ROLE OF GEOLOGICAL SURVEY OF PAKISTAN IN CREATING OPPORTUNITIES IN MINERAL SECTOR

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1.Introduction

2. Mineral Potential of Pakistan including Strategic Resources

3. Exploration and Optimum Utilization of Resources

4. Way Forward For investment opportunities in mining sector

GEOLOGICAL SURVEY OF PAKISTAN

1. *An attached department of the Federal Ministry of Petroleum and Natural Resources*

CHARTER

1. The organization, as per its approved charter, is responsible for the study of geology of the country in detail, and to assess its resource potential. It undertakes:

- **Geological mapping and other geoscientific surveys,**
- **Basic and applied research in earth sciences,**
- **Scientific investigations for an accurate understanding of the country's geological resources and their prudent management, and**
- **Environmental geology and hydrogeological studies**

MINERALS UNDER EXPLOITATION

1. Antimony
2. Aragonite/Marble
3. Argillaceous Clay
4. Asbestos
5. Ball Clay
6. Barites
7. Basalt
8. Bauxite
9. Bentonite
10. Beryl
11. Brine
12. Building Stone
13. Calcite
14. Celestite
15. Chalk
16. China Clay
17. Chromite
18. Coal
19. Dolomite
20. Emerald
21. Epidot
22. Feldspar
23. Fire Clay
24. Flint Stone
25. Fluorite
26. Garnet
27. Garnite
28. Gypsum
29. Iron Ore
30. Laterite
31. Limestone
32. Magnesite
33. Manganese
34. Marble Onyx
35. Nepheline
36. Syenite
37. Ochers
38. Phosphate
39. Pumice
40. Quartz
41. Red Oxide
42. Rock Salt
43. Ruby
44. Serpentine
45. Shale Clay
46. Silica Sand
47. Soap Stone
48. Sulphur
49. Tourmaline
50. Trona

From 5 at the time of Independence to 50 under exploitation today

Constitutional Apportionment -1973

Federal:

- Geological surveys & discovery of mineral deposits.
- National policies / plans formulation and coordination at the national and international levels.

Federating Units:

- Mineral exploration and development.
- Regulation of mineral sector.
- Safety of exploration and mining operations.

Mineral Potential of Pakistan

- Pakistan is home to many varieties of minerals, some of which make it prominent in the world.
- Pakistan is emerging as a very promising area for exploration of mineral deposits.
- Exploration by government agencies as well as by multinational mining companies and various regional geological surveys, conducted in the recent past have confirmed the great potential of Pakistan in minerals like copper, gold, silver, platinum, chromites, iron, lead zinc and crude oil.

METALLOGENIC ZONES OF PAKISTAN

1 Chagai Raskoh Magmatic Arc

2 Chaman- Ornach-Nal Transform Fault zone
Lasbela- Khuzdar, Muslim Bagh, Zhob-Waziristan

3 Ophiolites & Melange zone

4 Sediment hosted Lead-Zinc- Barite- Flourite deposits.

5 Kirthar Thrust & Fold Belt.

6 Sulaiman Thrust & Fold Belt.

7 Indo Pakistan Shield rocks of Sargodha, Kirana & Nagar Parkar

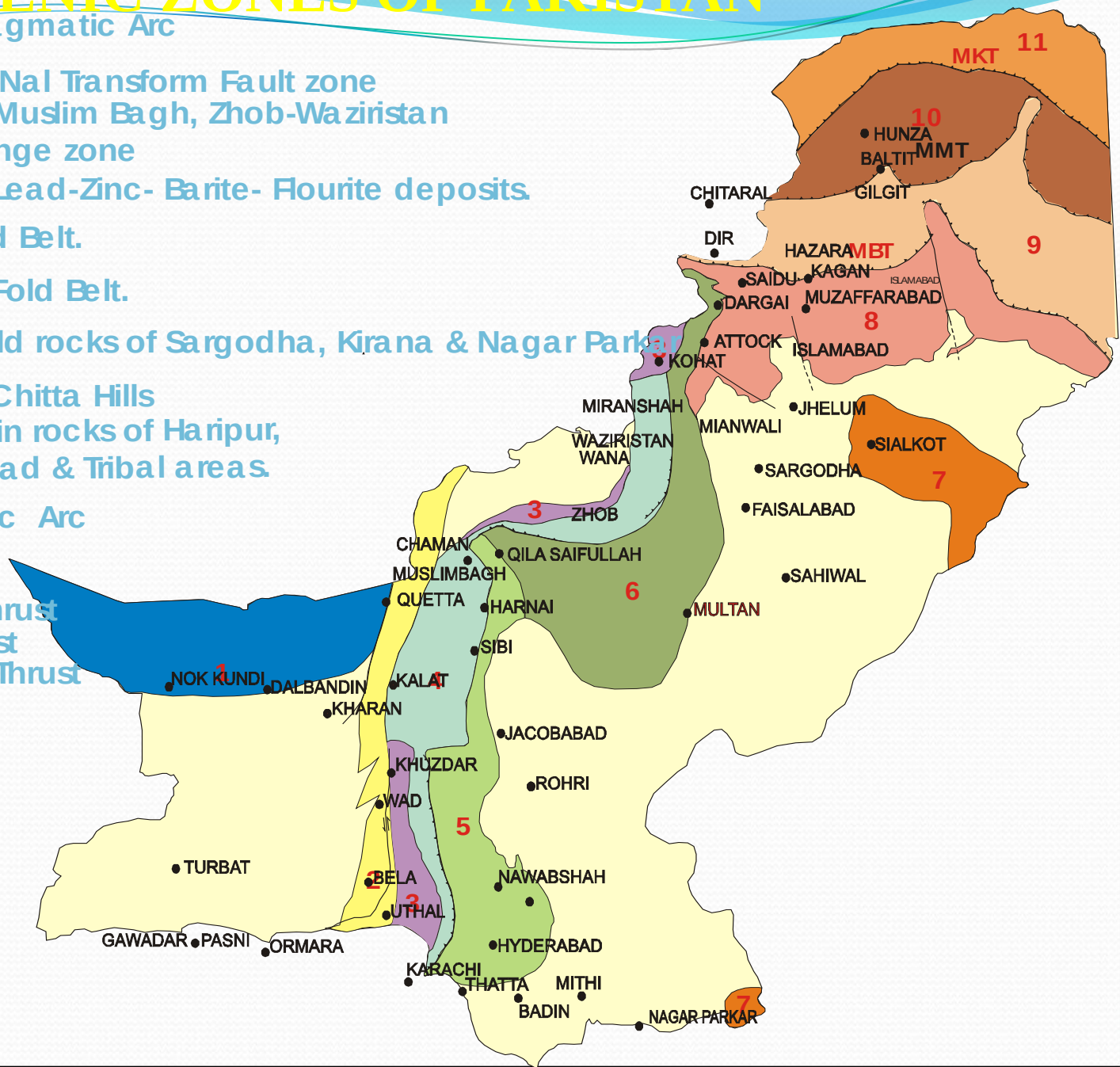
8 Salt range & Kala-Chitta Hills

9 Gondwanic domain rocks of Haripur, Sherwan, Abbotabad & Tribal areas.

10 Kohistan Magmatic Arc

11 Karakoram Block

MBT Main Boundary Thrust
MMT Main Mantle Thrust
MKT Main Karakoram Thrust



Geological Survey of Pakistan
Ministry of Petroleum and Natural Resources
Government of Pakistan

Antimony

Vein type deposits of antimony ore mineral - stibnite are known from the vicinity of Qila Abdullah, Panjgure, Kharan and Turbat districts in Baluchistan province and hosted mostly in Khojak and, Hushab Shale. In Khyber Pakhtunkhwa, antimony occurs in the Lutkho and Partisan areas near Kriej village, Chitral district. Stibnite (SI2 S3) is found as veins, lenses and irregular masses along shear zones in Chitral slates. Present estimate of available ore, in the country, is 88,000 tonnes but detailed investigations may prove more tonnage. The reported average annual production has been over 200 metric tonnes but now-a-days due to various tribal issues its production is almost negligible.

Chromite

At present chromite is being produced from Muslimbagh, Wad and Sonaro areas of Baluchistan Province and Malakand and Kohistan areas of Khyber Pakhtunkhwa province. The ortho chromite produced in the country is exported. Generally, Pakistani chromite containing over 46% Cr2 O3 , 16 to 15% AI2 O3 , less than 10% SiO2 and with Cr, Fe ratio over 2.8. Present estimate of available ore in the country, is over 2.527 million tonnes. The reported average annual production is 30,366 metric tonnes.

Copper

Baluchistan 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, Kahtal Koh, Koh-i-Dalil, Missi and Ziarat Pir Sultan (Ahmad 1986). All these deposits occur in Chagai District of Baluchistan province. Similar deposits may be found in the Federally Administrated Tribal Areas (FATA) and Ba. Federally Administered Northern Areas (FANA) while massive sulphide type copper deposits may be found in Chagai, Lasbela and Kharaller districts of Baluchistan, Waziristan Agency, FANA and other Tribal Areas. Data on Saindak copper –gold deposit is as follows;

Production of Mister copper started, from the 412 million tonnes Saindak copper gold deposit, during 1993 and stopped due to certain reasons - after making the total production of 1,500 tonnes of blister copper which was successfully marketed in the Iriternational Market. The production resirned in 2002 through a contract with a Chinese firm M/S Metal Construction Company (MCC) which later on reformed as Resource Development Company Limited (MRDL). The project is producing 15,672 tonnes of copper blister, 51052 Oz of gold (1.47 metric tonnes) and 97356 Oz of silver (2.76 metric tonnes) annually.

Reko Diq Copper –Gold deposit is a very promising deposit, discovered by GSP in 1978-79. M/S Terhiin Copper Company (TCC) has invested over 500 million US $ for exploration of the deposit which is expected to start production within next few years. Later on the ownership of TCC was sold jointly to M/S Barrik Gold of Australia and Antofagasta of Chile, both holding 37.5% share each while the Government of Baluchistan is holding 25 % share. Current status of this world class deposit is that the Government of Baluchistan has declined to convert the "Prospecting Lease" of the area to "Mining Lease" and the matter is sub-judice. Basic facts about the deposit are given below:

Reserves	> 5 Billion tonnes
Copper Content	= 0.54 %
Gold	= 0.24 g/t

Gold / Silver

It has been established that there are indications that Pakistan has a significant potential of gold, particularly in the felsled belt regions (Northern Mountain belt, Island Arc system), its association with volcanogenic sequences, porphyry copper and in shear zones. In the Northern Areas, spread of gold anomalies is concentrated along the Main Karakoram Thrust (MKT) within each geologic unit. The istribution of gold anomalies, obtained through geochemical sampling, vary between 2 ppm to 338 ppm in this area.

