gemmological research he has travelled world widely. Kazmi has published more than 40 professional papers, 50 professional reports, and three books. His three books are entitled "Emeralds of Pakistan" (Kazmi & Snee, editors, Van Nostrand Reinhold, New York, Publishers), "Significance of Coal Resources of Pakistan" (Kazmi & Siddiqui, editors, published by Geological Survey of Pakistan and "Gemstones of Pakistan" (Kazmi & O'Donoghue) published by Gemstone Corporation of Pakistan.

Presently he is the Director General of the Geological Survey of Pakistan, President of the Pakistan Institute of Geoscientists and a member of the Board of International Geological Correlation Programme (UNESCO).

**S. Ghazanfar Abbas** received his B.Sc. (Hons) and M.Sc. degrees from the University of Karachi. He has been a member of the CENTO working group on Intrusive and volcanic rocks, ICCP group 169, Karakoram expedition and Geological Society of America. He has worked on several economic geology projects, important among these are the exploration and evaluation of Malakand and Muslim Bagh chromite deposits, discovery and evaluation of first massive sulfide type deposit in Lasbela District, evaluation of Kalat fluorite deposit, evaluation of Duki and Khost-Shahrig-Harnai coal fields. He was selected as project leader for Duki coal exploration project by the World Bank. He has more than 20 publications to his credit as author and co-author.

Presently he is Deputy Director and incharge of the Economic Geology Cell of the GSP Head Quarters office at Quetta.

GOVERNMENT OF PAKISTAN  
GEOLOGICAL SURVEY OF PAKISTAN

**A BRIEF REVIEW OF THE MINERAL  
WEALTH OF PAKISTAN**

BY

ALI H. KAZMI

AND

S. GHAZANFAR ABBAS

Issued by the Director General, Geological Survey of Pakistan  
October, 1991

# C O N T E N T S

FOREWORD ... ..	iv
INTRODUCTION ... ..	1
MINERAL PRODUCTION ... ..	2
METALLIC MINERALS ... ..	3
Antimony ... ..	3
Chromite ... ..	4
Copper ... ..	5
Iron ... ..	7
Lead and Zinc ... ..	8
SOLID FUEL ... ..	9
Coal ... ..	9
PRECIOUS AND DECORATIVE STONES ... ..	13
Precious Stones ... ..	13
Marble/Aragonite... ..	14
CERAMIC MINERALS ... ..	15
Barytes ... ..	15
Celestite... ..	17
China Clay ... ..	17
Fluorite ... ..	19
Fuller's Earth ... ..	20
Fire Clay... ..	21
Feldspar ... ..	22
Limestone ... ..	23
Silica Sand/Glass Sand ... ..	24
FERTILIZER AND INDUSTRIAL MINERALS... ..	25
Magnesite... ..	25
Ochre ... ..	25
Rock Salt... ..	26
Sulphur ... ..	27
Soapstone and Talc ... ..	27

MINERAL BASED INDUSTRIES ... ..	28
RECENT MINERAL DISCOVERIES ... ..	28 ✓
CONSTITUTIONAL AND INSTITUTIONAL FRAME WORK ... ..	29
CONCLUSIONS ... ..	30 ✓
ACKNOWLEDGEMENTS ... ..	31
REFERENCES ... ..	32
Table - 1: Mineral sector share in the GNP of Pakistan.	2
Table - 2: Saindak ore reserves and grades.	6
Table - 3: Estimated recoverable quantities and values.	6
Table - 4: Location, reserves and grade of iron ores in Pakistan.	7
Table - 5: Summary of coal resources of Pakistan as on January, 1990 (in million tonnes).	11-12
Table - 6: Range of proximate analyses of Pakistan coals (Kazmi, 1989).	13
Table - 7: Mineral and Gemstone occurrences in Pakistan, (Kazmi, et al., 1989).	16
Table - 8: Range analyses of barytes, (Klinger and Richards, 1967; Klinger and Ahmad, 1967; Afridi, 1986).	16
Table - 9: Chemical composition of Shah Dheri China clay (Moosvi, A.T., 1975).	18
Table -10: Chemical composition of Nagar Parkar china clay (Griffiths, 1987).	19
Table -11: Chemical analyses of fuller's earth (Ahmad, et al, 1987).	20
Table -12: Chemical analyses of selected Pakistani fire clays (Raw basis, Hussain and Naqvi, 1973).	22
Table -13: Chemical analyses of selected Pakistani fire clays (calcined basis, Hussain and Naqvi, 1973).	22

Table -14: Analyses of feldspar from Swat (Griffiths, 1987).	23
Table -15: Analyses of silica sand (%) (Griffiths, 1987; Hussain, 1976, Hussain, undated).	24
Table -16: Analyses of magnesite from Muslim Bagh (Nagell, 1971).	25
Table -17: Analyses of rock salt (Griffiths, 1987).	27
Figure 1: Map showing location of major metallic mineral deposits of Pakistan.	
Figure 2: Map showing solid fuel resources of Pakistan.	
Figure 3: Location map of gemstone showings in Pakistan (Kazmi et al., 1990).	
Figure 4: Map showing main deposits of precious and decorative stones of Pakistan.	
Figure 5: Map showing main deposits of ceramic minerals in Pakistan.	
Figure 6: Map showing location of main deposits of fertilizer and industrial minerals.	
Annexure-1	Yearwise production of different minerals for the period 1982-83 to 1987-88 (in tonnes).
Annexure-2	Reserves and production of minerals during the year 1987-88 being mined in substantial quantities.
Annexure-3	Table showing reserves of minerals which have prospects for economic development and exploitation.

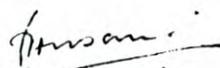
## FOREWORD

The Geological Survey of Pakistan, since its inception in 1947-48, has served the nation in more than one way. One of the significant objectives of the GSP has been, and still is to keep the nation informed of its mineral wealth. Although not all of our reports are published, the Geological Survey of Pakistan welcomes everybody to seek information about our mineral deposits and to exploit them for the good of the country.

In 1947, only six minerals were being mined. The number has now been increased to more than 30. This is itself, not counting the multitudes of other benefits, is a tribute to the national Geological Survey, to the earth scientists and to other earth science organizations of the country.

The present brochure, briefly describes several economic mineral deposits of significance in Pakistan. It may be mentioned that several of these have come to light as a result of the efforts of the Geological Survey of Pakistan. Coal fields of Sonda-Lakhra (Sindh), iron of Chiniot (Punjab), lead - zinc - barytes of Khuzdar (Balochistan) and porphyry copper-gold-molybdenum of Saindak (Balochistan) can be cited as examples. The present brochure gives some basic informations about these and many other mineral deposits of Pakistan it is hoped that the readers will find the brochure useful.

Dated: 12th October, 1991

  
Dr. Farhat Husain  
Director General  
Geological Survey of Pakistan

# A BRIEF REVIEW OF MINERAL

## WEALTH OF PAKISTAN

By

A. H. Kazmi

and

S. Ghazanfar Abbas

### INTRODUCTION

The mineral industry in Pakistan is still in a nascent stage and its contribution to GNP is 2.08% (Table-1). However, in recent years a fair amount of progress has been made. The geology of the country is now known in much greater detail and even more cautious experts are now willing to concede that, although it is likely that Pakistan, with more intensive exploration, may not prove to be a highly mineralised country, such as Chile or South Africa, there is no doubt that the mineral industry can be enlarged many times. This is well reflected in the progress achieved so far. At the time of Independence only chromite, coal, gypsum, limestone and salt were being mined in an appreciable quantities. Now, promising deposits of copper, iron, chromite, lead and zinc are known to occur in the country. Geological environments suitable for the localization of important metallic minerals such as antimony, gold, lithium, silver and platinum has been identified in different parts of the country. Vast resources of coal, over 19.0 billion tonnes, have been identified. Inexhaustible resources of construction materials are available in all the provinces and are being utilized in large quantities.

Buried mineral resources are of little value and consequence unless taken out and utilized. A summary of these resources and their development potential is given in annexures 1,2 and 3. These mineral deposits are also described briefly in this paper along with a summary of activities in the field of mineral exploration and development.

TABLE-1: MINERAL SECTOR SHARE IN THE GNP OF PAKISTAN

(in millions)

Year	GNP	Population	Mineral sec.share	Percentage share
1974-75	105787	69.21	793	0.75
1975-76	124415	71.29	968	0.79
1976-77	141166	73.43	1196	0.85
1977-78	171979	76.61	1317	0.77
1978-79	192377	78.94	1464	0.76
1979-80	228537	81.36	2239	0.98
1980-81	269721	83.84	3149	1.17
1981-82	315137	86.44	3578	1.14
1982-83	367304	89.12	4199	1.14
1983-84	415387	91.88	5086	1.22
1984-85	473326	94.73	7116	1.50
1985-86	530735	97.67	11029	2.08
1986-87	582381	100.70	12136	2.08

Source: Statistical Division, GOP

**MINERAL PRODUCTION**

During the recent past the mineral sector in Pakistan has gone through a substantial transformation. In general most of the indigenous minerals have registered an increase in production and some significant discoveries have been made. The production of barytes, bentonite, various types of industrial clays, fire clay, gypsum, limestone, marble, magnesite, ochre and silica sand has increased appreciably (Annexure-1).

Some important new mineral discoveries have been made recently such as lead-zinc deposits of Lasbela-Khuzdar, chromite deposits of Khuzdar, coal deposits of Sonda and iron ore of Kirana, near Chiniot.

Minerals which are being mined in fairly large quantities, are barytes, celestite, china clay, chromite, coal, dolomite, ebrystone, fire clay, fuller's earth, gypsum, limestone, marble, phosphate, rock salt, silica sand, soapstone and sulphur (Annexure-1).

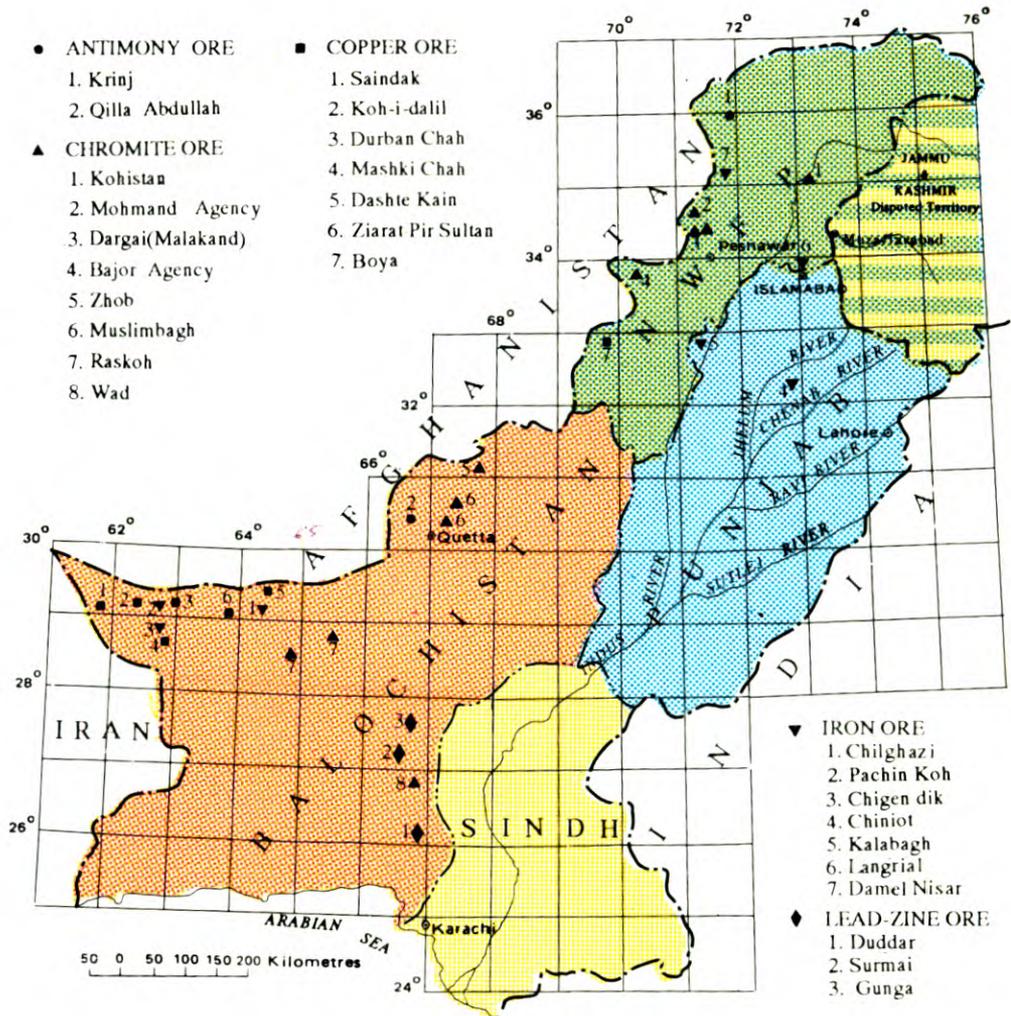


Figure 1: Map showing location of major metallic mineral deposits of Pakistan.

