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Yemen Mineral Sector Review

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Oil, Gas, Mining Policy Division, Oil, Gas, Mining and Chemicals Department Middle East and North Africa Region



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Currency Equivalents

1 US Dollar equals 199 Yemeni rials (YER)

Weights and Measures

Metric System

Fiscal Year

January 1- December 31

Abbreviations and Acronyms

ASM	Artisanal and Small-Scale Mining
BGR	(German) Federal Institute for Geosciences and Natural Resources
BS	Building Stones
CDS/ISIS	Software Package for Generalized Information Storage and Retrieval Systems
CDMA	Code Division Multiple Access
CMS	Construction Materials Sector
СОСРО	Oil, Gas, Mining Policy Division, World Bank
DS	Dimension Stones
EI	Extractive Industries
EIA	Environmental Impact Assessment
GDP	Gross Domestic Product
GEUS	Geological Survey of Denmark and Greenland
GIS	Geographic Information System
GSM	Global System for Mobile Communications
GSRMB	Geological Survey and Mineral Resources Board
GoY	Government of Yemen
IDA	International Development Association
IFC	International Finance Corporation
IMF	International Monetary Fund
IM	Industrial Minerals
IPP	Independent Power Producers
IWRM	Integrated Water Resources Management
\mathbf{JV}	Joint Venture
MEP	Ministry of Electricity and Power
MIGA	Multilateral Investment Guarantee Agency
MPM	Metallic Minerals and Precious Metals
MTIT	Ministry of Trade and Information Technology
MW	Megawatts
NWRA	National Water Resources Authority
NS	Natural Stones
ONDD	Belgian Export Credit Agency
ORGM	Algerian Mining and Geology Research Bureau
PEP-MENA	Private Enterprise Partnership – Middle East and North Africa (IFC)
PTC	Public Telecommunications Corporation
PCDP	Public Consultation and Disclosure Plan
SME	Small and Medium Enterprises
SSM	Small-scale Mining
YLNG	Yemen Liquefied Natural Gas (Project)

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REPUBLIC OF YEMEN

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REPUBLIC OF YEMEN

STUDY TO ASSESS MINERAL SECTOR POTENTIAL

1. EXECUTIVE SUMMARY

Dependence on the oil sector as a source of economic growth is no longer sustainable given the rate at which oil reserves are being depleted. Yemen will come to rely on other sectors of the economy, some of which have potential but remain under-developed. The mineral sector is one of these. The Third Five Year Plan for Development and Poverty Alleviation 2006-2010, identified the mineral sector as one of the key sources of future growth for the country – along with tourism and agriculture.

This study was conducted to assess the potential contribution of the mineral sector to sustainable growth and poverty alleviation in Yemen and to define the constraints that will need to be overcome if this potential is to be realized. In so doing it helps to define those areas of government action and donor support that will need to be sustained over the medium to long term.

Promising Mineral Potential

The geology of Yemen is promising for metallic and industrial minerals and there are ample deposits of natural stones in the country. However, with the exception of a relatively artisanal exploitation of natural stones, the country does not have a mining tradition and any development of the sector will require significant and sustained efforts.

The positive assessment of minerals prospectivity is based on a substantial amount of work that has been done over the years to map the country's geology, as part of projects funded by external agencies, by the Yemen Geological Survey and Mineral Resources Board (GSMRB) and by private companies. Encouragement is drawn, in particular, from the mineral deposits found and being developed in neighboring Saudi Arabia and comparison with analogous mineral-bearing geological structures in East Africa.

A large amount of data of reasonable quality are available in Yemen on the geology, mineralization, environment and hydrology of the country. Access to these data could be improved and there are a number of specific measures that could be taken by GSMRB that could result in improvements in the presentation and promotion of the data.

In terms of prospective minerals, there is ample evidence of gold mineralization and some estimates indicate that the country could host some world-class deposits. A zinc deposit at Jabal Salab is under development and should start production late in 2010 and Cantex of Canada, which has been exploring in Yemen for many years recently announced that Vale, one of the largest mining companies in the world, has agreed to fund a portion of work to further explore the promising Suwar Nickel-Copper-Cobalt massive sulphide deposit north west of Sana'a. Other potential minerals receiving attention include titanomagnetite and rare earth elements. The table below presents a potential mining sector growth scenario in the short to medium term.

Existing or under development	New investment	Annual Volume	Annual Sales Value	Annual Export Share	Annual Tax Revenues ¹
Start up of Jabali zinc in 2009		70,000 t/yr zinc oxide (80 percent zinc content)	US\$56mn (@\$1000/t zinc)	100 percent	US\$1-2mn in the early years
	Al Hariqah gold developed by end of period	200,000 oz/yr gold	US\$180mn (@\$900/oz gold)	100 percent	US\$5-10mn
Productivity improvement at existing quarries during the period		n/a	US\$20-30mn	10-20 percent	US\$2-3mn
	One or more new large granite/marble quarries for export of dimension stone opened during the period	n/a	US\$20-30mn	75 percent	US\$2-3mn
Little growth in the sca exploration programs	le and variety of	n/a	n/a	n/a	n/a
1. Revenue receipts based on royalty, duties and taxes, however, tax holidays, duty exemptions and investment allowances may result in low revenue from duties and taxes in the early years of a mine					

Table 1. Mineral Sector Growth Scenario 2010-2015

Yemen also has a range of industrial minerals that could be exploited, principally by small and medium- to large-sized companies. Lhoist Co. (Belgium), one of the largest mining companies in the world in lime production, is currently conducting explorations for limestones and dolomite in Yemen. However, many of these minerals require further work to understand better the market opportunities and to provide assurance of the commercial feasibility of any development. Several raw materials related to cement production are already being exploited, as is rock salt.

The natural stone industry is already substantial in Yemen and could be made significantly more efficient and economic through a programme of raising market awareness, improving quality and installing modern technology. This sector is considered ripe for relatively rapid development, and with German assistance, existing cooperation programs have created an initial platform for this. The strengths, weaknesses, opportunities and threats associated with the three groups into which minerals have been divided in this study are shown below.

 STRENGTHS Good geological structure for mineralization, particularly gold, zinc and copper Geological maps of the whole country Reports of previous work done by the GSMRB and predecessors readily available 	 WEAKNESSES 1. Lack of mining culture 2. Yemeni geologists are not trained in economic geology 3. Previous work is not to modern standards 4. Lack of infrastructure (mainly roads and power)
OPPORTUNITIES 1. New mining legislation should provide improved investment conditions 2. Precious metals markets are likely to continue to be strong	 THREATS Insurrection in the north of Yemen gives poor image of country to investors Access to resources may be difficult on tribal lands

Metallic Minerals and Precious Minerals

 3. Lo	ng term metal markets likely to	be robust		

Industrial Minerals

<u>STR</u> 1. 2.	ENGTHS Significant geological potential in Yemen; mainly for: limestones, feldspars, pumice, perlite and scoria, quartz and silica sand, kaolin, natural zeolite, etc. Many important sites are close to the main Yemeni ports	WE 1. 2. 3.	AKNESSES Lack of mining culture Yemeni geologists are not trained in economic geology Lack of infrastructure (mainly roads and power)
<u>OPP</u> 1. 2. 3.	ORTUNITIES Local demand of IM is not satisfied. Current import from abroad can present opportunity for larger domestic production. The development of the natural stones (NS) sector, will also provide strong benefits to the future production of low cost aggregates and other IM, from waste use of quarrying and processing operations. Large demand for some IM in the regional developing markets (mainly Gulf): e.g. the perlite and scoria to make pozzolanic light cement and lightweight concrete and blocks.	<u>TH</u> 1. 2.	REATS Development of quarrying activity may be complicated by issues regarding access to tribal land. New mining law may not encourage small enterprises

Natural Stones

STF 1. 2. 3. 4. 5. 6. 7. 8. 9.	ENCTHS Extensive and significant geological potential in Yemen Presence of thick sequences of limestones Presence of large masses of travertines Presence of promising occurrences of coloured granites Large availability of attractive coloured volcanic stones (ignimbrites, tuff, etc.) Old tradition in NS working and quarrying Old tradition in NS architecture and paving Large availability of local potential manpower Low shipping costs to regional Arab markets and most of other Asian markets	 WEAKNESSES No industrial NS quarries in operation, using modern exploitation methods and equipment Low availability of modern, well managed NS processing plant Absence of skill in quarrying and processing NS with modern industrial and semi-industrial international standards No professional technical search and evaluation works and studies conducted on NS in Yemen Lack of local NS experts No particular studies conducted on optimization and use of waste material from quarrying and processing operations Lack of modern and good infrastructure in Yemen: roads, electricity etc. 	:
OPI 1. 2. 3. 4. 5. 6.	PORTUNITIES High (often rising) demand of NS in the international market High demand for limestones and travertines in the international market Relatively good potential domestic market Good regional market (e.g. Gulf countries and Middle East) Relatively low shipping costs to Gulf area and India and Far East markets New interest in the NS sector among some international donors	 THREATS Very large and strong competition from new NS producing countries: India, China, Egypt, Turkey etc. No particular legislation for NS (provision in the revised Mining code, currently under review) Tribal land issue → difficult development of the quarrying activity, which is the source of the entire NS sector 	•

Constraints

Hurdles to the sustainable development of the mineral sector in Yemen include the need for: (i) improved infrastructure; (ii) careful management of social aspects, especially regarding access to tribal lands; and (iii) strengthening of government regulatory institutions. Further consolidation of ongoing legal and fiscal reforms will also be needed.

The development of a mining industry and of downstream mineral processing, in particular, will depend on adequate infrastructure. Development of the road system is underway, but the topography of western Yemen dictates that road building will be expensive. An ambitious plan for the construction of a railway from Sana'a to the south coast ports (Belhaf, Shabwa province) has been proposed in order to provide transport to external markets. Such a project would undoubtedly assist in the development of other industries in the east and south of the country. However, detailed economic and technical studies will be required before the feasibility of the proposal can be evaluated fully. Other limiting factors include the availability of power and of water. Nevertheless, activities that would in any case be necessary to develop the mining sector could usefully be initiated whether or not the railway proposal is approved. These are explored in Chapter 10.

The social aspects that require attention include the instability in some parts of northern Yemen and the traditional, tribal nature of life outside the main urban centers. Access to mineral resources is complicated by the existence of tribal land claims. These need to be recognized and managed carefully by authorities at central and district levels. In addition, and most importantly, mining companies must build up good relations with the local population. These social development issues are described in more detail below, and possible approaches are reviewed, drawing on experience in the oil sector. Some of these approaches rely on recognition by mining companies and host tribes that mining development can provide opportunities for job generation and community development.

The strengthening of government institutions engaged in promoting and managing the mining sector is a prerequisite for sustainable mineral sector growth in Yemen. This implies a higher profile and better resourcing for the main regulatory agencies. Although core competencies exist, these agencies have not yet gained experience in supervising large-scale mineral operations, especially in the mine development and production phases. Even in the exploration phase, a limiting factor for the promotion of exploration opportunities has been the limited experience among GSMRB geologists and other agency staff with mineral economics and markets. In addition to any physical investments, therefore, considerable investment will be required to strengthen sector know-how and skills development.

Finally, it will be important for the Government of Yemen to signal its intent and commitment to give to the mineral sector the type of support that will be required over the medium to long term in order to successfully harness the country's mineral potential and bring about wider economic benefits. The draft National Mining Policy, which has been prepared by the government with support from the World Bank Group, provides such a signal. A modern and efficient legal and fiscal framework for mining is in the process of being reviewed for legislative enactment. These are important steps, which will need to be consolidated through specific regulatory and institutional measures to ensure effective implementation.

Support for Mineral Sector Development

Realistically, any programme to assist Yemen in developing its mineral sector must take a longterm view of up to ten years, although benefits can be achieved in certain areas well before this timeframe. The objectives of future support to the sector, which arise from this study, can be listed as follows:

- Build on the work already underway to improve activities in the natural stone sector through improved efficiency, higher quality products and better understanding of stone product markets
- Build capacity in the government administration to provide support services to local enterprises and to improve regulation of the sector, including, where necessary, sensitisation in social and environmental management
- Encourage local enterprises to involve local populations in mineral activities and develop a mining culture for mineral commodities amenable to exploitation and marketing by local enterprises
- Identify and promote mineral occurrences that require specialized mineral exploration approaches from international mining companies

A detailed list of activities that can help attain these objectives is included in Chapter 10. These activities are intended to reach all sectors of the economy and social ranks, focussing on capacity building at all levels and the involvement of local communities. It is implicit in these recommendations that spreading economic development to all sectors of society will enhance Yemen's capacity to achieve future economic independence and stability and alleviate poverty.

2. INTRODUCTION

The oil sector has been the major source of revenues and foreign exchange for the Government of Yemen (GoY). Hydrocarbon output (oil and gas) represents about one-third of GDP, almost threequarters of Government revenues, and 90 percent of exports.¹ However, Yemen's oil reserves are rapidly depleting: in the absence of a new discovery, crude oil output (currently at around 270,000 barrels per day) is expected to be exhausted in the next 10-12 years. Oil revenues fell 20 percent in 2007 to US\$3.3 billion as output dropped to 42 million barrels from 64 million barrels the year before. With the recent drop in petroleum prices, the GoY is facing a budget deficit in 2009. The fisheries sector is the second revenue provider for the GoY.

The mining sector in Yemen could be one of the few viable alternatives to foster growth outside of the oil sector. The Third Five Year Plan for Development and Poverty Alleviation 2006-2010 identifies the mineral sector as one of the key sources of future growth for the country—along with tourism and agriculture.

The GoY has sought assistance from the World Bank to help it evaluate the potential contribution of the mineral sector to the economy and to identify critical factors that may constrain its growth. An earlier World Bank sponsored program, the Yemen Mineral Sector Project, supported the preparation of a comprehensive review of the Geology and Mineral Resources of Yemen². This project followed immediately after a program funded by the United Nations Department of Economic and Social Development³, which had provided much useful prospecting and early-stage exploration data.

There are several mineral sector reforms underway, driven by the GoY and organised with assistance from the donor community. Since 2006, the GoY has been working closely with the International Finance Corporation's (IFC) PEP-MENA group on revising the mining law and regulations and updating institutional arrangements in regard to the mining sector. The World Bank Group's Mining, Oil, and Gas Policy division has helped implement two trust funds focused on institutional development and mining sector promotion. Activities have included revisions to the legal and regulatory framework, some promotional efforts and digitisation of geological information. *These interventions are positive developments, but need to be scaled up if GoY is to achieve its ambition of turning the mineral sector into a sustainable source of economic growth.*

This review of the mineral sector is therefore intended to provide a basis for developing a comprehensive mineral sector strategy, which would be implemented over some five or more years and would serve to help the Yemeni authorities develop the country's mining sector. This would include, *inter alia*, completion of legal and regulatory reforms; institutional strengthening for management of the sector; development of modern minerals licensing administration; development of investment promotion programs; investment in geo-data acquisition and interpretation; initiatives to foster infrastructure development; development of an environmental and social management framework; arrangements for community development and benefit

¹ Hill, Ginny, Yemen: Fear of Failure, Chatham House Briefing Paper, <u>www.chathamhouse.org.uk</u>, November 2008.

² McCombe, D.A., Fernette G.L., and Alawi A.J. (compilers), The Geology and Mineral Resources of Yemen: Ministry of Oil and Mineral Resources, Geological Survey and Minerals Exploration Board, Yemen Mineral Sector Project, 1994 (reprinted 2001).

³ Robertson Research Minerals Limited, a series of reports on prospecting and exploration of minerals in Yemen, Republic of Yemen Geological and Mineral Exploration Board, 1993

sharing; development of value-added and downstream activities in mining; and interventions to support sustainable small scale mining.

This study analyzes separately the following groups of minerals: Metallic Minerals and Precious Metals (MPM), Industrial Minerals (IM) and Natural Stones (NS), because in the Yemeni context each will require a different set of approaches if full advantage is to be taken of the opportunities that exist.

3. GEOLOGY OF YEMEN AND DATA AVAILABILITY

3.1 GEOLOGY

A summary of Yemen's geology is provided below; more details can be found in a book published following a previous World Bank program.⁴

Figure 3.1 Geological Map of Yemen



Yemen comprises rocks from Precambrian to Pleistocene in age. *Precambrian rocks* outcrop in two main areas, the Sa'dah block in the northwest and the Al-Bayda-Lawder-Mukulla block in south-central Yemen. They comprise predominantly gneiss, schist and greenstone intruded by numerous late Proterozoic granites.

Palaeozoic rocks are uncommon and occur mainly as isolated outcrops of continental-fluvial or glacio-marine clastic sediments (mainly sandstones and tillite deposits associated with siltstone), unconformably overlying basement rocks within northwest Yemen. These lithofacies outcrops are represented by Wajid Sandstone and Akbarah Shale Formations.

Mesozoic sediments are widely exposed. Jurassic sediments were deposited as shallow water carbonate facies rocks within two basins: the northwest trending Saba'tayn rift in central Yemen

⁴ Menzies, M.M., Al-Kadasi, M., Al-Kirbash, S., Al-Subbary, A., Baker, J., Blakey, S., Boscence, D., Davison, I., Dar, C., Owen, L., McClay, K., Nichols, G., Yelland, A., and Watchorn, F., Geology of the Republic of Yemen, in McCombe, D.A., Fernette G.L., and Alawi A.J. (compilers), The Geology and Mineral Resources of Yemen: Ministry of Oil and Mineral Resources, Geological Survey and Minerals Exploration Board, Yemen Mineral Sector Project, 1994 (reprinted 2001).

and the easterly trending Jeza Basin in eastern Yemen. These basins host gas and oil near Marib and Shabwah Provinces.

Four main lithostratigraphic units are present:

- 1. Kuhlan Formation (spelled Kohlan in some references): a non-glaciogenic arenaceous succession, of Lower-Middle Jurassic age, overlying the basement and underlying the Jurassic carbonates.
- 2. Amran Group: an Upper Jurassic succession, predominantly carbonate marl/shale units divisible into a lower shallow marine facies of the platform and of pre-rift areas and an upper more pelagic marly-shaly facies with locally an evaporitic development in restricted basins.
- 3. Tawilah Group: a continental to fluvial marginal marine lithofacies of Cretaceous age, composed mainly of sandstone, often cross-bedded, at times gravely and frequently cut by numerous Tertiary fissures and dykes.

Tertiary rocks are predominantly volcanic within the west of Yemen with marine sediments to the east. The volcanics are related to north-northwest extension and uplift, and are represented by mainly basalt and rhyolitic sequences with shallow granitic plutons.

Rifting in the Red sea and uplift of western Yemen postdated this magmatism. Volcanic activity renewed in the *Quaternary* with basaltic fissure eruptions and the formation of composite shield volcanoes.

It is particularly useful to refer to a summary map showing the main geological features of the Arabian Peninsula in Figure 3.2. This places the geology of Yemen, as seen in Figure 3.1, in its regional context.



Figure 3.2: Geology of the Arabian Peninsula

Figure 3.2 demonstrates that the western portion of Yemeni territory contains a part of the Arabian Shield Precambrian deposits, which are similar to mineral bearing deposits in northeastern Africa. In addition, the Saudi Geological Survey has published useful data on the work done in their country on such rocks, which can be extrapolated to Yemen. This work is referred to in particular in Section 4: Mineral Prospectivity.

In addition to the general lithologies and structures shown above, the uplift and geological disturbance that have characterized the area have resulted in significant faulting in the northwest to southeast direction. These disturbances would have acted as conduits for mineralizing fluids and so metallic ores may be expected along these structures forming mineralization zones.

Yemen, in its Precambrian Formations, is mainly characterized by the presence of different lithologies (e.g. meta-volcanic rocks: mica-schists, quartzites and gneisses) and structures (NW-SE faults and shear zones) similar to those of the very well known greenstone belts in Africa (the Birrimian in West Africa), hosting important world-class gold and other metallic minerals ore bodies.

Box 3.1 provides a short description of the main rock formations existing in Yemen, described by ages and type of rocks; this is useful to identify and evaluate Yemen's NS potential.

