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Mineral development profile of North West Frontier Province and the role of Directorate General Mines and Minerals in the mineral resources development

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ABSTRACT: *North West Frontier Province (NWFP) is considered to be a prospective geological domain for a variety of mineral potentials, Such as (i) Dimension stones (ii) Gemstones (iii) Industrial non-metallic minerals, (iv) Metallic minerals and (v) Fuel/Energy minerals. Occurrence of vast resources of ordinary stones for use in construction industry, are in addition to these. Major resources include marble, granite, gemstones, phosphate, nepheline syenite, limestone, clay, silica sand, soapstone, chromite and iron as well as metallic minerals including gold and base metals. Occurrences of coal have also been reported along a prospective belt in the southern part of N.W.F.P.*

As an institutional reforms, the government of N.W.F.P, created the Directorate General Mines and Minerals (DGMM), in August 2001 by integrating the three mineral related agencies (i.e. Mineral Wing of Sarhad Development Authority, Mineral Wing of Directorate of Industries Commerce and Mineral Development and Inspectorate of Mines and Labor Welfare, in line with the National Mineral Policy, 1995). This is with the aim to provide one-window facilities to attract as well as to facilitate national and overseas investment in the mineral sector of the province.

Based on the exploratory and developmental activities of the government of N.W.F.P, the DGMM has so far granted more than 1400 mining concessions under N.W.F.P Mining Concession Rules 1976. The DGMM has established GIS-RS laboratory as a tool for mineral information and management system. DGMM has also established a well-equipped Mineral Testing Laboratory (MTL) to facilitate the mineral sector in testing and analyses of samples including facilities for environmental research, related to mining industry.

Mineral industry of NWFP has tremendous potential to attract investment in exploration, development and mining. However, this warrants human resource development to have the capability of environment-friendly development of mineral resources.

INTRODUCTION

With an area of about 74,521 km^2, almost 70% of the North West Frontier Province (NWFP) is occupied by mountainous terrains. The province has an exceptional resources of semiprecious and precious stones, metallic and non-metallic minerals, energy minerals and industrial raw material. The mineral potential of the province can contribute

significantly to the socio-economic uplift of the region with an enhanced contribution towards the GDP of the country. Northern part of the North West Frontier Province has potential for marble/granite, nepheline syenite, phosphates, and gemstones, metallic minerals including gold and base metals and variety of other industrial minerals. Southern part of the N.W.F.P has extensive potential of rock salt, gypsum, coal, limestone and clay minerals in addition to the potential of hydrocarbons.

Pursuance to implementation of National Mineral Policy, 1995, as institutional reforms, the Government of N.W.F.P, created the Directorate General Mines and Minerals (DGMM), N.W.F.P in August, 2001 by integrating the three mineral related agencies (i.e., Mineral Wing of Directorate of Industries Commerce and Mineral Development, the Mineral Wing of Sarhad Development Authority and the Inspectorate of Mines), with the aim to provide one window facilities to attract as well as facilitate national and overseas investment in the mineral sector of the province. The Exploration Promotion Division of the Directorate General Mines and Minerals (DGMM) continued its activities for the exploration and development of mineral resources of the province in regard to gold and base metals in Chitral, Malakand and Hazara regions besides exploration of emeralds and other gemstones resources, marble, granite and other dimensional-stones and the generation of Geo-Data relating to mineral potential of North West Frontier Province.

The Licensing Division has so far granted more than 1400 mining concessions for different minerals in the private sector, where the revenue recovery to the Government. Exchequers is about Rs. 140 million per year.

Investment friendly regulatory and fiscal regimes are being introduced in the shape of modified mining concession rules to facilitate and promote the investment in mineral sector of North West Frontier Province.

MINERAL POTENTIALS OF N.W.F.P.

Mineral potentials of N.W.F.P are categorized into five sub-divisions:

1. Dimensional stones (marble, granite etc.).
2. The gemstones (precious and semi precious).
3. Metallic minerals including gold and base metals, scheelite (tungsten ore) chromite and manganese etc.
4. Industrial minerals including soapstone, feldspar, Nepheline-syenite, rock phosphate, cement grade limestone and clay etc.
5. Fuel minerals i.e. coal, natural oil and gas.

1. Dimension stones and marble resources

The Dimension stones potential of North West Frontier Province, which include marble, granite, serpentine and other stones, are the vast potential of the province, warranting systematic developmental activities through involvement of local and overseas investors (working group on minerals, 1978; Kazmi & Jan, 1997).

The estimated resource of marble in N.W.F.P is about 3.0 billion Tonne but so far no systematic exploratory coverage has been extended. The potential marble bearing areas having variety of metamorphosed marble occurrences of different colors and shades are being mined in prominent areas of Buner, Swat, Mohmand, Bajaur agency, Mulagori and Chitral (Fig. 1). At present about 80% of marble production in raw form is being marketed to Punjab and Sindh for its value

addition in the shape of marble tiles, table tops and other decoratives. Although the private sector is involved in mining of marble in N W.F.P, but for getting immediate return, they resort to indiscriminate blasting for recovery of marble lumps rather than systematic marble blocks. To over come these bottle necks, the DGMM has launched a comprehensive exploratory programme to scan the marble bearing areas, which are amenable to block extraction and to reserve the same for systematic marble quarry development, with application of marble cutting machinery etc.

