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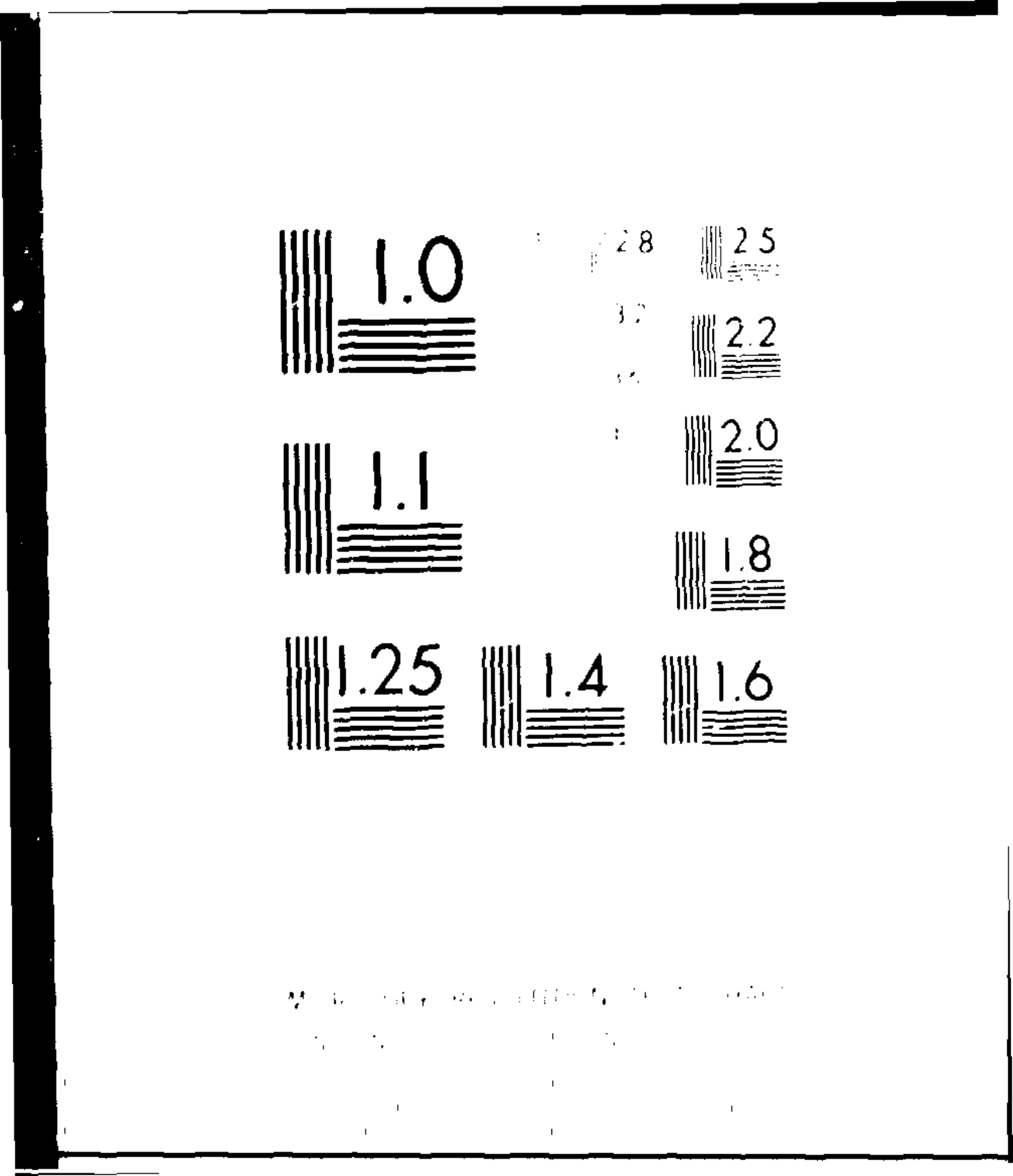
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MINING PROGRESS IN AFRICA: OPTIONS AND OPPORTUNITIES[+]

by

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Prepared on behalf of the Metallurgical Industries Section,
Division of Industrial Operations
UNIDO

for

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0. Executive summary

0.1. General indicators of the African economy

In 1977, Africa without South Africa held 9.7 % of world population; it is expected to hold about 12 % in the year 2000.

The African economy as a whole is characterized by slow growth from a low base: Africa's share of world manufacturing value added, 0.7 % at present, is not expected to exceed 1.5 % in the year 2000.

Africa North of the Sahara is an entity which, thanks largely to its long association with the Mediterranean region and to its rich mineral deposits /oil, gas, phosphates/, is forecast to grow more rapidly from a higher base than Africa South of the Sahara.

0.2. Indicators of the African mining economy

Both for open pits and underground mines above 150 000 tpy output, Africa's share of the market-economy world at 10 % or so is about one-third its share of market-economy world land area.

Africa is a major power in rock phosphate, slightly less important in copper and iron ore. Natural gas, crude petroleum and tin mark the order of decreasing importance. Disregarding South Africa, the African continent is of little importance in precious metals. There is no African country among the first ten developing country exporters of nonferrous metal ores and concentrates. On the other hand, Africa is again a major power in diamonds.

The major exporters of crude oil include Algeria, Angola, Congo, Egypt, Gabon, the Libyan Arab J., Nigeria and Tunisia.

The major exporters of fertilizers include Morocco, Togo and Senegal.

The major exporters of ores and metals include Liberia, Mauritania, Niger, Zaire and Zambia. A second league includes Angola, Gabon, Ghana, Rwanda and Sierra Leone. Guinea, for which no figures are available, is a major exporter of bauxite.

0.3. The resource base

Africa as a whole is rich in ores, fuels and other mineral resources. The distribution of these riches among the countries of Africa, however, is very uneven. This is due not only to non-uniform natural endowments but also to diversity in exploration and prospection intensity. South Africa's being the African country with the most diversified mineral resource base is due to its high level of exploration and prospection. The implication is that further exploration and prospection efforts are likely to throw up further important mineral finds in most African countries.

For all its richness in minerals, the African continent is remarkably short of some, e.g. potash.

0.4. Prospects of the world markets of minerals and minerals-derived commodities

Contrary to a widely held belief, the prices of mineral commodities have, except for petroleum, barely kept up on an average

with world inflation. This general statement covers, of course, a diversity of details. The "hedge assets" have fared well, and so have certain other commodities /cobalt, tin/. Most if not all other minerals have been depressed by the lack of vitality in world economic growth. In future, the world mining economy will have to adapt to slowed-down rates of world economic growth.

In the face of an expected increasing price volatility of mineral commodities, assessing the economic viability of mining projects will have to fall back on an estimation of comparative advantages.

0.5. The economics of extracting Africa's mineral wealth: future prospects

Mining development in developing countries is an ambivalent proposition. In many ways, mining development is little suited for promoting the development goals of most developing countries. On the other hand, exports of mineral commodities are crucial for the welfare of many African countries, representing their main linkage with the world-wide division of labour.

Most of the finance required for mining and minerals processing investment in Africa will have to be put up internationally.

Mining investment in Africa in the years up to 1984 is not expected to decrease dramatically, but some shift into other developing regions, Latin America in particular, is expected to take place. Exploration expenditure, on the other hand, seems too low, and this may create an insufficiency of deposits available for viable mining ventures in five to ten years from now.

0.6. UNIDO assistance to African mining

UNIDO's minerals-related activities show a strong bias in favour of Africa. More than 40 % of UNIDO's minerals-related programme budget for 1980-81 is devoted to African projects. One quarter is to be spent on ores, 70 % on ceramics, cement and other building-industry inputs, and smallish amounts on rock phosphate and glass.

It is necessary to improve the systematic and interdisciplinary aspects of UN activity as well as co-ordination among the different organisms of the UN family.

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1. General economic indicators for Africa

Africa including the surrounding islands, but excluding South Africa is comprised of 52 sovereign states. Total population of those in 1977 was 400 million or 9.7 % of world population. 1/

By the year 2000, Africa /not including South Africa/ is expected to have a population of around 760 million or around 12 % of world population. According to the Lima target of the developing world's industrialisation /UNIDO, loc. cit./, Africa is expected to produce in 2000 a share of 1.5 % of world manufacturing value added. Corresponding shares are to be 13.0 % for Latin America, 9.5 % for South and East Asia and 1.8 % for West Asia.

The only African state with a population exceeding 50 millions is Nigeria /66.6 millions according to the UN Statistical Yearbook; as much as 80 million according to some estimates/. Zaire, Ethiopia and Egypt have populations between 25 and 50 millions; six further countries /Uganda, Kenya, Tanzania, Algeria, Morocco and Sudan/ have populations between 5 and 10 millions, and 16 states between 1 and 5 millions. The rest, including all the islands except Madagascar, have less than one million.