In recent years deposits of several other minerals have also been located which are presently being worked on a very limited scale although there are good prospects that these may be developed and produced in large quantities. This category of minerals comprises gemstones and industrial minerals such as abrasive, mica, graphite, and trona (Annexure-2).

A brief description of the mining potential and production of some of the more important minerals is given in alphabetical order in the following pages and in Annexure-3.

### METALLIC MINERALS.

#### **Antimony**

Antimony is an element and an important metal. It occurs as native metal in nature but more frequently the ore is in the form of either sulphide or oxide of the metal. The most common antimony ore is stibnite ( $Sb_2S_3$ ). It is used for making alloys in which antimony imparts hardness to the final product. It is also used in the manufacture of antimony compounds and other chemicals having varied commercial uses. An important antimony salt is its trisulphide which is used in the production of safety matches, in percussion caps of cartridges, in tracer bullets and similar light signals.

Antimony deposit, which has been sporadically mined in the past, is near Qila Abdullah in district Pishin of Balochistan. In this area, stibnite is associated with quartz veins which fill fractures and joints in Khojak shales of Oligocene age. More showings of antimony in similar geological setting have been recently discovered by GSP in Kharan district.

At present, antimony deposits are being mined in NWFP only. The deposits occur in the Lutkho and Partsan areas near Krinj village, Chitral district. Stibnite ( $Sb_2S_3$ ) is found as veins, lenses and irregular masses along shear zones in Chitral slates.

The production\* from Lutkho deposits of Chitral during the year 1986-87 was 45 tonnes but no production could be

---

\* Mineral production data largely based on Mineral Year Book 1989, issued by the Central Statistical Division, Islamabad.

obtained during the year 1987-88. A maximum production of 650 tonnes was achieved in the year 1940 (Hussain, 1974). Decline in production is mainly due to the fact that there is no local market for the ore and the area remains cut off from rest of the country for most part of the year. The ore is first converted to antimony trioxide and then air lifted to Peshawar, making it very costly.

Present estimates of available ore is 26,000 tonnes but detailed investigations may prove more tonnage. The antimony content of the ore varies from 7 to 12% (Hussain, 1974).

### Chromite

Chromite with a general chemical formula  $(Mg, Fe^2)(Cr, Al, Fe^3)_2O_4$  is the only source of chromium metal. Chromium metal is mainly used in the manufacture of stainless steel. Chromite is also used in making chemicals and salts of chromium, having a wide range of industrial uses. The use of chromite as refractory material is also quite common.

Chromite is associated with ultramafic rocks, occurring as layered intrusions (Bushvelled & Stillwater, etc) or as ophiolitic sequences (Sumail & Varinous, etc). Chromite ore in layered intrusions occurs as large extensive layers with huge tonnage while chromite ore bodies associated with ophiolitic type of rocks are generally irregular podiform in shape and small in size. The chromite deposits associated with ophiolitic rocks are generally called alpine type.

The chromite deposits of Pakistan are of the alpine type. They are associated with ophiolitic rocks emplaced along the colliding plate boundaries. The chromite is found as pods, lenses and irregular shaped bodies in dunite. The dunite occurs in the basal part of the ophiolites, i.e., in ultramafic tectonites and ultramafic cumulates.

Chromite is largely mined in Balochistan and NWFP. Its deposits occur at the following localities:-

- Muslim Bagh (District Qilla Saifullah)
- Wad, Sonaro (District Khuzdar)
- Bunap, Rayo Valley (District Kharan)
- Dargai (District Malakand)
- Besham, Kohistan (District Swat)
- Pranghar, Bucha (Mohmand Agency)
- Boya (North Waziristan)

At present chromite is being produced from Muslim Bagh, Wad and Sonaro areas of Balochistan Province and Malakand and Kohistan areas of NWFP. A total production of 8,628 tonnes was achieved during the year 1987-88 as reported by the Directorates of Mineral Development of NWFP and Balochistan. However, in some of the previous years annual production of upto 35,000 tonnes was achieved from Muslim-Bagh alone.

The Geological Survey of Pakistan has explored the Muslim Bagh deposits and has carried out geological mapping, geophysical surveys and some drilling (Asrarullah, 1960; Farah, et al, 1970; Rossman, et al., 1970; Van Volten, 1970). The Dargai chromite deposits (Malakand District) have also been investigated in some detail with the help of large scale mapping and very limited drilling (Rossman et al., 1970). Preliminary reconnaissance survey of other deposits have been conducted by the GSP .

In Wad-Sonaro area sizeable reserves of high grade lumpy ore are available (Abbas, 1989); while in Malakand large deposits (Rossman, et al., 1970) of disseminated ore are found which can be beneficiated to produce salable chromite concentrate. The large exposures of ultramafic rocks in Las Bela-Khuzdar, Muslim Bagh, Waziristan, Mohmand, Bajor and Kohistan suggest reasonably good prospects of finding more chromite deposits in Pakistan.

The entire chromite produced in the country is exported. Generally, Pakistani chromite containing over 46%  $\text{Cr}_2\text{O}_3$ , 10 to 15%  $\text{Al}_2\text{O}_3$ , less than 10%  $\text{SiO}_2$  and with Cr:Fe ratio over 2.8 has been mined and exported. Due to recent increase in world demand, production and export of inferior quality chromite with 35%  $\text{Cr}_2\text{O}_3$  and Cr:Fe = 2.5 have started.

## Copper

Copper is next to iron in demand as metal of commercial and strategic use. It is an important metal having varied industrial uses. The largest use of copper is in electrical equipment , power and telecommunication transmission lines, automobiles, airplanes, conductors, circuit breakers and in many other specialised fields due to its high electrical and thermal conductivity, durability, strength and high resistance to fatigue. It is also used for making a number of alloys with other metals which have varied industrial uses.

Balochistan Province has vast resources of copper ore. Porphyry type copper ore bodies have been discovered by the Geological Survey of Pakistan at Saindak, Dasht-e-Kain, Kabul Koh, Koh-i-Dalil, Missi and Ziarat Pir Sultan (Ahmad, 1986). All these deposits occur in Chagai District.

Saindak copper deposit has been evaluated in detail, first by G.S.P. and later by the GSP personnel working for the Resource Development Corporation (RDC). The deposit has been evaluated to contain 412 million tonnes of ore with an average content of 0.38% copper and recoverable quantities of molybdenum, silver and gold.

**Table:2 SAINDAK ORE RESERVES AND GRADES**

Deposit	(million tonnes)	(% of copper)
North	28	0.440
South	111	0.430
East	273	0.340

**Table-3: ESTIMATED RECOVERABLE QUANTITIES & VALUES**

Commodity	Current Price	Value in million US\$
1.Copper 1.69 million tonnes	1 US\$/tonnes	3,726.45
2.Gold 2.24 million ounces	450 US\$/oz	1,008.00
3.Silver 2.49 million ounces	15 US\$/oz	37.35

The feasibility studies of Saindak copper deposits have been completed and recently Government of Pakistan has negotiated an agreement with Government of Peoples Republic of China to develop the deposit at an estimated cost of 316 million U.S. dollars. It is planned to produce about 15,800 tonnes of copper blister, 1.47 tonnes of gold and 2.76 tonnes of silver annually.

Waziristan Agency of Federally Administered Tribal Areas (FATA) is another area where deposits of copper were discovered by GSP (Asrarullah, 1957) and are being evaluated by FATADC with the technical collaboration of the GSP.

## Iron

Iron ores are used for the extraction of iron which is the most commonly exploited metallic mineral in the modern world. Iron is used for making steel and a number of other-alloys .

Iron, being the third most abundant element on the earth's crust, is found in a variety of geological environments. All three major classes of rocks, i.e., igneous, metamorphic and sedimentary, serve as host for the mineralization of iron ore.

Many small and large deposits of iron ore have been found in different parts of the country. Important among these are the Dammel Nissar and Langrial deposits of NWFP, Chichali and Kalabagh deposits of Punjab province and Chilghazi, Chigendik and Pachin Koh deposits of Balochistan province.

Large reserves of over 400 million tonnes of iron ore (Asrarullah, 1976), are available in the country. The Kalabagh, Langrial and Chilghazi iron ores were discovered and evaluated by GSP. PMDC and PIDC were technically assisted by GSP in the evaluation of Chigendik and Pachin Koh deposits. The location wise data regarding the Pakistani iron ores is as follows:-

Recently GSP has discovered high grade iron ore (hematite) near Chiniot. It is presently being explored and evaluated.

Table-4: LOCATION, RESERVES AND GRADE OF IRON ORES IN PAKISTAN

Area/Locality	Reserves (million tonnes)	Quality	
		Chemical	Mineralogical
1. Kalabagh/ Chichali- Makarwal area, Mianwali District	300	25-35% Fe	Silicate- carbonate ores; containing siderite, glauconite, chamosite, limonite, hematite and goethite.

2.	Langrial, Hazara District	30	30-40% Fe	Primarily a silicate oolitic ore, oxidised to oxide ore.
3.	Dammel Nissar Chitral District	3	Upto 60% Fe	Magnetite, Hematite.
4.	Chigendik, Chagai District	5	20-60% Fe	Magnetite.
5.	Pachin Koh, Chagai District	45	35-48% Fe	Magnetite.
6.	Chilghazi, Chagai District	23	10-55% Fe	Magnetite.
7.	Kirana, Sargodha district	being estimated by GSP	upto 94% iron oxides	Hematite

Due to the complex mineralogical composition of some of the deposits such as those of Chichali and Langrial, the extraction of iron from these ores through commercial processes poses some problems.

Pakistan Steel is considering plans to set up a mini steel mill plant near Quetta based on iron ores of the Chagai District, Balochistan.

### Lead and Zinc

Lead and zinc, due to their normal close association in nature, are being dealt with together. Both the metals form important alloys having varied industrial uses. Lead is an important strategic mineral as it is used in ammunitions.

Though a number of oxides, carbonates and sulphates of lead and zinc occur in nature which are being exploited for commercial extraction of the metals Pb and Zn, but the most common minerals of economic significance are galena (PbS) and sphalerite (Zn, Fe)S.

In recent past, the Geological Survey of Pakistan has discovered several deposits of lead and zinc ore in Las Bela-Khuzdar region of Balochistan Province. These deposits are associated with carbonate rocks of Windar Group and

Shirinab Formation. Three of these deposits namely Gunga, Surmai and Duddar have been investigated in some details by GSP with the help of UNDP and JICA. The results of these investigations have been found very encouraging. Balochistan Development Authority (BDA) has, therefore, taken over the Gunga deposits while Pakistan Mineral Development Corporation (PMDC) has taken over Duddar deposit for developing them into mining ventures.

The preliminary estimates made by the GSP indicate the availability of over 10 million tonnes of lead-zinc ore and barytes at Gunga near Khuzdar with about 8 percent total metal value. The Duddar deposit is estimated to contain 600,000 tonnes of ore, averaging 15.45% Zinc and 2.9% Lead. At Surmai, the mineral exploration carried out by GSP has revealed the presence of 2.93 million tonnes of ore with average metal content of 6.5 percent. Further exploration may reveal additional reserves in all these areas.

The lead-zinc resource of Balochistan Province alone has been estimated at about 14 million tonnes. It is, therefore, expected that Pakistan will soon emerge as basemetal producing country.

Near Besham in Kohistan, lead-zinc mineralization occurs in pelitic, psammitic and calcareous rocks of Besham group. These deposits are being investigated and evaluated in detail by Sarhad Development Authority (SDA).

### SOLID FUEL.

#### Coal

Coal is a sedimentary rock largely consisting of organic plant remains. It is an important source of energy in the world as it is second only to oil in the generation of electricity.

The present annual production of coal in Pakistan is about 2.7 million tonnes. Almost the entire production of indigenous coal is being used for firing brick kilns. However, in the near future large scale thermal power generation based on local coal is being planned. According

---

FATADC: Federally Administered Areas Development Corporation.  
UNDP : United Nation Development Programme.  
JICA : Japan Internaitonal Cooperation Agency.

to these plans, three mini power plants will be set up Deghari by private sector in the Salt Range (Punjab), the Sor Range - Deghari (Balochistan) and the Lakhra, (Sindh) while WAPDA in collaboration with the Peoples Republic of China is planning to install a power plant of 150 to 450 MW at Lakhra.

Coal is formed by the accumulation and burial of plant material along old river banks, deltas, lagoons, marshes, etc. In Pakistan conditions favourable for the formation of coal existed during Paleocene - Eocene age. Coal is being commercially exploited from rocks of the Hangu Formation (Paleocene) and Patala Formation in NWFP and Punjab provinces. Ghazij Formation (Eocene) is the coal bearing rock formation in Balochistan while Bara Formation (Paleocene) and Sunhari Beds of Laki Formation (Eocene) contain large deposits of coal in Sindh. Some Permian coal has been reported from Punjab and GSP is presently carrying out exploration programme to find out thicker beds of better quality Permian coal.