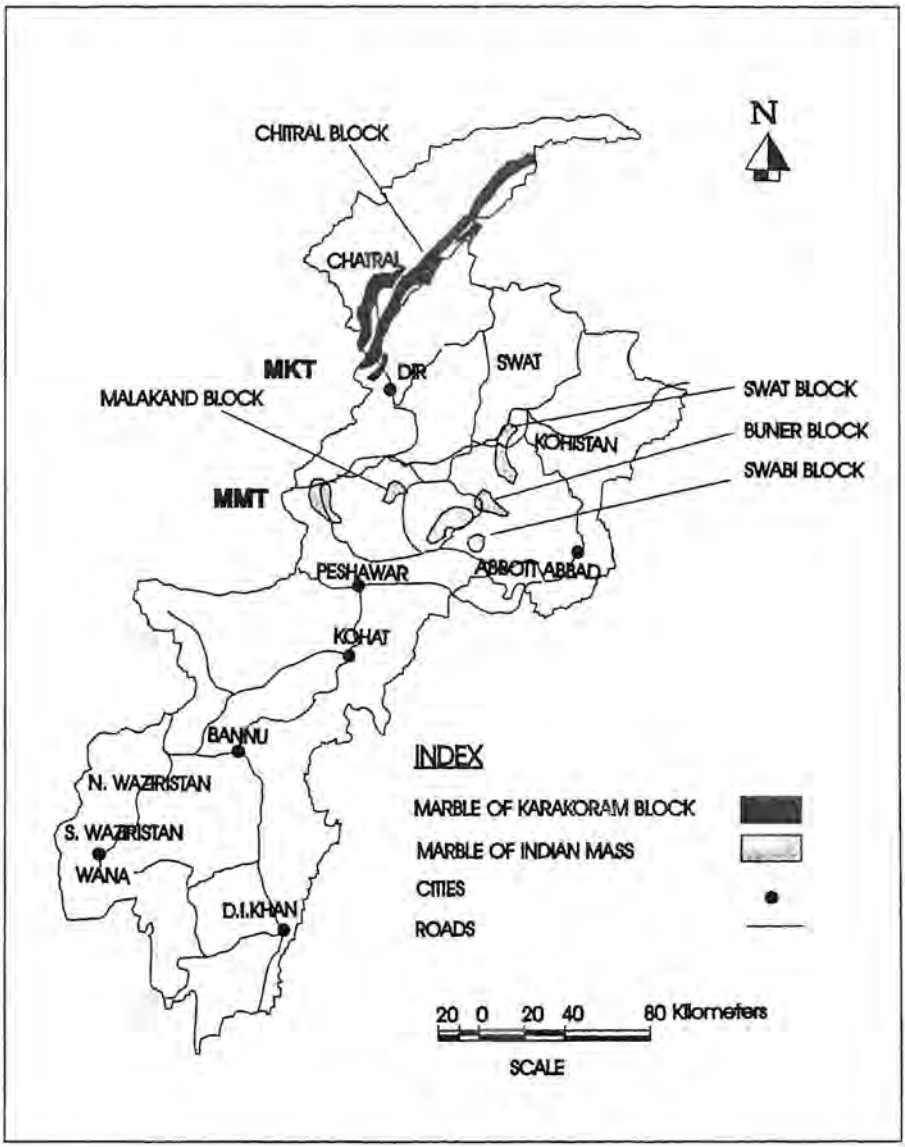

Fig.1. Map showing the investment targets of marble resources of NWFP.

The government of N.W.F.P is planning to organize the marble and granite mining sector of N.W.F.P by providing basic guidance to private sector for systematic exploration and development of marble and granite resources to ensure block extraction. The purpose is to avoid wastage of marble through indiscriminate blasting and to ensure extraction of geometrical shapes and sizes of marble blocks by using modern marble cutting machinery. That would entail value addition to marble in the shape of marble/granite decoratives and the substantial enhancement of foreign exchange revenue through exports. The private sector would be advised by the Exploration Promotion Division, DGMM for systematic development and mining, based on the information to be generated about the potential of marble and granite deposits/resources. The private sector would be invited to coordinate and cooperate with the DGMM for any assistance in planning and exploitation of the marble resources.

To provide basic guidance to the private parties, a pilot marble quarry has also been proposed for development at any suitable place at Buner with the application of modern cutting machinery, as a training institute to be executed jointly by the public/private sector. A systematic training programme would be launched for skill development of the workers and the staff of the private mining concerns.

In order to achieve the above targets, the Exploration Promotion Division, DGMM, N.W.F.P, is implementing the ADP funded PC-II scheme "geological survey and evaluation of marble and granite resources of N.W.F.P". The main objective of the scheme is to generate the necessary geological data for evaluation of marble and granite resources in N.W.F.P and to establish a model geotechnical studies on selected prospects of marble and granite outcrops amenable to quarry development for extraction of geometrical blocks. The major belts of marble occurrences identified in the province are those of four parallel belts of marble (i.e, Reshun marble, Shoghore marble, Gahiret marble and Shishi Valley marble), having a potential of more than 1000 million Ton. There is an extensive marble belt of Mardan-Buner with vast potential of more than 1000 million Ton, besides occurrences in Swabi area. Pink marble occurs as a hillock near Nowshera having an estimated resource of about 100 million Ton. Other scattered occurrences of marble are those of Swat and Kohistan regions and southern part of N.W.F.P, having a potential of about 800 million Ton. The occurrence of marble in Bajaur, Mohmand and Warsak areas of FATA are in addition to these marble resources.

