



PRIMERA UTILIZACION EN CHILE
DEL SISTEMA DE MOLIENDA AUTOGENA
COMPANIA MINERA DISPUTADA DE LAS CONDES S.A.



The Disputada Mining Co was bought by Exxon in 1978 for 108 M USD. The two mines operated by Disputada, Los Bronces (left) and El Soldado. In Colombia Exxon has opened a major coal mine, El Cerrejo



Exxon Minerals: Big Oil's last stand in mining?

By Al Gedicks

During the last decade the major oil companies have acquired substantial interests in some sectors of the mining industry.

Al Gedicks looks at the background to these investments, the financial results obtained, and the prospects for a continued presence by the oil companies in the mining industry.

Faced with the prospects of nationalization of their supply sources in the Third World and the eventual depletion of their remaining crude oil reserves, the oil companies began searching out profitable areas for diversification. In the mid 1960s they began buying into the mineral industry by acquiring coal and uranium reserves. This trend accelerated after the 1973 jump in oil prices and profits. During this same period, when copper prices were depressed and their stocks undervalued, oil companies bought up copper companies at bargain basement prices (see Table 1). By 1981 Big Oil had major interests in seven of the top ten US copper producers and controlled more than 55 per cent of domestic primary copper production capacity (see Table 2). Seven of the then largest oil companies had investments in minerals, either through acquisition of existing mining companies or through building up their own mineral reserves from scratch.¹

Big Oil viewed mining as a logical extension of their expertise in natural resource extractive industry and as a convenient outlet for their rapidly accumulating cash reserves. Today, however, these same oil companies are scrambling over one another to rid themselves of their unprofitable mining operations. Penzoil has put up its Duval mining subsidiary for sale; Atlantic Richfield (ARCO) has done the same for its Anaconda mining subsidiary, which has lost 785 M USD since it was purchased in 1977. Kennecott Copper Corporation has lost 483 M USD since it was acquired by Standard Oil of Ohio (SOHIO) in 1981. Sohio's Chairman, Alton W Whitehouse, Jr, recently told *Business Week* that "We just aren't going to take Kennecott's losses indefinitely".²

But the biggest loser in Big Oil's diversification into mining may well be Exxon, the world's largest private corporation. The company's minerals division, whose main source of revenues is copper, has

posted losses every year from 1971 through 1984.³ Record losses of 43 M USD were reported in 1980, only to be far surpassed by losses of 112 M USD in 1981 (see Table 3). "Even for a company with an annual net income of some 5.6 G USD in 1980 and 1981", concludes one study, "the mounting losses on minerals activities must be at least psychologically unnerving".⁴ In December 1981, William McCardell, president of Exxon Minerals, announced that "some lower priority (minerals) projects will be re-evaluated and may fall by the wayside".⁵ While he refused to identify specific projects, industry observers believed they included the huge Crandon, Wisconsin zinc-copper deposit, the Mount Hope, Nevada molybdenum deposit, the company's US uranium operations, and the expansion of Exxon's Chilean copper mines.

Exxon Minerals is not the only diversification move that has encountered major problems. In 1979 the company spent 1.2 G USD to buy Cleveland-based Reliance Electric, supposedly because the company had developed an energy-efficient electric motor. *Fortune* magazine has described Exxon's acquisition as "a managerial blunder of epic proportions that has cost Exxon at least 600 M USD. That figure represents the premiums the oil company paid for Reliance in the belief, subsequently proved naive, that the synthesizer was a hot product ready to bring to market."⁶ Nor has Exxon's thirteen year venture into the office automation business fared much better. Exxon Office Systems, a division of Exxon Enterprises, has been unprofitable since at least 1981, when it reported losses of 100 M USD.⁷ Exxon recently announced that it was trying to sell the division.

In terms of its size and scope, however, Exxon's mining operations have received far less attention than these well-publicized failures. A review of Exxon's almost two decades in the mining business may provide some insights into the problems of Big Oil's diversification into mining.

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Diversify or die?