At the time of independence thin coal beds with difficult mining conditions were known to occur in Khost-Shahrig-Harnai, Sor Range-Deghari and Salt Range areas of Pakistan. These deposits were being mined on small scale and no estimates of existing reserves were made. The first assessment of the coal available from all the coal fields of Pakistan was made by the Geological Survey of Pakistan in 1950 and the resource base was estimated to be 104 million tonnes (Khan, 1950). In 1962, GSP discovered the large coal field of Lakhra (Ghani and Harbour, 1966). In the early eighties GSP discovered the Sonda coal field, which has now proved to contain the largest known reserves of coal with low sulphur. In the recent past, GSP has collected geological information which may lead to the discovery of large reserves of coal under Thar desert and the Badin area. The Geological Survey of Pakistan in collaboration with USGS and with assistance from USAID has started investigation and evaluation of coal fields on priority basis. This evaluation work includes detailed geological mapping, study of geological palaeoenvironment and drilling of test holes.

In the year 1986, estimates of all categories of known coal resources amounted to only 824 million tonnes (Ahmed, 1986). The coal resources evaluation work carried out at Lakhra, Sonda, Salt Range and other coal fields of Pakistan during the past three years has revealed much larger resource base (Table-5) estimated at over 9 billion tonnes in 1989 and present estimates indicate the resource base at over 19.7 billion tonnes (Kazmi, 1989, ref. not listed).

The recent work by GSP has proved that Sindh Province has very large reserves of coal. The coal resource base of this province alone exceeds 19 billion tonnes. Sindh Province is the main future hope of Pakistan for production of thermal energy based on coal fired power stations. The coal resources base of the Punjab Province is over 250 million tonnes. The coal seams are, however, thin and large scale coal production needed for big power plants will not be possible. Possibility of installing small coal fired thermal power plants however, cannot be ruled out. Balochistan Province has a coal resource base of over 190 million tonnes but again due to thin and steeply dipping coal seams obtaining large production is not possible. Small power plants based on local coal may however, be planned for Mach, Sor Range - Daghari, Pir Ismail Ziarat, Khost - Shahrig - Harnai and Duki areas.

Table-5: SUMMARY OF COAL RESOURCES OF PAKISTAN AS ON JANUARY, 1990

(In Million Tonnes).

COAL FIELD	AVERAGE MINEABLE THICKNESS (metres)	PROVED	INDICATED	INFERRED	HYPOTHETICAL	TOTAL	COAL RANK (ASTM)	ANNUAL PRODUCTION. 10 <sup>3</sup> TONNES
<b>BALUCHISTAN</b>								
1. DUKI	0.5	14	11	25	---	50	SubC-SubA	250
2. MACH-ABEGUM	0.75	9	---	14	---	23	SubC-subB	125
3. SOR RANGE-DEGHARI	0.75	15	---	19	---	34	SubB-SubA	460
4. PIR ISMAIL-ZIARAT	0.5	1.5	1.5	8	---	11	hvCb	115
5. KHOST-SHAHRIG-HARNAI	0.75	13	---	63	---	76	hvBb-hvAb	100
<b>PUNJAB</b>								
6. MAKARWAL	0.75	5	8	9	---	22	hvCb-hvBb	225
7. SALT-RANGE	0.5	43	13	---	178	234	hvCb	225
<b>SINDH</b>								
8. LAKHRA	1.5	244	629	739	28	1640	LigA-SubC	300
9. SONDA	-	188	1388	5724	---	7300	LigA-SubB	---
10. JHIMPIR	0.5	10	43	108	---	161	LigA-SubC	40

11. BADIN	-	---	---	---	9000	9000	---	---
12. THAR DESERT	-	---	---	---	1200	1200	---	---
TOTAL:-		542.5	2093.5	6709	10406	19751	---	1840

Out of the known coal fields of Pakistan the Thatta-Sonda coal field , the largest coal field of Pakistan, contains sub-bituminous B to lignite A, , low to medium sulphur and medium to high ash coal (Table-6). Lakhra coal is generally lignitic with high sulphur and high ash. Jhampir coal is generally sub-bituminous C and B with medium to high sulphur and medium to high ash content (Table-6). Coal found in Balochistan coal fields is generally high volatile sub-bituminous B and C type with medium to high sulphur and medium to high ash (Table-6). Coal from Punjab is similar to Balochistan coal.

Coal also occurs in Kotli district of Azad Jammu and Kashmir. Coal has recently been found in Cherat and Hangu, FATA of the north. GSP is investigating and evaluating these deposits for assesment of quality and quantity. The preliminary investigations carried out so far indicate that Cherat coal is similar to Salt Range coal in quality but the thickness variations of beds are quite rapid and structure of the coal bearing area is quite complex. The Hangu area appears to be very favourable for coal mining and development. The coal found in Orakzai Agency and Azad Jammu & Kashmir is of low quality and has small resource potential.

The coal exploration and evaluation work undertaken by GSP so far has proved beyond doubt that Pakistan in general and Sindh province in particular has very good potential of having very large reserves of coal. It is unfortunate that we have not as yet started coal based power generation. Import of oil for power generation is a major drain on our foreign exchange earnings and due to very high rate of burning of gas for meeting the energy requirements of the country and its reserves are fast depleting. It is, therefore, essential that Pakistan should start using coal as the main source of power generation. The geological information available from oil well and tube well cuttings and geology exposed on the Indian side of the border indicates that in the southeastern part of the Sindh Province geological conditions conducive to the accumulation of thick coal seams prevailed during Paleocene and Eocene age. Thick coal seams amenable to large scale production and capable of meeting the demands of big power plants may be present in the Sindh coal fields.

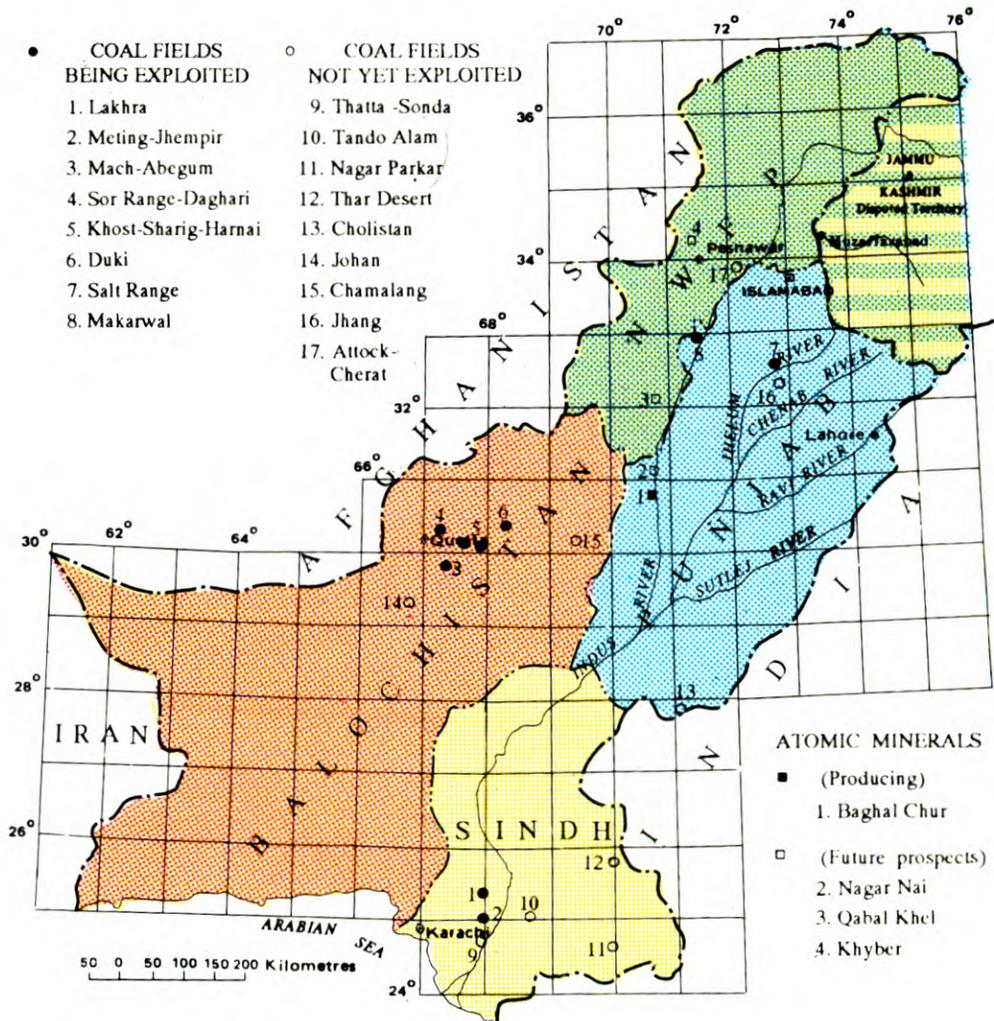


Figure 2: Map showing solid fuel resources of Pakistan.

Balochistan has been producing the major share of coal in Pakistan since Independence but now Sindh is overtaking it. This is due to the fact that coal seams in Balochistan are thin and steeply dipping, the mines are underground and their efficiency decreases with increasing depth. However, small power generation plants based on indigeneous coal can be set up in areas like Sor Range - Deghari, Khost - Shahrig - Harnai, Mach-Abe Gum and Duki. If sufficient reserves can be brought to the mineable category the efficiency of the present mines can be increased.

Tertiary coal of the Punjab found in Salt Range is found as thin lenticular bodies, ruling out the possibility of large scale production from this area. However, its nearness to thickly populated centres has provided it a ready market with high demand. It has been thus possible to mine with profit coal seams which are 12 inches thick or less. This trend will continue as long as the brick industry grows and thrives.

The coal resources of the NWFP have not been explored fully as yet. The main reason being that the coal bearing rocks in this province are tightly folded, highly fractured and fissured rendering exploration difficult and costly. Further, the geological conditions suggest that mining also would be difficult and expensive. However, recently GSP has started systematic coal resources evaluation in this province. Drilling for coal is presently in progress and good results are expected from the Hangu area.

TABLE-6: RANGE OF PROXIMATE ANALYSES OF PAKISTAN COALS.  
(Kazmi, 1989).

Coal field	Moisture %	Volatile %	Fixed Carbon %	Ash %	Sulphur %	Calorific Value Col/kg
BALOCHISTAN						
DUKI	3.7 - 4.81	32.77- 38.37	46.49- 50.82	9.11- 16.03	4.31- 6.15	2,826 - 6.748
MACH	7.1 - 12.0	34.5 - 39.4	32.4 - 41.5	9.6 - 20.3	3.2 - 7.4	5,104 - 5.717
SHAHRIG-HARNAI	1.53 - 7.9	30.29- 43.69	28.49- 53.14	6.33- 30.34	2.8 -12.63	4,173 - 7.531
SOR RANGE	5.1 - 21.2	31.0 - 43.1	36.0 - 43.0	2.7 - 14.3	0.4 - 5.6	4,822 - 6.049
PUNJAB TRANS INDUS						
MAKARWAL	2.8 - 5.3	42.4 - 48.1	36.7 - 44.9	6.4 - 11.5	2.8 - 6.8	6,328 - 6.769

PUNJAB CIS INDUS

SALT RANGE	3.2 - 7.6	26.3 - 38.8	29.8 - 44.8	12.3- 37.7	3.5 - 10.7	3,941 - 6.161
SINDH						
EAST OF INDUS	39.07-40.91	16.67- 28.61	23.80- 28.91	2.94- 11.65	0.23- 1.84	3,836 - 4.268
JHERRUCK (SONDA)	27.24-39.26	18.07- 31.07	20.12- 44.51	4.88- 29.27	0.52- 4.89	3,003 - 5.488
JHIMPIR-METING	15.4 -29.8	29.8 - 39.9	31.0 - 36.3	8.2 - 14.6	3.4 - 7.4	4,106 - 5.439
LAKHRA (NORTH (CENTRAL, SOUTH)	26.4 -33.3	22.4 - 39.0	22.3 - 35.7	6.7 - 26.6	2.9 - 9.0	2,840 - 4.990
SONDA	7.0 - 26.98	15.94-48.1	12.58- 64.9	3.96- 39.2	0.56- 8.25	3,646 - 6.957

---

PRECIOUS AND DECORATIVE STONES

**Precious stones**

A variety of precious stones occur in Pakistan mainly in the North Western Frontier Province, FATA and Northern areas of Pakistan. The more valuable ones include emerald, ruby, and pink topaz. Other varieties found in Pakistan area aquamarine, tourmaline, topaz, moonstone, quartz and red garnet (Kazmi, et al., 1989; Kazmi and Donoghue, 1990). Occurrence and distribution of these gemstones are shown in Figure-3 and Table-7.

Gemstone Corporation of Pakistan (GEMCP) has been established to explore, exploit, cut, polish and market these precious stones. Since its inception in 1979 GEMCP has sold gems worth over Rs.78.95 million.