Countries with population densities exceeding one hundred per sq. km are Mauritius /444/, the Seychelles /222/, Rwanda /166/ and Burundi /142/. Countries with population densities between 50 and 100 per sq. km are the Cape Verde Islands /76/, Nigeria /72/, Uganda /52/ and the Sao Tomé group of islands /85/. Countries with a population density less than 10 per sq. km are Algeria, Botswana, the Central African Republic, Chad, Djibouti, Gabon, Mali, Mauritania, Niger, Réunion, Somalia, Sudan, Western Sahara and Zambia.

UNIDO's document "World Industry since 1960: Progress and Prospects" /:ID/CONF.4/2, New York, 1979:/ classes+

as large countries:

Egypt,	South Africa,
Ethiopia,	Zaire,

as small countries with modest resources:

Benin	Mauritius,
Botswana,	Niger,
Burundi,	Rwanda,
Central African R.,	Sierra Leone,
Chad,	Somalia,
Congo,	Sudan,
Gambia,	Togo,
Guinea,	Tunisia,
Kenya,	Uganda,
Madagascar,	U.R. of Cameroon,
Malawi,	U.R. of Tanzania,
Mali,	Upper Volta and
	Zimbabwe,

1/ The data are from the UN Statistical Yearbook, 1978.

+ This list excludes Djibouti, Equatorial Guinea, Guinea-Bissau, Lesotho, Libya, Western Sahara and all the islands except Madagascar.

as small countries with ample resources and a primary orientation:

Angola,	Liberia,
Gabon,	Mauritania,
Ghana,	Nigeria ** and
	Zambia,

as small countries with ample resources and an industrial orientation:

Algeria,	Mozambique,
Ivory Coast,	Senegal,
Morocco,	Swaziland.

The World Bank[+] gives the following GDP per capita ranking for the African countries, in US dollars per year:

middle income countries:

Algeria	1260	Zimbabwe	480
Tunisia	950	Zambia	480
Ivory Coast	840	Liberia	460
Morocco	670	Cameroon, U.R.	460
Nigeria	560	Ghana	390
Congo	540	Egypt	390

low income countries:

Senegal	340	Niger	220
Kenya	330	Zaire	210
Togo	320	Sierra Leone	210
Sudan	320	Guinea	210
Angola	300	Rwanda	180
Lesotho	280	Malawi	180
Uganda	280	Upper Volta	160
Mauritania	270	Mozambique	140
Madagascar	250	Chad	140
Centr. Afr. R.	250	Burundi	140
Tanzania	230	Somalia	130
Benin	230	Mali	120
Ethiopia	120		

Missing from this list are Botswana, Gabon, Swaziland, Djibouti, Equatorial Guinea, Guinea-Bissau, Libya and Western Sahara, also all the islands except Madagascar.

In another classification of developing countries /UNCTAD's Handbook of International Trade and Development Statistics, 1979/, there are in the world 18 developing petroleum exporters, of which

** Nigeria, a large country, was placed here in order to have all the oil producers in one group.

[+] IBRD: International Development Report, 1980

five are African /Algeria, Angola, Gabon, Libya and Nigeria/; there are six fast-growing exporters of manufactures, none of which is African; there are 30 least-developed countries, 19 of which are African, and 45 most severely affected countries, 28 of which are African[+].

2. Indicators of the African mining economy[§]

Table 1 presents the distribution by size and world region of the more sizeable open pits and mines, as well as Africa's share of the market-economy world total and of the developing market-economy world total. It emerges that

- the developing world's share of open pits is greater than its share of underground mines by a rough ratio of 4:3,
- somewhat counterintuitively, the developing world's share of very large mines, both open-pit and underground, is less than its share of medium-sized and smaller ones,
- both for open-pit and underground mines, Africa's share is roughly one-third its share of the market-economy world's land area, which is 28.6 %; for a comparison, the developing market-economy world's share of open pits is roughly in line with its share of the market-economy world's land area, which is 60 % or so, but its share of underground mines is less,
- Africa's share of open pits, on the other hand, is not significantly higher than its share of underground mines; also, Africa's share of very large mines, both open-pit and underground, is not significantly less than its share of medium-sized and smaller ones.

Table 2 assigns ranks to the first ten developing-country exporters of nine commodities. It emerges on adding up the rank points that, with totals of 37 and 22, respectively, Africa is a major power in crude fertilizers /rock phosphate/; it is hardly less important in copper; it is at the top of the second league with a sum of 17 for iron ore and concentrates, and with 14 for natural gas; at 11 each, it is still less important in crude petroleum and tin; at 2, it counts little in precious metals; and there is no African developing country among the first ten developing-country exporters of nonferrous metal ores and concentrates on the one hand and of petroleum products on the other.

[+] The most seriously affected African countries are the following /those marked with an asterisk are also least developed/: *Benin, *Burundi, *Central African Republic, *Chad, Egypt, *Ethiopia, *Gambia, Ghana, *Guinea, Guinea-Bissau, Ivory Coast, Kenya, *Lesotho, Madgascar, *Mali, Mauritania, Mozambique, *Niger, *Rwanda, Senegal, Sierra Leone, *Somalia, *Sudan, *Uganda, U.R. of Cameroon, *U.R. of Tanzania, *Upper Volta and *Cape Verde Is. Countries that are least developed but not most seriously affected are Botswana and Malawi.

[§] South Africa is excluded from all the considerations to follow unless expressly stated otherwise.

Table 1

Distribution of the major mines of the world by size and world region in the non-socialist world in 1979

Top line: open pit; bottom line: underground

	0.15 to above 3 million tpy	0.15 to 0.3 million tpy	0.3 to 0.5 million tpy	0.5 to 1.0 million tpy	1.0 to 3.0 million tpy	above 3.0 million tpy
North America	167	13	15	18	43	78
	172	46	28	32	45	21
Australia	30	2	3	5	9	11
	18	4	4	3	6	1
Western Europe	29	5	4	4	10	6
	155	34	32	33	47	9
South Africa	16	2	2	1	7	4
	70	8	8	13	26	15
Israel and Japan	4	-	-	3	1	-
	16	4	6	4	2	-
Developed market economies, altogether	246	22	24	31	70	99
	431	96	78	85	126	46
Pacific	12	1	3	4	3	1
	1	-	1	-	-	-
Latin America	88	10	6	9	35	28
	70	21	29	12	5	3
Africa without S. Afr.	58	7	11	8	15	17
	68	15	12	20	15	6
Asia without Isr., Jap.	80	15	19	8	24	14
	42	17	13	7	2	3
Developing market economies, altogether	238	33	39	29	77	60
	181	53	55	39	22	12
Total, market economies	484	55	63	60	147	159
	612	149	133	124	148	58
Developing market economies' share of all market economies	49.1 %	60.0 %	61.9 %	48.3 %	52.4 %	37.7 %
	29.5	35.6	41.3	31.5	14.9	20.7
Africa's share of						
- developing market economies	24.4 %	21.2 %	28.2 %	27.6 %	19.5 %	28.3 %
	37.5	28.3	21.8	51.2	68.2	50.0
- all market economies	12.0 %	10.8 %	17.5 %	13.3 %	10.2 %	10.7 %
	11.1	10.1	9.0	16.1	10.1	10.3

Source: Mining Magazine, January 1980, and the author's calculations

Table 2

Market shares of developing-country exporters of nine commodity groups of mineral origin, 1975

rank and total score	place among developing country exporters	country	percentage in commodity's exports: world	percentage in commodity's exports: developing-cty	country's total exports
Crude fertilizer: SITC 271					
10	1	Morocco	64.88	35.13	55.00
9	2	Tunisia	8.96	4.85	13.69
8	3	Senegal	8.90	4.82	17.69
7	4	Togo	6.16	3.34	64.56
3	8	Algeria	1.08	0.58	0.33
37					
Iron ore and concentrates: SITC 281					
9	2	Liberia	12.76	5.38	74.53
5	6	Mauritania	4.81	2.03	63.50
2	9	Angola	2.40	1.01	5.55
1	10	Algeria	1.02	0.43	0.55
	11	Sierra Leone	0.64	0.27	11.68
17					
Nonferrous base metal ores and concentrates: SITC 283					
	11	Gabon	3.42	1.43	9.05
	13	Zaire	2.30	0.96	6.63
	14	Niger	2.22	0.93	60.77
	15	Mauritania	2.01	0.84	28.86
	18	Morocco	1.65	0.69	2.67
	25	Ghana	0.75	0.31	2.55
0					
Crude petroleum and the like: SITC 331					
6	5	Nigeria	7.10	6.53	92.76
4	7	Libyan Arab Jamah.	6.24	5.74	95.16
1	10	Algeria	3.50	3.22	85.16
	13	Gabon	0.75	0.69	82.89
11					

