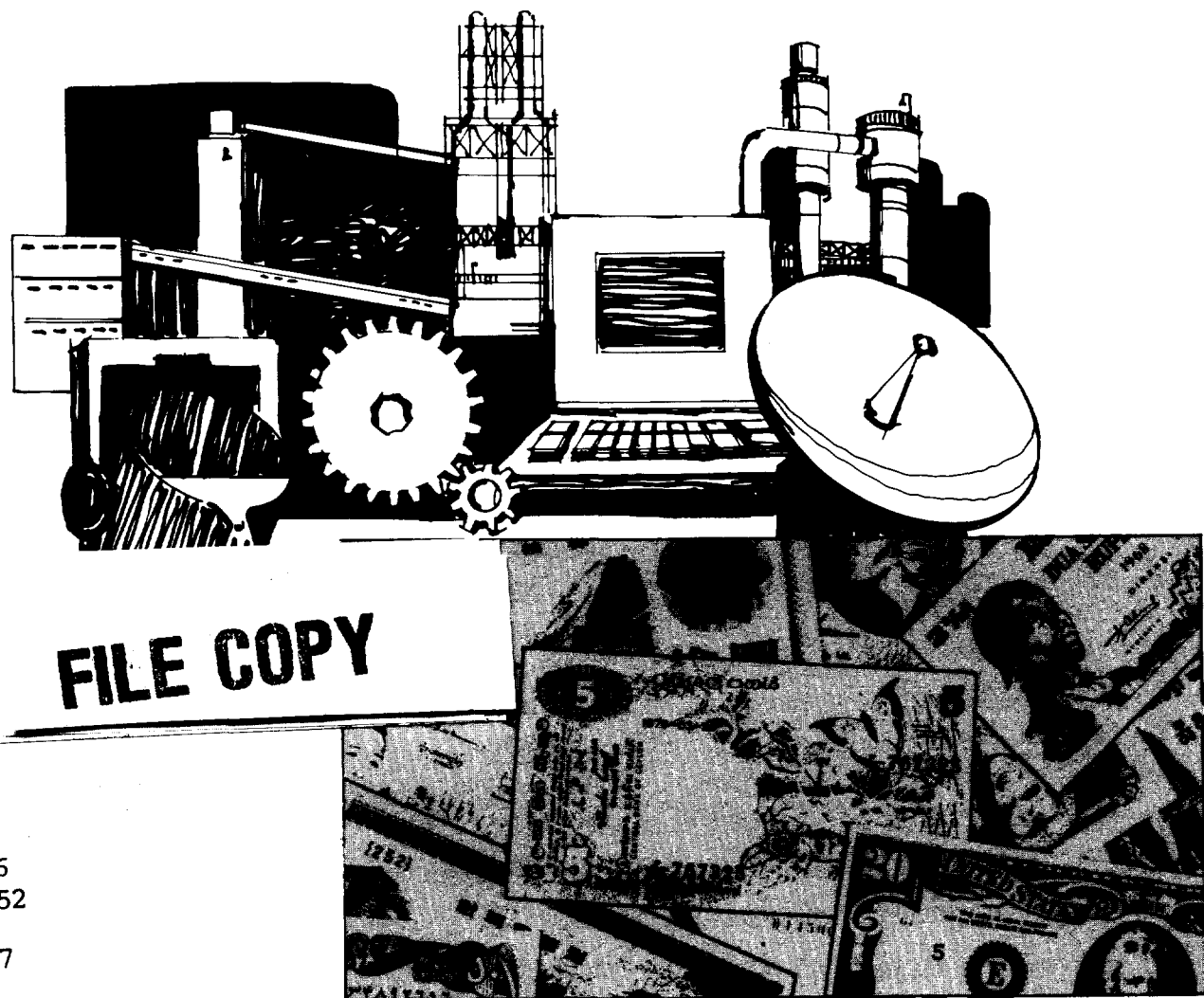


# Small-Scale Mining

## A Review of the Issues

Richard Noetstaller



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## A Review of the Issues

Richard Noetstaller

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ABSTRACT

The paper addresses the principal issues generally associated with small-scale mining in less developed economies and summarizes constraints and barriers that adversely affect SSM establishment and self-reliant growth in this country group. It examines conditions and circumstances under which small- and medium-scale mining is economically justified or desirable as opposed to large-scale operations and identifies options for promotional action in support of this segment of the extractive sector.

Due to the absence of scale-effects, small mines are, *ceteris paribus*, high cost producers that require favorable geological conditions, high-grade mineralizations or an infrastructurally isolated local market to remain competitive vis-à-vis large operations. Key size-related attributes making the SSM-operations particularly attractive for the lower-income developing countries include low investment costs, short implementation periods combined with the creation of above average employment opportunities for low-skilled labor, frequently in rural areas. In addition, small mines permit the extraction of numerous, otherwise unexploitable small mineral deposits.

The paper concludes that in most LDC's specific promotional initiatives will be required to strengthen the SSM-segment. The introduction of a size-neutral policy environment together with extensive technical and financial assistance provided by multinational lending or development institutions to be channeled through competent national intermediaries and local commercial banks, are key elements in programs designed to accelerate small-scale mining development in LDC's.

GLOSSARY OF ABBREVIATIONS

BAMIN	=	Banco Minero de Bolivia
CADETAF	=	Centrale d'Achat et de Developpement de la Region Miniere du Tafilalet et de Figuig
CFM	=	Consejo de Fomento Minero
COMIBOL	=	Corporacion Minera de Bolivia
CRM	=	Consejo de Recursos Minerales
ENAMI	=	Empresa Nacional de Mineria
FONEM	=	Fondo Nacional de Exploracion Minera
GDP	=	Gross Domestic Product
LSM	=	Large-Scale Mine
MLI	=	Multinational Lending Institution
MSM	=	Medium-Scale Mine
Mt	=	million tonnes
Mt/y	=	million tonnes per year
n.a.	=	Data not available
NGO	=	Non-Government Organization
SMM	=	Small and Medium-Scale Mines
SSE	=	Small-Scale Enterprise
SSM	=	Small-Scale Mine
st	=	short tons
tpd	=	tonnes per day
tpy	=	tonnes per year
UNRFNRE	=	United Nations Revolving Fund for Natural Resource Exploration
U.S.A.	=	United States of America
U.S.B.M. (USBM)	=	U.S. Bureau of Mines
U.S.\$	=	United States Dollars
VSSM	=	Very Small-Scale Mine

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SUMMARY

1. Small-scale mineral properties represent a segment of the extractive sector with a high potential to create beneficial effects in the less advanced economies. Major arguments in favor of small-scale mine (SSM)-development are the utilization of otherwise unexploitable small mineralizations, high absorptive capacity of low-skilled labor in rural areas, efficient use of scarce capital, modest infrastructural requirements, opportunities for indigenous entrepreneurial development, conservation of scarce high-skilled manpower, low investment costs and short implementation periods.

2. In view of the absence of scale-effects, small mines are, in general however, high cost producers. In a competitive market they can, therefore, only succeed if they enjoy cost-reducing, comparative advantages, sufficiently strong to compensate for the under-utilized scale-effects. In metal mining, producing commodities for export markets, small mines are viable only if they extract considerably higher grade ore than their large-scale competitors. Ease of access, mining and processing may provide further comparative advantages to small operations. For SSM's extracting low-value, high-volume commodities such as coal and industrial minerals, proximity to consumers together with infrastructural isolation of local markets provides the necessary comparative advantage vis-a-vis low-cost, large-scale producers. A significant comparative advantage moreover, lies in the low labor costs of developing countries, provided appropriate technologies are employed. Moreover, the higher the capital-labor-cost ratio, the higher the comparative advantage of small labor-intensive operations. Low-income developing countries, therefore, present particularly favorable targets for SSM-activities.

3. Apart from their inability to benefit from scale-effects, small operations are usually confronted with constraints and barriers which prevent or retard their spontaneous development and self-reliant growth. Constraints frequently identified include a policy environment favoring large-scale investment and discriminating against small enterprises, an institutional framework inadequate to support the small-scale segment, regulations and circumstances that exclude small operations from institutionalized finance and lack of appropriate marketing facilities. The inherent qualities of SSM's and their beneficial impact on developing economies together with the existence of specific constraints discriminating against them, provide the fundamental justification for SSM-promotion and outside intervention. A number of key options have been identified which, if combined in sufficient quantity and quality, will result in an adequate promotional strategy for the target segment.

4. An essential policy recommendation is to minimize the application to the target segment of tax duty regimes that directly increase costs, e.g. production taxes, export taxes and royalties, a measure which is justified due to its positive effect on increasing the domestic natural

resource endowment. To the extent that taxation appears necessary, only reasonably dimensioned profit taxes should be levied, to be applied in combination with adequate depletion allowances. Tax holidays are not considered favorable due to their potential of temporarily inducing highgrading practices. Similarly, depreciation allowances for mining equipment should be granted cautiously in order not to jeopardize the choice of the appropriate technology. Conversely, all expenses for evaluative and operational exploration must be made fully tax-deductible.

5. Licensing and registration procedures required to obtain exploration or mining rights have to be simple, rapid and inexpensive. Free access to public land and grant of rights to first applicant are powerful instruments to enhance interest in SSM-activities. Free transferability of concessions to parties meeting eligibility criteria is desirable, while guaranteed entitlement to be granted mining rights once a prospect is found viable is an essential precondition. Regulations regarding minimum concession area, duration and annual work program are considered important. An appropriate definition of environmental, health and safety standards and documentation requirements is also a necessity, in order to assure adherence to minimum standards without creating unduly strong barriers to entry.

6. Institutional assistance is one of the most critical elements in a promotional strategy. It is important that institutions which assume the responsibility for assistance in the target segment, are completely autonomous, compact, competent and efficient. To reach this goal, it must be assured that agencies are staffed with highly qualified and motivated personnel by offering attractive salaries and adequate fringe benefits for extended field assignments. Institutions, furthermore, have to act through regional offices in SSM-districts, equipped with field laboratories and ore collecting stations, where appropriate. In its relationship with the target sector, emphasis must clearly be on the guiding and enabling function of the agency, rather than on the controlling function.

7. In the absence of private companies providing these services, the installation and operation of mobile or regional concentrators in metal mining districts has to be taken over by public agencies. Treatment charges should reflect the full costs of these services. Additional functions of these agencies could include the provision of technical assistance from property evaluation through mine planning and operation, product marketing, and to a lesser extent, financial assistance.

8. Financial assistance should preferably be provided through local commercial banks, which frequently have a large branch network with branch offices close to mining districts and greater lending and collecting experience with small borrowers than public institutions. Incentives to increase commercial bank involvement include the introduction of risk-sharing schemes and larger spreads during initial years while

confidence is still lacking, as well as rediscounting arrangements with the central bank based on the assistance of an apex institution with specialized experience in SSM projects. Concessionary interest rates for the SSM-segment, except temporarily for promotional purposes, should be avoided since experience shows that these may lead to a misdirection of funds or to less productive use of capital. Exceedingly high interest rates are equally undesirable because of their negative effect on resource utilization. Positive, real interest rates close to those prevailing on the money markets and reflecting the cost of lending appear adequate.

9. Repayment conditions of loans should be set in strict accordance with the cash-flow generating capacity of the project, and lengthy grace periods are usually not necessary in view of the short development period of SSM-projects. Lending institutions should be encouraged to accept demonstrated reserves and physical assets as collateral. This will require improved documentation which can only be prepared by SSM's with extensive external assistance. The installation of a national exploration fund is appropriate under specific circumstances, particularly in countries where large metal mining districts with a high potential for SSM-exploitation are known to exist, and where exploration has been limited in the past.

10. The provision of extensive technical assistance aimed at introducing sound mining and business practices in SSM-districts appears to be equally important. The most appropriate method is the execution of on-the-job-training programs in existing MSM or LSM-operations. In the absence of suitable training mines, the establishment of a demonstration mine by the responsible agency, operating under representative conditions, appears to be the only other option. The acquisition of sound mining and business practices is an essential precondition for self-sustaining development and growth of the target segment, particularly in places where mining tradition is weak.

11. Equally important is the provision of basic infrastructural facilities to the SSM-operators including access roads, power supplies and process water. These could be provided at no cost (e.g. roads) or reduced rates (e.g. power and process water) where specific circumstances, including considerations of regional development and employment, justify such measures. In metal mining districts, marketing assistance in the form of installation and operation of ore collecting stations, transport facilities and concentrators by a government agency may be required if adequate private facilities are not available. In such cases, an attempt should be made to encourage private companies or miners' cooperatives to take over such plants after initial operating periods have confirmed their viability. Assistance should furthermore be concentrated primarily on very small-scale mines (VSSM's) and SSM's, which require it most, rather than on medium-scale mines (MSM's).

12. Other possible incentives suitable to encourage SSM-development comprise purchase agreements with public or private institutions, the assurance of fair and attractive prices for mineral products and, where necessary, the admission of competitive commodity purchasing through licensed buyers. The opportunity of renting mining equipment for limited periods of time and equipment leasing arrangements may also prove to be highly beneficial, particularly in cases where credit for equipment purchases cannot be obtained at reasonable terms. Combined packages comprising purchase agreements associated with the provision of working capital and rental equipment are highly attractive arrangements for small producers.

13. Where ore reserves and geological conditions permit, growth of mine size should be encouraged to avoid the smallest, highest-cost operations and to enhance benefits resulting from scale-effects. Capacity increases, however, have to be planned carefully and implemented cautiously to exclude undesirable losses of the inherent beneficial effects of the target segment. In economies with a high capital-labor-cost-ratio, such as in lower-income developing countries, the average mine-size should be kept smaller than in countries where capital-labor-cost ratios are lower. In the MSM-segment, further capacity increases usually will not result in an additional overall net benefit so that growth-promoting measures should be concentrated on the lower end of the target segment.

14. The choice of technology is a particularly delicate matter since potential beneficial effects associated with SSM-activities are highly related to the use of the appropriate technology. Here again the prevailing capital-labor-cost ratio is the critical quantity. The rule to be applied is that high values of the capital-labor-cost ratio favor the use of a mining technique with a lower degree of mechanization, as do smaller mine sizes, and vice versa. The use of a capital-intensive technology in small mining is economically incorrect and results in the loss of the potential benefits of the target segment.

15. Both management and organizational structures have to be adjusted to the size of the enterprise. Full size SSM's and MSM's have to have a formal organization with a one- to two-level management organization and a departmentalized structure, while the smaller mines will usually have to be owner-managed with a simple organizational structure. Private companies are the preferable form of ownership in small-scale mining. Of particular importance appears to be the introduction of adequate bookkeeping and accounting procedures in the target segment.

16. For VSSM and smaller SSM-operations, the formation of miners' associations and cooperatives is the only possibility of partially capturing scale-effects. In the absence of other options available to strengthen the position of the small operator, such formations should be encouraged. While their usefulness is disputed, evidence exists that they can operate successfully provided that they are established in a voluntary effort of individual small miners, rather than on the initiative of

authorities and that they limit their role to providing certain services to their members at cost, rather than to attempt operating mines on a collective basis. Functions of cooperative organizations should primarily include maintaining ore collecting stations, assaying facilities and concentrators, equipment rental and the provision of operating supplies at cost, to the extent that such services cannot be obtained from other organizations at lower cost.

17. Multinational lending institutions (MLI) can play an essential role in the process of promoting and stimulating activities in the SSM-segment. In view of the repeatedly demonstrated, favorable economic impact of SSM-activities, MLI's should continue to expand their involvement in supporting the sector. Low-income developing countries apparently offer the best targets. Promotional initiatives should be extended to industrial minerals and coal produced for local markets, as these commodities create substantial domestic linkages and carry relatively low risks.

18. In the promotional approach, MLI's should continue to initiate policy adjustments in target countries aimed at creating an economic environment conducive to SSM-growth and to expand the capabilities of institutions acting as executing agencies. In cases where severe distortions discriminating against SSM's have been identified, the effectiveness of MLI loans should be made conditional upon the initiation of adequate policy reforms. Increasing emphasis should be placed on channeling funds through commercial lending institutions and on expanding non-financial assistance, particularly on introducing sound mining and business practices through on-the-job-training programs in existing mines. The use of appropriate technologies and further domestic processing should be encouraged in an effort to enhance economic benefits. Where project conditions are not favorable, a staged implementation approach should be followed, rather than excluding a target from promotional initiatives a priori.



## I. INTRODUCTION

1.01 In recognition of the essential role of natural resources in economic development, the mining sector has traditionally attracted considerable interest both on a national and international level. In this context the small-scale mining sector has recently received increasing attention as a promising goal for intensified developmental efforts. While this was motivated by empirical evidence that small enterprises contribute significantly to economic progress and have considerable potential for development, diverse opinions exist regarding promotional approaches to and economic justification of small-scale mining.

1.02 Responding to this situation, this Small-Scale Mining Review was initiated. The paper's objectives are (i) to identify and evaluate development constraints and issues of this target sector and to recommend strategic actions for their solution, (ii) to evaluate approaches, policies and strategies governments and private organizations have followed dealing with this segment of the mining industry and to derive and formulate policy recommendations to serve as guidelines for future Bank operations, and (iii) to define circumstances under which small- and medium-scale mining is economically justified and to make recommendations as to the Bank's role and approach to support the sector.

1.03 The review has been carried out as a desk study, based on an assessment and interpretation of the relevant professional literature published within the past 15 years as well as the documentation of Multinational Institutions' (MLI) lending experience to small enterprises in general and the small- and medium-scale mining sector in particular. In addition, the elaboration has been greatly assisted by two recent papers on the subject that provided both fundamental insights into the problem and valuable direction in addressing it. 1/, 2/

1.04 While an extensive and valuable volume of literature exists on the subject, one major problem has been the lack of coherent quantitative and statistical material aggravated by the poor comparability of data resulting from the absence of a common, universally applied definition of the terms small- and medium-scale mining. The large number of issues to be addressed, the heterogeneity of mineral commodities combined with the uniqueness of individual mineral deposits and the great differences between nations, have further added to the complexity of the subject. This led to the necessity to treat the subject on a comparatively high aggregate analytical level and to frequently rely on judgement in the evaluation and interpretation of issues, the selection of options and the drawing of meaningful conclusions.

1.05 In Section II, an attempt is made to arrive at a broadly applicable working definition of scale segments for the purpose of this study. It also examines the contribution of the small-scale mining segment to socio-economic development and its share within the industry. Section III explores the characteristics and implications of small-scale mining

while Section IV seeks to provide solutions appropriate to strengthen the sector. Section V identifies conditions and circumstances under which small- and medium-scale mining is economically justified or superior and includes a delineation of the principal characteristics of potential target areas. In Section VI options for the promotion of the sector are investigated and an approach for assistance by MLI's is developed.

II. DEFINITION AND SIGNIFICANCE

A. Concepts and Definitions

2.01 In spite of the frequent use of scale concepts, a universally accepted consensus regarding the definition of the terms small-scale and medium-scale mining in quantitative units does not exist. This is attributable to the fact, that a number of factors can basically be employed for demarcation purposes, each apparently particularly suitable in a specific situation. Generally, definitions are based on one or more of the following criteria which exhibit distinct variances as a result of the scale of operation, as indicated:

Criterion	Generally Observed Quality for	
	SSM	LSM
Mine output in tpy	small	large
Number of persons employed per unit of output	large	small
Gross annual income of firm	low	high
Degree of mechanization or capitalization	low	high
Labor productivity	low	high
Size of mining concession or lease	small	large
Size of reserves	small/unknown	large/well known
Continuity or intermittence of operation	frequently intermittent	continuous

2.02 For reasons discussed in paragraph 2.03, mine output is the only broadly applicable and universally acceptable measure for the delineation of scale of operation in the mining industry. To allow for the wide variations in the content of the valuable mineral components in in-situ ore, both between individual commodities and deposits, mine output has to be measured in terms of run-of-mine (r.o.m.) ore. Of this output, varying but generally very small proportions represent the mineral to be extracted through the following processing stages. Since it is general practice to report mine production in tons per year, mine output in tpy r.o.m. ore will be employed as the main criterion for the definition of scale segments.

