



Mineral trade policies and agreements – environmental implications

By Alyson Warhurst

This paper analyses some of the environmental and economic implications of current trade policies and changes in the world trading system for metal producers and consumers. The principal factor which determines environmental performance is whether firms have the resources and capabilities to undertake innovation, which in turn reflects their level of competitiveness. Therefore, particular emphasis is placed on anticipated effects of liberalised trade on innovation and competitiveness at the firm level.

Dr Alyson Warhurst is Director of International Centre for the Environment, and Mining & Environment Research Network, School of Management, University of Bath, Bath BA2 7AY, UK

Metal mining and processing operations in industrialised countries have experienced a number of challenges in the past 20 years. Tilton [19] has summarised these in the context of North America, claiming that firms in this region “have struggled with excess supply, redundant capacity, cheap imports, low profits, plant closures, and even firm failures”. Analysts who have attempted to explain these troubles generally belong to two different schools. One group stresses that the core location of mining and mineral processing activity is increasingly moving away from the industrialised countries towards developing countries because they are endowed with higher ore grades and relatively lower wage rates. Another school suggests that industrialised producers have suffered a decline in ‘revealed’, not natural comparative advantage. The latter argue that the shift of metal mining and processing cost advantages towards developing countries is primarily considered to be the result of public policies. These analysts stress the adverse competitive effects of public policies in the industrialised countries (especially environmental laws, and health and safety regulations), in contrast to protectionism, subsidisation and lax environmental policies in developing countries. The trend towards liberalised trade might be expected to accelerate the geographic relocation of metal mining and processing away from the industrialised towards developing countries, because of natural comparative advantages in ore grade quality. Indeed, this expectation has been a primary driving force behind developing countries’ interests in trade liberalisation. However, trade liberalisation may also provide opportunities for industrialised mineral-producing countries to ‘win back’ their natural comparative advantage through a ‘levelling of the playing field’.

This debate about liberalised trade has recently adopted a new focus – that of environmental impact. Whichever way the geographic distribution of metal min-

ing and processing is to shift, whether it is away from the industrialised countries, towards developing countries or vice versa, then there should be provisions in place to ensure operations are closed in an environmentally sound manner. However, if liberalised trade is to ‘level the playing field’, then a different set of issues relevant to environmental protection need to be addressed regarding the relationship between environmental management, production efficiency and competitiveness.

Determinants of competitiveness in metal production

Considerable empirical analysis has shown that, in the absence of tariffs, quotas or other trade policy interventions, the production of minerals will gravitate towards those firms which have the lowest production costs. Cost-determining factors often relate to the geological endowment available to firms, but can also be influenced by a host of other factors including access to credit, technology and skilled labour. Public policies can also play a significant role in shaping the competitiveness of mineral-producing firms. They influence the extent to which firms are able to implement technological change, economies of scale, learning processes and product differentiation etc., and consequently can have a profound impact upon world trade of minerals commodities. While Peck et al [16] have maintained that, in the long run, production of metals will continue to gravitate towards those locations and firms with the lowest production costs, they acknowledge that public policies can work to reduce market imperfections, improve environmental performance, assist in economic diversification efforts and help in the achievement of other social goals. Warhurst [22,23] has supported this finding and has argued that policy mechanisms are required to enhance the metal and mineral processing industry’s ability to innovate by promoting technological and organisational

change as well as economic and productive efficiency. Thus, trade policy, industrial policy, science and technology policy and regional policy can play an important role towards achieving the twin objectives of environmental and economic development. Indeed as Aydin [3] has suggested, in order to implement the provisions with respect to trade, development and environment outlined in Agenda 21, the Plan of Action which resulted from the Rio Earth Summit in 1992, "creating a competitive pressure to undertake environmentally sound management practices is better than creating a competitive pressure to avoid environmental liability costs...". This observation is crucial to an examination of the effects of new and existing trade policies on the relationship between environmental and economic performance in metal mining and processing firms.

Both absolute values of production costs and changes in relative costs are important indicators of competitiveness in the minerals industries. The former reflect geographical and geological features as well as domestic factor prices, production methods, exchange rates, taxes and institutional arrangements. Differences in absolute costs can be enhanced or offset by differences in ore grades and, for some minerals, the value of by-products or penalties for associated pollutant elements. These variations in costs mean that trade policies are likely to have a differential impact on the competitiveness of firms in different countries. In other words, high cost producers are more likely to go out of business (with concomitant clean-up problems) than low cost producers. In addition, firms mining high grade ores using inefficient techniques could make just as much profit (with a poorer environmental record) as firms mining lower grade ores using more efficient technologies.

Environmental performance relates to the proficiency of a firm's environmental protection strategy and the effectiveness of its environmental management sys-

tem. It is related to, but not contingent upon, the firm's record of environmental compliance.

Environmental implications arising from geographical patterns of production

A review of trends and shares in production capacity and reserves by region, see tables 1 and 2 respectively, indicates a general upward trend in developing country shares of future production capacity, particularly for bauxite, copper and tin. Environmental problems associated with metals production are evident throughout the world. The existence of important mining regions in North America, and Australia mean that upstream problems such as land degradation, acid mine drainage and tailings stability, are not simply confined to developing countries, which are usually considered the major exporters of primary materials and the site of pollution havens. Nor is smelting-related pollution a problem confined to the industrialised countries. Rather, pollution problems relate to the scale, vintage and efficiency of operations, not to the mining activity per se.

Most smelters located in developing countries were established before rigorous environmental regulation was introduced and then would lose their cost advantages if they were obliged by law to incorporate expensive add-on environmental controls to match the environmental standards achieved by new flash smelters in countries such as the USA, Canada and Japan.

It is also important to note that if trade policies or environmental regulation forced these smelters in developing countries to close (as they have in the United States), new investments (re-enforced by credit-conditionality requiring best-practice technology) would likely result in the installation of modern flash smelters regardless of location and regulatory regime.

Satisfying demand through increasing metals recycling also poses significant

environmental and trade implications. First, policies to promote a greater degree of recycling within a country could constitute a non-tariff barrier to metals trade. Second, there could be unforeseen environmental effects in increasing secondary output at the expense of primary production. Finally, changes in trade policy may also stimulate further technological advance towards 'dematerialisation' or metals substitution in industrial products.

Environmental implications of the socio-economic context of metals production

A number of socio-economic and political factors influence the environmental performance of mining and mineral processing operations across trading regions. For example, in the small enterprises that predominate in many developing countries, factors related to poverty may condition behaviour toward the environment. Moreover, the socio-economic organisation of the production enterprise and its relationship with the state may also effect the nature and extent of environmental degradation.