Table 2 /contd./

Petroleum products: SITC 332

	12	Algeria	1.37	0.66	5.38
	14	Senegal	0.77	0.37	19.75
	16	Libyan Arab Jamah.	0.61	0.30	1.51
	18	Kenya	0.29	0.60	22.11
0					

Gas, natural and manufactured: SITC 341

9	2	Libyan Arab Jamah.	18.33	4.19	3.34
5	6	Algeria	6.39	1.46	1.85
14					

Copper: SITC 682

9	2	Zambia	31.05	11.59	89.59
8	3	Zaire	19.95	7.45	53.57
5	6	Angola	0.78	0.29	1.83
22					

Tin: SITC 687

7	4	Nigeria	4.12	3.39	0.39
4	7	Zaire	0.71	0.58	0.63
11					

Silver, platinum etc.: SITC 681

2	9	Morocco	0.61	0.15	0.18
2					

Table 3

Share of minerals and certain minerals-derived commodities in the exports of the developing countries of Africa

Country	Year of recording	Ores metals	Fertilizers	Crude oil	Petroleum products	Other fuels
		as percentage of total export proceeds				
Algeria	1977	1.28	0.34	90.78	2.24	2.88
Angola	1975	8.45	-	48.29	3.66	0.06
Benin	1975	0.24	-	-	0.24	-
Burundi	1975	0.95	-	-	1.37	-
Cape Verde Is.	1975	2.50	-	-	-	-
Centr.Afr.Rep.	1977	0.16	-	-	-	-
Chad	1974	0.28	-	-	9.73	-
Congo	1977	6.01	7.28	54.39	0.12	-
Djibouti	1975	2.42	-	9.68	0.63	-
Egypt	1977	2.44	0.19	17.82	6.38	-
Ethiopia	1975	0.42	-	-	3.34	-
Gabon	1975	10.19	-	82.89	-	-
Gambia	1975	-	-	-	-	-
Ghana	1975	8.17	-	-	2.77	0.02
Guinea		high				
Guinea-Bissau	1975	0.95	-	-	0.30	-
Ivory Coast	1977	0.27	0.14	-	3.78	0.02
Kenya	1977	1.04	-	-	17.44	0.05
Liberia	1975	79.36	-	-	0.04	-
Libyan Arab J.	1975	-	-	95.15	1.51	3.33
Madagascar	1975	4.11	-	-	8.79	0.01
Malawi	1976	0.29	-	-	-	0.03
Mali	1976	0.11	-	-	-	-
Mauritania	1975	90.08	-	0.69	0.01	-
Mauritius	1975	0.06	-	-	0.01	-
Morocco	1976	45.30	40.58	-	1.27	0.14
Mozambique	1975	2.99	-	-	7.33	3.50
Niger	1975	60.88	-	-	0.02	-
Nigeria	1976	0.32	-	93.09	0.72	-
Réunion	1977	0.16	-	0 01	1.11	-
Rwanda	1975	18.03	-	-	-	-
Senegal	1975	19.80	18.85	-	19.75	0.06
Sierra Leone	1975	15.33	-	-	-	0.94
Somalia	1975	0.01	-	-	0.02	-
/South Africa	1975	25.19	0.57	-	0.22	0.90/
Sudan	1975	0.59	-	-	3.62	-
Togo	1975	65.53	64.56	-	0.02	-
Tunisia	1976	10.28	11.63	40.95	1.41	-
Uganda	1976	2.18	-	-	0.44	-
U.R. Cameroon	1977	4.41	-	-	0.07	-
U.R. Tanzania	1975	0.39	-	-	5.47	-
Upper Volta	1975	0.29	-	-	-	-
Zaire	1975	70.66	-	-	0.67	-
Zambia	1975	97.55	0.03	-	0.01	0.30

Source: UNCTAD: Handbook of International Trade and Development Statistics, 1979

The share of minerals and certain minerals-derived commodities in the exports of a number of African countries is shown in Table 3. Two explanations are necessary:

- The "Ores, metals" column includes the "Fertilizers" column also: hence, for countries exporting fertilizers, the true exports of ores and metals can be established by subtracting Column 4 from Column 3.
- The figures include reexports also, which distorts the picture in a few cases /as cf. the large share of petroleum in the exports of Djibouti/.

These figures give rise to the following classification.+

- Predominant export: crude oil. Algeria, Angola, Congo, Gabon, Libyan A.J., Nigeria, Tunisia.
- Predominant export: fertilizers. Morocco, Togo, Senegal.
- Predominant export: ores and metals. Liberia, Mauritania, Niger, Zaire, Zambia. A "second league", with export shares about 10 %, includes Angola, Gabon, Ghana, Rwanda and Sierra Leone. A country with a high share of ores and metals exports for which UNCTAD provides no figures is Guinea.

There is a fair degree of correlation between the share of minerals and minerals-derived commodities in a country's exports and its economic welfare as expressed in per capita GDP. There are, of course, also exceptions, Niger being one of the most conspicuous /share of ores and metals in total exports: 60.88 %, per capita GDP: $220/. Guinea would seem to be another such exception.

3. The resource base

3.1. Some introductory remarks

The following analysis of the African minerals resource base relies heavily on the US Bureau of Mines' Bulletin No. 667, Mineral Facts and Problems /1976/, as the most consistent set of figures available, although it is slightly outdated.

The likelihood of a region being endowed with a fair share of mineral resources is the greater, the more extensive the territory. This is certainly true for the African continent at large, which is rich or at least moderately so in most minerals, potash being the most notable exception at the time of writing. The distribution of these mineral riches among the African countries is not by far uniform, however. Petroleum and phosphate rock concentrate in the countries bordering on the Mediterranean and on the Atlantic; bauxite in the West African intertropical zone; gold, diamonds, uranium and the "older major metals" copper, lead, zinc and tin in the ancient shield regions. This leaves many African countries without any workable mineral deposits at all.

Can this situation be regarded as definitive? Certainly not. There are some African countries that are very well-prospected indeed, such as the Maghreb group of countries, whose degree of geological and geophysical coverage, for historical reasons, is com-

+ Unfortunately this statistic does not cover a few important items such as diamonds.

parable with that of France. Others, such as the ex-Portuguese colonies, have not been prospected either systematically or adequately. Future prospecting is therefore likely to change the minerals map of Africa quite substantially. This assumption is borne out by the example of South Africa: one of the major mining countries of the world and certainly one of the most extensively and intensively prospected, it has a minerals resource and output quite out of proportion to its territory.

Prospection so far has been governed by a few main principles which have left their imprint on coverage:

- As the markets for the minerals extracted in Africa are largely overseas, and land transport is costly, proximity to tidewater is essential, especially for low-unit-value ores such as iron ore or bauxite. Mineral deposits removed from tidewater must either be huge /bauxite in Guinea, iron ore in Liberia/ or very rich /the Copperbelt/ to be economically viable. Conversely, in the regions very far from tidewater with practically no infrastructure, such as e.g. the Hoggar or the Ennedi, it is very difficult /albeit not impossible/ to imagine an economically viable deposit of any mineral, except perhaps those of a very high unit value such as diamonds.

- The greatest prospection efforts are made as a rule close to those places where somebody else has already found a similar deposit. Thus the Copperbelt has been very thoroughly prospected for copper, West Africa for bauxite, etc. Conversely, there are large tracts of territory altogether unprospected for certain specific minerals. In Guinea e.g., at the time of independence, the existence of alluvial diamond deposits was well established, but nobody seemed to be looking for kimberlite pipes. Subsequent systematic mapping and exploration, initiated by the Government rather than by private interests, has eventually proved that there are in fact also kimberlite pipes in the country.

- Prospection tends to concentrate around existing infrastructure. This is not as self-explanatory as it seems because any new large-scale mining venture is unlikely to be accommodated by the old infrastructure, but the fact is there nevertheless.

- One implication of this is that mining countries are likely to spend more on exploration and prospection than countries with little or no mining.

- Especially in post-World War II times, the emphasis /or overemphasis, as the case may be/ has been on prospecting for deposits accessible to open-cast mining. Despite the obvious advantages of an open-cast mine, this is not self-explanatory, either: mining in the Copperbelt /or in South Africa, for that matter/ proves that underground mining /some of it very deep indeed/ is not a priori unviable in an African context. Nevertheless there may, for example, be for all we

know about it, another Copperbelt in the Mauritanides range of Mauritania: so far only one deposit amenable to open-pit mining /Akjoujt/ has been prospected by drilling. Of course, underground mining might well be unviable for low-unit-value products such as bauxite or iron ore, whose world market price /this is the essential point/ is largely a function of open-cast mining costs.