**Marble/Aragonite**

Marble is extensively used in the construction industry, for decorative purposes in building facings, bath rooms and for floor tiles. It is also used for making handicraft items.

Large reserves of re-crystallised limestone and marble occur widely in the Gilgit and Skardu region, in Chitral, Khyber Agency, Swat and Mardan districts of FATA, NWFP and in Azad Jammu & Kashmir (Asrarullah and Hussain, 1985). Onyx marble of high quality is found in Chagai District of Balochistan Province (Ahmed, 1965).

During 1987-88 about 216,000 tonnes of marble was produced. The private sector exclusively deals with the production, processing and marketing of marble.

## CERAMIC MINERALS

### **Barytes**

Barytes is a mineral with chemical formula  $BaSO_4$  but naturally occurring barytes contains minor quantities of impurities such as silica, limestone or dolomite.

It is mainly used as weighting agent in oil well drilling mud. It is also used for making barium chemical, white pigment and in paper industry.

Balochistan contains very large deposits of Barytes. These deposits are located in the area between Uthal and Khuzdar. The barytes is found in Zidi, Shirinab and Windar formations (Triassic-Jurassic) forming bedded replacement or shear veins of hydrothermal origin. The ore bodies generally contain large tonnage.

Barytes also occurs in Abbottabad District of NWFP. Barytes is deposited by hydrothermal solutions generated during the time of sedimentation or after it. It is found as bedded replacement, fracture filling and shear veins in limestone formation of Mesozoic age.

The Barytes deposits of Balochistan were discovered by the Geological Survey of Pakistan (Ahmad and Klinger, 1967). Deposits at Gunga near Khuzdar and Duddar in Bela district have been investigated in detail with the help of large scale mapping and drilling. It has been estimated that at these two localities over 12 million tonnes of Barytes is present. The Khuzdar deposits have been developed through a joint venture between Balochistan Government and Pakistan Petroleum Ltd.

The deposits from Lasbela-Khuzdar produced about 11,200 tonnes during the year 1987-88. Hazara deposit produced about 1300 tonnes of barytes during this period.

Barytes reserves of Pakistan estimated at over 30 million tonnes are available mainly from Las Bela-Khuzdar area. The production from indigenous deposits meets the total requirement of barytes for oil well drilling and barium based chemical plants of the country.

The barytes deposits of the country are sufficient and suitably located for large scale production provided export market could be developed.

Table 7: Mineral and Gemstone occurrences in Pakistan.

	GONDWANIC DOMAIN			T E T H Y A N D O M A I N					
	Platform Marginal fold belt	Sub- Himalayan Thrust belt	Himalayan Crystalline Zone	Chaman Trans fault Zone	Chagal Calc. alk Magm. arc	Indus Suture Zone	Kohistan Island arc.	Karakoram Suture Zone	Karakoram Thrust & Fold belt
Oil & gas	⊕								
Coal	⊕								
Dolomite	⊕		⊕			⊕			⊕
Gypsum	⊕								
Iron Ore	⊕		⊕		⊕ ⊕		⊕	○	
Laterite/Bauxite	⊕								
Rock salt	⊕								
Sulphur	⊕				⊕				
Barite	⊕		⊕						⊕
Celestite	○	○							
Fluorite	⊕		⊕						
Galena	⊕		⊕				⊕		
Lead / Zinc	⊕								
Uranium	⊕						⊕		
Cu-Zn-Ag-Au			⊕		⊕ ⊕				
Antimony			⊕	⊕					⊕
Poly met. Sulphd					○	⊕	⊕	⊕	⊕
Manganese		⊕							
Chromite		⊕			⊕	⊕			
Magnesite		⊕	⊕			⊕			
Asbestos		⊕				⊕			
Graphite			⊕				⊕	⊕	
RK. Phosphate	⊕		⊕						
<b>GEMSTONES</b>									
Aquamarine			⊕				⊕	⊕	⊕
Topaz			⊕			⊕	⊕	⊕	⊕
Tourmaline			⊕			⊕	⊕	⊕	⊕
Moonstone			⊕			⊕			⊕
Quartz Crystal			⊕				⊕	⊕	⊕
Spinel									
Pargasite								⊕	
Ruby								⊕	
Emerald						⊕ ⊕			
Epidote			⊕			⊕	⊕		
Garnet			⊕ ⊕			⊕			⊕
Turquoise					⊕				
Agate	⊕								

- ⊕ OPHIOLITIC
- ⊕ CONTACT METASOMATIC
- UNDIFFERENTIATED
- ⊕ MISSISSIPPI VALLEY TYPE
- ⊕ METAMORPHIC OR HYDROTHERMAL
- ⊕ PYROMETASOMATIC
- ⊕ SEDIMENTARY
- ⊕ SANDSTONE TYPE URANIUM
- ⊕ PEGMATITIC
- ⊕ REPLACEMENT
- ⊕ MANTO TYPE
- ⊕ TRANSFORM FAULT RELATED
- ⊕ PORPHYRY TYPE
- ⊕ VOLCANOGENIC

Table-8: RANGE ANALYSES OF BARYTES. (Klinger and Richards, 1967; Klinger and Ahmad, 1967; Afridi, 1986).

Locality	Sp.gravity	BaSO <sub>4</sub>	SiO <sub>2</sub>	Fe <sub>2</sub> O <sub>3</sub>	CaO	MgO	LOI
Kohala-Hazara	3.45-4.2	88-92.76%	0.45-3.34	0.09-0.2	0.28-2.73	0.20-104	0.26-1.04
Gunga-Khuzdar	3.96 - 4.35	91.86-95.92	1.84-2.48	0.02-0.03	0.49-0.98	0.76-1.91	0.67-1.63

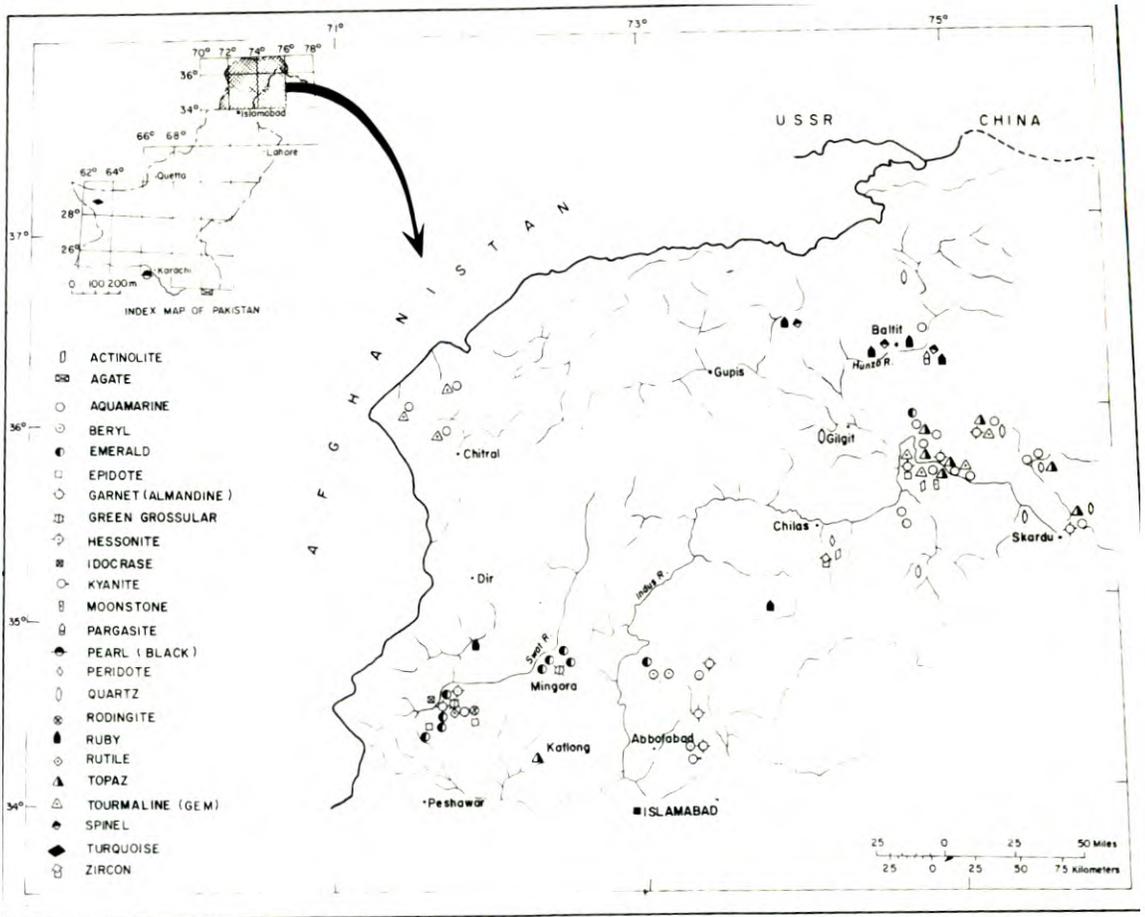


Figure 3: Location map of gemstone showings in Pakistan (Kazmi et. al, 1990).

## Celestite

In pure form celestite is sulphate of strontium with chemical formula  $\text{SrSO}_4$ .

Powdered celestite is used as filler in white paint. It is used in the manufacture of strontium and strontium compounds which are used in pyroelectrics, such as tracer bullets. Strontium salts are also used in ceramics, caustic soda, oil refining, luminous paints, plastics and welding rod coatings.

In Pakistan the celestite deposits are confined to Dadu district, with small reserves (Gauhar, 1969). Hydrothermal type celestite deposits are located along fissures, joints and fractures in Thano Bulla Khan area in Sindh. Limited mining and extraction of the mineral is going on. The present annual production is about 1000 tonnes. The ore with over 94%  $\text{SrSO}_4$  is produced and is used locally by paint industry.

## China Clay

China clay is white kaolin formed due to alteration of feldspars. It is mainly used in the manufacture of table-ware, sanitary fittings and electric insulators. It is also used as paper filler and in the manufacture of special type of cement.

China clay deposits are found at Shah Dheri, Swat, NWFP, and in Nagar Parkar, Sindh. Some smaller deposits have been found in Dir, Hazara and Gilgit also. The Geological Survey discovered both the Shah Dheri and Nagar Parkar deposits (Moosvi, 1975; Kazmi, et al., 1973) and investigated these deposits in detail with the help of detailed geological mapping, channel sampling and physical and chemical tests. The Shah Dheri deposits have been evaluated to contain 29.8 million tonnes (Moosvi, 1975) of raw china clay. Plagioclase rich leuco-quartz diorite is the parent rock from which kaolin has been formed as a result of alteration of feldspars. Kaolin zones occur as patches, pods and streaks in unaltered rock. Typical analysis of Swat china clay is as follows:-

Table-9: CHEMICAL COMPOSITION OF SHAH DHERI CHINA CLAY,  
(Moosvi, A.T., 1975)

	Raw	Washed
SiO <sub>2</sub>	42 to 58%	46 to 48%
Fe <sub>2</sub> O <sub>3</sub>	1 to 5%	1 to 5%
Al <sub>2</sub> O <sub>3</sub>	31 to 36%	34 to 37%
CaO	9 to 13%	3 to 7%
MgO	1 to 3%	1 to 2%
Na <sub>2</sub> O	1 to 2%	1 to 2%
K <sub>2</sub> O	traces to 0.2%	traces to 0.2%
Loss on ignition	4 to 5%	9 to 12%

China clay was discovered by GSP in Nagar Parkar, Sindh (Kazmi, et al, 1973). In Nagar Parkar area deep weathering and alteration of granitic rocks have produced china clay. The clay occurs extensively in a flat plain area at shallow depths (a few centimetre to less than a few metre below ground surface). Reserves of Nagar Parkar china clay are estimated at 3.6 to 5 million tonnes. PMDC aims to install a 40,000 tonnes per annum capacity elutriation plant based on Nagar Parkar deposits. The beneficiation tests have shown that Nagar Parkar clay is easily washable and can be used for paper coating, paper filling and ceramics. Typical analysis of Nagar Parkar China clay is as follows:-

