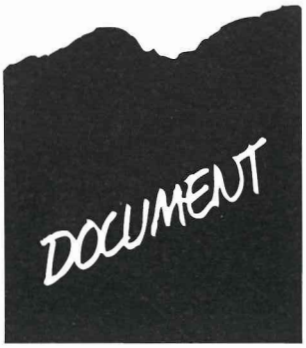

UNCTAD: Commodity resources – sustainable development

This document is a reprint of one part of the UNCTAD report "Management of Commodity Resources in the Context of Sustainable Development: Governance Issues for the Mineral Sector", 1997. The entire report summarizes some of the main findings of an UNCTAD project which examined the role of the mineral sector in the development process of developing countries. The overall aim was to identify policies which are likely to enhance the contribution of the mineral sector to economic development. The part presented here focuses on environmental management and sustainable development issues, and their implications for policy.

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MINERAL RESOURCE MANAGEMENT

Environmental management

Few mining-related issues have attracted as much attention in recent years as the environmental impact of mining. It is easy to understand why the environmental consequences of mining have attracted so much attention and why – at least in the view of mining companies – such disproportionately little notice has been taken of the progress made in reducing negative environmental effects. While environmental degradation from other causes is often invisible to the naked eye or spread out over large areas so that it is less noticeable, the highly localised environmental impact of mining is often dramatic and obvious.[1] Recent events that could have had extremely serious consequences, such as the collapse of tailings dams in Guyana and the Philippines, have resulted in additional attention being focused on the environmental impacts of mining. For the general public it is difficult to believe that a large hole in the ground does not necessarily mean eternal devastation of the landscape or that substances which they have repeatedly been told are detrimental to human health, wildlife and vegetation, such as copper, lead and sulphur, can be mined without escaping to the environment in harmful quantities.

This said, however, it has to be recognised that mining has been and can be the cause of major environmental degradation in the absence of remedial measures. Governments anxious to ensure that mining contributes to the development of their countries have to be able to reassure the general public that policies are in place to deal not only with the environmental impact of new projects but also with past environmental neglect.

The environmental impacts of mining and mineral processing operations are summarised in Table 1.

Methods for reducing the environmental impact of mining and metallurgical operations have improved considerably over the last couple of decades. At the mining stage, methods for rehabilitating mined-out areas to the original or new land uses have been developed and are applied in most new mining projects. Similarly, releases of effluents to surface water bodies or to groundwater are controlled and reduced through judicious planning at the very beginning of mining projects.

While changes in environmental legislation have certainly been an important factor in the changes in practice, it must also be recognised that the attitudes of mining companies to environmental protection have changed considerably over the last years. There is growing evidence that at least large international mining companies have made environmental quality an integrated element of their corporate policies. Many mining companies have implemented environmental management systems and several also carry out internal environmental audits, and in some cases have initiated such audits by external auditors.[2] The change that has taken place in corporate thinking about the environment was illustrated by the creation in 1991 of the International Council on Metals and the Environment. This is an industry group consisting of most of the world's largest mining and metals companies that promotes the development and implementation of sound environmental and health policies and practices to ensure the safe production, use, recycling and disposal of metals.

There are several reasons for the change in attitudes. The most important may be the pressure of public opinion. Companies are anxious to maintain their reputation as "good corporate citizens" and dislike being identified in the mass media as polluters. They also realise that as public opinion evolves, environmental standards are likely to become more stringent everywhere and that, even in countries with "soft" environmental requirements, conditions are likely to evolve towards more stringent standards

in the future. Unlike more "footloose" industries, mining companies are tied for very long periods of time to their deposits and they cannot close down their operations and move elsewhere in response to a change in legislation.[3] For this reason, and since it is usually considerably less costly to take environmental precautions at the beginning of a project than to add modifications later, mining companies prefer to anticipate future regulations rather than adapt to them as they occur. Accordingly, companies often take environmental control measures that are more ambitious than required by existing legislation.

Second, conditionalities aimed at ensuring good environmental practices are increasingly being required by international financial institutions and by commercial banks.[4] Given the increased importance of loan financing in large mining projects, companies are naturally anxious to heed the advice of their financiers.

Third, environmental control measures in new projects usually do not entail major cost increases and may even improve production economies.[5]

Government regulations for environmental management in mining are relatively recent in most countries and, indeed, do not exist in some developing countries. Despite this short history of regulation, however, approaches have evolved considerably.