The N.W.F.P has also vast potential of a variety of granite resources of different shades and texture warranting systematic exploration and evaluation of granite outcrops in the accessible localities. Quantitatively, resources are rated in billion Ton (Fig. 2). The term granite is here assigned to rocks harder than marble but amenable to extraction of blocks and processing to cut and polished tiles and tops and other decoratives. The known outcrops of granite in N.W.F.P can be categorized as the *dark colored granites* dominated by green shades. Mafic and ultramafic rocks, also used as dimension stone, outcrops in Chitral, Swat and Kohistan, having a potential of more than a 500 million Ton. The accessible outcrops of green metabasites and dark coloured diabase dikes in Chitral, Dir-Timergara, Swat and Kohistan have a potential of about 1000 million Ton (Fig. 2). The accessible outcrops of the light colored granites of Tirich Mir and Karakorum Batholith/granitoids in Chitral region are estimated to 500 million tons (Fig. 2). Kohistan Batholith in Dir, Swat and Kohistan, having suitable outcrops (1000

million tons) along the main roads, can be used for extraction of granite blocks and development of quarries. About 1000 million tons of Indian Mass granitoids in Swat, Buner and Hazara regions can be utilized for further development and exploitation.

2. Gemstone resources

Geological environment of northern part of N.W.F.P. is inferred for diversity of precious and semi precious gemstone potential (Fig. 3). Following belts have been identified as prospective target for gemstone exploration: 1) Pegmatite-hosted beryl-tourmaline–topaz-garnet clan, occurring within a linear domain of about 30 kms between Garram Chishma and Kafirristan areas of Chitral, besides other occurrences in Drosh and possibly emerald mineralization in the Shishi valley and 2) corrundum/rubby occurrences in Timergarah and Swat area, along a geological domain of amphibolites, being a major belt should have vast potential for similar gemstones (Kazmi et al., 1990; Kazmi & O'Donoghue, 1990; Kazmi & Jan, 1997).