Small-scale informal mining enterprises have grown in developing countries for a number of reasons including the closing down of large-scale inefficient mines and processing plants, growing poverty, and new 'gold rush' phenomena associated with recent large gold discoveries in the Amazon and its tributaries in Bolivia, Brazil, Colombia, Ecuador, Peru and Venezuela. In Brazil alone, the number of tin and gold 'garimpeiros' are estimated to number between 300 000 to 1 million, Hanai [9]. The environmental behaviour of these small-enterprises is closely linked to poverty. The miners generally are poorly educated with no formal technical training. They have little access to technology or the credit to buy it. Trade policies that result in the closure of large scale inefficient mining operations might be expected to lead to an increase in the number of small-scale enterprises. Miners who have

Table 1. Mine and processing plant capacities for selected non-ferrous metals

Commodity/Region	Actual						Projected			
	1985		1987		1990		1995		2000	
	kt/y	%	kt/y	%	kt/y	%	kt/y	%	kt/y	%
Bauxite mining										
World	120 030	100.0	124 343	100.0	131 706	100.0	134 608	100.0	143 158	100.0
Industrial countries	43 410	36.2	44 895	36.1	43 345	32.2	42 745	31.8	44 745	31.3
Dev. countries (incl. China)	60 170	50.1	62 998	50.7	71 913	54.6	75 413	56.0	81 412	56.9
ex-USSR and Eastern Europe	16 450	13.7	16 450	13.2	16 450	12.5	16 450	12.2	17 000	11.9
Alumina										
World	41 925	100.0	41 549	100.0	42 414	100.0	44 334	100.0	48 825	100.0
Industrial countries	23 875	57.0	22 629	54.5	21 109	49.8	21 609	48.7	22 600	46.3
Dev countries (incl. China)	11 400	27.2	12 520	30.1	14 905	35.1	16 325	36.8	19 325	39.6
ex-USSR and Eastern Europe	6 650	15.9	6 400	15.4	6 400	15.1	6 400	14.4	6 900	14.1
Aluminium										
World	18 461	100.0	18 928	100.0	20 420	100.0	21 739	100.0	24 246	100.0
Industrial countries	11 099	60.1	10 429	55.1	10 533	51.6	10 859	50.0	11 446	47.2
Dev. countries (incl. China)	3 812	20.7	4 687	24.9	5 957	29.2	6 580	30.3	8 300	34.2
ex-USSR and Eastern Europe	3 550	19.2	3 812	20.1	3 912	19.2	4 300	19.8	4 500	18.6
Lead mining										
World	3 323	100.0	3 429	100.0	3 469	100.0	3 525	100.0	3 600	100.0
Industrial countries	1 812	54.5	1 949	56.8	1 890	54.5	1 875	53.2	1 800	50.0
Dev. countries (incl. China)	1 511	45.5	1 480	43.2	1 579	45.2	1 650	46.8	1 800	50.0
ex-USSR and Eastern Europe	—	—	—	—	—	—	—	—	—	—
Lead refining (primary)										
World	3 619	100.0	3 447	100.0	3 522	100.0	3 612	100.0	3 550	100.0
Industrial countries	2 354	65.1	2 206	64.0	2 221	63.1	2 221	61.3	2 100	59.2
Dev. countries (incl. China)	1 265	35.0	1 241	36.0	1 301	36.9	1 400	38.7	1 450	40.9
ex-USSR and Eastern Europe	—	—	—	—	—	—	—	—	—	—
Lead refining (secondary)										
World	2 365	100.0	2 358	100.0	2 420	100.0	2 346	100.0	2 700	100.0
Industrial countries	1 947	82.3	1 897	80.5	1 897	78.4	1 921	75.5	2 000	74.1
Dev. countries (incl. China)	418	17.7	461	19.6	523	21.6	625	24.6	700	25.9
ex-USSR and Eastern Europe	—	—	—	—	—	—	—	—	—	—

Source: Minerals Handbook: 1990/91, Stockton Press, NY, 1990, Prepared by D C O'Connor.

lost jobs in the formal sector would be likely to regroup as small cooperatives to mine deposits considered unviable by the formal sector.

State-owned mining companies are generally larger-scale operations found in the developing countries of Africa, Latin America and Asia. These operations are often inefficient and more polluting than private sector firms. They tend to employ obsolete technologies which were designed before their associated environmental effects were fully understood or deemed relevant. Often the plant processes were inherited on nationalisation in the 1950s and 1960s, and have not been modernised since. Inefficient operating regimes, a lack of spare parts, excess capacity, frequent breakdowns, and ignorance of environmental safety procedures combine to cause environmental problems. A lack of investment capital, which characterises many of the mineral producing developing countries, further reduces the prospects of State mining companies to reducing pollution. Moreover, by virtue of being State-owned, such facilities may exacerbate their situation through receipt of 'inappropriate' aid packages which impose over-specified or poorly adapted processes and procedures. Corruption on the part of poorly informed government officials may reinforce subsequent poor technological choices resulting in pollution problems, Warhurst [22].

Privately-owned and multinational mining corporations, which are prevalent in the industrialised mining countries as well as in developing countries, benefit from a number of factors which frequently combine to render them less serious environmental offenders than are small scale or state owned firms. These factors include greater economic efficiency, greater access to modern technology, greater degrees of technology diffusion between subsidiaries and their other centres of operations, fear of expropriation or retrospective penalty for 'poor' environmental behaviour, finance condi-

tionality, and finally the opinions of increasingly more environmentally-conscious shareholders or the public in their home country. These factors, however, are only emerging influences and do not apply to all international operations.

Free trade agreements and metals production

As a result of several rounds of negotiation in the General Agreement on Tariffs and Trade (GATT), tariffs on base metals and minerals are likely to be a smaller impediment to trade than was once the case. As metal producers in industrialised countries have lowered tariffs on minerals, however, there has been a concurrent shift in these same countries towards the use of contingency measures such as anti-dumping regulation, countervailing duties, and orderly marketing agreements, to protect domestic metal producers from perceived forms of foreign subsidy. Many developing countries, moreover, continue to use import levies as a source of government revenue and to encourage domestic production. Tariff protection in most industrialised countries is low on raw minerals, but on processed minerals often escalates to 2–20 times the rate on raw ore or concentrates. Gallagher [7], for instance, has noted that while US and Japanese tariffs on unalloyed zinc were 1.9 per cent and 3.5 per cent respectively, tariffs on alloyed zinc were 19 per cent and over 50 per cent respectively. Similarly, titanium ore admitted to the US market is not subject to tariff, but the import of titanium dioxide is subject to a tariff of 6.9–9.9 per cent and refined titanium receives a levy of 17.5 per cent. The reduction of these tariffs could offer significant opportunities for developing countries to diversify their minerals production activities into high value-added products. The associated new investment would, by virtue of its modern and credit-conditioned nature, be likely to incorporate best practice in environmental protection.