Like the other oil giants, Exxon has been accumulating enormous cash reserves while reducing the size of their domestic oil and gas reserves. Exxon has spent 4.2 G USD on exploration and production since 1973 yet its reserves of crude oil have fallen 20 per cent.⁸ It spent 500 M USD bidding for oil leases in the Baltimore Canyon off the US East Coast but has yet to find any oil. Exxon's investments in the North Sea and Alaska's North Slope are largely responsible for the company's recent profitability. However, as George Baker, an economist with Petroleum Analysis Ltd points out,

"there are predictions that by the 1990s Exxon may have to start liquidating corporate assets if its earnings from devolving oil and gas production can't be reinvested in other areas fast enough."⁹

Exxon's planning for diversification into mining dates back to the early 1960s when they started a domestic uranium exploration program and began buying up coal leases and water rights in the western United States. It is now the fifth largest holder of US coal reserves. The company operates coal mines in Wyoming, Illinois, West Virginia and owns lignite reserves in Arkansas, Montana, North Dakota and Texas. Exxon's Intercor affiliate has recently formed a joint venture with the government of Colombia, South America to exploit one of the richest undeveloped coal fields in the world at El Cerrejon.¹¹

In 1968 Exxon discovered one of the largest uranium deposits in the United States in Wyoming's Powder River Basin. The following year the company formed Exxon Nuclear to find and develop other uranium sources and to fabricate nuclear fuel rods from uranium. Exxon's own top researchers had raised serious questions about the economics of nuclear energy as early as 1977. The company's nuclear division was so upset by the conclusions of this internal company study that it tried

to have it suppressed.¹² By 1981 it had three uranium mines in operation, producing 3.1 million pounds of uranium

concentrates. However, the company's losses on its uranium mining and nuclear activities have been considerable, aver-

Table 1
Mining company acquisitions by oil companies

New parent company	Acquired company	Year bought	Minerals
Cities Service	Tennessee & Miami Copper	1963	Cu
Gulf Oil	Pittsburg & Midway coal	1963	Coal
Conoco	Consolidation Coal	1966	Coal
Occidental Petroleum	Island Creek Coal	1968	Coal
Pennzoil	Duval	1968	Cu, Mo, Ag, Au
Standard Oil of Ohio	Old Ben Coal	1968	Coal
Ashland Oil	Arch Mineral	1969	Coal
Shell Petroleum	Billiton	1970	Cu, Sn, Al
Union Pacific	Rocky Mountain Energy	1970	Coal
Elf-Aquitaine	Le Nickel-SLN (50%)	1974	Ni
Standard Oil of California	Amax (20%)	1975	Cu, Mo, Pb, Zn, Al, Fe, Ni, Coal
Atlantic Richfield	Anaconda	1977	Cu, U, Pb, Zn, Al, Au, Ag, Mn
Louisiana Land & Exploration	Copper Range	1977	Cu, Au
Shell Oil	Seaway Coal	1977	Coal
Union Oil of California	Molycorp	1977	Mo
Exxon	Compania Minera Disputada	1978	Cu
Natomas	Brown Badgett	1978	Coal
Standard Oil of Indiana	Cyprus Mines	1979	Cu, Mo, U, Ag
Superior Oil	McIntyre Mines (53%)	1979	Au, Cu, Ni, U
Atlantic Richfield	Beaver Creek Coal	1979	Coal
Britain Petroleum	Selection Trust	1980	Ni, Cu, Ag, Fe, Zn
Gatty Oil	Plateau Mining	1980	Coal
Murphy Oil	Brilliant Coal	1980	Coal
Tenneco	Houston Oil & Minerals	1980	Coal
Standard Oil of Indiana	Empire Energy	1980	Coal
Gulf Oil	Kemmerer Coal	1981	Coal
Natomas	Trail Mountain Coal	1981	Coal
Standard Oil of Ohio	Kennecott Copper	1981	Cu, Pb, Zn, Mo, Ag, Au
Elf Aquitaine	Texasgulf	1981	Fe, Cu, Pb, Zn, Ni
Du Pont	Conoco	1981	Coal, U
Dome Petroleum	Hudson's Bay Oil & Gas	1981	Coal
Diamond Shamrock	Amherst Coal	1981	Coal
Eapco Services	Kem Coal	1981	Coal
Eapco	Earth Resources	1981	Ag, Au
Getty	Energy Fuels Corp	1981	Coal
Occidental Petroleum	Cities Service	1982	Cu, Mo, Zn