Box 3.1 Rock Formations in Yemen

Metamorphic Rocks

The Precambrian basement rocks in Yemen comprise metavolcanic (see above), metasedimentary, gneiss and migmatite belts produced in arc environments intruded by post tectonic granites and granodiorites. These are found throughout western Yemen from the northwest (Sa'dah - Al Jawf) and southwest areas (Marib-Al-Bayda), in addition to small outcrops in south of Taiz and west of Mukalla. The oldest known rocks in Yemen occur in the Al Bayda terrane which contains late Archaean aged (Sm-Nd: 2700-2900 Ma) gneisses, amphibolite dykes and granites

Sedimentary Rocks - These comprise the following:

Paleozoic Sediments

- Ghabar Group (Infra-Cambrian-Earliest Paleozoic): Sandstone, limestone, silt, gypsum.
- Qinab Group (Infra Cambrian-Lowest Cambrian): Volcano-sedimentary succession consisting of dolerite, sandstone, silty shale and tuff.
- Wajid Formation (Permian and older): Quartz sandstone.
- Akbarah formation (Late Carboniferous-Permian): Tillite (pebbles and boulders of basement rocks), shales, mudstones, and siltstones.
- Mesozoic Sediments
- Kuhlan Formation (Lower-Middle Jurassic): Sandstones, thin claystone and siltstone interbeds.
- Amran Group (Middle Jurassic-Lower Cretaceous): Carbonate marl/shale with evaporitic succession.
- Tawilah Group (Cretaceous): Sandstone with siltstone, marl, and shale, often interbedded with sandstone and also forming distinct marl or shale intervals and with generally persistent limestone-marl clasts.
- Mahra Group (Cretaceous): Limestone, marl, and shale, often interbedded with sandstone.

Cenozoic Sediments

- Hadramawt Group (Paleocene-Middle Eocene): Dolomite, shale, limestone with chalk and dolomite, marl, papery shale, bedded gypsum, and alternating sand stone and claystone.
- Majzir Formation (Paleocene-Lower Eocene): A shallow marine-littoral sandstone succession.
- Shihr Group (Oligocene-Pliocene): Conglomerate, sandstone, silt, limestone and gypsum.
- Tihamah Group (Middle-Upper Miocene): Sandstone, conglomerate, gypsum, rock salt, shell, mudstone and limestone.

Volcanic and Intrusive Rocks

A time of Regional uplift occurred in western Yemen in the Paleocene/Eocene as evidenced by intermittent volcanic activity commencing in the Early Eocene which culminated in Oligocene–Miocene times with extensive extrusive and plateau flood basalt eruptions forming the Yemen Volcanic Group. This comprises an older "trap" series and younger Volcanic Series.

These series include the whole spectrum of basaltic lithologies to silicic ignimbrites and tuffs. Sedimentary units, generally occurring as lenses of limited extent and thickness, occur in many parts of the volcanic sequence between flows (Geukens, 1960, 1966). These are generally composed of lacustrine deposits consisting of calcareous sandstone, mudstone and reworked volcanic clasts. Also observed in inter-trap sedimentary units are fluvio-aeolian sands and palaeo-soils, generally lateritic, often developing along plane surfaces but at times locally cutting across different beds.

The Yemen Volcanic Group is intruded by granitoid rocks along much of the edge of the High Plateau of Yemen, which forms the great eastern escarpment of the Red Sea. Intrusions also occur in the Sana'a and Taiz districts.

3.2 AVAILABILITY OF DATA

The Yemen Geological Survey and Mineral Resources Board (GSMRB), the agency in charge of managing the country's mining sector, has had the benefit of cooperation with a range of international institutions over the years, including for geological mapping.

Such cooperation has included German bilateral programs. Germany's Federal Institute for Geosciences and Natural Resources (BGR) worked with the GSMRB to commence the geological mapping of the country at a scale of 1:100,000 in 1990; this work is now being continued by the GSMRB, which has a program to update the coverage of the country.

The GSMRB holds significant geological, geophysical and report data within its structure. A booklet issued in 2000⁵ provides a good summary of the available data. Other data comprising borehole logs from drill holes for oil exploration or wells are available within the Ministry, although these are not currently accessible within the GSMRB database. Similarly, the Yemeni National Water Resources Authority (NWRA) holds a great deal of data, much of which can be accessed through the ongoing BGR Integrated Water Resources Management (IWRM) assistance programme. The Geo-environmental Information and Monitoring programme team leader has an office in the GSMRB.

In general there are sufficient data available in the country for incoming investors, although much of the data and documents are very general in content. More detailed chemical, mineralogical and mining data are generally not presented to a standard and format that allows them to be offered directly to potential international mining investors. The GSMRB's goal is to be able to access all the data and have it available for investors.

Examples of the available data and their location are provided below:

3.2.1 Geology

A geology map at a scale of 1:1,000,000 for the entire country is published and readily available from the GSMRB. 35 more detailed sheets at 1:250,000 scale are available for the country and further mapping is underway with the objective of covering the entire country at this scale.

To date 33 maps at a scale of 1:100,000 have been completed and a further 200 are in progress.

Discussions at the GSMRB revealed that the field teams carrying out the mapping are quite competent, but that they would benefit from the assistance of an experienced mapping geologist, particularly for the mapping of basement rocks.

3.2.2 Environmental Issues

Thematic maps and images covering a wide range of topics are also available, including:

- Topographic maps in scale 1: 250,000 (but only about 10-15 percent are in digital form)
- Satellite images from Land sat
- Hydrological maps (2 sheets at 1:1,000,000 and 35 sheets at 1:250.000)
- Geological risk maps

⁵ Yemen Geological Survey and Mineral resources Board, Geological and Geophysical Data, 2000

The GSMRB has compiled thematic maps on water pollution, oil station locations, quarries and crushers. The BGR IWRM project is working on thematic maps particularly for water supply (e.g. wells, drainage patterns and pollution) using remote sensing (satellite imagery) and Geological Information System (GIS) techniques.

These data are available for specific regions, but are not countrywide. Overall, the data available are not considered to be fully sufficient for international investor purposes and could benefit from modernization.

3.2.3 Geophysics

A magnetic anomaly map of Yemen has been prepared from 26 different surveys of varying specifications carried out between 1976 and 1985. A map showing the surveys and indicating the spacings between survey lines is available at the GSMRB. This demonstrates that over much of the eastern two-thirds of the country the spacing between the survey lines was rather wide for mineral purposes (the closer the spacing and the lower the flight of the aircraft, the more detail can be obtained for relatively shallow structures likely to be of interest to mineral investors: the wider spacing and higher flight lines are adequate for deeper and often larger structures pertinent to oil traps.)

In the west of the country a number of aeromagnetic and radiometric surveys were carried out in 1984-1985 using fixed-wing aircraft and a helicopter. These provide better data for this part of the country. A series of maps are available at scales of 1:50,000, 1:100,000 and 1:250,000 showing contours of key indicators.

In 1990 helicopter magnetic and electromagnetic surveys were carried out over two selected areas: Al Beyda Mukiras and Al Hamurah. Both these blocks are of interest due to iron mineralization and exploration is currently being carried out in both of these areas.

Airborne geophysical methods and ground follow-up are particularly useful for the identification of potentially mineralised structures, as well as for oil and water potential. The GSMRB has limited capability for ground geophysics and does not have modern equipment for data acquisition or for interpretation. The understanding of modern airborne techniques within the GSMRB appears limited (which is not surprising as these techniques have developed significantly in the past decade). However, there are geophysicists within the organisation who would benefit from access to and interaction with international expertise.

3.2.4 Reports

The GSMRB houses a well-run library facility where many reports dating back decades are located. These reports may be consulted in the library.

The Geological Survey of Denmark and Greenland (GEUS) is working with the GSMRB, through the World Bank, to implement a Mining Investment Promotion project. In addition to the preparation of promotional pamphlets, a database for reports and maps is being implemented within the GSMRB. This project is underway; the following is a summary of progress and objectives:

• *Reports*: In the library, GSMRB has a PC with CDS/ISIS installed. This database includes titles for about 800 registered reports. GSMRB has scanned more than 160 reports so far and is continuing to do so.

• *Maps:* The library contains a Microsoft Access database with metadata for a number of different types of maps available at GSMRB, including geological maps, geophysical maps, and mining thematic maps. Many of these maps have been scanned. The library will continue updating the map database, ensuring that the scanned maps can be linked with the corresponding records in the map database.

3.3 SUMMARY AND SUPPORT REQUIREMENTS

A large amount of data of reasonable quality is available in Yemen on the geology, mineralisation, environment and hydrology of the country. Access to these data could be improved, however. Following is a list of areas in which some assistance to the GSMRB could result in improvements in the presentation and promotion of these data:

- The GSMRB is continuing to map the country at 1:100,000, but would benefit from support from an experienced mapping geologist, particularly for the mapping of the basement rocks.
- The GSMRB would benefit from the advice of an experienced geo-physicist in order to review the geophysics data already available and to identify potential targets for a modern airborne geophysical survey, as well as to update the skills and tools of the organisation's geophysicists.
- The GSMRB has a database for reports etc., and is updating this for promotional use. However, the country would benefit from an integrated database in which all the geological, hydrogeological and drill hole data from a variety of sources (GSMRB, NWRA, Ministry of Oil and Minerals etc.) would be accessible.
- Support to the GSMRB laboratory, especially to the activities related to the industrial minerals, could be merited.
- In each of the activities mentioned, some form of budget support would assist the GSMRB to plan and implement their programs and retain their competent personnel.

4. MINERAL PROSPECTIVITY

Over the years, work by the GSMRB has resulted in the identification of a number of mineral prospects for metallic and non-metallic minerals and stones. The GSMRB's priority has been to seek building stone prospects, as it is in this sector that the Government has identified the major opportunities for creating jobs and income.

However, referring to the maps produced internally by the GSMRB depicting identified occurrences of metallic minerals and non-metallic minerals in Yemen (see later in this Chapter), mining companies' activities in Yemen in 2008 (see Chapter 5) and also to the information available from the Saudi Geological Survey, the substantial potential for more finds becomes evident.

In particular, the Arabian Shield has been shown to be a repository of significant mineral potential in Saudi Arabia.

Apart from the Jabali Zinc Project, which is already in an advanced phase and where mining will start in 2010, the potential MPM mining targets are presented in a general and superficial way. This is partly due to the fact that some of these target areas and sites (for iron, copper, uranium, gold) are held under exploration licences by foreign mining companies, and as a result very few new data are publicly available.

A number of IM target areas (rather than real projects) have been identified by GSMRB, and first sampling and analyses have been made which could be used to address future, more comprehensive and targeted exploration campaigns (see section 4.2).

With reference to NS, the detailed information and data available are not directly usable by professional investors. Only general information on target areas exists, and structured and more detailed field geological investigations and site evaluations, carried out by NS experts with technical and marketing know-how and experience, would be required.

The prospectivity of various minerals is analyzed in the remainder of this chapter. More details about the work being carried out by the GSMRB and the private sector are provided in Chapter 5.

4.1 METALLIC MINERALS AND PRECIOUS METALS

A wide suite of MPM has been found in Yemen. Some of the indications found may now be defined as deposits, whereas others appear too small for industrial exploitation, or require further work to define their full potential. The various minerals are considered in groups, and the relative prospectivity *according to present knowledge* is assessed below.

Figure 3.1 is a map showing the locations of identified occurrences of metallic minerals in $Yemen^{6}$.

⁶ Provided by the Promotion and Evaluation Department of the GSMRB.



Figure 4.1: Locations of identified occurrences of metallic minerals in Yemen Source: GSMRB

4.1.1 Precious Metals

Historically, Yemen was the seat of the Sabayans (best known by reference to the Queen of Sheba), a nation that was well known for its wealth in gold. Since there appears to be evidence that the west of Yemen was the source of much of this $gold^7$ it may seem surprising that in modern times little gold mining has been recorded.

The GSMRB publication "Mineral Resources in Yemen"⁸ states that there are over 40 known gold or silver occurrences and records 12 sites of recognized gold and silver mineralization, a number of which are the subject of exploration by international companies. That such a number of sites should be identified is not a surprise, considering the trend of gold mines and occurrences in the west of Saudi Arabia and recorded by the Saudi Geological Survey is considered, see Figure 4.2. The Mahd ad Dhahab mine has been known since antiquity and taken together the gold mines in this area provide significant resources and creators of employment for Saudi Arabia. With reference to Figure 4.1, it may be concluded that the trend evident in Saudi Arabia continues into Yemen.

⁷ Dr Nok Frick: personal communication. The Sabaeans were known as traders who specialized in gold, some of which will have come from East Africa.

⁸ Republic of Yemen, Ministry of Oil and Minerals, Geological Survey and Mineral Resources Board; Mineral Resources in Yemen, 2007.



Note to Figure 4.2: The area outlined is the part of the Arabian Shield directly to the north of Western Yemen. The clear trend of gold occurrences in the Shield provides confidence that there should be similar occurrences in Yemen.

Figure 4.2: Operating Gold Mines and Gold Occurrences in the Arabian Shield, Saudi Arabia (Source: Saudi Geological Survey)

By inference from the Saudi Arabian experience, the likelihood that there are commercially viable gold deposits in Yemen is high. The gold is generally found as primary gold in rock formations and not in alluvial or fluvial terraces. The latter are the most easily discovered and mined deposits and therefore the most frequently exploited deposits for artisanal or small-scale mines; this may explain the absence of small-scale gold mining in Yemen.

It appears clear from a review of gold occurrences in Yemen which was carried out for this report, that there is a large number of occurrences and although some of these are covered by exploration licences, there are still areas available for further work.

From published information,⁹ Cantex Mine Development Corporation expects to be able to demonstrate a 2 to 3 million ounce gold deposit in northwestern Yemen (Al-Hariqah deposit); that is a world-class deposit.

Conclusion: There is high prospectivity for gold mining in Yemen.

4.1.2 Lead – Zinc

Lead and zinc mineralization occurs in a few sites in Yemen, generally situated in carbonates or volcanogenic massive sulphides. As in Saudi Arabia, many of the known occurrences appear to

9 www.Cantex.ca

be of limited extent, although the Jabali project (see Section 5) is the exception to date, with a mine in development.

Conclusion: The Jabali project has demonstrated that there is potential for zinc in Yemen and this should encourage other investors.

4.1.3 Copper – Nickel – Cobalt

Copper mineralization, together with associated minerals, is widespread in the pre-Cambrian rocks of the Arabian Shield. In Saudi Arabia it is reported that in pre-Islamic and Abbasid times there was a significant copper mining and smelting activity in the area and it is supposed that this could also have been true in Yemen.



Figure 4.3: Principal Copper Occurrences in Yemen

Note to Figure 4.3: The area outlined is the part of the Arabian Shield directly to the north of Western Yemen. The trend of copper occurrences in the Shield provides confidence that there should be similar occurrences in Yemen and reference to Figure 4.1 would tend to confirm that conclusion.

The GSMRB lists seven occurrences of Copper – Nickel – Cobalt mineralisation. Exploration licences have been acquired by Cantex and Ansan Wikfs, and a licence area at Shabwah – Taiz has also been acquired for exploration by Stone Resources. Cantex, which has been working in the country for many years, claims to have discovered two potential major nickel resources with conceptual in-ground metal values of US\$12 to 30 billion.¹⁰ These would be world-class deposits. One of these is northwest of Sana'a and is understood to be in an area where relations with the local tribes are good (see Chapter 5.2).

Conclusion: There is every chance that significant developments may occur for these minerals in the next few years.

4.1.4 Iron, Titanium, Vanadium

Other metallic minerals occurring in Yemen include iron, titanium and vanadium. These metals are in high demand worldwide and although the tonnages estimated and the grades recorded by

¹⁰ www.Cantex.ca

the GSMRB are in general relatively poor or marginal, further work to indicate additional resources may well be warranted.

According to the available information, two companies are exploring for iron ore: Yemen Iron and Steel in the Al-Thanyyah area east of Marib, and Minerals and Metals Mining Shabbir Company near Al Baydah.

In 1990 helicopter magnetic and electromagnetic surveys were carried out in the Al Baydah and Al Hamurah blocks to complement the earlier series of fixed-wing surveys carried out by a number of different companies at different specifications, mainly in the 1970s and 1980s.¹¹ Further ground-based geophysical surveys have been carried out by the GSMRB, and these have affirmed targets for iron ore exploration.¹² From the published data, the current estimates of resources in these areas are not world-class in terms of the quantities available. However, work on these sites is ongoing, and it is understood that the companies involved are identifying further zones of mineralisation.

Conclusion: It is too early to state with confidence that there might be commercial deposits of iron ore in Yemen, but it is hoped that the companies involved will continue to explore the license areas, as the future demand for iron ore is likely to be robust. Any future mine development would, however, be contingent on building or obtaining access to reliable bulk commodity transport and port facilities.

4.1.5 Other Metallic Minerals

Rare Earth Element mineralization is also recorded in carbonatites southeast of Lawdar (southern Yemen) and in pegmatites. These occurrences would appear to warrant further investigation to evaluate their potential.

Conclusion: there is evidence of a range of other metallic minerals which could be marketable.

4.2 INDUSTRIAL MINERALS

As regards IM, it appears that the local institutions responsible for mining sector development (e.g. GSMRB) and the private mining community, which is relatively small to date, have not yet completely identified the main targets and priorities for both minerals and areas. As with metallic minerals, the work is in a phase, typical of growing non-mining countries, where all minerals occurrences are regarded as possible mining targets and promoted as a whole, without identifying possible markets. Some concrete IM targets have only been identified in recent years: Feldspars (K and Na), Silica Sand and Quartz, Magnesite, Limestones (mainly tertiary in Eastern rock-desertic area), Scoria-Perlite-Pumice, and of course, clays, sand and aggregates. These areas have been the subject of preliminary evaluations by GSMRB, although not yet using detailed analytical methods and commercial logic. The main targets identified to date are illustrated in Figure 4.4.

¹¹ Geological and Geophysical Data, Yemen Geological Survey and Mineral Resources Board, 2000

¹² Dr Faisal Saeed Al-Huzaim and Mohamed Shamsadin, personal communication.



Figure 4.4 Locations of identified occurrences of non-metallic minerals in Yemen *Source: GSMRB*

Figure 4.4: Locations of Identified Occurrences of Non-metallic Minerals in Yemen (Source: GSRMB)

Some areas taken by international companies in Yemen (e.g Lhoist – Limestone; 3S Minerals – Limestone; and Arabian Mining Company– Magnesite) are undergoing more detailed evaluation, and some of them may be close to a pre-industrial phase. These private projects are contributing to the development of an improved understanding of IM potential in Yemen.

The only current IM mining (exploitation) operations are for sand and aggregate (limestone, granite and basalt), gypsum and salt quarries, often carried out by local companies in an artisanal, non-industrial manner and, apparently, often outside the control of the local mining authorities. Gemstones are being exploited in a destructive way. Improved commercial opportunities would result from improved mining methods and marketing knowledge.

The GSMRB prepared four summaries of exploration work it has carried out on IM for the Mining Investment Promotion project with GEUS (Magnesite, Zeolite, Perlite and Pumice, Scoria, Gypsum and rock salt). These summaries are more comprehensive than the metallic mineral summaries, reflecting the priorities within the GSMRB and the GoY overall. In addition, the GSMRB has prepared brief information files on other IM:

- Celestine (clays used in various processes as fuller's earth, foundry clay and rinsing clay, preparation of drilling mud, carriers and material absorption, filter material and in paper fabrication)
- Gypsum (used as a retardant in cement manufacture and for the manufacture of building plaster and plasterboard); extensive deposits occur in the Sana'a and Hodeidah regions and current mining appears to produce only low quality materials for decorative purposes
- Perlite and Pumice (used in the production of lightweight concrete blocks; perlite can also be used as a soil additive and for cat litter)
- Rocksalt, which has been exploited for hundreds of years, occurs in the centre of the country in Shabwah and thick deposits have been found in the Marib-Al-Jawf basin in oil wells¹³
- Scoria (used in pozzolan Portland cement production and aggregates for lightweight construction concretes)
- Zeolite (for uses in ion exchange, filtering, odour removal, chemical sieve and gas absorption tasks; as an additive to animal feeds can remove toxins and is used in water softeners)

¹³ Geology and Mineral Resources of Yemen, GSMRB, 2001

Limestone for the production of Lime exists in Hadramawt and in several other places on the Southern coast. If the two main quarry operations run by foreign mining companies (e.g. 3S Minerals) are excluded, both in the start up phase, current exploitation is artisanal and could be improved to provide better commercial opportunities for the inhabitants.

Further work will need to be done to identify possible markets and on the economics of the minerals in order to place the potential in context. However, many of these minerals are being, or could be, exploited by small and medium enterprises (SMEs).¹⁴

4.3 CONSTRUCTION MATERIALS / NATURAL STONES

The construction material sector (CMS), also known as the NS Sector, is a very particular mining sub-sector with its own rules, features and consequent methods of evaluation. This is true worldwide, not only in Yemen.

More than the other mining sectors, the NS sector affects not only geo-mining activities but also the local society and community and its traditions. These impacts are related to exploitation as well as to the use of stones (architecture, housing etc.). For these reasons it is often difficult to implement change and improvements over a short time frame. "Softer", medium- to long-term approaches are often required, supporting technical, training and social development activities.

On the other hand, in many developing countries, the NS sector—possibly more than any other mining sub-sector—represents long-term benefits through income and job opportunities for the local community. In Yemen in particular, due to the ancient stone tradition, the wide diffusion of these activities and the strong existing domestic market, the improvement and development of this sub-sector would be a priority for all the local institutions and authorities that work on social and economic development on a stable long-term basis.