2.03 It is obvious that a small number of employees may be equally indicative of a highly mechanized, large-scale open-pit operation or a small underground mine using traditional or intermediate technology, resulting in different levels of labor productivity. Even if measured per unit output, the number of persons employed is strongly variable in accordance with the type of operation and the geological features of the deposit. Gross annual income largely depends on the unit value of the commodity produced which varies widely within the industry. The size of

the mining lease required to permit a desired scale of operation is influenced by geological characteristics, such as the shape and type of the mineralization, while the size of reserves is dependent, inter alia, upon ore grade. Continuity or intermittence of operation, finally, may be caused by factors other than seasonal employment in other sectors of the economy, e.g. climatic aspects or market forces. As a result, these criteria are suitable only as additional indicators and for orientation purposes in the demarcation process.

2.04 In an attempt to arrive at a quantitative delineation of scale segments, it is appropriate to examine the economic consequences of scale variations. Ample evidence exists that the mining sector is characterized by substantial economies of scale. <sup>3/</sup>,<sup>4/</sup> This means that, ceteris paribus, larger scale mines produce at lower unit costs than smaller operations. In this context, the term "ceteris paribus" refers primarily to comparable geological conditions and mining technology. Theoretical considerations supported by comparative observations suggest that the unit cost disadvantage of small operations becomes extremely severe in the lowest size segment that corresponds to approximately 10-20% of the production capacity at which the minimum cost level can be attained. From the same relationship it appears that under comparable operating conditions there is little difference in the unit cost between medium- and large-scale mines and even between the lower and the upper segment of the medium-scale operations.

2.05 A further narrowing down of quantitative demarcation lines is complicated by the fact that the long-range average-cost curve, reflecting the effects of economy of scale, is different for individual commodities and types of operation. For typical large-volume minerals extracted in open-pits, e.g. iron ore and coal, the threshold capacity at which the minimum unit cost level is reached, is higher than for a typical low volume mineral extracted in underground operations. This appears to be the main reason why a generally accepted, single, quantitative segment demarcation has not been put forward and may not be practical. A brief review of statistical data on the global distribution of Western World non-fuel mine sizes serves to illustrate the situation.

2.06 Annual surveys of the number of producing mines in different size categories above 150,000 tpy have been published by Mining Magazine for many years. A summary of the 1986 survey in the form of the world total is presented below. <sup>5/</sup>

Size Range (Mt/y)	Number and Share of Producing Mines			
	Open Pit		Underground	
	No.	%	No.	%
0.15 - 0.30	89	16	201	30
0.30 - 0.50	57	10	135	20
0.50 - 1.00	91	16	134	20
1.00 - 3.00	123	22	137	20
above 3.00	197	36	68	10
World Total	557	100	675	100

According to this survey, which does not include the size category below 150,000 tpy that is thought to contain the small scale mine (SSM) segment, 50% of the underground mines fall into the category 150,000-500,000 tpy, while 30% have a capacity of 150,000-300,000 tpy. The respective figures for surface mines are 26% and 16%. From the large proportion of producers in the lowest category it can be concluded that this segment already enjoys the benefits of economy of scale in the form of low unit cost. Thus, the demarcation line between the SSM- and the Medium-Scale Mine (MSM)-segment must be well below the 150,000 tpy mark. The data also clearly indicate that the demarcation lines for underground and open-pit operations should be set at different capacity levels.

2.07 It, therefore, appears appropriate to select different segmentation lines for the mining sector depending on the type of operation. This will be facilitated by reviewing a selection of classification limits as proposed or adopted by different authors and as presented below.

		Classification Value in tpy r.o.m. Ore		
	SSM		MSM	Source
below	50,000		-	United Nations, 1972
below	50,000	50,000 to	500,000	P.C. Kotschwar, 1986
below	100,000		-	J.S. Carman, 1985
below	100,000	100,000 to	1,000,000	G.F. Leaming, 1983
below	100,000		-	D.N. De Bord and W.G. Mikutowicz, 1981
below	100,000		-	U.S.B.M., 1983
from	20,000 to	200,000	-	D. Ingler, 1983
below	150,000		-	<u>Mining Magazine</u> , 1986 and previous years
below	50,000	50,000 to	1,000,000	J.C. Fernandez, 1983
below	60,000		-	G. del Castillo, 1980

While most authors agree that quantitative classification limits employed have been drawn more or less arbitrarily, it is interesting to note that the upper SSM-demarcation line varies from 50,000 tpy to 200,000 tpy with the 100,000 tpy mark chosen most often.

2.08 If one of the principal motives for selecting quantitative classification limits is to establish criteria for eligibility evaluation for assistance programs, demarcation lines have to be set sufficiently narrow to permit efficient treatment of individual segments in accordance with the respective needs. As a consequence, the following segmentation is adopted for the purpose of this study, admittedly also with a certain measure of discretionary judgement.

Size Segment	Mine Output in tpy r.o.m. Ore	
	Underground Mining	Surface Mining
VSSM	below 5,000	below 10,000
SSM	5,000 - 50,000	10,000 - 100,000
MSM	50,000 - 500,000	100,000 - 1,000,000
LSM	above 500,000	above 1,000,000

In spite of the narrow segmentation, a number of mines with output levels corresponding to the SSM and MSM category are not exposed to the issues and constraints typical for the majority of smaller mines in developing countries. For the analytical purposes of this paper and with a view to eligibility assessment as well as assistance program design, further qualifications are, therefore, desirable. Accordingly, SSM and MSM shall refer to mining operations with output levels as specified above, yet only to the extent that they are confronted with barriers to entry regarding access to institutionalized credit and marketing of mine production.

2.09 The definition chosen here is primarily of an indicative nature. It will not always be in full congruence with data presented in the following sections in the form of quotations under the terms SSM and MSM. Conclusions reached in the analysis would, however, essentially not be different if segmentation boundaries were somewhat relaxed.

#### B. Share of Small-Scale Mining

2.10 A comprehensive investigation of the contribution of small mines to the global output of all major metals and industrial minerals has been conducted recently. <sup>6/</sup> The analysis which covers the segment of mines with less than 100,000 tpy mine output, concludes that the share of small mines in the global output of non-fuel minerals is about 16% in terms of gross value, equivalent to US\$21.6 billion in 1982 dollars.

2.11 The share of small mines in solid fuel mineral output is not well documented. Data on two leading coal-producing countries may therefore serve as an indication. In 1979, China produced 635 Mt of coal of which 43.7% came from some 20,000 small mines. <sup>7/</sup> Of these only 1,600 had a capacity of over 30,000 tpy. Another source reports that in 1983, the share of national coal output of approximately 700 Mt, from small mines with an average capacity of 100,000 tpy amounted to 49.2%. <sup>8/</sup> Even in the highly competitive environment of the USA small coal mines still play an important role. In 1977, a total of 20% of US coal production of 700 Mt came from mines with an output of less than 100,000 tpy, practically unchanged from previous years. <sup>9/</sup>

2.12 Similarly significant is the share of small mines in the global output of precious stones. It is estimated to be in the range of 75-80% for semi-precious stones and 10-15% for diamonds. <sup>10/</sup>

2.13 The shares of small mines for individual commodities of the commodity groups metals and industrial minerals, both in terms of mine production and estimated value are presented in Annex A. Based on data contained there and material discussed in the preceding paragraphs, the following shares of small mines in global production by major commodity groups can be estimated.

Commodity Group	Global Share of Small Scale Mining (below 100,000 tpy) in Terms of	
	Mine Production	Estimated Value
Metals	12%	11%
Industrial Minerals	31%	25%
Coal	20%	20%
Precious Minerals		
Diamonds	10%	10%
Gemstones	75%	75%

2.14 The figures presented clearly indicate that the share of small mines in world mineral production is considerably higher than the 10% generally assumed. Particularly impressive are the proportions of small mines in the output of industrial minerals and gemstones. More than 1/2 of the major industrial minerals and nearly 1/5 of the major metals are mined predominantly on a small scale. Developing countries for which an important small-scale mining activity has been reported are presented in Annex B.

#### C. Contribution to National Objectives

2.15 Under favorable circumstances, SSMS have the potential of contributing significantly to economic progress in developing countries. Traditionally, SSM activities have played an important role in the development of many nations' mineral resources by substantially contributing to new discoveries and permitting the exploitation of limited deposits. <sup>11/</sup><sub>12/</sub> Still today SSM's have or can have a significant impact on employment creation, development of regions with otherwise little economic potential, skills formation and creation of export revenues.

2.16 The true importance of the extractive industry lies in its strong linkages with the secondary and tertiary sectors of the economy, particularly in its role as a supplier of production inputs for a large number of other economic activities. Practically all services and goods marketed in a modern economy require energy, machinery or material inputs that can be traced back to minerals. Furthermore, establishing and operating mines creates demand for large quantities of capital and fixed assets, transportation services and energy. This is documented by the values of multipliers which have been determined for a number of states in

the USA that have an important small-scale mining segment. <sup>13/</sup> There, output multipliers for mining and mineral processing range from 1.3-2, while employment and income multipliers reach values from 3-5 and 2-3.5 respectively.

2.17 For a large number of developing countries, notably the minerals led economies, mineral production can also provide a substantial direct contribution. A selection of countries in which non-fuel mining provides an important share of GDP and employment is presented in Annex C. Of equally great significance is the contribution of the non-fuel mineral industry to the export earnings of the developing countries which amounted to 16% of total exports from this country group in the mid 1970's compared to 12% in the mid 1950's. Moreover, mining can have an important indirect foreign exchange effect in the form of substituting commodity imports that would be necessary in the absence of indigenous mineral extraction.

### III. CHARACTERISTICS AND IMPLICATIONS

#### A. Peculiarities of Commodity Subgroups

3.01 While minerals are an extraordinarily heterogeneous group of earth materials, certain characteristics can be identified that are specific of major commodity subgroups. Broad commodity groupings most frequently referred to comprise (i) metals, (ii) precious minerals, (iii) industrial minerals, and (iv) solid mineral fuels (mainly coal). Characteristics of particular relevance in the present context include grade-volume-value relationship; type, quantity and location of end-use; mode of occurrence and regional distribution of resources; complexity of mining and processing requirements; and stability of market parameters.

3.02 Small metal deposits require a combination of higher ore grade with higher-unit-value ores and/or favorable geological conditions to compensate for the cost disadvantages of small-scale operation. These are the main reasons why metal ores that frequently meet these conditions, such as antimony, chromite, tungsten, mercury and beryllium are mined on a predominantly small-scale while others, such as gold, silver, lead, zinc and tin have important small-scale components. For the vast majority of metals, the proportion of the valuable constituents in the in-situ and the run-of-mine ore is very small. The concentration factor, representing the reduction ratio of the volume of r.o.m. ore to that of the traded metal or concentrate is correspondingly high. Inversely this also applies to the ratio of the respective unit-values. As a general rule, the larger the mineral-specific concentration factor, the more urgent is the economic necessity for concentrating the ore close to the point of extraction.

3.03 Another peculiarity of metal ores is that they require pyro-or hydrometallurgical processing for the production of tradable metal. As a consequence, investment costs per unit output are considerably higher for metals than for other mineral subgroups. Moreover, modern smelting operations are highly energy-consuming and demanding in terms of skilled-labor, all factors that have special implications for small-scale projects in developing countries. On the other hand, smelters usually are the least profitable element in the mining cycle. A special characteristic of some metals, their potential of being recycled and substituted by other materials, will have dampening effects on the growth of primary demand, international trade and depletion. Noteworthy is also the tendency of the price of many metals for short-term fluctuations and its sensitivity to changing levels of economic activity. In addition, short-run price elasticities of metals are generally low due to the fact that metal demand is a derived demand from a multitude of end-uses and lead times for increasing productive capacities are long. For the same reason, metals are of strategic importance to most modern industrial economies. Local demand for metals in developing countries is generally low, production therefore primarily serves export and foreign exchange earnings objectives.

3.04 With precious minerals, the outstanding characteristics compared to other commodity subgroups are their exceptionally high unit-value and their usually extremely small fraction of the total deposit. A characteristic favoring small-scale mining of precious stones from many small alluvial and vein deposits is the applicability of simple processing methods such as gravity separation which does not require special skills or expensive concentration facilities. Most important, however, although large quantities of ore have to be processed, the final product is obtained in extremely small quantities of very high unit-value. This practically eliminates the physical efforts in product marketing since volume transportation problems do not exist, a quality that is equally important in small-scale precious metal mining. These peculiarities are factors in favor of small operations that will be effective to reserve small mines a significant role in this commodity subgroup. As local demand in developing countries is negligible, output of these commodities is almost exclusively exported to earn foreign exchange. Another special feature is a relatively easy, albeit strongly fluctuating market in which the finished product is sold to end consumers virtually without further processing steps.

3.05 Within the industrial minerals subgroup and in comparison to all other minerals, construction materials are characterized by abundance and a very low unit value which results in an extremely strong market orientation and the need for lowest possible production costs. Production is therefore almost exclusively by open-pit and producers are located close to the points of demand, i.e., urban areas and infrastructural construction sites, since prices do not permit long hauls. Other characteristics are their evenly distributed wide-spread occurrence throughout the world and the simplicity of exploitation and processing methods associated with little or no volume reduction. These qualities, particularly the small marketing radius resulting in a dispersed pattern of small operations, make construction materials natural candidates for small-scale extraction where local demand is limited, although physical marketing requires certain basic facilities due to quantities involved. Demand for construction materials exists in developing countries already in early stages of development, increasing as the economy advances. Output, therefore is used locally.

3.06 For a variety of other industrial minerals serving a large number of end-uses, the unit-values are considerably higher resulting in a correspondingly large marketing radius. In addition, quantity demand is lower so that requirements in terms of large-volume transport infrastructure is reduced. Many of them, such as fluorspar, graphite, talcum, vermiculite, feldspar, clays, gypsum and barite are produced predominantly on a small-scale, either because they occur in small deposits or because they are produced for a limited local market. Volume reduction usually is much lower than with metals although processing and quality requirements can be quite demanding. Considerable local demand exists already in moderately advanced developing countries, growing with increasing economic activity. Production, therefore, is equally important for local consumption and export.

3.07 Coal, as the most important solid mineral fuel, is comparable in economic characteristics more readily to industrial minerals than to metals. Occurrence is fairly wide-spread and the unit-value lies between the construction materials and the variety industrial minerals. Processing is frequently comparatively simple and volume reduction through processing is small. In the absence of other low-cost energy sources, the availability of coal is of vital importance to economic development in its early phases and to the continuance of economic activity in modern industrialized countries. While coal is mined predominantly on a large scale, the examples of China, Pakistan, Colombia, Philippines and the USA demonstrate that small coal mines can competitively supply local markets within a limited transport radius.

3.08 A synoptic profile of the commodity subgroup typification developed above is presented in Annex D. It contains a summary of the relevant characteristics and their associated implications in the present context. It should be emphasized that a binding, all-inclusive typification is impossible in view of the uniqueness and heterogeneity of individual commodities and that qualifications used have to be interpreted in a comparative sense. In spite of this limitation, the profiling is helpful in demonstrating that considerable differences in the significance of development issues and constraints between commodity subgroups can be expected which necessitate variations in the evaluative and supportive approach.

#### B. Attributes and Issues

3.09 Deposit Utilization and Wastage. One of the negative aspects frequently associated with SSMs is the inclination of the small miner toward highgrading (mining only the best parts of the deposit) resulting in the poor utilization of mineral deposits and the wastage of natural resources. Reasons for this shortsighted and damaging practice are lack of knowledge of the deposit worked, combined with the intention to make a quick profit. 14/

3.10 While the extreme form of highgrading is without doubt economically undesirable, there is reason to believe that both its damaging effect and its extent in SSM is overestimated. Its practice is largely limited to narrow, vein-type metal ore deposits which constitute only one category of mineralizations worked by SSMs. Highgrading is less applicable in mining of coal or industrial minerals and in placer deposits. Moreover, the transition from selective mining, which is a generally accepted and frequently employed form of extracting mineralizations, to highgrading is gradual and qualifications, therefore, are a matter of subjective judgement. Strictly speaking, any advanced degree of selective mining can be interpreted as highgrading.

3.11 On the other side, numerous mineral deposits with complicated geometric conditions and limited resources can only be extracted by small operations. These resources would remain unutilized unless they were

exploited by SSMs. Examples range from tungsten and tin mineralizations in Rwanda to coal mined from steep, faulted seams in China, Colombia or the Philippines. The small miner, thus, frequently acts as a scavenger. <sup>2/</sup> Comparative observations of this nature lead to the conclusion that in total the positive effect of the utilization of marginal natural resources through SSM by far outweighs the damage done by localized or occasional highgrading. Even so, measures to reduce highgrading should be introduced into projects designed for mining districts, where severe damaging effects are expected.

3.12 Apart from highgrading, poor recovery of mineable in-situ mineral can be caused in cases where uncoordinated small-scale mining by a large number of individual small operators results in the fragmentation of orebodies of a size and nature that would permit exploitation by a single larger operation. Suboptimal utilization of the mineral potential also occurs if small operators lacking the financial resources for optimum-scale mine development, are allowed to tie-up large deposits that could be exploited economically at higher output levels. Such practices are clearly undesirable and have to be corrected through encouragement toward organized systematic exploitation or excluded a priori by the authorities by means of appropriate provisions in national mining codes. The same applies to situations in which small operators create safety hazards for adjacent or subsequent full-scale mines in the form of unsecured and unreported mine workings, water and gas accumulations, etc.

3.13 Exploration and Risk. Traditionally, the small, independent prospector has played an important role in the exploration of the earth's surface for interesting mineralizations and his contribution to the identification of workable mineral occurrences has been significant in many industrialized nations. It is estimated that more than 50% of the major mines currently operating in the USA derive from exploration targets found by small prospectors. <sup>13/</sup> Generally however, small prospectors and miners in developing countries lack both the knowledge and the means required for extensive target exploration and evaluation. Confirmation of mineralizations is based frequently only on a few randomly collected surface samples that are not representative and exploitation is started primarily on faith with little or not pre-operational exploration and mine planning. The typical small mine thus follows the ore immediately in sight. It is apparent that the entrepreneurial risk such miners face is enormous resulting in a high frequency of failures. Even when a long tradition of mining provides evidence of the existence of wide-spread areal mineralization, the miner has little control over the quality of r.o.m. ore without prior exploration. As a result, the erratic occurrence of values in the ore mined will always be a marketing constraint and a serious threat to profitability and ultimately existence.

3.14 With the possible exception of VSSMs worked by purely artisanal methods, a certain minimum amount of professional, pre-operational exploration, therefore is a necessity for systematic mining, regardless of

scale of operation. In the individual case, the adequate amount of exploratory work is highly dependent upon the complexity of the deposit and the financial resources required to establish a mine. Larger operations extracting complex ore from an unfavorable geological environment thus necessitate substantially more detailed exploration than small units extracting homogeneous material from a uniform undisturbed deposit. As a consequence, SSM operations in industrial minerals and coal generally require less pre-operational exploration than SSMs and MSMs in metal mining.