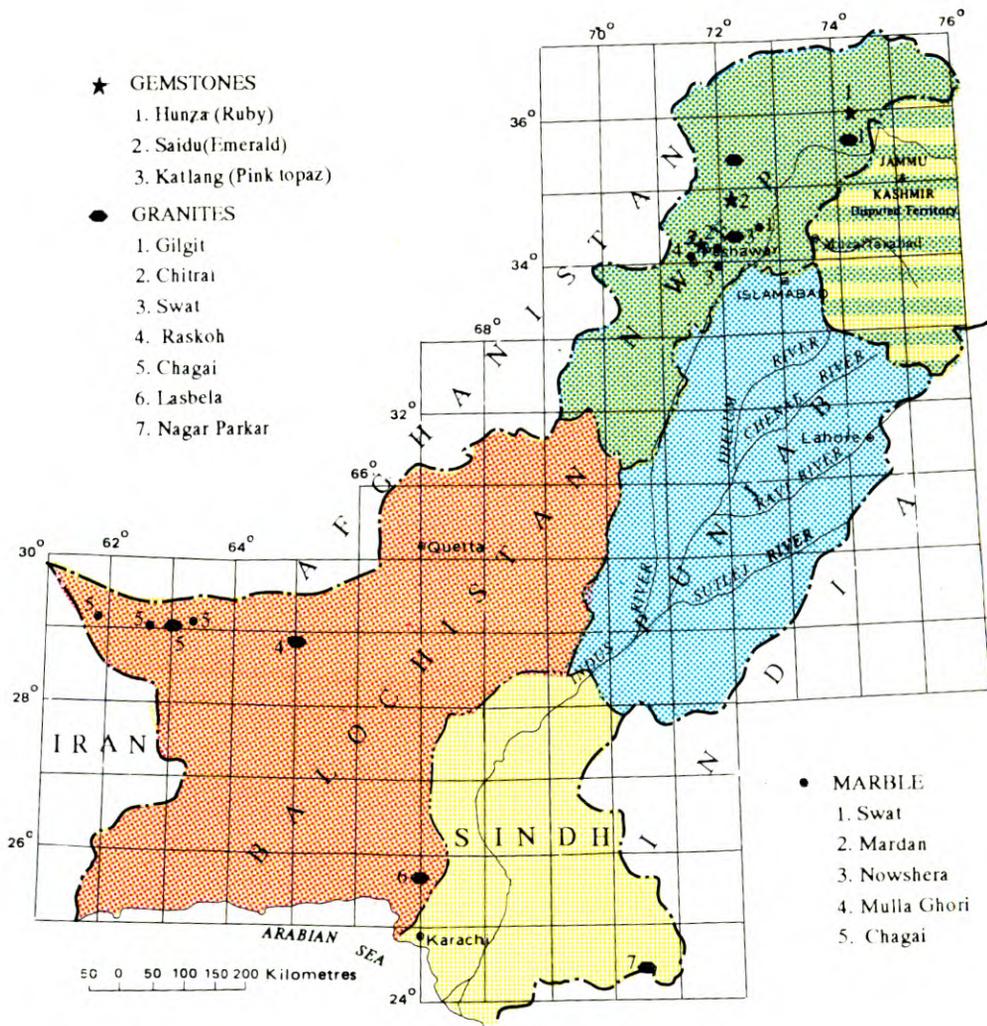


Figure 4: Map showing main deposits of precious and decorative stones of Pakistan.

K <sub>2</sub> O	1.94	2.62
L.O.Ign.	16.18	12.65
Total:-	98.87	98.71

### Fire Clay.

Fire clay is resistant to shrinkage, abrasion and corrosion under high temperatures and withstands thermal spalling. It should be very low in iron oxide content (<2%) and high in alumina (24-45%).

Punjab is the main producer and consumer of fire clay, where sizable deposits occur in Mianwali, Sargodha and Attock districts. Fire clay is also found in Thatta and Dadu districts of Sindh and D.I.Khan district of NWFP. These are residual sedimentary deposits generally found at the base of Patala Formation of Paleocene age in the Punjab and at the base of Sonhari beds of Paleocene age in Sindh. The total reserves of fire clay in Pakistan are estimated to be over 100 million tonnes (Griffiths, 1987). The bulk of the present production (100,100 tonnes) is derived from Mianwali and Sargodha deposits which could be classed as heavy duty refractory clay. It is used mainly for furnace lining in cement and other industries.

The fire clay deposits of Punjab have been investigated in detail by the Geological Survey of Pakistan. The detailed studies included large scale mapping, channel sampling, chemical analysis and estimation of reserves (Hussain and Sibghatullah, 1966; Akhtar and Cheema, 1989).

There is a wide range of variation of chemical composition in the material being mined and marketed as fire clay. The high grade fire clay contains as much as 65% Al<sub>2</sub>O<sub>3</sub> while the low grade as low as 35% Al<sub>2</sub>O<sub>3</sub> (Griffith, 1987).

The fire clays of Pakistan are slow slacking, moderately plastic, firing shrinkage varies from 0.66 to 10.14% water absorption 31 to 40% and firing behaviour is good (Ahmad, et al., 1987).

The chemical composition of some of these clays is given in Tables 12 and 13. The production of fire clay during the year 1987-88 was about 134,000 tonnes.

**Table-12: CHEMICAL ANALYSES OF SELECTED PAKISTANI FIRE CLAYS**  
(Raw basis, Hussain and Naqvi, 1973)

Locality	SiO <sub>2</sub> %	Al <sub>2</sub> O <sub>3</sub> %	Fe <sub>2</sub> O <sub>3</sub> %	TiO <sub>2</sub> %	CaO %	MgO %	LOI %	Alka- lies %	Calcu- lated PCE*
Musakhel	59.82	25.40	2.89	1.32	1.10	0.23	7.73	1.47	1659
-do-	48.49	35.14	0.61	2.79	Nil	Trace	12.19	0.78	1714
Katha- Saghral.	13.19	64.58	2.07	0.69	2.88	-do-	16.46	0.11	1836
Chhoi.	6.00	74.24	0.64	3.65	0.76	-do-	14.51	0.20	1881

\* Pyrometric cone equivalent.

**Table-13: CHEMICAL ANALYSES OF SELECTED PAKISTANI**  
**FIRE CLAYS (calcined basis, Hussain and**  
**Naqvi, 1973)**

Locality	SiO <sub>2</sub> %	Al <sub>2</sub> O <sub>3</sub> %	Fe <sub>2</sub> O <sub>3</sub> %	TiO <sub>2</sub> %	CaO %	MgO %	Alkalies %
Musakhel	64.83	27.57	3.13	1.43	1.19	0.24	1.61
-do-	55.22	40.01	0.69	3.17	Nil.	Traces	0.91
Katha Saghral.	15.78	77.43	2.47	0.82	3.44	-do-	0.36
Chhoi.	7.01	86.84	0.74	4.28	0.88	-do-	0.25

### Feldspar

Feldspars are complex silicate of sodium, potassium and calcium, naturally occurring as an important group of rock forming minerals. The potash feldspars are found associated with acidic group of rocks while sodic and calcic feldspars are important constituents of intermediate and basic group of rocks.

Feldspars are used in ceramic and glass industry. Large deposits of both sodic and potassic feldspars have been found near Mingora in Swat district of NWFP. Feldspar is widespread in pegmatites in Chitral, Gilgit and Skardu. Deposits of orthoclase feldspar have been recently discovered by GSP in pegmatites in Nagar Parkar area of Sindh. A total production of 9,980 tonnes was obtained from the Swat deposit during the year 1987-88.

Table-10: CHEMICAL COMPOSITION OF NAGAR PARKAR CHINA CLAY,  
(Griffiths, 1987)

	Raw	Washed
SiO <sub>2</sub>	66.46%	46.06%
Fe <sub>2</sub> O <sub>3</sub>	0.38%	0.85%
TiO <sub>2</sub>	-	0.86%
Al <sub>2</sub> O <sub>3</sub>	21.57%	35.70%
CaO	2.56%	1.31%
MgO	0.34%	0.34%
Na <sub>2</sub> O	0.05%	0.15%
K <sub>2</sub> O	0.21%	0.21%
Loss on ignition	-	14.23%

### Fluorite

Fluorite is chemically Ca F<sub>2</sub>, i.e, calcium fluoride, but naturally occurring fluorite contains some Mg and Fe ionically replacing Ca and impurities such as silica and calcium carbonate are usually associated with it.

It is mainly used as flux in steel making and is the only source of fluorine which is required for hydrofluoric acid and other fluorine compounds. Balochistan province is the main producer of fluorite in Pakistan. Fluorite is found in Maran, Pad Maran and Dilband areas of Kalat district, Balochistan. These deposits were discovered and evaluated by the Geological Survey of Pakistan (Bakar, 1965; Abbas, et al., 1980). Fluorite is found as bedded replacement, shear veins and fracture filled bodies in Chiltan limestone of Jurassic age. The hydrothermal solutions depositing fluorite have deposited calcite along with the fluorite in Maran and Dilband areas while silica and barytes occur as important gangue minerals in Pad Maran area. The

reserves are estimated at over 0.1 million tonnes (Abbas, et al., 1980). High grade ore (over 96%  $\text{CaF}_2$  and less than 5%  $\text{SiO}_2$ ) is mined from Maran and Dilband areas while low grade ore with less than 85%  $\text{CaF}_2$  and high  $\text{SiO}_2$  content is found at Pad Maran. The total production of fluorite during 1987-88 was about 1000 tonnes.

### Fuller's Earth

Fuller's earth is a nonplastic clay or clay like material, usually high in magnesia, that has adequate decolorizing and purifying properties.

Locally fuller's earth is used in oil industry and in foundries. Punjab and Sindh provinces have very large resources of fuller's earth. In Sindh these deposits occur at Thano Bulla Khan (District Dadu), Shadi Shahid (District Khairpur) while in Punjab the main deposits are found in D.G.Khan. Fuller's earth is formed along the flood plains of ancient river channels. The Paleocene-Eocene rivers which deposited coal in NWFP, Punjab, Balochistan and Sindh also deposited fuller's earth in the adjoining areas. The present total annual production of 16,064 tonnes is being utilised in oil refining and other industries in the country. With activation of this clay it may be used in the vegetable oil and ghee industry. It is also being used by insecticide, foundries and steel industries. Thus a sharp rise in the demand of fuller's earth may be expected in future.

Table-11: CHEMICAL ANALYSES OF FULLER'S EARTH  
(Ahmad, et al., 1987)

Percent Composition	D.G. Khan	Khairpur
$\text{SiO}_2$	49.60	46.20
$\text{Fe}_2\text{O}_3$	6.66	8.76
$\text{Al}_2\text{O}_3$	11.94	22.86
CaO	9.12	2.43
MgO	3.18	1.94
$\text{Na}_2\text{O}$	0.25	1.25

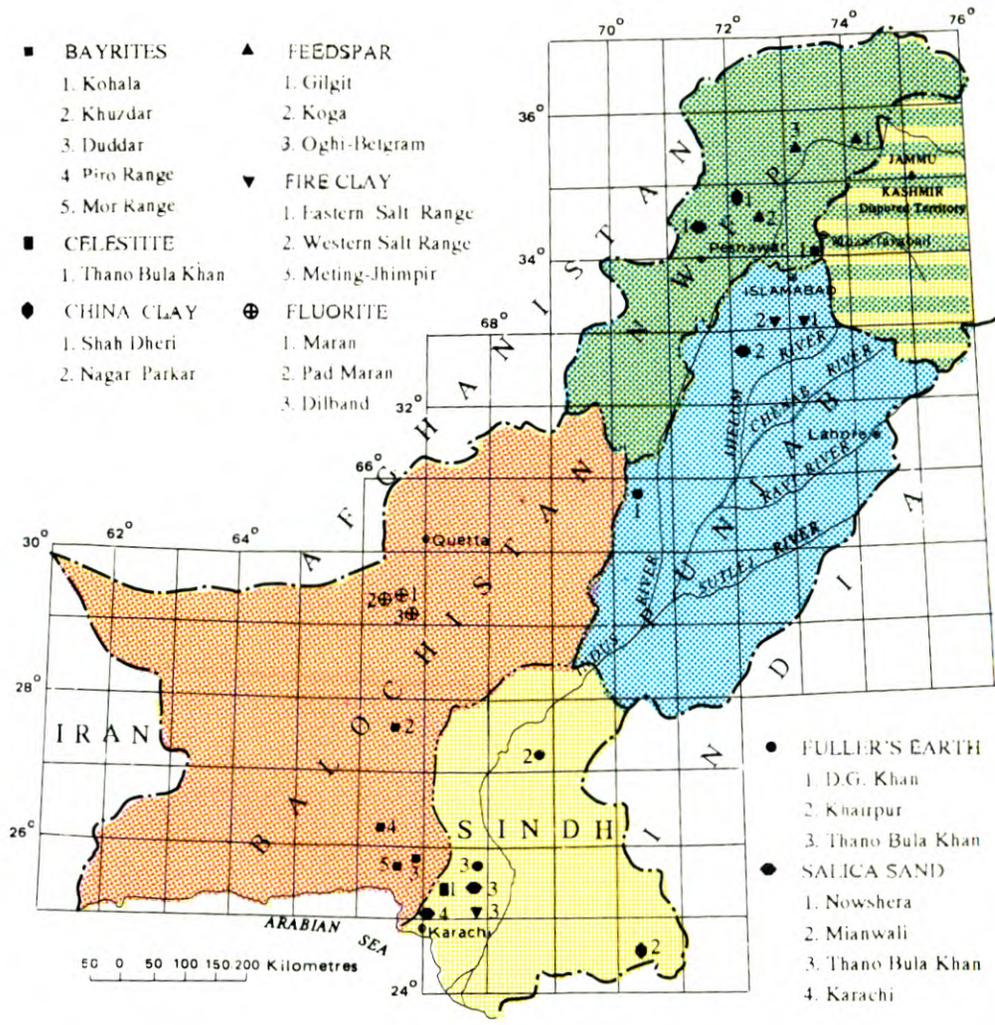


Figure 5: Map showing main deposits of ceramic minerals in Pakistan.