Because of the sub-sector's high potential, this report addresses it separately. Local and international institutions that intend to support it may also wish to distinguish this sector from other industrial mining. Within the NS Sector alone, at least four or five different sub-groups are identified, each with its specific features and method of evaluation and support:

<u>Dimension Stones</u>: Any granite, marble, limestone and travertine or other stone that can in principle be quarried/produced in large blocks more than 2-3 m³ in volume (using particular handmade as well as more sophisticated methods) and processed in large slabs (semi-finished products) and tiles or cut-to-size products (finished products).

Building Stones: Any "soft" stone (e.g. limestone, "marble", sedimentary, tuff and other sedimentary and volcanic rock), that can be quarried and finished by hand or using simple but

From website:- www.Yemenstone.com

¹⁴References used:

Introduction The Geology and Mineral Resources of Yemen, MINERAL EXPLORATION BOARD, 1990.

Building and Ornamental rocks of Yemen (in Arabic), prepared by: Amer Al-Sabri, and Dr. Ismail Al-Ganad, GSMRB REPORT,

^{2003.} Rocks and minerals of Yemen, prepared by: - Dr. Mohamed Ali Mattash, FAN AL-TIBA'A (PRINT AR), 2006.

Introduction to artificial uses of industrial rocks of Yemen (in Arabic), prepared by Said Gerjes Al-Taie, reviewed by Amer Al-Sabri and Dr. Ismail Al-Ganad, GSMRB REPORT, 2003.

Geological survey and Mineral Resources Board Ministry of Oil and Mineral Resources Republic of Yemen, GSMRB REPORT,2001. Mineral Resources in Yemen, prepared by:- Amer Al-Sabri, Ali Abdullah Al-Sofi, Nabil Al-Raziihi, GSMRB REPORT, 2007. Minerals in Yemen, author: Ahmad Barakat, (Arabic) Afif Foundation, 1996.

Natural Zeolite in Yemen, (in Arabic) Prepared by: Amer Al-Sabri, GSMRB REPORT, 2001.

effective mechanical equipment, to obtain final stone products for housing and building: small building blocks and thick cladding stones.

<u>Ornamental/Decorative Stones</u>: Any coloured stone that can be worked to produce small decorative elements for interior design (in Yemen: tuff, ignimbrite, sandstone, limestone, etc.)

Landscaping/Paving Stones: Any hard and resistant stone that can be utilised (in thick tiles or cubes) for road paving works. Like building stones, they can be produced by hand and by simple mechanical equipment

Aggregates and Sand for Building and Road Construction

Yemen appears to have significant stone potential, but this fact should not result automatically in "instant" positive conclusions and expectations regarding export potential and foreign currency income. An in-depth analysis of the various stones available and of currently operating or potential mining sites is needed, to identify attractive stones and those suitable in principle to be exported to both regional markets (Gulf area, Oman and Middle East) and overseas international markets (EU, USA, Far East, etc.).

In analyzing NS, in addition to the division into the sub-groups listed above, other constraints and features should be considered, such as:

- type and quality of stone
- distance from the main ports and markets, transport and access
- know-how in quarrying and processing
- level of technology
- type of market approach
- social structure and related security in the quarry

Figure 4.5: Main Operating and Potential Natural Stones Sites in Yemen (Source: GSMRB)



4.3.1 Dimension Stones

The Yemeni Dimensions Stones (DS) sector has significant potential, which is not yet or only partially evaluated. This sector should thus be the subject of careful exploration and evaluation.

Not all the current DS quarries and identified sites are good for industrial and semi-industrial business, although some that are currently exploited using artisanal methods, if properly reorganised and supported, could provide very good products for the local markets. These include some standard granite quarries (medium-coarse grained grey and rose granites or migmatites) and many tertiary limestone quarry sites. On the other hand, several new potential stones and/or sites could be of significant interest for domestic use and future export, such as travertine, some high quality limestones, certain coloured "granites" (gneisses, migmatites, labradorites, etc.), and perhaps some hard thick coloured bedded volcanic rocks. The latter often do not represent a good source for DS, as they tend to be altered and weathered. Detailed studies and tests will need to be carried out on the volcanic stones in Yemen that could represent a significant potential source of NS for any market, provided that some key geological and mechanical features can be confirmed.

Tertiary limestones, quaternary travertines and some pre-cambrian migmatitic "granites", coloured granites and marbles can be considered of first priority, provided that the geological and mining features of the identified sites fit well with international market standards:

- ability to extract consistently large regular blocks
- attractive colour and texture
- good mechanical characteristics
- consistent quality

In general, the main characteristics mentioned above must be homogeneous and consistent over large volumes of stone that will allow a medium-long term life of the quarry.

Figure 4.6: Carbonates Rocks - Dolomite, Limestone, and Travertine Locations in Yemen

arbonates rocks:- Dolomite, Limestone, and Travertine locations in Yemen, from GSMRB



Figure 4.6: Carbonate Rocks – Dolomite, Limestone and Travertine Locations in Yemen (Source: GSMRB)

<u>Limestones</u> in Yemen are widespread and contained in sedimentary sequences ranging in age from Jurassic to Pleistocene. They are distributed within five geological groups: Amran, Mahrah,

Hadramawt, Shihr, and Tihama. Deposits at Hadramawt, Wadi La'ah, Wadi Medhab, Abyan, Lahj and Khamir between Sana'a and Sadah have low silica and alumina contents and are located near paved highways.

Yemen limestones are generally compact and fine-grained, and the colour ranges from yellow to cream/beige (for example Hasheed and Arhab), to whitish to gray and dark gray.

Other limestone occurrences that have received at least limited study are Am Qawz, Wadi Marek, Batys, Jebal Salafiyah and Al-Maharah. Most of them are already quarried using artisanal and "traditional" methods involving poor technology with no mechanisation. Based on visits to a few processing companies and deposits in Sana'a and Aden, carried out during the present project, it is clear that most of them (as seen in the deposits and currently processed) have limited potential for overseas markets. A few, however, if properly selected and quarried (with competitive prices), have the right characteristics to be introduced into regional and international markets.

Main uses of limestone in Yemen are as DS, mostly in cement manufacturing.

Dolomite stones and marbles can also be included in this group. In Yemen there exist a few sites for dolomitic limestones and marbles located in the southern part of the country: Mukalla, Brum, Al-Jawf, Mareb and in Jabal Aokebah in Hodeidah Province. In this area real crystalline metamorphic marble outcrops as lenses and bands within the old pre-Cambrian basement.

Some pure white and banded crystalline marbles, with interesting DS features, have been seen in the deposit, and some attractive samples have been shown during the workshop held at the GSMRB in Sana'a on November 9, 2008. It is important to verify on-site how representative these samples are, because metamorphic marbles are very often irregular and highly fractured and it is very difficult to organise proper successful quarrying operations.

Travertine: Two main sites/deposits are known as potential sources of DS. Quaternary travertine exists in large masses all around natural hot springs, in Hammam Damt, near Al Dhali, south of Dhamar and Nihm area, West of Marib, northwest of Sana'a. Though the existing travertine quarries in Yemen are not properly developed and the rocks do not have an attractive light color, they would appear to have good enough characteristics to be successful in the export market. The characteristics of the travertine are: light brown-cream to brownish color, high mechanical strength, large volume, and availability of large blocks.

Several other travertine occurrences exist, which are still to be evaluated and tested for DS.

Due to the high and consistent demand for travertine in the international market, an evaluation programme for this rock is strongly recommended.

<u>Granites:</u> Two major types of "granite" and granitoid rocks exist in Yemen: tertiary granite, post-collisional intrusions and Precambrian meta-granites, gneisses and migmatites.

Tertiary Granite rocks generally have a medium grained texture and gray colour.

Precambrian Granite rocks, located in the old metamorphic basement, outcropping from the northern Arab Peninsula to Southern Yemen, were all formed during the pre-Cambrian geotectonic multi metamorphic-structural cycle. They are of various structures and colours "opposite of tertiary granite", according to their emplacement as compared to the orogenic phases and mineralogical composition.

Figure 4.7: Dimension Stone Granite Sites in Yemen



Some old meta-granites and gneissic-migmatitic bodies show specific ornamental qualities that enhance their potential as DS. In particular, the light rose migmatite-gneiss—similar to the Indian Colombo and Juparana granites, which are well known in the market—may have good export potential (at least as regards their stone quality).

In general, some granite sites in Yemen have the right mining characteristics for possible industrial quarry operations (e.g. good large volumes of homogeneous rock in terms of colour, grain and texture, low fracturing, availability of large blocks, relatively good access, etc.).

The most promising locations of "granite" in Yemen are:

- Tertiary Granite: Taiz, Bajil, Sana'a, and Al-Mahweet
- *Precambrian Granite:* Al-Bayda, Taiz, Hajjah, Al-Jawf, Sadah, Mareb, Abyan, and Hadramowt provinces. (see tables for more information).

The main uses of granite rocks in Yemen are as DS, for facing walls of dams, as ornamental decorative stone and as cobble stones for paving.

Other possible targets to evaluate are: labradorites and other rare ultrabasics (microgabbros), late orogenic-syenites and other particular metamorphic rocks of the old basement.

Yemen has a small number of large masses or dykes of ultrabasic rocks such as: labradorites, gabbros and norites, belonging to the Precambrian (Archean) Basement. There is currently a strong demand for these rocks, known as "Black Granites" in the international DS market. Some occurrences of potential ultrabasic formations outcrop in northwest region within the northeast portion of the Precambrian basement outcropping area, 100 km east of Sa'dah.

Tertiary volcanics (tuffs, ignimbrites and some lava) are, in principle, the most readily available DS in Yemen. They are frequently used for construction; however, due to their high susceptibility to weathering, they do not usually represent a good use as DS, even if exploitable in large blocks with marketable colors. Some of them, however, particularly if hard, fresh,

unaltered, and with attractive colors, may be utilised for very specific DS product lines (mainly unpolished products). See Section 3.3.2 below for more information on Yemen's volcanic stones.

4.3.2 Building Stones

Yemen, due to its complex geology (a mixture of old basement rocks and relatively newer volcanic and sedimentary formations), has a high geological-mining potential as regards Building Stones (BS). This is also demonstrated by the historical tradition of using BS in the local architecture and by the numerous small artisanal quarries of BS located in many areas of the country.

The main BS in Yemen are: tuffs, ignimbrites, basalt, sandstone (rare), granites and limestones. BS production exists in Yemen, although it is largely artisanal. As a result, production data are often not easily usable because they generally include both building stone and aggregate figures, and at times also include dimension stones and limestone.

Production is stated to have increased recently by an average of 20-30 percent annually. Tables 4.1 and 4.2 provide the official production figures for 2001 and 2007, respectively.

Table 4	4.1
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Governorates	Number of quarries	Labor force	Production	Production value (in
	_		in metric tones	1,000 YER)
Sana'a	26	171	210,200	225,630
Ibb	17	281	745,200	819,720
Taiz	19	455	665,300	912,990
Dhamar	11	201	483,840	672,192
Al Bayda	10	68	140,400	75,540
Amran	8	60	69,000	193,800
Abyan	7	22	47,404	12,481
Hajjah	5	49	63,000	54,900
Marib	4	120	41,800	55,740
Al Jawf	4	12	10,000	10,000
Al Mahwit	3	12	24,000	9,600
Lahaj	3	19	53,788	14,968
Hodaidah	3	26	25,000	21,500
Sa'adah	2	20	12,000	1,080
Shabwah	2	10	24,300	35,070
TOTAL	124	1,526	2,615,232	3,115,211
Source: Ministry o	f Oil and Minerals Statistic	s on Oil Gas and Mi	nerals: 2001 Annual Bulle	tin (original in Arabic)

Building Stone	Production in	Yemen 2001

Table 4.2: Building Stone Production in Yemen 2007

Annual Production and Annual Price of Crushing Stones, Building and Ornamental Stones including Aggregates in tones 2007								
Governorate	No Quarries		Labor Force		Annual Production (T)		Annual price of production in YER	
	Quarries	Crushing	Quarries	Crushing	Quarries	Crushing	Quarries	Crushing
Sana'a	608	89	4344	725	4,456,800	48,384,300	14,911,200,000	6,998,400,000
Dhamar	240	400	861	60	495,360	1,845,000	1,097,600,000	1,102,498,200
Ibb	170	5	329	173	326,016	738,000	246,359,280	885,600,000
Taiz	405	5	982	106	1,388,352	194,400	1,743,104,160	138,960,000
Hudaidah	118	6	647	61	121,320	76,320	1,630,954,440	126,720,000
Hajjah	45	5	350	70	100,800	90,720	927,000,000	226,800,000
Amran	455	8	1556	68	1,152,000	423,450	1,440,000,000	493,920,000
Al-Mahwit	65	-	420	-	475,200	-	950,400,000	-
Total	2106	518	9489	1263	8 515 848	8,206,290	22,946,617,880	9.972.898.200

Box 4.1 Main Building Stones Extracted in Yemen

a. Tuff and Ignimbrite

Tuff is the general term for rock formed of pyroclastic material. Ignimbrite is identical to tuff in formation, but is specifically rock formed by widespread deposition and consolidation of volcanic ash flows. The principal chemical composition of Tuff and Ignimbrite in Yemen is SiO₂, which comprises 60-70 percent of the stone.

This rock is especially preferred for building stone due to its variety of bright colours and ease of processing. The colours available are yellow, green, red, brown, and grey; on the whole, pale colors dominate.

The occurrences of tuff are concentrated in the western highlands of Yemen, in Sana'a, Dhamar and Taiz and Ibb govemorates, where tertiary volcanics outcrop. The reserves in Taiz, are the most abundant and varied in color. The common use of tuff dimension stone in Taiz makes the buildings there more diverse in color, making the city a distinctive tourist attraction.

Other significant extraction and potential areas/regions for Tuffs and Ignimbrites are:

Haddah, Al-Rafsah, Baiet Al-Shuryhie, Jabal Al-Taweel, Jabal Qameer, Jabal Rahabie, Jabal Al-Maslama, Dar Al-Tabaqie, Jabal Al-Sharekha, Jabal Al-Qaherah, Jabal Qarwan, Al-Shahik, Al-Sheraf, Tawalb, Jabal Kenan, Al Mekraf, Al-Robo'a, Al Yadoom.

b. Basaltic Rocks

Basaltic rocks are basic volcanic rocks of fine crystallization similar to gabbros in mineral composition. Basalt is one of the most widely distributed basic rocks forming lava plateaus, volcanic cones and sills and dikes. Basaltic rocks are developed as dykes crossing basement rocks, Jurassic and Cretaceous sedimentary rocks and as interstratified flows in Ignimbrite and Tuff rocks, in alternances of lavas (basalt) and pyroclastics.

The basalt rocks tend to be black in colour; they are used as decorative and building stones, road and railway pavement, cement barriers, corrosive-resistant pipes and in the rock wool industry.

Quaternary basaltic rocks, the most significant, appear as flows and volcanic cones. The basaltic rocks have a large thickness showing cooling fissures which give them a special property, namely to detach in fissural columns of 0.3 - 4 m, allowing basalt to be mined easily and used as building stone and aggregates after crushing.

The main outcropping and mining areas in Yemen for Basalts are:

Sana'a region, Banie Qaydas region, Jabal Al-Samam region, Wade Al-Rowan region, Jabal Al-Lowz region, Jehana region

Most of these locations represent future target areas to be evaluated in detail for further industrial development of this "key industry" in Yemen. Some semi-industrial quarrying operations together with well organized and structured artisanal mining ones, should be planned, organized and supported.

4.3.3 Ornamental/Decorative Stones

This particular sub-sector, still at a very early stage of development in Yemen, has significant potential due to the high geological potential in the country. The main source rocks (mainly colored), are the same as for BS, as described above.

4.3.4 Landscaping Stones

Although several old towns in Yemen are paved with stones, this sub-sector is currently generally undeveloped. Its development will depend, much more than other sub-sectors described above, on a wide promotion and market test effort, to be carried out initially in the domestic market and in the export market thereafter.

Geological potential for paving stones is relatively promising in Yemen, and several field analyses are needed to evaluate some potential formations. A historical study on stones utilised in old paving projects will certainly facilitate this geological evaluation.

The geological rocks with the most potential for this type of product are Precambrian quartzites and slates, some jointed granites, Paleozoic sandstones and slates, tertiary bedded limestones, bedded volcanics.

4.3.5 Precious Stones

Though no targeted in-depth studies have been done to determine Yemen's precious stones potential, there are some indications that a thorough evaluation of the gemstones sector is merited. The southern part of Yemen, around Aden, is thought to be especially promising. GEUS, as part of their project, evaluated rubies, beryls (aquamarine and heliodor), tourmaline, cordierite and garnet and found all of the stones it examined to be of very high quality.

5. CURRENT MINERAL ACTIVITIES AND COMMERCIAL OPPORTUNITIES

Mineral activities in Yemen are documented in an annual publication issued by the Statistics Technical Committee of the Ministry of Oil and Minerals. The majority of the publication is dedicated to the petroleum sector. Though relatively small, the minerals section provides useful data on activities in the sector year-on-year. The information published in the past two years^{15,16} and additional updates provided by the GSMRB have been used to provide a snapshot of current activities. Another useful publication, "Mineral Resources of Yemen", is published by the GSMRB.¹⁷

This section of the report is not meant to provide a comprehensive database: that may be found in the referenced publications. A summary of the activities undertaken by the GSMRB is followed by information on the operations of private sector companies active in the country.

5.1 GEOLOGICAL SURVEY AND MINERAL RESOURCES BOARD ACTIVITIES

The structure and activities of the GSMRB have been described by CMA Limited¹⁸ and they will not be repeated here. However, the organizational chart of the GSMRB is presented below as a useful reference.



Figure 5.1: GSMRB Organizational Chart

¹⁵ Republic of Yemen, Ministry of Oil and Minerals, Statistics Technical committee: Oil, Gas and Minerals Statistics 2006.

¹⁶ Republic of Yemen, Ministry of Oil and Minerals, Statistics Technical committee: Oil, Gas and Minerals Statistics 2007.

¹⁷ Republic of Yemen, Ministry of Oil and Minerals, Geological Survey and Mineral Resources Board; Mineral Resources in Yemen, 2007.

¹⁸ THE REPUBLIC OF YEMEN, IFC Private Enterprise Partnership Middle East and North Africa (IFC PEP-MENA) World Bank Group, MINING POLICY REFORM IN YEMEN, FINAL REPORT: Review of the Yemen Geological Survey and Mineral Resources Board, CMA Limited Tunbridge Wells, UK, July 2007 Activities that are directly relevant to the discovery of mineral occurrences are carried out by the General Department of Mineral Exploration and Industrial Rocks, which comprises the Mineral Exploration Department (responsible for metallic minerals) and the Industrial and Construction Materials Department (responsible for non-metallic minerals). The General Department identifies priorities and prepares a programme of work, which is submitted to the Ministry of Finance. The budget for the year is on the order of US\$20,000 and the programme tends to follow a strategy set by the Board. It is thus understood that its current field programme involves follow-up work on gold and base metals, and on dolomite, talc, cement raw materials and aggregates. The stated priority is on the building stone market and does not appear to be influenced by an overall understanding of the world market for mineral commodities.

The General Department's reports, which are somewhat academic in content, are sent to the Department of Evaluation and Promotion for release to investors or the wider public in the form of brochures or fact sheets. The Department of Evaluation (in the Promotion and Evaluation Department) is also responsible for any follow-up bulk sampling, analysis and test work on a mineral prospect.

With these limitations on its activities, it is not surprising that progress in further identifying important mineral occurrences is slow. The General Department of Mineral Exploration and Industrial Rocks was charged with the preparation of summary reports to be used in the Mining Investment Promotion Consultancy project being carried out by GEUS under a World Bank-executed trust fund.

These summary reports are of uneven quality, but have provided useful insights into the work being performed by the GSMRB and also into GSMRB's level of understanding of the information required by investors. Yemen benefited from GEUS assistance to attend the Prospectors and Developers Association of Canada (PDAC) Conference in March 2009.¹⁹

The Department of Promotion and Evaluation also prepares documents relating to ongoing activities in Yemen and has published a document entitled "The Project of Development of the Mining Industry in the Republic of Yemen" in 2008. This latter has the objective of encouraging the following:

- 1. Investment in the mineral resources discovered in Yemen and therefore accelerating development. The first stage emphasises developments in Al-Jawf, Ma'rib and Shabwa governorates, which form one connected geographical sector.
- 2. Creation of job opportunities to decrease unemployment and poverty.
- 3. Diversification of the sources of national income, widening of the production base, and decreasing dependence upon oil production as a main source of national income.
- 4. Activation of other economic sectors in the same geographic region through the followon benefits of the infrastructure necessary to the project.

