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

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Chemist,
Geological Survey of Pakistan
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
1. An attached department of the Federal Ministry of Petroleum and Natural Resources

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,
- 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-Paskoh Magmatic Arc
2. Chaman-Omach-Nal Transform Fault zone
3. Lasbela-Khuzdar, Muslim Bagh, Zhob-Waziristan Ophiolites & Melange zone
4. Sediment hosted Lead-Zinc-Barite-Flourite deposits.
5. Kirthar 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
The province is host to the world famous Green Onyx found in abundant quantities in the Chaghai region. Almost 20 varieties of beige Limestones and other unique dimensional stones are found in the region.
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 0.44 g/t Gold
  - In-Situ value of contained Metals is at least US$ one trillion at present prices.
Reko Diq Porphyry
# IMPORTANT INVESTIGATED COPPER PROSPECTS BY GSP

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Location</th>
<th>Prospect Million Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dasht-e-Kain</td>
<td>Dalbandin</td>
<td>400</td>
</tr>
<tr>
<td>Durban Chah</td>
<td>Nok Kundi</td>
<td>&lt; 100</td>
</tr>
<tr>
<td>Talaruk</td>
<td>Near Rabat</td>
<td>0.657</td>
</tr>
<tr>
<td>Ziarat Pir Sultan</td>
<td>Dalbandin</td>
<td>200</td>
</tr>
<tr>
<td>Kabul Koh</td>
<td>Dalbandin</td>
<td>50</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Deposits</th>
<th>Reserves (M.T)</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gunga</td>
<td>10.00</td>
<td>8.0% Pb-Zn</td>
</tr>
<tr>
<td>Surmai</td>
<td>3.00</td>
<td>6.5% Pb-Zn</td>
</tr>
</tbody>
</table>
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 lenticular bodies in the ultramafic rocks in Raskoh range, District Chagai, Balochistan.

- The Raskoh Chromite deposits contain 47~57% Cr\textsubscript{2}O\textsubscript{3} 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

<table>
<thead>
<tr>
<th>Coal Fields</th>
<th>Coal Resources (Million tonnes)</th>
<th>Rank ASTM Classification</th>
<th>Heating Value Btu/lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khost-Shahrig -Harnai</td>
<td>76</td>
<td>Sub B to hv bA</td>
<td>9,637-15,499</td>
</tr>
<tr>
<td>Sor Range -Deghari</td>
<td>50</td>
<td>Sub A to hv bB</td>
<td>11,245-13,900</td>
</tr>
<tr>
<td>Duki</td>
<td>50</td>
<td>Sub B to hv bA</td>
<td>10,131-14,164</td>
</tr>
<tr>
<td>Mach - Abegum</td>
<td>23</td>
<td>Sub A to hv bC</td>
<td>11,110-12,937</td>
</tr>
<tr>
<td>Pir Ismail Ziarat</td>
<td>12</td>
<td>Sub A to hv bV</td>
<td>10,786-11,996</td>
</tr>
<tr>
<td>Chamalong</td>
<td>6</td>
<td>Hv bC to hv bA</td>
<td>12,500-14,357</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>217</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Total area of the Map: ~1280 Sq Km.
DECORATIVE STONES GALLERY AT GSP

Limestone
Grey Cloud

Multi Onyx

Red Onyx
DECORATIVE STONES GALLERY AT GSP

Marble: Chagai, Bela, Kalat & Khuzdar

Marble: Chocolate Marble

Limestone: Verona

Basalt: Black Gold
DECORATIVE STONES GALLERY AT GSP

Sandstone

Granite:
Chagai, Balochistan

Granite

Limestone
BALOCHISTAN GEMS

In Chagai: Chrysocolla, Malachite, Azurite,

Turquoise, Glossularite Garnet, Brown Garnet,

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

Lapis Lazuli and Spar
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
- Miscellaneous clays
- Ochre
- Phosphorite
- Potash
- Quartz
- Rock Salt
- Silica Sand/Glass Sand
- Sulphur
**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