3.15 In order to reduce the risk element of SSM and MSM in developing countries to acceptable levels, the national mining legislation has to contain provisions that make the issuance of mining licenses contingent upon the submission of an adequate mining plan for all prospective operators. The degree of detail of such a mining plan has to be set in accordance with the individual requirements depending on mine size and nature. Since, however, exploration is both costly and inherently risky, such mining legislation has to be accompanied by a framework of incentives sufficiently attractive to keep an active exploration process alive. For the same reason SSMs will only be able to conduct pre-operational exploration work to the extent that they receive outside financial assistance at acceptable terms. Similarly, mining legislation has to include provisions that link the continued validity of exploration permits to a minimum level of annual exploration conducted, to exclude the possibility of individuals maintaining exploration rights for speculative purposes without the genuine intention of establishing a mine, thus delaying the utilization of natural resources.

3.16 Employment and Social Impact. A highly beneficial attribute of small enterprises for developing countries is that they are more labor-intensive than large firms and thus account for an appreciably larger share of recorded employment. <sup>15/</sup> The same is true for small mining operations which frequently employ large numbers of workers in rural mining districts, where job opportunities are particularly scarce. <sup>16/</sup> Examples of the employment capacity of the SSM-segment are provided for selected developing countries below.

Country	Persons Employed in SSM	Percentage of Mining Sector Employment	Source	
Bolivia	23,800	30%	U.S.B.M.	1981
Chile	11,000	15%	U.S.B.M.	1980
India	n.a.	47%	UNITAR	1980
Mexico	25-30,000	20-22%	UNITAR	1980
Morocco	39,400	40-50%	UNITAR	1980
			U.S.B.M.	1984
Peru	40,000	50%	UNITAR	1980
			U.S.B.M.	1981
Philippines	200,000	78%	<u>Metro Manila Times</u>	1986
Rwanda	11,000	n.a.	UNITAR	1980
Zaire	20-50,000	20-35%	U.S.B.M.	1985

3.17 Data presented illustrate that SSMs can contribute significantly to national employment objectives, reducing unemployment and underemployment primarily in rural areas, thus helping to control rural-urban migration. Labor intensity is particularly great in VSSM operations of artisanal mining districts, where engagement in mining is frequently intermittent in accordance with seasonal work in agriculture. Comparative data consistently show that with increasing mine size, labor intensity decreases as a result of increasing mechanization and associated labor productivity. In underground mining, employment per unit output may differ by a factor of 30 between mines using traditional, artisanal methods and highly mechanized operations. <sup>17/</sup> In surface mining, such technology-related differences in labor intensity can even be considerably larger. Including, moreover, indirect and induced employment resulting from SSM-activities, it is obvious that the total social and economic impact in a small-scale mining district can be highly beneficial.

3.18 Moreover, mining operations, regardless of size, offer an excellent opportunity for transforming unskilled labor into semi-skilled or skilled industrial labor. Here again, SSMs and MSMs, employing comparatively more persons contribute more to basic skill formation objectives than LSMs. In addition, the smaller operations using less sophisticated technology tend to conserve on highly skilled labor that is generally scarce in developing countries.

3.19 Negative aspects are that small enterprises operating outside the formal sector usually do not provide the standard of social welfare offered by larger firms. Particularly in the VSSM--and the lower SSM--segment, earnings of workers are frequently below the legal minimum wage level and social welfare programs are not made available. Most often this can be observed in regions where mining is the only or major local source of employment. In such cases, again local administrative authorities have to ascertain that a minimum standard of workers remuneration and benefits is maintained and that additional social amenities are provided to the extent the economic situation of the mines permits.

3.20 Health and Safety. There is a significant difference in safety performance between large and small mines with the former having the better record. <sup>18/</sup> Reports on VSSM and SSM operations in developing countries give evidence that often even the most basic industrial hygiene principles and safety practices are ignored, causing extremely unfavorable and hazardous working conditions for the persons engaged in mining. In cases of mine accidents, the situation is usually aggravated by the geographically isolated location of such mining districts. Accidents are most frequently caused by the absence of adequate roof support to prevent rock falls and by inadequate travelling and transport facilities in underground openings. Health problems stem from poor ventilation, sanitation, lighting and inadequate dust control.

3.21 Both from a humanitarian and an economic point of view, the consequences of poor health and safety practices are unacceptable. As a consequence, a minimum standard of health and safety measures has to be

provided in all mines, regardless of size. Mine safety codes have to be established by national authorities and enforced through mine inspectorates. <sup>19/</sup> Minimum requirements include safe travelling and transport installations, provisions for a safe roof, adequate ventilation, lighting and sanitation as well as first-aid facilities. The degree of enforcement of safety regulations has to be chosen in accordance with the individual requirements of the type of mine in each case. It is obvious that underground coal and metal mines require a considerably more stringent application of safe mining practices than open pit operations exploiting industrial mineral or metal ores.

3.22 Environmental Concerns. Environmental concerns and adherence to regulations hardly exist in the typical SSM-districts of developing countries. However, in view of the usually isolated location of mining districts, the direct effects on the population are generally smaller than from other industries. Moreover, the magnitude of the environmental impact is generally related to the size of mine output and type of mine. It is apparent that the primary effects on the environment created by SSMS are necessarily smaller than those of LSMs.

3.23 Since the preservation of the environment is a principle that does not require further justification, the adoption of measures appropriate to avoid the damaging effect on the environment is a necessity for all mining operations. Some flexibility may, however, be justified for small operations with regard to the degree and timing of environmental measures, given their altogether smaller impact and more limited resources. This pertains particularly to measures of surface reclamation and land restoration which in many mining districts in developing countries, particularly in remote, desertic areas, cannot be considered a matter of high urgency. In VSSMs and SSMS in developing countries, ecological measures should therefore usually concentrate on the installation of water tight tailings ponds to collect flotation effluents and the use of plastic membranes in precious metal leaching operations.

3.24 Technology and Efficiency. A characteristic commonly associated with small-scale mining in developing countries is the predominance of antiquated, inefficient mining methods and the limited application of modern extraction technology. In fact, artisanal mining characterized by the extensive use of human energy aided only by simple tools, is still dominating the VSSM-segment. There, mineral extraction usually involves digging or rock breaking with handheld tools, mineral concentration includes handpicking, panning and other simple gravity methods, while loading and transport of ore and concentrate is in large part also by hand.

3.25 Conversely, also numerous highly mechanized mines, generally belonging to the upper MSM- and LSM-segment, can be found in less developed countries. Frequently, these operations are established as local enclaves, poorly integrated with the economic environment of the host country. <sup>3/</sup> They allow little local backward integration, depending largely on foreign supplies of highly skilled manpower, fixed assets and spare parts to

initiate and maintain operation. The value added generated in large, enclave-type mines in developing countries is in high measure exported in the form of dividends and interest payable for foreign capital, payments for imported operating inputs and repatriated salaries of expatriate employees.

3.26 Typically, the share of the national value added generated in the VSSM and SSM-segment using simple technology is considerably higher than from LSMs and MSMs that are operated as enclaves. For the same reason, indirect and induced effects on the local economy emanating from VSSM and SSM, will generally be substantially greater per comparable unit of output. Thus, promotion of SSM appears justified even though their technology and efficiency levels are low.

3.27 Apart from economic aspects, technology in the extractive sector varies greatly in complexity and degree of sophistication with type of operation, geological factors such as type and dimensions of mineralization and material strength as well as type of mineral exploited. As noted earlier, placer deposits containing precious minerals amenable to small-scale mining can be worked successfully by very simple methods using light, inexpensive equipment. Similarly, small-scale surface mining of industrial minerals, metals ores and coal usually does not require sophisticated technology, although methods can be entirely different between commodities. On the other hand, underground mining of most minerals is much more demanding in terms of the complexity of operations and the technology required. An excellent descriptive treatment of mining practices in small operations has been provided by F.H. Skelding and F.N. Earll et al. 20/, 21/.

3.28 Entrepreneurship and Business Development. In contrast to large-scale industry, the small enterprise segment has consistently been identified as a fertile ground for the growth of indigenous entrepreneurship. 22/ Small firms thus play an important role in the industrial development process of less advanced economies. The simple explanation for this favorable attribute is that barriers to entry in terms of capital needs and formal educational requirements are considerably lower than with larger enterprises. In mining, this is particularly true for the artisanal operations of the VSSM-segment. Both financial and skill requirements necessary to start exploiting a placer deposit on a very small scale are low, growing with the size of operation and the complexity of the deposit worked. Similarly, an entrepreneur attempting to establish an open pit extracting construction materials, coal or industrial minerals on a small scale may face only moderate difficulties, while the same person can have considerable problems in starting a small scale underground metal or coal mine. Generally speaking, the smaller the mine, the closer the mineral is located to the surface and the simpler the mineral specific concentration process to be employed, the easier it is for an entrepreneur to start and develop business successfully.

3.29 Another aspect of importance in this context is that the smaller the mine, the shorter is the time to bring it into production. While the period required for the development of small mines ranges from 1-2 years, the respective values of large operations are in the order of 5-8 years, excluding time spent on pre-operational exploration. <sup>23/</sup> The longer periods are usually required in developing countries and for underground mines. VSSM-operations of readily accessible surface mineralizations, such as placer deposits, can frequently be started immediately or at least with very little time spent on development work. Rapid mine development means quick returns for the entrepreneur and early accumulation of new funds for further investment. Another aspect to be noted here is that small mining operations occasionally develop into large mines of national importance.

### C. Constraints and Barriers

3.30 Mining Tradition and Training. Since most forms of mining require unique and sometimes complex technical operations, a strong mining tradition must be considered a significant advantage when starting new operations. Even more important than experience in mining practices on the enterprise level, is an understanding of the problems of the extractive industry on the part of the local authorities which is likely to affect their ability to respond to the concerns of the sector efficiently. As the urgency of problems, however, varies substantially between types of operation and commodity subgroups, so does the importance of a mining tradition. In the case of establishing simple surface operations on placer deposits or industrial minerals, mining tradition may play a negligible role, while in the case of developing an underground coal or metal mining district, its role will be decisive.

3.31 As a consequence, the supportive approach has to be designed in accordance with the extent of the mining tradition and the needs of the type of operation under consideration. Where underground mines exist, the development of new underground operations extracting different minerals will usually not cause severe problems. The same applies to open pit mining. Even in the absence of open pits, the development of a surface mine will not be problematic in most developing countries as long as some experience in construction work exists, which uses similar methods. Where no underground mining is practiced, the development of new subsurface mining activities, regardless of size, will require a considerable amount of preparatory work and outside assistance. This would have to include both extensive training of the labor force required and strengthening of the public sector agencies supporting and controlling such activities. In such a situation the best approach would be to establish a demonstration and training mine as a first step to be used for teaching the elements of the trade to the work force required for further expansion of mining activities. <sup>24/</sup>

3.32 Dependence on Infrastructure. The ability to get by with a minimum of infrastructure is considered a major advantage of small-scale mining. Again the VSSM-segment, employing artisanal methods has the least demand for material infrastructure, while requirements grow with increasing

mine size and degree of mechanization. Requirements also heavily depend upon the type of operation and the commodity produced. Where the marketable product is a high-volume, low to moderate unit-value commodity, such as construction materials, coal and certain industrial minerals, transport infrastructure is essential. In developing countries, the most appropriate transportation mode for these minerals, over short haulage distances, will be by truck. In metal mining and processing, power requirements and demand for process water is generally substantially higher than for other commodity subgroups. Although quantities of concentrates or final products are comparatively lower, transport infrastructure for marketing is necessary. For the typical SSM exploiting metal ores the preferred form of transportation to mill and smelter again will be trucking. An exception will be the VSSMs and the smaller SSMs extracting commodities with very high volume reduction that yield small daily product quantities which can be moved by any available means.

3.33 While infrastructural requirements for VSSMs are generally negligible, some basic infrastructure, mostly in the form of an access road, is necessary for SSM-operations. Mining of metals with high concentration ratios also depends on a sufficient supply of water and energy. Although comparatively small, such facilities are clearly beyond the financial capabilities of the SSM-segment, which will likely consist of a large number of small units which would find difficulty in organizing themselves to provide and finance common services. Unless such basic infrastructure is financed and provided through outside assistance, even minor requirements would pose a major constraint to SSM-development. Public sector assistance appears necessary in cases where infrastructure is unlikely to be financed out of private sources. Subsidization, however, could only be justified to a small extent, where a clear allocation of costs and benefits may be difficult (roads) or where incentives are to be provided for SSMs development because of its importance to achieve regional and employment objectives.

3.34 Processing and Marketing. Most minerals extracted cannot be marketed without some form of prior processing and upgrading to obtain a marketable product. To illustrate this, a comparison of in-situ ore grade and marketable product grade is presented for selected minerals in Annex E, Table E.1. The concentration factor, expressed as the ratio of the quantity of ore processed per unit of marketable product, is indicative of the extent of processing requirements. Comparative values for selected commodities are presented in Table E.2.

3.35 As a general rule, the lower the unit value of the final product and the higher the concentration factor, the more important it is to concentrate close to the point of extraction, eliminating the transportation of large volumes of sterile material. Metal ores, thus, have to be processed close to the mine. Small miners, however, usually work higher grade deposits, a fact that results in lower quantities of r.o.m. ore per unit final product and in lower concentration factors for the same commodity. Working higher grade deposits can, thus, be interpreted as a form of pre-concentrating. It is important to recognize

that the availability of concentrating facilities close to the mine permits to extract lower grade ore, thereby extending individual reserves and national resources. On the other hand, tonnage mined by small operators, is frequently insufficient to justify the installation of captive mills. Various alternatives are available and have been used in practice to solve this problem.

3.36 One option is the installation of regional concentrators, strategically located to serve a number of small mines.<sup>25/</sup>, <sup>26/</sup> In Mexico, a total of 20 regional beneficiation plants were installed between 1963 and 1984 to which 335 mines are supplying ore. Six more are projected to be installed shortly. Installation and operation is the responsibility of CFM, a government institution. Regional concentrators serving small-scale miners are also operated in Chile by ENAMI, a state-owned enterprise engaged in concentrating, smelting and refining of copper ores.<sup>27/</sup> A different approach has been chosen in Morocco, where movable concentrators have been supplied through CADETAF, a government agency, which rotate among several locations in an artisanal mining district on a predetermined time schedule.<sup>28/</sup> Another possibility is the treatment of ores of small miners in captive mills of larger operations, located sufficiently close. Bolivia is one example where BAMIN, a government-owned mining bank, buys concentrates from mines which either operate their own concentrators or which have their ores concentrated in facilities of other private companies. In the U.S.A., custom milling and smelting is an important private sector activity serving the SSM-segment.<sup>13/</sup>

3.37 There is no doubt, that the availability of concentration capacity closeby is a vital condition for VSSM and SSM-development in metal mining. In the decision between mobile concentrator or regional beneficiation plant, the local supply density in terms of tpd/km<sup>2</sup> is the critical quantity. Aggregate transport requirements for feeding the concentrator in terms of ton-kilometers, have to be considered in the optimization problem. Where aggregate output from mining sub-districts is small and several sub-districts can be served, mobile concentrators are the adequate choice. With increasing aggregate regional output, the installation of regional concentrators becomes preferable. For precious minerals, concentration at the point of extraction is a necessity. Ore from placer deposits can be treated with traditional artisanal methods yielding marketable products, thus eliminating the need for concentrators. Ore containing unliberated precious metals can be treated on a small scale by hydrometallurgical processes. Heap leaching is comparatively inexpensive to install since it requires little sophisticated equipment. This process also features low energy consumption, low operating costs and a short construction period, characteristics which make it particularly suitable for application in SSM.

3.38 For industrial minerals and coal, processing close to the mine is not as important as for metal ores. To the extent that processing is required, methods and facilities are comparatively simple and specific investment costs are correspondingly lower. Marketing constraints are

usually associated with physical commodity distribution and transportation. Problems may occur in cases where small producers operate too close to larger mines marketing the same commodity. On the other hand, the low unit-value severely restricts the transport radius of the large producer, protecting the trading area of the small mines. VSSM's and SSM's extracting metal ores for export are normally unable to market their product except through custom milling facilities as described above. By contrast, for small producers of precious minerals marketing usually is not a problem, although frequently illegal marketing outlets are used. Illicit trading of precious minerals is always indicative that official prices are not fair. Where traditional, well-functioning marketing structures exist, they should be legitimized through local districts authorities rather than replaced by official licensed buyers. Furthermore, paying an attractive price officially appears to be economically more efficient than maintaining a large security force to control illicit trading.

3.39 It is apparent that the constraints processing and marketing potentially causes to mine development are greatest for the smallest operators, diminishing in importance with increasing mine size. The situation is aggravated, because regardless of the commodity extracted, small producers generally incur higher initial transport costs per unit mineral due to the comparatively small lots involved. In addition, revenues for small miners are usually lower as a consequence of their inability to sell on a long-term contract basis and to provide quality control assurances that tend to increase sales prices.

3.40 Investment and Finance. Since SSM's usually employ more labor-intensive methods with a lower degree of mechanization, investment cost per ton of output is considerably lower in this segment than in MSM's and particularly in LSM's. It is obvious, that here again, investment requirements are lowest in the VSSM segment, increasing with mine size, depth of mining, complexity of processing and degree of mechanization. The effect of the capacity-mechanization-employment relationship on mine investment cost is illustrated by the experience from current MLI projects in Mexico. There, in 1980 median investment cost per new job created was estimated to be US\$7,000 for SSM's and US\$12,000 for MSM's.<sup>29/</sup> In 1985, average capital investment cost per job created in the Mexican mining sector was US\$10,000-30,000 for SSM's, as compared to US\$100,000-200,000 in LSM's.

3.41 Specific investment costs also vary substantially between commodities, type of operation, project region and mine size. For construction materials and coal, cost per unit capacity is extremely low compared to the respective values for new metal producing capacities from mine to smelter. Due to the lack of more recent data, figures for the year 1977 may serve for illustrative purposes. In that year, cost per annual ton of capacity amounted to US\$20,000 for nickel, US\$7,000 for copper, US\$1,750 for zinc and US\$1,400 for lead.<sup>30/</sup> At that time, corresponding values for surface and underground coal mines were US\$20-30 and US\$50-60 respectively.<sup>31/</sup> It is important to note that for identical technological

levels, specific investment costs fall with increasing mine size, due to the effects of economy of scale.

3.42 In spite of the great investment cost differences in favor of the smaller operations, lack of finance is generally acknowledged as one of the principal constraints of SSM-development. As a rule, VSSM and SSM-entrepreneurs have very little access to bank or public sector lending. As an indicator, according to a recent survey, combined borrowings from private and public lending institutions amounts to less than 10% of initial investment of small enterprises, with less than 1% of SSE's reporting institutional lending to be an important source of their finance.<sup>22/</sup> The main reasons why small enterprises have been largely precluded from the commercial credit market, are their real or perceived high risk level in the absence of an acceptable collateral, difficulties of assessing their markets and prospects, and the high unit costs of administrating small loans. In mining, the risk of the small entrepreneur is compounded by the risk elements inherent to the sector, i.e. uncertainties regarding geological factors and commodity markets. From experience, this risk is highest in underground metal mining, diminishing for coal and industrial minerals and being practically negligible for construction materials extracted from open pits. An additional factor limiting the access of SSM's to credit markets is the general unfamiliarity of the financial systems in many countries (even mining countries) with mining and with project financing.