Most governments have made the "Polluter Pays Principle" (PPP) an integral part of their environmental policies. According to this principle "the polluter should bear the expenses of carrying out pollution prevention and control measures decided by public authorities to ensure that the environment is in an acceptable state. In other words, the cost of these measures should be reflected in the cost of goods and services which cause pollution in production and/or consumption".[6] The arguments for the principle derive from allocation and equity considerations. If a production activity is accompanied by disutilities affecting one or more economic agents, such as pollution, a discrepancy arises between the private cost of the activity and the corresponding social cost. The effect causing this discrepancy is called a "negative external effect". Misallocation of resources results from the existence of such effects. First, since consumers do not pay the full social costs of pollution, pollution-intensive goods are underpriced relative to other goods, and hence overconsumed and overproduced. The economy fails to achieve allocative efficiency. Second, producing firms, to the extent they can, will substitute environmental resources, which for them are free, for labour, capital and other inputs, for which they must pay. This results in lower production efficiency. Finally, if producing firms are charged the full social costs for the environmental resources they consume, they have strong incentives to develop and adopt new technologies that have less negative effects on the environment. If they are not required to pay for their pollution, however, they have no incentive to develop new technologies. This results in lower dynamic efficiency.[7]

The PPP aims to improve economic efficiency in the three ways just mentioned by internalising social costs so that they are taken into account by producers. When applying instruments for this purpose, the question of sharing the cost arises. This problem of cost sharing calls for equity as well as efficiency; it appears reasonable that everyone must assume responsibility for the damage he or she causes, and if an environmental policy redistributes incomes unfairly, corrective measures may have to be taken. Although the demands of equity are not economic in themselves, they have to

Table 1. Environmental impacts of mining and mineral processing

1. Surface water pollution
Soluble contaminants in domestic or agricultural use waters from release of mine and processing water or leakage from waste deposits
Deposition of solids on agricultural land and in shallow sea zones
Withdrawal of water for industrial purposes
Alteration of aquatic flora and fauna, including destruction of fish species and accumulation of toxic elements in fish
Sand deposition in river channels and shallow sea zones

2. Underground water pollution
Soluble contaminants in wells springs etc. resulting from leakage from waste heaps and mine water
Natural water sources dying up as a consequence of water table lowering

3. Air pollution
Dust blown on inhabited, agricultural land
Accumulation in plants of toxic elements carried by dust
Acidification of water bodies and soil resulting from SO_2 emissions
Damage to buildings from SO_2 emissions

4. Solid waste
Hazards related to lack of stability of waste deposits
Land disturbance
Withdrawal of agricultural land

5. Excavation
Loss of fauna and flora habitats
Land subsidence due to underground mining

6. Noise and vibration
Effects on human health
Damage to buildings

Source. Based on United Nations Environment Programme. 1991. p. 26.

be given consideration.[8] It should be noted that the PPP, as usually understood, is not a principle of compensation for damage caused by pollution. If a country decides that, above and beyond the costs of controlling pollution, polluters should compensate pollutees for the damage which would result from residual pollution, this measure is not in contradiction with the PPP, but the PPP does not make this additional measure obligatory.[9]

The instruments available to governments for influencing environmental practices in the mining and metals industries are often divided into three categories:

- administrative regulation ("command and control");
- information and education;
- economic instruments.

"Command and control" policies are representative of the early era of environmental regulation, but they still dominate the approach to environmental regulation in many countries. These policies are characterised by a reliance on predetermined environmental standards which have to be observed by mine operators. The standards are often general in nature, applying to all industries and all parts of the country. The government's role is to establish the standards and to enforce them through monitoring of operations and levying of penalties on operators that do not observe them. Standards may classified as follows:[10]

- Ambient standards: determine the permitted concentration of pollutants in a given medium (air, water or soil);
- Emission standards: set maximum levels of pollution releases, by plant, industry or region;
- Technology standards: determine the technology to be used in the production process;
- Performance standards: specify pollution release per unit of output from a given plant;
- Product standards: specify the physical or chemical properties of a product.