The proposal to develop Yemen's mineral resources recognises the need for infrastructure to facilitate transport of commodities. One of its core pillars is the construction of a railway line from Sana'a, passing through Al-Jawf, Ma'rib and Shabwa and ending in Belhaf port on the coast of the Arabian Sea, to transport mineral resources from these regions to the international markets. This is proposal is discussed further in Section 5.2.

¹⁹ Annual Prospectors and Developers Association of Canada (PDAC) event, which takes place in Toronto. www.pdac.ca

The following sections provide a brief overview of the current activities of private sector companies engaged in the mineral industry in Yemen. The map in Figure 4.3 provides a summary of the license holders of November 2008, as provided by the Department of Promotion and Evaluation. There are currently 17 companies registered as having licences and it is worth noting that some companies that appeared on earlier lists have had their licences withdrawn because they had not carried out work in the licence areas.


Figure 5.2: Mineral deposit locations in Yemen



Figure 5.3: Mining Companies Holding Licenses in Yemen Source: GSMRB; Department of Promotion and Evaluation

Some details of the active mining companies are provided in Table 5.1.

Company	Licenses	Notes
Jabal Salab Company	Jabali zinc-lead-silver	Project is at development stage and should
(Yemen) Ltd.		enter production in 2009. (JV between
		ZincOx Resources plc and Ansan Wikfs)
Cantex Mine	Al Hariqah (Au)	Cantex carried out an extensive
Development	Suwar (Ni, Cu, Co)	geochemical program in the north of
Corporation	W. Qutabah (Ni, Cu, Co, PGE)	Yemen and has now spent some US\$ 17
	Al Masna'a (Ni, PGE)	million on exploration. Option Agreement
	Al Fayad (Au)	was signed with Vale in November 2008,
		on the Suwar, Wadi Qutabah nickel,
		copper, cobalt and PGE projects.
Thani Dubai Mining	Exploration of gold and associated minerals at the	Exploration and drilling.
	Wadi Maddan area in Hadramawt Governorate and	
A	wadi Sharis area in Hajjan Governorate	
Alisan wikis (Hadramaut) I td	i) A working interest in Japan Zinc mine project,	Exploration underway on the exploration
(Hadramawi) Lid.	(i) Exploration permits in three areas for gold,	permits.
	metals	
Yemen Iron Steel	Exploration license to carry out exploration for Iron	Manning sampling and drilling
Limited	Ore and associated minerals at the Al-Thanyvah	
	area (Marib Governorate).	
Mashrea Mining Co.	Exploration license in the area of Juban in Al	Exploration.
1 0	Dhali' Governorate for iron ore.	
Stone Resources	Exploration license for Cu-Ni and associated	Exploration
(Yemen) Limited	minerals: Al-Hamurah blocks in Ta'iz governorate	
Volrock Mining	Prospecting for gold and associated Minerals at	Prospecting
Limited	Ahim-Washah, and Wadi Hard-Jabal Balan areas,	
	Hajjah Governorate, and at Haydan-Saqayn area,	
	Sadah Governorate	D
CC Mining S.A.	Prospecting for gold in three license areas within Vener Veleznic Group	Prospecting
Minerals and Metal	Exploitation contract to exploit iron oxides in Al-	
Mining Shabbir Ltd.	Bayda: exploration license to carry out exploration	
	for iron ore in the adjacent areas of Al-Bayda	
Triton Resources	Exploration license to carry out exploration for	
	metallic minerals at Jabal Al-Sa'di area of Sana'a	
	governorate	
3S Mineral Limited	Exploitation of Limestone at Yathmoon and Al-	
	Ma'abir areas in Hadramawt Governorate	
Naine Minerals	Exploration for industrial minerals	
Kesources	Device of the stars is the second R. D. 11	
Arabian Limestone	Exploration of limestone in the area of Ras Darajan	
(I hoist Group)	Directorate of Qishn in Al-Manran Governorate.	
Areb Mining	Exploration for Magnesite and dolomite minerals at	· · · · · · · · · · · · · · · · · · ·
	the Al-Thanyah area of Marib Governorate	
Nagariuna	Exploration for Magnesite and dolomite minerals in	
Corporation Ltd.	Marib	

Table 5.1 Companies Active in Yemen

5.2 METALLIC MINERALS

A number of companies have licenses to explore or develop metallic mineral deposits in Yemen. Table 4.1 above provides a summary of these and where applicable, the work carried out to date.

The major project of interest is the development of the Jabali zinc project by Jabal Salab Company (Yemen) Ltd., a joint venture between ZincOx Resources plc and Ansan Wikfs (Hadramawt) Limited. This is moving towards development with a projected start of mining in 2009. The history and activities related to this project are described in Section 5.2.1. This is of importance since the best promotion for a sector is a successful project and this one required the raising of some US\$ 200 million in financing.

In addition, Cantex Mine Development Corporation (Cantex) has been drilling at its Suwar Nickel-Copper-Cobalt massive sulphide deposit northwest of Sana'a, and it is understood that the results are likely to be very positive. On November 20, 2008, Cantex announced that Vale International SA ("Vale"), a wholly owned subsidiary of Companhia Vale do Rio Doce (NYSE: RIO, Vale), has signed a letter agreement to earn in to this project.²⁰ This is further good news for Yemen, as Vale is the world's largest producer of iron ore and iron ore pellets, the world's second-largest producer of nickel and one of the world's largest producers of manganese ore and ferroalloys.

Other active companies are the Yemeni firms Ansan Wikfs and Yemen Iron Steel. Ansan Wikfs is a multi-disciplinary investor, which also has exploration licences in Sudan. The company is actively exploring on its licences and has acquired the services of a senior geologist from Ethiopia to increase their know-how. Yemen Iron and Steel is a company owned by a prominent Yemeni national from the area in which their licence is located. Al Thani Company of Dubai is also an active participant in the country's mining sector and has retained the services of an internationally known geologist, further indicating a growing interest in the metal minerals industry.

5.2.1 The Jabali Zinc Deposit²¹

The Jabali zinc deposit is located 110 km northeast of Sana'a. It contains a geological resource, calculated in accordance with the JORC code, of 12.6 million tonnes of oxide ore, grading 8.9 percent zinc, 1.2 percent lead and 68g/t silver.

The mineral rights to the deposit are currently held through a mining licence owned by a joint venture, Jabal Salab Company (Yemen) Ltd., comprising ZincOx (52 percent), and Ansan Wikfs (Investments) Ltd. (48 percent). The contract granting the mineral rights was issued by the Parliament of Yemen and ratified by the President in August 2007.



²⁰ Cantex announces Option Agreement with Vale: <u>http://www.cantex.ca/2008-11-20.pdf</u>, 20 November 2008.

²¹ See the ZincOx Resources plc website: <u>www.ZincOx.com</u>.

SUMMARY OF THE HISTORY OF THE JABALI PROJECT

Artisanal workings at Jabali date back about 2500 years. These workings exploited the relatively soft oxidised ore which was locally silver-rich. Mining was performed by both underground and open cast methods. It has been estimated that 30 galleries extending between 10 and 150m are present underground. A large number of open pits, some up to 25m deep are found within in the area. 300,000 - 400,000t of ore is believed to have been mined historically, totalling 7,000-10,000t of contained Pb and 30-50t of contained Ag.

The deposit was rediscovered during a joint exploration project between Bureau de Recherches Géologique et Minières (BRGM) and the Yemen Geological Survey and Mineral Resources Board (YGSMRB) in 1980. During 1981 - 1986 they performed geological mapping, rock geochemistry, geophysics and drilled 57 holes totalling 7,974m. Two resources were estimated - one for open cut extraction being 3.0Mt at 15.2 percent Zn and the other of 1.24Mt at 13 percent Zn quoted for underground extraction. Both were calculated using a 7 percent Zn cut-off.

In November 1990 Watts, Griffis and McOuat of Canada carried out a World Bank funded evaluation of the deposit, drilling a further 12 holes totalling 1050m to assess the mineralogical continuity. In addition to the drilling, 16 trenches were excavated and further mapping was conducted. Following exploration a pre-feasibility report was completed in 1993. This report stated a "geological reserve" of 3.6Mt at 16.37 percent Zn at an 8 percent cut-off. In 1996 Minorco, now Anglo American (Anglo) and Ansan Wikfs (Hadramawt) Ltd (Ansan) entered into a joint venture agreement. They were primarily interested in any potential sulphide material below the identified oxide mineralisation in the area. The drill program was abandoned quickly as mineralisation was seen to terminate within the oxide zone.

ZincOx Resources Plc (ZincOx) entered into a joint venture agreement with Anglo and Ansan in 1998, with ZincOx providing expertise at extracting and processing more metallurgically complex oxide ores. ZincOx became the manager and operator of development for the deposit. In 1999 a new pre-feasibility study was completed. ZincOx under took further drilling in 2000 and 2002, and 49 holes were drilled to improve confidence in the mineral resource. This work, along with data from the earlier work, formed the basis for the Feasibility Study completed in 2005 for ZincOx by MDM. In March 2005, ZincOx announced the results of this feasibility study for the development of the Jabali deposit at the rate of 800,000 tonnes per annum of ore, with a grade of 9.2 percent zinc, over a mine life of 12 years. The potential to increase the mine life by exploration success is considered good, as the deposit is open on two sides. A small amount of lead is recovered and sold but generally the lead is not of an economic grade. The silver, however, passes to the tailings and a separate study in due course may look at recovery of the silver.

An update to the Feasibility was completed in early 2007 and new design, engineering and cost estimates completed by SNC Lavalin Europe, MDM Engineering and ZincOx. An audit of the updated study was carried out by Saint Barbara Consulting Services in London, on behalf of Exotix Limited, an investment banking boutique specialising in emerging markets, which was mandated by the project company to assist in the provision of finance for the project. The updated study concluded that the total funding requirement to finance the capital cost of plant and equipment, including contingencies and all financing costs needed to construct the mine and associated facilities, and working capital sufficient to finance operations until such time as positive cash flow is forecast to be generated in the last quarter of 2009, was estimated to be \$186 million. Financing of the project was announced in January 2008, and construction of the mine and plant has commenced in the first quarter of 2008, with first production due in the last quarter of 2009. The financing includes a loan of \$120 million to ZincOx's 52 percent owned subsidiary Company, Jabal Salab. The Facility was arranged by Exotix Limited.

Mining will be from an open pit, with a 2:1 ratio of waste to ore. The ore will be treated by means of a proprietary hydrometallurgical process, test work on which has indicated a 77 percent zinc recovery. The process flow sheet was designed by ZincOx and tested in a pilot plant operated by CTP, an independent Belgian metallurgical laboratory. The plant is designed to produce approximately 70,000 tonnes per year of high quality zinc oxide, containing 80 percent zinc. Marketing studies and test work carried out by ZincOx indicate that the final product should be of a quality suitable for direct marketing to zinc oxide consumers in Europe, the Far East and America. This material will command a higher price for the contained zinc than that offered by zinc smelters, which typically only pay about 55 percent-65 percent of the value of the metal contained. Scott Wilson Mining carried out an Environmental Impact Assessment (EIA) as part of the feasibility study, in accordance with World Bank guidelines and input from the Yemen Environmental Protection Authority (EPA). The study states that overall the project is considered to provide a net beneficial impact. The effect of the project with respect to employment and infrastructure development will have a long term positive impact beyond the life of the project and the area of the mine.

5.3 INDUSTRIAL MINERALS

Table 5.1 shows that a few companies are looking at the potential of the country's industrial minerals. These include 3S Mineral Limited, Naine Minerals Resources, and Nagarjuna Corporation Limited and Trimex.

It was noted in Section 4.2 that there is a wide range of minerals that could be exploited for industrial uses and examples were provided in that section. In many cases these could be open to Yemeni SMEs. Since industrial minerals usually have a relatively small margin, they tend to be most useful to local or regional enterprises and so understanding of the markets is of great importance.

The GSMRB has assembled significant information on these minerals, but further marketing studies are needed in order to evaluate the commercial viability of the minerals. The work being carried out by the private sector companies could provide these studies for the licenses concerned. However, some assistance will be required to encourage local enterprises in other areas.

5.4 NATURAL STONES

The NS sector in Yemen is one of the most important mining sub-sectors, with significant potential as regards mining resources, market and manual labour availability.

However, although it is a traditional sector known for several centuries, NS (mainly quarrying and processing) is neither well-developed nor well-organised and the marketing organisation and structure is poor.

Sub-sector Structure and Current Production-Supply Chain

The production supply chain follows ancient rules and is simply structured. It consists of quarry production using artisanal methods; the sale of irregular blocks to truck owners; transport of blocks to main towns in particular "market" areas, or directly to main processing companies; sale by truck owners to small factories/workshops or to the main processing companies; simple processing in small workshops to produce building stones or other simple stone products for the construction industry; or more mechanised processing by the main stone companies, as described in the following paragraphs. No modern business-oriented marketing structures exist in the sector.

Three main production-market "areas" can be identified in the NS sector in Yemen:

a) Dimension Stones

<u>Quarry Producers</u>: a *few large quarry owners* (e.g. Al-Thanyah for Marble & Granite, Ayan Marble Co., Yemen Stones) and *many small artisanal companies and groups of individuals*, both operating in a simple, un-mechanised manner.

Large Processing and Trading Companies: (e.g. Al Rahiby for Granite and Marble Co., Al-Rawhani Marble & Granite Factory, Nagi Engineering Establishment, in Sana'a and Faisal Co., in Aden) mainly operating in the local market with relatively few spot exports of finished products. Some companies (e.g. Al-Rawhani), import DS blocks and slabs from overseas, to be processed and sold in the domestic market. These large companies, of which there are not more than five or six in the country, usually run relatively large processing equipment (mainly Italian), both modern and old, and provide the complete line of production: large blocks (direct contacts with quarry producers), slabs, tiles, and also building stones.



<u>Small Processing (cutting) companies and individuals</u>: Hundreds of small workshops, generally equipped only with a small circular saw (diamond disk), operate in Sana'a and in all other larger towns. They cut the small irregular stone blocks purchased in the open market areas into small building blocks that are generally cut only on the visible sides (two or three). These building blocks are sold directly in the town market to private and construction companies.



b) Building Stones

This particular segment of the NS sector in Yemen is certainly the oldest, the most traditional and the largest as regards material, quarries, workshops and workers involved. It is probably the least developed in terms of mechanization, organization and skill.

It comprises small artisanal quarry producers, often located in remote desert areas, which extract small stone blocks by using very simple methods (mainly explosives). Irregular blocks are transported to town by truck and sold "in the market" to the small "one diamond disk" workshops mentioned above, to produce tuff-ignimbrite, basalt and limestone building blocks.



c) Aggregates

Some large aggregate plants exist in Yemen, often located close to main towns producing stone aggregate, mainly from basalt and ignimbrite. Current methods of production generate a great deal of waste in the form of crushed stones (such as from the artisanal basalt quarries in Subahah area and in many other areas of central Yemen). A betterstructured and organised BS sub-sector will be needed to address this problem.

5.4.1 Quarrying of NS in Yemen

BS and most of the DS deposits in Yemen are run and managed in an artisanal manner, with underdeveloped mining methods and equipment. Most exploitation is accomplished through drilling and splitting by explosives, and in many cases exclusively by using explosives in the joints with no drilling at all.

Whereas this simple method does not adversely affect the exploitation of small blocks for BS, it does adversely affect the quarrying of large DS blocks by causing cracking in the rock mass and not allowing extraction of large regular blocks. This happens mainly in limestone and travertine quarries and in some granite ones. Some of the granite quarries produce relatively regular blocks using the drilling and splitting (by plugs and feathers) method, with very low or no use of explosives.

Quarry structure and management skills are very limited; building this capacity would require a long-term training program.

The present situation in the Yemeni DS quarries does not enable consistent and high quality production and is estimated to cause a loss of approximately 60 to 80 percent of exploitable and marketable (medium-large size blocks) rock by volume. Average block sizes of limestones and travertines probably range between 1 to 3 m³, and most of them are irregular in shape. Average granite block size is slightly larger, reaching up to 4-5 m³ in some quarries.

The conditions described above can easily be observed by visiting the block deposits of the leading DS companies in Yemen.

5.4.2 Processing of NS in Yemen

As mentioned above, processing of NS in Yemen is at a very low level of sophistication, due to a lack of skills and of high standards in the domestic market.

BS are mainly produced by very small "one diamond disk" units/workshops that cut small blocks from limestone, tuff and ignimbrite and basalt artisanal quarries. Some large processing companies have their own simple BS production lines.

DS are mainly processed in large and medium size companies (not more than 12 in the country). They process large and medium size limestone, travertine and granite blocks using relatively modern equipment, which is often poorly maintained.

In general, processing plants in Yemen need major restructuring and reorganisation as regards equipment layout, management and operating skills.

5.4.3 Market and Marketing of NS in Yemen

In Yemen, most of the NS operators operate in the domestic market and the very few spot exports (not more than 1-2 percent of total production) are mainly to the result of one-to-one friendly marketing agreements, concluded in Saudi Arabia, Jordan and Gulf countries.

Most finished products are sold in the domestic market directly to private owners and to construction companies, as tiles, cut-to-size products and building stones. Three large companies did have significant business in the last three years, supplying the large Mosque Project in Sana'a. Selling transactions are generally made one-to-one between producer and client, without any intermediary.

To date, only two or three companies in Yemen have some knowledge of the export market and contacts with international suppliers and customers (mainly in Italy and India). The same companies also have professional showrooms and shops in town.

5.5 PRECIOUS STONES

The market for gemstones is traditionally very strong in Yemen. Most of the precious stones sold in Yemen are imported and the ones that are thought to be locally produced are cut and polished to meet international standards.

Locally produced gemstones of good quality would likely have enough local demand to justify small- to medium-sized production. Identification of gem potential would be required in the form of detailed mapping followed by sampling. Furthermore, for Yemen to fully benefit from exploitation of the gemstone sector, it will be important to set up cutting and polishing facilities and training programs.

6. INFRASTRUCTURE

6.1 **POWER**

Mining operations require access to reliable supplies of power at varying levels throughout the mining cycle and will use these criteria when deciding whether to invest in a country. Many mining firms, however, will build their own power supply for the mine to ensure reliability. Downstream value-added plants, such as smelters, not only have a high demand for electricity, but also need to be assured that there is continuity of supply. A smelter cannot be allowed to go through cycles of heating and cooling depending on electricity availability. An open-pit mining operation which produces concentrate for export might be competitive even if it has to install its own generators, but the viability of extensive underground mines (which require access by shafts and continuous ventilation) and smelters or refineries will depend on the cost of energy, which is often a substantial proportion of the operating costs.

Budgeting for power generation is quite normal among mining investors, especially for those operating in remote locations. A number of examples from Africa are pertinent. For example, the remote mines in Mali (e.g Sadiola, Morila) have installed dedicated generators to supply their needs. The Selebi Phikwe copper-nickel mine in Botswana is supplied by the national grid and, as it has a large smelter to operate, the continuity of power is of great importance.

Potential investors in Yemen's mining sector are sure to assess the country's power sector. Yemen has the lowest access to electricity in the Middle East region, with little over 40 percent of the total having access, compared to a regional average of about 90 percent.

During 2009, Yemen's interconnected installed generation capacity was 910MW of which 732 MW was available. In addition, rental capacity available to the interconnected system was 210 MW. Total installed isolated capacity was 357 MW of which 242 MW was available. In addition, rental capacity available to the isolated system was 63 MW. Total available capacity in Yemen was, therefore, 1,247 MW.

The Government has embarked on a number of reforms in the power sector, aiming to increase the available capacity and to bridge the gap with the ever-rising demand. Further expansion and diversification is expected to take place in the domestic gas market, namely in the electricity sector by substituting heavy fuel oil (HFO) and diesel to natural gas. Eventually, this would reduce the need for diesel imports, and lower the cost of power generation, also reducing the need for government subsidies to existing and new electricity consumers. The GOY has allocated 5.2 tcf of natural gas to meet the demand of the power sector over the next 25 years.

A number of the existing power plants, such as Mocha, Hiswa and Al-Hodeidah that produce most of the power generation in the country, are old and in need of rehabilitation. The state-owned Public Electricity Corporation (PEC) owns and manages generation plants that are in need of an overhaul. During FY05-07, PEC's losses increased significantly from YR4.5 billion (US\$22.5 million) to YR17.6 billion (US\$88.5 million) and hence it is not in a position to finance these major overhauls through its internal resources. PEC has therefore undertaken a number of

corrective measures, such as reducing losses, increasing electricity tariffs for certain consumer categories etc.²²

The short-term priorities for the country's power sector are: increase in generation capacity through the installation of small diesel plants, major overhaul of several power stations; and continued reduction of transmission and distribution losses. In the medium-term, the government will be generating additional power using natural gas - a 739 MW gas-fired generation is expected to be commissioned in two phases. The first phase, with installed capacity of 339MW, will be ready by 2010 and the second phase, with installed capacity of 400MW, is expected at a later point in time.²³

In summary, despite the reforms and concerted efforts to improve the availability of electricity, at present the electricity generating capacity and grid are inadequate and most large-scale mining investors will have to budget for independent generators. This will increase costs and limit the possibilities of downstream value added, which in the mineral industry usually requires substantial power inputs.