Coal Fields
1. Indus East
2. Sonda-Thatta-Jherruck
   - Ongar
3. Meting-Jhimpir
4. Lakhra
5. Badin
6. Thar (Northern & Southern)
7. Mach-Abegum
8. Pir Ismail Ziarat
9. Sor Range-Dighari
10. Khost-Shariq-Harnai
11. Duki
12. Chamalang
13. Makarwal-Kurd-Sho
14. Salt Range
15. Hangu
16. Cherat
17. Kotli

Coal Occurrences
18. Dureji
19. Balgor
20. Johan
21. Margat
22. Kach
23. Badizai
24. Choi
25. Rashit

Geological Survey of Pakistan
2001

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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
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

<table>
<thead>
<tr>
<th>Name of Deposit</th>
<th>Resource (MT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Kalabagh</td>
<td>250</td>
</tr>
<tr>
<td>2. Dilband</td>
<td>200</td>
</tr>
<tr>
<td>3. Nizampur</td>
<td>168</td>
</tr>
<tr>
<td>4. Pezu</td>
<td>13</td>
</tr>
<tr>
<td>5. Langrial</td>
<td>20</td>
</tr>
<tr>
<td>6. Chiniot/Rajoa</td>
<td>220</td>
</tr>
<tr>
<td>7. Nokkundi</td>
<td>45</td>
</tr>
</tbody>
</table>
PRINCIPAL IRON ORES

- Hematite $\text{Fe}_2\text{O}_3$
- Goethite $\text{FeO(OH)} + \text{Mn}$
- Magnetite $\text{Fe}_3\text{O}_4$
- Siderite $\text{FeCO}_3$
- Limonite (Bog Iron) $\text{FeO(OH)}$
- Pyrite $\text{FeS}_2$
Dilband - Iron Ore Deposit

• Discovered by GSP in 1998
  Hematite Iron ore with above 40% \( \text{Fe}_2\text{O}_3 \)
  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

Metallic Minerals
- Antimony
- Arsenic
- Chromite
- Copper
- Gold
- Iron

Non-Metallic/Industrial Minerals
- Alum
- Asbestos
- Bauxite
- Bentonite
- China Clay
- Corundum
- Dolomite
- Feldspar
- Fire Clay
- Fluorite
- Fuller's Earth
- Garnet
- Granite
- Graphite
- Gypsum/Anhydrite
- Kyanite
- Laterite

Precious & Decorative Stones
- Aquamarine
- Beryl
- Emerald
- Jadeite

Laterite
- Lead & Zinc
- Manganese
- Nickel
- Tin
- Tungsten
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

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<tbody>
<tr>
<td>Hangu/Orakzai</td>
<td>82</td>
<td>Sub A to hv bA</td>
<td>10,500-14,149</td>
</tr>
<tr>
<td>Cherat/Gulla Khel</td>
<td>9</td>
<td>Sib C to hv bA</td>
<td>9,388-142,171</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>91</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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

- **Geothermal spring near the snout of Pechus Glacier**
  - Bodelas Geothermal springs
    - T: 36 - 46°C
- **Yasin District Hot Sulphourusspring**
- **Geothermal springs located within Reshunand Ayun fault domain**
- **Geothermal springs at the north of Zhob valley**
  - Griendari Hot Spot
  - Koh-e Sultan thermal springs
    - T: 25.6 – 34.8°C
  - Lakhra thermal gradient
    - 3.3°C/100 m
  - Khashkelithermal gradient
    - 3.5°C/100 m
  - Talhar thermal gradient
    - 3.5°C/100 m
  - Karsaz geothermal spring
    - T: 39°C
- **Murtazabad Geothermal springs**
  - T: 26 - 92°C
- **Dassu area Skardu**
  - Geothermal springs
    - T: max 71°C
- **Mushkin geothermal**
  - T: 57°C
- **Tatta Panigeotherm**
  - T: 65.5 - 83°C
  - Bakkur thermal spring
  - Tausra thermal spring
  - Zinda Pir thermal spring
  - Uch thermal spring
- **Garm ab thermal spring**

Prepared by ORMEJoothermal Inc., September 2006
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 INVESTORS

- 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 standardized methods
MAY ALLAH KEEP
PAK-CHINA
FRIENDSHIP ALIVE
FOREVER