As far as mining and metallurgical operations are concerned, governments rely mainly on emission standards and performance standards, with technology standards being found too inflexible. Increasingly, however, governments have found general standards to be inefficient, since they require all polluters to reduce their emissions to the same level (whether in absolute terms or in terms of emissions per unit of output), regardless of the cost of pollution reduction and the absorbing capacity of the environment. Accordingly, they have often opted for emission limits determined on an individual basis for operations.[11] Although this approach requires a greater degree of sophistication on the part of regulators, it increases flexibility and avoids both under-regulation and over-regulation.

While there is no doubt that administrative regulation has to a certain extent been successful in improving environmental quality, in particular in developed countries, the situation in developing countries is less clear. In many cases, regulations have proved to be legally or practically unenforceable, technically difficult to monitor and generally to have an insufficient deterrent effect. Enforcement problems often result from shortages of adequately trained staff and equipment.[12] The practice of borrowing standards that have been established in developed countries has led to problems in many cases where standards did not sufficiently take into account local climatic, ecological or cultural characteristics.[13] Such standards also entail high bureaucratic costs and substantial informational requirements as well as problems of sociocultural acceptance.

Many governments also see information and education as an important part of their environmental policies. Elements of this approach include training of operators, in particular smaller ones who do not have easy access to the technology required and who may be unaware both of environmental impacts and of methods to alleviate them. Information and education are elements of a less confrontational and more cooperative approach than traditional "command and control" policies. The change in corporate attitudes described earlier has encouraged the development of cooperative approaches whereby regulators and operators of mines attempt to arrive at mutually acceptable solutions to environmental problems, taking into account both the need to minimise environmental damage and the circumstances of the individual operation. While such approaches may require a great deal of sophistication and flexibility on the part of both parties, they often result in less environmental damage and lower costs than would otherwise have been the case.

Economic instruments are receiving increasing attention from governments as a potentially more effective way of internalising the social cost of environmental damage than administrative regulation, which is seen as excessively rigid and too blunt an instrument. Since administrative regulation necessarily implies that polluters have to reduce pollution according to a predetermined standard, and since polluters are likely to face very different costs of abatement? there is no assurance that optimum reduction of pollution will be achieved[14] or that the amount of pollution reduction per monetary unit spent on it will be maximised. Examples of economic instruments include charges or taxes on pollution, subsidies and marketable pollution permits.[15] At the United Nations Conference on Environment and Development in Rio de Janeiro in 1992 governments agreed to promote the use of economic- instruments.[16] In practice, economic instruments have been very little used for mining, and where applied, it has usually been under legislation not confined to mining, such as the use of marketable pollution permits under the Clean Air Act by metallurgical companies in the United States.[17]

There are some examples of economic instruments not directly aimed at internalising environmental costs but rather at

promoting pollution control measures. These include tax incentives such as accelerated depreciation for pollution control equipment. While these instruments are likely to contribute to reductions in pollution, they are not very cost-effective from the government's point of view.[18] Furthermore, they may provide an incentive to companies to invest in "end-of-pipe" technology, that is, to treat emissions rather than to prevent pollution from occurring in the first place through appropriate process design. The latter would be preferable from the point of view of maximising pollution reduction in relation to cost, but would provide no tax advantage.

Several arguments are put forward as to why the use of economic instruments has not developed more rapidly in developing countries, both in general and specifically for mining. (The application of such instruments in developed countries is also in its early stages, although some systems are now in use.) In general, governments find it difficult to establish the "right" rates of taxation and fees, and they are sensitive to public opinion which might interpret economic instruments as allowing polluters to buy the right to pollute. The first argument would appear to be based on the assumption that the imposition of fees and the like would in principle require more knowledge than the imposition of administratively enforced limits on pollution. It could be argued, however, that if the information is good enough for applying administrative limits, it should be good enough for allowing the use of taxes or fees. In practice, economic instruments may prove to be easier to administer and enforce. This is particularly because they may be more flexible than alternative approaches, since they allow the operator to select the most appropriate technology to reduce pollution to the point where the pollution tax or charge is equal to the marginal cost of abatement. The second argument is of course politically valid, but might be better dealt with through information and education. It should also be noted that economic instruments such as pollution charges or taxes may be a source of revenue for the government.