Despite recent GATT negotiations, considerable reluctance has been shown on the part of some countries to reduce tariffs on processed minerals, or in the case of developing countries, on metal ores. In December, 1993 Brazil announced that it would raise import duties on lead, zinc, aluminium, tin, cast iron, cobalt, and ferro-alloys to 5 per cent of the product's value. Previously, the 5 per cent tax was charged only on imports of copper and nickel. The Commerce Secretariat in Brazil has claimed that the country "needs minimal tariff protection due to the problems caused by low world prices, the flood of imports from the former Soviet Union and exchange rate difficulties" [10]. Some Latin American metal producers (Brazil, Argentina, Paraguay and Uruguay), which will operate within the MERCOSUR common market after January 1, 1995, have indicated that they may adopt a common 18 per cent tariff on imports of non-ferrous metals from third countries.

However, the most contentious set of tariffs originate in Japan, a country with virtually no natural mineral resources. Japan has built a thriving metal processing industry which is extensively protected by tariff walls. For instance, Japan currently imposes an 8 per cent duty on imports of refined copper, a value which translates to about 15000 JPY/tonne or 6.5 cents/lb [11]. Only 1 per cent of the copper smelted in Japan comes from Japanese mines; rather concentrate is acquired (duty free), processed, and sold to domestic customers at a considerable profit. The duty on refined copper imports discourages domestic industries from using foreign supplies. Moreover, the Japanese smelting and refining industry accounts for more than 60 per cent of the supply of internationally traded copper concentrate. Firms such as Magma (in the US) have indicated that this tariff is an implicit subsidy for Japanese producers. The US producers' claim is that the tariff leads to severe market distortions since Japanese producers occasion-

ally export their 'subsidised' refined copper to other Asian countries with heavy demand – such as Taiwan and South Korea – through cartel-type networks.

The Canada–United States Free Trade Agreement (FTA), signed on 2 January, 1988, set the stage for many of the free trade agreements currently being negotiated in other parts of the world as well as for the GATT negotiations. The FTA called for a total elimination of tariffs between the two countries within ten years of its enactment on 1 January, 1989. The FTA established a new set of trade rules, common to each country, to govern countervailing and anti-dumping actions. For instance, by 1 January, 1996, Canada and the US are to have negotiated a common agreement on subsidies. Anderson [1] has suggested that it is unlikely that Canada and the US will agree on a common subsidy code, given basic national differences with respect to the role of government in regional development, industrial policy and social welfare. Yet a common subsidy code is expected to be at the heart of this and many of the free trade agreements undergoing present negotiation. A binding dispute resolution mechanism was negotiated to deal with the application of countervail or antidumping duties. Such duties are usually applied when one of the two countries perceives that exports are the recipient of 'unfair' production subsidies. The FTA, therefore, provides an appeal system which can take action against the decisions of each other's trade regulatory bodies. The Canada-USA Trade Commission can make use of a binding bi-national panel of five members, which provides a means by which regulatory bodies review trade dispute cases and, if necessary, allow similar trade restrictions or termination of the agreement. This appeal system is generally considered to be much faster and more cost effective than the old mechanism of dispute resolution which involved international diplomacy or costly legal action. However, each country does retain the right to impose sovereign rules on trade.

The North American Free Trade Agreement (NAFTA), which has been negotiated between the governments of Canada, the US and Mexico, aims to remove all trade and tariff barriers between the three countries over a fifteen year period. It was signed on December 17, 1992 and is very much based on the current Canada-US FTA model. Member countries of the European Union have accepted a more formal arrangement, consenting to the establishment of a central form of government which deals with a number of issues, including those relating to trade and environment, on a Union-wide basis. Moreover, the Union can become party to international trade conventions such as GATT and international environmental agreements such as the Montreal Protocol." The Union has a supra-national authority to address trade matters of relevance to the Union's Member States.

MERCOSUR is a new regional trading block in Latin America that became fully operational on December 31, 1994. The signatory countries, Brazil, Argentina, Paraguay and Uruguay, have agreed to form a single market economic block, similar to the European Union. To date, most of the activity within MERCOSUR has concerned trade and economic policy aimed at boosting its export-oriented status. Less consideration has been given to national industrial policies, planned growth, regulation of labour and environmental protection, Onestini [13]. Moreover, little consideration has been given to enhancing the trade of goods and services between the signatory countries. Rather, the emphasis has remained on exploiting comparative advantages in the signatory countries to achieve the best export performance possible for the MERCOSUR block. This type of trade policy would naturally tend to favour non-value added exports of commodity type products - including, to a large extent minerals and metals. The MERCOSUR trading block, therefore, appears to be oriented predominantly towards enhancing exports of unprocessed products to

earn foreign exchange in the short term, rather than ensuring long-term environmentally and economically sustainable development within the trade region. Public pressure has not forced MERCOSUR to deal with the latter, as it did in the NAFTA negotiations. Whether this will effect the trade block in the future remains to be seen, since environmental considerations will inevitably have to be dealt with if it wishes to become fully integrated with the NAFTA agreement.

Environmental protection and liberalised trade in metals production

One of the most widely discussed and controversial aspects of the 1992 United Nations Conference on Environment and Development (UNCED) in Rio was the goal of increased integration of international trade and environmental protection objectives. Chapter 2 of Agenda 21 (the Programme of Action which resulted from the Rio Earth Summit) describes the relationship between international trade and environmental protection, as well as the conditions under which the two objectives can be mutually supporting. Chapter 8, which is concerned with economic and environmental integration, calls for the reduction of subsidies which do not conform to sustainable development objectives; the reformation of economic and fiscal incentives to promote environmental and development objectives; and the establishment of new markets in pollution control and environmentally sound resource management.¹

However, there remains a split between two schools of thought on these issues. One contends that increased liberalisation of trade will improve environment and development objectives, through accelerated modernisation. The other claims that the two goals are not mutually supportive, Bhagwati [4] and Daly [6]. The two key problems which, in our opinion, need to be resolved to reconcile these differences of opinion con-

cern first, green protectionism and second, the focus and interpretation of government policies to promote and regulate industry.

Green protectionism

Much confusion surrounds the use of the term "Green Protectionism". It essentially refers to various forms of trade protectionism under the label of environmental protection. Government in both the industrialised and developing countries have expressed fears that environmental protection measures could be turned into instruments of trade protectionism.