3.43 As a consequence, for the small metal miner debt financing as a source of investment funds is particularly difficult to obtain. The almost exclusive source of funds for VSSM's and most SSM's has therefore traditionally been personal savings of the owner, supplemented by loans or gifts from relatives. In developing countries, this form of equity financing, of course, has severe limitations due to the low capacity to accumulate savings. While it is generally difficult for the entrepreneur to raise investment capital for SSM-development, obstacles in financing pre-operational exploration are even greater. This is the explanation for the fact that very little exploratory work usually precedes mine development in the VSSM and SSM-segment.

3.44 In this context it is worthwhile to point to existing evidence indicating that small enterprises use capital more productively than large ones.<sup>22/</sup> This has been explained with the fact that small entrepreneurs, being excluded from institutional finance at favorable terms, face higher costs of borrowing. Hence, they tend to conserve their scarce capital and to use it more productively than their larger counterparts. It can, therefore, be argued that making money available to SSE's at lower rates would promote a less careful use of funds, eliminating this important advantage. Thus, special financing schemes offered in addressing the financing constraints of SSE's could have counterproductive effects on other objectives.

3.45 As a possible solution to provide incentives to private intermediaries to lend more readily to and get acquainted with small enterprises, the relaxation of administrative controls on the level of interest rates has been proposed.<sup>32/</sup> It is argued that in the absence of high interest rates that more closely reflect the risk and cost of borrowing to small enterprises, the capital market will not respond to the financial demand of small entrepreneurs. If, on the other hand, interest rates are allowed to rise to risk-and cost-reflecting levels, financial institutions would be prepared to lend to small borrowers. In order to keep such interest rates at levels which do not counteract the promotional objective, it is further argued that this measure would initially have to be accompanied by a risk-sharing scheme between the private and public sectors.

3.46 While this is an interesting option, high interest rates affect the smaller miner in various ways. Like high infrastructure costs, they tend to reduce project viability, raising workable cut-off grades and promoting highgrading, thereby reducing exploitable national mineral resources. Higher interest rates also mean that larger portions of the cash flow have to be devoted to debt services, making SSM's more vulnerable in case of downward price fluctuations. Limited access to finance being a major problem for SSM and MSM establishment and expansion in developing countries, national authorities together with MLI's can play a significant role in alleviating this constraint and in promoting development of this segment of the extractive sector. Implications of SSM-financing, however, make a cautious approach combined with a careful program design extremely important.

3.47 Management and Organizational Structure. Primitive organizational structure and lack of sound management practices are frequently associated with small enterprises. While this characteristic implies that small operations are generally not managed as efficiently as they could be, it can also be interpreted as having the advantage of conserving on managerial skills that are scarce in developing countries.<sup>22/</sup> Evidently, SSM's can also utilize and generate basic managerial and technical skills that are not sufficient for larger firms, using more advanced techniques. Since most small firm proprietors have no professional or formal education in management, they administer their business on the basis of experience gained on the job and on common sense. Weaknesses in SSE business administration are particularly conspicuous in matters of financial records and bookkeeping which are either rudimentary or non-existent.

3.48 It is obvious that in artisanal mining conducted by individuals, often in combination with subsistence agriculture, management functions are negligible. Similarly, in VSSM's run by an owner-operator as a family business, all efforts are concentrated on mineral extraction and management activities are few. In this smallest segment of mining, management problems are related almost exclusively to product marketing. With growing mine size, management functions, however, become increasingly important.

Particularly, in situations when VSSM's expand into SSM's and these into MSM's, relying on larger numbers of hired, paid labor and employing a growing amount of fixed assets, sound business administration practices are vital. In the lower SSM-segment, management is primarily a matter of solving technical problems and maintaining continued production.<sup>33/</sup> In the upper SSM-segments and in MSM's, management requirements to conduct business successfully are multiple and complex. They include procurement of inputs, production control, investment decisions and securing finance, recruiting and training workers, product marketing and customer relations and dealing with the public bureaucracy.

3.49 Accordingly, organizational structures vary substantially with the size of operations. MSM's and the larger SSM's require a formal organization with departmentalized structure, the number of departments increasing with firm size. Such enterprises usually have to have a two-level management structure, comprising a professionally trained general manager and qualified department heads, including an accountant. Mines of the lower SSM-segment are usually owner-managed and a simple management structure is sufficient, typically consisting only of a production foreman and a clerical officer. It has to be emphasized that especially with increasing mine size, the quality of the organizational structure of the enterprise and the qualifications of the management personnel, particularly regarding financial matters, are instrumental in the performance and efficiency of the firm. Observations from SSE's show that poor performance frequently results from the absence of conscientious supervision and that a strong association exists between bankruptcy rates and inadequate management and accounting practices.<sup>15/</sup> Upgrading of management through appropriate training programs, thus, appears to be an aspect of SSM and MSM development of great urgency.

3.50 Although management skills of this type are not required in the artisanal operations of the VSSM-segment, the need to conduct certain functions of business administration that are beyond the capability of the individual miner has created various other forms of organizations. One common practice is tributing or leasing, an arrangement under which an individual or a group of miners leases the mineral property from the owner or license-holder. The lessor may also provide tools and food for the tributors and may receive payment in cash, in kind or in the form of a share of mine output. This system has been used successfully in the diamond-fields of Sierra Leone, in mining alluvial gold in Cameroon and in exploiting alluvial cassiterite in Burundi.<sup>20/</sup> Other important organizational arrangements established for the purpose of carrying out certain tasks on a collective basis are miners associations and cooperatives. The latter particularly exist in a number of developing countries which have an important VSSM- and SSM-segment, such as Lesotho, Morocco, Rwanda, Zimbabwe, Bolivia, Mexico and Chile. Evidently cooperatives have the relatively greatest importance in artisanal mining of precious minerals and of various metals extractable only in small individual quantities due to legal or geological factors.

3.51 The main objective of the formation of mining cooperatives by small producers is to provide its members with certain goods or services that they need in order to operate their business more efficiently and to strengthen the position of the individual operator vis-a-vis the outside world. Typical services may include product marketing, procurement of tools and operating supplies, equipment pooling and leasing, technical and financial assistance, training and medical insurance. Cooperative principles are the provision of services at cost, exercising democratic control and limited return on equity capital. Although governments usually support mining cooperatives, opinions on the usefulness of this form of organization are controversial. Possible drawbacks of cooperatives include inefficient decision making due to diluted and vague management responsibility and a potential for dishonest business conduct. On the other hand, under circumstances that do not permit the establishment of a more compact organization due to the multitude of individual owners and operators in a mining district, the formation of producer cooperatives appears to be a suitable alternative to support small mining. It is a possible way in which a group of small individual operators can partially utilize effects of economies of scale.<sup>34/</sup>

3.52 Institutional and Policy Framework. The preceding discussion clearly documents that the characteristics of the VSSM and SSM-segment have implications resulting in development constraints and barriers which the small miner cannot overcome on his own. Improvements in the utilization of the development potential of this target segment are, therefore, dependent in large measure on external assistance. A significant factor in this context are policy initiatives of national governments appropriate to create an environment conducive to mining sector growth. These, however, have to include elements specifically designed to address the most important problems of the small producers. In addition, institutions are required capable of acting as intermediaries between the source of assistance and the beneficiary target segment. Experience shows that both the quality of the policy framework and that of the intermediary, in their catalytic and executive function, are decisive for SSM-development.

3.53 It has been observed that two elements in the economic environment in many countries result in discouraging SSE development. One is the fact that trade, investment and other policies implicitly favor large-scale industry. The other is that capital markets are frequently not designed to permit adequate investment levels in small-scale industry.<sup>22/</sup> SSE's are usually unable to follow bureaucratic procedures required to obtain import licenses or foreign exchange allocations for the import of capital goods or operating supplies. Less familiar with small industries and faced with competing credit demand, the banking system prefers to provide loans to low-risk large firms, rather than SSE's. Apart from these general factors, the extractive industry is directly affected by the provisions of the mining legislation and the tax regime pertaining to mining.

3.54 Mining codes contain legal arrangements regulating the various stages of mineral development from exploration through evaluation and production. They stipulate eligibility criteria and procedures for

obtaining exploration and mining permits, obligations and rights of license holders, size and tenure of mineral rights as well as ownership of land and mineral. It is apparent, that simplicity combined with concise terminology is an extremely desirable attribute of mining codes. 35/ Again, complex licensing procedures will affect particularly the small miner. Equally important is the tax regime applicable to the sector. Possible government revenues associated with mineral exploitation include prospecting and exploration fees, taxes on land held under title, taxes on mine production, customs duties on imported goods or exported commodities and taxes on operating profits. Both the mining code and the fiscal regime can be designed in a way that discriminates against the VSSM and SSM-segment, that is neutral or that favors this target group.

3.55 In addition, a number of other incentives are occasionally used by government authorities to encourage activities in the extractive sector or to support the smaller producers. These may range from exploration and marketing services to infrastructure development. In all cases, authorities have to act through intermediaries established to conduct promotional and monitoring functions of this nature. Such services may be rendered directly by the geological and mines department of the ministry of mines, by mining banks, state mining corporations or large mining companies. In view of the strong dependence of the small miners on outside assistance, the absence of an appropriate legal and fiscal framework or the absence of an efficient executing agency must be considered a severe constraint to the development prospects of the target segment.

#### IV. CORRECTIVE AND STRENGTHENING OPTIONS

##### A. General Considerations

4.01 The diagnostic insights obtained in the course of the preceding analysis of small mine characteristics clearly document the concurrence of two strikingly distinct symptoms. One is the existence of major inherent development issues and constraints, placing this target segment in a marginal position within the extractive industry. The other concerns ample evidence of its strong potential to generate social and economic effects that can be highly beneficial in a less advanced economic environment. These attributes, together with the significant share of small-scale mining, both on a global scale and in many developing countries, provide sufficient justification for outside intervention aimed at promoting improvements for this group of the extractive community.

4.02 In the pursuance of this objective it will be essential to focus attention simultaneously on two equally critical areas. First, on reducing or removing obstacles not resulting from the very nature of the activity and second, on exploiting more effectively the inherent comparative advantages of the target segment. It is obvious that this process has to be initiated and accompanied by a review and evaluation of the experience accumulated with projects designed to promote the target segment and of the various approaches, policies and strategies that have been followed with this intention. In view of the multitude of factors involved, it will be necessary to adopt a selective and issue-oriented approach. This will be done by evaluating measures primarily on the basis of their apparent potential to increase benefits and reduce costs of small mines.

4.03 The analysis above also showed the different impact of constraints and beneficial effects in accordance with the size of the operation, the type of operation, and the commodity sub-group. Any assistance programs will essentially depend on these factors.

##### B. Experience and Approaches

4.04 Experience collected in the course of lending projects to small enterprises conducted by MLI's within the past decade, led to a number of essential conclusions regarding the factors affecting the promotional mechanism. It became evident that the policy framework and institutional factors are of critical importance 36/ and that they frequently show features counteracting SSM development, including the following: (i) Exemption from import duties, favorable depreciation treatment, an overvalued currency and subsidized interest rates encourage excessive capital-intensity in project design and thus favor the establishment of larger enterprises. (ii) Price controls discriminate particularly against SSE's, since they have less potential to initiate price changes. (iii) Minimum wage regulations, social security and employment legislation force SSE's into the informal sector, if applied unrelaxed, thus excluding them from assistance programs. (iv) Lack of incentives to encourage savings

restraints accumulation of funds for equity financing, leading to lack of investment. (v) Banking regulations, financial policies, including collateral requirements of up to 150% of the loan amount, high loan transaction charges, and unfamiliarity with mining projects discourage or exclude SSE's from institutional credit. (vi) Bureaucratic licensing and registration procedures discriminate against SSE's in an indirect way. The conclusion is that policy factors that have hindered economic development in general have particularly slowed the growth of SSE's.

4.05 Regarding institutional factors and project considerations, the following observations were made: (i) Dependence and reliance on a single intermediary is unfavorable. The availability of various intermediaries including commercial banks and other financial institutions is preferable. Commercial banks have proved to be a crucial element in fund channeling along with development finance corporations or promotional agencies. (ii) All participants must accept the high risk associated with lending to SSE's. Mechanisms have to be found to finance losses from defaults and arrears, screening procedures have to be adjusted, contingencies increased and supervision of project implementation improved. (iii) In sub-project design, a more careful assessment of the economic impact appears desirable including the choice of the appropriate technology and the greater use of local resources. (iv) In credit arrangements, terms of loans have to be synchronized with the repayment potential of the sub-project. Both the availability of working capital and of a reasonable grace period have to be assured. Interest rates have to be set close to those prevailing on the capital market and should be positive in real terms. (v) Efforts to introduce financial discipline in subloan repayment are required using penalty rates and foreclosures as effective means of improving portfolio performance.

4.06 Technical assistance components are recognized as essential elements of promotional programs for SSE's. Aspects to be observed in the design of technical assistance components include: (i) Independent, small, local agencies with strong links to financial institutions and industry are generally more effective in delivering assistance than large, national or regional institutions. (ii) Assistance components may take longer to implement than other project components. (iii) Increased reliance on local experts rather than expatriates is warranted. Experience also shows that channeling funds to the very small enterprises is particularly difficult, although a global demand exists to assist this segment.

4.07 Lessons learned in the course of MLI lending operations to SSM's and MSM's are also highly instructive and largely confirm observations from other SSE projects. Conclusions on a development project in Bolivia are:<sup>37/</sup> (i) Most subprojects utilized the loans well, expanding and modernizing their operation, although the preselection procedure of sub-borrowers was not effective and the original focus on SSM's only was broadened to include some MSM's. (ii) Due to a lack of technical assistance, gold mining cooperatives experienced high mineral losses in processing. Inadequate pricing policies also resulted in increased sales

through unofficial channels. (iii) Institutional development of BAMIN (the mining bank and implementing agency) was limited due to frequent personnel changes, lack of physical resources and insufficient qualified staff. BAMIN's technical assistance to borrowers was inadequate and collection practices were poor. Some improvements were, however, achieved in BAMIN's organizational structure and appraisal capability. (iv) Separation of subproject preparation, conducted by GEOBOL, (the geological institution) from financing and supervision through BAMIN was ineffective, due to lack of coordination. (v) Aid to the SSM-segment requires careful supervision, effective channeling of funds, providing technical assistance and an adequate sector framework. A climate of mutual trust and understanding between the intermediary and the target segment also appears to be essential.

4.08 Experience from a SSM and MSM development project in Mexico can be summarized as follows:<sup>26/</sup> (i) The project initiated a beneficial process in institutional upgrading. Project intermediaries have successfully provided term lending to SMM's and they made progress toward becoming efficient financial institutions. (ii) Initial delays in commitments and disbursements due to the prevailing level of local interest rates, had to be corrected by revising onlending interest rates. (iii) A number of subprojects of the non-metallic subgroup experienced cost overruns which may result in downward deviations from the ex ante rates of return. However, the overall impact at the subproject level has been positive. (iv) The project, moreover, made a contribution toward inducing the government to establish a coordinated policy framework for mining sector development.

4.09 Observations made in connection with lending operations directed at the SSE or SSM-segment clearly document the critical role of policy and institutional factors. It is therefore desirable to further examine this aspect by reviewing the respective practices adopted by selected developing countries that reportedly have a significant SSM-segment. In this context policy and institutional profiles for a sample of 10 developing countries have been prepared which are presented in Annex F. The profiles show that all countries reviewed take an active approach of controlling and supporting the mining sector through a combination of selective fiscal instruments, legislative regulations and institutional provisions. It is, moreover, interesting to note that a number of countries have recently made adjustments in policy instruments in the attempt to encourage activities in the SSM-segment. Measures are primarily directed toward reducing production costs through discounts on or exemptions from taxes and duties, preferential depreciation allowances and concessionary credit repayment arrangements. The review also indicates an increasing inclination by governments to support the target segment with improved technical and financial assistance delivered through state agencies where these services are not being adequately provided by the private sector.

4.10 Furthermore, recent initiatives to promote the SSM-segment have been reported from a number of other countries.<sup>38/</sup> In Argentina, for

example, the Secretariat of Mining announced plans to develop a new approach to encourage small- and medium-size mining projects. The Chinese Government in 1984 granted permission to individuals to mine gold; according to estimates nearly 50% of the country's total gold production comes from about 40,000 individuals. In Zaire, the government sanctioned presence of licensed counter-buyers in mining areas together with a floating market exchange rate resulted in an increased output of diamonds, tin and tin by-products, as well as in an increase in artisanal workers. To improve legal gold trading, the Rwanda Government in 1984 allowed private buyers and competitive bidding to enter the market. Nicaragua raised the price of gold by applying a higher exchange rate to reduce illicit trading of gold panned by individuals. A negative example is reported from Thailand where high royalties (five times the Malaysian rate), led to a deterioration of the already serious tin smuggling problem.

4.11 The essential conclusion to be drawn from this review of experiences and approaches is that SSM's, like other SSE's, because of various factors related to size, location, mobilization of financing, and government policy, do frequently not enjoy the same market entry opportunities as larger mining companies. Because of SSM's contribution to economic development it is justified to remove these constraints: (i) on a cost recovery basis for constraints which are due to the special character of the activities; and (ii) on a subsidy basis where constraints are created by a government policy which is not neutral to size.

#### C. Policy and Institutional Measures

4.12 Fiscal Regime. Determining the appropriate measure of mining taxation is highly critical due to the cost character of taxes and their impact on resource utilization. Increasing taxes affects economically exploitable cut-off grade thereby pushing more reserves into the sub-economic category. Prospecting and exploration fees and taxes on mining concessions are usually small and only of a token nature, mainly designed to cover the costs of the associated administrative services.

4.13 Production taxes, frequently also referred to as ad-valorem taxes, and royalties are generally set as a percentage of the mine-head value of the ore after concentration to a marketable product. They have the undesirable effect of raising minimum exploitable cut-off grade and of adversely affecting the competitive position of domestic production on the export markets. A reasonable level in the order of 5% should, therefore, not be exceeded. This type of tax is easy to administer and provides a more regular fiscal revenue for the state, advantages that encourage its use. While export taxes are similarly simple to administer, they have the same drawbacks as production taxes. Customs duties on imported mining equipment and operating supplies are usually low in most developing countries. Very low customs duties, however, tend to favor capital-intensive, large projects and discourage local equipment manufacturing. Artificial exchange rates can work in the same direction. Profit or income taxes, payable on the operating profit of a mine are more

equitable than other forms since they allow for differences in the revenue-cost situation of individual properties. For the authorities they carry the disadvantage of a less stable stream of income due to fluctuations in commodity prices and administering them can be more difficult.

4.14 A unique fiscal device occasionally used to reduce taxation rates in the extractive sector is depletion allowance. It is a tax deductible item designed to compensate the mine operator for the continuous physical reduction of his non-renewable resource through exploitation. Other tax incentives frequently made available by the authorities are accelerated depreciation of pre-production and mine development expenses and tax holidays during initial years of operations. While such incentives are clearly adequate to encourage mining activities, tax holidays may provoke undesirable exploitation practices, comparable to highgrading.

4.15 As noted in para. 2.04, small mines are, in general, higher cost producers than larger operations. In view of this marginal position within the sector, the tax regime for mines of the VSSM and lower SSM-segment should be favorable to the extent that their activities are considered essential in the pursuit of regional development, employment creation or other policy objectives. This is particularly important for underground operations and those producing metal ores. For the other SSM - and the lower MSM - operations selective tax reductions, exemptions and incentives are also desirable, although less urgent. For small operators extracting minerals for the domestic market, such as construction materials, tax concessions are usually not vital. Preferential tax treatment of the target segment is particularly warranted in all cases where demonstrably small mineralizations are exploited, not workable by larger units, thus extending national resources.