Source: Atlantis, Inc. *Big Oil's Move Into Mining*, 1983.

aging 23 M USD per year for the 1970s. Exxon Nuclear lost 32 M USD in 1980 and 50 M USD in 1981.¹³ The company stopped production at its Highland, Wyoming uranium mines in 1982 and postponed further investment in the development of a major uranium deposit at Mid-west Lake, Saskatchewan, Canada. Esso Exploration and Production, Australia also withdrew from a joint venture to develop the Yeelirrie uranium deposit in Western Australia with Western Mining and Urangesellschaft.¹⁴

Base metals mining

Exxon's entry into base metals mining has been through exploration and leasing as well as direct acquisition of existing mining companies. The company's most significant exploration success was the discovery of a 75 Mt zinc-copper deposit, averaging 5 per cent zinc and 1 per cent copper, near Crandon, Wisconsin in 1975. Its most important acquisition was the 1978 purchase of Chile's Compania Minera Disputada de las Condes from the

military dictatorship of General Augusto Pinochet. Both projects are technologically complex but fulfilled Exxon's corporate need for "mega projects" – large, expensive ventures that promised enormous profits.

Chilean copper

Exxon bought Disputada for 112 M USD and immediately announced a 1.2 G USD program to expand the rich open pit at Los Bronces into Chile's third largest mine (after Chuquicamata and El Teniente) and one of the half-dozen largest copper mines in the world. The plan called for Los Bronces to increase its ore-processing nine-fold to produce 250 kt of copper a year. Exxon anticipated that this expansion could account for about 75 per cent of Exxon Minerals' operating earnings by 1990.¹⁵ The company was guaranteed a cheap labor force thanks to the repressive measures administered by the Pinochet regime. Moreover, an accelerated depreciation tax clause would have exempted it from paying any taxes for 10 years.¹⁶

Despite this "favorable investment climate" the project risks are enormous. The Los Bronces expansion is considered one of the most difficult technological undertakings in mining history. The deposit is 14,000 feet high in the Andes mountain in an avalanche-prone snow belt. The project also requires a 20 mile long tunnel cut through the mountains to carry the ore down to a mill – an unprecedented feat in the mining world.¹⁷ In 1978 an avalanche destroyed the already operating pits and the concentrator. It took 13 months to get the operation going again.

Meanwhile, project costs have soared from 1.2 G USD to 3 G USD. After investing 350 M USD in Disputada, it has lost money on the project every year, including 77 M USD in 1981 and 66 M USD in 1982.¹⁸ Allen B Hollett, a former Exxon Minerals vice president, blames the Disputada fiasco on the company's atti-

Table 2
Oil firms in the copper business

Copper Producer	Acquiring oil company	Date of acquisition	Current annual copper mine capacity (short tons)
Tennessee and Miami Copper	Cities Service	1963	95,000
Duval Corporation	Penzoil	1968	135,000
Anaconda	Atlantic Richfield	1977	200,000
Copper Range	Louisiana Land	1977	80,000
Cyprus Mines	Standard Oil of Indiana	1979	125,000
Amex	Standard Oil of California	1981	60,000
Kennecott	Standard Oil of Ohio	1981	450,000

Source:
Simon D Strauss, *The New York Times*, 1981-04-12.

