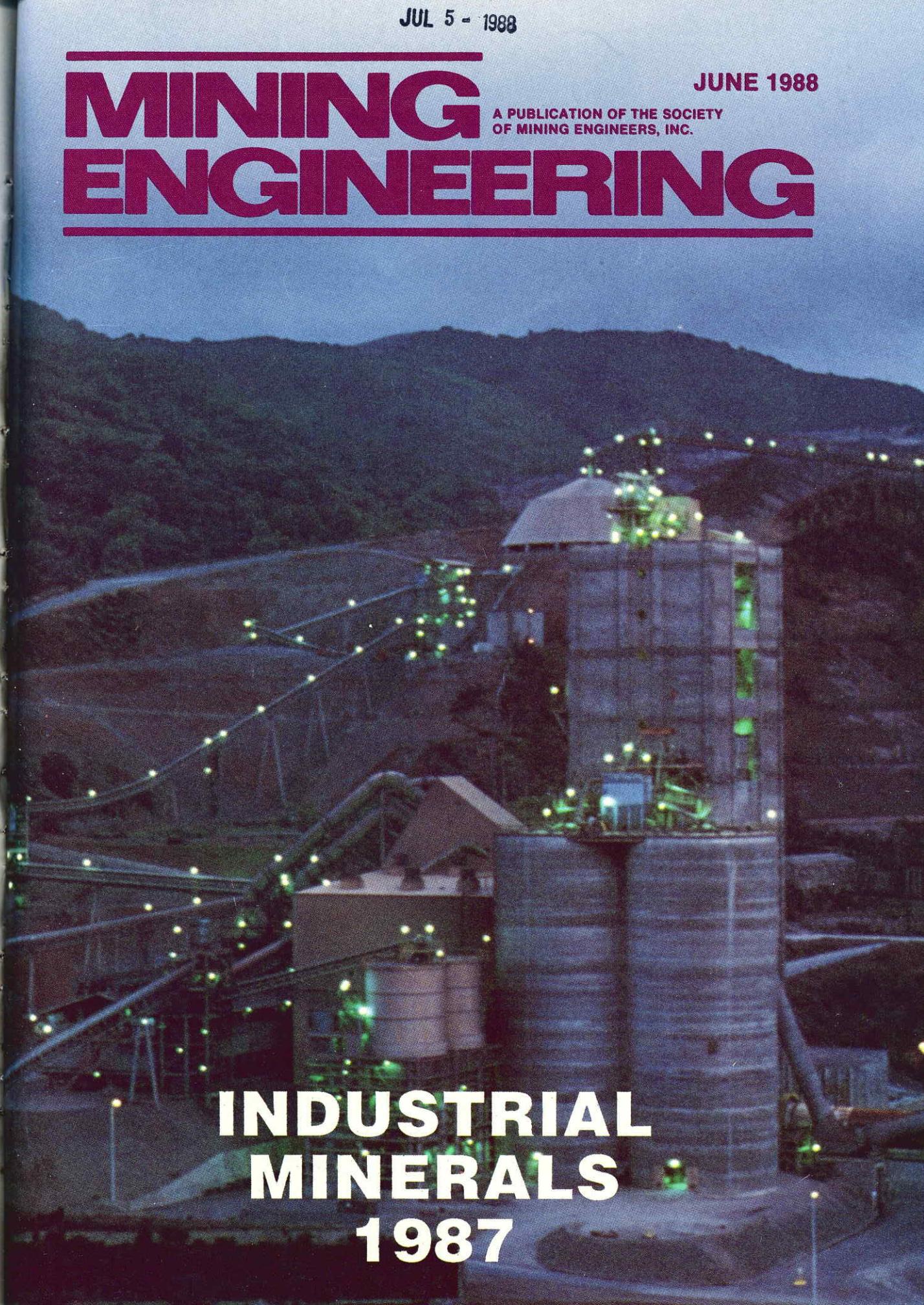


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# MINING ENGINEERING

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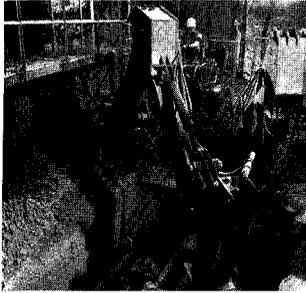