The conclusion to be drawn from all this is that /1/ further sizeable mineral deposits will probably be discovered by more systematic prospecting in many countries of Africa, /2/ more and more, prospecting will have to be carried out or at least very tightly managed by country governments if it is to be sufficiently comprehensive and otherwise adequate from the viewpoint of the country's best interests.

3.2. The fuels base

3.2.1. Hydrocarbons

We shall not dwell here on hydrocarbons whose extraction is in any case somewhat remote from mining in the strict sense and which have received all the attention that they deserve since the first oil price surge in 1973. It may suffice to state their African reserves in relation to world reserves and resources /Tables 5 and 6/.

3.2.2. Coal

African reserves of bituminous coal are shown in Table 4. At 3.6 per cent of world reserves /of which 1.1 per cent in South Africa/, they are not rich. There is a strong geographical bias in reserve distribution in favour of the Southern African countries which have Palaeozoic coal-bearing Karroo deposits /South Africa, Swaziland, Zimbabwe, Botswana, Zambia, Mozambique etc./. The exceptions to this rule are rather minor /Algeria, Egypt, Morocco, Nigeria, Zaire/. Most of cocking coal is in the Southern African deposits.

3.2.3. Hydro-power

A renewable rather than a mineral resource, hydro-power merits mention here for the sake of completeness. Of the world total hydropower potential of 2 261 000 MW, Africa at almost 20 % has the greatest share of all the continents after Asia /not including the Asian part of the USSR/. As regards developed hydro-power potential, Africa at 9 % /30 000 MW/ likewise has a fair share of the world total of 329 000 MW. Hydro-power is an important asset in the processing of minerals to metals /electric steelmaking, ferroalloy production, aluminium smelting/. The three major aluminium smelters of Africa, Tema in Ghana, Edéa in the U.R. of Cameroon and Nag Hamadi in Egypt, are all supplied with power by hydroelectric generating facilities.

3.3. Metals

3.3.1. Ferrous metals

A. Iron ore

African reserves/resources of the sort of high-grade iron ore used in iron making today are shown in Table 7 to be limited to 3.3/4.1 per cent of the world reserve/resource. A large share of this

Table 4

Bituminous coal reserves /known, recoverable/ of the world and of Africa
billion tons; percentage

World, billion tons	430.1	
of which:		
- Africa, %	3.6	
- Africa without S. Afr.	1.1	
- Botswana	506	million tons
- Nigeria	180	
- Zimbabwe	1390	
- Swaziland	1820	
- Zaire	720	
- Others	324	

Table 5

Natural gas reserves /known, recoverable/ of the world and of Africa
thousand million cubic metres; percentage

World, 10^9 m^3	63108
- Africa, %	9.3
- Algeria	5.5
- Libya	1.3
- Nigeria	2.2
- Other Africa	0.1

Table 6

Petroleum reserves /known, recoverable/ and production of the world and of Africa
million tons; percentage

	reserve	production
World, 10^6 t	74 587	2985.9
of which:		
- Africa, %	9.6	10.2
- Algeria	1.8	1.8
- Libyan A.J.	4.6	3.3
- Nigeria	2.2	3.4
- Other Africa	1.0	1.7

Source for all three tables: UN Statistical Yearbook, 1978

Table 7

Iron ore reserves and resources of the world and of Africa
million tons Fe content; percentage

	Reserves	Others	Resources[+]
World, 10^6 t Fe	90 500	105 500	195 500
of which:			
- Africa overall, %	3.3	4.1	3.7
- Africa without S. Africa, %	2.1	2.5	2.3
- Liberia	0.4	0.3	0.3
- other Africa	1.7	2.2	2.0

Source: US Bureau of Mines, Mineral Facts and Problems, Bulletin No. 667, 1976.

Table 8

Chrome ore reserves and resources of the world and of Africa
million tons; percentage

	High-chrome ores			High-iron ores		
	Reser.	Others	Resou.	Reser.	Others	Resou.
World, 10^6 t	590	590	1180	1090	2090	3180
of which:						
- Africa overall, %	95.5	95.3	95.4	96.4	98.1	97.1
- without S. Africa	86.9	86.7	86.8	4.7	2.5	3.2
- Madagascar	0.7	0.5	0.6	0.1	0.1	0.1
- Zimbabwe	86.2	86.2	86.2	4.6	2.4	3.1

Chrome production capacities of the world and of Africa
thousand tons; percentage

	1973	1978
World, 10^3 t	2420	3170
of which:		
- Africa overall, %	36.5	37.8
- Africa without South Africa, %	12.2	13,4
- Madagascar	2.2	2.9
- Zimbabwe	9.4	10.0
- Sudan	0.6	0.6

Source: as for Table 7

[+] Here and in the following, "resources" equals the sum of "reserves" and "others".

/: 1.2/1.6 % :/ is in the Republic of South Africa. The major established producers are Liberia and Mauritania: Angola may soon be back among them again. Major new projects are coming along in Guinea /Mifergui-Nimba/, the Ivory Coast /Mt Kodjo/, Gabon etc.

All over intertropical Africa, there are vast expanses of iron-rich laterites, some of which qualify as fairly high-grade iron ores. Some of these lend themselves to the making of pig iron or metallized concentrates, whereas some others contain alloying elements /Cr, Mn, Ni, Co/ in embarrassing quantities - to high to permit the making of simple mild steel and too low to be extracted on their own merit. These lateritic iron ores and other ores not sufficiently abundant or high-grade for export may serve as viable raw materials for domestic iron-making in several countries of intertropical Africa.

B. Steel alloying elements

Africa is a major source of chrome ore to the world /total output in 1978 almost 38 % of world output, of which 13.4 % from outside South Africa/. Africa also contains more than 90 % of the world reserves of both the high-chrome and the high-iron types of chrome ores, Zimbabwe /at more than 85 %/ being richest in the first and South Africa /at more than 90 %/ in the second - cf. Table 8.

A major power in cobalt also, Africa holds 42.5/26.0 % of world reserves/resources. Zaire and Zambia have almost the total reserves; Morocco has a minor share. Zaire is about twice as rich as Zambia - cf. Table 9.

Nickel: Africa has a minor share /: 1.3/4.1 % :/ of the world reserve/resource.

Africa's share in vanadium is a major one /18.7 % of reserves, 33.9 % of resources/, largely concentrated in South Africa /all of the reserves and one-third of the resources/.

Molybdenum is a steel alloying element, lubricant and catalyst in which Africa is poor, with an insignificant share of the world reserve and just 0.16 % of the world resource.

Africa has minor quantities of tungsten /0.6 % of world reserve and 0.5 % of world resource, practically all of it outside South Africa/.

Africa has 50 per cent of both the world reserve and resource of manganese, more than 45 % of it in South Africa, outside of which Gabon is the only country with reserves/resources of world significance /Table 10/.

3.3.2. Non-ferrous metals

A. Bauxite

Africa is a major bauxite region of the world, with 33/29 % of world reserves/resources /Table 11/. The single bauxite giant is Guinea with 26/17 %, but the reserves/resources of Ghana, Cameroon and some other African countries are also significant on a world scale.

The world market of bauxite being dominated by very large-scale mines in the more or less close proximity of large-capacity tidewater ports, bauxite deposits lying further inland than a few hundred kilometres tend to be economically unviable owing to the

Table 9

Cobalt reserves and resources of the world and of Africa
million tons; percentage

	Reserves	Others	Resources
World, 10^6 t	2.45	1.83	4.28
of which:			
- Africa overall, %	42.5	min. 3.9	min. 26.0
- Morocco	0.5	n.a.	0.3
- Zaire	27.8	3.9	17.6
- Zambia	14.2	n.a.	8.1

Cobalt production capacities of the world and of Africa
thousand tons; percentage

	1973	1980
World, 10^3 t	27.7	37.6
of which:		
- Africa overall, %	72.3	66.3
- Morocco	5.1	4.8
- Zaire	55.7	50.7
- Zambia	11.5	10.9

Source: as for Table 7

Table 10

Manganese reserves and resources of the world and of Africa
million tons; percentage

	Reserves	Others	Resources
World, 10^6 t	1800	1450	3250
of which:			
- Africa overall, %	50.2	50.2	50.2
- Africa without S. Africa	5.2	1.4	3.5
- Gabon	5.0	...	2.8

Further countries with minor reserves/resouces include Ghana, Ivory Coast, Morocco, Upper Volta and Zaire.