In the 1980's, trade laws – particularly in the US – could be interpreted as moving increasingly towards using green protectionism to protect domestic natural resource-processing industries. In several well-documented cases, government-sponsored initiatives to encourage sustainable environmental management or economic diversification were questioned as being unfair subsidies. Palmeto [15] documented a relevant case for the minerals industry concerning the banning of Canadian asbestos by the United States. This determination was applied to a wide variety of asbestos-based minerals with very different properties (which as a result generated very different types of risk). The interpretation of this case by Palmeto as one of green protectionism stems from the fact that most of the asbestos consumed in North America is produced in Canada, but used in the US. The ban would have led to the employment of substitute products not sourced in Canada, thereby diverting trade to other sources – including US production of substitutes.

The International Council on Metals and the Environment (ICME) has been arguing at the international level for governments not to impose wide discrimination against natural products. Instead, it argues, discrimination should be made on the basis of 'speciation' – the form in which metals are used in society, and whether these individually represent un-

acceptable risks to society and the environment. By banning an imported product on environmental grounds, a country could promote domestic production of substitutes at the expense of the import. In many industrialised countries, the metals producing industries are viewed as being in decline, mature and polluting, therefore there is considerable effort to develop metal substitutes. The use of environmental import limitation mechanisms may also provide incentives for the development of a domestic production capability for substitutes. It is, therefore, increasingly being recognised that workable modern trade agreements cannot be made without taking such resource and environmental issues into consideration.

Environmental regulations

Another significant debate surrounding the implications of liberalised trade for minerals production, concerns environmental regulations. In industrialised countries, the primary concern of mining firms is that lower environmental standards in developing countries might serve as unfair sources of competitive advantage. In these cases, producing firms see the costs of meeting increasingly stringent environmental regulatory standards as "additional" production costs not yet borne by firms in developing countries. Another concern of industry in some industrialised countries, such as the US, is that government intervention to help polluting mineral producers achieve improved levels of environmental performance constitute unfair forms of subsidy (since these efforts can simultaneously lead to improvements in production efficiency or reductions in operating costs, through related savings in energy or reagent inputs). However, the public in some industrialised and indeed many developing countries, accept the need for government intervention to help modernise key industries in an effort to alleviate environmental pollution. Firms in developing countries, however, are primarily concerned that higher environmental standards in industrialised countries, or a

move towards the 'eco-labelling' of imports to reflect environmental standards at source, may be used implicitly as non-tariff barriers against their exports.

Much of the policy discussion concerning the environmental implications of liberalised trade has therefore focused explicitly on how a set of environmental regulatory "floors" can be built, to ensure that liberalised trade does not promote growth at the expense of the environment. While this discussion is key in moving towards a realisation of environmental and economic benefits from liberalised trade in the metals sector, it needs to be reconciled with the general question of what constitutes a subsidy in the metal mining and processing industry.

Subsidies

Mineral-producing firms can benefit from a range of government policy instruments, which vary between countries, such as tax benefits, grants, concessionary loans, research and development programme support, utility concessions, and infrastructure development projects. Many of these practices are deemed to be direct forms of subsidy. They have come to be an increasingly important issue for the mining and metals industries because, in times of low or declining world economic growth, there is increased pressure to take refuge from the free market.

Governments most often intervene at low points in metals cycles, Porges [17]. GATT, however, endorses the argument that subsidies distort international trade and that the appropriate action to offset this is a countervailing duty on subsidised imports. The GATT "Subsidies Code" is important in helping to determine what constitutes a countervailable subsidy. The third "Subcode" is most relevant to metals and minerals trade since it limits government subsidisation of exports of industrial products and minerals.² The Subsidies Code also obligates countries to take action which prevents the use of certain forms of domestic subsidy. Therefore, while the GATT Subsi-

dies Code recognises the legitimacy of countries to use certain forms of domestic subsidy, it also provides an international legal basis for use of countervailing duties against those subsidies which could injure domestic producers in an importing country. If competitors are "dumping" government subsidised minerals in export markets, then anti-dumping duties can be used to offset the "margin" of dumping.³

The highly cyclical, price-dependent nature of minerals production has made some mineral producers highly conscious of perceived subsidy in other countries, especially during cyclical downturns. US copper producers, for instance, have been critical of price support guarantees provided by the Chilean government to private sector mines, so that even in periods of depressed copper prices, the continuation of operations is ensured. These critics have claimed that such subsidies have led to surplus production, where otherwise operations would have curtailed production, Romagnoli [18].

Mineral-related subsidy practices have been under scrutiny at GATT and in the Canada-USA FTA. The subsidy debate is relevant to mineral producers throughout the world. Some mineral producers have attributed a large part of their current economic problems to foreign subsidisation practices.⁴ As a result, subsidies have been interpreted in new ways (conferred by means other than direct payments) and do not necessarily result in lower costs or prices, Anderson [1].

The role of government in assisting firms to comply with environmental regulations is increasingly relevant to the debate over subsidies. Some governments require the costs of adjustment to environmental regulations to be borne exclusively by industry, while other governments pick up part of the costs through direct cash transfers, the tax system, or research and development support. In 1984, for instance, the Canadian federal and provincial governments

agreed to a two-phase (25 per cent by 1990 and 25 per cent more by 1994) sulphur dioxide reduction programme as part of international negotiations with the US. The cost of this program for smelting firms was estimated by one study to be between 1.4–1.8 billion CAD in capital expenditures plus additional initial operating costs, Gerin [8]. This Acid Rain Reduction Program called for cost sharing by the federal and provincial governments and the private sectors. To assist firms meet negotiated targets, the federal government contributed 150 MCAD, a figure matched by the provinces, to be made available to firms for pollution control and the modernisation of facilities. Of this total amount contributed by government, a 25 MCAD fund was established for smelter research and development. Moreover, an 18 MCAD per year fund was set up for joint federal/provincial research and monitoring. US producers objected to the availability of this type of assistance despite its targeting of environmental protection improvement measures, on the basis that it represented a subsidy. However, these objections ignored that fact that at least part of this subsidy benefited those affected by acid rain. While no countervail action was taken against Canadian mineral firms which benefited from the Acid Rain Control Programme, there remains a possibility that government intervention to improve environmental protection through direct or indirect subsidy is a potential 'black hole' in the liberalised trade discussion. In fact, there has been limited consideration of how liberalised trade will deal with:

- Government intervention designed to promote the development of greenfield projects which incorporate very high environmental standards
- Government intervention that simultaneously improves environmental protection and the economic performance of firms.

The subsidy debate has also focused on investments in mine-related infrastructure for greenfield projects, Anderson [2].