Gold panning was in practice at several places in the northern areas now constituting Pakistan along the course of Indus River and its tributes before partition. Locally some gold is still produced in these areas. Precambrium shield rocks exposed in Chitrot area of Punjab and Tharparkar area of Sindh are also favourable for localization of gold deposits. Large scale production of gold and silver along with copper has started from Saindak porphyry copper deposits in Chagai district of Baluchistan.

Iron

Many small and large deposits of iron ore have been found in different parts of the country. Important among these are the Hammed Nissar and Langrial deposits of Khyber Pakhtunkhwa, Chichali and Kalabagh deposits of Punjab province and Chilghazi, Chigandik and Pachin Koh deposits of Baluchistan province (Asrarullah 1976). The iron ore deposits recently discovered by the GSP at Dilband in Kalat district, Uthal in Lasbela district of Baluchistan and Nizampur area in Khyber Pakhtunkhwa province are of great economic significance.

Present estimate of available ore in the country is over 1,400 million tonnes. The reported average annual production is 341,651 metric tonnes (2010-2011). It must be noted that the production of iron ore has registered a tremendous increase (about 1300%) during the last 3-4 years as compared to the average production. During the last 10 years the average production was 24,322 metric tonnes.

Lead and Zinc

The Geological Survey of Pakistan has discovered several deposits of lead and zinc ore in Lasbela-Khuzdar region of Baluchistan 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 result of these investigations were found very encouraging (Ahsan et. al. 1994). PMDC with the technical and financial assistance of UNDP undertook the preliminary evaluation of lead-zinc deposits at Duddar and evaluated 6.86 million tonnes of proved reserves and 3.43 million tonnes of inferred reserves with 11.34% zinc and 2.29% lead (Jones and Shah 1994). These deposits have been jointly evaluated for development by Pakistan Mineral Development Corporation (PMDC) and Baluchistan Development Authority (BDA) and the earlier estimates of reserves have almost been doubled.

The preliminary investigations by the GSP have indicated the availability of over 10 million tonnes of lead-zinc ore along with baryte at Gunga near Khuzdar, Baluchistan with about 8 percent total metal value (Ahsan et al 1994).

At Surmai, exploration work carried out by GSP and JICA proved the presence of 2.93 million tonnes of ore with average metal content of 6.5 percent (Ahsan et.al. 1994). Further exploration may reveal additional reserves in the area as only a very small part of the deposit was investigated during the project period.

Present estimate of available ore, in the country, is over 23 million tonnes. Production of lead-zinc commenced during 2010-2011 with total metal production of 12692 metric tonnes (Lead + Zinc).

Manganese

Manganese ores are found at many localities in Lasbela, Kharan, Chagai and Zhob districts in Baluchistan. The host rock of almost all the manganese deposits in the Lasbela district is the volcanic assemblage of olivine basalt and pillow lava belonging to Bela Volcanic Group. The manganese minerals are mainly psilomelane, and pyrolusite which occur in the jasperoid layer above pillow lava and below shale sedimentary rocks.

The manganese occurrences in Chagai district are found as veins cutting limestone beds and basalts of Cretaceous age. These occurrences are reported from Ras Koh (Charkoban area) Nish Koh and Sokizoh in Chagai district of Baluchistan. The manganese deposits reported from Zhob district occur in silicified siliceous limestone associated with pillow lava of Cretaceous age. The manganese localities in Zhob district of Baluchistan are at Sawesha and Warsak Kili area.

Present estimate of available ore, in the country, is over 600,000 metric tonnes and the average annual production is 2,712 metric tonnes. Current production of manganese has shown an increase over the past few years, as earlier it was about 1,500 metric tonnes per annum.

SOLID FUEL

Coal

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 185 billion tonnes out of the total coal resources of the country exceeding 186 billion

tonnes. Sindh province, especially huge lignitic resources at Thar make the future hope of Pakistan for production of thermal /electrical energy based on coal fired power stations. The coal resources base of the Punjab Province is over 235 million tonnes. Baluchistan Province has a coal resource base of over 217 million tonnes but 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 Chamalang, Mach, Sor Range - Dughari, Pir Ismail Ziarat, Khost - Shahrig - Harnai and Duki areas. Coal also occurs in Kotli district of Azad Jammu and Kashmir and in Cherat and Hangu, Khyber Pakhtunkhwa, and Orakzai Agency in FATA.

Almost the entire production of indigenous coal is being used for firing brick kilns and some industrial units. Two coal fired power plants with 7.5 MW capacity each were operational since 1964 near Quetta but have since been closed. Three coal fired power plants of 50 MW capacities each based on fludized bed technology have been set up at Khanot near Hyderabad.

Present estimate of available coal resources in the country is over 186 billion tonnes. The reported average annual production is 3.3 million metric tonnes.

Gems and Precious Stones

Some of the important gemstones, which have given Pakistan a recognized position amongst supplier of precious and semi-precious stones in the international market, include emeralds, rubies, topaz (golden and white), tourmaline, garnet, beryl, zircon, rutile, quartz, rutile quartz, morganite, apatite, spinel, pargasite, sphene, agate, zoisite, epidote, emerald-colour tourmaline, diopside, amethyst, scheelite, moon stone, aquamarine and fluorite. Mainly these deposits have been found in Gilgit-Baltistan, FATA and Azad Jammu & Kashmir.

CERAMIC MINERALS

Barite

The barites deposits of Baluchistan province were discovered by the Geological Survey of Pakistan (Ahmad and Khinger, 1967). These deposits are located in the area between Uthal and Khuzdar. 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 to meet local demand and as well as export.

Total reserve of barites in Pakistan has been estimated at 13.71 million tonnes and it is believed that more huge resources are available in the country. The reported average annual production is 33,312 metric tonnes.

China Clay

China clay deposits are found at Shah Dheri, Swat, Khyber Pakhtunkhwa and in Nagar Parkar, Sindh. Some smaller deposits have also been found in Dir, Hazara and Gilgit. The Geological Survey of Pakistan discovered both the Shah Dheri and Nagar Parkar deposits (Mosovi 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 (Mosovi 1975) of raw china clay. Plagioclase rich lesuc-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:-

Overall estimation for the country has not been worked out but it is believed that huge resources are available in the country. The reported average annual production is 22,790 metric tonnes, registering about 50% decrease over the past few years.

Feldspar

Large deposits of both sodic and potassic feldspars with over 6 billion tonnes of reserves have been found near Mingora and Bunair in Swat district of Khyber Pakhtunkhwa (Buddrah 1994). Feldspar is widespread in pegmatites in Chitral, Gilgit and Skardu. Deposits of orthoclase feldspar are also present in Nagar Parkar area of Sindh.

Overall estimation for the country has not been worked out but it is believed that large resources of feldspar are available in the country. The reported average annual production is 150,487 metric tonnes. Production of feldspar has shown tremendous, about 500% increase, over the past few years.

Fuller's Earth

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 Palaeocene-Eocene rivers which deposited coal in Khyber Pakhtunkhwa, Punjab, Baluchistan and Sindh also deposited Fuller's earth in the adjoining areas. The present production is being utilised in oil refining and other industries in the country. It is also being used by insecticide, foundries vegetable oil, ghee and steel industries. Thus a sharp rise in the demand of Fuller's earth is expected in future.

Overall estimation for the country has not been worked out but it is believed that huge resources are available in the country. The reported average annual production is 6,774 metric tonnes, showing notable decline in production over the past few years as earlier it was about three times of this figure.

Fire Clay

Sizable deposits of fire clay are found in the province of Punjab, which is also the main consumer of this commodity. Large 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 Khyber Pakhtunkhwa. 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 bulk of the present production is obtained 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.

Total reserve of fire clay in Pakistan are over 100 million tonnes and reported average annual production is 289,573 metric tonnes.

Silica sand/Glass sand

Datta Formation of Jurassic age and its equivalent formations contain thick beds of silica sand in Khisor and Marwat Ranges, between Paniala and Pezu, over a length of 16 km with an estimated reserves of 20 million tonnes (Raza and Iqbal 1997). In Salt Range and Surghar Range glass sand beds occur in Datta Formation and Patala Formation (Late Paleocene). Near Mallakhel, glass sand beds with over 99% SiO2 occurs in Lumshival Formation of Lower Cretaceous age (Ahmad 1959, Shah 1980). In Hazara high grade silica sand occurs as thick layers within a 150 m thick sequence of metamorphosed calcareous sandstone at Mand Kachcha (Raza and Iqbal 1977). Large deposits of glass sand are found in Dadu District of Sindh province in Eocene and Oligocene sediments. Large lenticular bodies of silica sand occur in mets sediments in Mohmand Agency with reserves of over 537 million tonnes.

Total reserves of silica sand in Pakistan are estimated to be 557 million tonnes and reported average annual production is 317,225 metric tonnes. The production of silica sand has also shown an upward trend and it has increased about 20% over the past few years.

FERTILIZER AND INDUSTRIAL MINERALS

Gypsum and Anhydrite

Pakistan has very large reserves of gypsum/anhydrite found in all the provinces of the country. Major deposits are those of Daud Khel, Khewra and D.G. Khan Punjab, Kohat Region in Khyber Pakhtunkhwa and Spinizagi and Chamalang in Baluchistan. Smaller deposits occur in Dadu district of Sindh and Lasbela district of Baluchistan. Present estimate of available gypsum resources in the country is over 4,850 million tonnes. The reported average annual production is 1,041,972 metric tonnes, registering an increase of about 100% over the past few years.

Magnesite

Magnesite is found at Wad and Muslim Bagh in Baluchistan and Malakand & Hazara in Khyber Pakhtunkhwa along fractures, joints and faults in ultramafic rocks. The Kumhar magnesite deposit of Hazara Khyber Pakhtunkhwa has been estimated to contain 8.75 million tonnes of total reserve. The magnesite from this deposit has been found suitable for production of refractory bricks and fused magnesium phosphate (Hinzpeter et. al. 1995).