Manganese production capacities of the world and of Africa
thousand tons; percentage

	1973	1980
World, 10^3 t	9740	13690
of which:		
- Africa overall, %	31.4	25.9
- Africa without S. Africa	13.7	11.3
- Gabon	9.8	9.4
- Ghana	1.3	...
- Zaire	1.7	1.3

Source: as for Table 7

Table 11

Bauxite reserves and resources of the world and of Africa
million tons recoverable aluminium content; percentage

	Reserves	Others	Resources
World, 10^6 t	3480	2240	5720
of which:			
- Africa overall, %	33.1	21.9	28.7
- Cameroon, U.R. of	3.9	6.1	4.8
- Ghana	2.0	1.0	1.6
- Guinea	26.0	4.0	17.4
- Other Africa	...	10.5	5.5

For capacities, cf. Table 11/A

Source: as for Table 7

Table 12

Copper reserves and resources of the world and of Africa
million tons; percentage

	Reserves	Others	Resources
World, 10^6 t	410	1450	1860
of which:			
- Africa overall, %	13.3	7.5	8.8
- Zaire	4.4	1.9	2.4
- Zambia	6.7	4.4	4.9
- Others	2.2	1.3	1.5

For capacities, cf. Table 12/A

Source: as for Table 7

Bauxite mining and processing capacities, 1978;
expected increments up to 1984;
relative capacities of processing stages, 1978-1984

Region	Bauxite mining			Alumina vs. bauxite capacity ratios		Alumina refining			Aluminium vs. alumina capacity ratios		Aluminium smelting			Aluminium vs. bauxite capacity ratios	
	Capacity 1978 '000 t	Increment up to 1984 '000 t	Percent of world incrmt.	1978	1984	capacity 1978 '000 t	Incrmt. up to 1984 '000 t	Percent of world incrmt.	1978	1984	Capacity 1978 '000 t	Incrmt. up to 1984 '000 t	Percent of world incrmt.	1978	1984
World	87 297	23 523	100.0	1.00	1.00	30 195	7 220	100.0	1.00	1.00	13 286	3 893	100.0	1.00	1.00
Africa 1/	14 262	6 945	29.5	0.14	0.10	700	0	0.0	1.43	1.97	442	191	4.9	0.20	0.19
Non-Japan Asia	3 756	105	0.4	0.86	1.27	1 120	540	7.5	1.34	2.10	662	941	24.2	1.15	2.67
Japan	0	0	0	∞	∞	2 580	0	0	1.45	1.25	1 645	1 483	38.2	∞	∞
Latin America	30 449	11 200	47.6	0.47	0.49	4 990	1 882	26.1	0.29	0.46	631	825	21.2	0.14	0.23
Oceania	28 000	3 245	13.8	0.70	0.81	6 800	1 700	23.5	0.13	0.36	399	989	25.4	0.09	0.29
Europe	8 680	2 040	8.7	1.89	2.39	5 675	2 963	41.0	1.49	1.10	3 730	622	16.0	2.82	2.62
North America	2 150	0	0	11.20	11.66	8 330	135	1.9	1.58	1.61	5 777	487	12.5	17.65	18.80

1/ South Africa's 80 000 ton smelter capacity, no expansion of which is being planned, does not affect the picture significantly. South Africa has no existing or scheduled bauxite mine or alumina plant.

Source: For capacities and increments: Chase Econometrics: Metals Investment in the Eighties - Supporting Volume 1 (Light Metals).

The rest are the author's calculations.

Table 11/A

Copper mining and processing capacities, 1978;
expected increments up to 1984;
relative capacities of processing stages, 1978-1984

Region	Copper mining			Smelter vs. mine capacity ratios		Copper smelting			Refinery vs.smelter capacity ratios		Copper refining			Refinery vs. mine capacity ratios	
	Capacity 1978 '000 t	Increment up to 1984 '000 t	Percent of world increment	1978	1984	Capacity 1978 '000t	Incrmt. up to 1984 '000t	Percent of world increment	1978	1984	Capacity 1978 '000t	Incrmt. up to 1984 '000t	Percent of world incrmt.	1978	1984
World	7 327	1 302	100.00	1.00	1.00	7 408	828	100.0	1.00	1.00	9 123	734	100.00	1.00	1.00
Africa without South Africa	1 445	68	5.2	0.64	0.73	932	125	15.1	0.97	0.88	1 110	0	0	0.62	0.64
South Africa	227	-5	-0.4	0.80	0.87	185	0	0	0.63	0.84	144	42	5.7	0.50	0.74
Non-Japan Asia	148	225	17.3	1.20	1.31	180	288	24.8	0.87	0.85	193	285	38.8	1.05	1.12
Japan	90	-15	-1.2	12.22	15.44	1 112	0	0	0.88	0.91	1 207	0	0	10.78	14.03
Latin America	1 722	497	38.2	0.77	0.77	1 341	295	35.6	0.67	0.75	1 106	364	49.6	0.52	0.58
Oceania	816	157	12.1	0.24	0.27	198	50	6.0	0.90	1.01	220	300	10.9	0.22	0.27
Europe	346	87	6.7	2.61	2.21	914	0	0	1.69	1.76	1 904	20	2.7	4.42	3.89
North America	2 533	288	22.1	0.99	0.97	2 546	70	8.5	1.03	1.02	3 239	-57	-7.8	1.02	0.99

Source: For capacities and increments: Chase Econometrics: Metals Investment in the Eighties - Supporting Volume 2 (Base Metals)

The rest are the author's calculations.

Table 12/A

overriding cost of haulage to tidewater. This is why the bauxite resources of a number of land-locked African countries have not even been surveyed adequately. A case in point is Mali, whose bauxites, not inferior to some of those being exported out of Guinea, have found no takers so far owing to the transportation problem.

One of the possible ways of developing these remote deposits is the conversion of their bauxite to either alumina or aluminium in the immediate proximity of the bauxite mine. This, too, requires a reliable transportation infrastructure, however.

B. Copper ore

Table 12 reveals the copper ore reserves of Africa /those of the Copperbelt countries in particular/ to be significant on a world scale. The same holds for the resources, although less strikingly so.

Most of the copper ore deposits now being mined in Africa are, at 3 to 6 % copper content, richer than the very large deposits mined by modern open-cast methods e.g. in Chile, where the average copper content of the ore is not above 1.5 %. This implies that, in the Copperbelt and elsewhere, detailed prospection may yet reveal some large Chilean-type /copper porphyry/ deposits, with or without additional mineralization of lead, zinc, silver, gold, cobalt, nickel, molybdenum etc.

C. Lead and zinc ore

Lead and zinc are usually, albeit not necessarily associated in their ores in most parts of the world, but less so in Africa than elsewhere, as indicated by Tables 13 and 14. The African countries with the most important lead reserves are Morocco, Namibia and Algeria; those with the greatest reserves of zinc are Zaire and Zambia where most of the zinc is mined together with copper.

D. Tin

Table 15 shows Africa to be an important holder of tin reserves and resources, with Nigeria dominant in reserves and Zaire in resources. Tin mining in Nigeria works alluvial deposits in open-cast pits.

3.3.3. Nuclear fuel

A. Uranium

Table 16 shows South Africa /its figures including those of Namibia for the time being/ to be a very important uranium-reserve area. Niger is another country important on a world scale; Gabon and the Central African Republic are less so. By its geological structure, Africa is likely to throw up some uranium finds of world importance also in the future. The political importance of such finds need not be emphasized. A neo-colonial type of power struggle may well develop around any of them.

B. Thorium

A metal more renowned for its other uses for the time being, thorium is expected to develop into an important nuclear fuel metal as technological development proceeds. The fairly low reserve figure for Africa probably reflects underexploration rather than a true shortage of viable deposits.

Table 13

Lead reserves and resources of the world and of Africa
million tons; percentage

	Reserves	Others	Resources
World, 10^6 t	150	150	300
of which:			
- Africa overall, %	3.0	5.4	4.2
- Morocco	0.9	0.9	0.9
- Namibia	0.9	1.5	1.2
- Algeria	0.4	1.4	0.9
- Other Africa	0.8	1.6	1.2

Lead mining capacities of the world and of Africa
thousand tons; percentage

	1973	1980
World, 10^3 t	4080	4400
of which:		
- Africa overall, %	5.6	5.8
- Morocco	2.0	...
- Namibia	1.8	...
- Other Africa	1.8	...

Table 14

Zinc reserves and resources of the world and of Africa
million tons; percentage

	Reserves	Others	Resources
World, 10^6 t	135.1	109.7	244.9
of which:			
- Africa overall, %	4.7	6.6	5.5
- Zaire	1.3	1.7	1.5
- Zambia	0.7	0.9	0.8
- Other Africa	2.7	4.1	3.3

Zinc mining capacities of the world and of Africa
thousand tons; percentage

	1973	1980
World, 10^3 t	6600	7920
of which:		
- Africa overall, %	6.0	5.7
- Zaire	2.7	...
- Zambia	1.2	...
- Other Africa	1.3	...