4.16 Mining Legislation. For the small entrepreneur not familiar with bureaucratic and administrative procedures it is extraordinarily important that regulations in mining codes are clear, simple to understand, concise and in definitive terms in order to create an atmosphere of confidence. In modern mining codes of developing countries mineral ownership is increasingly placed in the hands of the state. Exploration and mining by private parties is only possible under license granted by the authorities. Basic alternatives regarding prospecting and exploration rights are (i) grant to the discoverer; (ii) grant to the first occupier or applicant; (iii) grant at the government's discretion or (iv) granting through public tendering or auction. Grant to the first occupier or applicant is particularly favorable in promoting interest in exploration activities.

4.17 To avoid fragmentation of deposits into small blocks that may not be workable economically, provisions regarding minimum size of the concession area have to be made. To eliminate undesirable delays in mining development, minimum work programs together with a certain level of annual expenditures are usually obligatory. In addition, applicants must prove the availability of adequate financial and technical means necessary to

conduct exploration work. It is important that exploration permits are valid for several years with the option for renewal. For small areas, successive periods of 2 to 3 years are recommended, shorter periods appear inadequate. A valuable provision to promote exploration efforts is the free transferability of concessions.

4.18 A legal provision of greatest significance is that the holders of exploration licenses are guaranteed automatic mining rights if a prospect has been identified as economically workable, and provided they meet the formal requirements of the new license. The duration of mining permits should not be too short; 20 to 30 year periods including a subsequent renewal option are considered adequate. To exclude undesirable speculation with concessions, a minimum level of activity should be enforced and continued inactivity without reason should lead to a cancellation of mining rights.

4.19 It is important that authorities follow a flexible approach in applying the mining code in the target segment. Licensing procedures must be simple and unbureaucratic, while the duration of mining permits can be shorter. Minimum initial durations for VSSM's of 5 years and for SSM's of 10 years with the possibility of renewals appear to be satisfactory. Free access to public land and grant of exploration right to the first applicant are options that have a favorable effect on sector development. The guaranteed right to be granted a mining permit after successful exploration has to be emphasized again as essential. Permission to use mining concessions as collateral would be of great assistance to the small producer.

4.20 Institutions and Executing Agencies. The top-level government institution responsible for policy formulation and sector administration is the ministry of mines. It usually encompasses the geological survey or department and the mines department. In many countries with an important extractive sector, frequently other institutions are established for the purpose of acting as operator or of providing specific services to promote the sector. These include mining banks, state mining corporations, research and training institutes, exploration funds and various types of promotional agencies. Where these institutions are controlled by the government, which provides the directives, they usually are given a legal identity separate from the state together with administrative autonomy.<sup>39/</sup>

4.21 As reported in paras. 4.06 to 4.09, experience with such institutions acting as intermediaries has been mixed, while at the same time their critical role in promoting small operator development was confirmed. It is obvious that agencies will only be successful in this role if they are completely autonomous, physically present in the mining district through district offices and staffed with competent and dedicated management and operating personnel. It has to be emphasized that qualified and motivated staff will only be available to the extent that attractive remuneration is offered. Highly qualified agency staff is particularly important in underground metal mining districts, where problems are usually greatest.

4.22 An illustrative positive example is the relationship of the small and medium miners community in Chile with ENAMI. ENAMI is a state-owned, autonomous enterprise engaged in concentrating, smelting and refining copper ores which it receives in part from small and medium-scale mining operations.<sup>40/</sup> It is a well-managed, efficient enterprise, acting as a service agency to the SMM-segment, providing also technical and financial assistance to artisanal gold miners. An important feature of ENAMI is that it operates regional concentrators located strategically in various mining districts. At one time it had more than 20 concentrators in operation, of which most of the small ones have meanwhile been sold to private enterprises.<sup>2/</sup> In contributing to keep small operations viable, ENAMI can secure a high level of capacity utilization in its own plants. Key factors in this successful symbiosis are the quality and dedication of the agency's staff combined with the application of management principles of a private enterprise and to some extent recognition of the fact that both parties benefit from the association.

4.23 Other examples of an effective and beneficial assistance provided to the SMM-segment by government agencies are reported from Mexico.<sup>26/</sup> There, CFM, CRM and FNM are actively engaged in extensive technical and financial assistance programs to SMM's. A similarly satisfactory relationship exists in Morocco between the public agency CADETAF and the small mining community although this agency has recently encountered increasing management and financial difficulties.

4.24 Where private enterprises provide the required services to SSM's, they usually achieve this objective more effectively. They include larger private mining companies operating in the district, toll or custom processors and smelters, metal merchants, precious mineral buyers and commercial banks. It is obvious that the business relationship between larger operators with ample experience in the trade, and small producers can be highly beneficial for the latter, provided they receive fair treatment. Similarly, custom processors and smelters offer the most favorable marketing outlet for the small producer, if they are located sufficiently close and ore collecting centers are maintained. Buyers and merchants are an effective means of marketing precious minerals from VSSM-producers as long as they are licensed and controlled by the government to protect the interests of the small operator.

4.25 Wherever possible, opportunities of using suitable private companies to promote SMM development through mutually beneficial business associations should be sought. Frequently this will only be possible to a limited extent either because adequate firms do not exist in the SMM districts or because they have no interest in providing certain essential services, such as exploration assistance. In such cases small operators depend on public institutions. An interesting option worth considering where other adequate alternatives are not available could be NGO's. These non-profit organizations, usually based on clerical or humanitarian initiatives, have traditionally played a role in health, education and rural agricultural development programs, providing both financial and

technical assistance. NGO's could be particularly helpful in artisanal operations of the VSSM-segment.

D. Assistance Options

4.26 Financial Assistance. Insufficient financing through development finance corporations and the limited availability of other sources of finance makes it particularly desirable to encourage commercial banks to increase their lending to SSE's. Their main advantages are that they usually have a large branch network facilitating contact to small borrowers, they are experienced in loan processing and debt collection and they are usually more responsive to small businesses than public agencies. A suitable option to promote commercial bank involvement appears to be the introduction of schemes for sharing the initial risks and administrative costs of small loans to first-time borrowers between the public and the private sector. <sup>32/</sup> This approach is supported by evidence that both the risks and costs are much lower for second and subsequent loans to individuals, falling to acceptable levels with growing experiences. An additional option is to require increased lender margins or spreads initially, gradually reducing them as risks and administrative costs become smaller.

4.27 Initiatives are currently taken in several countries to encourage commercial bank lending to SEE's through risk-guarantee and rediscounting arrangements provided by public banks and agencies.<sup>22/</sup> Evidence suggests that initially default levels of 10 -15% have to be expected in SSE lending. Higher default rates and high levels of arrears may occur if loan supervision is inadequate and collection practices are poor. Reducing the risk factor in lending to the SSM-segment, therefore, requires improved subproject appraisal capability and screening of sub-borrowers, improved supervision of subproject implementation and extensive technical assistance. Penalty rates and foreclosures have to be employed to maintain financial discipline in subloan repayment. Subloan rescheduling may be desirable occasionally to reduce default rates. Designing realistic repayment schedules in conformity with subproject cash-flow generating capacity is essential. Acceptance of mining concessions and mineral reserves as collateral should also be considered.

4.28 Given the great geological and financial risk of exploration, expenditures associated with this highly important pre-operational activity are particularly difficult to finance. International mining companies, national governments and bilateral assistance have been traditional sources of funds. Reluctance in providing sufficient funds on the part of the traditional sources in the face of rising exploration costs, has led to the establishment of national and international exploration funds, such as the United Nations Revolving Fund for Natural Resource Exploration (UNRFNRE) or the National Mineral Exploration Fund of Bolivia (FONEM).<sup>41/</sup>, <sup>42/</sup> A scheme with similar objectives is also operating in Canada, and the idea is under discussion by interested institutions in Chile. Exploration funds are self-replenishing lending institutions financed by government or member contributions and replenishment payments from successful projects.

4.29 A major problem of exploration funds is the tendency of applicants to submit only the relatively unpromising prospects. This leads to an unfavorable success ratio and inadequate fund replenishment. Funds that place part of the financial risk on the applicant are more successful in terms of the number of exploitable discoveries. A policy mix, whereby at the low-cost, high-risk prospecting stage the entire risk is borne by the fund, while at the high-cost, low-risk feasibility stage part of the risk is placed on the applicant, appears to be appropriate in this context. Moreover, in the long run, exploration funds can only succeed in countries with a large mineral potential. Their installation is, therefore, appropriate where a large mining district or several adjacent mining districts can be served. Where this is not the case, the only option for SSM's is to have exploration work conducted as part of technical assistance programs of public agencies or mines cooperatives.

4.30 Non-Financial Assistance. One of the most essential elements in SSM-development is the provision of extensive technical assistance aimed at introducing sound mining and business practices in SSM-operations. The most appropriate method for this purpose are on-the-job-training courses for small miners to be conducted in suitable mines operated in the district. Apprenticeship programs at existing MSM or LSM-operations with extensive training at the working face is one form in which these could be executed. For the training of technicians and supervisors, adequate courses in polytechnical schools would be desirable. In the absence of a suitable operating mine, the establishment of a demonstration mine by the promotional agency, operated for training purposes, is the second best option. A certain amount of technical assistance could be provided for free if it serves to start up a mining district or if it is provided by a metal processing industry or trader with the objective of business development. School training should be handled and financed in accordance with the general rules of the country's education system. Costs for technical assistance beyond these purposes should be borne by the miners.

4.31 Provision of basic infrastructural requirements by the local authorities is another essential promotional precondition for the successful development of the target segment. Infrastructural requirements are usually modest and comprise the construction of access roads which can be unpaved, the installation of an energy supply system and the provision of a water supply. Availability of water is a necessity for many minerals that require wet concentration processes at or close to the point of extraction, such as precious minerals, tungsten, tin, etc. Adequate roads are of greater importance in target areas where comparatively high volume minerals are exploited, such as construction materials or other industrial minerals and coal. Provision of some basic infrastructure (e.g. roads) at no cost or subsidized rates to the SSM-segment can be justified if this measure has beneficial effects on the development of other sectors in the area. However, costs of commercial infrastructure, such as electricity or water should generally be recovered fully if they represent economic costs of the activity and if a subsidy does not appear justified for other specific reasons.

4.32 Small producers in metal mining districts will benefit most from the establishment of regional concentrators operating in combination with a cluster of ore collecting stations located close to mine sites. Factors justifying the installation of regional beneficiation plants or the use of mobile concentrators have been discussed in paras. 3.37 and 3.38. This measure will not only improve the economic situation and viability of the individual mine, it is also highly efficient in stretching natural resources by reducing the need for highgrading. Costs of this activity should be borne fully by the miners.

4.33 An important issue in this context requiring careful consideration is the determination of the appropriate degree of domestic processing of minerals in developing countries. Basically it is desirable to enhance national value added by further integration of processing stages through smelting and refining. The final answer, however, has to be found in each individual case by assessing the comparative advantages of additional treatment. Real cost of energy and production factors, availability and cost of technology, and availability of skilled labor are key factors in the analysis. Moreover, local supply density, in terms of tons of r.o.m. ore per year and square kilometer and total domestic output in relation to the smallest economically justified smelter capacity, are essential aspects. A decision should be based on a comparison of the effects of alternatives with or without additional treatment on the net national value added. A low net national value added effect is indicative of a lack of comparative advantage which suggests that resources required for further processing may be used more productively elsewhere.

4.34 Other assistance options that have the character of strong incentives are fair prices with minimum fluctuations, and purchase agreements provided by promotional agencies. They have been successfully used in the U.S.A. to stimulate the supply of strategic minerals from domestic sources in times of need. Purchase arrangements combined with the provision of working capital to small miners frequently also prove to be beneficial to both parties. Two important assistance options which eliminate the difficulties in obtaining loans for equipment purchases, are equipment rental and leasing arrangements. Equipment rental is usually for short periods and therefore particularly attractive for the smaller operators who are unable to fully utilize the capacity of purchased or leased machinery over an extended period. For the smallest producers, very short rental periods from one to several weeks, should be made available. Where difficult geological conditions do not permit the execution of a sufficient amount of pre-operational exploration to establish an adequate quantity of reserves, equipment rental may be the only low-risk possibility of semi-mechanized exploitation of small mines.

4.35 Leasing arrangements which are for longer periods from one to several years and usually carry the option for subsequent equipment acquisition are best suited for the larger operators of the target segment which can utilize the capacity of the machinery and generate enough cash-flow for later equipment purchase. For practical purposes leasing or

rental pools should be physically attached to existing MSM or LSM-operations equipped to maintain the machinery, with the provision that repair and maintenance costs are recovered through rental and leasing charges. In the absence of suitable MSM or LSM-operations, this function has to be taken over by miners cooperatives. Equipment leasing pools are furthermore, particularly suitable for financing by local commercial banks since the machinery can serve as collateral.

#### E. Operational and Organizational Measures

4.36 Optimum Mine Size. As noted in para. 2.04, unit production costs (under similar conditions) are highest in the smallest mine size category, decreasing rapidly with increasing mine size until an almost constant minimum cost level is reached at higher production capacities. From this it can be concluded that in the smallest size range, a modest amount of capacity-increasing investment will result in a large beneficial effect in the form of a significant reduction in unit production costs, while the same investment in the MSM or LSM-category will have a negligible cost-reducing effect. Apart from the effects of economy of scale, the ratio of capital cost to labor cost is a decisive criterion for mine size optimization.<sup>43/</sup> As a general rule, it can be stated that the higher the capital-labor-cost ratio, the lower will be unit costs of smaller operations, and vice versa. This is based on economic relationships and aspects further discussed in paras. 4.40 and 4.41. As a consequence, in developing countries with comparatively high real interest rates and a low wage level, the least-cost production occurs in the smaller output range. This fundamental relationship is illustrated in Annex G.

4.37 From this it follows that in a comparative sense, in less developed countries the emphasis on smaller mines is economically justified. On the other hand, the smallest segment of mines clearly suffers from higher production costs even in the presence of high capital-labor-cost ratios. Moreover, with the smallest producers the inability to deal with constraints is much more pronounced than with operators of higher output levels.

4.38 Considering these aspects it can be concluded that it is, as a general rule, (and under fairly similar conditions) economically advantageous to avoid the very small capacity segment and to select the comparatively highest output level justified under the circumstances. Hence, it is desirable to promote the graduation of VSSM's into SSM's and further into MSM's. This is contingent upon the size of the deposit worked, its geological characteristics and, most importantly, on the capacity of the market to be served. For low unit-value commodities, the economically acceptable distribution radius will, moreover, generally impose an upper limit to mine size.

4.39 It has to be emphasized that in developing countries determination of the optimum mine size is a particularly delicate matter that requires great caution. Reasons are that, while very small mine sizes

are clearly unfavorable from the production cost point of view, certain beneficial effects diminish with increasing size. These include high absorptive capacity of low-skilled labor, easy entry for entrepreneurs, efficient use of capital and modest infrastructure requirements. Another argument is that once the MSM-segment is reached, further size increases will not cause substantial additional benefits. And, as has been stated, cost reducing effects of size increases are highest where capital-labor-cost ratios are low being much less important in developing countries, where such ratios are greater. Hence, the general rule is to focus growth-promoting measures on VSSMs and SSMs and to take particular care in analyzing the justification of assistance to operations exceeding the lower MSM-segment. Based on these guiding principles, the optimum mine size has to be determined independently in each individual case, using standard engineering and financial criteria.

4.40 Appropriate Technology. Another essential rule in target sector development is that traditional and even artisanal methods are economically justified in the VSSM-segment of developing countries, while in SSM's and the lower MSM's primarily the intermediate technology level will be appropriate. This is based on the fact, that in technology selection again the prevailing factor-cost ratio is the key criterion. Accordingly, in economic environments with a high capital-labor-cost ratio, as typical for developing countries, the least-cost factor combination corresponds to a lower degree of mechanization, while in the industrialized nations which generally have smaller capital-labor-cost ratios, a higher degree of mechanization is optimal.<sup>44/</sup> This fundamental relationship is depicted in Annex H.

4.41 Apart from this very significant relationship, both theoretical models and empirical evidence confirm that for constant capital-labor-cost ratios, the technology selected depends substantially on the size of the operation. In larger operations, the least-cost position coincides with a more highly-mechanized technology, while in smaller operations lowest unit costs are achieved with a technology of a lower degree of mechanization. The combined effect of these two relationships clearly demonstrates the existence of a twofold economic justification to differentiate in the choice of technology. One is based on the level of the capital-labor-cost ratio and the other on the size of operation. As a consequence, the general conclusion can be drawn that the smaller the mine size and the lower the state of economic development, the lower the degree of mechanization will be that results in least-cost production.<sup>45/</sup>, <sup>46/</sup>

4.42 It has to be reiterated that the use of highly advanced technology in developing countries has a very undesirable direct employment effect both in terms of absolute numbers and in terms of conserving scarce skills. On the aggregate level, these consequences are further magnified through the employment multiplier, which is particularly high in the mining sector, as reported in para. 2.16. Apart from the employment issue, specific capital requirements are strongly dependent upon the choice of technology. The appropriate technology, being less capital intensive, economizes on scarce funds in developing countries and uses investment more

productively. Loan requirements are lower than with a highly mechanized technological solution, making a mining project less vulnerable in times of weak commodity markets. And finally, mining operations using appropriate technology can get by with a more modest physical infrastructure. The conclusion can thus be drawn that small mining in developing countries will only be economically successful and beneficial to the extent that appropriate technology is employed, determined in accordance with the principle of selective mechanization based on the prevailing factor cost relationship.

4.43 Mining and Business Practices. Both the efficiency of the mining activity and the extent of the undesirable characteristics of small mines are directly associated with the quality of work practices. Typical problems, such as resource wastage, entrepreneurial risk, health and safety hazards and environmental damage can only be reduced or avoided by adhering to established engineering rules of the trade. Thus, the introduction and maintenance of an acceptable basic standard of sound technical and commercial practices in the conduct of business must be considered an absolute necessity for SSM and MSM enterprises. For VSSM operations and particularly for artisanal workings in alluvial precious mineral deposits, this condition can be relaxed, although even there a minimum level should be adhered to.

4.44 The need for the use of sound mining practices grows with increasing mine size and it is greater for underground mines than for surface operations. It is also extremely important that the miners concerned understand the impact of such measures on the efficiency and profitability of their operation. This will require on-site demonstration that improvements in essential tasks such as track laying, roof support or mine layout will directly result in a smoother operation with less downtime and enhanced productivity in terms of tons per man-shift. The resulting positive social effects, particularly the improvement in the utilization of national resources, are an important argument for an active involvement of the authorities. This will in most cases be an essential precondition, both in the form of extensive technical assistance and careful control.

4.45 Small miners, attempting to establish and maintain an efficient enterprise have to apply a number of principles and procedures in the various unit operations from exploration through marketing. A certain amount of pre-operational exploration is required to obtain a sufficient knowledge of the geometry and the mineral content of the deposit. The quantity and quality of reserves to be determined and the required degree of assurance depend primarily on mine size and capital employed. Reserves must be sufficient to permit recovery of investment in machinery and mine workings. Adequate reserves are a precondition for loan-financing part of the investment. Based on an understanding of the deposit, a mine plan has next to be developed including the selection of an adequate mining method with the required equipment, a basic layout of mine workings and the determination of the production schedule. Ideally, such a schedule would contain information on tonnage, ore grade, metallurgical characteristics and marketing arrangements.