The magnesite resources in Pakistan have been estimated at 12 million tonnes whereas the average annual production is 9,844 metric tonnes, registering an increase of about 200% over the past few years.

Rock Salt

Huge deposits of rock salt are located in the Salt Range in Punjab province and in Kohat district of Khyber Pakhtunkhwa. Salt mining has been traditionally carried out by the government since annexation of Punjab and Khyber Pakhtunkhwa during the British rule, but recently some private parties have also started salt mining.

In the 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 rock salt resources of Pakistan stands at 800 million tonnes and the reported average annual production is 2,021,008 metric tonnes, showing an increase of about 36% over the past few years. About 40% of the total output is consumed by soda ash, caustic soda and leather industries and rest is marketed for domestic / human consumption. A certain amount of rock salt is also exported to a number of countries.

Soapstone and Talc

Soapstone deposits occur in Parachinar area, Kurram Agency; Jamrud, Khyber Agency; Dargai, Swat district; Sherwan, Abbottabad district; Muslim Bagh & Wadh-Uthal areas in Baluchistan. The Sherwan deposit is the major producer of soapstone in the country but other deposits of Khyber Pakhtunkhwa and FATA/ FANA have also started producing and are expected to increase the production as the demand rises.

Soapstone deposits of Kurram Agency have been estimated to contain 1.6 million tonnes of reserves (Hashmh 1994).

Overall estimation of soapstone has not been worked out but it is believed that huge resources are available in the country. The reported average annual production is 147,250 metric tonnes, showing about 137% increase over the past few years.

BUILDING AND DECORATIVE STONES

Pakistan is blessed with a variety of exquisite building and decorative stones throughout the country. The most commonly used and mined in large quantities are marble, onyx marble, various types of limestone and igneous rocks, mainly granite, diorite and gabbro.

Large reserves of re-crystallized limestone and marble occur widely in the Gilgit and Skardu region, in Malakand, Khyber Agency, Swat and Mardan districts of Khyber Pakhtunkhwa, Bajaur and Khyber Agencies of FATA, in Azad Jammu and Kashmir (Asrarullah and Hussain 1985). Onyx marble of high quality is found in Chagai District of Baluchistan Province (Ahmad, 1965). Other forms of building stones like slate, sandstone, boulders and gravels

are are abundantly available throughout the country. Attractive and good quality granitic, dioritic and gabbroic rocks occur in Gilgit, Chitral, Swat, Raskoh, Chagai, Lasbela and Nagarparkar areas.

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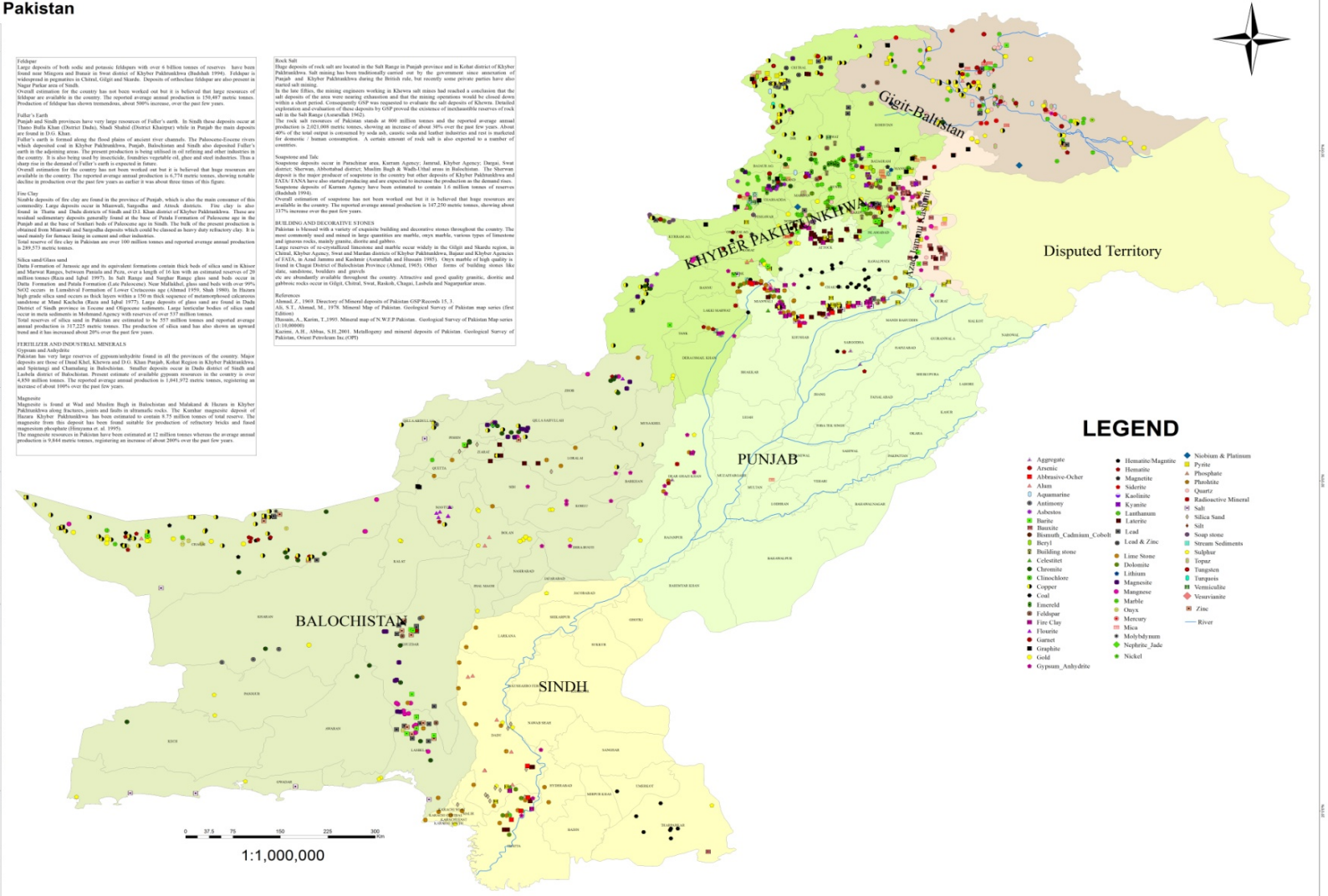

MINERAL MAP OF PAKISTAN
2015

Compiled by: Naghma Haider,
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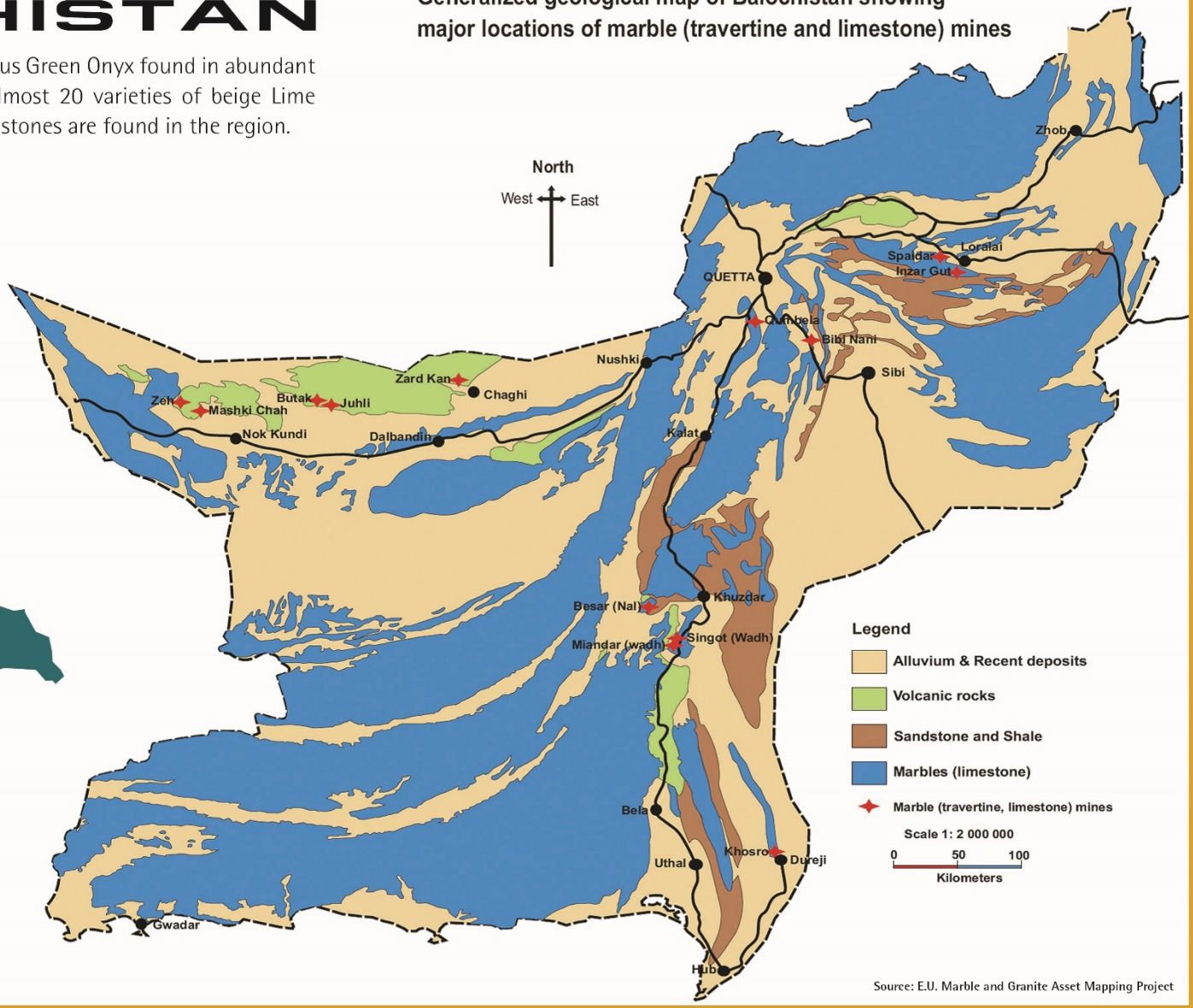
Mineral Potential of Baluchistan