The infrastructure system is normally owned and operated by governments and their involvement in the development of such projects is usually rationalised in social terms. The infrastructure debate is likely to become more contentious in the 1990s. Anderson [2] has claimed, furthermore, that there are inherent problems in attempting to measure such subsidies. Critics of US trade practice have identified related practices which could be interpreted as subsidisation. For instance, the vast US infrastructure system, including many aspects necessary for minerals production, was largely funded, directly and indirectly, by government. The Alaska Industrial Development Authority, a state agency, pre-built the necessary infrastructure for Cominco's large Red Dog project at a cost of over 150 MUSD.

Other practices such as percentage depletion of capital investment, royalty-free mineral development rights, preferential government procurement, and concessionary financing could also be interpreted as subsidies to minerals production. Over the past decade, numerous concessions and grants were provided to US copper producers to facilitate mine re-opening. These included property tax remissions, concessional financing (industrial development revenue bonds and pollution revenue bonds) and concessionary power rates.

Firm-specific government assistance schemes have also been utilised in the minerals industry to support one-industry towns. Without such assistance, it has been argued, a mining community could suffer severe economic hardship. The case for public assistance is particularly strong if a firm's problems are thought to be cyclical, if the population is aged, if alternative economic prospects are extremely limited or if the population is highly resistant to relocation.

Table 2. World mineral reserves, total and by region 1988–1989

Mineral	World estimated reserves ⁹ , Mt	Static reserve life, years	Shares of global reserves, %		
			Developed countries	Developing countries	Centrally planned
Bauxite	23 200 ¹	217	25	71	4
Copper	352 ²	40 ⁸	30	55	15
Gold	0.42 ³	22	69	16	15
Lead	70 ⁴	20	59	14	27
Nickel	49 ⁵	57 ⁸	26	21	53
Silver	0.28 ⁶	19	44	36	20
Tin	4.3	21	11	72	17
Zinc	14 ⁷	21	64	21	15

Source: Mineral Handbook 1990/91, Stockton Press, New York, 1990, prepared by D C O'Connor.

Notes: **1. Bauxite:** Based on existing recovery techniques, the recoverable aluminium content of the world's bauxite reserves is 1 billion tonnes for developed economies, 3 billion for developing economies, and 250 million for centrally planned economies. **2. Copper:** Measured in terms of contained copper. **3. Gold:** Million tonnes of metal; the figures for centrally planned economies are only for the USSR; there are substantial stocks of gold held in central banks, estimated at 39,000 tonnes, plus 48,000 tonnes held in the form of coin, bullion and jewellery.

4. Lead: Million tonnes of metal. **5. Nickel:** Measured in terms of contained nickel; the average grade of the reserves included exceeds 1 per cent nickel. **6. Silver:** The greater part of reserves and resources is associated with base metals such as copper, lead, and zinc. **7. Zinc:** Measured in terms of contained zinc. **8.** Refers to land-based reserves only. **9.** Reserves are defined as recoverable materials in the reserve base that can be economically extracted or produced at the time of determination. The reserve base also include demonstrated marginally economic and subeconomic reserves.

In many developing or newly industrialising countries (which represent much of the "new" competition in the mineral sector) market failure abounds and governments commonly intervene to promote industrial development. These countries fiercely protect their sovereign right to pursue mineral development through a variety of state-supported schemes. Most countries do not consider their natural resource assets to be subject to negotiation, Romagnoli [18]. Moreover, national resource investment decisions have routinely been excluded from trade treaty negotiations. Although many governments pursue economic growth objectives and the earning of crucial foreign exchange through the development of mineral resources, they also place emphasis on distributional and regional stabilisation objectives. Attention to other non-market objectives such as na-

tional unity, regional employment, cultural identity and economic sovereignty is also relevant to minerals development. In some situations, therefore, the stimulation of mining activity will be seen to be the most efficient policy instrument for attaining objectives such as incremental income and employment, preservation of community life, and diversification of the economic base. Many of these broad goals have been nurtured through explicit regional development policies. The Uruguay Round of GATT negotiations has resulted in changes to the GATT Subsidies Code which recognises that subsidies towards regional development, R&D, and some pollution control equipment are "non-actionable". However, given the differences in political philosophy across nations with respect to the involvement of government in mineral development projects, it is highly likely that

perceived minerals-related subsidies will continue to receive attention in the international trade arena.

Trade-related investment measures

The mining and processing industry today is more global than ever. Countries without significant natural resource endowments are still host to firms which operate in countries that contain significant deposits. Moreover, firms in traditionally strong mineral producing countries with large sources of domestic supply (such as Australia, Canada and the United States) have moved their operations beyond national boundaries in search of new, higher grade deposits and attractive economic opportunities. The liberalisation of investment regimes, commonly as part of structural adjustment policies, has led to a growth of joint ventures between multinational compa-

nies and minitirised state corporations. Developing country firms have also become increasingly involved in joint ventures with firms in other developing countries, Warhurst [21].

Governments in both industrialised and developing countries offer incentives to attract investment (both from domestic or foreign firms) for mineral development projects. Develop-for-import schemes, involving forms of firm-level collaboration, technological transfer, and training assistance are increasingly common. These can be supplemented by other incentives such as the provision of infrastructure, access to state-conducted research, government-secured loans, or favourable tax rates. In many countries, however, governments are also imposing conditions on the way in which mineral development occurs. The primary reasons behind such conditions are socially related – to promote opportunities for employment and economic diversification, and the protection of worker health and the environment. Credit, loan or permit approval may be conditional upon the guarantee that international mining and metal processing firms use best practice technology and techniques, as well as provide adequate training for the local workforce. Environmental protection requirements are another form of conditional constraint on investment, especially when liability provisions are included through bonding mechanisms or when a certain level of performance is required to maintain operating permits.

The most important government fiscal instruments applied to mineral development, which hence can act as important incentives or disincentives to investment, are royalties, corporate tax, additional profits tax, withholding tax on interest and dividends, depletion allowances, various sales taxes, and government equity holding acquired on concessional terms. In most countries corporate tax is the principle form of resource rent extraction. Tax levied on income after deduction of clearly defined production

costs and allowances is often intended to create development incentives, particularly in developing countries.

Sometimes as an investment incentive, private investors may be allowed to write off all pre-operational expenses at a project's outset, rather than charging them incrementally over the project's lifetime. This can be extended to include costly environmental impact assessments and public enquiries. Governments have developed a number of other innovative ways of reducing the tax burden on certain mineral-producing ventures. For instance, they may choose to receive dividends rather than taxes. This type of arrangement is well-suited to the cyclical nature of the metals industry and may improve the competitive position of firms adversely affected during market downswings. Another interesting tax break enables fees for managerial and technical services to be charged and deducted from net profits which are exempt from local taxation, Padmore [14]. A further concession relating to price cycles is the provision for the carrying forward of losses. Mining firms are also often able to take advantage of special provisions concerning exploration and development which in some cases are extended to research and training, in addition to depletion and other development oriented activities. For example, the Canadian government recently decided that environmental performance liability bonds, required for mining operations in some provinces, can be tax deductible [12].