4.46 Physical mine development, moreover, must be systematic, planned and farsighted. In driving development openings, adherence to the principle of respecting horizontal, inclined and vertical planes is a necessity.<sup>14/</sup> Another, similarly important element of sound mining practices is the preparation and periodic updating of a mine map based on regular mine surveys. Observation of basic safety aspects is equally essential, particularly in underground operations. Main requirements to ascertain safe working conditions have already been discussed in para. 3.21. Others are associated with the quality of the workmanship of the mine worker. Elements of the trade which the mine worker has to be acquainted with sufficiently well include drilling and blasting, handling of explosives, setting of timbers, roof control, track and pipe laying as well as operating, maintaining and repairing simple mine equipment.

4.47 Rational management of a mining operation will furthermore involve a certain amount of clerical and administrative work, even if the operation is small. This is underlined by the evidence of a strong association between business failures of SSE's and poor accounting practices. As a result, the introduction of a minimum standard of bookkeeping and accounting must be considered a vital condition for all SSM operations. Depending on the size of the mine this will have to include primarily the compilation and documentation of data on monetary transactions such as sales revenues, purchases of operating supplies, wage payments, as well as the maintenance of production and personnel records, time sheets and records on inventories.

4.48 The most effective method of introducing sound work practices in the target segment is through the installation of apprenticeship programs in existing MSM or LSM-operations that already apply suitable practices, as described in para. 4.30, thereby self-generating skilled miners on the job. Where adequate mines do not exist, the establishment of a demonstration mine, operated by a competent government agency or cooperative, appears to be the only practicable alternative.

4.49 Organizational Options. Regardless of ownership, for MSM's and frequently for full size SSM's a formal, two-level organization with departmentalized structure will be necessary. Sole proprietorship companies and joint ventures are a frequent form of ownership in this category which are more often managed by owners than by professional managers. Mines of this category are usually capable of operating without major direct outside assistance. Attributes of private companies which make them usually more competitive than government owned firms, are the dedicated engagement and the enterprising spirit of the owners, their profit-orientation and their responsiveness to market opportunities. If combined with sound mining and business practices, this appears to be the preferable option for MSM and SSM enterprises.

4.50 In the middle and lower SSM-segment, management structures are considerably less formal and the entrepreneur typically executes all management functions. Due to the limited size, mines of this category usually face severe constraints in obtaining finance and in product marketing. This group of producers is, therefore, highly dependent on

outside assistance. Without assistance it will be vulnerable and unable to grow to a size at which its position vis-a-vis the outside world is sufficiently strong to guarantee unsupported existence. In the absence of an adequate level of assistance, small miners have traditionally made efforts to combat the unfavorable effects of size related constraints. This has primarily been attempted through the formation of cooperative organizations or through establishing business associations with larger operators.

4.51 From the discussion in para 3.51 it is apparent that cooperative organizations do generally not function as efficiently as the compact formal business administration of the private mining company, ideally suited for MSM and full size SSM operations. In view of the limited options for the small miner, cooperative organizations, however, deserve further consideration. The only other options for the small producer are to rely on existing private or public enterprises that are capable of providing financial and marketing assistance at acceptable terms. To clarify a general misconception of the nature of cooperatives it should be pointed out that they are not organized to operate a number of mines collectively, but rather to provide their members with certain services and goods at cost.<sup>34/</sup> If they limit their role to these functions, and if organized efficiently and capitalized adequately, they can provide the small miner with the same services as suppliers and middlemen, yet at substantially lower cost thus increasing the competitiveness of the activity. An equally essential precondition for a successful cooperative organization is that it is established in a voluntary effort by individual small miners, rather than on the initiative of labor unions or government authorities.

4.52 Multipurpose mining cooperatives typically can assume the functions of maintaining ore collecting stations, assaying facilities and marketing outlets, of operating concentrators, toll or custom smelters and transport facilities, of renting mining equipment and providing operating supplies at cost. A potential advantage of cooperatives is that they are basically capable of building up a strong capital base by accumulating retained surpluses, because they are not treated as taxable entities since they have no income of their own. In addition, they are able to act as a counterpart organization to government agencies in programs designed to assist the small miner. Reaching the individual beneficiary could be extremely difficult without them.

4.53 The formation of miners' cooperatives has recently been suggested by the U.S. Bureau of Mines as the most practical way to deal with the problems of concentrating, smelting and marketing ore produced by small mines in the Western United States.<sup>13/</sup> Similarly, combining the efforts of small coal mine operators through the formation of small producer cooperatives has been identified as the key option to reduce costs and create market opportunities for this group of miners in the United States.<sup>9/</sup> In evaluating the evidence, it can be concluded that cooperative organizations are generally not a favorable option in situations where adequate financial and marketing assistance and supply services are being provided by private or public enterprises or individuals at competitive

prices. However, in the absence of such opportunities, a mining cooperative or association appears to be the only organizational option to enable the initiation and continuation of mining on a small scale. If encouraged and promoted by government authorities it may well offer a great opportunity for small mine development under favorable circumstances. The existence of mining cooperatives in a number of developing countries, as stated in para. 3.50, for a continuing period of time, is clearly indicative of their usefulness under certain conditions.

## V. CONDITIONS OF ECONOMIC JUSTIFICATION

### A. Basic Economic Aspects

5.01 The fundamental justification for small mine development lies in the inherent qualities of the target segment which are of particular value for developing countries. It has been shown that justification for SSM-development is particularly great in the lower-income countries having a large low-skilled population, associated with a high capital-labor-cost ratio.

5.02 In spite of their highly desirable attributes, SSM's are, in general, high cost producers, due to the absence of scale effects. As a result, their position in a competitive market is weak unless they enjoy comparative advantages sufficiently strong to largely compensate for the cost-reducing scale-effects. The existence of comparative advantages is absolutely necessary where SSM's are in direct competition with low-cost, large-scale producers serving the same market. This is primarily the case in the mining of internationally traded commodities produced for export markets. Most of the metal ores and some of the industrial minerals extracted in developing countries fall into this category.

5.03 Comparative advantages can be due to favorable geological characteristics, special market factors or infrastructural conditions. An important potential comparative advantage is a low level of labor costs which will, however, only be exploited to the extent that an appropriate technology is employed. Thus, for SSM's in developing countries, the choice of technology is of great significance. The use of a capital-intensive, labor-saving technology in a small enterprise in an economy abundantly endowed with low-skilled labor, therefore, has to be interpreted as a failure to utilize a potential comparative advantage.

### B. Target Eligibility Profile

5.04 Geological Factors. Determining geological factors decisive in mine capacity dimensioning include the size of the deposit to be exploited and the position, geometry and regularity of the mineralization. It is obvious that isolated, small ore bodies and larger, but scattered and irregular deposits or narrow mineralizations are not amenable to modern, large-scale mining techniques. The quantity of ore and the dimensions of the mineralization are unalterable natural conditions that set an upper limit to mine size. Small mineral occurrences with a total tonnage of 50,000 tons or less can support nothing but a VSSM-operation while in-situ reserves of not more than 500,000 tons will permit only the establishment of an SSM-capacity underground mine. MSM-operations require a minimum of approximately 1,000,000 tons of demonstrated reserves of adequate quality ore.

5.05 The shape of the mineralization, closely associated with the size of the deposit, is another important factor in capacity considerations. Vein-type, lenticular or pod-shaped mineralizations with small dimensions

in one or two of the main directions, are not favorable for large-scale mining. The situation is aggravated, if the regularity and continuity of the mineralization is tectonically disrupted. As a result, a number of minerals typically occurring in vein-type or lenticular deposits are frequently mined on a small scale. Among these are lead, zinc and copper ores, antimony, tungsten, barite, graphite and precious minerals. Others, such as beryllium, mica, lithium or tin occur in pegmatites which often also occur as irregularly shaped and narrow ore bodies. Similarly, highly faulted, steeply dipping coal seams are not amenable to large-scale mechanized exploitation.<sup>47/</sup> Under such limiting geological conditions which exclude large-scale operations, small-scale extraction is the only possibility.

5.06 Comparative advantages of a geological nature that contribute to making VSSM's or SSM's viable, are the quality of the mineral extracted and the position and nature of the mineralization.<sup>48/</sup> In the absence of other comparative advantages, small metal mines can only survive in a competitive market if they can extract considerably higher grade ore than larger operations. Figures presented in Annex E clearly confirm that for many mineral commodities a wide range of exploitable r.o.m. ore grade exists which is largely attributable to differences in mine size. Typical exploitable r.o.m. ore grade may range from 2 to 20% Pb for lead, from 5 to 25% Zn for zinc and from 0.4 to 4% Cu for copper, with the higher value typically standing for smaller mines. Equally important is the position of the mineralization in the earth crust and its accessibility from the surface. Surface deposits readily accessible without overburden removal, such as placer deposits containing tin or precious minerals are favorable targets. Similarly, near-surface deposits that can preferably be developed through short horizontal hill-side adits have a distinct advantage over deeper ore-bodies requiring vertical or inclined shafts.

5.07 Other significant factors include the ease of extraction which is dependent upon the strength of the mineral and of the surrounding rock as well as the ease of processing. Low strength minerals occurring in high strength host rock are favorable factors for SSM-operations. The absence of mine water, the possibility of utilizing gravity for ore transportation and the applicability of natural ventilation and natural drainage in underground mining are equally desirable. In metal ore mining, the amenability of the mineral to processing by a simple method can be decisive in small operations.

5.08 Marketing Factors. In non-metallic mineral deposits, such as coal and industrial minerals, differences in in-situ mineral grade are considerably smaller than with metal ores. Quality differentials therefore usually do not occur in magnitudes sufficiently great to provide a small producer with a comparative advantage. Unlike metals, minerals of this group furthermore are low to moderate unit-value, comparatively large-volume commodities. With these minerals, transport and distribution costs have a decisive effect on total delivered product cost and thus on the price at which the commodity can be marketed at the point of consumption.<sup>49/</sup> For coal and most of the industrial minerals, distribution

costs thus are one of the critical factors for determining the size of the extractive operation. It is obvious that, for a given delivered unit price, a large scale, low-cost producer can afford a higher transport cost component than a smaller higher-cost operator. *Ceteris paribus*, the larger operator can thus competitively cover a wider marketing radius.

5.09 Additional factors in mass mineral marketing are the quality and type of the transport infrastructure available and the areal density of the demand for the product. For a low average demand density, in terms of tons per year per square kilometer, the distribution radius for a given product quantity is large, and vice versa. Similarly, for a given demand density, the distribution radius increases with increasing mine size, associated with the necessity of transporting a larger share to the peripheral sub-areas, located farther away. This means that transport expenditures, as the arithmetical product of quantity and average distance, increase progressively with growing extractive capacity. The progressive increase in transport costs is, however, partly offset by the cost-reducing effects of graded freight rates charged for larger lots. Of major importance are, furthermore, the great differences in specific freight costs, depending on the means of transport employed. In mass transport, the least-cost transportation is by ship or barge, followed by railway and finally by road. High freight rates are therefore always an indication of a less favorable transport infrastructure. Poor infrastructural development on the other hand, is typical for most developing countries, particularly for the landlocked mountainous regions.

5.10 It follows that small, higher-cost producers can be competitive in regions where they enjoy the comparative advantage of proximity to consumers and the natural protection provided by an unfavorable transport infrastructure which is highly effective in excluding lower-cost producers, located farther away, from the market. Small operations, producing low-value commodities for local consumption are, therefore, ideally suited to operate in the infrastructurally less developed and poorly accessible regions of developing countries, including especially the land-locked states.

5.11 Examples in this context are the small coal mines operating in Colombia, partly in geologically extremely difficult conditions, providing fuel for local industrial plants.<sup>50/</sup> More than 1,100 very small coal mines are reported to be still active in Colombia.<sup>38/</sup> Many small coal mines also exist in a number of other countries, such as China, Philippines, India and the U.S.A. In China more than 4000 small cement plants, scattered throughout the country are in operation, as a consequence of infrastructural limitations and associated distribution cost implications.<sup>51/</sup> In almost all countries of the world, small operations extracting construction materials, such as sand, gravel, gypsum and ceramic raw materials exist for the same reasons. Conversely, markets located close to seaports, navigable waterways or railway lines are easily accessible for large, low-cost producers of bulk mineral commodities and do not, therefore, provide favorable conditions for small operators.

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## VI. PROMOTIONAL APPROACH

### A. Role and Promotional Initiatives of Multinational Lending Institutions

6.01 It is apparent that the supportive approach to be followed by MLI's in promoting the target segment has to be different from that adopted in dealing with the large-scale sector. Main reasons necessitating adjustments in the approach are the facts that SSM's are confronted with various typical constraints which have to be specifically addressed, and that a large number of small operations, frequently scattered over a wide area, have to be reached. As the experience accrued during the first generations of lending projects to SSM's documents, these factors have to be taken into consideration in program design. All evidence confirms that three elements are of critical importance in SSE development. A favorable policy environment, access to financial resources and technical assistance, and the quality of the institutional framework. These areas, therefore, require particular attention in the formulation of the approach taken by MLI's.

6.02 As a consequence, the principal functions of MLI's in supporting the target segment comprise (i) initiation of policy adjustments aimed at creating a policy environment conducive to SSM-activities, (ii) building and strengthening of the institutional framework required to reach the potential beneficiaries, and (iii) provision of funds and technical assistance through intermediaries. In view of the significance of the policy environment, MLI loans should be made conditional upon the initiation of policy reforms in cases where severe distortions discriminating against SSM's have been identified.

6.03 A "size-neutral" policy environment can basically be created by removing regulations directly or indirectly favoring the larger segment or by granting compensating privileges to the smaller segment. Frequently the latter will be preferable, since abolishing existing incentives for large-scale industry may be difficult to execute. Effective options are neutralization of discriminatory effects of royalties or ad-valorem taxes and sufficient flexibility in creating a suitable and feasible regulatory environment. Temporary subsidies of interest rates for promotional purposes, introduction of a market exchange rate and removal of price controls are additional measures.

6.04 Given the potentially large numbers of beneficiaries in SSM-projects and their specific problems, the role of institutions acting as intermediaries and executing agencies is essential for project success. In recognition of this fact, the MLI's have already in the past SSE and SSM lending operations devoted a major effort to institution strengthening through appropriate upgrading programs. Such programs have typically included one or more of three elements, i.e. (i) strengthening of the organizational set-up of institutions selected as project intermediaries and upgrading of managerial and technical capabilities of its staff through training programs, (ii) strengthening the capability of institutions in

subproject appraisal, subproject supervision and subloan management, and (iii) expansion of the physical capacity of institutions to provide assistance to SSM's through the acquisition of equipment, the installation of laboratories, concentrators and other facilities. Such programs have to be implemented by providing credit to the institutions involved and by financing consultancy cost for preparing and carrying out action plans for institutional development. Programs of this nature will certainly be required by most of the future lending operations to the target segment.

6.05 An effective means of initiating the institutional upgrading process has been to request the submission of adequate operating guidelines by the executing agency selected for SSM-projects. These documents typically contain guidelines for the development activities of the institutions, including credit policies, project appraisal policies, project supervision and portfolio control requirements, financial policies, procurement policies, disbursement policies, subproject eligibility criteria, financing terms, strategies regarding the installation of laboratories and concentrators and policies relative to the cooperation with other institutions. Other documents that appear to be highly valuable in this regard include operating manuals for subproject appraisal, subproject supervision and subproject processing.

6.06 As outlined earlier, limitations of government institutions in channeling funds to a large number of small borrowers make it highly desirable to encourage increased commercial bank involvement. MLI's can make a significant contribution to this end, in continuing to press for the introduction of mechanisms appropriate to reduce and remove the reservations of commercial banks vis-a-vis lending to SSM-operations. Increased spreads in the initial years of SSM-programs appear to be appropriate, to be gradually reduced as experience and confidence builds up. Guarantee schemes have been used with some success to overcome the risk aversion of commercial banks, whereby part of the loan is guaranteed through a central bank fund.

6.07 The most successful method of inducing commercial lending institutions to act as financial intermediaries are rediscounting arrangements involving the central bank. Under such arrangements, commercial banks can increase their loan portfolio without having to commit a large part of their own financial resources, a feature which makes them particularly attractive. The ultimate aim should be that much of the MLI financial assistance be channeled through commercial banks since these are well equipped and efficient in credit transactions involving small loans to a large number of borrowers. An important element in increasing commercial bank involvement can be an apex institution which is specifically geared to SSM project lending and which serves as adviser to commercial banks and as a promotion agency for mining projects.

6.08 Previous experience also shows that greater care needs to be exercised in the selection of subprojects both to raise the degree of

success of subprojects and to achieve a more favorable overall economic impact. The solution of both problems will require the continued initiative on the part of the MLI's to fulfill their guiding and advising function in program design and project execution. Executing agencies will have to be encouraged to place increasing emphasis on the application of stringent eligibility criteria and efficient subproject appraisal procedures. With regard to enhancing the positive economic impact of SSM-development, the critical importance of the choice of technology and scale of production cannot be overestimated. Executing agencies have to be convinced that only if appropriate technologies are employed, optimum economic benefits in terms of employment generation, national value added, net foreign exchange earnings and domestic linkage effects, can be expected.

6.09 It is obvious that MLI's can play a decisive role in ascertaining that an environment conducive to SSM-development is created by making the effectiveness of loans contingent upon the fulfillment of conditions that appear to be essential for project success. This instrument has been used successfully in the past to accomplish the necessary policy reforms and to improve the required institutional framework. Its increased use is appropriate in cases where uncertainties regarding geological conditions, institutional capabilities and the effectiveness of policy adjustments are indicative of elevated project risks. In such cases it is also advisable to rely on a staged project design, starting with an initial pilot stage of reduced scope, to be followed by a full-scale second generation of projects if the pilot initiative proves sufficiently successful. This approach makes it possible to evaluate the effects of policy adjustments, it gives institutions involved, including commercial banks, an opportunity to accumulate experience and it thus permits optimization of program design for the second stage projects.

#### B. Profile of Policy Guidelines

6.10 Observations made in the preceding sections and conclusions derived therefrom, demonstrate that ways exist and means are available to foster the growth of the SSM-segment. Specific guidelines relative to the role and approach of MLI's can be summarized as follows:

- (i) MLI's should continue to expand lending operations to SSM's in view of the potential economic benefits of this activity.
- (ii) In target selection, low-income developing countries with high real capital-labor-cost-ratios should be given priority; there, SMM-projects should be given distinct preference over LSM-projects.
- (iii) The promotion of industrial mineral, coal and metal ore projects should receive equal attention. Industrial minerals produced for local markets create substantial domestic linkages and carry relatively low risks.

- (iv) MLI's should continue to initiate policy reforms and adjustments adequate to create an economic and regulatory environment conducive to target segment development, through neutralizing policy elements biased in favor of large-scale investment.
- (v) MLI's should continue to expand the capabilities of institutions acting as executing agencies through financing appropriate strengthening and upgrading programs. Thereby, over-reliance on a single intermediary should be avoided.
- (vi) The increasing involvement of commercial banks for channeling financial assistance funds should be forcefully promoted through appropriate incentive schemes. Whenever private companies can carry out assistance functions, such as the operation of regional concentrators and custom smelters, they should be encouraged to do so, and government agencies should only provide this assistance, if the private sector is not ready to carry it out.
- (vii) Increasing emphasis should be placed on non-financial assistance components, particularly on the introduction of efficient mining and business practices through extensive training programs. On-the-job training programs in suitable existing MSM or LSM-operations should be installed in underground mining districts, particularly where mining tradition is weak.
- (viii) Intermediaries and beneficiaries should be encouraged to maximize national economic benefits through careful project design, the use of the appropriate technology and increasing domestic processing, where respective comparative advantages exist.
- (ix) In cases where initial project conditions are not favorable, due to an inadequate policy and institutional framework, geological uncertainties and a weak mining tradition, MLI lending operations should follow a staged approach, starting with a moderately-sized pilot project, to be expanded, if successful, in subsequent stages.
- (x) MLI's should continue to use the instrument of setting adequate conditions for credit effectiveness and credit disbursement to initiate and accomplish reforms and adjustments in the policy and institutional framework, where necessary, to promote target segment development.