Source for both tables: as for Table 7

Table 15

Tin reserves and resources of the world and of Africa
million tons; percentage

	Reserves	Others	Resources
World, 10^6 t	10.104	27.490	37.630
of which:			
- Africa, %	7.1	10.9	9.9
- Nigeria	2.8	2.2	2.4
- Zaire	2.0	7.4	5.9
- Other Africa	2.3	1.3	1.6

Tin mining and smelting capacities of the world and of Africa
thousand tons of contained tin; percentage

	1973	1980
Mining capacity		
World, 10^3 t	295	341
of which:		
- Africa, %	9.0	8.3
- Nigeria	3.4	
- Zaire	2.8	
Smelting capacity		
World, 10^3 t	341	394
of which:		
- Africa, %	8.3	6.0
- Nigeria	3.4	
- Zaire	1.1	

Source: as in Table 7

Table 16

Uranium reserves and resources of the world and of Africa
Market-economy countries only: thousand tons U; percentage

	Reserves	Others	Resources
World, 10^3 t U	970	720	1690
of which:			
- Africa, %	27.6	12.2	20.5
- Africa without South Africa and Namibia, %	6.9	2.4	5.0
- Central African R.	0.8	-	0.4
- Gabon	2.0	-	1.2
- Niger	4.1	1.4	3.0
- Other Africa	-	1.0	0.4

Uranium mining capacities of the world and of Africa
Market-economy countries only: tons U; percentage

	1973	1980
World, t U	26750	53890
of which:		
- Africa, %	21.4	23.9
- Africa without S. Africa	5.8	10.4
- Gabon	2.7	1.7
- Niger	3.1	3.0
- Namibia	-	5.7

Table 17

Thorium reserves and resources of the world and of Africa
thousand tons Th; percentage

	Reserves	Others	Resources
World, 10^3 t Th	710	1120	1830
of which:			
- Africa, %	5.1	4.8	5.0
- Africa without S. Africa	4.5	3.6	3.9
- Nigeria	1.9	1.6	1.7
- Other Africa	2.6	2.0	2.2

Thorium mining capacities of the world and of Africa
tons Th; percentage

	1973	1980
World, t Th	1880	2010
of which:		
- Africa, %	2.2	2.7
- Zaire	1.0	1.35
- Other Africa	1.2	1.35

Source for both tables: as for Table 7

Table 18

Phosphate rock reserves and resources of the world and of Africa
million tons; percentage

	Reserves	Others	Resources
World, 10^6 t	16 070	60 040	76 107
of which:			
- Africa, %	72.5	81.5	79.6
- Africa without S. Africa	71.9	81.4	79.4
- Algeria	0.6	0.1	0.2
- Egypt	1.1	0.3	0.5
- Morocco	56.5	75.4	71.5
- Senegal	0.7	0.1	0.2
- Western Sahara	9.6	3.0	4.4
- Tunisia	2.8	2.3	2.4
- Other Africa	0.6	0.2	0.2

Phosphate rock mining capacities of the world and of Africa
million tons; percentage

	1973	1980
World, 10^6 t	104.4	173.2
of which:		
- Africa, %	28.7	31.1
- Africa without S. Africa	27.3	29.3
- Algeria	0.7	1.0
- Morocco	16.7	15.8
- Senegal	1.7	1.3
- Western Sahara	1.7	5.3
- Togo	2.3	1.7
- Tunisia	3.5	3.4
- Other Africa	0.7	0.8

Source: as for Table 7

3.4. Fertilizer minerals

This is one of the cases that show how distribution of mineral resources among the continents also has its quirks. Phosphate rock is something of an "African mineral resource" whereas, as far as it is currently known, Africa has only the most minimal deposits of potash.

As already stated, phosphate rock /more precisely, sedimentary phosphorite/ reserves concentrate on the Mediterranean seaboard /Algeria, Egypt, Morocco, Tunesia; geologically, Western Sahara is also part of this zone/ and on the Atlantic seaboard /Senegal; the important phosphate rock deposits, not yet shown in the table, of Angola, in the provinces of Cabinda and Zaire, and presumably continuing in between, in the territory of the Republic of Zaire/. The South African deposit is of the igneous type and less important as to size.

Africa has less than 0.2 % of the known or surmised world reserves and resources of potash; its production, confined to Congo, is less than 2 % of world production.

3.5. Hedge assets

We shall consider in this group the minerals of gold, silver and diamonds. They are called hedge assets here because they provide owners and speculators with a means of anti-inflation hedging operations. Of course, there are a number of non-mineral hedge assets as well, such as certain types of stocks, art treasures etc. The common feature of hedge assets is that their prices in these times of inflation are high and are likely to remain high as long as high inflation lasts.

The reserves, resources and production capacities of gold and silver are presented in Tables 19 and 20; those of diamonds /as far as they are known/ in Table 21. Here again, there is a glaring disproportion between Africa's very large gold and diamond reserves and her small silver reserves and production.

3.6. Other minerals

For lack of space, this paper does not go into some other mineral products such as stones, clays etc. Although important both as to uses and volume, these do not as a rule enter into international trade: this has been the main criterion of leaving them out of account here.

Table 19

Gold reserves and resources of the world and of Africa
million troy oz; percentage

	Reserves	Others	Resources
World, 10^6 ozs	1320	580	1900
of which:			
- Africa, %	64.4	40.5	57.1
- Africa without S. Africa	3.8	6.0	4.5
- Ghana	1.9	0.9	1.6
- Zimbabwe	1.1	1.7	1.3
- Other Africa	0.8	3.4	1.6

Gold mining capacities of the world and of Africa
thousand troy oz; percentage

	1973	1980
World, 10^3 ozs	49500	53250
of which:		
- Africa, %	67.9	61.0
- Africa without S. Africa	3.2	4.7

Source: as for Table 7

Table 20

Silver reserves and resources of the world and of Africa
million troy oz; percentage

	Reserves	Others	Resources
World, 10^6 ozs	6000	16630	22630
of which:			
- Africa, %	0.3	0.9	0.9

Silver mining capacities of the world and of Africa
million troy oz; percentage

	1973	1980
World, 10^6 ozs	353.5	421.1
of which:		
- Africa, %	4.2	4.7

Table 21

Diamond reserves of the world and of Africa

A. Industrial diamonds: Reserves

World:	680 million carats
of which:	
- Africa. %	96.3
- Africa without South Africa	89.0
- Botswana	7.4
- Ghana	3.7
- Zaire	73.5

NB. Of the world reserve, about 170 million carats is industrial stones; the rest is crushing bort.

B. Gem diamonds: Reserves

World reserves are supposed to be divided up about half-and-half between Africa and the USSR, totalling about 100 million carats.

C. Gem diamonds: Production, 1974

World:	12 519	thousand carats
Africa:	80.	%
	53.0	% without South Africa
- Angola	12.7	
- Botswana	3.3	
- Centr.A.R.	2.4	
- Ghana	2.1	
- Guinea	0.2	
- Ivory Coast	1.0	
- Lesotho	0.0	
- Liberia	3.0	
- Sierra Leone	5.4	
- Namibia	11.9	
- Tanzania	2.2	
- Zaire	8.8	

4. Prospects of the world market of minerals and minerals-derived commodities

Theory states that, in a closed world where all the mineral reserves have been explored, and mining priorities are allotted in full possession of all the data required, the cost of extracting minerals and, hence, in the long run, also the minerals' prices, should rise more or less continuously. Up to about 1972, however, minerals prices in fact declined in real terms in the post-World War II period: also since 1972, contrary to a widely held belief, the prices of minerals except petroleum have just barely kept up with inflation.+

The reason for this deviation from a fairly plausible theory is that, as far as mineral reserves are concerned, the world is far from closed. It may appear quasi-closed /with the spectre of exhaustion looming large/ for individual minerals, such as petroleum and tin today, but then some breakthrough or new discovery usually removes the barrier and the reserve picture becomes open-ended again. /In petroleum, there have been several such breakthroughs in the past, the most notable being the development of offshore fields. Breakthroughs such as these may, of course, raise the cost of exploring and developing the mineral quite substantially./ In an open-ended world, the prices of minerals are determined by supply vs. demand on the one hand and by perceived shortage on the other /as distinct from true shortage which, as pointed out above, cannot at present be convincingly asserted for any mineral commodity/.