Exploring the environmental implications of liberalised trade for the minerals industry

The discussion above highlights the general point that governments can intervene in minerals production using a range of mechanisms, not typically associated with trade policy, but which currently have important implications in the new era of liberalised trade. Environmental protection in mineral-producing coun-

tries or regions, however, remains very much firm-specific. Empirical evidence generated by the Mining and Environment Research Network, has demonstrated that there is as much variation in firms' environmental practices within countries (operating under a single regulatory regime) as between countries (operating with different regulatory systems), Warhurst [22]. The explanation for this is rooted in the determinants of environmental management practices in the firm. Indeed, the environmental protection strategy of a mining enterprise seems more closely related to its innovative capacity than to the regulatory regime within which it operates, Warhurst [22]. Capacity to innovate, in turn, is related to production efficiency, the entrepreneurial characteristics of the firm's management, access to capital, technological resources and skills, and the broader policy and economic environment in which it operates. This evidence also suggests that technical change is reducing both production and environmental damage costs to the advantage of those dynamic firms which possess the competence and resources to innovate. Such firms include mining enterprises in developing countries, as well as multinational firms. However, the evidence is strongest for large new investment projects and greenfield sites. In older, ongoing operations, good environmental practices correlate closely with production efficiency, and environmental degradation is greatest in inefficient operations working with obsolete technology, limited capital and poor human resource management. The challenge of the liberalised trade paradigm is to ensure the closure of such operations does not involve transferring an environmental legacy to society. If liberalised trade causes high cost operations to close and transfer high externalities, in the form of environmental damage costs, directly to society, then many would argue that it has failed from an environmental perspective. However, if liberalised trade provides an incentive

for mineral-producing firms to improve productive efficiency while internalising and diminishing the environmental externalities associated with their operations, then it can be argued that the paradigm succeeds from an environmental perspective. There is an important role for government, or the appropriate inter-governmental authority, to play to ensure that the latter occurs, rather than the former.

Governments tend to intervene in mineral development projects for a variety of reasons. From an environmental perspective it could be argued this intervention should be away from practices which support the continued operation of high-cost, inefficient operations, towards fostering the development of technological and managerial capabilities to promote organisational and technological change in such organisations. Opening new lines of credit may be an important starting point. The improved production efficiency resulting from such an approach will a priori result in improved overall environment management, including better workplace health and safety. This is starting to occur and the Acid Rain Control Programme in North America is a good example. However, it remains unclear as to how such forms of intervention will be interpreted under the paradigm of liberalised trade due to the concurrent enhanced efficiencies in both economic and environmental performance that would be expected to occur.

Environmental regulation and trade agreements and policies

To a significant extent, the stringency of environmental regulation has compelled firms to innovate and develop more cost efficient production techniques and methods of organisation, sometimes achieving environmental standards above those currently required, Tilton [19] and Warhurst [22]. Crowson [5], Tilton [20] and Warhurst [22] have suggested that

the cost advantages derived by major metal mining firms from lenient environmental policies and standards may be short-lived. Although environmental regulations, like infrastructure and geologic potential, play a role in determining mineral project decisions, most new metal producing technologies are in any case developed to meet stringent environmental standards. Since these techniques also happen to be the most cost effective, often by virtue of their superior energy efficiency, they tend to diffuse throughout the world. As suggested above, governments can assist the diffusion of environmentally efficient equipment and knowledge through carefully crafted trade-related investment measures and other incentives. Even in less regulated developing countries, environmentally-sound technology is being used for minerals production despite the relative lack of stringency in the enforcement of environmental protection legislation, Warhurst [22].

This evidence contradicts the pollution haven hypothesis about world trading patterns, which suggests that international firms will respond to stringent regulation at home by moving the more pollutant parts of their production process to developing countries or by selling their old pollutant technology to developing country firms at discount prices. Mineral-producing firms are also aware that even if current law does not require best environmental practice, it will likely do so in the future. Since the production life of large mining and mineral processing operations can be quite long, it is much cheaper in the long run to avoid retrofitting and introduce environmental best practice into a project at the outset, rather than when controls are inevitably required later on. Furthermore, accumulated environmental liabilities limit the option of firms to sell-out should investment conditions change. Finally, it is important to emphasise that environmental regulation per se may not confer a negative effect on either competitiveness or

the geographical location of facilities. Rather the effectiveness of the regulatory mode, its means of implementation, and contradictions arising from related industrial policy objectives may all combine to influence the investment and operating strategy of the mineral-producing firm. Consequently, years of delay in obtaining project approval, or changeable retrospective regulation, may generate far more serious economic implications for the investment strategy of some mining firms rather than the existence of strict regulatory requirements in themselves.

Although some studies have shown that the effect of environmental regulation on competitiveness is not significant, this view is not shared universally. At the heart of much discussion on the trade-environment question is whether universal environmental standards should be developed and used for trade discrimination purposes. The controversy over such a proposal is two-fold: a view on the part of some developing countries that such standards would automatically add to the trade discrimination currently levied against their exports by consumers in the industrialised countries; and, the question of how and by whom such standards would be set, monitored and enforced. The suggestion that baseline environmental standards be added to trade agreements has also been interpreted by some as evidence of further restrictions levied against the South by the North. Such suggestions do not, moreover, recognise that the environmental effects of mining, and the degree of hazard posed to health and ecosystem stability, is highly site-specific – making it very difficult to apply universal standards. It could be argued, therefore, that the international system of trade in metals would be better served, not by penalising those who do not comply with environmental standards, but rather through the broad acceptance of economic mechanisms which can simultaneously motivate productive efficiency and environmental protection. It is precisely this

issue however which has received limited attention in the environmental discussions concerning liberalised trade.