**Annex A.** Share and Estimated Value of Small Mine Production

Table A.1. Share of Small Mines in Global Production of Industrial Minerals  
(Mine Size below 100,000 tpy)

Commodity	1983 World Production <u>1/</u> (1000 st)	SSM share <u>2/</u> (%)	SSM production (1000 st)
Fluorspar	4 677	90	4 209
Graphite	632	90	569
Talc	7 553	90	6 798
Vermiculite	495	90	445
Pumice	11 700	90	10 530
Feldspar	3 878	80	3 102
Clays	461 000	75	345 750
Gypsum	85 800	70	60 060
Barite	6 087	60	3 652
Sand and Gravel	8 400 000	30	2 520 000
Stone	2 912 760	30	873 828
Salt	179 710	20	35 942
Asbestos	4 582	10	458
Phosphate Rock	148 810	10	14 881
Bauxite	18 327	negligible	-
Potash	29 342	negligible	-
Sulfur	55 635	negligible	-
Total	12 330 988 (100 %)		3 880 224 (31 %)

Source: 1/ U.S. Bureau of Mines, Min. Facts. & Prob., 1985.  
2/ J.S. Carman, 1985.

Table A.2. Share of Small Mines in Global Production of Metals  
(Mine Size below 100,000 tpy)

Commodity	1983 World Production <u>1/</u> (short tons)	SSM share <u>2/</u> (%)	SSM production (short tons)
Beryllium	191	100	191
Mercury	7 144	90	6 430
Tungsten	42 859	80	34 287
Chromite	2 745 000	50	1 372 500
Antimony	53 300	45	23 985
Manganese	8 800 000	18	1 584 000
Tin	233 686	15	35 053
Iron Ore	466 200 000	12	55 944 000
Lead	3 714 727	11	408 620
Zinc	6 909 171	11	760 009
Cobalt	25 500	10	2 550
Gold	1 527	10	153
Silver	13 466	10	1 347
Copper	8 928 571	8	714 286
Bismuth	4 467	negligible	-
Cadmium	21 715	negligible	-
Columbium	10 525	negligible	-
Magnesium	5 512 000	negligible	-
Molybdenum	68 915	negligible	-
Nickel	759 500	negligible	-
Titanium	2 427 000	negligible	-
Total	506 479 487 (100 %)		60 887 411 (12 %)

Source: 1/ U.S. Bureau of Mines, Min. Facts & Prob., 1985.  
2/ J.S. Carman, 1985.

Table A.3. Estimated Value of Small Mine Production of World  
Industrial Mineral Output  
(Mine Size below 100,000 tpy)

Commodity	Gross Value of Output (10 <sup>6</sup> U.S. \$)	Share of SSM (%)	Gross Value of SSM Output (10 <sup>6</sup> U.S. \$)
Flourspar	745	90	670
Graphite	221	90	199
Talc	182	90	164
Vermiculite	51	90	46
Pumice	114	90	103
Feldspar	124	80	99
Clays	2 592	75	1 944
Gypsum	682	70	477
Barite	300	60	180
Sand and Gravel	10 103	30	3 031
Stone	14 957	30	4 487
Salt	2 703	20	541
Asbestos	1 444	10	144
Phosphate Rock	3 788	10	379
Bauxite	3 008	negligible	-
Potash	3 830	negligible	-
Sulfur	5 471	negligible	-
Total	50 315 (100 %)		12 464 (25 %)

Source: J.S. Carman, 1985.

Table A.4. Estimated Value of Small Mine Production of World Metal Output  
(Mine Size below 100,000 tpy)

Commodity	Gross Value of Output (10 <sup>6</sup> U.S. \$)	Share of SSM (%)	Gross Value of SSM Output (10 <sup>6</sup> U.S. \$)
Beryllium	38	100	38
Mercury	77	90	69
Tungsten	272	80	218
Chromite	633	50	316
Antimony	126	45	57
Manganese	1 634	18	294
Tin	3 118	15	468
Iron Ore	32 638	12	3 917
Lead	1 977	11	217
Zinc	5 064	11	557
Cobalt	675	10	67
Gold	16 060	10	1 606
Silver	2 962	10	296
Copper	12 812	8	1 025
Bismuth	15	negligible	-
Cadmium	39	negligible	-
Columbium	97	negligible	-
Magnesium	731	negligible	-
Molybdenum	158	negligible	-
Nickel	4 512	negligible	-
Platinum Group	1 801	negligible	-
Titanium	413	negligible	-
<b>Total</b>	<b>85 852</b> (100 %)		<b>9 145</b> (11 %)

Source: J.S. Carman, 1985.

**Annex B. Developing Countries with an Important Recently or Currently Active Small-Scale Mining Segment**

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Country	Mineral Commodity Mined by SSM
<b><u>Africa</u></b>	
Algeria	Antimony, barite, bentonite, diatomite, mercury, zinc
Central African Rep.	Diamonds, gold
Ethiopia	Gold, manganese, platinum
Gabon	Gold
Ghana	Diamonds, gold
Kenya	Beryl, copper, gemstones, gold, silver, vermiculite, wollastonite
Lesotho	Diamonds
Liberia	Diamonds, gold
Madagascar	Bismuth, colombite, gold, rare earth minerals, tantalite
Morocco	Antimony, barite, lead, manganese, tin, zinc
Nigeria	Asbestos, barite, colombite, gold, lead, tantalite, tin, zinc
Rwanda	Beryl, gold, tin, tungsten
Sierra Leone	Diamonds
Tunisia	Lead, mercury, zinc
Tanzania	Diamonds, gold, magnesite, mica, precious stones, tin, tungsten
Uganda	Beryl, bismuth, tungsten
Zimbabwe	Antimony, beryl, chromite, copper, gemstones, gold, lithium, manganese, mica, silver, tantalite

**Annex B.**      (continued)

Country	Mineral Commodity Mined by SSM
<b><u>Asia</u></b>	
Burma	Antimony, manganese, tin, tungsten
China	Tin, antimony, tungsten, iron, coal
India	Barite, borax, iron, manganese, mica, tin, coal
Indonesia	Tin, gold
Iran	Barite, copper, lead, zinc
Malaysia	Gold, iron, manganese, tin, tungsten, zinc
Philippines	Chromium, copper, gold, silver, zinc, coal
Thailand	Antimony, tin, tungsten
Turkey	Chromite, copper, lead, magnesite, mercury, zinc
<b><u>Latin America</u></b>	
Argentina	Antimony, asbestos, beryl, bismuth, columbite, lithium, mercury, tantalite, tungsten, vermiculite
Bolivia	Antimony, copper, gold, mercury, silver, sulphur, tin, tungsten, zinc, lead
Brazil	Beryllium, chromite, columbium, gold, precious stones, tin, titanium
Chile	Barite, copper, gold, lead, manganese, mercury, sulfur
Colombia	Antimony, chromite, emeralds, iron ore, lead, mercury, precious stones, zinc
Cuba	Copper, manganese, pyrite
Dominican Republic	Gold
Guatemala	Antimony, lead, manganese, mica, tin, tungsten
Mexico	Fluorspar, mercury, sulfur, tin, uranium, niobium
Peru	Antimony, bismuth, copper, diatomite, lead, manganese, molybdenite, silver, tin, zinc
Venezuela	Asbestos, diamonds, gold

Source: R. Bosson and B. Varon, 1978.  
W. Gocht, 1983.

**Annex C. Selected Countries with Important Direct Mining Sector Contribution**

Table C.1. Share of Mining in GDP

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Country	Share of Mining in GDP in % (1983)
Bolivia	9.9
Botswana	25.9
Chile	8.7
Jamaica	14.3
Liberia	15.1
Morocco	4.9
Papua New Guinea	9.0
Peru	11.7
Zaire	8.8
Zambia	16.1

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Source: C.J. Johnson and W.S. Pintz, 1985.

Table C.2. Share of Mining in Employment

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Country	Employment in the Mining Sector in % (1970 - 1980)
Bolivia	5.6
Botswana	6.8
Brunei	9.2
Gabon	6.1
India	4.0
Jordan	5.5
Liberia	11.3
Sierra Leone	9.9
Swaziland	3.7
Trinidad and Tobago	5.5
Turkey	4.0
Zambia	15.9
Zimbabwe	6.6

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Source: C.J. Johnson and W.S. Pintz, 1985.

**Annex D. Summary Profile of Commodity Subgroup Typification**

Commodity Subgroup	Characteristic	Implication
<b><u>Metals and Precious Stones</u></b>		
<b>Alloy and Base Metals</b>	high volume reduction - large concentration factor	concentration close to point of extraction imperative
	mining and processing moderately to highly demanding	comparatively high specific investment, special skill requirements
	medium to high product unit value and moderate product quantities	moderate, physical marketing effort, large marketing radius, internationally tradeable
	economic parameters sensitive and hardly foreseeable	entrepreneurial risk comparatively high
<b>Precious Metals and Stones</b>	extremely high volume reduction and concentration factor	concentration at point of extraction imperative
	mining and processing simple to moderately demanding	low specific investment, low skill requirements generally sufficient
	'very high product unit-value; extremely small product quantities	small physical marketing effort, practically unlimited marketing radius, illicit trading potential
	economic parameters moderately sensitive and hardly foreseeable	entrepreneurial risk moderate to high

**Annex D. (continued)**

Commodity Subgroup	Characteristic	Implication
<b><u>Industrial Minerals and Coal</u></b>		
Construction Materials	<p>very little volume reduction, very low concentration factors</p> <p>mining and processing very simple</p> <p>very low product unit-value, comparatively large product quantities</p> <p>economic parameters stable and foreseeable</p>	<p>location of processing site irrelevant</p> <p>low specific investment, minimum skill level sufficient</p> <p>small marketing radius, comparatively large physical marketing effort, dispersed pattern of operations, only for local market</p> <p>low risk business, important local input</p>
Other Industrial Minerals	<p>low to moderate volume reduction and concentration factors</p> <p>mining and processing moderately difficult to demanding</p> <p>product unit-value and product quantities moderate</p> <p>economic parameters comparatively stable and foreseeable</p>	<p>processing fairly close to point of extraction</p> <p>moderately high specific investment and skill requirements</p> <p>moderate physical marketing effort, medium marketing radius</p> <p>low to medium risk business; important local input with export potential</p>
Coal	<p>low volume reduction, small concentration factor</p> <p>mining moderately to highly demanding, processing simple to moderate</p> <p>low to moderate product unit-value, comparatively large product quantities</p> <p>economic parameters comparatively stable and reasonably foreseeable</p>	<p>location of processing plant not critical</p> <p>specific investment costs moderate, skill requirements moderate to high</p> <p>small marketing radius for small producer, comparatively large physical marketing effort</p> <p>entrepreneurial risk low to moderate, important local input with export potential</p>

Annex E. Effect of Processing and Upgrading

Table E.1. Comparison of Typical Grades for R.O.M. Ore, Concentrate and Marketable Product for Selected Commodities

Commodity	Typical Grade R.O.M.			Typical Content Concentrate			Content Marketable Product	
	expressed as	from	to	expressed as	from	to	expressed as	min.
<b>ALLOYS AND BASE METALS</b>								
Beryllium	% BeO	0.20	3	% BeO	10	N/A	% Be	98.00
Mercury	% Hg	0.15	4	% Hg	60	N/A	% Hg	99.99
Tungsten	% WO <sub>3</sub>	0.20	4	% WO <sub>3</sub>	60	70	% W	N/A
Chromite (metall.)	% Cr <sub>2</sub> O <sub>3</sub>	20.00	46	% Cr <sub>2</sub> O <sub>3</sub>	40	N/A	% Cr	99.00
Antimony	% Sb	2.00	12	% Sb	45	60	% Sb	99.20
Manganese (metall.)	% Mn	10.00	50	% Mn	40	50	% Mn	99.50
Tin (standard grade):								
Placer	% Sn	0.01	N/A	% Sn	60	N/A	% Sn	99.75
Rock	% Sn	0.20	N/A	% Sn	60	N/A	% Sn	99.75
Iron ore	% Fe	30.00	65	% Fe	60	65		
Lead	% Pb	2.00	20	% Pb	60	80	% Pb	99.985
Zinc (sp. high grade)	% Zn	5.00	25	% Zn	48	N/A	% Zn	99.99
Cobalt (powder)	% Co	0.10	5	% Co	4.5	N/A	% Co	99.50
Copper (anode)	% Cu	0.40	4	% Cu	11	N/A	% Cu	99.70
<b>PRECIOUS METALS AND STONES</b>								
Gold								
placer	g/t Au	0.20	N/A	% Au	N/A	N/A	% Au	99.50
rock	g/t Au	2.00	N/A	% Au	N/A	N/A	% Au	99.50
Silver								
Ag-deposit	% Ag	0.05	N/A	% Ag	N/A	N/A	% Ag	99.90
as by product	g/t Ag	50.00	N/A	% Ag	N/A	N/A	% Ag	99.90
Diamonds	g/t	0.04	N/A				%	100.00
<b>OTHER INDUSTRIAL MINERALS</b>								
Flourspar	%	30.00	70	%	50	70		
Talc	%	15.00	85	%	25	100		
Vermiculite	%	30.00	50	%	N/A	N/A		
Phosphate Rock	%	5.00	N/A	%	30	38		

N/A = data not available

Table E.2. Concentration Factors for Selected Commodities <sup>1/</sup>

Commodity	Concentration Factor USA 1983 <sup>2/</sup>	Maximum Concentration Factor <sup>3/</sup>
<b>1. ALLOYS AND BASE METALS:</b>		
Beryllium	N/A	1900.0
Mercury	N/A	770.0
Tungsten	N/A	700.0
Chromite	N/A	16.0
Antimony	N/A	53.0
Manganese	N/A	11.0
Tin placer	N/A	12500.0
Iode		625.0
Iron ore	2.5	2.2
Lead	18.4	56.0
Zinc	26.0	22.0
Cobalt	N/A	1100.0
Copper	176.1	280.0
<b>2. PRECIOUS METALS &amp; STONES:</b>		
Diamonds		
Gold (primary)	437556.0	
(alluvial)	5370247.0	
Silver	8751.0	
<b>3. CONSTRUCTION MATERIALS:</b>		
Clays	1.0	
Gypsum	1.1	
Sand and gravel	1.1	
Stone - dimension	2.1	
Stone - crushed	1.0	
<b>4. OTHER INDUSTRIAL MINERALS:</b>		
Flourspar	2.3	
Graphite	N/A	
Talc	1.0	
Vermiculite	N/A	
Pumice	1.9	
Feldspar	1.1	
Barite	1.1	
Salt	1.0	
Asbestos	N/A	
Phosphate rock	3.2	
Bauxite	2.0	
Potash	9.6	
Coal (estimated)		1.1

N/A = data not available

<sup>1/</sup> Concentration Factor = Ratio of processed ore per unit marketable product (tons/ton).

<sup>2/</sup> U.S. Bureau of Mines, Min. Yearb., 1983.

<sup>3/</sup> Values calculated based on data presented in Table E.1.

Annex F. Policy and Institutional Profiles of Ten Developing Countries

Table F.1. Bolivia

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FISCAL REGIME	<p>1980, the 7,5 % special export levy was abolished and the income tax (regalia) was raised for tin from 38 % to 53 %, the latter is imposed on selling price minus government - set presumptive cost.</p> <p>Up to 40 % of output increasing investment in tin mines can be deducted from the "regalia". Same tax system applies to copper, antimony and tungsten. For zinc and silver royalties of 20 % and 7 % respectively are applied.</p>
MINING LEGISLATION	<p>Policy prepared 1983, unapproved as yet, proposes more state control in mining and metallurgy, a state marketing monopoly of minerals, co-participation of workers in management of state mining corporations and labor union representatives in the management of private mining companies.</p>
INSTITUTIONS	<p>Banco Minero de Bolivia - BAMIN provides financial and technical assistance to SSM's and cooperatives, including credits for working capital and mine development, purchasing of ore and selling to smelters.</p> <p>National Fund for Mineral Exploration - FNEM was created in 1977 to assist SMM's in expanding their ore reserves through financing prospecting and exploration activities.</p> <p>Servicio Geologico de Bolivia - GEOBOL is the primary agency for national prospecting and exploration activities.</p> <p>National Association of Medium Miners, established 1939, includes 25 private, medium-sized mining companies.</p> <p>Camara Nacional de Minería includes 2,500 small miners and 97 cooperatives organized under the Federacion de Cooperativos.</p>

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Sources: World Bank data, 1979.  
U.S. Bureau of Mines, Min. Persp., 1981.  
U.S. Bureau of Mines, 1982.

Table F.2. Chile

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FISCAL REGIME	<p>Main policy objective is to maximize fiscal revenue through productivity increases in mining operations.</p> <p>Mining taxation consists of a 50 % tax on profits. State also applies mining concession tax in order to bring properties into production.</p>
MINING LEGISLATION	<p>Free-market principles and direct private foreign investment are given central importance. Previously exercised discretionary granting of mining concessions has been abolished in favor of granting concessions automatically to any claimant meeting requirements.</p> <p>Exploration concessions are limited to a period of 4 years, exploitation concessions are of indefinite duration.</p> <p>Concession is an unlimited title which can be sold or otherwise transferred freely.</p>
INSTITUTIONS	<p>Empresa Nacional de Minería - ENAMI is an autonomous national mining company and government agency promoting SSM's. Through regional offices, ENAMI provides financial and technical assistance, including purchasing, processing and marketing of ore. ENAMI operates 5 regional concentrators and 2 smelting and refining facilities. It can adjust custom milling tolls or provide bonuses to subsidize the small - mining sector when metal prices are depressed. ENAMI encourages small mine development by providing low-cost loans to miners, accepting ore as collateral.</p> <p>Other institutions active in the sector are CODELCO and CORFO.</p>

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Sources: World Bank data, 1985.  
U.S. Bureau of Mines, Min. Persp., 1981.  
U.S. Bureau of Mines, 1982.

Table F.3. India

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FISCAL REGIME	The government offers tax concessions to the mining industry in the form of allowances for depreciation and rehabilitation, expenditure on scientific research, amortization of preliminary expenses, deductions of prospecting and exploration expenditures and tax holidays.
MINING LEGISLATION	<p>The Indian Mining Law regulates the granting of prospecting licences, mining leases, mineral conservation and development.</p> <p>Owners of minerals are the States. Minerals are divided into 2 categories, i.e. minor minerals and others. Leases of other minerals are granted by the state government (in some cases with approval of the Union Government), leases of minor minerals may be obtained from the district authorities.</p> <p>Regarding small mines of other minerals, the law does not make special provisions except that persons with lower qualifications are permitted to be employed as mine managers.</p>
INSTITUTIONS	<p>The Indian Bureau of Mines - IBM provides some assistance to small miners, specifically surveying, metallurgical testing, assistance in mineral marketing, and geological appraisals. The IBM plans to study the geology of small mines, which do not yet have surveys. Almost 80 % of the working mines need such studies in order to proceed with exploration and development.</p> <p>The Geological Survey of India - GSI provides systematic geological mapping, regional exploration, drilling, preliminary assessment of mineral resources and metallurgical testing. The GSI has been evaluating gold prospects in several States, including Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu and along the Himalayan foothills.</p>

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Sources: U.S. Bureau of Mines, Min. Yearb., 1984.  
UNITAR, 1980.