Table 3
Exxon minerals earnings (losses) by segment, 1977–1981 (M USD)

Segment	Year				
	1977	1978	1979	1980	1981
Coal mining & development	(6)	(20)	(13)	3	11
Uranium mining & nuclear fuel fabrication	(30)	(51)	(25)	(32)	(50)
Minerals mining & development	(9)	(23)	(28)	(43)	(112)
Total	(45)	(94)	(66)	(72)	(151)

Source:
Exxon.

tude that "projects have to be Exxon size". Some of Exxon's own engineers had urged going into the project on a much smaller scale by expanding the smaller and less costly El Soldado deposit.¹⁹ Exxon's current plans for Los Bronces have been scaled down considerably and the 20 mile long tunnel has been scrapped in favor of a slurry pipeline. Total project costs are now estimated at 1 G USD but a final decision to go ahead has not yet been made.²⁰ Technological and financial considerations notwithstanding, the growing democratic opposition to the Pinochet regime makes Exxon's investment in Chilean copper highly uncertain.

The Crandon Deposit

The oil giant's preference for huge, expensive projects rather than the smaller undertakings appropriate for starting up new mines is evident at Crandon, Wisconsin as well. "By the mid 1980s", states the *Engineering and Mining Journal*, "Exxon may become a significant producer of copper and zinc at facilities based on the massive sulphide deposit discovered by the company at Crandon, Wisconsin".²¹ Exxon has described the deposit as one of the 10 largest known metallic sulphide deposits in North America.

As in Chile, the technological risks are enormous. The deposit rests at the headwaters of the Wolf River watershed, a large drainage area that supports unique and delicate habitats, such as trout streams, wild rice lakes and bogs. The upper Wolf River is designated wild and scenic. Out of an estimated 75 million metric tons of ore Exxon plans to mine and mill, only about 14 per cent would be usable concentrate. The remaining 86 per cent of waste rock would be discharged as finely ground tailings. Exxon proposes to store the tailings, containing an estimated 31 million cubic yards of iron pyrites, within embankments more than 90 feet tall, covering 600 acres. A company engineer once pointed to the

terrain map of the mine and said that, from the standpoint of the wetlands, the ground water and the overall topography, "You couldn't find a more difficult place (in the world) to mine".²²

Exxon originally contemplated a "dry" mine until drilling revealed that the ore body wasn't as solid as first thought. The company has consistently underestimated the potential for mine inflows from the groundwater. Early estimates called for dewatering the mine at the rate of 2 000 gallons per minute (gpm). The latest figures now place the amount at 3 700 gpm or 5.3 million gallons per day. This is not the first time Exxon Minerals has encountered this problem. Esso Minerals (Canada) started production at its Gays River, Nova Scotia lead-zinc mine in 1979 amid recurring flooding problems from both surface and groundwater sources.²³ Esso suspended production at the mine in 1981 because of heavy inflows of water.

The proposed underground mine at Crandon is not only technologically complex but is also highly visible in a socio-political sense. Exxon Minerals has generated considerable local opposition to the project from both Indian and white landowners adjacent to the mine because of environmental effects. Local landowners are concerned that the cone of depression that will be created around the mine from constant dewatering will lower the water table and dry up the area's lakes and wells. Exxon responded to these concerns by saying that nearby lakes were "perched" above the water table and thus would be unaffected by the water drawdown. The Wisconsin Geological Survey disagreed; they chided Exxon for ignoring all the evidence of the interconnection of the lakes and groundwater.

The Sokaogon Chippewa Indians, whose reservation is just two miles from the mine site, are concerned that the mine-dewatering will affect their wild rice lake, the tribe's most important resource. Wild rice is a traditional source of food, a

cash crop and an important part of Chippewa religious rituals. Tribal leaders were insulted when Exxon's biologist expressed his amazement at why there was so much concern about those "lake weeds".²⁴ Studies done by tribal consultants show that water removed from the mine could drop the water level of the rice lake — which is now only 5 or 6 feet deep — and endanger the rice beds.

After almost 10 years of project planning the Crandon mine faces further delays due to unresolved engineering problems (mine dewatering, tailings disposal) and an increasingly vocal citizen-tribal opposition in the local area. Robert Russell, Exxon's longtime Crandon project manager, was forced to resign last year as it became clear he was incapable of handling the growing local opposition.²⁵ At the same time, project costs have soared from 350 M USD to over 1 G USD. These delays could doom the project since there are richer, less expensive zinc deposits which, if brought into production, could saturate the already depressed zinc market. Comico's Red Dog deposit in Alaska, for example, may be the largest and richest undeveloped zinc-lead deposit in the world. Reserves are estimated at 77 Mt averaging 17 per cent zinc and 5 per cent lead. Cominco, one of the world's largest producers of lead and zinc, anticipates a start up date of 1988 at a cost of 350–400 M USD for an open pit operation.²⁶ Exxon's mine permit application for the Crandon project is tentatively scheduled for a contested case hearing before the Wisconsin Department of Natural Resources in 1987.