Recently, environmental regulatory regimes have moved to incorporate the principle of 'Pollution Prevention'. Pollution prevention as an idea is fundamentally appealing but problems have been encountered in its exact definition – especially as to whether it should include recycling. At a very general level pollution prevention simply represents an ideal – that proactive prevention of pollution is more desirable than dealing with its clean-up. The policy challenge, in the context of new trade agreements and market pressures, therefore, is to keep mining firms sufficiently dynamic and to stimulate them to reduce pollution at source, profitably clean-up pollution which 'escapes', and generate a sustainable amount of economic wealth. A central aspect of this policy challenge, therefore, concerns combining the regulation and promotion of industrial activity into integrated policies. Under currently evolving international trade regimes, however, there is some question as to whether such policies and programmes will be interpreted as unfair or as subsidies to industry. In developing countries, particularly, support is occasionally required to help firms through painful periods of plant upgrading or modernisation or to help firms improve environmental protection and comply with environmental regulations. Government support of human resource development programmes and technology transfer schemes may also be a pre-requisite to promote environmentally-sound development efforts in the mining industry. Trade-related measures which challenge these policies could reduce environmentally-sound innovation and might also prove a disincentive to clean-up abandoned mine sites.

From an environmental perspective, liberalised trade could therefore put the brakes on policy initiatives which are only now starting to abandon outmoded

ideas and acquire innovative environmental twists. At the very least, it could make governments wary of intervening in industry in situations where intervention might be the only way to improve environmental protection. The Uruguay Round of GATT did begin to address this issue. As noted above, negotiations resulted in changes to the GATT Subsidies Code which recognise that subsidies for regional development, research and development, and for 20 per cent of the costs of installation of pollution control are acceptable and "non-actionable". However, these mechanisms are predicated upon firms adopting add-on, end-of-pipe pollution control measures and do not address the more intangible issue of promoting technological and organisational innovation to prevent pollution from the outset. Furthermore, it remains ambiguous as to whether government efforts to promote mineral-producing firms to improve their economic position through the acquisition of new equipment and technical and managerial expertise, will be viewed as a non-actionable subsidy. As a consequence, trade-related disputes and decisions concerning various types of government intervention within the sector are likely to be ad hoc until a more substantive discussion is convened.

Conclusions

This paper suggests that the environmental effects of liberalised trade will be most manifest in their effects on the competitiveness of firms. These environmental effects will reflect the socio-economic and policy context within which inefficient operations are forced to close, with concomitant clean-up problems; and, new investment opportunities are created, wherein pollution prevention and resource conservation can be encouraged from the outset. Those producing firms which remain uncompetitive (high cost) in this new competitive environment will likely disappear in the absence of government intervention under liberalised

trade. Moreover, they may put lower-cost more environmentally benign producers out of business. Environmental policies will need to be designed in harmony with trade policies so that competitiveness, production efficiency and innovation are promoted simultaneously; first, to lessen the negative environmental effects of decommissioning and closure; and, second, to optimise the positive effects of the development and commercialisation of new more economically efficient and environmentally proficient technology and environmental management practices.

Currently, trade policy and environmental regulatory policy are in danger of developing in opposing directions. It is increasingly recognised that command and control regulation of the 'polluter pays' mode tends to deal with the symptoms of environmental mismanagement rather than the causes – production inefficiency, obsolete technology, and a lack of capital and trained human resources. However, emerging regulation, particularly that of the 'pollution prevention' mode, by virtue of requiring a reduction or elimination of pollution at source, requires technological and organisational change of traditional production processes. This implies the need for policy to target comprehensively the promotion and regulation of industrial activities – concerns which have previously been separated. Consequently, for pollution prevention to work, policy mechanisms are needed which will promote competitive and environmentally sustainable production from the outset. A new approach to technology transfer stimulated by the recommendations of Agenda 21, will be vital.

Trade liberalisation should also improve market access for those developing countries wishing to sell more diversified, value-added forms of minerals to industrialised countries (through a reduction in tariffs). There is a danger that industrialised countries which have traditionally carried out refining and fabrica-

tion tasks will re-orient efforts towards the development of metal substitutes, but developing countries should see prospects for investment in refining and fabrication facilities improve in the future. Moreover, many trade distortions will undoubtedly continue and it remains unclear whether some of the policy mechanisms discussed here – economic incentives, new lines of credit, the promotion of R&D, taxation reform, etc. could be considered ‘Green Protectionism’ or unfair subsidy. The industrialised mineral-producing countries in particular need to provide some form of incentive to those countries which currently have neither the technical or managerial expertise nor the capital resources necessary to insure that their supply comes from environmentally efficient operations. In such situations, joint ventures between firms in developing countries and technologically advanced firms may prove to be especially valuable and governments (and the international trading system) should make an effort to see that they are properly fostered so that both parties receive economic and environmental benefits.

Finally, this analysis recognises that technological and organisational innovation, which can be stimulated by comprehensive and integrated trade, industrial and environmental policies, can change the broader context within which metals production and subsequently pollution takes place. Who wins a greater share of the world mineral markets will not be those firms that avoided environmental controls (only to be forced later to retrofit and internalise the high costs of having done so), but will be those that used their innovative capabilities to their competitive advantage. Within this context, government policies which assist in promoting efficiency, new investment, new supplier links and new forms of technological collaboration, can assist both to diffuse innovative environmental management practices to developing countries at the same time as re-

ward the innovator, through providing a new set of commercial opportunities, for developing new technology and work practices.

Notes

This article draws on a longer report written for the OECD Environment Directorate, 30 March 1994: “*The Environmental Effects of Current Trade Policies and Liberalisation on Metals Production*” and shorter articles for *The International Review of World Trade and Natural Resources Forum*. The background research was undertaken with assistance from Mr Richard Isnor. The author would also like to thank Diane Milton and Christine Ellis for their help in the preparation of this article.

¹The Montreal Protocol is an international environmental agreement which requires a phase-out of ozone-depleting chemical substances in signatory nations.

²Agenda 21, Paragraph 8.32.

³Export subsidies (those subsidies which favour the export of minerals over domestic consumption) are considered to be the most basic and blatant form of government subsidy. The GATT Subsidies Code specifically calls for the total removal of export subsidies from world trading practice.

⁴The term “dumping” refers to the sale of goods in a foreign market at prices less than those charged in the home market. Alternatively, dumping consists of selling goods in a foreign market at prices less than the total average cost.

⁵One problem with the subsidy question is that a country’s mineral producers may tend to attribute virtually all of their problems to foreign activities - overlooking important factors such as geological quality of resources, domestic macro-economic policy, and technological innovation capabilities. A number of these factors have contributed to the decline of the mining industry in some nations. Declining ore grades, high wages, rigorous environmental regulations, and currency appreciation have been blamed for the competitive decline of the US mining industry in the late 1970s and early 1980s. The US non-ferrous metals producing industry has, as a result, recently emerged from a major industrial restructuring, requiring cost-cutting and the closure of highest cost producers.