Table F.4. Mexico

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FISCAL REGIME	<p>In 1983, the mineral production tax was eliminated and replaced by a new "right-to-exploit" payment, which is 7 % for gold, silver and sulphur, 2 % for coal, iron ore and manganese and 5 % for other minerals on the net smelter value. At the same time the dividend tax was raised from 21 % to 55 %.</p> <p>In 1984, the import tax exemption, the last specific subsidy to the sector, was eliminated. In the same year, the President signed a decree granting certain fiscal benefits designed to stimulate the mining industry, especially the small and medium- size operations.</p>
MINING LEGISLATION	<p>Underground minerals belong to the state, surface deposits belong to the landowner.</p> <p>Mining concessions for exploration and exploitation are transferable and can now be used as collateral for loans.</p> <p>Mining concessions for exploration are granted up to 3 years on a maximum of 50,000 hectares; for exploitation, concessions are granted for 25 years up to 500 hectares, renewable for another 25 years.</p> <p>Small miners with concessions below 25 hectares are allowed to start exploitation, while still in the exploration stage, helping to self-finance exploration.</p>
INSTITUTIONS	<p>Comision de Fomento Minero - CFM, a government agency providing technical and financial assistance to SSM's, including short- to long-term credit and equipment leasing. CFM also currently operates 20 regional beneficiation plants. Tolls are set to cover operating and administration costs.</p> <p>Fideicomiso de Minerales No Metalicos Mexicanos - FNM, a government trust which provides technical assistance and credit to the non-metallic mineral segment including SMM's.</p> <p>Consejo de Recursos Minerales - CRM, a decentralized public institution also provides technical and financial assistance to the SMM - segment.</p>

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Sources: World Bank data, 1985.  
U.S. Bureau of Mines, Min. Yearb., 1984.  
U.S. Bureau of Mines, 1982.

Table F.5. Morocco

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FISCAL REGIME	<p>Taxes levied on mining are ad valorem taxes on the basis of the "pit-head" value of the mineral, e.g. zinc: 0.5 % on minehead price; lead 5 % on minehead price if the LME price is below or equal to US\$ 870 per ton and 10 %, if above.</p> <p>The Code of Investment provides incentives to the SSM-sector, such as exoneration from taxes on the products, exoneration from customs duties on equipment for mining, exoneration from patent fees for a duration of 5 years; etc.</p>
MINING LEGISLATION	<p>Laws relating to mining are contained in the Mining and Petroleum Regulations of Morocco. The products from mines and quarries are separated into 8 categories, with specific provisions applicable to certain categories.</p> <p>Mining rights are conferred to the discoverer of the mineral property.</p> <p>Exploration and mining concessions have a specified time span as distinct from the ownership of land. A minimum work program must be undertaken to retain the concessions. The work programs are subject to the approval of the administration.</p>
INSTITUTIONS	<p>The Centrale d'Achat et de Developpement de la Region Miniere du Tafilalet et de Figuig (CADETAF), a non-profit public agency under the authority of the Ministry of Energy &amp; Mines, provides for the small scale mining operations in the south-east</p> <ul style="list-style-type: none"><li>- technical assistance</li><li>- purchase and marketing of ore</li><li>- explosives, hand tools, etc.</li><li>- professional training</li></ul>

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Sources: U.S Bureau of Mines, Min. Persp., 1984.  
U.S. Bureau of Mines, 1982.  
World Bank data, 1982.

Table F.6. Peru

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FISCAL REGIME	<p>Since 1984, a new 5-10 % tax on all exports and domestic sales of traditional metals is effective for export prices exceeding a given reference value for each metal.</p> <p>Small miners are exempted from income tax and other taxes on the capitalization/reinvestment of profits. Small miners may also apply for a discount of up to 50 % on import duties for new or used mining equipment. Small miners imports of equipment for gold mining are totally exempted from import duties.</p>
MINING LEGISLATION	<p>1981 size of claims qualifying as small mines were increased from 1,000 to 5,000 hectares, the new production limit was set at 350 tpd with the provision that this can be exceeded by 30 % without losing special tax protection until 1991.</p> <p>The general mining code of 1971 declares state ownership of all mineral found in the land and sea, modifications to encourage the mining industry have been made.</p> <p>Current government policies appear directed toward a greater role for private enterprise aimed at stimulating activity in the sector.</p>
INSTITUTIONS	<p>Banco Minero de Peru - provides technical and financial assistance to small miners, specifically laboratory services, renting and selling of equipment and operating supplies at favourable terms. It maintains 7 regional concentrators throughout the country which are used by small miners to concentrate their ores.</p> <p>Instituto Geologico Minero Metalurgico - INGEMMET is responsible for research in geology, mining and metallurgy.</p> <p>Minero Peru Commercial - MINPECO is a state agency responsible for marketing mineral production from state mining companies or private producers.</p>

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Sources: U.S. Bureau of Mines, Min. Persp., 1981.  
U.S. Bureau of Mines, Min. Yearb., 1984.  
U.S. Bureau of Mines, 1982.

Table F.7. Philippines

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FISCAL REGIME	<p>In 1981, new tax exemption rules were issued to benefit new mines and also old mines which had ceased operations. Tax exemptions are granted for 2- or 5-year periods depending on the volume of ore reserves of the mine.</p> <p>Tax exemptions include duties on imported equipment, royalties, sales tax and real estate tax.</p> <p>Royalty tax is bound to the return on investment of mining companies, i.e. companies with a return on investment of 12 % pay 4.5 % royalty tax, while those with less than 12 % pay a lower tax.</p>
MINING LEGISLATION	<p>In 1984, a new mining law was issued to encourage the development and exploitation of small but relatively high-grade untapped mineral deposits (Decree No. 1899). The law defines SSM as any single unit mining operation with an annual production of not more than 50,000 tons of ore. It regulates a minimal investment of infrastructure and processing plant, mining equipment not to be sophisticated, ownership, management, etc. The law provides various incentives, such as technical assistance, simplified processing and granting of permits or licenses to the holder of mining rights on a SSM property.</p>
INSTITUTIONS	<p>The Development Bank of the Philippines provides financial assistance at attractive interest rates to primary gold producers, e.g. Manila Mining Corp.</p> <p>The Bureau of Mines provides technical assistance to mining firms in the exploration and development of mineral properties. The services include leasing of drilling equipment to private parties and providing of personnel at its own expense. It has been proposed to establish gold mills in strategic areas where several gold mines are located.</p>

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Sources: U.S. Bureau of Mines, Min. Yearb., 1984.  
U.S. Bureau of Mines, 1982.  
UNITAR, 1980.

Table F.8. Rwanda

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FISCAL REGIME	<p>Taxes levied on mining include customs duties, fiscal taxes, export taxes and corporate taxes on profits. The rate of taxation depends on the mineral mined, e.g. cassiterite: custom duties are 10 % on basic value of 2.110 Frw/10 kg, determined by the National Bank according to market conditions.</p> <p>The Government grants exonerations from duties and fiscal taxes when importing some materials and raw materials, from tax on profits during the first 5 years of operation, from export duties in some cases.</p> <p>Furthermore the tax regime guarantees stability in regard to taxes and duties.</p>
MINING LEGISLATION	<p>The mineral resources of Rwanda are considered state property.</p> <p>Mining leases are for 30 years, with an unlimited number of 15-year renewal periods possible.</p> <p>Artisans, independent of SOMIRWA (Societe Minière du Rwanda) are granted a special license for mining work by the Ministry of Natural Resources, Mines and Quarries.</p>
INSTITUTIONS	<p>The Ministry of Natural Resources, Mines and Quarries assists the artisan mining activities, e.g. technical assistance (mining techniques, safety), formation of mining cooperatives, topographical mapping for artisans with special licenses, laboratory analysis of rock and ore samples.</p> <p>Societe Minière du Rwanda - SOMIRWA has been reported to provide technical assistance in the form of renting equipment and providing operating supplies; it also acts as an ore purchasing agent.</p>

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Sources: UNITAR, 1980.  
U.S. Bureau of Mines, Min. Persp., 1984.

Table F.9. Zaire

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**FISCAL REGIME**

Taxes on corporate income include a profits tax, which is 50 % of taxable profits from a Zairian source, various sales taxes and an employment tax.

Royalties are not fixed by law, but can be determined on an ad hoc basis by the Government.

The Government reserves the right to purchase all or part of the production of any mining operation at a "just price", regulate the quantity of production, etc.

Tax incentives available to qualified parties under the investment code are: up to 5 years tax holiday, exoneration from customs duties and sales taxes on new equipment which cannot be supplied by local industry, etc.

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**MINING LEGISLATION**

Changes in the mining law and in foreign currency exchange regulations resulted in increases in reported production of several minerals in 1984, particularly diamond and cassiterite.

Zairians are permitted to mine diamonds without a permit in nonconcession areas. Private ownership and transport of diamonds in Zaire is legal, but exports are only by licensed counter-buyers.

Excluding native artisanal working for diamonds and precious metals, mining rights are granted under the terms of personal prospecting permits, research permits, development permits, etc.

Laws relating to mining investments are found in the Investment Code, 1979.

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**INSTITUTIONS**

There are no institutions reported to specifically assist the small miners in Zaire.

However, owing to changes in the mining code for Zairian citizens and a floating exchange rate output by artisanal miners has become available for sale and export. Output from artisanal sites is purchased by Sediza, a De Beers Central Selling Organization - CSO affiliate, and other licensed buyer-counters, of which about 12 exist in Zaire.

The most important government institution serving the sector is La Generale des Carrieres et des Mines du Zaire (GECAMINES).

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Sources: U.S. Bureau of Mines, Min. Persp., 1985.  
U.S. Bureau of Mines, Min. Yearb., 1984.

Table F.10. Zimbabwe

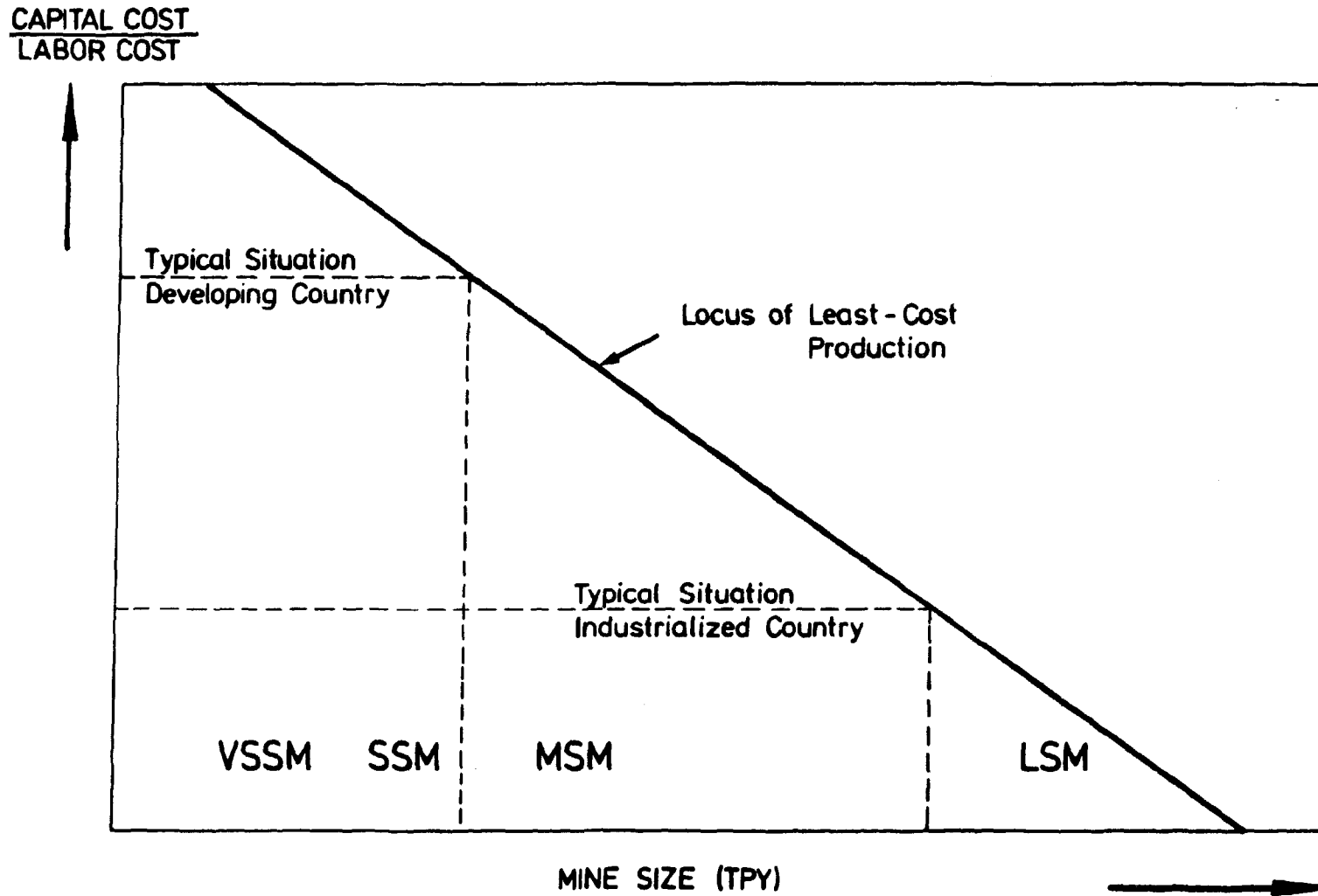
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FISCAL REGIME	<p>Corporate taxes have an effective rate of 51,75 % for companies. Other taxes include a 15 % tax on consumables, a 5 % import duty on mining equipment, a 15 % import tax and a 15 % surtax. Dividends are subject to a 20 % nonresident shareholders tax.</p> <p>Special tax provisions intend to encourage mineral exploration and development, e.g. allowances for prospecting and exploration, depletion allowances, capital redemption allowance and capital replacement allowance. Other incentives are an exemption from the 15 % sales tax for a number of mining inputs and a refund of sales tax for certain capital expenditures.</p>
MINING LEGISLATION	<p>The Mines and Minerals Act regulates among other acts mining management and safety, export of minerals and metals, financial assistance to gold mining, gold trade etc.</p> <p>The establishment of the government controlled Minerals Marketing Corp. in 1982 has resulted in new regulations pertaining to the marketing of minerals.</p> <p>Four District Mining Commissioners are responsible for granting mining rights, supervising pegging and mining procedures and providing advice and assistance.</p>
INSTITUTIONS	<p>The Loan Fund Account provides assistance to miners and particularly to small operators. The fund provides various types of loans to purchase land and equipment, assists in marketing and builds processing plants and utilities. Mining authorities provide financial and technical assistance.</p> <p>Various types of Government loans are available to very small mining operations. A guaranteed purchase price is provided by the Government to maintain the level of gold production.</p> <p>Advice and assistance on mining matters are available from the Ministry of Mines and Energy Resources, normally free of charge. Advice on mining methods, ventilation problems, etc., is provided by the Department of Mining Engineering.</p>

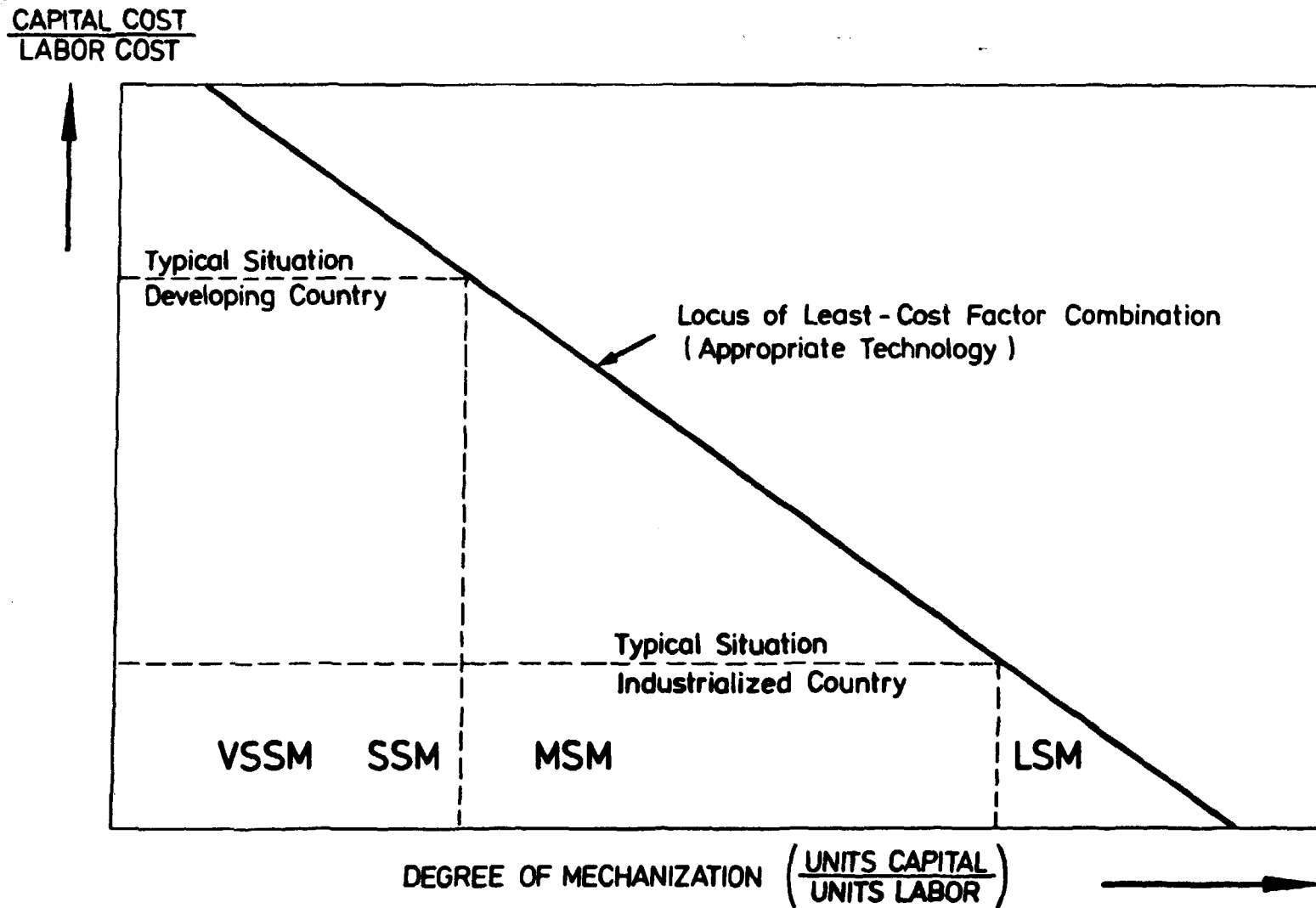
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Sources: U.S. Bureau of Mines, Min. Persp., 1984.  
U.S. Bureau of Mines, Min. Persp., 1981.  
U.S. Bureau of Mines, Min. Yearb., 1984.  
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Annex G. Fundamental Relationship between Capital-Labor-Cost Ratio and Mine Size



Annex H. Fundamental Relationship between Capital-Labor-Cost Ratio and Degree of Mechanization



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