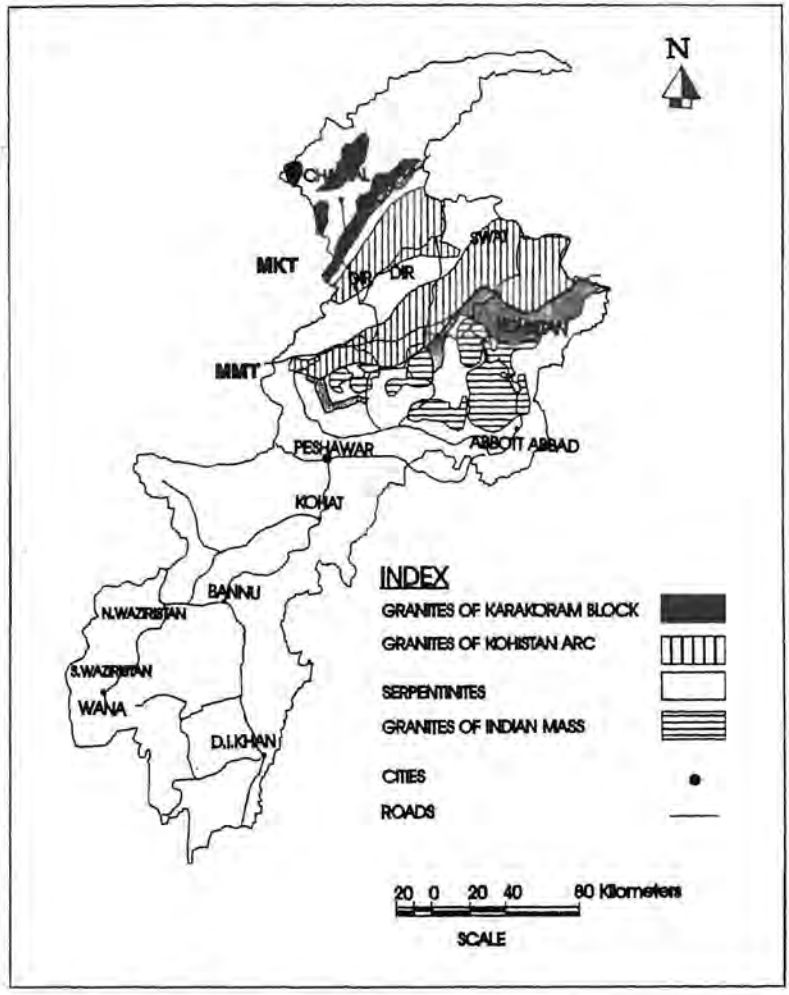

Fig.2. Map showing the mining exploration targets of granites

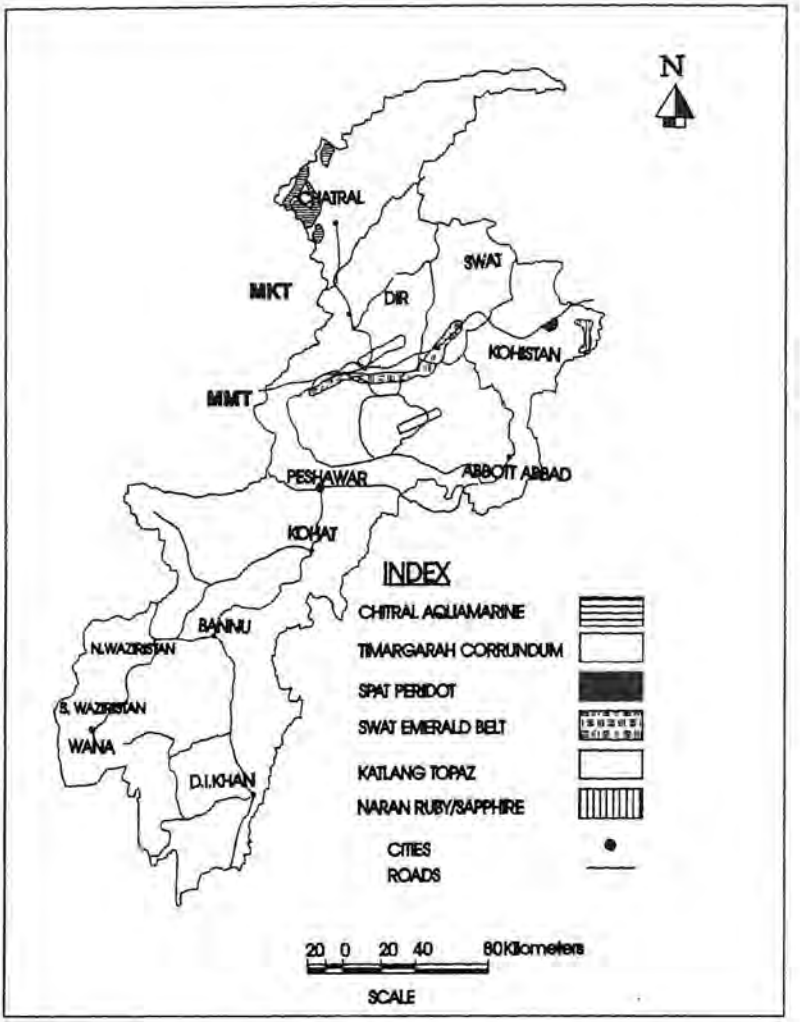

Fig. 3. Map showing the exploration/mining targets of gemstones.

The Exploration Promotion Division (EPD) of DGMM, N.W.F.P initiated its activities from development of the Mingora Emerald Mines, in the year 1973-74 when it was a part of the Sarhad Development Authority (SDA) in the year 2001. Presently exploration and evaluation of Swat emerald belt, covering an area of about 2000 Km^2, is under process. Significant mineralization has been recorded in Makhad and Charbagh areas of swat. The department has also initiated systematic exploration of the Chitral region for evaluation of the known gemstones resources as well as prospecting for new occurrences through implementation of a PC-II scheme.

The worldwide known famous Swat emeralds, found along a linear belt of more than 50 kms, from Shangla-Alpuri in the east to Shewa-Shamozai in the west. Further extension of the same belt is reported from Bajaur and Mohmand Agencies in the west. The inferred/proven emerald deposits of

Mingora, Gujar Killi and Shamozai have the estimated resource of over 50 million carats, which are being placed for open auction for sizeable investment. Carbonate-hosted topaz of pink, yellow, white and other shades occurs in Mardan/Katlang areas. Geologically, the host rocks extends upto Buner area for about 40 Km. Ultramafic-hosted peridote in Spat Kohistan, should have possible extension upto Jijal across the Indus river in the west for more than 30 km. Metasediments-hosted corrundum (ruby and sapphire), in upper Kaghan valley of Hazara division. The occurrences are possibly the extension of the famous Kashmir ruby. Other scattered occurrences of precious and semi-precious gemstones in Buner upper Swat valley and elsewhere in the mountainous terrains of the region.

The government of N.W.F.P is paying special attention to the development of gemstone resources and has constituted the N.W.F.P Gems and Mineral Promotion Committee having participation from both the public and private sector. The committee has formulated small-scale gemstone policy as an approach to explore and develop, the gemstone potentials of the region. The DGMM has so far granted more than 40 Mining Leases under the said policy.

To further facilitate the small gemstone lease-holders, the DGMM has initiated implementation of two Public Sector Development Program (PSDP) funded projects sponsored by Ministry of Petroleum and Natural Resources, Islamabad. The main objective of the PC-I schemes, one each in Malakand and Hazara regions, is to provide training for systematic prospecting and mine development. Under this programme, the staff of private mining concerns will be offered the necessary training for skill development in mining of gemstone.

The major emeralds and other gemstone deposits of Mingora, Gujar Killi and Shamozai emeralds in Swat, Katlang Topaz has been reserved for sizeable investment under 10 years mining leases in each case, expecting the financial/revenue receipts of over Rs.500 million to the government exchequers, besides development of the resources in private sector in addition to socio-economic uplift of the remote areas of N.W.F.P. The other small gem bearing areas are being explored and developed by investment of local communities under small gemstone leaseholders to regularize illicit mining and marketing. This is also an approach towards exploration and identification of new discoveries of gemstones.

The Directorate General Mines and Minerals is also implementing a PC-I scheme at its Mineral Testing Laboratory to establish a Gems Testing Section and to facilitate exploration, mining, value addition and trading the gemstones in the private sector. Peshawar is the Hub of gem trading, mostly undertaking the business/marketing activities through smuggled raw gems from neighboring countries in local gem markets. Small scale cottage units, established in the main city area of Qisa Khawani and Nimak Mandi, Peshawar. To regularize the gem trade, the government has established the Gem and Gemological Institute of Pakistan (GGIP) at Peshawar, which would ultimately be converted into a training/value addition institute besides the establishment of trade center. Hopefully with these actions, the present level of export of gems worth about US$ 12 million would be enhanced to about US$ 100 million in a short span.