References

1. D.L. Anderson, “Implications of the Canada-USA Free Trade Agreement for the Canadian minerals industry”, *Resources Policy*, Volume 14, 1988, p.121–134
2. D.L. Anderson, “Subsidy measurement problems in new mining projects”, *Resources Policy*, Volume 16, 1990, p.162–171.
3. Z. Aydin, “The Role of Major Groups in Implementing Agenda 21”, Paper presented for the International Conference “Striking a Green Deal: Europe’s Role in Environment and North-South Trade Relations”, The European Parliament, Brussels, 7–9 November, 1993.
4. J. Bhagwati, “The case for free trade”, *Scientific American*, Volume 269, November, 1993, p.18–23.
5. P. Crowson, “Copper”, in M.J. Peck, H.H. Landsberg and J.E. Tilton eds, *Competitiveness in Metals – The Impact of Public Policy*, (London: Mining Journal Books, 1992).
6. H. Daly, “The perils of free trade”, *Scientific American*, Volume 269, November, 1993, p.24–29.
7. P. Gallagher, “Problems in access to developed country minerals markets”, *Materials and Society*, Volume 8, 1984, p.505–506.
8. G. Gerin, “Sulphur dioxide control strategies for non-ferrous smelters”, in *Acid Rain Controls and the Economics of the Canadian Non-Ferrous Mineral Industry*, Seminar Proceedings (Kingston, Ontario: Centre for Resource Studies, 1982).
9. M. Hanai, “Formal and ‘Garimpo’ Gold Mining and the Environment in Brazil”, Paper presented at the Third Workshop of the Mining and Environment Research Network, Wiston House, Steyning, U.K., September 14–16, 1993.
10. *Metal Bulletin*, “Brazil proposes new 5 per cent metals import tax,” 13 December, 1993, p.9.
11. *Metal Bulletin*, “Magma wants end to Japan’s copper tariff,” 11, October, 1993, p.19.
12. *Mining Environmental Management*, “Income tax rules for mine reclamation in Canada,” 1(1993), September, p.4–5.
13. M. Onestini, “MERCOSUR and Trade Blocks in Latin America”, Paper presented at the International Conference Striking a Green Deal: Europe’s Role in Environment and South-North Trade Relations, The European Parliament, Brussels, 7–9 November, 1993.



Books received

14. G. Padmore, "Government participation in mining projects: fiscal, financial and regulatory implications for developing countries", *Natural Resources Forum*, Volume 16, No. 1992, p.132-140.

15. D. Palmeter, "Environment and trade: Who will be heard, What law is relevant?", *Journal of World Trade*, Volume 26, 1992, p.35-41.

16. M.J. Peck, H.H. Landsberg and J.E. Tilton, "Introduction", in M.J. Peck, H.H. Landsberg and J.E. Tilton eds, *Competitiveness in Metals - The Impact of Public Policy*, (London: Mining Journal Books), p.3.

17. A. Porges, "Government Subsidies", *Materials and Society*, Volume 8, 1984, p.497-499.

18. E.A. Romagnoli, "Setting the framework for minerals trade", *Materials and Society*, Volume 13, 1989, p. 137-143.

19. J. Tilton, "Changing trends in metal demand and the decline of mining and mineral processing in North America", *Resources Policy*, Volume 15, No. 1, p.12-23.

20. J. Tilton, "Mineral endowment, public policy and competitiveness: a survey of the issues", *Resources Policy*, Volume 18, 1992, p.237-249.

21. A. Warhurst, "South-South Cooperation: Opportunities in Minerals Development", in Lynn K Mytelka (Ed) *South-South Cooperation: In a Global Perspective*, OECD, Paris, 1994.

22. A. Warhurst, "Environmental Degradation from Mining and Mineral Processing in Developing Countries: Corporate Responses and National Policies", OECD, Paris, 1994.

23. A. Warhurst, "Environmental Regulation, Innovation and Sustainable Development", Paper Prepared for the Third Mining and Environment Research Network, Wiston House, West Sussex, UK, 14-17 September, 1993. ■

Australian Mining Industry Council, *Safety Performance of the Australian Mining and Minerals Industry 1993/1994*, Australian Mining Industry Council, P.O. Box 363, Dickson ACT 2602, Australia 1995. Fax: (06) 279 3699. 36 pp. Free except postage.

The Australian Mining Industry Council (AMIC) represents the majority of major companies involved in mining and mineral processing operations throughout Australia. AMIC commissioned this report to demonstrate the mining industry's continued commitment to improving safety, to enhance the changing safety culture and attitudes within the mining industry and the community at large. The report includes three analyses: a review of the Australian mining performance to 1993/94, an international benchmarking comparison and a review of health incidence data for the mining industry as provided by Worksafe Australia.

Barham, Bradford, Bunker, Stephen and O'Hearn, Denis, *States, Firms, and Raw Materials. The World Economy and Ecology of Aluminium*, The University of Wisconsin Press, 114 N. Murray Street, Madison, Wisconsin 53 715 USA 1994. ISBN 0-299-14110-1. 341 pp.

The book offers a closely integrated collection of case studies on aluminium production, blending empirical data with current theories, of the state, the firm, industrial organisation, and industrial development. The contributors consider historical, sociological, economic, and ecological factors affecting the organisational dynamics of aluminium production. The overall project is to determine

the causes and consequences of the organisational dimensions of raw materials acquisition.

Billiton Metals' Lead-Zinc Market Report, Billiton Metals Ltd, 84 Fenchurch Street, London EC3M 4BY, England.

Crowson, Phillip, *Minerals Handbook 1994-95, Statistics and analyses of the World's Minerals Industry*, Globe Book Services, The Mcmillan Press Ltd, Houndmills, Basingstoke, RG21 2XS, UK 1994. ISBN 1-56159-113-0. 328 pp. Price: GBP 75.

Ten summary tables provide data on 50 minerals and such topics as: value of annual production, import dependence, world reserves and reserve bases, world production, productive capacity, secondary production, the adequacy of reserves, consumption, end-use patterns, value of contained metal in annual production, annual average prices for the past five years, and marketing arrangements. Crowson has contributed with a clear compact and accessible account of the world's mineral reserves, a very useful up-to-date reference work.

Crush, Jonathan and James, Wilmot, *Crossing boundaries - mine migrancy in a Democratic South Africa*, International Development Research Centre, P.O. Box 8500, Ottawa, Canada K1G 3H9, IDASA/IDRC 1995. Fax: (613) 563 0815. ISBN 1-874864-12-8. 233 pp.

South Africa's mining industry is in crisis. Retrenchments, cutbacks and rationalisation have resulted in more than 180 000 jobs being lost over six years. This book comes at a time when South Africa's new government of national unity is grappling with the task of transforming labour policy. If the migrant labour system stays, a central tenet of apartheid will be preserved. If it goes, the result will be unprecedented regional hardship. Based on a conference which brought together