Table-14: ANALYSES OF FELDSPAR FROM SWAT  
(Griffiths, 1987)

Chemical analyses.

SiO <sub>2</sub>	65.00%
Al <sub>2</sub> O <sub>3</sub>	18.70%
TiO <sub>2</sub>	0.05%
MgO	0.09%
CaO	0.08%
K <sub>2</sub> O	14.74%
Na <sub>2</sub> O	0.11%
Loss on ignition.	0.11%

Mineral composition.

Feldspar	86%
Quartz	2%
Albite	12%
Kaolinite	traces

**Lime Stone**

The term limestone includes those rocks which contain more than 50 % minerals calcite (Ca CO<sub>3</sub>) and dolomite Ca Mg (CO<sub>3</sub>)<sup>2</sup>. Limestone deposits extensively form on continental shelves as detrital, biogenic or chemical precipitates.

The rock is extensively used as crushed stone, for concrete aggregates, road metal, rail roads ballasts . It is the basic raw material for portland cement . Limestone is also used as fluxing agent , soil conditioner, source of lime , chemical raw material and as dimension stone .

Pakistan has vast resources of limestone exposed from the coastal regions near Karachi to as far north as Khyber Pass. In most places the limestone is exposed near the railway tracks or road, making its utilization easy. These rocks generally contain over 50% calcium oxide, less than 5% silica and less than 1% iron oxide making them suitable raw material for the manufacture of cement . However, the existing cement factories do not utilize a fraction of the

vast resource available in the country and different type of cements worth Rs 18.76 million were imported during the year 1989-90. In addition imports of calcium chemicals cost the country rupees several hundred millions every year.

In view of the above facts it is highly desirable that steps should be taken to boost up the production of cement, lime and calcium chemical in the country so that the country not only becomes self sufficient in these finished products of limestone but starts exporting them.

#### Silica sand/Glass sand

Quartzose sand, free of impurities, is used as silica sand or glass sand. Silica sand deposits of Mianwali District of Punjab is the main producing deposit of the country but large deposits of silica sand also occur in Nowshera, D.I.Khan, and Abbotabad of NWFP and Dadu district of Sindh.

Silica sand is used as abrasive, for the manufacture of glass and some chemicals. It is also used in refractory and metallurgical applications. Datta Formation of Jurassic age and its equivalent contain thick beds of silica sand in NWFP and Punjab while in Sindh silica sand is found in rocks of Eocene and Oligocene age. The foundry requirements are met with molding sand or loose sandstone with rounded grains found in various parts of the country, while locally produced glass sand is used for making sheet glass and bottles. The present consumption and requirements are mainly met from the local production which is about 164,000 tonnes per annum. These demands are likely to rise with increase in the production of iron, steel and with expansion of glass and other user industries.

Table-15: ANALYSIS OF SILICA SAND(%).  
(Griffiths, 1987, Hussain, 1976,  
Hussain, undated)

	Mianwali	D. I. Khan	Hazara
SiO <sub>2</sub>	95.00 - 96.33	92 - 99	95 - 98
Fe <sub>2</sub> O <sub>3</sub>	0.53 - 0.83	0.01 - 1.2	0.02 - 11.0
Al <sub>2</sub> O <sub>3</sub>	2.62 - 3.07	0.18 - 5.77	0.1 - 4
CaO	0.35	0.38 - 1.68	0.1 - 0.5
MgO	0.14 - 0.57	0.10 - 1.60	---

## FERTILIZER AND INDUSTRIAL MINERALS

### **Magnesite**

Magnesite is chemically a carbonate of magnesium with chemical formula  $MgCO_3$ . Naturally occurring magnesite contains minor amounts of silica and calcium carbonate as impurities. Fe and Ca may replace Mg to some extent.

Magnesite is used as refractory in steel industry and foundries.

Magnesite deposits occur at Muslim Bagh, Balochistan, Malakand and Hazara, NWFP. It is found along fractures, joints, and faults in ultramafic rocks. Magnesite is formed by deep alteration of ultramafic rock, dolomite and even limestones. The alteration takes place due to percolation of magnesium rich solution along joints and fractures.

The magnesite resources in Pakistan have been estimated at 12 m tonnes (GSP, 1989), whereas the annual production was about 6800 tonnes in 1988-89.

**Table-16: ANALYSES OF MAGNESITE FROM MUSLIM BAGH**

(Nagell, 1971)

MgO	38	to	44%
SiO <sub>2</sub>	0.38	to	2%
Fe <sub>2</sub> O <sub>3</sub>	0.79	to	4%
CaO	1	to	10%
Loss on ignition	49	to	51%

### **Ochre**

Ochre is a commercial name for hydrated oxides or silicates of iron which can be used for imparting colour.

The lateritic beds found in Katha Nasral area, district Sargodha, Punjab, in Dadu and Thatta districts, Sindh and in Ziarat area, Balochistan, contain lenticular pockets of ochre, which is being used locally for paint making and other industries.

The deposits are formed as residual soils on the erosional surfaces in the geological past. The base of Ranikot Formation in Sindh and Dunghan Formation in Balochistan, both of Paleocene age and the base of Hangu Formation in Punjab contain lateritic horizons which can be used as ochre.

The lateritic deposits of Punjab and Balochistan provinces and other areas have been investigated in some detail by the Geological Survey of Pakistan. These investigations include large scale mapping, detailed sampling and chemical assay of the samples (Kazmi, 1961; Shah, 1975; Hussain, 1975).

The limonite deposits in Reshian, Azad Kashmir are also being mined and utilized at Daudkhel Fertilizer Factory as a filter bed. The present annual production of ochre is about 3400 tonnes.

### **Rock Salt**

Chemically rock salt is chloride of sodium with formula NaCl. In pure crystalline form it is known as halite. Salt is an essential nutrient for the existence of life and is an important industrial raw material. In the chemical industry it is used as a primary raw material for several products.

Rock salt is formed by the evaporation of sea water in restricted shallow basins. Thick sedimentary beds of salt occur in Salt Range Formation of Pre-Cambrian age in Punjab. In NWFP, Shekhan Formation of Eocene age contains thick beds of rock salt.

Pakistan has immense deposits of rock salt located in the Salt Range in Punjab province and in Kohat district of NWFP. Salt mining has been traditionally carried out by the government since annexation of Punjab and NWFP by the British, but recently some private parties have also started salt mining.

In late fifties, the mining engineers working in Khewra salt mines had reached a conclusion that the salt deposits of the area were nearing exhaustion and that the mining operations would be closed down within a short period. Consequently GSP was requested to evaluate the salt deposits of Khewra. Detailed exploration and evaluation of these deposits by GSP proved the existence of inexhaustible reserves of rock salt in the Salt Range (Asrarullah, 1962).

The present annual production of rock salt is about 500,000 tonnes. Rock salt is mostly used in the country. About 40% of the total output is consumed by soda ash, caustic soda and leather industries and rest is marketed for human consumption. A certain amount of rock salt has been exported to Afghanistan and India from time to time.

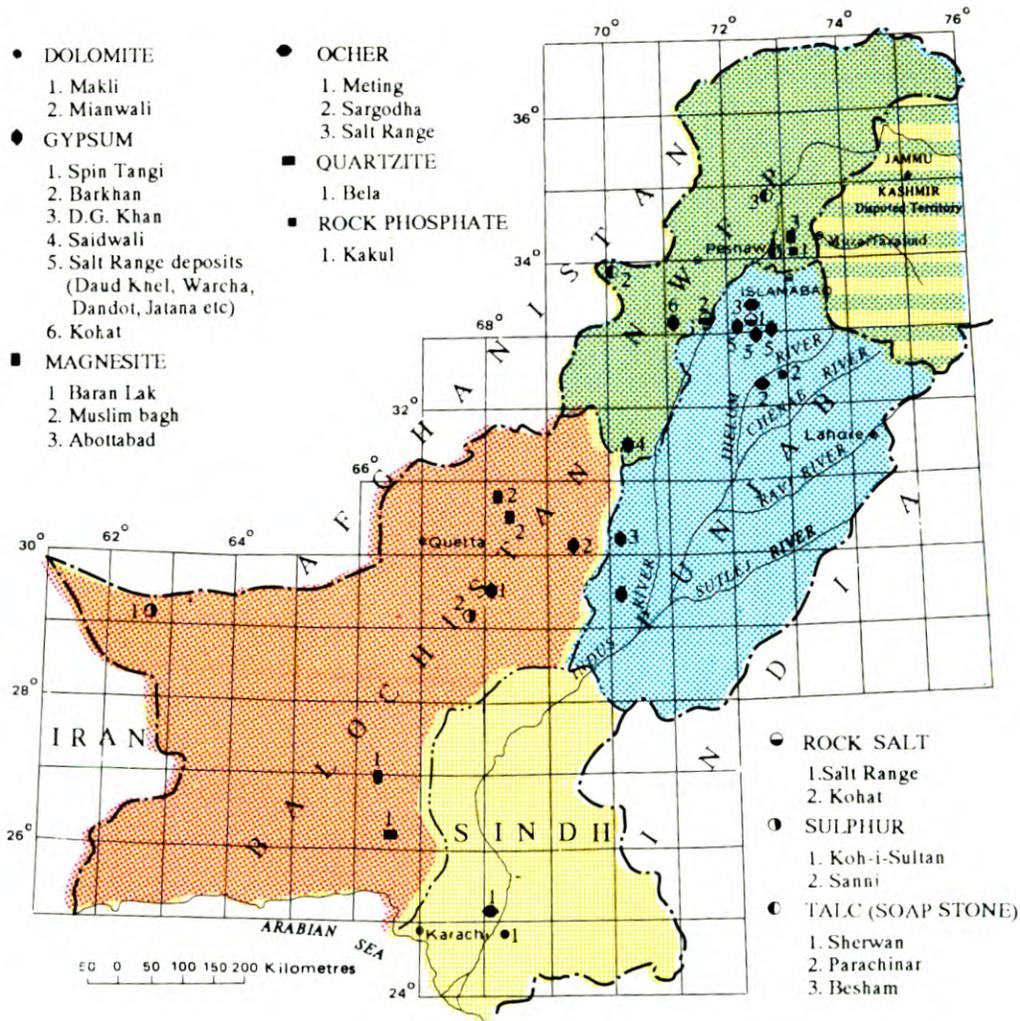


Figure 6: Map showing location of main deposits of fertilizer and industrial minerals.

Table-17: ANALYSES OF ROCK SALT(%) (Griffiths, 1987)

Na Cl	98.65	Moisture	0.11
Ca SO <sub>4</sub>	0.41	Insolubles	0.03
Mg SO <sub>4</sub>	0.40	Undetermined	0.16
NaSO <sub>4</sub>	0.24		

### Sulphur

Sulphur in free state occurs as an element. Sulphur is an important strategic mineral as it is extensively used for making explosives. It is also used in insecticides and for sugar refining.

Only Balochistan province produces sulphur in Pakistan. It is known to occur in Koh-i-Sultan area of Chagai district and Sanni area of Kachhi District (Ahmad, 1962). Koh-i-Sultan deposits have formed by the deposition of sulphur from the volcanic exhalations of the volcano which is now quiescent. Sanni sulphur has resulted from the decomposition of bitumen found in the host sediments. Both Koh-i-Sultan and Sanni sulphur deposits have been investigated in detail by GSP. The work done by GSP included large scale mapping, channel sampling, chemical assay of the samples and preliminary assessment of reserves (Muslim, 1973a, 1973b.) Koh-i-Sultan deposits are expected to contain 737,000 tonnes of ore containing over 52% sulphur (Muslim, 1973a) and have been mined intermittently since the Second World War. Muslim (1973b) estimates availability of 50,000 tonnes of ore containing 45% sulphur at Sanni. BDA has set up a beneficiation plant at Quetta for recovering sulphur from Koh-i-Sultan ore. Total sulphur ore produced during the year 1987-88 was 600 tonnes.

### Soapstone and Talc

Talc is a hydrous, silicate of magnesium while soapstone is an impure talcose rock in which talc is intimately mixed with various impurities such as dolomite, serpentine and calcite. Soapstone is formed by hydrothermal alteration of nonaluminous magnesium minerals.

Soapstone and talc are mainly used in ceramics, paints, paper, cosmetic, plastic and insecticide industries.

Soapstone deposits occur in Parachinar area, Kurram Agency; Jamrud, Khyber Agency; Derai, Swat district and Sherwan, Abbottabad district. The Sherwan deposit is the major producer of soapstone in the country but other deposits of NWFP have also started producing and are expected to increase the production as the demand rises. Total production achieved during 1987-88 was about 33,500 tonnes.