Exxon Minerals originally planned to enter the base metal mining business by developing its Pinos Altos, New Mexico copper-zinc deposit, discovered in 1972.²⁷ It is a far less complex mine than Crandon and would have operated at about one-fifth Crandon's capacity. The company had completed an environmental base line study and submitted it to the local US Forest Service in support of its

Exxon geologists examining a core sample from the copper-zinc mine, near Pinos Altos, New Mexico. The mine was sold to Sweden's leading private mining group, Boliden, in 1982.



application to begin test mining. A preliminary feasibility study indicated that Pinos Altos was economically feasible.²⁸ Test mining was scheduled for 1982. Then, in February, 1981, Exxon Minerals unexpectedly announced its withdrawal from the project. An Exxon spokesperson

said the decision followed a corporate reorganization which gave the project a lower priority.²⁹ Sweden's Boliden acquired the property from Exxon in 1982.

Exxon's withdrawal from the Pinos Altos project seems to confirm predictions made by mining industry executives

that smaller projects which are important to the operation of mining companies may not be pursued if these projects have to compete with other budgetary demands within a huge oil conglomerate.

Synfuels

Exxon entered the oil shale mining business in May 1980 by acquiring Atlantic Richfield's 60 per cent interest in the Colony oil shale project in Colorado for 400 M USD. The Colony project, which uses technology developed by Tosco (the 40 per cent owner of the project), is designed to produce 47,000 barrels per day of premium synthetic crude by 1985. The project fits Exxon's corporate need for diversification into an area comparable in size to oil. "This is a risk-taking venture with high front-end costs", said Clifton Garvin, Exxon's chief executive. "But the country needs a big industry and we feel it is the right time for us."³⁰

Exxon's plan called for an open pit mine 3.5 miles long and 1.75 miles wide — larger than any mine in the world today. The oil-bearing rock would be mined at a rate of 650 feet per year, or a total of 9 miles during the 75 year life of the mine. The rock would then be crushed, heated and the oil extracted. The project would employ about 22,000 miners and about 8 000 in the processing plant.³¹ Initial costs of the project were estimated at 2 G USD.

In June 1980 Clifton Garvin presented his company's plan for shale oil production at a closed meeting of the Business Roundtable, a group of chief executives of the nation's largest corporations. Exxon's projections, contained in its report, "The Role of Synthetic Fuels in the United States Energy Future", pointed to the decline of conventional oil and gas reserves and suggested that only synthetic fuels could fill the energy gap. The two major sources of synthetic fuels, according to Exxon, were oil shale and coal.

Garvin outlined a plan that would turn

Colorado into the center of a 500 G USD oil shale industry. Exxon envisioned building 150 plants in Colorado capable of producing 8 million barrels a day of synthetic fuels by 2010. The *Wall Street Journal* described Colorado officials as "up in arms over Exxon's proposal".³² A spokesperson for Governor Richard Lamm called the Exxon proposal "unrealistic", adding that Exxon didn't consult with state officials before announcing its plan.