6.2 TRANSPORT

Yemen currently claims some 71,300 km of roads, of which only 6,200 km are paved. A highway is planned between Sana'a and Aden, but its state of planning needs to be confirmed.

Figure 6.1 is a map provided by the GSMRB which shows the road network, including roads under construction and under study.



* Figure 6.1: Map Showing Actual and Proposed Road Network

One of the major routes, the road Safir / Marib to Saiyoun, via Hisn Al Abr and Al Qatn is recent and it continues all the way to Oman by way of Thamoud. There is also a tarred road running all the way up the south coast from Aden to the Oman border and other tarred roads that link the two.

Yemen's cities and main population centers are linked by sealed, twin-lane highways that trace the topography. There are no bridge constructions or tunnels to straighten the traffic arteries. Goods-carrying trucks travel at average speeds of 30-50km/h (less in mountain regions). Lorries in Yemen have an average load capacity of 15-20tons, with no trailer and a single driver. 40ft containers are transported on articulated lorries; 20ft containers are usually transported by dump truck as a load. Mobile cranes are available everywhere. Containers tend to be loaded and unloaded on site.

Freight rates are heavily dependent on day-to-day business, and thus on prevailing levels of demand; rates also vary according to the direction of travel and the volume of cargo. For example, the Aden to Sana'a route has a different price to the same route in reverse. In 2005, Yemeni firms reported minimum rates of between \$400 and \$600, depending on the route. Trips from the port towns of Aden and Hodaidah to Sana'a are expensive. Despite the long distance, the Sana'a-Marib-Saiyoun route is relatively inexpensive. A shipment of stone by 20-ton dump truck from a mine in Marib province to Sana'a costs around US\$150. External enquiries often attract higher freight costs.

There is no countrywide alternative to lorry transport at present. It is notable that the majority of licenses taken out by mining companies (Figure. 5.2) are relatively close to roads. The Jabali project is close to a major sealed road that will enable its production to travel to the Red Sea ports. However, should Yemen Iron Steel find a commercial deposit at its license east of Marib, or should the Cu - Ni deposit at Suwar being exploited by Cantex, transport will be a major concern. Similarly, the cost of transport from any potential stone quarries located away from a main road might well penalize the project and prevent its development.

The organizational potential for resolving transport problems is evident throughout Yemen. The fishing industry, for example, manages to distribute fresh fish across the country daily.

During the GSMRB's workshop, held in Sana'a on November 9, 2008, many quarry owners complained about the poor access to their properties and the subsequent costs of transporting their materials to market. Other industries have similar concerns about access, and the Social Fund for Development (SFD)²⁴ is supporting the construction of feeder roads to rural and poor urban areas in order to encourage economic growth. Nonetheless, the mountainous terrain encountered in particular in the west of Yemen will continue to pose difficulties and even if good quality roads are provided, the costs of transport will be high due to the gradients that the traffic will encounter.

Also, fuel is heavily subsidized compared to world prices. It is unclear whether this will continue to be possible in the future.

Box 6.1 provides a useful illustration of what can be achieved in cooperation with the local population. Lessons can be drawn from this experience when considering projects to ameliorate access for small- to medium-sized mining projects.

²⁴ Social Fund for Development, Annual Report 2007 and <u>www.sfd-yemen.org</u>

Figure 6.2 illustrates what can be done by mobilizing local communities and using labor intensive methods to improve road surfaces. Incidentally, it also illustrates a good use of local stone for paving the road. This application of paving stones could also be extensively used for town roads and could represent a "key" stone product to optimize the problem of waste in dimension stone and building stones quarries.

Figure 6.2 Rural Road, Aljabeen, Raymah Source: Social Fund for Development, Annual Report 2007



Box 6.1: Bani-Araf rural road—a pathway to relief and livelihood

In the past, residents of Bani-Araf Mountain (Bani-Araf sub-district, Sa'afan district, Sana'a governorate) faced considerable hardship due to the rugged and harsh road leading to and from the area. Many parts of the road were extremely steep and narrow, with rocky protrusions.

Community members bitterly recalled this difficult situation. They said that they would exit their cars until they passed the most "terrifying" parts of the road, and only then would they get back in. Moreover, car drivers often refused to use the road, particularly during rainy seasons. These conditions made life difficult for many villagers, especially if someone had to be rushed to the nearby health clinic.

A villager also noted that, "If we wanted to leave the village to fetch something nearby during the day, we could not return to our homes that same day. Instead, we were forced to spend the night outside the village and return the next day. It was almost impossible to find a vehicle whose driver or owner would agree to take you home in the same day. And if you could find one, then either the driver would not risk mounting the road or the cost would be exorbitant." Others recalled how they often had to resort to primitive means of transport, such as donkeys.

In 2005 an SFD team visited the area and verified the community's road needs. The SFD decided to rebuild parts of the road, expand and improve/ rehabilitate other parts, and rehabilitate and protect the rest. Benefiting about 9,000 people, works extended over the 6.5 kilometer road and cost nearly US\$64,000.

After the project was completed, villagers expressed their satisfaction with its outcome. Abdurahman Mas'oud and Muhammad Al-Qaderi, both car drivers, summarized the difference the area witnessed after the SFD intervention. "The road became safer, and the number of vehicles entering and leaving the village rose from two to eight per day." Muhammad Saleh, a farmer, added that he could now transport up to 200 kilograms in one trip, with the cost not exceeding 2,000 Yemeni rials (previously 50 kilograms or less at a cost of up to 8,000 rials). Other villagers indicated that transport fees per passenger had fallen from 500 to 150 rials. Moreover, they pointed out, ascending or descending the road now takes half an hour, compared with one to two hours before. "As a result, we can leave our village and return in the same day without the need to stay overnight away from our wives and children," said some of them.

Benefits from the project go beyond the far easier transportation and transfer of people and their goods and the relatively lower cost of basic commodities. Some villagers—who oversaw collections of community contributions during implementation of the project—gained knowledge and experience in contracting and executing community development projects. Consequently, they found opportunities for new livelihoods for them and their families. As a result, they have participated in the contracting and implementation of other projects in the area and beyond.

For instance, some participated in the rainwater harvesting project in Bani-Araf, implemented through community contracting, by participating in partial biddings on the project. Others worked with the contractor during implementation of the A'al-Taliyan rural access road (Mareb governorate). Many are sharing in biddings and implementation of community contracting projects such as the Bait-Al-Zawahi rural road (Sa'afan, Sana'a), Gabal-Ikbari rural road and Bani-Khatab and Masra rainwater harvesting cistern (both in Manakha, Sana'a). Such ambitious, hard-working villagers, now successful contractors, include Abdulrahman Ali Mas'oud, Muhammad Muhammad Hasan Al-Qaderi and Faisal Abdullah Ali Mas'oud. In addition, more than 30 skilled mason builders and laborers emerged from the Bani-Araf road project, and are currently working on various SFD-supported projects. Among them are Abdulghani Mas'oud, Ali Qa'yed Hamoud and Ahmad Ghaleb Majalli.

Source: Social Fund for Development, Annual Report 2007

The Government of Yemen is interested in seeking ways to link infrastructure development with the diversification of economic activities, including mineral resources development. One possibility that has been proposed by the GSMRB is to build a rail link to the eastern part of the western highlands, running south to north from the Gulf of Aden. This route would traverse an area that already has some active quarry operations and a number of mineral prospects, as well as potential for some other types of industrial activity. It is understood that discussions might have already taken place at government level to obtain support from China.

The viability of such a rail link would need to satisfy a number of important economic tests. In modern times, rail transport of minerals has worked successfully in the few cases in which there is a constant flow of bulk mineral deliveries from an anchor supplier to an export facility at a port, typically over twenty or more years. Examples of such successful uses of rail transport include shipment of iron ore in Mauritania, phosphates in Morocco and iron ore in Western Australia. The economic threshold at which rail-based transport solutions become viable increases as a function of logistical complexity (e.g. several geographically dispersed suppliers each requiring spur rail lines and facilities for consolidation on the main line) and unstable/short-lived supplies. It would be important to conduct some pre-feasibility evaluations to determine roughly what economic thresholds would apply in the Yemeni case and find out how these might compare with truck-haulage based alternatives.

A railway is also planned to connect Saudi Arabia in the northwest and Oman in the east. The proposed route is along the coast. These projects are for the medium to long term and, unless they are confirmed and a firm programme of development published, investors will probably discount them.

There are airports in Aden, Ataq, Elgaydah, Hodeidah, Sana'a, Saiyoun, Riyan, Socotra and Taiz. International flights operate from Sana'a and are fairly frequent, in particular to Dubai. Plans have been drawn up to expand and modernise the airports at Sana'a, Saiyoun and Aden in the near future; these airports will then be able to handle international connections, partly via existing links in neighbouring countries.

6.3 PORTS

The main international seaports are Al Hodaydah on the Red Sea and Aden at the southwestern end of the Gulf coast. The other ports (including Salif, Ras Isa, Mokha, Mukalla, Moalla and Ash Shihr) basically serve local needs.

Aden can be considered the country's most important port. A large-scale expansion is under way, which will incorporate large areas of the region into a free zone. Given the current political and economic conditions, this region could become the main focus for business activity in Yemen.

Rates for sea freight vary and depend on the supplier. In 2005, prices from Al Hodaydah for a 20ft container of around 10-15 tons stood in the region of US\$900 to Italy and US\$1200 to Hamburg.

6.4 **COMMUNICATIONS**

The Ministry of Telecommunications and Information Technology (MTIT) regulates the country's telecommunications market and collects the operators' license fees. The Government of Yemen also fully owns and directly oversees the operations of the monopoly fixed line operator, Public Telecommunications Corporation (PTC), and owns a controlling stake in the CDMA cellular operator, Yemen Mobile, through the PTC.

The fixed lines are predominantly available in urban areas, although the PTC intends to provide improved fixed line services in the rural areas of Yemen. A recent report from the Arab Advisors Group²⁵ projects Yemen's mainlines to reach 1.432 million lines by end of 2012 with a penetration rate of 5.76 percent. This corresponds to an annual growth rate of 7.1 percent between 2008 and 2012.

There are now four cellular operators in Yemen, of which all but Yemen Mobile are GSM:

- Yemen Mobile,
- Sabafon,
- MTN Yemen, and
- HitsUnitel.

The Arab Advisors Group's report projects Yemen's cellular coverage to grow substantially at an annualized rate of 15.7 percent from 2008 to 2012, reaching 10.537 million subscribers (a cellular penetration rate of 42.4 percent) up from 4.437 million by end of 2007.

Other details related to communications are²⁶:

- Telephones
 - Domestic: the national network consists of microwave radio relay, cable, tropospheric scatter, and GSM cellular mobile telephone systems
 - International: country code 967; satellite earth stations 3 Intelsat (2 Indian Ocean and 1 Atlantic Ocean), 1 Intersputnik (Atlantic Ocean region), and 2 Arabsat; microwave radio relay to Saudi Arabia and Djibouti
- Radio broadcast stations: AM 6, FM 1, shortwave 2 (1998)
- Television broadcast stations: 7 (plus several repeaters) (1997)
- Internet country code: .ye
- Internet hosts:5 (2007)
- Internet users: 270,000 (2006)

The GSM networks cover most of the inhabited areas—some 80 percent of the country. Even out in the middle of the Ramlat al Sabata'yn, a signal is usually available from the top of a sand dune. In the central mountains, coverage is patchy. However, the networks are there; the local people know where they are and walk uphill or over to a particular spot to connect.

Mining investors can thus be reassured that contact is usually available across most of the country, and other options, such as satellite communications, need only be budgeted for as backup.

6.5 WATER SUPPLY

Yemen has no permanent surface water. Water is in short supply, with most water extracted from deep wells. In areas used for agriculture, seasonal rainwater is preserved by means of small (possibly temporary) retaining walls; these enable it to be used for irrigation purposes over longer periods. The quantities of water currently being extracted are rapidly depleting the supply of ground water, with utilization at approximately 135 percent of resources. Agriculture accounts for

²⁵ Yemen Communications Projections Report, Arab Advisors Group Strategic Research Service, July 2008 (see <u>http://www.arabadvisors.com</u>) (this report was not analysed in detail by the Consultants).

²⁶ CIA World Factbook

90 percent of the available water used. In areas with the highest population density, centralized state supplies of water are erratic.

Water is normally supplied from tanks filled on a regular basis by water transporter vehicles, most of which are privately operated. In comparison with Europe, the cost of water is disproportionately high. With just 30 percent of the population having regular access to drinking water, international development and technical cooperation agencies have launched a number of ambitious projects designed to alleviate the water crisis.

Within the Yemeni natural stone industry, all large companies visited had implemented reasonably effective water recycling systems.

7. SOCIAL ASPECTS

Due to the history of the Republic of Yemen and the nature of the local social networks, it will be important for any investor in the country to take into full consideration the environmental and social impacts of working in the country. This chapter delves into a number of social issues that affect mining sector development in Yemen. Because large-scale mining is nascent, in a number of instances this section draws on information from the oil sector to give examples of what may happen in the mining sector, once it develops further.

7.1 THE SOCIAL CONTEXT

The significance of Yemen's tribal populations for the future development of the country's mineral industry should not be underestimated. While mining and oil and gas companies are focused on what lies underground, the people they operate around make their living from the land, which itself defines their history, their livelihoods and their future. 70-75 percent of Yemenis live in rural areas and derive their primary living from farming. For this majority, therefore, land ownership is of major significance. 90 percent of Yemen's land is owned by tribal individuals. For the tribe or extended family, the function of the land is to maintain tribal cohesion and order. The tribal name is synonymous with the place—the land over which they predominate.

The part of the Yemeni population organized along tribal lines currently makes up three dominant tribes: the Bakiel, the Hasched and the Mathhadj. Tribes are hierarchical, headed by a chieftain. Given that the sphere of influence of these tribes mostly extends to areas outside of the cities and population centers, it is reasonable to assume that tribal law must be taken into account across broad swathes of rural Yemen.

Despite a generally stable social environment, Yemen is changing fast. The key elements of change, listed below, could have a considerable impact on the country's complex social fabric.

- Yemen's government derives 85-90 percent of its income from the oil and gas sector, while oil production is declining by between 14-18 percent a year.
- Inflation runs between 8 to 18 percent and is affected largely by fluctuations in imported food prices.
- Three-quarters of Yemen's population lives in rural areas, and about half of these rural residents are poor—living on less than US\$1.50 per day per person.
- Despite one of the world's highest infant mortality rates, Yemen's population continues to rise by about 3-3.6 percent annually.

Changes in the management of finite land assets are determined by subsidized diesel, which has afforded a shift from extensive rainfed farming to intensive irrigated farming. Yemen now runs a water deficit of between 700 and 900 million cubic meters of water per year, with a consequent drop in groundwater levels and water quality.

Around 80-85 percent of water usage is for agricultural irrigation and of this amount, around 40 percent is used on Qat *Catha edulis*, a plant whose leaves are chewed as a stimulant with mild narcotic properties. Qat production is profitable for growers but presents a significant loss to the economy. Irrigation itself is very inefficient: most studies show that improved irrigation scheduling and monitoring alone could reduce irrigation water consumption by around 40 percent. Inefficient irrigation results from very low prices for diesel fuel. This situation equates

to the wastage of a 'free' resource, while the benefits of the diesel subsidy are captured by those who use the most. The subsidy thus exacerbates income disparities.

The consolidation of production around irrigable land also leads to significant increases in income disparities between communities, a process that is ongoing and unchecked and has considerable impacts on the traditional social fabric. Table 7.1 gives an indication of the significant changes in land use:²⁷

	,000 Ha	,000 Ha	,000 Ha	,000 Ha	
Year	Rainfed	Well	Spring	Spate	Total
1975	1,285	37	73	120	1,515
1990	685	310	25	101	1,121
1995	579	369	20	100	1,068
2000	515	457	46	126	1,144
2005	609	393	34	137	1,173

 Table 7.1: Changing Land Use in Yemen

Coupled with population growth, the fragmentation of land under Islamic inheritance laws has led most young men in rural communities to have difficulties finding the means to get married. Land stress is by far the most common source of disputes, which usually occur within an extended family.

7.2 TRADITIONAL GOVERNANCE AND COMMUNITIES

By design, the extension of government into the countryside is the same throughout Yemen; in practice, however, government powers are exercised very differently in different parts of the country. The majority of remote rural communities are governed by their sheikhs or *aqils*. In the plateau areas of Hadramawt and Shabwa, in particular, the divisions between tribes are more readily recognised than lines drawn by government. Traditional leaders govern their communities by consent, but in accordance with their interpretation of the *Quran*, the Islamic *Sharia* law, and their traditional or tribal laws known as '*Erf*'. These laws or customs, which often include significant rules regarding environmental and land use, tend to regulate rural life to a much greater extent than central government legislation.

Under the formal set of ethical values known as '*Qabylie*', strong tribal laws are maintained that both pre-date and challenge the laws of Islam. For tribal people, land is inherited, and although the *Quran* is clear that daughters shall inherit land if they are married to men from another tribe, in many cases women are given cash and/or prevented from inheriting land in order to maintain the land's original tribal ownership and the homogeneity of land ownership in the area. In addition, there is a *Qabylie* law, the *Juwara* law, which prevents tribal people from selling land to other tribes. This law is more flexible than it once was, since the size of landholdings per farmer has decreased as the population has doubled in the last two decades and real incomes and opportunities have fallen dramatically.

Landholdings are composed around inheritance, and inherited assets denote the class of the owner. Yemen has complex but changing class structure. The broadest division is between tribal and non-tribal. To a limited extent, these class divisions are breaking down. The divisions over labor are different today than they were ten years ago, when tribal men from landowning families

²⁷ Al Ulaqi, N A [2008] Issues of Decentralised Water Demand Management in Yemen, In Proceedings of Workshop on the Political Economy of Water Demand Management in the MENA Region July 2008, Water and Environment Centre, University of Sana'a.

would not work the land or engage in manual labor. More recently, the labor market has forced men to take most of the work that is available, though tribal men still will not work in kitchens, toilets or laundries.

The major socio-economic division throughout much of rural Yemen is between those families that receive remittances from family members living and working in the Gulf Countries and Saudi Arabia, and those families that do not have this support. The neighbouring states themselves make a strong distinction between tribal and non-tribal people. As a result, there are very few, if any, *Abid* families from Yemen with members working overseas. The importance of land cannot therefore be underestimated. As mining companies are granted exploration or exploitation licenses by the central government, they need to be aware of potential complications that may happen "on the ground".

7.3 THE IMPORTANCE OF DIRECTLY ADDRESSING COMMUNITIES

Companies strive to achieve the lowest possible operating costs. The fiduciary duties of the Board of any publicly-quoted company include returning a profit to shareholders on a fully competitive basis. If the company's shareholders decide that the Board failed to do this, they may have grounds for legal action against the Board. On the other side, any mine-affected community in Yemen will seek the highest possible level of compensation, priority access to jobs and contracts, and whatever other benefits can be gained from the company's operation in that area. Furthermore, once established, a mine cannot be moved to another location easily. Developing a positive working relationship with the surrounding community is therefore crucial.

The preferences of the two entities are neither parallel nor reconcilable without mediation by a strong third party. In a developed political economy, that third party is government; however, for a multitude of reasons, in Yemen government agencies cannot play this role in a way that provides adequate security for the private sector investor.

The quality of the government's relationship with local communities is also critical. The District Chairman is predominantly appointed by the Provincial Governor, himself appointed by the President. In most cases, the District Chairman will represent the tribal majority, and is frequently someone of some independent wealth. Selection is not merit-based, however, and accountability to constituents is not complete. Under and around the formal government structures, tribal systems and structures provide both support and opposition to government.

The lack of uniformly credible, accountable and effective local government across much of Yemen indicates that private companies need to work with two sets of entities—community structures *and* government structures—and navigate any tensions that may lie between the many stakeholders in each group. The onus thus falls on private sector investors to take on two roles: that of investor, and that of support agent to both government and the stakeholder communities in developing robust civil society structures that function to mutual benefit.

The rural communities are typically very poor, highly underemployed, and well armed. Given the entrance of a company into their territory, their primary concerns will be:

- *Employment*: How many of the local people can be hired to work in the company?
- *Contracts*: How can the local businessmen/tribal leaders gain contracts with the company to supply services and goods?
- *Compensation*: What will the company pay the community in compensation for loss of land, destruction of trees, and damage to infrastructure?