As regards mining specifically, it could be argued that many of its environmental impacts, for instance the disturbance of natural ecosystems, are difficult to measure and that economic instruments are therefore difficult to use. While it is certainly true that mining does not have all the characteristics of the theoretical polluting industry that responds to a pollution charge by reducing pollution by the optimal amount, other economic instruments can be used to provide operators with an incentive to minimise environmental damage. Examples of such instruments could be charges proportional to the area disturbed, which might be designed to escalate over time. Furthermore, pollution charges or similar instruments could be used for those types of environmental damage for which they are suited. It would appear that they could have an important role to play, particularly in reducing pollution from mineral and metal processing.

The most common economic instrument used to influence environmental management in mining is financial assurance for rehabilitation of mine sites.[19] Financial assurance schemes could be termed a "hybrid" instrument of environmental policy, encompassing aspects of both economic instruments and administrative regulation. Financial assurances typically require mining companies to guarantee financial responsibility for reclamation of mine sites. There are a number of specific financial vehicles and mechanisms grouped within the broad category of financial assurance, including several types of bonding, trust funds and insurance programmes. Standard financial assurance tools and mechanisms are intended to ensure that a normal range of costs associated with reclamation and closure of mines will be paid for by the mine owner or operator, either directly or through some alternative mechanism which guarantees their financial responsibility. These schemes have been extensively used in Canada and the United States as well as in some developing countries, notably Malaysia. Several other developing countries have recently introduced similar schemes or are about to do so. For financial assurance mechanisms to be successfully used, there must be a financial industry capable of providing these services. This industry must also be monitored and regulated, something which may be difficult in many developing countries. The importance of adequate regulation is illustrated by the experience in the United States, where many of the firms which provided financial assurances went bankrupt themselves, leaving governments and taxpayers with the financial responsibility.[20] Furthermore, the additional costs of purchasing bonds or insurance, as well as the costs of engineering to higher environmental standards, may threaten the economic viability of small mines.

A subject which is often referred to in the context of environmental management, although the connection between the issues that give rise to the discussion and the environment may be tenuous, is the relationship between mining operations and local communities. Attention has been drawn to this subject by events such as reported massacres on Yanamomo Indians in Brazil by artisanal gold miners[21] and by the rebellion on the island of Bougainville in the North Solomons Province of Papua New Guinea.[22] The interests of local communities, which are often isolated and may have little political power, have sometimes been jeopardised by mineral development projects. Such projects have led to environmental degradation, displacements of populations, reduced possibilities of exercising traditional occupations such as hunting and fishing, and conflicts between local inhabitants and immigrants drawn to the region by the mineral development. While some densely populated developing countries, such as India,

have long experience of this problem and have evolved instruments for dealing with it[23], others are still attempting to formulate mechanisms that ensure local participation in the process leading up to a decision whether to approve mineral development projects, and if so, on what conditions.

Sustainability in mineral resource use

The issue of sustainability in the exploitation of mineral resources arises from the argument that the people alive today should not limit the production and consumption choices of future generations by using up "too much" of existing mineral resources. This implies that the income from the exploitation of a mineral deposit should be invested in other forms of capital in such a way that the present value of future return on that capital equals the present value of the mineral deposit, that is, the natural resource capital should be replaced by an equal amount of other forms of capital.[24]

Following the emergence of the concept of sustainable development, there has been a debate in recent years among economists on how to ensure sustainability in resource use. A large part of this debate has focused on the fact that national income accounts do not measure the use of natural resources.[25] It is argued that just as depreciation of man-made capital is reflected in Net National Product (NNP), so should the decline in stocks of natural resources be taken into account, since that decline reduces their availability in the future, and since otherwise society's total capital stock would be exaggerated. It is further argued that the resulting adjustment could lead to a dramatic downwards revision of NNP[26] – an illustration of the fact that economic growth as conventionally measured has been achieved at the cost of depleting the natural resource base and reducing future growth, and that, consequently, measures need to be taken to ensure the sustainability of economic growth, with this generally implying changes in production and consumption patterns.

While it is not the intention here to discuss in detail how depletion of mineral resources should be measured and how they should best be reflected in national accounts, some observations arising from recent work on the subject may nevertheless be useful in providing a perspective on the issues and on their implications for policy formulation in the area of mineral resources.

It should first be noted that while commercial natural resources are measured directly in national accounts, in the sense that the value-added associated with their exploitation is measured in national income, the economic value of these resources as assets appears only implicitly. Resource rents show up as a portion of operating surplus for the resource sectors, but are not explicitly measured. Consequently, the value of economic depreciation of a deposit as a result of exploitation is not measured either, which means that resource depletion does not enter into the calculation of net product.