3. Metallic mineral resources

Northern part of N.W.F.P. is conceptually considered to be prospective for a variety of metallic minerals including gold and other precious metals (Fig. 4) (Ahmad, 1969; 1983; Calkins et al., 1981; working

Group on Minerals, 1978; Islam et al., 1993; Khan et al., 1982; Ashraf & Hussain, 1982; Miller et al., 1991; Badshah, 1983; WPIDC, 1970b; Shah, 1997; Shah & Moon, 2004; Shams, 1995). The Exploration Promotion Division of DGMM has worked on various localized mineral occurrences including Malakand and Kohistan chromite; Besham lead-zinc; copper in Drosh and Dir; tungsten, antimony, iron, low tonnage-high grade gold in Chitral and other exploration targets of gold and base metals identified in Chitral, Malakand and Hazara regions. Presently, the Exploration Promotion Division (EPD) is implementing a Public Sector Development Program (PSDP) funded PC-I scheme of pilot/bench scale studies on processing of ores for extraction of metals. The studies under the scheme will also be helpful for assessment and exploitation of the small-scale occurrences of metallic minerals, identified in N.W.F.P.

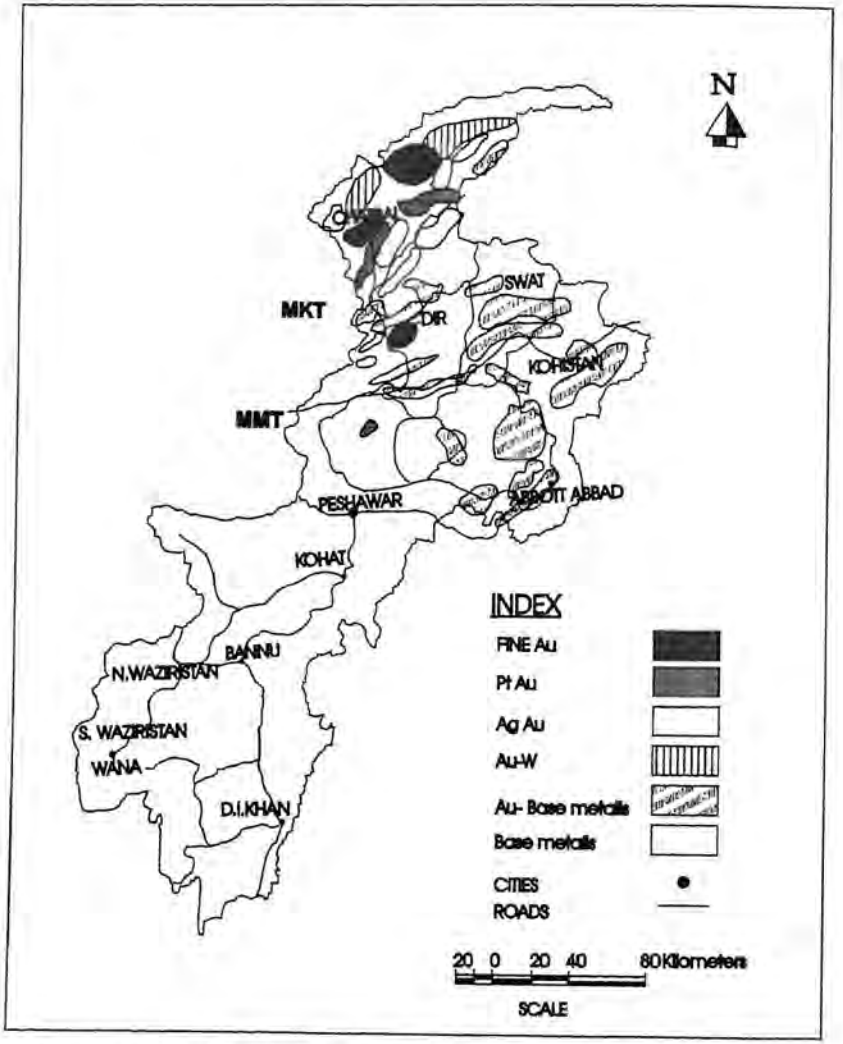

Fig. 4. Map showing the exploration targets of gold and base metals.

The government of N.W.F.P with technical assistance of Australia initiated systematic exploration coverage, mainly through drainage geochemical survey under the Gold Exploration and Mineral Analysis Project (GEMAP) of Australian aid in Chitral in the year 1992. Under this programme, the Pakistani geoscientists including exploration geologists were acquainted with necessary training in gold prospecting Australia as well as on-site training in northern Pakistan (i.e., Chitral and Gilgit regions).

Keeping in view the effectiveness of the GEMAP exploration, the Malakand and Hazara region of the province were also subjected to the systematic exploration coverage as per pattern designed under the GEMAP. As such the government of N.W.F.P has now completed a first pass exploration coverage of northern part of N.W.F.P over an area of 40,000 km^2, which resulted into generation of expanded database for follow-up exploration of selected targets of gold and related metallic minerals of the region. The data is interpreted into 34 targets areas of gold and base metals anomalies for follow-up exploration and also to provide investment opportunities for the private sector, particularly overseas exploration and mining companies.

From north to south, the selected target areas of gold and base metal anomalies in N.W.F.P., based on geological domains are further categorized, as follows: 1) Six targets over an accumulated area of 1000 km^2 for follow-up exploration of gold, tungsten, lead, zinc and nickel along the Pamir Block in Chitral (Fig. 4), 2) five target areas of gold, copper, lead, zinc and silver as well as gold-platinum suit along the Karakorum Block, over an accumulated area of 800 km^2, 3) fourteen target areas over an accumulated area of 3000 km^2 in Darosh-Chitral, Dir, Timergara and Kohistan areas, along the geological belt of Kohistan island arc sequence of northern part of N.W.F.P and 4) nine selected targets of gold, lead, zinc and other base metals over an accumulated area of 1300km^2 along the geological domains of Indian plate in Swat and lower Hazara.