The details of this highly generalized picture are very diverse. Apart from the dramatic price rise in petroleum and the concomitant one in natural gas, high prices have been commanded by the "hedge assets" into which money can flee from inflation; gold and diamonds. Metals with an impending apparent shortage barrier looming up /tin and cobalt/ have also fared well. Most if not all other minerals have been depressed by the lack of vitality in world economic growth. Some of the prices have been further depressed by an "inverse elasticity effect": contrary to theory, by which output should contract at times of declining prices, some producers were compelled to sell more on lower margins of profit or, indeed, at a loss, in order to meet criteria distinct from the simple profit-maximization criterion, such as maintaining hard-currency balances, meeting debt-servicing obligations, financing imports at steeply rising prices etc. Needless to say, most of the countries having to consider these additional criteria are developing ones.

What are the implications for the future? The principal one is that the world mining economy will have to adapt to slowed-down rates of world growth. This will, after a period of more or less general overcapacity and the concomitant lack of propensity to invest, bring supply capacity and demand more closely into line once more, and the glaring differences between different minerals are likely to be reduced. On the other hand, the decreasing oligopo-

+The price index, 1972 = 100, in the second quarter of 1980 was 340 for exported minerals except petroleum, and 320 for world trade at large /computed from figures in the UN Monthly Bulletin of Statistics, October 1980/.

lisation of most mineral markets, the world-wide dissatisfaction with the transnational corporations and the growing tendency to give up producer pricing may increase the volatility of prices despite efforts to the contrary /of the latter, the UNCTAD Common Fund, the Lomé Convention and the increasing tendency to conclude long-term minerals supply agreements government-to-government may be mentioned/. Periodical flights of money into commodities, the hedge assets in particular, but also into the metals traded on the London Metals Exchange and others, may also contribute to higher volatility.

One of the principal facts of mining economics is that the life of a mine is, more often than not, longer than about 20 years whereas the market fluctuations are a few years long at most. What prices to expect, then, for the entire life of a mine? The most likely answer is that the market will guarantee roughly average returns on capital for mining projects of roughly average comparative advantages in a long enough run /and 20 years may be regarded as a long enough run in this context/. This means that, in assessing the viability of a mining project, its comparative advantages or disadvantages in relation to other, similar projects will have to be taken into account rather than the instantaneous state of the market /or forecasts which have a disconcerting tendency always to reflect the instantaneous state of the market/. The comparative advantages in question include

- ore grade and maximum viable annual output,
- depth of mining; ease of mining of the host /surrounding/ rock,
- availability or otherwise of infrastructure,
- distance from likely markets,
- distance from tidewater,
- availability or otherwise of finance for the maximum viable project size and for the further processing /smelting, etc./ of the mineral,
- etc. etc. etc.

In sum, a knowledge of what mining is up to in other countries in the world is crucial for assessing the viability of any one mining project in any one country. Now since professional services are not available for such comparisons except in the most developed of the developing countries, one of the very important tasks of the UN family of agencies has been and will be to provide consultancy services on these and related issues.

One of the issues that must be clearly seen is that a developing country deciding upon the viability of this or that mining project may have criteria other that just simple profitability in mind. It may decide to embark upon a project loss-making in home currency if it can earn sufficient hard currency, or develop a backward region, or for a number of similar reasons. It is imperative that these reasons be understood very clearly both by the developing-country government and its consultants.

5. The economics of extracting Africa's mineral wealth: future prospects

Mining development in any developing country is an issue fraught with a great deal of ambivalence. Informed opinion the world over seems to be that the minerals required for the future growth of the world economy will have to be produced largely by the developing countries, more or less as an obligation to the rest of the world. A more profound analysis reveals, however, that mining investment is in many respects eminently unsuited for promoting the development goals of most developing countries: mining projects tend to be capital-intensive whereas most developing countries are chronically short of development capital; they employ few and comparatively highly skilled labour; and their forward and backward linkage effects on the rest of the economy tend to be weak. Exceptions are few and far between, such as gold and diamond washing in Africa /largely illegal/ or small-scale tin mining in Malaysia.

We have seen on the other hand that the exports of minerals and minerals-derived commodities are crucial for the balance of payments and often for the welfare of many African countries. The explanation of this contradiction is, of course, that minerals and their derivatives are for the time being one of the most important groups of commodities /tropical produce being one other such group/ by which the developing countries can readily participate in the international division of labour. It is not the aim of this paper to examine whether this form of participation is equitable or not: let it suffice to make two points here.

/1/ The profits to be made out of mining depend very greatly on the individual mineral. Now profits and their distribution among the processing steps of a commodity are as good a rough measure of equitability as any. It can thus be said that, at present, profits distribution is more or less inequitable to the producer in, say, copper, but more or less inequitable to the consumer /especially to the oil-less developing country consumer/ in the case of petroleum and petroleum products.

/2/ Improving the equitability of distribution of profits to be made out of commodities at large is one of the main issues of the developing countries' drive for a New International Economic Order, a struggle waged largely in the international political sphere.

Investment finance for mining. In the 1950s and the early 1960s, the typical financing of new mining ventures used to involve a debt/equity ratio of roughly 50:50, with the equity put up largely by the international mining houses. These mining houses thus largely self-financed their new ventures: they could do this because taxation levels in the industry were relatively low. One of the main features of this type of financing was that profits made in mining did as a rule get invested in mining, but not necessarily /indeed, not even largely/ in the countries where they

had been made. In the main, however, new mining ventures were by and large judged on their techno-economic merits and, the merits of projects in the developing world usually looking better, international mining tended to expand into the developing world.

The current situation differs in several respects. Higher taxation both in the home countries of the international mining houses and in the countries hosting their operations have reduced the houses' self-financing capability; nationalization of their assets and other manifestations of the developing countries' sovereignty over their natural resources have reduced the propensity to invest in the developing world. Simultaneously, the recycling of the petrodollars has created much surplus liquidity in the hands especially of the developed market-economy countries' banks, and those banks have been eager to finance promising-looking ventures practically anywhere in the world /including also the countries with centrally planned economies/. Typical financing patterns today therefore have debt/equity ratios around 80:20, with the credits put up by consortia made up in some cases of fifty or more banks and the equity put up by several mining houses, as a risk-spreading measure. In the case of minerals of strategic importance such as petroleum or uranium, part or all of the finance may carry the guarantee of the government of a developed market-economy country. Moreover, since the host country government is likely to insist on majority participation in the venture, it also will put up some of the capital, although not a majority percentage of it as a rule. The upshot of this pattern is that profits made in mining are more likely to remain, to a greater extent than heretofore, in the country where they have been made, but are much less likely to be reinvested in mining, as the host country government very probably has other investment projects on its hands, some of them much more pressing. Also, in addition to the techno-economic merits of this or that mining project, other criteria of evaluation have entered the picture: in fact, these often tend to overshadow the techno-economic points: they include considerations such as the "investment climate" in the host country, the likelihood of expropriation, of what is called "creeping nationalization" /changing the terms of an agreement unilaterally/, the creditworthiness and debt-servicing burden of the host-country government, etc. etc. <u>The fact remains, however, that most of the finance required for mining and minerals processing investment in the developing world will have to be put up internationally.</u>

<u>Current spread of investment finance in mining.</u> Apart from the fact that the substantial decrease in the economic growth of most world regions has led to a reduction in mining investment at large, there has been a certain shift of emphasis in the regional distribution of investment also, from the developing world into the developed market-economy countries, particularly into the prominent mining countries such as Australia, Canada and the US, also to some extent into South Africa. The facts of the case do not, however, justify the assumption of an inadequacy of mining finance currently available for Africa, say. In fact, Table 22, condensed out of a list of reasonably likely mining projects in the January, 1980 number of Mining Magazine /those projects

Table 22

Investment finance earmarked for mining and minerals processing projects in the various world regions, million $US

	1980	1981	1982	1983	1984	Total
Canada	340	1080	380	345	-	2145
USA	1700	715	435	235	100	3185
Australia, New Zealand	195	780	1405	2175	590	5145
Europe	1785	330	-	-	600	2175
South Africa	650	520	365	330	-	1865
Total dev'd market ec.	4670	3425	2585	3085	1290	15055
Latin America	850	3140	2035	3045	1100	10170
Africa without S. Africa	1235	339	810	450	1000	3834
Asia without Japan	2125	546	3355	1255	900	8181
Total dev'ing market c.	4210	4025	6200	4750	8000	22185
Total market economies	8880	7450	8785	7835	4290	37240
Developing-world share, percent	47.4	54.0	70.5	60.4	69.9	59.6
Africa's share of developing world, percent	29.3	8.4	13.0	9.5	33.3	17.3
Africa's share of market-economy world, pct.	13.9	4.6	9.2	5.7	23.3	10.3

Source: author's calculation based on information in the January, 1980 number of the Mining Magazine

that have both a startup date and an investment sum attached to them/ reveals that, over the years 1980 through 1984, Africa is to receive about 10 per cent of all investment into mining and minerals processing, and about 17 per cent of the investment into the developing countries, slightly but not strikingly less than its share of mines as shown in Table 1. /Both sets of figures leave the centrally planned economies out of account./ Nevertheless, the fact that the developing world at large, which has a 50 % share of world open-pit mines, is to receive almost 60 % of the finance does reveal a certain shift of mining investment out of Africa and into the other developing regions, Latin America in particular.