These concerns may not seem onerous, but in some cases communities can feel that they have the right to deliver services to any outside interest in their territory at a price they believe is justifiable, without the need to ensure competition or quality.

The imperative of working with communities in a complex role challenges traditional Western corporate structures, which have to create and integrate an important new function. The task for companies:

- is not simple and never static;
- requires skills that are not present in the 'normal' makeup of a mining operation;
- is expensive in terms of time and management;
- should be a planned-in cost; and
- should be recognized and supervised at the highest level of in-country management.

These issues are crucial for consideration by any foreign company that plans to operate in Yemen.

7.4 IMPLEMENTATION OF SOCIAL IMPACT ASSESSMENTS

It is not yet common in Yemen for formal social impact studies to be incorporated into company environmental assessments when projects are being developed, although there are some exceptions. OilSearch, for example, has worked proactively and in advance of work in the field as an integral part of its normal planning process. More usually, where SIAs have been performed, these have been retrospective, i.e. performed in reaction to community pressure and on the realization that the company needs a clearer understanding of community structures or in order to meet safeguard standards (e.g. Equator Principles) established by financiers.

In the case of mining, the EIA performed in 2004-2005 by Scott Wilson Mining for ZincOx resources at Jabali concentrated on local people and livelihoods and comprised a number of local workshops. The final report contains a qualitative section that describes local livelihoods in the context of a brief analysis of regional data. The report goes on to draw up a checklist of mitigating actions that the mine can develop into processes to address social impacts.

Box 5.2: Delays to the Jabali Project

EXCERPT FROM ZINCOX RESOURCES PLC HALF-YEARLY REPORT 2008

The Jabali project, in Yemen, is progressing steadily and over the past four months, in spite of a very tight employment market, we have begun to secure key personnel for the production operations. Most of the major processing equipment has been ordered, the mining fleet is being commissioned and mining operations will commence before the end of this year. However, we have been frustrated by a dispute between one of the tribes that own land through which our access road passes and the road building contractor. This resulted in a suspension of road construction work. The Yemen government have been working to assist in the resolution of this, and in addition we have recently engaged a negotiator experienced in tribal matters and we are hopeful that the issues will be settled in the near future. In the meantime road building activities have resumed.

The completion of the access road is an important milestone for project development and as a result of the disruption to its construction we now believe the final completion of the project may slip into the first quarter of 2010, although our project team continues to make efforts to mitigate this disruption.

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Source: Excerpt from ZincOx Resources plc Half-Yearly Report, 2008.

7.5 THE JABALI PROJECT

The Jabali project (see section 5.2.1) has progressed well and the Joint Venture Company developing the project, Jabal Salab Company (Yemen) Ltd., has worked to maintain a good relationships with neighbouring tribes. Delays have resulted, however (Box 5.2).

7.6 COMMENT AND SUGGESTIONS

Working in a basically rural country such as Yemen requires a sensitive approach to relationships with the local tribal people. Investors must develop an understanding with community leaders and find a way to involve them in the project.

In the case of the Jabali project, the local partner, Ansan Wikfs, provided invaluable assistance to the foreign joint venture partner, ZincOx Resources. ZincOx also had experience working in other environments, and the senior staff understood the need for careful maintenance of tribal relationships.

The security situation in Yemen cannot be fully explained without reference to the country's tribal traditions. A lack of knowledge of the complex social relationships in Yemen can lead the uninitiated inadvertently into dangerous situations or lead to project failure.

A social structure based on tribal affiliations is not a peculiarly Yemeni phenomenon: similar structures permeate the entire Arabian Peninsula, stretching from Lebanon and Syria in the north to the southern border of the Russian Federation and, farther east, to the border of India. In addition to these structures, affiliations are also marked out by language and dialect.

Specific tribal interests will, of course, differ across the country, and in some areas there is still a perceived or even real threat to incomers. This is particularly the case in the Sa'dah zone to the northwest (see for example the Chatham House briefing paper).²⁸ In order to reduce the risk posed by these threats, incoming investors might usefully seek a local partner from the relevant license areas.

Another cultural aspect that overseas investors find difficult to come to terms with is the habit of chewing Qat in the afternoons. Foreign firms frequently lack understanding of the important cultural implications of Qat and do not adjust their expectations of local workers accordingly.

Finally, investors will need to be aware of the relative lack of opportunities for women. In much of the country, women have significantly fewer educational opportunities than men and, although women can be found working in many organizations (e.g. in the GSMRB library and in the General Investment Authority), their full potential is not available to the general economy of the country.

In conclusion, at least a part of any investment program in Yemen should target assistance to help the people in the tribal areas to develop their own enterprises, thus providing them with a vehicle for job creation and entrance into the real economy.

²⁸ Hill, Ginny, Yemen: Fear of Failure, Chatham House Briefing Paper, <u>www.chathamhouse.org.uk</u>, November 2008.

8. INVESTMENT CONDITIONS

8.1 INVESTOR DECISION MAKING

The opportunity for Yemen to take advantage of favorable geology to develop mineral deposits will, in the case of most metallic mineral and some industrial mineral opportunities, depend a great deal on attracting foreign mining companies that have no prior experience of working in Yemen and have, because of the international scope of their operations, the possibility of investing in mineral exploration and mining operations in many other countries. This places a premium on the government understanding the way in which investment decisions are made and taking actions, wherever possible and reasonable to address investor requirements. The purpose of this chapter is to provide a brief assessment of factors other than the geology and mineralogy of the country that may influence decisions by foreign mining companies on whether or not to invest in Yemen.

In general investors will evaluate factors such as:

- Stability of the political regime and safety and security.
- Existence of a reliable and attractive Mining Code.
- Existence of a stable fiscal regime.
- Existence of reliable and acceptable environmental legislation.
- Previous mining activity by whom, and was it successful?
- Marketing and distribution networks.
- Infrastructure roads, water, power distribution, ports, etc.
- Labor both skilled and unskilled with (preferably, but not essentially) a mining tradition.

Notwithstanding the above factors, it should be remembered that some companies are specialized in certain geological environments and others have experience working in certain political or economic environments. Therefore, from an investment promotion point of view, the officials responsible for promoting the sector should be aware of such companies.

8.1.1 Political Factors

Investors will evaluate political risk factors when considering investment. This is partly for security reasons (with perceived insecurity due to terrorists or banditry acting as a negative deciding factor) and partly due to the fact that perceived or real risk increases the cost of capital and thus the cost of an investment.

Other local aspects that influence investors include the level of uncertainty with regard to relationships with local populations and between central or local government and local and traditional leaders. These social aspects were addressed in Section 7.

It is important for the national government to recognise and address these potential risk factors and make local populations aware of the potential benefits to be derived from investment in their territory. Progress in these areas requires a deep understanding of the traditions of the local population and must therefore be resolved internally within the country; the imposition of solutions from outside can be counter-productive, although outside assistance to the government can yield dividends.

8.1.2 Legislative and Fiscal Environment

As part of their assessment of whether or not to invest in a country, mining companies will seek a number of basic assurances, which are described in the following paragraphs. The Government of Yemen is currently revising its mining legislation, which was prepared with assistance from IFC's PEP-MENA project. The new Mining Law is currently pending approval by Parliament. This will replace existing mining legislation and, in so doing, will significantly modernise and standardise sector regulation in accordance with international best practice. The points presented below show a number of generic characteristics that investors seek in a country's mining legislation.

<u>A secure title to mining rights</u>. In Yemen, as in most countries, minerals in the ground are the property of the state and an investor in the mining sector is not permitted to explore for or produce minerals without being authorised so to do by a licence granted under the applicable law. The investor's root of title is this licence and it must authorise the specific activities in which the investor is engaged at any given moment in the life of the project.

In judging whether the applicable law gives an appropriate measure of security, the potential investor will be concerned with a few specific issues:

- (a) Does the law ensure that a license, once granted, cannot be suspended or revoked except on specific grounds that are clearly set out in the law and invoke the application of objective criteria?
- (b) Does the law provide reasonable assurances that guarantee the continuity of operations over the life of the project? The investor will be particularly concerned with the granting of a right to mine. If a separate mining license is required, the investor will want to be certain that the holder of a prospecting (or exploration) license who identifies a commercial deposit will have the legal right to the granting of a mining license. That right may not be unconditional; however investors will be looking for a legal entitlement, linked to objective criteria, which could if necessary be enforced through an agreed dispute settlement mechanism.
- (c) Does the law ensure that the holder of a license has the sole and exclusive right to conduct the mineral activity authorized by that license?

In addition the investor will often ask:

(d) Does the law allow the normal license period to be extended, and minimum expenditure requirements to be waived, on areas where the explorer has already expended substantial sums of money identifying a mineral deposit, but where current economic, technical or political factors make immediate progression to exploitation uneconomic, or otherwise unacceptable for the license holder (sometimes called a retention license)?

Objective criteria should also determine the investor's rights to the renewal of licenses at different stages in the life of the project.

<u>A satisfactory fiscal regime</u>. No mining company will spend substantial sums on exploration for minerals unless it is satisfied that—in the event of it identifying a commercial deposit—the fiscal regime will permit the company, when the mine is developed, to earn what it regards as an appropriate rate of return on its investment. There are two critical factors in deciding whether a particular regime passes the test of acceptability:

- (a) Are the terms offered competitive when judged against terms offered by other countries with similar geological endowments?
- (b) Is the fiscal regime structured in such a way that high royalties or other up-front payments will not prevent the development of marginal discoveries, or delay the recovery of the high investment costs associated with large-scale mining projects?

Stability of the Fiscal Regime. Stability of the fiscal regime. The mining investor must be able to calculate the likely financial outturn of a project. This implies that the country's fiscal regime will remain stable. Investors will be seeking effective guarantees from the government that, over the life of the project, there will be no new taxes or duties and no increase in existing tax rates that will significantly alter the assumptions about costs and profits on which the original investment decision was made.

Foreign exchange retention and repatriation rights. Investors in the mining sector will expect to have the right to retain the proceeds from the sale of mine products, together with the funds borrowed in foreign exchange for mine development, in offshore banking accounts under their own control. Investors will also seek assurance that there will be no restriction on their right to convert profits earned in local currency into foreign currency and to remit these profits abroad. Such facilities may be a pre-requisite for international lenders before they will provide loans towards the capital cost of any mine and may well be a requirement for the equity investor(s) too. The reason for this is that providers of capital, including lenders and a company's shareholders, and foreign suppliers of equipment and services will require timely repayment/payment in hard currency.

<u>The right to dispose of mine products freely</u>. Mining companies may require agreement that mine products can be freely marketed for export or as the company sees fit and appropriate. Obligations to sell mine products to the government or to market them through a state-controlled agency are often unacceptable to investors.

The right to assign. Companies will expect the right to assign the mineral rights they hold. This means having the right to assign up to 100 percent of the interest held, or to "farm out" part in an unincorporated joint venture. Importance will also be attached to the right to dispose freely of the shares in a mining company, subject to the applicable company laws.

Companies seek the right to assign mainly because the cost of a mining project may not be apparent at the beginning of the exploration phase and because companies themselves are subject to changing fortunes that cannot always be predicted. Where there is the right to assign, a company has the opportunity to share the risk of a project with one or more partners, and that action may enable a project that would otherwise have been abandoned to be sustained and completed.

Stability in environmental management. At the development stage of any mining project, consideration will always be given to environmental issues. However, in many developing countries and in countries emerging from conditions of state monopoly, there is no existing network of statutory requirements for mining operations. Provisions to prevent or limit environmental damage will be project-specific and will need to be agreed upon between government and the mining investors. When investors put forward proposals for environmental management as part of a mine development plan, they will need the assurance that—in the event that the plan received approval—it would, over the life of the project, define the limits of the environmental obligations of the investor.

In the event that government wishes to alter the requirements imposed on a license holder because, for example, stricter international standards have been developed or new scientific data may have become available showing the existence of dangers not previously recognized, such a right should be recognized but in narrowly defined circumstances.

<u>International arbitration</u>. A satisfactory procedure for the settlement of disputes will be regarded by most mining investors as essential for a major investment. For most companies this will mean international arbitration.

<u>Freedom of commercial operation</u>. Investors will seek the freedom to manage their operations in the most appropriate manner based on commercial criteria and without government intervention in decisions that are essentially commercial.

Previous mining activity. Mining investors will be aware of recent mining activity in a country in which they may be considering investment. Previous successful ventures will provide confidence to the mining company and to the potential project investors. Unsuccessful ventures, on the other hand, will raise questions in the minds of newcomers and can result in a reluctance to invest, especially if the lack of success be attributable to local issues. It is thus of utmost importance that those charged with the promotion of the sector are aware of the circumstances of unsuccessful investments as well as successful ones.

In this context, the successful financing of the Jabali project is a positive news story (although the delay due to a dispute between a contractor and the local tribes is negative) and the signing of an Option Agreement between Cantex and Vale is also very positive.

Previous small-scale or artisanal mining can also provide information to companies interested in an area's potential. In the case of Yemen, there is evidence of mining activity in the distant past, but little evidence of recent artisanal or small-scale precious metal mining. This is not necessarily a handicap, but it would indicate to an incoming investor that there is an absence of a mining culture in the country.

8.1.3 Infrastructure and Services

Mining requires access to power, water and other services in varying degrees at the different stages of the mining cycle.

It must be recalled that a mining project will only be successful if the cost of recovering the mineral ore over the lifetime of the project is less than the market value of the product to an extent adequate to provide the rate of return required by the investor when taking into account all the costs (which are also affected by perceptions of risk). Therefore the cost of infrastructure, such as power, water and transport, may be a determining factor.

Similarly, if services required by the mining company are not available or expensive, this will affect the viability of an investment. This will include the availability of experienced and qualified labor. It is expensive for a mining company to import technical, management or other skills. Although a foreign company will wish to have in place a minimum number of its own senior experienced staff, the greater the availability of qualified local staff, the more likely it will be that costs and work practices can be optimized, whether or not there is a legal requirement for the company to employ local people.

The availability of infrastructure, services and qualified staff—and possible ways to improve these factors—is considered elsewhere in this report.

8.2 DOING BUSINESS IN YEMEN

The World Bank Group's "Doing Business" rankings provide a useful source of information on the cost of doing business in a given country.²⁹ It is not the purpose of this report to analyse these rankings in detail. However, it is useful to note that while Yemen ranked 98th out of 181 countries overall in 2009, the country's "worst" rankings were in the following sub-categories:

Ease of	Rank out of 181
Getting Credit	172
Protecting Investors	126
Paying Taxes (this relates to the administrative burden and the number of payments to be made)	138
Trading Across Borders (including cots to import and costs to export)	126

In other aspects, however—such as starting a business, dealing with construction permits and enforcing contracts—Yemen scored relatively well, particularly in relation to other countries in the region.

A mining investor seeking to invest in Yemen will probably seek to acquire political insurance and for that might approach the Multilateral Investment Guarantee Agency (MIGA), a member of the World Bank Group. It is therefore useful to understand the risk level that MIGA would apply to Yemen. It appears that MIGA uses the risk assessment of ONDD, the Belgian Export Credit Agency,³⁰ whose conclusions are considered below.

8.2.1 Risk Assessment

ONDD considers that political risk for Yemen is low for short-term export transactions, but relatively high for medium- to long-term transactions. It places Yemen in the lowest of three Commercial Risk ranks. Where Direct Investments are concerned, War Risk is considered medium (3 out of 7), whereas risk of Expropriation and Government Action is relatively high (5 out of 7) and Transfer Risk even higher (6 out of 7). These classifications are illustrated in Figure 7.1. Overall, these data provide an indication of the perceptions of investors and areas to be addressed.



Figure 8.1 Yemen Risk Assessment

8.2.2 Feedback from Existing Investors

It is clear that many potential investors are concerned with the general security of access to sites remote from the major cities. As a result, it will be important for the Government of Yemen to address the perceptions derived from the risk assessment discussion above, as well as governance in the tribal areas (see Chapter 6).

It should be mentioned that, although some companies have clearly been dissuaded from investing in Yemen, those that are present are relatively positive about the general investment conditions. However, both foreign and local investors have mentioned concerns about employment legislation and (probably) custom. For example, it appears that if a company employs personnel, it is expected to care for them even after they have been released. Yet companies have stated that they have a policy to employ casual or subcontract labour in order to limit the number of full-time employees. Other examples include cases of staff being terminated for illegal activities, then the company being found at fault by the courts for allowing such activities. It is well understood and commendable that Yemen wishes to protect its workers. However, doing so within improved labor legislation and with greater transparency could provide an incentive to investors to employ more people.

9. PROJECTED MINERAL SECTOR GROWTH AND BENEFIT STREAMS

Mining represents a source of economic growth in Yemen, offering employment, revenue in the form of royalties, duties and taxes, foreign exchange earnings and raw materials demanded in the domestic market. This Chapter sets out our projections of mineral sector growth and benefit streams based on the preceding analysis of mineral prospectivity and conditions for investment and assuming that the underlying economic and security conditions for development of mining within Yemen do not deteriorate. It is also assumed that progress will continue to be made by the Government to implement measures to support the development of the sector.

Projections of mineral sector growth and direct economic benefits are presented over a five year time horizon and, more speculatively, 10 to 15 years into the future (Section 9.1). The wider benefits of mineral sector growth are also discussed, mainly by reference to the experience of other countries that have experienced mineral sector growth, and by distinguishing between artisanal and small scale mining and quarrying and industrial-scale mining (Section 9.2).

9.1 **PROJECTIONS OF MINERAL SECTOR GROWTH**

9.1.1 **Projection for 2010 to 2015**

Given the mineral resource base (Chapters 2 and 3) and current activity in the sector (Chapter 4), it is possible to develop a growth scenario for the five-year period 2010 to 2015 (Table 9.1).

Existing or under development	New investment	Annual Volume	Annual Sales Value	Annual Export Share	Annual Tax Revenues ¹
Start up of Jabali zinc in 2009		70,000 t/yr zinc oxide (80 percent zinc content)	US\$56mn (@\$1000/t zinc)	100 percent	US\$1-2mn in the early years
	Al Hariqah gold developed by end of period	200,000 oz/yr gold	US\$180mn (@\$900/oz gold)	100 percent	US\$5-10mn
Productivity improvement at existing quarries during the period		n/a	US\$20-30mn	10-20 percent	US \$2-3 mn
	One or more new large granite/marble quarries for export of dimension stone opened during the period	n/a	US\$20-30mn	75 percent	US\$2-3mn
Little growth in the scale and variety of exploration programs		n/a	n/a	n/a	n/a
1. Revenue receipts b allowances may result	ased on royalty, dutie	es and taxes, how ties and taxes in t	ever, tax holiday: he early years of a	s, duty exemptions	s and investment

 Table 9.1 Mineral Sector Growth Scenario, 2010-2015

The scenario shown in Table 9.1 is naturally conjectural, but reasonable assumptions have been

The scenario shown in Table 9.1 is naturally conjectural, but reasonable assumptions have been used. Under this scenario, the value of mineral sales would grow substantially from existing

levels to reach some US\$300 million annually by the end of the period with a marked impact on exports. The revenue impact would also be significant, albeit starting from a low base. One of the main sources of uncertainty is the present depressed state of mineral commodity markets and the global financial crisis. The longer these conditions last, the less likely is it that the new investments shown in Table 9.1 will materialise.

Some of the key assumptions underlying the mineral sector growth scenario for 2010 - 2015 are:

- Jebali Zinc Mine: The Jebali zinc mine is due to start operating in late 2009 and has the financing in place to proceed as planned. Zinc prices are sharply lower than at peak in 2008, but they are still within the range used to evaluate the feasibility of the project. The product exported is an upgraded zinc oxide with 80 percent zinc metal content (for further details see Section 4.2.1. and Section 8.4).
- Al Hariqah Gold Prospect: Cantex is in the process of drilling the deposit to establish full grade-tonnage data and commence mine and processing design. Because the gold price outlook remains robust there is every chance that Cantex will seek to sustain its program, whether on its own or by seeking a partner. The company aims to prove the presence of a large low-grade deposit (1.65g/t Au) amenable to open-pit mining with gold content of some 2 to 3 million ounces recovered by heap-leach chemical processing at site (www.cantex.ca). Cantex operates under an agreement that secured it a 1 percent net smelter royalty and a tax holiday.
- Quarry stone sector existing quarries: The quarry stone sector is already widespread in Yemen but underperforms owing to (a) strong price competition in the domestic market from Indian and Chinese suppliers, (b) high transport costs from quarry to processing plant and then to buyers and (c) low capitalization and hence poor equipment, an unskilled workforce and weak marketing. The focus of effort in the 2010-2015 period would need to be on addressing some of these barriers, resulting in productivity improvements, the re-capture of some of the domestic market and new opportunities for export. Building stone production is estimated to be valued at some US\$10-15 million. This could potentially double over a five year period, principally by capturing more of the domestic market.
- Quarry stone sector new investment: The assessment in this review is that one or more mineral deposits suited to the commercial quarrying of granite, marble, limestone and travertine dimension stone for export does exist and that, given targeted support to build market interest, it should be possible for investment to be forthcoming. A large-scale granite quarry would typically require an outlay of US\$2 million and another US\$1-2 million for modern processing plant. Such operations could generate some US\$20-30 million in sales, mostly for export. Jordan, for example, went from producing dimension stone valued at little more than US1 million to export sales of around US\$30 million in just a few years.
- *Exploration*: There are numerous holders of exploration rights in Yemen, many of whom have been implementing programs of exploration over a number of years. The outlook for this effort being sustained at this time is clouded by uncertainty due to depressed mineral markets, cutbacks in exploration budgets and a strong likelihood that many junior exploration companies simply will not survive. That is why the growth scenario projects that few exploration prospects will graduate to mine developments by 2015.