The Exploration Promotion Division (EPD) is in a process of systematic documentation of the data generated through systematic exploration coverage of northern part of N.W.F.P for gold and base metals for dissemination of the same among the investors for follow-up exploration of the selected targets. In order to demonstrate follow-up exploration to a logical end, the 300 km^2 top priority target of Mirkhani copper-gold anomalies were followed-up to the stage of prospect identification and to reach the source of gold mineralization. The EPD has accordingly identified the porphyry style copper-gold mineralization in 75 km^2 area in Chitral. The gold values in volcanic breccia- hosted mineralization range upto 80 g/t in the said target of gold and metal anomalies.

4. Industrial and non metallic mineral resources

These reserves include 1) fertilize grade phosphate in Hazara, 2) glass and ceramic grade nepheline syenite in Buner, 3) Cement grade limestone and clay in Banda Chashma, Pezu, Lachi, Nizampur and Mardan area, 4) glass grade silica sand in Munda Kucha and in southern area of N.W.F.P and 5) Langrial iron ore, Shirwan soapstone and other industrial minerals in N.W.F.P, (Fig. 6) (Ahmed & Siddiqui, 1992; Ahmad, 1969; Kazmi & Jan, 1997; Khan & Ghazanfar, 1966; Raza & Iqbal, 1977; Butt & Latif, 1992; Chemical Consultant, 1970; Mikrch, 1976; Hasan & Ghaznavi, 1980; Khan & Ahmad, 1991). A list of major industries proposed on mineral identified for investment in N.W.F.P, is reproduce as under:

a) Portland cement plant of 3000 tons per day capacity involving an investment of Rs.5 billion, one each on limestone and clay deposits in Banda Chashma D.I.Khan; Lachi-Kohat and Nizampur-Nowshera, Mardan-Katlang. The deposits are in the range of 600, 200, 600 and 200 million tons, respectively.

b) Gypsum plaster and plaster board industries of 60,000 tons per year capacity on about 150 million tons of high grade gypsum in Kohat-Karak ranges. The investment on the industries is estimated to be approximately Rs.2 billion.

c) Soda ash caustic soda plant of 50,000 tons per year capacity on about 100 million tons rocks salts deposits in Kohat-Karak regions, involving an estimated investment of Rs.800 million.

d) Marble and granite tiles and decorative processing plants basing the marble and granite resources of Buner, Mardan, Chitral, Hazara and Kohistan regions. At least 10 units of 200,000 tons per year capacity each involving about Rs.30 million investments can be established for utilization of the marble and granite resources of these areas.

e) Sheet glass manufacturing Industrial units of 20,000 tons per year capacity basing the silica sand deposits of Pezu D.I.Khan and Munda Kuccha, Mansehra. The investment on the said industrial unit is estimated to be approximately Rs.300 million.

f) Glass and ceramic industry basing the vast potential of nepheline syenite in Buner area. A 30,000 tons per year capacity plant may be proposed on the nepheline syenite having estimated reserves of 6,000 million tons. The investment on the unit is estimated to be Rs.50 million. The said resources may also be utilized for the extraction of alkali complexes and manufacturing of portland cement.

g) Establishment of chemical and refractory grade industry utilizing the chromite resources of Malakand and Kohsitan areas. This chromite may also be utilized for manufacturing of chrome magnesite bricks by blending the same with the magnesite deposits of Abbottabad in Hazara. A refractory unit of 20,000 tons per year capacity can be designed for the manufacturing of chrome magnesite bricks.

h. Operation of National Fertilizer Corporation (NFC) plant and establishment of other fertilizer plants basing the Hazara rock phosphates of about 20 million tons resources.

5. Fuel mineral resources

Amongst the fuel minerals, the occurrences of coal have been reported along a geological horizon extending from Nizampur to Hangu through Chirat, Dara Adam Khel and extending to the tribal belt along the border with Afghanistan, (Fig. 5) (Gauhar, 1988; Kazmi & Jan, 1997). A number of exploration licenses and leases have been granted to private parties for exploration and development of coal resources in this particular belt. Another prospective belt lies at Karak area where private parties have developed localized operations. Prospection in the karak area has provided encouraging results. All the coal showings of the Karak, Nowshera, Dara Adam khel and Hangu areas are confined to the Paleocene strata. Recently coal occurrences have been reported from Mansehra in Hazara region appear to be an eastward extension of the same horizon. The coal belt, therefore, warrant systematic studies for further assessment of the same.

INSTITUTIONAL FRAMWORK OF THE DGMM FOR MINERAL EXPLORATION

The Exploration Promotion Division of DGMM has initiated systematic compilation of the data generated under the aforementioned exploration activities. It has been planned that all the manually documented data will be systematically computerized by using the GIS format. Accordingly, the DGMM is implementing the following schemes to create a Geo-Database by using the data generated on exploration of gold and base metals, from 40,000 sq kms of N.W.F.P. This data together with the exploration data on localized occurrences of metallic and non-metallic minerals will be compiled in conjunction with licensing / mineral tenement data for further processing of the same into mineral data packages and dissemination of the data among the interested parties. This geodata will be utilized as a tool to attract as well as to facilitate the private investment in the mineral sector of the province.