BALOCHISTAN

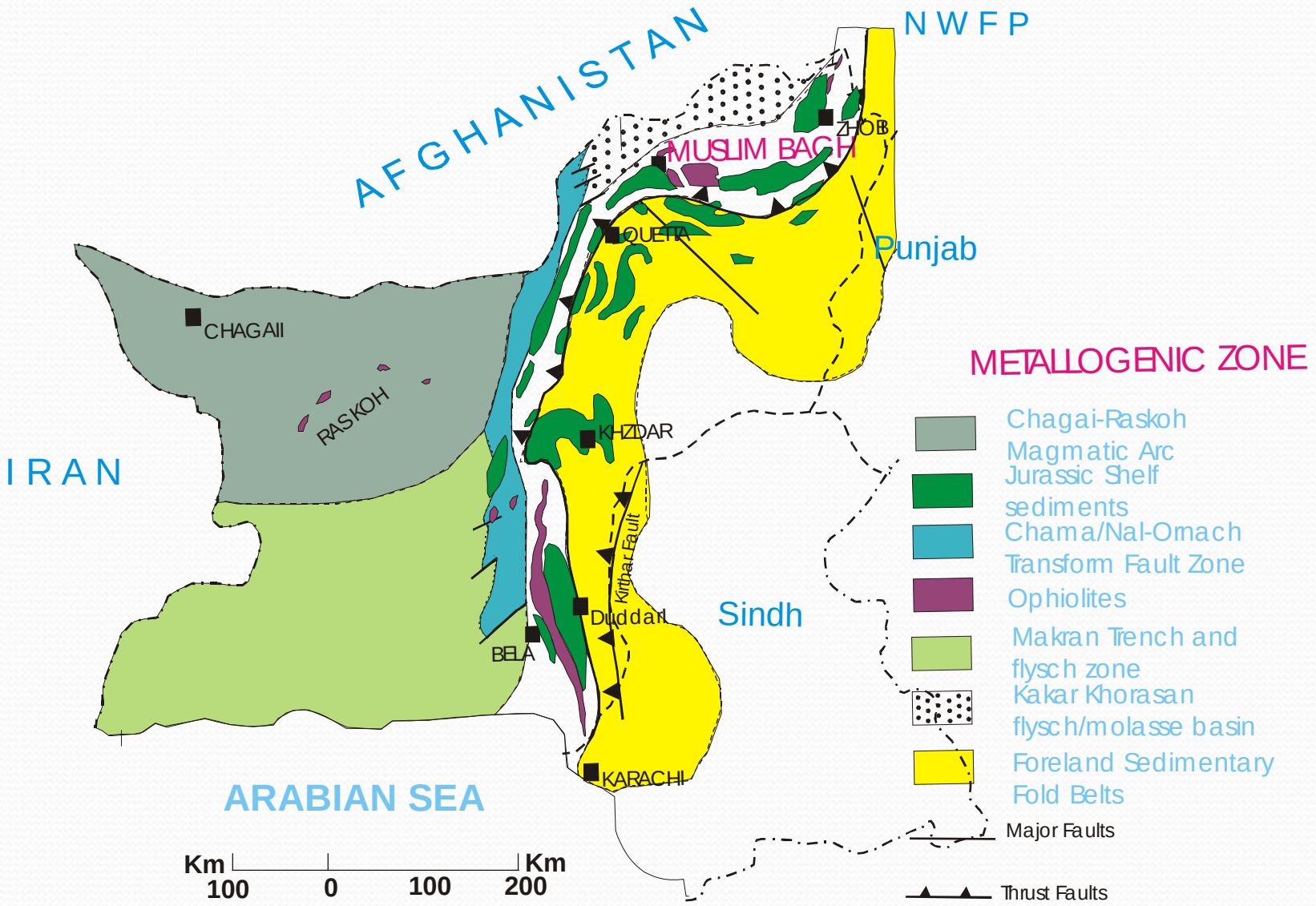
The province is host to the world famous Green Onyx found in abundant quantities in the Chaghai region. Almost 20 varieties of beige Lime stones and other unique dimensional stones are found in the region.

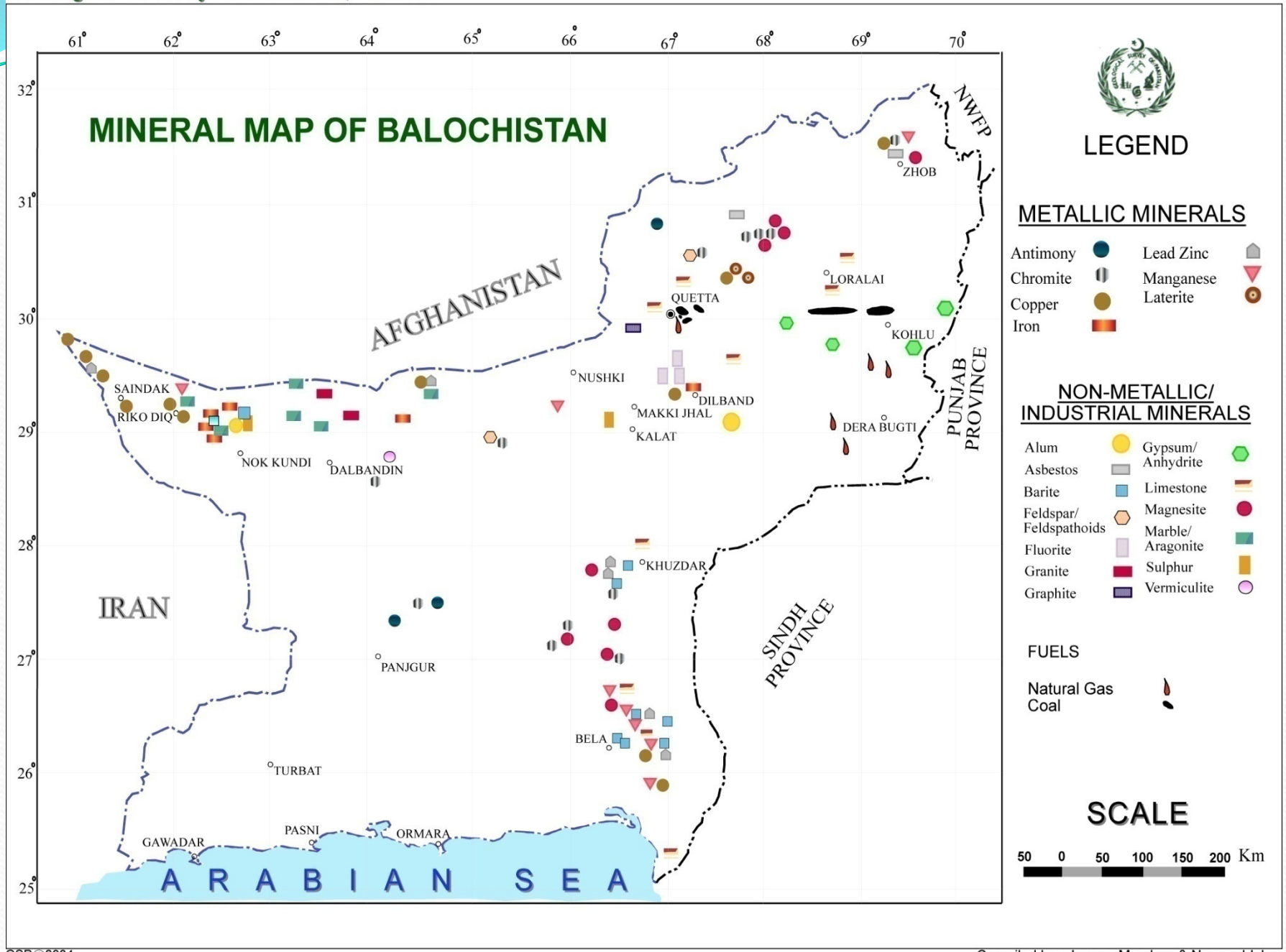
Generalized geological map of Balochistan showing major locations of marble (travertine and limestone) mines



Source: E.U. Marble and Granite Asset Mapping Project

METALLOGENIC ZONES OF BALOCHISTAN





GSP©2004

Compiled by: Joozer Marzban & Nazar-ul-Islam

MAJOR AND IMPORTANT MINERAL FINDINGS OF GSP

- **SAINDAK COPPER - GOLD DEPOSIT**

Discovered by GSP in 1973. GSP initiated the work and in collaboration with RDC completed the prefeasibility study

Reserves > 400 million tonnes

Copper = 0.4 % with 1.7 million tonnes

Gold = 0.30 – 0.48 g/ton

Presently MCC of China is producing with 15,000 tonnes of copper, > 1.5 tonnes of gold and > 2.8 tonnes of silver per annum

In-Situ value of contained Metals is over US$ 250 billion at present

Mining Site

MAJOR AND IMPORTANT MINERAL FINDINGS of GSP

❖Reko Diq

- **One of the very promising deposits discovered by GSP.**
- **Tethyan Copper Company worked to develop the mine but could not start mining due to litigation.**
- **Antofagosta also worked for its development**
- **Reserves > 5 Billion tonnes @ 0.64% Copper and**
- **In-Situ value of contained Metals is at least US$ one trillion at present prices.**

Reko Diq Porphyry

IMPORTANT INVESTIGATED COPPER PROSPECTS BY GSP

Deposit	Location	Prospect Million Tons
Dasht-e-Kain	Dalbandin	400
Durban Chah	Nok Kundi	< 100
Talaruk	Near Rabat	0.657
Ziarat Pir Sultan	Dalbandin	200
Kabul Koh	Dalbandin	50

Duddar – Lead Zinc Deposit

Discovered and initial investigation done by GSP

Combined Lead-Zinc Ore with 7% Zn & 3.2% Pb

Reserves = 15.5 million tonnes

MRDL of China has been given the lease to develop Duddar Deposit as joint project with PMDC

In-Situ value of contained Metal US$1.33 billion at present prices.

Gunga and Surmai - Lead Zinc Deposits

Deposits		Reserves (M.T)	Grade
unga		10.00	8.0% Pb-Zn
Surmai		3.00	6.5% Pb-Zn

CHROMITE

- Chagai-Raskoh : The Chromite deposits in Chagai - Raskoh magmatic arc of Balochistan occur in Nag Bunap and Rayo valley.
- The deposits occur respectively as small isolated lenticullar bodies in the ultramafic rocks in Raskoh range, District Chagai, Balochistan.
- The Raskoh Chromite deposits contain 47~57% Cr2 O3 having 2.6~3:1 Cr : Fe. ratio. The estimated reserves are about 30,000 tons.
- The chromite reserves in commercial quantity are available in Lasbela, Chagai, Pishin, Sonaro and Muslim Bagh.