9.1.2 Speculative Prospects for 2016 to 2030

Given the mineral resource base and the preceding growth scenario, potential mineral sector growth beyond 2015 can be forecast as follows:

- Suwar nickel prospect: This mineral prospect is considered to be a potential world-class mine, as demonstrated by Vale's decision in 2008 to finance further evaluation by Cantex and thereby earn an equity interest in the prospect. However, it may take many years to establish the viability of developing Suwar into a mine. Nickel, copper and cobalt are three of the minerals most severely affected by the current global recession. Moreover, development of a large-scale operation with sophisticated processing technology will present significant technical, logistical and transportation challenges. The prospect has potential to generate some US\$250-500 million in sales annually.
- Additional gold prospects: The occurrence of several types of gold mineralisation analogous to those found on the Arabian Shield and other gold mining belts worldwide, as well as the progress already made to evaluate a number of deposits, including Cantex's Al-Hariqah prospect, implies that several gold mines could eventually be developed in Yemen. Moreover, gold prices have demonstrated resilience in the present global recession, thereby sustaining interest in conducting gold exploration. Two or three additional gold mines of medium scale could be speculated to generate some US\$50-100 million in sales annually.
- *Iron ore prospects*: There are a number of iron ore deposits undergoing investigation, but it is too early to state with confidence that there might eventually be commercial iron ore mines in Yemen. Any future mine development would be contingent on building or obtaining access to reliable bulk commodity transport and port facilities. One might speculate that such conditions will eventually be in place towards the end of the period.
- **Industrial mineral prospects:** Some concrete industrial mineral targets have been identified recently, only some of which (industrial limestone, tantalum, scoria and pumice) are under active investigation. It seems probable that, if such investigations can be sustained and establish that deposits can be mined to supply a product meeting the specifications required by users, mine development will take place in the forecast period.
- Quarry stone sector: The key to continued growth of the natural stone sector in Yemen beyond 2015 will be a deeper understanding and investigation of the suitability of the main mineral deposits—especially granite, marble, limestone and travertine used for dimension stone—to be quarried with sufficient scale and reliability to meet export market requirements. Efforts undertaken in the 2010-2015 period, especially selected pilot programs to test the exploitation of high-potential deposits, will provide an indication of how much growth can be realised over the longer term. In principle, it is possible to speculate that Yemen could eventually generate sales value of some US\$25-50 million annually from this sector.
- **Exploration:** Over the longer term, only sustained exploration work will supply the next generation of mineral prospects that can be evaluated and some of which will eventually be commercialised. It is assumed that global exploration programs will continue to experience ups and downs, as in the past, but that further successes by mining companies in finding and developing mines in Yemen will provide the impetus necessary to attract other companies to explore for minerals in Yemen.

9.2 THE WIDER BENEFITS OF MINERAL SECTOR GROWTH

The benefits of mineral sector growth will be felt in many different ways; so too will the impacts and associated risks. It is important to distinguish between different scales and modes of mining activity, since the types of benefits and impacts—and accordingly the focus of government strategies for mineral sector development—will differ according to the type of mining that will take place.

For convenience, three types of mining can be distinguished:

- Artisanal mining,
- Small-scale mining, and
- Industrial-scale mining.

In some cases, the definitions of artisanal and small-scale mining are assimilated into the same activities, whereas in other cases artisanal mining is defined specifically as exploitation working with simple tools and equipment, usually in the informal sector, outside the legal and regulatory framework.

9.2.1 Artisanal Mining

Artisanal mining is typically understood to be a form of mining conducted using rudimentary equipment and tools with heavy reliance on manual efforts to extract stones and ores and simple but sometimes dangerous methods to obtain a saleable mineral. In the context of Yemen, this definition applies mainly to the rudimentary stone quarries, sand and clay winning and gemstones pits that proliferate throughout the country.³¹

The draft of Yemen's new Mining Law, which defines artisanal mining as a site where a maximum of five workers are permitted and where no machinery is allowed, would seem to be a consistent albeit somewhat narrow approach to dealing with the legalisation of such activities. Legal artisanal mining practices should be reserved, as much as possible, for local communities (especially to avoid "rushes" by outsiders for high-value minerals). Every encouragement should be given to such communities to improve their mining practices by employing machinery appropriate to the scale of their operations so that they can become small-scale mechanised miners. In this case a rigid differentiation of mineral rights between artisanal and small-scale mining might be counterproductive.

In many cases, artisanal mining is an important aspect of rural livelihoods, representing a source of cash income for local people between planting and harvesting crops. Some studies have concluded that poor access to infrastructure prevents local populations from easily transporting agricultural products to markets. These communities often turn to artisanal mining to provide more easily marketable products. This cash income might allow rural populations to invest in improving their own living environment.

³¹ In many parts of the world a broad range of minerals is extracted by artisanal and small-scale miners. The practice is an enormous generator of jobs: according to the MMSD Draft Global report on Artisanal and Small Scale Mining, November 2001artisanal and small-scale mining is thought to involve 13 million people directly and affect the livelihoods of a further 80–100 million worldwide. It is clear that the vast majority of artisanal miners are very poor, exploiting marginal deposits in harsh and often dangerous conditions. Such mining practices have a considerable negative impact on the environment, well beyond the overall benefit to the country.

However, artisanal mining can also be very disruptive, either by keeping children out of school for the purposes of employment or by creating a sudden 'rush' causing local people to desert their farms or encouraging immigration. When the rush is over, most of the profits are likely to have disappeared, while the social and environmental damage persists.

The environmental impacts of artisanal mining are of great concern to many observers. These impacts include direct dumping of waste and effluents into rivers, threats from improperly constructed tailings dams, river damage in alluvial areas, river siltation, erosion damage and deforestation, and landscape destruction. (In some countries, uncontrolled artisanal metal mining operations are associated with a risk of pollutants such as mercury and cyanide and of tailings deposition or leaching into waterways and resources.)

Artisanal mining practices often leave behind lands that are unsuitable for any other use, due to the destruction of the surface and lack of rehabilitation of the land (Figure 8.1). A lack of awareness, combined with a lack of information about affordable methods to reduce impacts and a lack of obvious incentives to change, all contribute to these problems. In some cases, recommendations have been made to limit artisanal mining to local communities, and to combine artisanal mining with a wider project to encourage agricultural development. This depends on local communities placing a greater value on the use of land and therefore actively working to rehabilitate land for diverse uses.

Natural stone artisanal quarrying is an area where support and technical assistance would benefit local communities as well as the entire NS supply chain. Such an approach at tribal level may have merits in a society like Yemen.

Additional impacts of artisanal mining relate to the social pressures engendered by an influx of miners and the associated service industries, including food supply but also prostitution. For many years there was pressure to ban the practices of artisanal mining, but more recently the donor community has begun to recognise the income-generation potential of artisanal mining activities.



Figure 9.2: Example of damage caused by poorly controlled artisanal mining

9.2.2 Small Scale Mining

Small-scale mining (SSM), where differentiated from artisanal mining, normally connotes organised mining of mineral deposits that requires some degree of mechanical equipment to assure regular extraction of ores and minerals that are often not accessible unless mined by such means, combined with processing facilities that recover a saleable mineral product. The dividing line between artisanal and small-scale mining can be somewhat fluid.

SSN operations are of a type where local communities or companies could directly participate, but the deposit being worked may not be of a scale or quality that would require high levels of investment in specialized mining operations and hence be of interest to international mining companies.

In the current Yemeni context, SSM activities appear to be confined to the stone sector. Historically, however, Yemen has had a culture of metal mining that by present-day definitions would be classed as SSM. This culture has seemingly disappeared over the years, but examples can be found. Artisanal workings were found at Jabali (Box 6) and during the time of the Queen of Sheba there is evidence that substantial gold mining was undertaken.

Box 9.1 Jabali Workings

Artisanal workings at Jabal Salab (Jabali) date back about 2,500 years. These workings exploited the relatively soft oxidised ore which was locally silver-rich. It was considered in the tenth century AD one of the biggest mines in the Islamic world for silver production. Mining was performed by both underground and open cast methods. It has been estimated that 30 galleries extending between 10 and 150m are present underground. A large number of open pits, some up to 25m deep are found within in the area. 300,000 - 400,000t of ore is believed to have been mined historically, totalling 7,000-10,000t of contained Pb and 30-50t of contained Ag.

Source: From a report by Saint Barbara Consulting Services and The Project of Development of the Mining Industry in the Republic of Yemen, GSMRB, Evaluation and Promotion Department 2008.

SSM, if properly conducted, can assist in introducing technical and management skills to local entrepreneurs and act as driver of the local economy by taking the artisanal mining concept to a higher level. In order to encourage this development, it would be useful to review the legal framework to encourage small-scale enterprises run by local communities or businessmen. These enterprises would require significant assistance in defining "reserves"; putting together business plans; conducting market research; acquiring finance; acquiring, operating and maintaining equipment and machinery of appropriate scale; and managing the exploitation and the environmental and social impacts. This assistance, in the form of extension services, could be provided by the GSMRB, which itself would benefit from external assistance to develop the skills required.

As part of any SSM reform, local communities or enterprises should be able to maintain a stake in any licence area if a larger deposit is discovered that requires a larger investment, probably from international investors. In view of the tribal nature of Yemeni society, the development of SSM by initially involving the tribal chiefs in prospective areas should be encouraged. If the culture of mining can be reintroduced into the country at large, this could improve the interaction between local communities and incoming investors.

Stone quarrying is an important aspect of SSM, where much of the energy and efforts of local and international institutions should be addressed, for the benefit of the sector. A good example is the case of Galalla Quarry District in Egypt, where small artisanal limestone quarries were developed into more organised quarries run by SMEs, which are now skilled technically and in marketing following a period of training and support by local institutions. As a result, this material and this district have become among the most significant and well known in the international market. Jobs have grown by 1,000 percent, with 2,000 percent of turnover in 5 years.

It would be appropriate to establish a programme to encourage SSM in local communities and develop extension services to be provided by the GSMRB.

9.3 INDUSTRIAL SCALE MINING

Industrial-scale mining is understood as large-scale operations, usually requiring significant capital and resources and often requiring inputs from international investors. One of the main, and most obvious, benefits of large-scale mining is employment. Large-scale/industrial mines provide construction phase employment and "full-time" employment thereafter. Construction phase employment is four to five times the size of "full time" employment, but usually lasts no more than 12 months. In addition to the direct employment provided by the mining company, a number of industries (and associated jobs) are created by the need to supply the mine with operating equipment and spare parts, transport and shipping services, communications, comestibles, etc. A summary of the benefits expected from the Jabali project is presented in Box 9.3.
Box 9.3: Benefits to Yemen from the Development of the Jabali Deposit

Employment

The mine, processing plant and associated facilities will employ approximately 370 people, the vast majority of whom will be Yemeni nationals. A further 100 nationals are likely to be employed by contractors (e.g. transport of materials to and from Hodaidah and Salif).

Training of Yemeni Personnel

A Yemenization policy and training programs will be put in place by Jabal Salab, so that after four years from the start of production over 95 percent of the staff will be Yemeni. A wide variety of skills will be required by Jabal Salab. These will include qualified managerial staff such as accountants, geologists, mining engineers, metallurgists, mechanical and civil engineers; skilled labor such as mechanics, electricians, heavy earth moving operators, highway drivers and plant foremen; and unskilled labor. Where suitably skilled and experienced workers are available these will be drawn from the area around Jabali, but where suitable people are not available locally these will be sourced from other areas in Yemen. In addition to the budget for training within the company, Jabal Salab has agreed within the terms of the Exploitation Agreement to make annual contributions towards a training and development program in the GSMRB.

Technology Transfer

There is currently no large-scale mining for metals being carried out in Yemen. The processing technology for the recovery of zinc at Jabali is new to Yemen, although it has been used in the copper and nickel industries elsewhere. Considerable transfer of both mining and processing technology will, therefore, take place.

Furthermore, if the silver that occurs at Jabali can also be recovered economically, the technology that is likely to be applied is also applicable to gold. Yemen has considerable gold potential, the exploitation of which would benefit from the skills and technology applied at Jabali.

Industry and Services

Construction of the processing and associated facilities at Jabali will require considerable input from local engineering contractors and services. While some specialized plant and equipment will be imported, civil engineering work will be contracted to local firms. During the 12 month construction period alone, it is estimated that over \$30 million of goods and services will be sourced in Yemen. Similarly, throughout the life of the mine, as many supplies as possible will be purchased locally.

At the end of the mine life the mining fleet and processing plant will have a value estimated at \$30 million.

Local Socio-Economic Benefits

An environmental impact study has been prepared for this feasibility study in accordance with the guidelines set down by the Yemen Environment Protection Authority and the World Bank. It shows that there are no significant negative impacts from the Jabali Project on the local environment. The study incorporates a socio-economic analysis into the impact of the mine's development on the local community. It summarises by saying that the employment opportunities, directly and indirectly derived from the mine, and the infrastructure improvements will have long-term benefits well beyond the life of the mine and the surrounding area.

Development of Infrastructure

Jabali is located in an area of mountain terrain, 16km off a good quality asphalt road from Sana'a to Marib. A new road to the mine site will be constructed by Jabal Salab. This will bring long-term benefits to the local Bedouin tribes by improving access to their villages.

Cont'd....

Benefits to Yemen from the development of the Jabali deposit concluded

Grid electricity is not available at Jabali, so the mine will operate on diesel-generated power. However, if at some time in the future a gas pipeline were constructed to transport gas to Sana'a from the gas fields near Marib, Jabal Salab would be a potential consumer.

ZincOx has spent over US\$300,000 identifying a reliable local source of water for the processing plant, in association with a team from the National Water Resources Authority (NWRA). A large source of sustainable water has been identified in Wadi Khaynagh, to the west of the mine. Jabal Salab will spend considerable sums to recycle water so that only a modest amount of water will need to be abstracted for mine use; this means that sufficient spare capacity will be available to sustain a potable water supply for the local community. Today none is available.

Tax Revenues

As a substantial investor in a remote rural region, Jabal Salab is eligible under the Investment Law for a 7-year tax holiday. Corporation tax revenue over the life of the mine payable by Jabal Salab (after the tax holiday) is estimated to be US\$58 million. In addition, the government will benefit from taxes and social security contributions amounting to approximately US\$10 million from employees of Jabal Salab over the life of the mine.

Royalty Revenue

The 2 percent net smelter return royalty payable by Jabal Salab is estimated to amount to approximately US\$15 million over the life of the mine.

Foreign Exchange

All zinc production from Jabal Salab will be exported and sold in US dollars, as is the case with most metal sales throughout the world. Since many of the costs will be incurred in Yemeni rials, the project will provide a flow of regular foreign exchange for the country.

All the zinc produced at Jabali will be exported through one of the Red Sea ports. Approximately 75,000 tonnes of oxide will be exported per year, adding significantly to Yemen's non-oil exports and port activity.

Exploration Potential

Jabal Salab believes the resources at the Jabali deposit extend to the south and east. The company will commit funds on further exploration. Extension of mineralization could prolong the mine life from 12 to 16 years or more, resulting in improved Government tax receipts and foreign exchange earnings.

Multiplier Effect

It is well recognised by economists that the development of a mining operation in an area with little economic activity, such as the area around Jabali, produces a large economic and social multiplier effect. If the value of the multiplier effect is three times the capital cost of the mine's development, then in the case of Jabali this could be worth over US\$225 million to the Yemeni economy.

Development of the Mining Industry and Foreign Investment

Perhaps the biggest benefit to Yemen arising from the development of the Jabali deposit is the significant impact it will have on the future of the untapped potential for large-scale mining in Yemen. Exploration and mining are inherently risky and capital-intensive businesses that depend on the ready availability of risk finance. Attracting such finance requires a fair and supportive fiscal policy that encourages foreign investors. Jabali's development will show the world that the Government of Yemen is serious about the development of its mining industry and its ability to diversify away from dependence on oil and gas production.

ZincOx and Anglo American are well known in the international mining industry and news of the successful project will spread rapidly. Likewise, Jabali is a high profile project due to its complex metallurgy and innovative processing technology. Its development under the umbrella of an attractive Exploitation Agreement will undoubtedly encourage other foreign companies into Yemen in a similar way to that experienced by the oil industry in the early 1980's.

Source: Extract from the report submitted to the GSMRB by Jabal Salab Company (Yemen) Ltd.; provided by the GSMRB.

Some historical examples of the benefits of industrial scale mining from elsewhere are provided in the following box.

Box 9.4 Examples of Benefits of Mining Developments

SADIOLA AND YATELA GOLD MINES: MALI

- In 2007, these two mines employed some 1,381 people directly and 2,737 contractors, of whom a great majority were nationals
- 2007 payments to the Government of Mali:

	М	ine	
000 US\$	Sadiola	Yatela	Total
Dividends	4,500	16,000	20,500
Corporate Taxation/Provision	25,639	40,253	65,892
Royalties	16,059	12,519	28,578
Other Taxes and Dues	4,669	4,881	9,550
VAT	27,775	10,395	38,170
Employee Taxes and Contributions	9,525	2,946	12,471
Totals	88,167	86,994	175,161

• The company has a well developed training scheme for national employees.

• In addition the mining company contributes to social developments in the mining areas (see www.anglogold.com). POURA GOLD MINE, BURKINA FASO

• This was an open pit and then underground gold mine located west of Ouagadougou, the capital. The mine is now closed.

- In 1995 the employees of the mine (about 400) supported directly more than 3,000 people.
- 11,000 people living in the area were dependent on the mine.
- An evaluation of the benefits of the mine indicated a multiplier effect of about 8 or 9, largely in view of the substantially higher salaries earned by the workers at the mine.

SELEBI PHIKWE NICKEL MINE, BOTSWANA

- Some 4,500 employees
- The town was built to service the mine and the industry now supports a population of some 40,000 in the region.
- Good infrastructure was developed due to the mine.
- Now as the mine nears the end of its life, there is a program to diversify the economy to maintain employment. OBUASI GOLD MINE, GHANA
- Extensive in-house training programs
- Health and sanitation
 - Built and furnished a Government Hospital
 - Company operates 170 bed modern hospital with eight (8) medical doctors including a specialist. External consulting specialists are also engaged.
 - o Medical care is extended to communities in and around Obuasi area
 - Finances street cleaning
- Urban development (including street lighting)
- Rural electrification projects
- *Rehabilitation of infrastructure (roads, bridges)*
- Rural water supply

COPPER MINES, ZAMBIA

- A range of diversified industries grew up in the vicinity of the mines.
- A great number of skilled workers and managers were trained up.
- Infrastructure was developed.
- The decline of the industry was an example of why a State should not become involved in the management of the industry.

ALUCAM, CAMEROUN

- Aluminium smelter
- Used local resources : cheap source of power available.
- The wealth creation is evident in the town of Edéa.
- Motor of the local economy

It should be recalled that the benefits to the Government are not only the jobs created and any royalty charges, but the revenues via taxation, both of the mining company itself and of the incomes of the employees and other beneficiaries. The mining company will pay taxes on the profits it makes and the employees will pay income taxes on the salaries they earn. In addition, the mining company will pay such indirect taxes as vehicle excise tax, local government taxes, property taxes, etc.

In Yemen currently the only operation that merits this label is the Jabali project, which has been described earlier. The investment required to develop the project is in excess of US\$ 200 million and this is likely to be the largest investment in Yemen in the resource sector outside the oil industry. In order for the company to raise the necessary finance it was necessary in this case for the Government to allow a tax holiday. Amongst other aspects, this enabled the company to recover the initial investment more rapidly and reimburse the finance. This shortened period of repayment effectively decreases the political and financial risk. If Yemen can present itself as a lower risk investment target, the need for such tax holidays would disappear and this would result in a more rapid return to the country in the form of increased taxes in the early years.