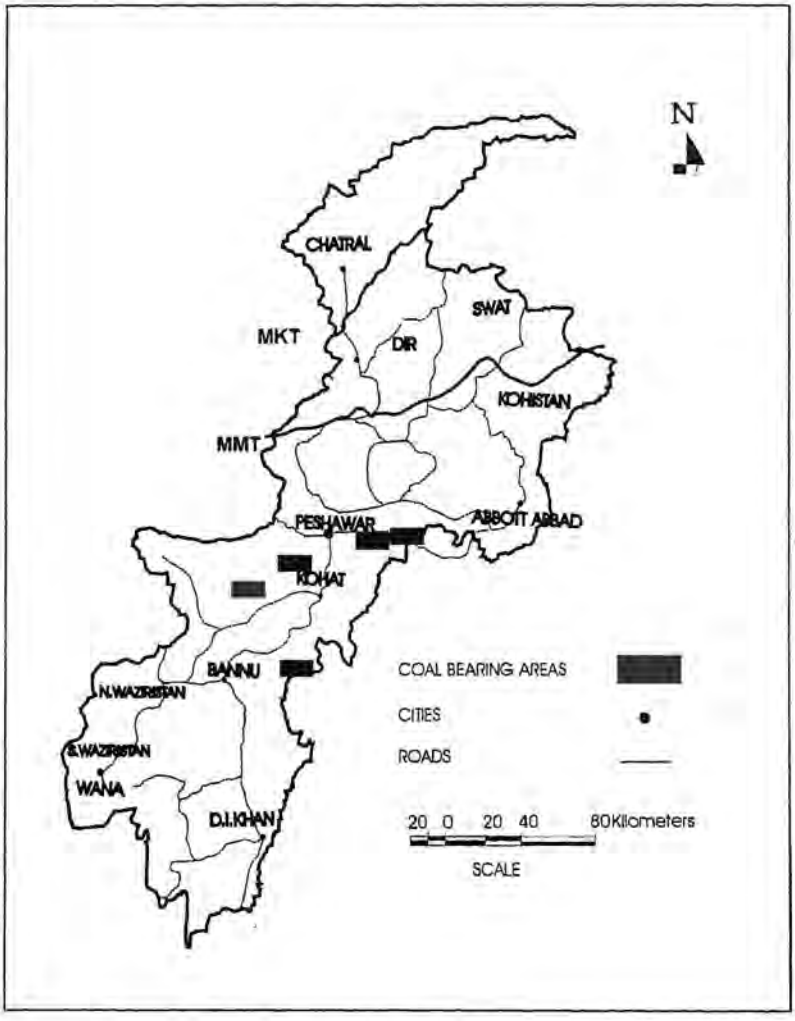

Fig. 5. Map showing the location of exploration/mining targets of coal prospective areas of NWFP.

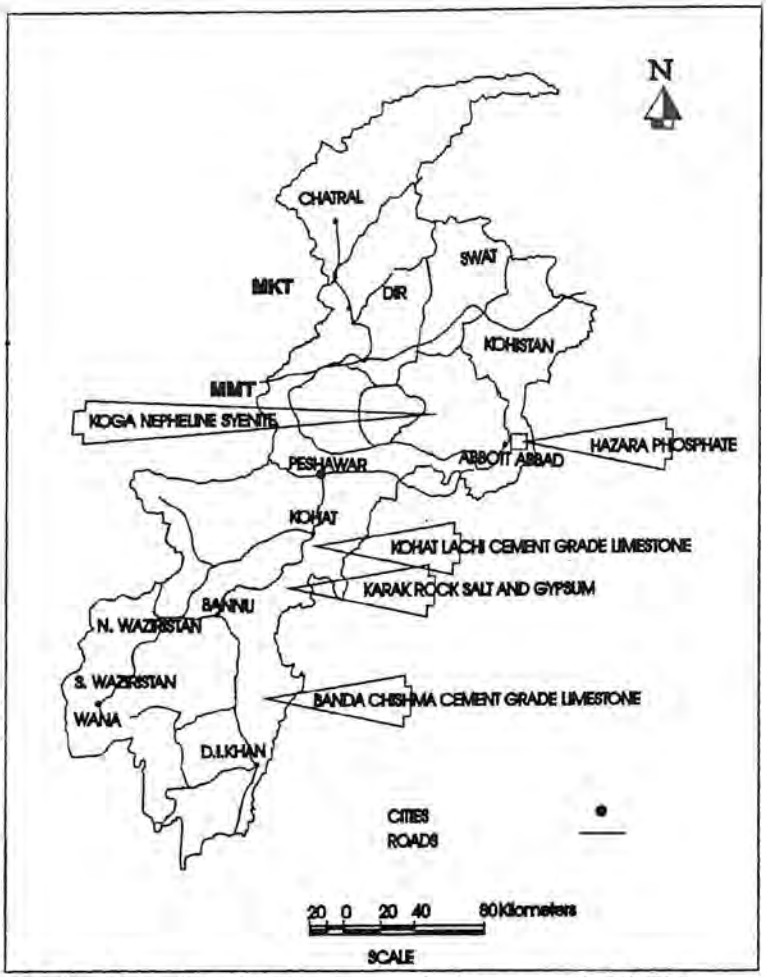

Fig. 6. Map showing the major mineral resources for investment in NWFP.

DGMM has also initiated acquisition of geological, mineral exploration data and mapping work by the application of Remote Sensing techniques. The DGMM has established a well equipped Mineral Testing Laboratory (MTL) at Industrial Estate, Peshawar in order to facilitate the mineral sector in conducting various types of tests and studies of mineral samples. This laboratory was upgraded under the Australian technical assistance "Geological Exploration and Mineral Analyses Project" (GEMAP) during the period 1992-95. Under the programme, the MTL was equipped with additional mineral testing facilities and the resource persons were provided with necessary training in Australia and in Pakistan. The laboratory has also gained the capabilities of analyzing the environment-related samples and studies, particularly in mining and mineral processing. The DGMM is also planning to further upgrade the laboratory facilities to convert the same from ore grade to exploration grade laboratory to facilitate the future foreign investment in analyzing the exploration samples from selected minerals prospects of gold and base metals and gemstones in northern N.W.F.P.