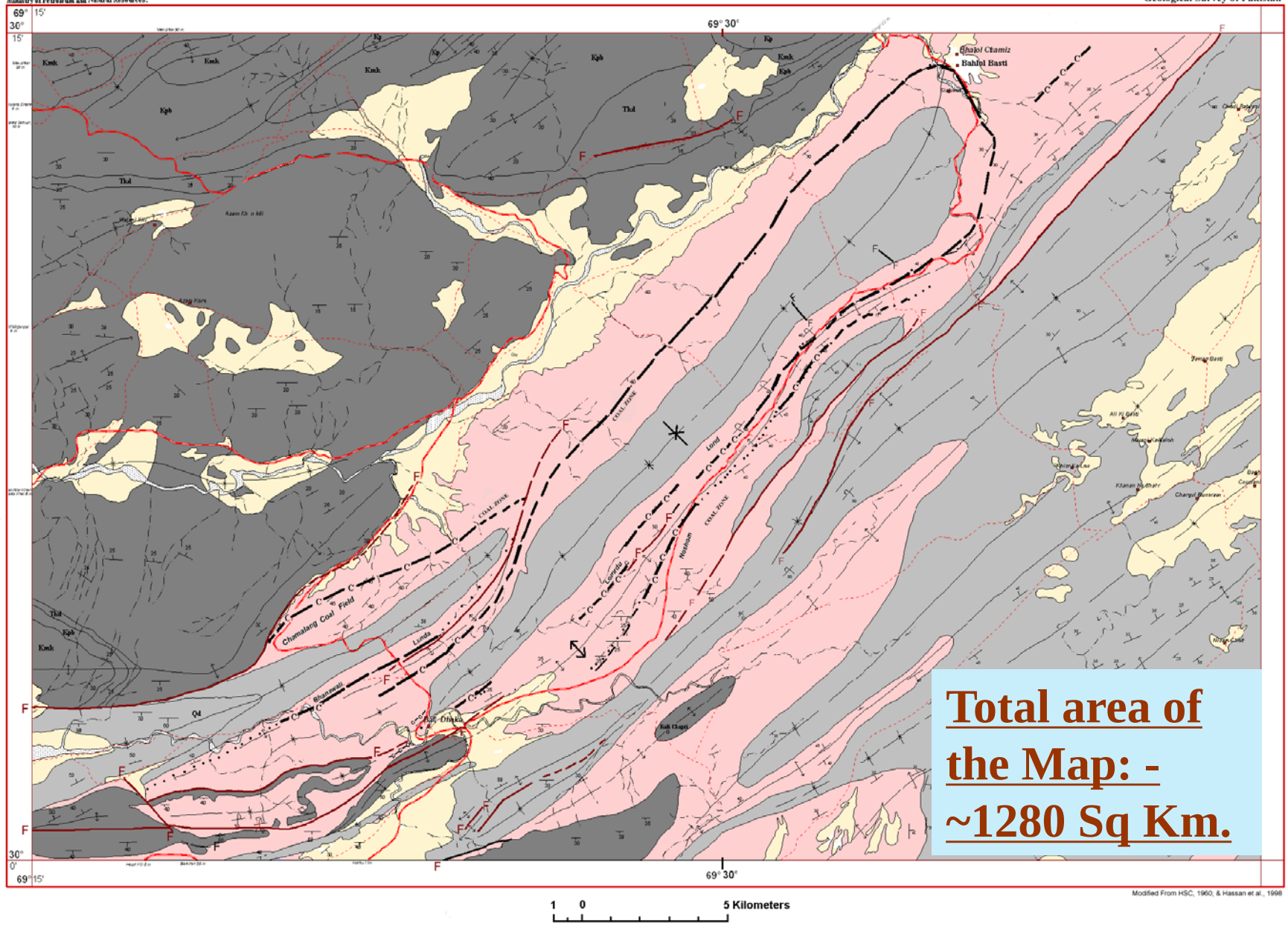
QUALITY & RESOURCES OF BALOCHISTAN COAL

Coal Fields	Coal Resources (Million tonnes)	Rank ASTM Classification	Heating Value Btu/lb
Khost-Shahrig -Harnai	76	Sub B to hv bA	9,637-15,499
Sor Range -Deghari	50	Sub A to hv bB	11,245-13,900
Duki	50	Sub B to hv bA	10,131-14,164
Mach - Abegum	23	Sub A to hv bC	11,110-12,937
Pir Ismail Ziarat	12	Sub A to hv bV	10,786-11,996
Chamalong	6	Hv bC to hv bA	12,500-14,357
TOTAL	217		

Government of Pakistan
Ministry of Petroleum and Natural Resources.

GEOLOGICAL MAP OF CHAMALANG-BALA DHAKA-BAHLOL COALFIELD

Geological Survey of Pakistan



LEGEND

QUATERNARY ROCKS
Quaternary rock deposit consists of recent and sub recent clay, silt, sand, gravel and conglomerate.

POST-GHAZIJ ROCKS
Post-Ghazij rocks (late early to middle Eocene) consist of limestone and shale of Drug, Baska, Habib Rahi, Domanda, and Drazinda Formations.

GHAZIJ FORMATION
Ghazij Formation (early Eocene) consists of mudrocks, sandstone, few beds of coal and fossiliferous marl/ limestone. Ghazij Formation is divisible in to three distinct parts:-

1. Lower part of Ghazij Formation predominantly consists of green-gray mudrocks with few thin sandstone beds.
2. Middle part of Ghazij Formation consists of gray mudrocks with beds of sandstone, coal and few fossiliferous marl/ limestone.
3. Upper part of Ghazij Formation dominantly consists of red mudrock with subordinate sandstone (channel) beds.

PRE-GHAZIJ ROCKS
Pre-Ghazij rock (Paleocene-Cretaceous) consists of limestone, shale and sandstone of Dungan, Khadro, Pab, Mughal Kot and Parh Formations

GEOLOGICAL SYMBOLS

- Contact
- Coal Outcrap
- Strike and dip
- Overturned strata
- Anticline
- Syncline
- Overturend anticline
- Folding (Un-mapable)
- Fault dashed where probable

NON - GEOLOGICAL SYMBOLS

- Stream
- Road
- Locality
- Fair Wather Road

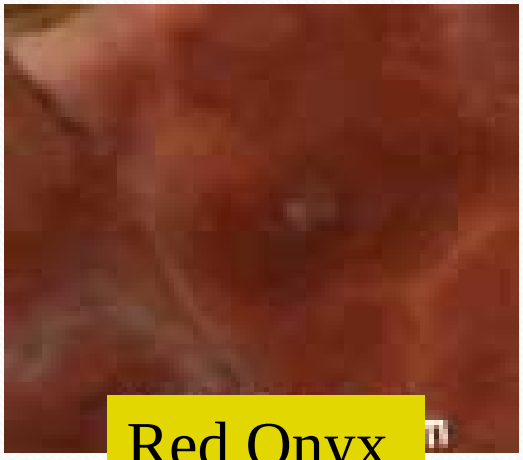
Total area of the Map: - ~1280 Sq Km.

Modified From HSC, 1960; & Hassan et al., 1998

DECORATIVE STONES GALLERY AT GSP

Limestone
Grey Cloud

Multi Onyx



Red Onyx

DECORATIVE STONES GALLERY AT GSP

Marble
Chocolate
Marble

Limestone
Verona

Basalt
Black Gold

Marble: Chagai, Bela, Kalat & Khuzdar

DECORATIVE STONES GALLERY AT GSP

Sandstone

Granite

Granite:

Chagai, Balochistan

Limestone

BALOCHISTAN GEMS

In **Chagai**: Chrysocola, Malachite, Azurite,

Turquoise, Glossularite Garnet, Brown Garnet,

Zircon, Obsidian, Jade, Jasper, Phrolusite, Lazurite,

Lapis Lazuli and Spar


L SURVEY OF PAKISTA
FLUORITE

POTENTIAL OF BALOCHISTAN

- Reserves

Marble 2.5 Billion Tons

Granite 1.5 Billion Tons

Onyx 15-20 Million Tons

- Annual production

Million Tons 3.3

- Clusters Areas

Quetta, Chaghi, Khuzdar, Dalbandin

Nukundi, Loralai, Lasbela

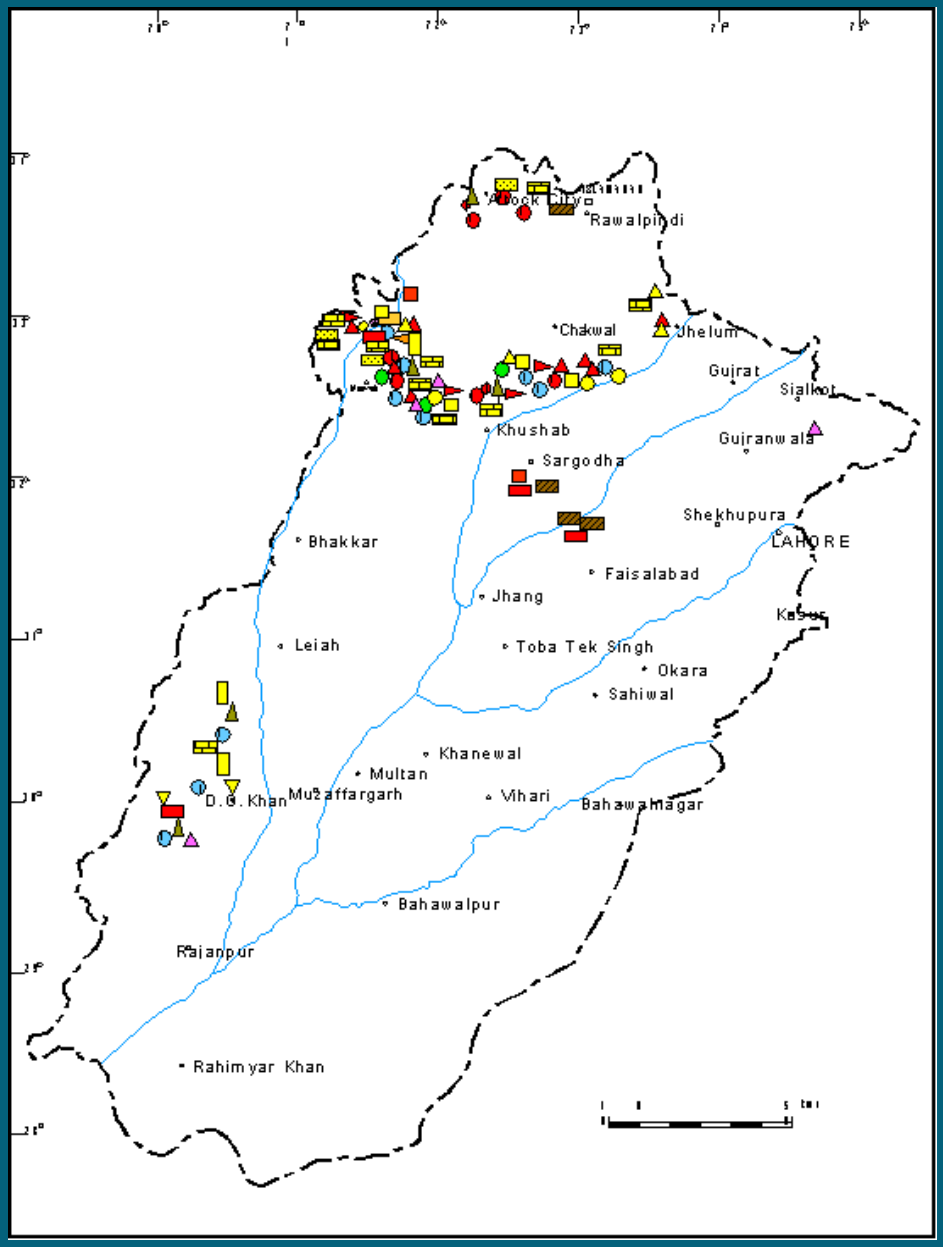
MINERAL MAP OF PUNJAB, PAKISTAN

Metallic Minerals

- Copper
- Iron
- Gold

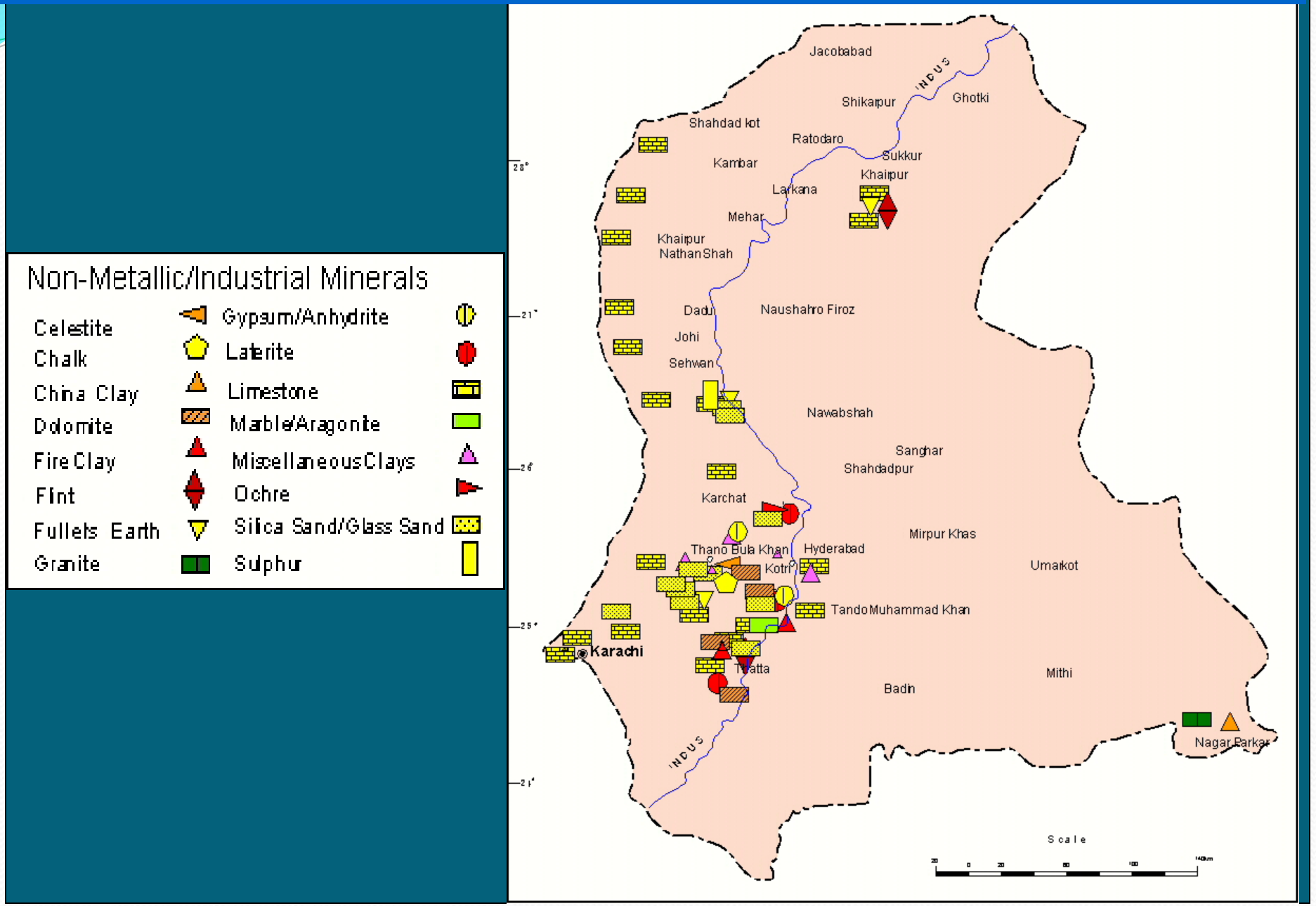
Non-Metallic/Industrial Minerals

- Aggregate Resources
- Alum
- Bauxite/Laterite
- Bentonite
- Celestite
- Fire Clay
- Fuller's Earth
- Gypsum/Anhydrite
- Limestone
- Miscelaneous clays
- Ochre
- Phosphorite
- Potash
- Quartz
- Rock Salt
- Silica Sand/Glass Sand
- Sulphur



Map of Pakistan Showing Location of the Project Area

MINERAL MAP OF SINDH, PAKISTAN



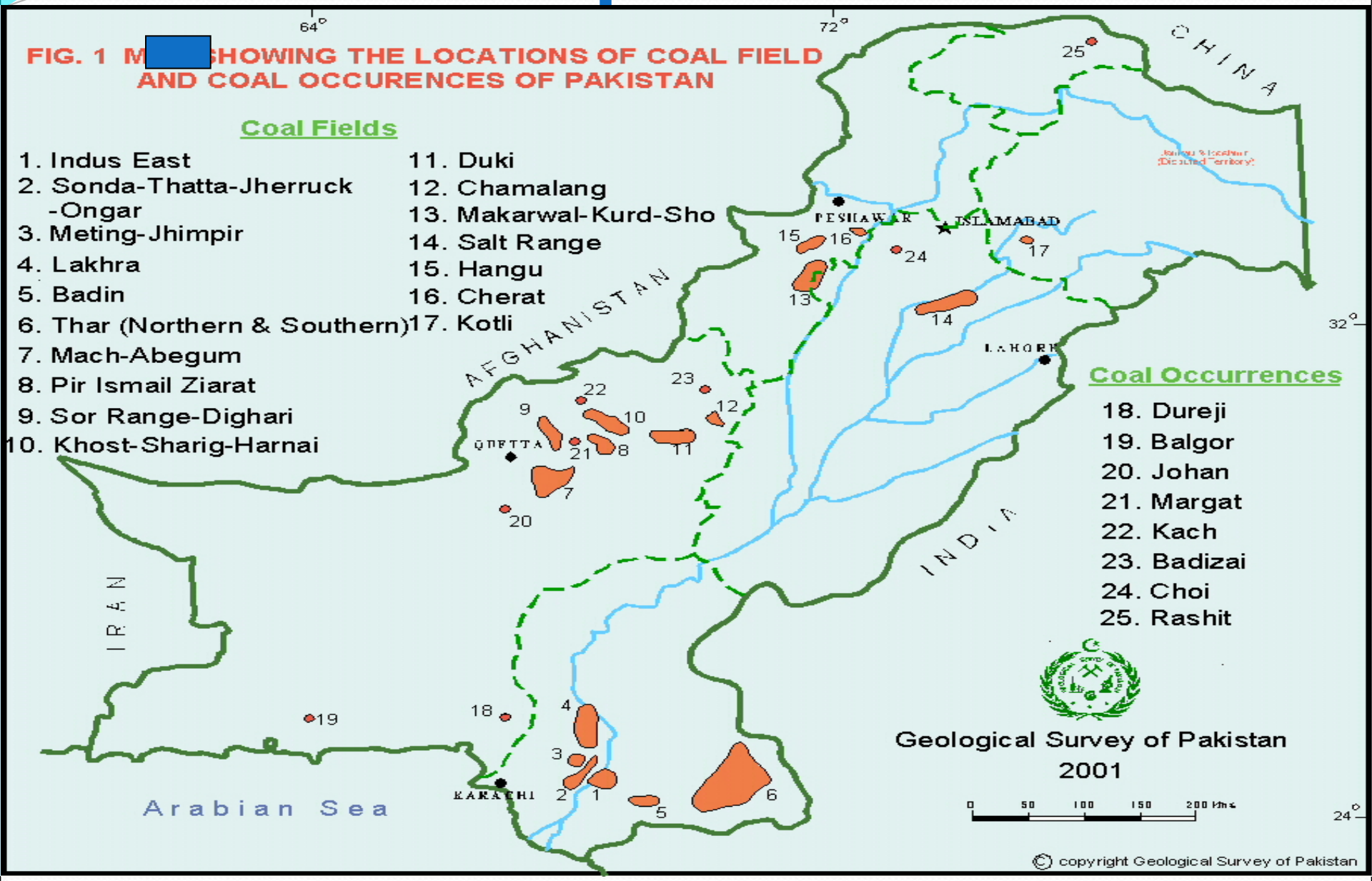
Power Generation in Pakistan

Under the present socio-economic scenario of energy requirements in Pakistan, there are compelling factors to maximize energy reliance on abundantly available coal deposits.