10. RECOMMENDED PROGRAM OF REFORM AND SUPPORT MEASURES

This final chapter sets out an indicative program of reform and support measures that will be necessary if the mineral development potential identified in the preceding chapter is to be realized. The focus is on priority actions that would aim to strengthen the regulatory framework for minerals development and build capacity in the key institutions that manage the sector. It is also recommended that studies be conducted to assess the potential for infrastructure development that would be supportive of mining and other productive activities in areas of the country where infrastructure provision is presently limited.

- Strong feedback from stakeholders has identified the need to further strengthen the regulatory framework and to build capacity of the institutions involved in regulating the Yemeni mining sector. Measures to achieve this are set out in Section 10.1.
- Minerals development will require attraction of investment, both foreign and local, but for this to happen on a sustained basis support is needed to further develop knowledge in GSMRB about mineral occurrences in Yemen and the commercial potential of their exploitation as a platform for effective promotion to the mining industry. Measures to achieve this are set out in Section 10.2.
- As yet little small-scale mining occurs in Yemen other than quarrying of building stone and other construction materials but there is potential, if supported with suitable programs, to create a basis for engagement by Yemeni's in this sub-sector of the mining industry. Measures to achieve this are set out in Section 10.3
- Skills development in the regulatory institutions through training and other forms of instruction is a key requirement that cuts across all areas of sector management and needs concerted effort. Measures to achieve this are set out in Section 10.4.
- Stone quarrying and processing is the most active part of the mining industry in Yemen at the present time but faces many challenges to operate on a commercially viable and competitive basis. As such, specific measures are seen as being necessary and, accordingly, these are addressed separately in Section 10.5.
- A significant constraining factor on the potential growth of the mining industry in Yemen is the remote location of mineralized areas in relation to available infrastructure. Stakeholders have identified the need for strategic investments to alleviate this constraint. Measures to assess the scope for infrastructure investment to address this challenge are set out in Section 10.6.

10.1 REGULATORY FRAMEWORK AND CAPACITY BUILDING OF REGULATORY INSTITUTIONS

In the context of these recommendations, capacity building refers to the improvement, or modernization, of the institutions concerned with the mineral industry in Yemen. The overall objectives of this pillar of the proposed investment program are to put in place administrative structures capable of:

- Regulating the sector,
- Promoting the sector,
- Providing services to the sector.

Additional efforts to build GSMRB's capacity and to improve its institutional organization are required. These activities would build on the work already carried out with the assistance of PEP-

MENA and the IDF, aimed at consolidating institutional streamlining of GSMRB, preparing the Yemeni authorities to be better equipped, when dealing with international investors.

10.1.1 Regulation of the Sector

In addition to the drafting of a National Mining Policy and new mining legislation, the World Bank is supporting, through the Institutional Development Fund, a mining cadastre baseline study and development of a monitoring and evaluation system. These important elements would be incorporated into any modified structure of the GSMRB.

The contract for consulting services to help the GSMRB conceive and design a mining sectorspecific monitoring and evaluation system and to train local central and provincial staff to implement it has been signed and is due to commence in the coming few months. These consultancy services will build on the work carried out by Chris Morgan Associates and Titan Consultants for the PEP-MENA operation on the institutional set-up and administrative procedural mapping at GSMRB, respectively.

In summary, this project will deliver:

- Diagnostic institutional study and preparation of reporting templates and procedures
- Preparation and delivery of "train the trainer" programs on monitoring and evaluation

The mining cadastre project will provide the tools required to record and regulate the mining licenses and train officers in the use of the computerised cadastre.

These projects intend to involve a cross-section of stakeholders in addition to the GSMRB and specifically agencies such as the Ministry of Local Administration, Ministry of Plan and Environment Ministry.

Regulat	Regulation of the Sector			
1	Monitoring and Evaluation System	IDF-World Bank underway		
2	Cadastre	IDF-World Bank underway		
3	Structure of the Regulatory Body	Using in part the applicable findings of Project No. 1 and the CMAL report, implement a reorganization of the regulatory agency.		

10.1.2 Promotion of the Sector

In order to develop a strategy for the promotion of any country's mineral sector, it is necessary to understand the point of view of the potential investor. The specific areas which the promoters of the mining sector will need to address are three components or pillars: (1) the geology; (2) the legal and regulatory environment; and (3) the human resources. The key objectives of the strategy will thus be to:

- Bring the current investment situation of Yemen to the attention of potential investors;
- Publicize the new mining legislative environment;
- Publicize the geological and mineralogical information;
- Encourage investors to take up mineral permits in Yemen.

A current project, Contract 7145061, funded by the World Bank Group and carried out by GEUS: Yemen Mining Investment Promotion Consultancy is contributing to this effort. However, considering the long term aspects, the specific role of a promotional cell in the GSMRB or elsewhere should be considered. An initial recommendation to this effect has been made by CMA Limited. However, if the mining sector in Yemen is to be actively promoted, then a clear promotional strategy should be developed and following this a specific promotional structure should be put in place.

Various structural models of the promotional Cell are possible, depending on the independence required of the Cell (with regard for example to the general Investment Promotion organization within Yemen) and on a decision as to which part of the mining administration should be responsible for the information database and library.

Pr	Promotion of the Sector		
4	Promotional Strategy	Develop a promotional strategy, including a review of the structure of the promotional department within GSMRB, long-term objectives and targeting of investors. Parts completed with the Danish Trust fund by GEUS.	

10.1.3 Provision of Services to the Sector

The GSMRB currently provides drilling and laboratory services to the mining sector and could provide geological and geophysical services to investors. A decision needs to be made regarding the way in which these services are provided. The CMA report recommends privatising the geophysical and drilling services and combining the Sana'a and Aden laboratories. In view of existing experience worldwide, this is a reasonable recommendation. However, the path to such a situation is not easy: the services must firstly be "commercialized" so that they are managed like a commercial operation, and then a method of placing them in the private sector must be found.

Experience elsewhere has shown that it is often difficult to find the investment required to place mining support services in a commercially competitive position. In Algeria, the drilling operations of the ORGM (the equivalent of the GSMRB) suffered from old equipment, inflexible procurement practices and a heavy administrative set up which did not encourage drilling teams to achieve high quality results. International private sector drilling companies could see no advantage in acquiring the assets. After a number of years, a capital injection from the petroleum industry's drilling sector has improved the situation. Other countries have relied on donor funding (World Bank or the European Union) to fund geophysical exploration campaigns.

The mining support service sector needs to be commercialized. A specific study should be undertaken of the markets, training and capacity building requirements in the organisation and the possibility of involving international industry in some way.

Initial tasks would include a detailed audit of the laboratory facilities, the geophysical department and the drilling department. These three audits would be carried out by experts in the specific fields and would have the following primary objectives:

• Laboratory Department: Benchmark against international best practice, define which markets the laboratories do/could serve, examine the case for laboratory certification and

recommend the scale and type of laboratory that should be supported by the government, with budgets and markets.

- *Geophysics Department*: Determine the skill and know-how levels within the department. Define the types of programmes that the department should be carrying out, including its provision of services to the public/private sectors. If the objectives warrant it, develop a scope of work for an airborne geophysics survey over target parts of the country (to be performed by an international contractor in association with the GSMRB Geophysics Department: see Section 10.2).
- Drilling Department: Audit the existing equipment and drilling skills and determine which markets it might be able to serve effectively (if any). Develop a commercialisation plan, with the possible medium to long-term objective of seeking private investment.

Se	Service Provision		
5	Laboratory Department	Carry out detailed study of the laboratory facilities, define markets, review need for outside certification. Review business case.	
6	Geophysics Department	Audit the Department, define training/capacity building needs, define objectives and scope for a modern airborne geophysical program.	
7	Drilling Department	Carry out detailed study of the drill facilities, define markets, review need for outside certification. Review business case.	

10.2 TECHNICAL PROGRAMS TO SUPPORT MINERALS SECTOR PROMOTION

Technical support programs in the context of this report are those that would invest in improving the understanding of the geology and mineralization of Yemen. In fact they would in part be a continuation of previous programs carried out in cooperation with the BGR.

- Geological mapping to 1:100,000 scale
- Airborne geophysics for mining purposes
- Specific studies on minerals prioritized according to their commercial potential

The GSMRB is continuing the program of producing 1:100,000 geological sheets. It is understood that they would benefit from an experienced mapping geologist. An audit should be made of their mapping techniques and if necessary an international expert or company should be assigned to work with the teams to transfer knowledge of modern mapping methods and to assist in completing the series of 1:100,000 maps.

The current geophysical team requires support to improve the understanding of the current state of practice. Following the work defined above, a consulting geophysicist should define training and capacity building needs, review the existing data from the historic surveys and, if appropriate, define the objectives and scope for a modern airborne geophysical programme, which could then be carried out with the cooperation of the department.

The GSMRB has recorded the presence of a wide range of minerals, in particular industrial minerals that could be potentially commercially important. A country-wide review of the data available at the GSMRB should be performed and specific studies scoped in order to provide specific data for judging whether the minerals could be exploited, the markets available inside or outside Yemen and the possibility of adding value in Yemen. The results might be initial business

plans for implementation by local SMEs or for presentation to potential foreign investors, if the size of the deposits and the markets justify it.

Tec	chnical Support Programs	
8	Geological mapping	Define GSMRB needs for mapping assistance, prepare scope of work and implement geological mapping program
9	Airborne geophysics	Further to audit of the Geophysics Department and scoping of new program: implement program
10	Specific studies on minerals	Carry out specific studies for minerals defined as potentially commercially important.

10.3 SMALL-SCALE MINING SECTOR

The encouragement of the SSM sector is considered a possible mechanism for involving the local population more meaningfully in the economy and providing jobs and income to tribal areas. Currently in Yemen the natural stone sector has a history of small-scale quarrying and stone production operations. Apart from some lime production and limited gemstone mining, there is little other mining culture in Yemen. The feasibility of developing this sector will also depend on understanding local cultural realities and this would need to be a part of any future programme.

A staged approach to the evaluation and development of the SSM sector is proposed.

The first task would be to identify the potential for SSM based on existing references and reports in the GSMRB library and on the experience of GSMRB staff. From a brief review of the mineral occurrences already identified in Yemen, possible targets could include:

- Gold
- Gemstones
- Tantalum/heavy sands
- Base metals
- Industrial minerals gypsum, feldspar, fluorspar etc.
- Limestone for lime production
- Building stones

Having identified likely targets, the approach would then be to work closely with the tribal chiefs to develop a programme. It would likely be possible to choose a small number of pilot schemes, probably three to four in diverse regions of Yemen. If the building stones sector is included, a larger number of projects might be defined; a specific section on this aspect is provided in Section 10.5.

Sm	Small Scale Mining sector		
11	Identification of Potential for SSM	From existing data, define the commodities that might be amenable to SSM and identify regions/zones of priority. Particular attention will be paid to NS target identification, based on market demand	
12	Pilot programs	Define pilot projects	

In the areas chosen, a limited number of local people would be selected to participate in the programme. The importance of mentoring by Yemeni professional staff will be paramount (see the discussion of training GSMRB staff below).

The programme will therefore comprise three pillars, once the pilot project areas have been identified:

- Involvement of the local population
- Locally focused project development
- Government/GSMRB level support

These pillars and their interaction are described in the following paragraphs.

10.3.1 Involvement of the Local Population

Since one of the key objectives would be to encourage the local population to become involved and to take ownership of any SSM activities, it will be important from the early stages to involve the tribal elders or chiefs in any program discussions.

If it is possible to choose areas where some business such as stone quarrying is already exists, then the work would at least start from a basic level of understanding the business and it may be possible to select some of the younger elements for training in the skills required. At least one of the team members should be someone who understands the cultural background of the local population. At the early stages it is probable that all the interlocutors would be Yemeni citizens who can relate to the population: the inclusion of foreign experts at too early a stage might be counterproductive.

12	Involvement of	Ensure that the local population understand the objectives
15	Stakeholders	and "buy in" to the projects

10.3.2 Project Development

The principal tasks for the development of the projects would be:

- Define the likely resource
- Identify the market
- Develop a (simple) mining plan, including local beneficiation to the degree possible
- Check business case
- Identify training needs of the local community
- Develop project in association with the local community, ensuring that:
 - Development takes account of possible upsides of the resource size
 - o Environmental impacts are managed/minimized
- If a larger resource or potential project is identified, ensure the local population maintains a stake

14	Program development	Carry out the tasks necessary to implement the pilot programs
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10.3.3 Government/GSMRB Level Support

Government support to the local initiatives would comprise both, assistance during the project development and ongoing support through the establishment of local extension service offices in the key regions.

Though it might at first seem logical to locate extension service offices in regional GSMRB offices, they should be close enough to the areas of mining development to be readily accessible, without being too decentralized. The locations would therefore be decided as a function of the project locations.

The extension service offices should be able to provide support in key areas such as:

- Geology
- Mining
- Marketing, management and accountancy/fiscal issues

It would be unrealistic to expect all these services to be immediately available all the time, and so a feasibility study should be performed to identify the specific needs in each area.

The GSMRB staff will also require training specifically for this support and such training would include:

- Economic geology,
- Marketing,
- SSM practices (including equipment),
- Environmental impact assessment and management,
- Management and accountancy.

15	Training	Training of GSMRB staff
16	Extension Services	Establish support services to the Industry

A summary of the proposed SSM support program is provided in Table 10.1 below.

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		t.	onsultar mal exp	onsulta mal exp	perts	nations	.n	fices to ness
		Commen	Local c internatio	Local c internatio	Local ex	GSMRB, with inte	Courses overseas	Local of effective
	e Development of Small-Scale Mining	Scope	From existing data, define the commodities that might be amenable to SSM and identify regions/zones of priority	From above and from a preliminary understanding of the markets, identify the best starting projects, ensuring they are spread across the country	Hold meetings with local chiefs and a mixed team of local social workers and technical staff from the GSMRB. Explain the benefits of developing an industry over which the local population can have some control and establish a team of local people who will work to make the projects a success. This might include local elders as well as younger people who would be trained to work on the projects and manage the future development	Define likely resources, identify market, develop (simple) market plan, including local beneficiation to the degree possible, check business case, identify training needs of the local community, ensuring that: Development takes account of possible upsides of the resource size, environmental impacts are mitigated	Complement overall GSMRB training program. Subjects will include: economic geology, marketing, SSM practices, environmental impact assessment and management, accounting	Define local needs to support the industry. Set up local extension offices which will have support from the center
0	Development of Program for the	Objective	Define potential for development of the sector	Define a few pilot projects	Ensure local population understanding of the objectives and "buy in" to the projects	Define all the tasks necessary to implement the pilot programs	Training of GSMRB staff	Establish support services to the industry
		Description	Identification of Potential for SSM	Pilot programs	Involvement of stakeholders	Program development	Training	Extension services
		Task No	1	5	e e e e e e e e e e e e e e e e e e e	4	5	9

Table 10.1 Summary of Program for the Development of Small-Scale Mining

10.4 TRAINING

Training is always an important part of any programme of investment and development. Many technical assistance programmes have failed to deliver their full potential due to inadequate follow-up and the lack of provision for continuous training or "professional development".

It is important that training programmes involve people at all grades of an organisation. Senior grades must maintain up-to-date knowledge of the sector and more junior grades need to acquire the most modern tools of the trade. Such programmes should also play an important role in providing Yemeni staff with the skills needed to interact with international experts or investors. The outline given below will attempt to meet these requirements.

A training needs analysis would be a first step to understanding existing strengths and future requirements depending on responsibility levels.

Tra	Training		
17	Training Needs Analysis	Analyse the training needs of staff according to their intended role in the GSMRB. Define appropriate short-term and long-term training programs	

10.4.1 Management, Economic and Financial Skills Training

Management skills include an understanding of mineral economics, presentational skills and possibly business administration skills. The objectives of this training would be to:

- Provide a deeper understanding of the economic case for exploring for and developing specific mineral prospects,
- Improve the understanding of mineral markets,
- Develop skills in economic modeling of mining prospects (and thus to understand the concepts of investment, cash flow, net present value and return on investment),
- Improve capability and confidence in presenting the sector to investors and other stakeholders (promotion),
- Improve the management of staff.

In the context of Yemen, it might also be useful to expose chosen staff to the type of political and public relations skills needed to communicate effectively with local tribal leaders.

The recommended training programme would thus include seminars in Yemen on mineral economics and mineral promotion, on marketing of minerals (metals, industrial minerals, and stones) and possibly social and environmental management. A number of staff would be selected to attend courses overseas.

10.4.2 Technical Skills Training

In a number of areas the GSMRB staff would benefit from updating their skills to keep up with recent advances. Some of these areas are:

- Mapping practice: best done by working with experienced mapping geologists
- Geophysics: the use of airborne methods has advanced significantly in the recent years
- Environmental assessment/modeling
- Geological modeling (use of software such as Surpac, Vulcan etc)

• Databases etc (ArcGIS, Mapinfo)

The recommended training and capacity building programme includes detailed training needs assessments and programmes to assist Yemeni technical staff in upgrading their skills.

Tra	ining	
18	Mineral Economics	Introductory course for GSMRB staff in Yemen and specific in-depth courses overseas for selected staff
19	Mineral Legislation	Introductory course for GSMRB staff in Yemen and specific in-depth courses overseas for selected staff
20	Technical Skills	Following training needs analysis, define and arrange for training in Yemen and overseas for GSMRB technical staff in a range of specialties.
21	Presentational skills	For staff responsible for promotion of the sector and selected senior management.
22	Markets	For staff responsible for reporting on possible deposits, for reviewing feasibility reports from operators and promotional staff
23	IT and database	Specialist training for IT sector, including databases and website maintenance.

10.5 THE NATURAL STONE SECTOR

The NS sector warrants its own capacity building programme. This would concentrate on training to SMEs, communities and related associations operating in this sector.

Since the objective will be provide support directly to the communities, it would be important initially to identify the commodities and regions with the greatest potentially for success. Pilot projects would subsequently be identified and training designed around those.

Associations of producers are useful in effectively spreading market knowledge and sharing in the support programmes. The existing efforts in Yemen will be taken into account, but for the purposes of this report, it is assumed that two associations might be created for DS and BS, respectively.

Capacity and Capability Building – Training, to SMEs, Communities and Related Associations Operating in the Natural Stone Sector					
24	Identification of Potential for Quarrying	From existing data, define the commodities that might be amenable to NS quarrying and identify regions/zones of priority, based on market demand (see also No. 11).			
25	Pilot programs	Define pilot projects (quarries and processing plants) among the existing and/or new sites from the results of No. 24 and also from knowledge of the social and environmental backgrounds of the areas.			
26	Support to NS Association	Support to the creation and development of a new Associations of NS producers. Two possible different Associations could be created for DS and BS.			

27	Training	Training for SMEs in quarry search and evaluation, quarrying methods and equipment, processing, marketing and management. The objective of this project is to establish skills within the SME community that can be used for future development of the sector and a professional approach to the market (domestic, regional and overseas).
28	Training of local communities	Training and educational programmes for rural artisanal quarrying communities on quarrying and management.

10.6 INFRASTRUCTURE

A significant constraining factor on the potential growth of the mining industry in Yemen is the remote location of mineralized areas in relation to available infrastructure, as described in Chapter 6. Stakeholders have identified the need for strategic investments to alleviate this constraint.

In this respect the ambitious plans proposed by the Government of Yemen through the GSMRB have been considered.³² This proposal was referred to in Chapter 4 and 5, which discussed the plans for a railway line from Sana'a to a coastal port, as well as the development of a new industrial city. The project also includes the construction of a technical centre for teaching modern scientific processes for exploitation of natural resources, and security and safety techniques in the mines in order to improve the level of mining technicians in Yemen.

The feasibility of the project has not been evaluated. Rail solutions for transportation of minerals and other goods must fulfill a number of economic conditions. Railroads of this size and scope are only very rarely economically viable, given that, as a rule, a large and consistent mineral supply needs to be guaranteed over many years. At this stage this proposal's suitability needs to be further explored and it is therefore proposed to conduct a scoping study of infrastructure solutions which would include an assessment of GSMRB's proposal. Were a rail-based scheme of this kind to be shown to have promise, a pre-feasibility study could then follow.

Infrastructure Projects Proposed				
A	Railway and Port Development	Scoping Study of proposal in The Project of Development of the Mining Industry in the Republic of Yemen, The Department of Promotion and Evaluation, GSMRB, 2008		
В	Railway and Port Development	Pre-Feasibility Study of proposal in The Project of Development of the Mining Industry in the Republic of Yemen, The Department of Promotion and Evaluation, GSMRB, 2008 (if step A/scoping study arrives at a positive conclusion)		

³² The Project of Development of the Mining Industry in the Republic of Yemen, The Department of Promotion and Evaluation, GSMRB, 2008