Once again, Exxon underestimated the technological risks of the project. D Roger Loper, president of Chevron Shale Oil Company, told a hearing before the Colorado Energy Coordinating Advisory Committee that "there is no proven process which produces shale oil from rock in anything like commercial quantities. The difficulties of handling many thousands of tons of shale through processing steps requiring heating of the entire mass to 900 degrees Fahrenheit, capturing the vapors, and cooling and disposing of the spent shale are enormous."³³

Nor did Exxon give much thought to the social and environmental consequences of this project. Oil shale mining would completely transform the landscape of two isolated counties in northwest Colorado, where much of the US oil shale reserves are located. After holding hearings on the Exxon plan, Colorado Senator Gary Hart concluded that it "would have devastating effects on Colorado. It would use all the water available in northwestern Colorado and take more from other states. It would require each year, five times as much mining – in just two counties – as all of the coal mining in the nation last year. It would produce a regional 'brown cloud' 15 times as thick as Denver's, and it would increase the number of people from a few tens of thousands to almost two million."³⁴

Public opposition soon manifested itself when the Colorado West Area Council of Governments (CWACG) objected to Exxon's request to the federal government to trade some private leases in

northwest Colorado for federal acreage to form a more economical mining unit for its Willow Creek project. The CWACG opposed the trade because the development would reduce government revenues, decrease the economic diversity of the area, and fail to provide funds to assist local government in mitigating the negative effects of such development.³⁵

In February, 1982 the *Engineering and Mining Journal* reported that Exxon had no intention of curbing back its capital budget for the Colony project, despite its cutbacks on other mining projects. Three months later, in May 1982, Exxon shocked Colorado and the synthetic fuels industry by announcing that it was withdrawing from the Colony oil shale project. Randal Meyer, president of Exxon Company, USA, said estimates which set the cost of the project at 2 G USD to 3 G USD had doubled while oil prices had fallen.³⁶ Counting the money Exxon had agreed to pay Tosco if it pulled out and the cost of developing the site, some estimates have placed Exxon's loss at more than 1 G USD.

Conclusion

After almost 20 years experience Exxon Minerals has yet to demonstrate that Big Oil's expertise or large cash reserves are a guarantee of success in the mining business. While both industries involve extraction, depend on exploration, and are highly capital intensive, there are some fundamental differences between the two. First, the development of mineral resources takes more time, and discovery of new supplies is more difficult. Second, the demand for minerals is more cyclical than the demand for oil. Moreover, the widely predicted minerals shortage failed to materialize. Third, the pay back period for mineral resources is three to four times as long as that of oil. Whereas an oil well starts contributing revenues almost immediately, a mine may not start contributing revenues until 5 or 10 years after construction begins. Oil company man-

agements tend to stress higher and faster rates of return on investment than traditional mining company managements. When Exxon's Clifton Garvin was asked if his company's non-energy businesses could ever prove as profitable as oil and gas, he replied: "We're not interested in being in businesses long-term don't meet the kinds of return criteria we see in oil and gas . . . if you can't see results in a two-to-four-year period, then you'd better start reexamining your hole (sic) card."³⁷

Finally, a mining company's operations are much more visible, in a socio-political sense, than that of an oil company. Mining, by its very nature, constitutes an assault upon the physical, cultural and economic environments of resource-rich areas. "Therefore", according to Dr Warnock Davies, a consultant to multinational corporations, "mining companies have a very different socio-political vulnerability pattern than oil companies, even though both are extracting nonrenewable resources".³⁸ This is clearly the case for mining investments in the Third World, but it is also true for investments in "politically stable" areas, such as the United States, where the mining of lower grade ores produces large volumes of waste which scar the landscape and pose serious environmental and health problems. The environmental and social costs of Exxon's Crandon zinc-copper mine or Colorado oil shale mining are visibly dramatic and encourage public opposition that may delay projects, increase the costs for pollution abatement technology and social impact mitigation or result in the cancellation of such projects.

Rather than recognizing this vulnerability and spreading investment risks over both large and small projects, Exxon Minerals has adopted its parent company's preference for mega projects like Crandon zinc-copper, Chilean copper and Colorado oil shale. The technological risks of such large scale projects have been consistently underestimated. This

has led to lengthy delays, soaring project costs and the cancellation of some projects. For any other company besides Exxon these miscalculations would have spelled disaster. Even if Exxon remains in the mining business it is unlikely that Exxon Minerals will ever contribute a significant share of Exxon's earnings.

Notes:

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² "The Death of Mining: America is Losing One of its Most Basic Industries", *Business Week*, 1984-12-17, p 70.