The United Nations has drawn up guidelines for the establishment of "satellite" accounts for natural resources and the environment. These accounts are parallel and linked to the standard accounts.[27] One of these accounts is the balance sheet for subsoil assets. An example of this appears in table 2. The table shows the value of subsoil assets for Papua New Guinea in 1988, including depletion, resource discoveries ("other volume changes") and revaluation due to price changes. Underlying this balance sheet is a set of accounts in physical terms detailing the stocks and flows of individual minerals.

Table 2. Papua New Guinea: Balance sheet for subsoil assets, 1988 (million kina)

Assets	Value
Opening stocks	3 683.7
Depletion	- 106.3
Other volume changes	175.6
Revaluation	-2 168.6
Closing stocks	1 584.4

Source: Bartelmus et al., 1993.

While the principle of natural resource accounts is easy to understand, the methods used to establish them are less self-evident. The physical volume of stocks is measured by proven reserves, a measure which is sensitive to price changes. It is agreed that reserves should be valued at the resource rent per unit, since the rent is what remains of the value of production after accounting for the returns to labour and "normal" returns to capital. However, two approaches to value resource depletion have been proposed. The first argues that "from the annual earnings from sale, an income portion has to be identified capable of being spent on consumption, the remainder, a capital element, should be set aside year after year to be invested in order to create a perpetual stream of income that would sustain the same level of "true" income, both during the life of the resource as well as after the resource has been exhausted".[28] The income portion, or user cost, is the value of the depletion of the resource. The other approach, the net price method, amounts to using the full value of current resource rents as the value of depletion.[29] The two approaches can yield significantly different results, arising mainly from the difference in the relative weight accorded to current depletion and new discoveries in relation to the total stock of resources.[30]

While data problems limit the usefulness of natural resource accounts as quantitative indicators of welfare or economic growth, the techniques described may, however, be useful as pedagogical tools that may help focus political attention on the need to replace natural resource assets with other types of capital in order to achieve economically sustainable development.

Notes

1. It is interesting to note the very small relative size of the areas affected by mining. For instance, over the period 1930–1980, only 0.25 per cent of the total land area of the United States was used for surface mining, disposal of wastes from surface and underground mines, and disposal of wastes from mineral beneficiation and further processing. Coal mining accounted for about half of this land, with mining of non-metallic minerals accounting for about two-fifths and of metallic minerals about one-tenth. Some 47 per cent of the land affected by mining and waste disposal had been reclaimed by the end of that period (Johnson and Paone, 1982).

2. Balkau, 1993, provides an introduction to environmental auditing in the mining industry.

3. While the costs of environmental control measures required by legislation may vary considerably among countries, there is no evidence that mining companies are attracted to countries with less ambitious environmental regulations. For a general review of studies on the impact on trade of differences in environmental costs, see Dean, 1991. A recent analysis by the UNCTAD secretariat (UNCTAD, 1994, paras 75–79) of industries with relatively high pollution abatement costs (operating costs 2 per cent or more of value of shipments, including iron and steel production and basic metals industries but not mining, however) shows that the share of intra-OECD trade in these sectors decreased slightly from 1980/82 to 1990/92 and that the share of OECD imports in these sectors from developing countries (except for European Union imports) and countries in transition increased. In some of the sectors, however, the share of intra-OECD trade increased. While the trends are consistent with the industrial relocation hypothesis, this could equally well reflect a normal pattern of industrialisation whereby the industries concerned grow at a higher rate initially. Nevertheless, there is evidence that in some cases, environmental regulations may lead to the relocation of mining and metallurgical industries. Thus, the closure of 29 secondary lead smelters in the United States in the latter half of the 1980s is attributed to more stringent regulation of air pollution (Mining Journal, 1991).