This has become all the more important as:

1. Hydel Power depends upon climatic ameliorations.
2. Thermal Power Generation is total drain on foreign exchange.
3. Indigenous gas resources are depleting.

Coal Map of Pakistan



THAR PAKISTAN

THAR COAL FIELD

Total Area = 9000 sq.kms.

Total Resources = 175.5 billion tonnes

No. of Drill Holes drilled by GSP = 217

Total Meterage Drilled = 45000 meters

Coal Quality (as received base)

Moisture	**30 % to 54 %**
Sulphur	**0.5 % to 1.5 %**
Ash	**3 % to 10 %**
B.T.U / LB	**5,780 to 6,398**

Coal Rank Lignite A – B

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 (Av.)	5,774 Btu./Lb.

- AR = as received basis

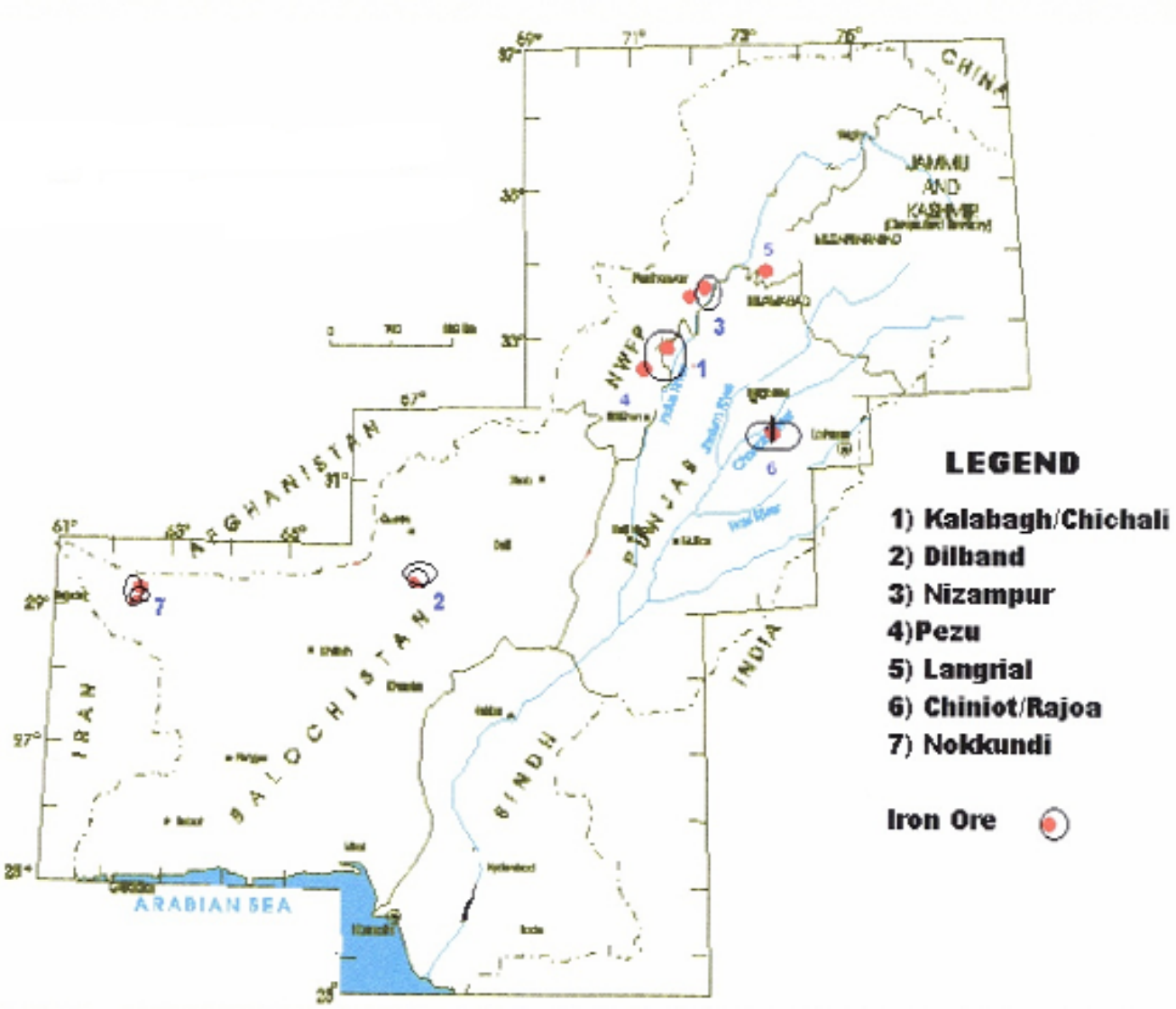
THAR COAL ECONOMIC VALUE

- Even if half of the coal reserves are exploited properly, Pakistan would be able to generate 100,000 Mega Watts of electricity for 30 years.

- Thar coal reserves, totaling an estimated 175.5 billion tons of Lignite grade coal (brown coal), which is equivalent to **50 billion tons of Oil** (more than Iran & Saudi Arabian combined oil reserves)

Iron-Ore Deposits of Pakistan

Name of Deposit	Resource (MT)
1. Kalabagh	250
2. Dilband	200
3. Nizampur	168
4. Pezu	13
5. Langrial	20
6. Chiniot/ Rajoa	220
7. Nokkundi	45



PRINCIPAL IRON ORES

- **Hematite Fe_2O_3**
- **Goethite FeO(OH) +Mn**
- **Magnetite Fe_3O_4**
- **Siderite $FeCO_3$**
- **Limonite (Bog Iron) FeO(OH)**
- **Pyrite FeS_2**

Dilband - Iron Ore Deposit

- **Discovered by GSP in 1998**

  Hematite Iron ore with above 40% Fe_2O_3

  Reserves > 200 million tones.

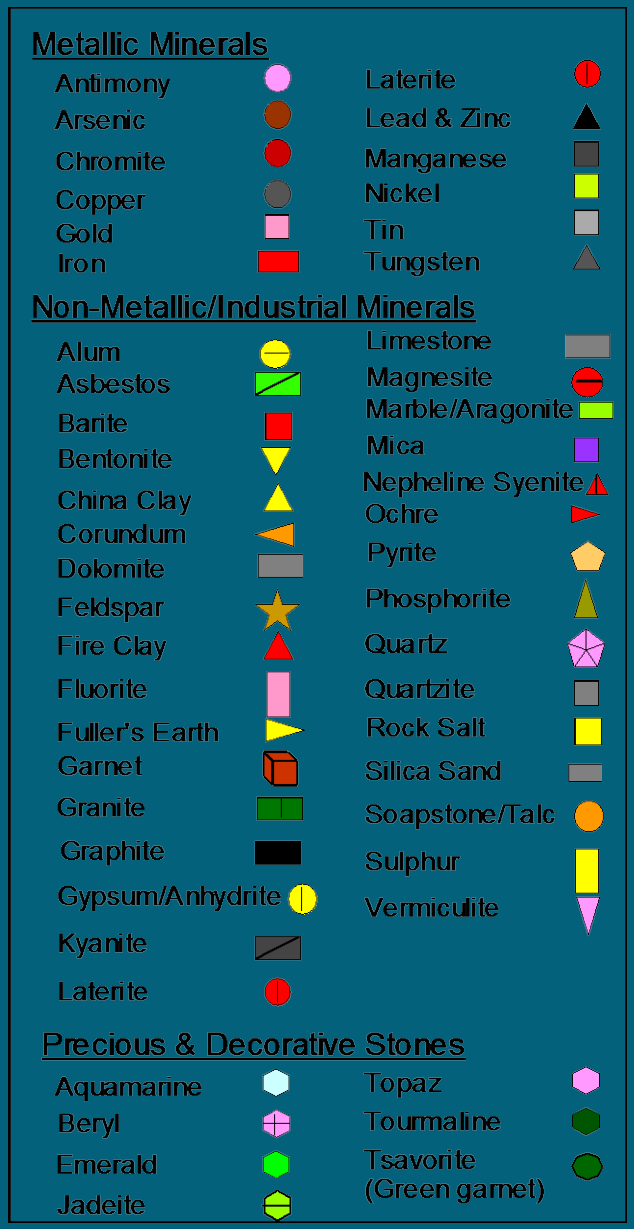
  In-Situ value of contained Metal Pak. Rs 240 billion or US$ 24 billion at present prices.

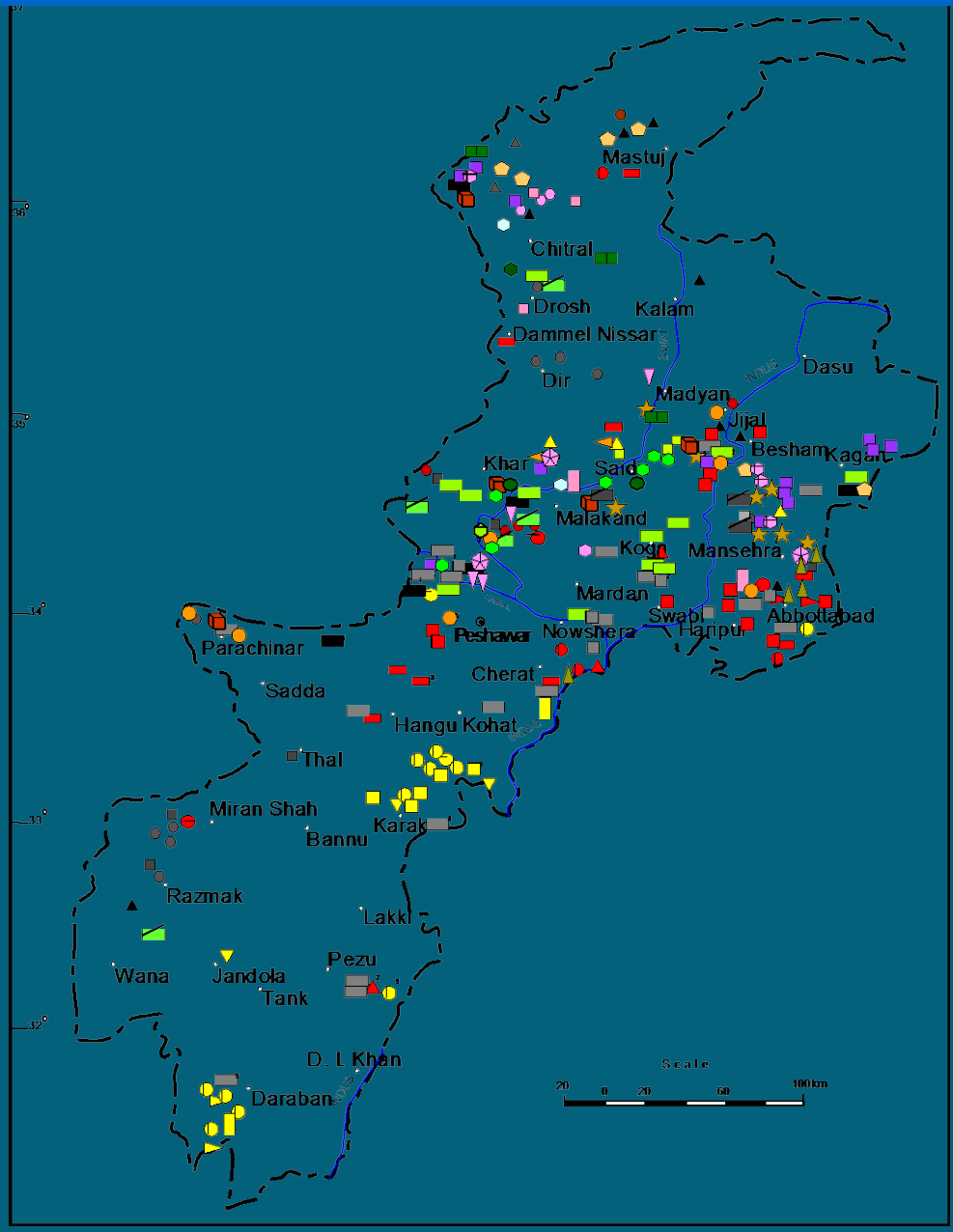
- **BME has evaluated the deposit for beneficiation, and exploitation for supply to Pakistan Steel.**