³ Atlantis, Inc, *Big Oil's Move Into Mining*, McGraw-Hill Publications Company, Washington DC, 1983, p 137. For 1983-84 figures see *Wall Street Journal*, 1985-01-25.

⁴ *Big Oil*, *op cit*, p 140.

⁵ "Exxon Minerals May Shelve Many of its 'Expensive' Minerals Projects", *Metals Week*, 1981-12-28. See also, "Exxon Will Shift Funds from Minerals to Oil/Gas in 1982 Spending", *Engineering and Mining Journal*, vol 183 no 2 (February 1982), p 55.

⁶ Lewis Beman, "Exxon's 600 M USD Mistake", *Fortune*, 1981-10-19, p 68.

⁷ "What's wrong at Exxon Enterprises", *Business Week*, August 24, 1981, p 87. See also "Exxon Trying to Sell Office-System Unit", *Wall Street Journal*, 1984-11-29.

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⁹ Jack Egan, "Profits Don't Comfort Exxon as it Seeks New Investments", *Washington Post*, 1978-10-16.

¹⁰ James Flanigan, "Does Exxon Have a Future?", *Forbes*, 1977-08-15.

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¹³ *Big Oil*, *op cit*, p 128.

¹⁴ Both the Saskatchewan and Australian uranium deposits are located on native and Aboriginal lands. See "Australian Uranium Connection", *Pacific Research*, vol 10 no 1 (First Quarter, 1979); Robert Regnier, "Uranium in Saskatchewan: Grass-roots Alliance Fights New Mines", *The Global Reporter*, v 1 no 4 (Spring 1984), p 7.

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¹⁶ Jackson Diehl, "Exxon, Others See Projects Sour in Chile", *The Washington Post*, October 1982.

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¹⁸ *Engineering and Mining Journal*, vol 184, no 4 (April 1983), p 104.

¹⁹ Shao, *op cit*.

²⁰ John R Burger, "Exxon Trims Chile Copper Plans to Fit Cost Escalation", *Engineering and Mining Journal*, vol 186 no 2 (February 1985), p 32.

²¹ Robin Neesham, "Exxon Emerging as a Major Mining Firm", *Engineering and Mining Journal*, vol 179 no 7 (July 1978), p 55.

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Mine Newest Nova Scotia Lead-Zinc Producer", *Canadian Mining Journal*, vol 101 no 4 (April 1980), p 69.

²⁴ *An Analysis of the Socio-Economic and Environmental Impacts of Mining and Mineral Resource Development on the Sokaogon Chippewa Community*, vol 1, COACT Research, Inc, Madison, Wisconsin (1980), p 461.

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²⁶ *Mining Engineering*, January 1985.

²⁷ Neesham, *op cit*, p 57.

²⁸ "Exxon's Pinos Altos Cu-Zn Prospect Nears an Active Test Mining Stage", *Engineering and Mining Journal*, vol 181 no 9 (September 1980), p 35.

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³¹ "Shale Oil - An Idea Whose Time Has Come, Exxon Tells Colorado Group", *Engineering and Mining Journal*, vol 181 no 10 (October 1980), p 35.

³² Bill Paul, "Exxon's Plan for Huge Oil Shale Project In Colorado Draws Strong Protest There", *Wall Street Journal*, 1980-06-18.

³³ *Engineering and Mining Journal* (October 1980), *op cit*.

³⁴ John Judis, "Rocky Mountain Lows", *In These Times*, 1981-09-16/22.

³⁵ "Local Government in Colorado Opposes Exxon Land Swap", *Engineering and Mining Journal*, vol 181 no 6 (June 1980).

³⁶ "Exxon Shocks the Synfuels World; Colony Pullout Leaves Workers, Western Colorado Towns in Haze", *Mine Talk*, vol 2 nos 1-2 (Summer/Fall 1982).

³⁷ Richard I Kirkland, Jr, "Exxon Rededicating Itself to Oil", *Fortune*, vol 110 no 2 (1984-07-23), p 31.

³⁸ "Managing Political Vulnerability", *Engineering and Mining Journal*, vol 183, no 2 (February 1982), p 88. ■