4. Warhurst, 1992

5. Warhurst, 1992, cites several examples of reduced operating costs and/or increased recovery of useful products resulting from improved environmental control measures, and makes the observation that the more dynamic firms innovate by building into the new generation of technology lower costs of both production and pollution control. In general, the costs of environmental control measures of course vary significantly from project to project. For most projects, however, the costs are likely to be relatively low. A recent survey by the Metals Economics Group of 105 gold projects of 54 companies found that environmental costs accounted for 14.1 per cent of capital costs. The share fell to 9.6 per cent if one particularly high-cost project was excluded. Environmental operating costs, including pollution control, monitoring, permit maintenance and reclamation concurrent with mining, accounted for on average 2.7 per cent of total operating costs, with reclamation accounting for a fifth. Reclamation after mining corresponded to on average 4.2 per cent of total life-of-mine capital costs (quoted in Mining Journal, 1994).

6. Organisation for Economic Co-operation and Development, 1975, pp. 12–13

7. Tilton, 1994, pp. 61–62

8. Organisation for Economic Co-operation and Development, 1975, p. 25

9. Organisation for Economic Co-operation and Development, 1975, p. 6

10. Jha and Teixeira, 1994, p. 12

11. Another reason why general standards may be inappropriate is that the undisturbed groundwater close to ore deposits that have not been mined can be naturally acidic and contain concentrations of metals that are far above general standards (Runnels et al. 1992). In Chile, standards were established using the standards set by the United States Environmental Protection Agency. However, some of the rivers in northern Chile have a base level of metallic elements that is higher than the standard, thus making the standard unenforceable (Lagos, 1994, pp. 91–92). High concentrations of metals in groundwater close to an ore deposit are identified through geochemical surveys and used as one of the tools for exploration.

12. UNCTAD, 1995, pp. 77–90

13. See note 11.

14. The optimum amount of pollution reduction is achieved when the marginal cost of reducing pollution is equal to the marginal social cost of pollution.

15. For a description and discussion of these instruments, see UNCTAD, 1991, paras 82–92, and de Castro, 1994, pp. 25–36. For a summary overview of instruments used in OECD countries, see Barde and Owens, 1996.

16. Principle 16 of the Rio Declaration adopted by the United Nations Conference on Environment and Development in Rio de Janeiro on 14 June 1992 states: "National authorities should endeavour to promote the internalisation of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment" (United Nations, 1992).

17. Mining Journal, 1992

18. See Lloyd, 1992, for a discussion of these aspects in the context of taxation in France.

19. See Anderson, 1995, and Intarapravich and Clark, 1994, for discussions of financial assurance schemes for rehabilitation of mine sites.

20. Anderson, 1995, p. 71

21. See May, 1991, pp. 24–30, for a review of the recent history and origins of conflicts between Indians and garimpeiros in the Brazilian Amazon.

22. In 1988, an armed rebellion against the central government broke out in Bougainville. The dispute arose out of the adverse effects resulting from the operations of Bougainville Copper Pty. Ltd., which was mining a large copper deposit on the island. The grievances of the local population included destruction of the environment resulting in damage to fisheries and agriculture, displacement of the population and insufficient compensation. In 1990, the mine was closed down, and there is at present no prospect of its reopening. For a discussion of the complex roots of the conflict, see Thompson, 1991.

23. Dhar and Sexena, 1992

24. This assumes full substitutability between natural resource capital and man-made capital, which may not be strictly correct, but which is a reasonable approximation for realistic time periods (although strict environmentalists

25. For a discussion of this issue as it relates to mineral resources, see Hamilton, 1994; Hartwick, 1990; Mikesell. 1994: and Solow, 1993.

26. A calculation of "Net Domestic Product" (NDP) for Indonesia, derived by subtracting

estimates of net natural resource depletion for three sectors (petroleum, timber and soils) from Gross Domestic Product (GDP) resulted in an average annual NDP growth rate of 4.0 per cent from 1971 to 1984. as compared with a GDP growth rate of 7.1 per cent for the same period (Repetto et al., 1989, p. 6).

27. United Nations, 1993

28. El Serafy, 1989, p. 13

29. Repetto et al., 1989

30. A study of sustainable income from seven non-fuel minerals and petroleum in Brazil over the period from 1970 to 1988 yielded results ranging from – 16 000 per cent in 1974 to +9 000 per cent in 1972 of conventionally calculated income for the net price method and 86.7 per cent (1974) to 97.9 per cent (1980 and 1988) for the user cost method (at a discount rate of 15 per cent). The difference was due both to differing impacts of resource discoveries and to the existence of very large reserves of some minerals (Frickmann Young and Seroa da Motta, 1994).

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