In regard to the mineral licensing and production in NWFP, the DGMM has so far granted total of 1445 concessionaries on different minerals in NWFP (Table 1). Production details of different minerals by the DGMM for the last 6 years are given in Table 2.

TABLE 1. NUMBER OF EXPLORATION LICENSES AND MINING LEASES, INDICATING DIFFERENT CATEGORY OF MINERALS IN RESPECTIVE DIVISIONS OF THE PROVINCE

	Chitral	Malakand	Hazara	Mardan	Peshawar	Kohat	D.I. Khan	Total
Dimension stone	41	227	74	59	22	11	00	434
Metallic minerals	13	7	39	-	26	03	06	094
Non metallic	27	153	236	73	109	92	94	784
Gemstone	1	12	09	02	-	-	-	024
Coal	00	00	03	00	41	60	05	109
Total	082	399	361	134	198	166	105	1445

TABLE 2. YEAR-WISE MINERAL PRODUCTION IN TONS FOR THE YEAR 1998-2004

Mineral Commodity	1998-99	1999-2000	2000-01	2001-02	2002-03	2003-04
Barites	3756	2253	3851	2542	3161	1032.825
Bentonite	-	-	3851	8010	3074	7690
China Clay	-	46806	33824	46389	25385	6591
Coal	109298	46355	49717	58539	68189.722	26268.7
Chromite	-	100	168	5143	25	-
Dolomite	88896	174498	183720	83574	232762	42896
Feldspar	33090	-	42780	35071	31326	20495
Fuller Earth	1490	1006	225	1541	2195	1035
Fire Clay	320	145	1170	8936	20104	3659
Gypsum	133266	123961	174127	196473	160845..32	87934.61
Granite	1869	-	4242	4820	2827	2871
Hornblendite	-	-	188	115	-	-
Limestone	3713228	4305933	5618546	3678156	4921431	2929429
Laterite	23540	25815	26474	14476	34516	13951
Marble	322367	455665	388722	405441	460202.50	235475
Manganese	-	-	1640	-	-	-
Magnesite	3405	3833	5590	5260	3363	3764
Phosphate	4034	-	2385	1362	2067	1614
Quartz	324	-	985	585	180	30
Quartzite	160	2119	-	1560	535	100
Red Oxide	3	-	16910	26345	17700	7160
Rock Salt	130362	121092	115989	118463	112282	50225
Soapstone	50148	47869	57487	46753	41402	21697
Silica Sand	40191	26877	21566	19424	23336	16443
Slate Stone	103650	221819	119498	161142	324266	120166
Shale Clay	685583	691604	898850	677694	776065	429971
Serpentine	2230	795	1018	2483	2131	1155

CONCLUSIONS

- N.W.F.P. is endowed with inexhaustible resources of a variety of mineral resources. To utilize these resources, public sector departments has to contribute in proper exploration, evaluation and development on updated lines.
- In order to take benefits of the mineral potential, development of the resources need to be associated with the Human Resource Development particularly for value addition to the commodities to ensure environment friendly development on sustainable basis.
- Reliable assessment of the resources will lead to an affective planning for development of the mineral sector.
- Capacity Building of the resource persons is needed on priority bases to meet the requirement of the mining industry and market.
- In order to demonstrate mineral potential, a systematic data generation and its documentation on sustainable basis is needed on priority bases.
- Reforms are needed in the fiscal and regulatory structure for creation of investment climate for environment-friendly development of the mineral resources.

RECOMMENDATIONS

To develop a progressive mining culture, following issues are to be addressed on priority bases. In order to attract private investment in mineral sector, the fiscal and regulatory framework is to be reshaped to provide incentives to the local mineral investors.

1. **Capacity Building of the resource persons to meet the requirement of the mining industry**
   i. Designing of curriculum for graduate and postgraduate studies/research by the academia for conducting specialized training courses in coordination with public and private sectors.
   ii. Need of market oriented trainings to stake holders of mineral sector by use of appropriate facilities / technology.
   iii. Vocational training of the supporting technical staff under partnership of the public and private sectors.
   iv. Centralized database of the geotechnical professionals for a categorized record of expertise and their interface with international experts.

2. **Systematic data generation and its documentation on sustainable basis to demonstrate mineral potential**
   i. Advanced geological exploration to facilitate geological mapping leading to conceptual and genetic modeling of mineral prospects.
   ii. Systematic geological mapping and air-born geophysical survey to facilitate mineral exploration coverage including resource mapping.
   iii. Systematic mineral exploration coverage by adopting appropriate techniques, leading to identification of follow up exploration and mining targets.
   iv. Creation of mineral Geo-database to facilitate an effective management of mineral resource by the department concerned. Avoid duplication of research and generation of geo-data by different departments.

3. **Creation of investment climate for environment-friendly development of mineral resources**
   i. Effective dissemination of mineral data as source of information and demonstration of mineral potential to attract as well as facilitate investment.

ii. Formulation of investment and environment friendly regulatory framework related to minerals.
iii. Redressal of local issues with regard to property and mineral rights.
iv. Competitive fiscal regime to attract investors in the mineral sector.
v. Provision of loan and development funding for viable mineral projects.
vi. Persistency and consistency in policies related to mineral development and its harmonization with the human resources development.

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