### **MINERAL BASED INDUSTRIES**

In recent years substantial progress in the industrialization of the country has taken place. The use of minerals as a raw material for the industry has increased manifold. With the coming in production of large cement plants like Attock Cement, Pakland Cement, Dada Bhoj Cement, Cherat Cement, Sarala Cement and Anwar-Zeb (white cement), the country has reached the stage of near self sufficiency in the cement requirements of the country. All the new plants are based on the locally available limestone and clay deposits of the area. The ever increasing demand of gypsum by the cement and fertilizer factories will continue to be met from local resources. A phosphate fertilizer plant has been set up by the National Fertilizer Corporation near Abbottabad. This is the first phosphate fertilizer plant based on indigenous phosphate ore. The local ceramic industry making tablewares, sanitary ware and tiles has started using locally available china clay from Swat and Nagar Parkar as raw material. The Nagar Parkar china clay is also in production. The total demand of silica sand for making second quality sheet glass and bottles is met from within the country. A barium based chemical plant near Hub Chowki has recently started production. The barium chemicals are produced from the barytes mined from Lasbela area.

### **RECENT MINERAL DISCOVERIES**

Due to acute shortage of energy in the country Geological Survey of Pakistan diverted its major proportion of financial and manpower resources for locating and proving coal resources of the country. The efforts proved very successful as very large resources of coal were found in Thatta-Sonda area of Sindh and Lakhra coal field was also proved to contain much larger reserves than envisaged earlier.

Another major achievement of the GSP in the recent past is the discovery of lead-zinc deposits in the area between Lasbela and Khuzdar of the Balochistan province. Several deposits such as Gunga, Surmai, Duddar, Dham Lak and Shekran have been discovered. Out of these three deposits i.e. Gunga, Surmai and Duddar have been investigated in some detail by the GSP. These deposits are expected to contain over 10 million tonnes of ore with more than 6% metal content. These deposits are expected to bring Pakistan on the world map of base metal producing countries.

Recently GSP has discovered high grade iron ore deposits near Chiniot and Sargodha in Punjab. Three holes drilled so far have given very encouraging results. These deposits are very similar to those found in India and Australia. Geophysical surveys carried out in Sargodha and Chiniot areas indicate the presence of geophysical anomalies which may be due to the presence of large iron ore bodies buried at shallow depth.

Geological Survey of Pakistan will continue its efforts towards finding new mineral deposits by systematic geological mapping, geophysical and geochemical surveys and drilling. Priority will be given to energy sector but assessment of economic potential of already discovered metallic and industrial mineral deposits will also be undertaken.

#### CONSTITUTIONAL AND INSTITUTIONAL FRAME WORK

According to the constitution of the Islamic Republic of Pakistan, mineral resources necessary for the generation of nuclear energy, mineral oil and natural gas come under the exclusive jurisdiction of the Federal Government. The Federal Government also has the control and right over all minerals in the federally administered areas. The provinces on the other hand have the control and right over all minerals other than oil, gas and radioactive minerals falling in their respective provinces. Thus in the provinces the granting and administration of prospecting licenses and mining leases for these minerals is the responsibility of provincial governments, whereas in the federally administered areas these functions are carried out by the Federal Government (FATADC). Regulation of labour and safety in mines is a subject that appears on the concurrent list of the constitution thus permitting both the Federal and Provincial Assemblies to make laws on this subject and to ensure that those laws concerned with safety, health and conditions of workers in mines and quarries are being observed. Geological research, geological surveys and basic geological and mineral exploration and evaluation is presently vested with the Geological Survey of Pakistan.

## CONCLUSIONS

From this review of mineral exploration and development activities in Pakistan it is apparent that during the past five years mineral production has increased and concrete plans and projects have been implemented through which minerals such as barytes, gemstone, china clay, dolomite, rock phosphate and Talc are being produced in substantial quantities. The upward trend in the production and utilization of industrial minerals is quite encouraging but with the exception of chromite no metallic mineral is being produced in substantial quantity. Though large reserves of copper, iron ore, lead and zinc have been established by the Geological Survey of Pakistan, production of metallic minerals has not started as yet due to one reason or the other. However, it is expected that with the policy of self reliance of the present government, mining projects of Saindak copper ore, Gunga (Khuzdar) lead-zinc ore and Chagai iron ore will be given priority and Pakistan will soon emerge on the map of the world as a metal producing country.

For achieving a break through in our economic development, to achieve a meaningful degree of industrialization and for self sufficiency and reliance it is essential that highest priority should be given to development and mining of large reserves of coal, copper, iron ore, lead and zinc that have been established by the Geological Survey of Pakistan. This buried mineral wealth is of little value and consequence unless taken out and utilized.

## ACKNOWLEDGEMENTS

The authors express their gratitude to Mr. Habib Malik, Stenographer for composing the report on Computer M/s Nazarul Islam and Mian Hassan Ahmad, Assistant Directors, for corrections after reviews. Mr. Intizar Hussain Khan, Assistant Director, Mr. B. Z. Zahid, Printing Officer, Mr. Ghulam Mustafa Ghazi, Assistant Publication Officer, Mr. S. Jamiluddin Ahmad, Deputy Director and Mr. I. H Quraishi, Director, reviewed the report at various stages while Mr. Zaki Ahmad, Deputy Director General, reviewed the final draft.

## REFERENCES

- Abbas, S.G., 1989; A short Note on the Chromite Occurrence of Sonaro Area, District Khuzdar, Balochistan; Geol. Surv., of Pakistan P&I file.
- Abbas, S.G., Sultan, M., and Bahadur, S., 1980; Geology and Economic Potential for Fluorite in Dilband, Maran and Pad Maran Areas, District Kalat, Balochistan, Pakistan.
- Afridi, A.G.K., 1986, Barite deposits of North West Frontier Province, Pakistan; GSP Inf. Rel.134, 35pp.
- Ahmad, M.I., 1962, Mineral localities in the Chagai, Koh-i-Marani Area West Pakistan; Geol. Surv. Pak., M.I.C.B.
- Ahmad, M.I., & Klinger, F.L., 1967; Barite deposits near Khuzdar, Kalat Division, West Pakistan; PK Series Rpt. No.21. A GSP, USGS Publication.
- Ahmad, M. U., 1986, Dasht-e-Kain porphyry copper prospect in context of the metallogeny of Chagai calc-alkaline volcano intrusive complex, Chagai district Pakistan; Ph.D Thesis (unpublished).
- Ahmad, N., Qaiser, M.A., Alauddin, M., and Amin, M., 1987; Physico-chemical Properties of Some Indigenous Clays; Pak J. Sci. Ind. Res, Vol.30, No.10.
- Ahmed, W., 1965; Onyx Marble of Chagai District, Quetta Division, West Pakistan; Rec. Geol. Survey, Vol.12, pt.2.
- Ahmed, W., Gauhar, S.H., & Siddiqi, R.A., 1988; Coal Resources of Pakistan; Rec. Geol. Survey Pak., Vol.73.
- Akhtar, M.K. and Cheema, M.R., 1989; Distribution and evaluation of fireclay and bauxite deposits of Chhoi-chak Jabbi area, Attock district, Punjab, Inf. Rel. No.331, Geol. Surv. Pak.
- Alam, G.S., and Khan, A.L., 1982; Gypsum and Anhydrite deposits in Salt Range area, Punjab, Pakistan, Rec. Geol. Survey Pak., Vol.59.
- Asrarullah, 1957; First note on certain reported minerals in the Khyber and North and South Waziristan Agencies; GSP, Open File Rpt.
- Asrarullah; 1960; Geology of Chromite in West Pakistan; In CENTO Symposium on Chrome Ore, Ankara, Turkey, pp.38,53.

- Asrarullah, 1962, Rock Salt Resources of Pakistan; Pak. Geol. Rev., Vol.18, No.193.
- Asrarullah, 1976; Iron Ores in Pakistan; Inf. Rel.108, Geol. Surv. Pak.
- Asrarullah, and Hussain, A., 1985; Marble Deposits of North West Frontier Province, Pakistan; Inf. Rel. 128, Geol. Surv. Pak.
- Bakar, M.A., 1965; Fluorspar deposits of Pakistan, Rec. Geol. Surv. Pak. Vol.XVI, Pt.2.
- Bakar, M.A., and Jackson R. D., 1964; Geological Map of Pakistan, 1:2,000,000 scale; A G.S.P Publication.
- Durrazai, M., Abdullah M.M., and Ahsen N., 1979, Cement Rawmaterials, Pab Range, near Bhawani Village, Hub Chowki, Las Bela, Balochistan, Div. Rpt. No.5, Geol. Surv. Pak.
- Farah, A., Raza, S.H., Rahim, S.M., and Dempsey, W.J., 1970, Gravity Survey of Hindu Bagh-Nasai Chromite bearing region, Zhob district, Balochistan, Pakistan; Pak. Geol. Surv. Rec. Vol.20, pp.143-153.
- Griffiths, J. B., 1987; Pakistan's Mineral Potential: Prince or Pauper., Industrial Minerals, July, 1987, No.238.
- Gauhar, S.H., Khan, S.H, and Sultan, M., 1976; The survey of raw materials around prospective sites for a cement factory in Balochistan; Inf. Rel.92, Geol. Surv. Pak.
- Gauhar, S.H., 1969; Economic Minerals of Pakistan (A brief review); Geol. Surv. Pak., PPI No.88.
- Ghani, M.A., and Harbour, R.L., 1966; Results of core drilling for coal at Lakhra anticline from December, 1961 to May, 1965; USGS, Rpt. PK 7.
- G.S.P, (Anonymous), 1989; Activities and achievements of the Geological Survey of Pakistan.
- Hussain, A., 1976; Silica Sand Deposits of Munda Kachha Area, District Hazara, NWFP, Pakistan; Inf; Rel.95, Geol. Surv. Pak.
- Hussain, A., 1978; An interim report on high grade limestone deposits around Attock, Nizampur area, NWFP, Pakistan; GSP Inf. Rel.100, p.21.
- Hussain, A., Undated; Silica Sand Deposits of Khisore and Marwat Ranges, D.I.Khan, NWFP, Pakistan; Inf. Rel.91, Geol. Surv. Pak.

- Hasan, M.T., and Ghaznavi, M.I., 1980; Phosphate Deposits of Hazara Division, NWFP; Rec. Geol. Surv. Pak., Vol.50.
- Hussain, T., and Sibghatullah, 1966; Interim Geological Report on Fire Clay Deposits of the Salt Range; GSP; prepublication issue No.31.
- Hussain, T., 1975; Interim Report on the Evaluation of High Alumina Clays/Bauxite deposits of Chhoi Jabbinwala Kas Area, Northern Kala Chitta Range, Campbellpur District, G.S.P unpublished report.
- Hussain, T., and Naqvi, A.A., 1973; High Aluminous Clay Deposits of the Punjab Province, Pakistan; Inf. Rel.59, Geol. Surv. Pak.
- Kazmi, A.H., 1961 Stratigraphy of the Ziarat area, Balochistan, West Pakistan; Pakistan Sci. Conf. 13th Proc.
- Kazmi, A.H., and Khan, R.A., 1973; Report on Geology, Mineral and Water Resources of Nagar Parkar, Sind, Pakistan; Geol. Surv. Inf. Rel.64.
- Kazmi, A.H. (editor), 1989; Review of Pakistan's Coal Deposits; Geol. Surv. Rpt. (unpublished).
- Kazmi, A.H., and Snee, L.W., Editors, 1989; Emeralds of Pakistan; published by GSP and VNR Co., pp.200.
- Kazmi, A. H., and O'Donoghue, M., 1990; Gemstones of Pakistan; published by Gemstone Corporation of Pakistan (GEMCP), Peshawar.
- Khan, N.M., 1950; Survey of Coal Resources of Pakistan; Rec. Geol. Surv. Pak., Vol.1, pt.1.
- Khan, S.H., 1980; Structural Geology of Darwaza area near Quetta with emphasis on recent tectonics; GSP, Rpt. unpublished.
- Khan, S.N., and Gauhar, S.H., 1966; Dolomite Resources of Pakistan; Geol. Surv. Pak, PPI No.49.
- Khan S.H., and Mengal M.J., 1989; Preliminary report on raw material resources for Cement Industry and coal showings in Dera Bughti Area, Sibi Division, Balochistan; Inf. Re. 408, Geol. Surv. Pak.
- Moosvi, A.T., 1975; Geology of China Clay Deposits, Shah Dheri; Rec. Geol. Surv. Pak., Vol.26.
- Muslim, M., 1973(b); The Evaluation of Sanni Sulphur Deposits, Kachhi District, Kalat (Baluchistan), Pakistan; Rec. Geol. Surv. Pak., Vol.21, pt.2, Rpt.6.