- Chagai (Including Pachin Koh, Chgen Dik, Chilgazi) > 85 MT high grade ore (20-60% Fe) expected to be in production in 2 years.
- Kalabagh 300 MT is silicate ore posing processing problems and high cost involved.
- Dilband ore > 250 already successfully tested by Pakistan Steel for 15-20% blending, it requires selective mining or beneficiation
- A comprehensive project under the PSDP is recommended

  for Uthal & Khuzdar districts detailed exploration

MINERAL MAP OF KPK, PAKISTAN





RARE EARTH ELEMENTS

1. Scandium
2. Erbium
3. Europium
4. Neodymium
5. Praseodymium
6. Gadolinium
7. Terbium
8. Dysprosium
9. Thulium
10 Ytterbium
11. Lutetium
12. Yttrium
13. Holmium
14. Samarium
15. Cerium
16. Lanthanum
17. Promethium

USES OF RARE EARTH ELEMENTS

- Neutron Capture
- Aluminium-scandium alloy for aerospace components
- High-Temperature Superconductors
- Fluid catalytic cracking catalyst for oil refineries
- Rare-earth magnets
- Nuclear batteries
- Lasers
- Vanadium Steel
- Infrared lasers
- PET Scan detectors

REE DEPOSITS IN PAKISTAN

- **KOGA, SWAT DISTRICT**
- **SILLAI PATTI, 30 KM WEST OF DARGAI**
- **LOE SHILMAN, KHYBER AGENCY**
- **SAKHAKOT QILA, MALAKAND AGENCY**

QUALITY & RESOURCES OF KPK COALS

Coal Fields	Coal Resources (Million tonnes)	Rank ASTM Classification	Heating Value Btu/lb
Hangu/Orakzai	82	Sub A to hv bA	10,500-14,149
Cherat/Gulla Khel	9	Sib C to hv bA	9,388-142,171
TOTAL	91		

GEMSTONES OF PAKISTAN

Ruby, Sapphire, Spinel, Pargasite, Aquamarine,

Emerald, Tourmaline, Topaz, Epidote, Garnet,

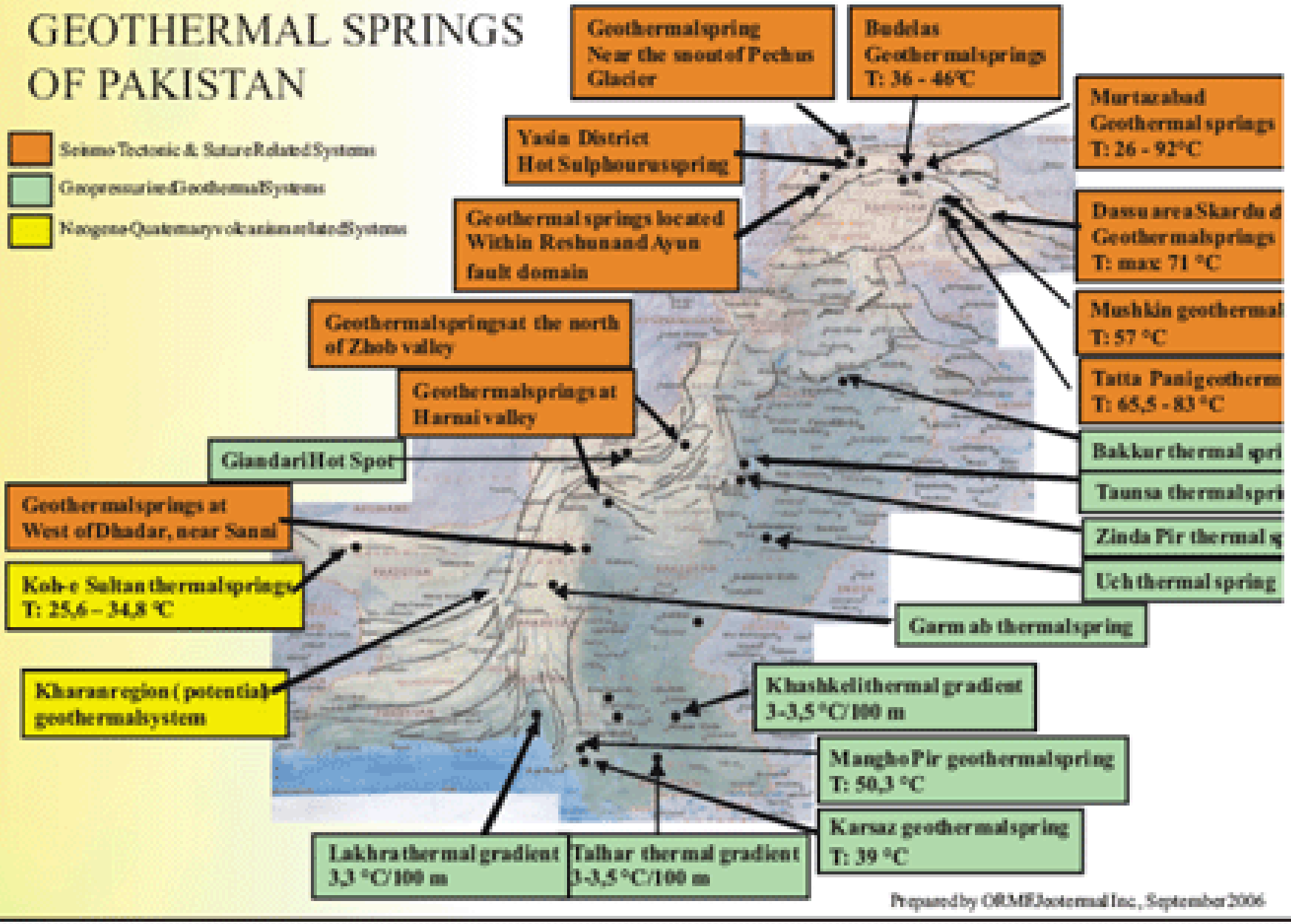
Chrome-Diopside, Apatite, Axinite, Titanite,

Sphene, Zircon, Feldspar, Quartz

GSP ACHIEVEMENTS IN NUCLEAR FIELD

- First ever discovery of radioactive minerals in Pakistan in Baghalchur area, Dera Ghazi Khan and Reko Diq area.
- Discovery of strategic minerals in Sonmiani area
- Preparation of tunnels for nuclear explosion

GEOTHERMAL SPRINGS OF PAKISTAN



MINERAL INDUSTRY IN PAKISTAN

a. **Complex**
b. **Complicated**
c. **Heterogeneous**
d. **Requires long gestation periods**
e. **Risky**
f. **Capital intensive**
g. **Proliferation of Departments with almost similar charters**

- **Hence multiphase exploration programmes need to be identified, planned and organized.**

OPPORTUNITY FOR INTERNATIONAL INVESTMENT

The Islamic Republic of Pakistan remains committed to the development of a prosperous Pakistani minerals industry. The NMP-2013 provides the Government with the direction and decision-making tools that will help to guarantee that the industry grows from strength to strength.

MAJOR MINING SECTORS FOR INTERNATIONAL IVESTORS

- Copper ore
- Iron ore
- Coal
- Chromite
- Phosphate
- Gemstones
- Geothermal Power Generation
- Exploitation and Processing

GRANT OF MINERAL TITLES TO FOREIGN NATIONALS

Foreign companies will be free to apply, however, no mineral title will be given until the foreign company is incorporated locally.

PROTECTION OF FOREIGN INVESTMENT

1. The Protection of Economic Reforms Act 1992 provides that no foreign industrial or commercial enterprise established or owned in any form by a foreign or Pakistani investor shall be compulsorily acquired or taken over by the Government;
2. The Foreign Private Investment (Promotion and Protection) Act, 1976 guarantees that a foreign in an industrial undertaking may at any time repatriate capital and profits. The mining sector will equally have this protection.

COOPERATION BETWEEN GSP AND CGS

1. GSP and CGS has signed the MOU for cooperation at various level

2. Number of Tanning Courses have been arranged every year to build our research and educational capacity for Pakistani Officials

Joint Ventures of GSP and CGS under the MOU Signed in 2010

1. Global Scale Geochemical mapping
2. National Scale Geochemical Mapping
3. Mineral resources assessments and exploration technology
4. Geo database Construction
5. Enhancing capacity building of GSP
6. Modern Technology to recognized or standerdized methods


MAY ALLAH KEEP
PAK-CHINA
FRIENDSHIP ALIVE
FOREVER