Exploration finance. Figures on the distribution of exploration finance all over the world are much harder to come by, but the general impression seems to be that exploration by the international mining houses in the developing world at large, and in Africa in particular, has fallen off rather dramatically, except in such shortage minerals as petroleum or uranium. This shortfall has only partly been offset by the developing-country governments' increased spending on exploration /mostly in those countries which already have some proven mineral riches anyway/ and by international or bilateral assistance programmes. This state of facts implies the risk of a bottleneck in financeable mining projects to develop in Africa and elsewhere in the Third World in five to ten years.

Minerals policy. It has been widely recognized that the political liberation of the developing countries after World War II has not been automatically followed by economic de-colonialization. Increasing political strength at home and also world-wide, however, has enabled the developing countries to demand better conditions for their participation in the international division of labour, partly by simple legislation at home concerning mining and related activities, partly by promoting internationally the set of ideas generically known as the New International Economic Order.

This being the case, the developing countries are in a much better situation now than at any time before to face those TNCs and other would-be investors and buyers interested in their mineral wealth. And since the major markets of most mineral-derived commodities are going to be the developed world regions also in the foreseeable future, and most of mining finance will have to come from those regions, it is very important to establish a just and equitable division of labour with them. On the one side, this implies that the developed countries and their corporations will have to respect the sovereignty of the developing countries over their natural resources; on the other, it implies that the developing countries will have to shed delusions of "commodity power" at large and progress to realistic assessments of what the market of this or that mineral commodity will bear in the matter of pricing, profits, return on capital etc.

It is in such realistic assessments that the UN and its agencies have done useful work in the past and should be expected to continue doing so on a much expanded scale.

6. UNIDO assistance to African mining

Within the UN family of agencies, UNIDO is only one of several dealing with mining-related projects. Others comprise DTCD /the Department of Technical Cooperation for Development/ and UNRFNRE, the UN Revolving Fund for Natural Resources Exploration.

UNIDO's brief concerning the development of mineral resources is described in some detail in Appendix I.

UNIDO's minerals-related activities show a strong bias in favour of Africa. Of the 10.1 million dollars earmarked for UNIDO's minerals-related programme budget for 1980-1981, 4,2 million dollars or 41.5 per cent is devoted to African projects. One quarter of this sum is to be spent on ores; small amounts /one per cent and 3.4 % respectively/ on phosphate rock and glass industry minerals, and the rest, more than 70 %, on minerals for ceramics, cement and other building-industry products. In addition, two of the five projects developed by ICPO /the Investment Co-operative Programme Office/ in the minerals-related field are African /a phosphate project for Mali and a magnesite project for Tanzania/.

Whereas the above effort represents what is feasible given current financial endowments, and is intended to help where help is needed most, there are several obvious ways in which this activity might be broadened, notably

- by systematically examining the domestic availability, if any, of mineral inputs, if such are required, into every UNIDO-assisted project,
- by assisting governments in the identification of viable industrial projects based on domestic minerals and on the processing of the minerals being extracted on their territory to stages of higher value added,
- by developing UNIDO's capabilities related to mining and mineral beneficiation both quality- and quantitywise, and
- by orientating ICIS, the International Centre for Industrial Studies, operative within UNIDO, more than heretofore towards the preparation of studies on mining and related issues.

As regards UN activity as a whole, it may be recommended that it, too, be rendered more organic and systematic. Currently, most of the work on mineral prospecting, beneficiation and mining is the responsibility of UNDP, also to some extent of DTCD and UNRFNRE, whereas metallurgy and basic transformation is the responsibility of UNIDO. The first three reside in New York, the fourth in Vienna. Even with the best of will, this situation may result in insufficient coordination, lack of information and missed opportunities. If one considers that any project must be initiated and cleared by local resident personnel cooperating with host governments, it becomes clear how extended the chain of information and decision-taking is. There is room for much improvement in this sphere.

Even more progress, however, can be expected of UN-sponsored complex programmes of development for mining and related activities, such as

- comprehensive government-level planning assistance covering the entire minerals sphere,

- identification of the most reasonable targets of geological activity and the scope of UN-sponsored assistance thereto,
- assistance in the planning, projection and running of mining operations at all levels, including the better utilization of existing capabilities and the realization of new ones,
- assistance in market research including the forecasting of domestic and foreign /also regional/ markets of minerals and products of mineral origin,
- assistance in the taking of decisions concerning development priorities and, more specially, of decisions between import-substituting and export-oriented growth.

APPENDIX I

UNIDO's activities in the field of mineral resources[+]

/a/ Legislative mandates

General Assembly Resolution 2152 /XXI/, which established UNIDO, stipulated that the Organization should offer advice and guidance on problems relating to the exploitation and efficient use of natural resources of developing countries, with a view to increasing their industrial productivity and contributing to the diversification of their economies.

The Lima Declaration and Plan of Action, adopted by the Second General Conference of UNIDO in 1975, emphasized the importance of natural resources in the industrialization of developing countries, and underlined the need for co-operation between developing and developed countries, to take the form of "urgent consultations... in particular /:concerning the:/ industries processing raw materials exported by developing countries." For these particular purposes UNIDO was requested to include among its activities a system of continuing consultations at global, regional and sectoral levels.

In addition to ECOSOC Resolution 1957 B /LIX/, Resolution 46 /X/ adopted by the Industrial Development Board in 1976 recognized "the importance of the gradual expansion of the activities of UNIDO regarding assistance to developing countries in the utilization of their natural resources, especially minerals, for the development of their national industries".

More recently, the New Delhi Plan of Action adopted by the Third General Conference of UNIDO in early 1980 and submitted to the General Assembly, under the chapter on "Industrial Production", requested UNIDO inter alia to "provide necessary support for the meeting of governmental experts of the Group of 77 regarding concrete measures of co-operation in production, identifying new possibilities for long-term agreements and examining joint efforts for marketing, exploitation, processing and financing in the mining and mineral sector" and to "identify and suggest remedial action regarding quality and other production constraints in major industrial production sectors". Among the special measures for least-developed and land-locked developing countries, the New Delhi Plan of Action further requested that urgent and effective steps be taken "to strengthen their technological and productive capacity, particularly... in processing of minerals...". Under the special measures for most seriously affected developing countries, assistance has also been requested in the establishment of comprehensive inventories of their resources and the preparation of industrial sector surveys to support indigenous exploitation of their resources.

[+] This is a somewhat abridged version of a text formulated by the Secretariat of UNIDO.

/b/ Activities planned for the biennium 1980-1981

In accordance with the above, the following activities related to minerals are planned:

A. Expert group meetings on preparatory work or follow-up on recommendations resoluting from consultations on fertilizers, iron and steel.

B. A world-wide study on the iron and steel industry, which will be revised during the biennium, contains information on supply and demand of iron ore and preparation of an example of long-term agreements in the field of iron ore trade.

C. Specialized in-plant training courses for groups of nationals from developing countries.

D/1. Non-ferrous metals

- Light non-ferrous metals /processing of bauxite and other ores for the production of aluminium; processing of titaniferous ores such as ilmenite for the production of TiO_2/.
- Heavy non-ferrous metals /processing of copper, zinc, nickel, lead, tungsten ores, etc./.

D/2. Iron and steel

- Processing of iron ores for the production of iron and steel, by conventional processes and direct reduction.

D/3. Building materials and construction

- The materials include cement and concrete products, heavy clay and ceramic products and glass. Emphasis is on utilization of local natural resources. Techniques used in the construction industry also belong here.

D/4. Fertilizers and pesticides

- Emphasis on organic fertilizers and bio-gas technology, etc.

D/5. Processing of metallurgical minerals

This is a new programme element, suggested to be introduced to comply with the New Delhi Declaration and Plan of Action. Its aim will be to provide technical assistance, especially to least developed countries, in the development of concentration and beneficiation of ores and non-ore minerals, including assessment of volumes and grades of reserves, sampling, laboratory and pilot plant test work to identify optimum uses of indigenous raw materials for local processing into added value products, thereby strengthening the technological and productive capabilities of the developing countries.

E. Preparation and evaluation of feasibility studies for industrial investment; formulation and promotion of proposals for such investment, including those based on industrial restructuring /redeployment/ of industries in developed countries.