- Muslim, M., 1973(a); Evaluation of Sulphur Deposits of Koh-i- Sultan (District Chagai), Baluchistan, Pakistan; Rec. Geol. Surv. Pak., Vol.21, pt.2, Rpt.5.
- Nagell, R.H., 1971; Sulphur, Fluorspar, Magnesite and Aluminous chromite deposits in West Pakistan, USGS Rpt. PK.49.
- Raza, S.Q., and Khattak, A.K., 1972; Gypsum Deposits of Kohat District, NWFP, Pakistan; Geol. Surv. Inf. Rel.48.
- Richard, R.L., and Klinger, F.L., 1967; Barite in Pakistan; USGS Rpt., PK.31.
- Rossman, D.L., and Abbas, S.G., 1970;Geology and economic potential for chromite in the ultramafic rock complex near Dargai, Peshawar Division. Pak. Geol. Surv. and USGS PK Series Rpt.
- Rizwani, I.A., and Hussain, S., 1978; Bentonite Deposits of Dheri Chohan Area, District Attock; DMD Punjab, Proj. Rpt.
- Shah, S.H.A., 1975; The Laterite Band of Ziarat, Sibi and Loralai districts, Baluchistan, Pakistan; Rec. Geol. Surv. Pak., Vol.37, Rpt.3.
- Schmidt, R.G., 1968; Exploration possibilities in the West Chagai district, West Pakistan; Eco. Geol. Vol.63 No.1.
- Sheikh, G.M., 1972; Evaluation of Gypsum Resources in Spintingi Area, Sibi District, Baluchistan, Pakistan; Inf. Rel.53, Geol. Surv. Pak.
- Vloten, R.V., 1967, Geology and Chromite deposits of Nasai area, Hindu Bagh Mining district, West Pakistan, Pk. Geol. Surv. Pre-pub Issue 2, 32p.

## P R O D U C T I O N

Yearwise production of different minerals for the period 1982-83 to 1987-88  
(in tonnes)

Mineral	82-83	83-84	84-85	85-86	86-87	87-88
Antimony	—	—	6	24	45	—
Aragonite/ Marble	120,597	100,989	53,202	122,134	203,088	215,715
Barytes	20,088	35,965	20,827	42,148	20,376	12,575
Bauxite	2,772	4,173	2,035	2,280	3,114	2,924
Celestite	406	302	680	873	956	1,117
China Clay	23,583	21,191	816	21,288	32,958	42,458
Chromite	4,487	4,180	3,090	10,127	6,541	8,628
Coal	1,854,514	1,926,350	2,167,904	2,114,532	2,156,704	2,727,307
Ebrystone	912	1,877	3,184	6,206	3,733	3,045
Fire Clay	69,443	83,676	76,551	73,414	100,101	133,869
Fluorite	2,938	3,618	5,770	4,052	3,956	800
Fuller's Earth	20,781	18,973	12,722	10,222	18,599	16,064
Gravel	418,456	84,543	8,769	5,936	10,750	12,670
Gypsum	340,747	338,971	400,264	381,263	411,875	404,042
Limestone	4,231,624	4,696,433	4,634,261	6,312,512	6,885,331	7,610,399
Magnesite	1,687	3,338	3,137	3,266	2,692	3,092
Manganese	—	—	138	135	638	—
Ochre	558	1,086	697	563	1,237	3,436

Mineral	82-83	83-84	84-85	85-86	86-87	87-88
Phosphate	_____	_____	_____	_____	_____	23,615
Rock Salt	547,546	580,988	573,075	619,285	502,797	502,281
Silica Sand	140,701	99,444	110,585	193,408	126,792	163,882
Soap Stone	19,089	15,606	17,192	20,602	24,504	33,492
Sulphur	824	570	884	1,337	1,176	600
	7,821,751	8,022,273	8,095,789	9,945,679	10,528,708	11,255,088

RESERVES AND PRODUCTION OF MINERALS DURING THE YEAR 1987-88  
BEING MINED IN SUBSTANTIAL QUANTITIES

MINERALS	RESERVES (IN MILLION TONNES).	* PRODUCTION (IN TONNES)	MINERALS	RESERVES (IN MILLION TONNES).	PRODUCTION* (IN TONNES)
Abrasive	NE	3045	Gypsum/Anhydrite	350	404,042
✓ Antimony	0.026	-	Iron Ore	400	-
Asbestos	NE	343	✓ Limestone	VLD	7,610,399
Barytes	30	12,575	Magnesite	12.0	3,092
Bauxite/Laterite.	74.0	2,924			
Building stones/ Engineering material	VLD	--	Marble/Aragonite	VLD	215,715
Calcite	NE	152	Mica	NE	25
Chalk	NE	1,894	Ochre	100	3,436
✓ Celestite	0.32	1,117	Phosphate rock	22	23,615
✓ Chromite	FLD	8,628	Quartz/Quartzite	VLD	32,904
Clay					
i. Bentonite	2.0	16,064	Salt:		
ii. China clay	34	42,458	i. Lake/sea salt	VLD	26,305
iii. Fire clay	100	133,869	ii. Rock salt	100	502,281
Coal	19.7 billion tonnes	2,727,307	Serpentine	NE	2,735
✓ Copper	500	--	Silica sand	VLD	163,882
Dolomite	VLD	2,00,000	Soapstone/Talc.	0.6	33,492
Feldspar	NE	9,980	Sulphur	0.8	600
Flint	NE	163	Fluorite	0.10	800
Trona	NE	470	Gemstone	NE	25,552 cts
✓ Zinc/Lead	10+	-			

\*During 1987-88. Production figures taken from the Statistical Year Book 1989 issued by the Central Statistical Division, Islamabad G.O.P. For those minerals for which data was not available in the Mineral Year Book data collected from Provincial Mineral Directorates.

VLD Very large deposits.  
FLD Fairly large deposits.  
NE Not estimated.

TABLE SHOWING RESERVES OF MINERALS WHICH HAVE PROSPECTS FOR ECONOMIC DEVELOPMENT AND EXPLOITATION

Mineral	Locality	Reserve	Production potentials (in tonnes/year)	Remarks
Abrasives.	Dir & Swat districts, NWFP; Gilgit Agency.	Not estimated	Large	Garnetiferous schists in northern areas and residue from the wash of Indus sand may provide substantial quantity.
Antimony	Kirinj (Chitral) Qila Abdullah (Balochistan)	0.026 million tonnes.	1000	Extreme weather conditions and difficult accessibility makes the exploitation difficult.
Asbestos	Mohmand, Waziristan Agencies and Malakand District	NE	500	Small pockets and veins found in altered ultramafic rocks. Large scale production not envisaged.
Aggregate and Building Stones	All the provinces of the country	Very large.	Very large.	All sort of building stones and other aggregates are available in very large quantities all over the country.
Barytes	Kalat & Lasbela districts, Balochistan, Hazara Division, NWFP.	Over 30 million tonnes.	More than 3,000	Very large deposits in Khuzdar and Lasbela districts.
Bauxite/ Laterite	Muzaffarabad & Mirpur Districts, Azad Kash- mir; Chitral & Hazara Division, NWFP; Dadu Thatta & Thar Parker Districts, Sindh	74 million tonnes.	More than 25,000	The deposits are only used in cement and other industries. Further investigations may prove a metallurgical grade deposit.

Mianwali, Attock and  
Sargodha Districts,  
Punjab; Kalat & Sibi  
Distts., Balochistan

Bentonite	Mirpur District, Azad Kashmir; Dadu & Khairpur Districts, Sindh; Peshawar District, NWFP; Jhelum, Rawalpindi and Sargodha Districts, Punjab	Over 2 million tonnes.	More than 10,000	The production is increasing with increase in demand. The bentonite being low to medium grade is being used in Tube Well and other drilling purposes.
Beryl	Gilgit Agency; Dir and Chitral Districts, NWFP	Not estimated.	Not determined.	The deposits of aquamarine in Skardu and beryl in Dir, needs further explorations which could prove a sizable deposit.
Celestite	Dadu District, Sindh; Mianwali District, Punjab	Over 230,000 tonnes	650	Mianwali deposits have not been fully explored.
China Clay	Shah Dheri, Swat; Thar Parkar District, Sindh; Hazara and Dir, NWFP	34 million tonnes	50,000	Deposits of Dir, Thar Parkar and Hazara require further exploration; Swat deposit is being utilized by Ceramic Complex of Nowshera.
Chalk	Dadu District, Sindh; Mianwali District, Punjab	NE	2,000	Total demand of the country can be met.
Chromite	Zhob & Wad Districts (Balochistan). Malakand & Kohistan Districts (NWFP); Mohmand & Waziristan, FATA	FLD	20,000	Being podiform ore bodies large producing mines cannot be planned but with some efforts the production can be raised many fold.

Coal.	Thatta-Sonda, Jherruck, Jhimpir & Sindh; Mach, Sor Range - Deghari, Pir Ismail, Ziarat, Khost-Shahrig-Harnai Duki, Chamalang, Balochistan; Makarwal, Salt Range, Punjab; Cherat, NWFP	Over 19.7 billion tonnes	Very large.	The production will increase many fold as soon as coal fired power plants are setup.
Copper.	North Waziristan Agency FATA, Chitral, Dir,, NWFP; Chagai, and Zhob Districts, Balochistan	About 412 million tonnes of ore in Saindak, Balochistan. About 122 million tonnes ore average 0.386% Cu in N.Waziristan	20,000 tonnes per day.	Development work on Saindak copper-gold project with annual production target of 15800 tonnes of blister copper, 1.47 tonnes of gold and 2.76 tonnes of silver started.
Dolomite	Mianwali, Sargodha and Rawalpindi Districts, Punjab; Mardan and Hazara Districts, NWFP; Thatta District, Sindh	Very large deposits	50,000	Kutki and Zaluch deposits (Mianwali District) and Jhimpir deposit (Thatta District) being utilized by Karachi Steel Mill.
Fluorite	Kalat Dist. Balochistan	0.1 million tonnes	5,000	Concentrated efforts are needed to increase production.
Feldspar	Swat and Mansehra of NWFP; Nagar Parkar Sindh	NE	10,000	The total demand of Ceramic Industry can be met locally.
Gemstone	Chitral and Mardan Districts, Mohmand Agency and Swat, Hunza and Dir Districts, Zhob District	Not estimated	800-1600 gms/year	Exploration of Topaz deposits of Chitral and Mardan Distts; & Ruby/Spinel deposits of Hunza and Dir Districts may prove a sizable deposit.

Gypsum/ Anhydrite	Mianwali, Jhelum, D.G.Khan, Punjab; Kohat, NWFP; Sibi, Balochistan	350 million tonnes	Very large.	The total demand of agricultural and industrial sector can be met locally.
Iron Ore	Mianwali and D.G.Khan, Sargodha District, Punjab; Hazara Divisi- ion, Chitral & D.I.Khan Districts, NWFP; Kalat and Chagai Districts, Balochistan	Over 400, million tonnes	Not being exploited	Exploration and metallurgical studies of these deposits should be continued, so as to meet Steel Mill's requirements if possible.
Limestone	All the provinces of the country	Very large	Very large.	Setting up of Steel Mill based on low grade ore of Mianwali and Mini Steel Mills based on Chagai ore should be given serious consideration.
Magnesite	Kalat and Zhob Districts, Balochistan Hazara Division, NWFP	12 million tonnes	50,000	Development of Hazara Magnesite can make achievement of production target possible.
Marble/ Aragonite.	Mardan, Nowshera, Swat, Khyber, NWFP; Chagai, Balochistan	VLD	Very Large	Very large deposits of recrystallized, fossiliferous and good colour limestone deposits occur all over the country, specially in the northern areas. The deposits are being mined on large scale. The production can be further increased many fold depending upon demand.
Ochre	Khushab, Mianwali, Districts, Punjab; Shekhai, NWFP	100 million tonnes	2000	The production can be raised many fold if the demand rises.

Phosphate	Abbottabad-Hazara, NWFP, Attock District, Punjab	30 Million tonnes	23,000 tonnes being produced from Hazara Distt.	Production of phosphatic fertilizer based on Hazara deposits has started.
Quartz/ Quartzite	Lasbela, Balochistan; Mohmand and Waziristan NWFP.	FLD	40,000	Total demand of Karachi Steel Mill and local Ceramic Industry are met locally.
Soapstone/ Talc	Hazara Division, Swat District, Khuber & Parachinar Agency, NWFP	Over 600,000 tonnes	8,262	Detailed exploration and development of Swat deposit for proving more reserves to meet the domestic and export requirements. Accessibility problem is hindering the development of Parachinar deposits.
Silica Sand	Dadu, Sindh; Jhelum, Mianwali and Khushab, Punjab; D.I.Khan, NWFP	VLD	Very large	Total demand of local market for sheet glass and furnaces being met. Production can be raised if the demand rises.
Serpentine	Lasbela, Balochistan; Swat, NWFP.	NE	5,000	The production can be raised depending upon market.
Sulphur.	Koh-i-Sultan and Sibi Distts, Balochistan; Reshian, Azad Jammu & Kashmir	800,000	3,310	Development on scientific lines is required for optimum production for defence and other purposes.