**INDUSTRIAL  
MINERALS  
1987**

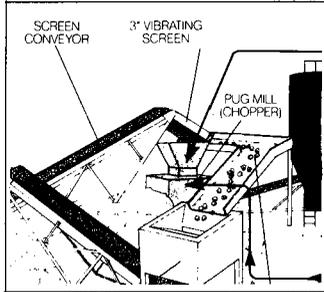
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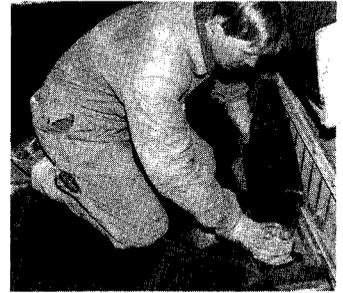
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Cover photo is of the Kaiser Cement Corp. Permanente plant near San Jose, CA. The review of 1987 industrial minerals activity begins on page 415.

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st). Its average value was \$117.15/t (\$106.28 per st) cif, delivered on-board barge or railcar, Burnside, LA.

China supplied 58% and Guyana 42%. Imports of other grades of calcined bauxite, primarily for the abrasives market, totaled 43 kt (47,000 st). They were supplied by Guyana (52%), China (24%), Australia (13%), and Suriname (10%), at an average value of \$74.75/t (\$67.80 per st), cif, US ports.

Alumina production from the four Bayer refineries operating in the United States last year was estimated at 4.2 Mt (4.6 million st), a 35% increase compared with 1986. Yearend 1987 capacity was about 4.6 Mt (5 million st), or a capacity use of 91%.

None of the 581 kt (640,400 st) of bauxite produced by US companies in 1987 was used in the production of primary aluminum metal. Estimated world production of alumina last year was 33.3 Mt (36.7 million st). Of that, the US produced about 13%.

Alumina imports for the year, including 19 kt (20,900 st) of aluminum trihydrate (as calcined equivalent) were 4 Mt (4.5 million st) valued at \$148/t (\$134 per st) cif US ports. The quantity imported was substantially greater than in 1985 or 1986. Australia supplied 83%, Suriname 8%, Venezuela 3%, and Jamaica 2% of the alumina.

It appears likely that the surge in demand for cell grade alumina that began in the last quarter of 1987 in response to increased primary aluminum output will continue at least into the third quarter of 1988.

There were no additional or withdrawals of bauxite from the National Defense Stockpile in 1987.

World bauxite production increased in 1987 to an estimated 86.4 Mt (95.2 million st) compared with 85.9 Mt (94.7 million st) in 1986. The major producers were Australia (39%), Guinea (14%), Jamaica (9%), and Brazil (8%).

Estimated world alumina production in 1987 was 33.3 Mt (36.7 million st), a gain of about 4% over 1986. Principal world producers were Australia (30%), United States (13%), USSR (11%), Jamaica (5%), and Suriname (4%).

In the final step toward a verti-

cally integrated aluminum industry, Venezuela's Bauxiven shipped, more than 134 kt (148,000 st) of bauxite from Los Pijiguaos mining operation down the Orinoco River to the Interalumina refinery at Ciudad Guayana. Shipments in 1988 are expected to reach 600 kt (661,000 st).

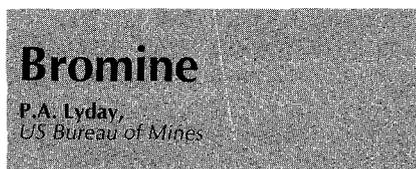
In Brazil, Mineracao Rio do Norte reported a record 1987 sale of 5.3 Mt (5.8 million st) of bauxite from the Trombetas mining operations.

Suralco, a Suriname subsidiary of the Aluminum Co. of America, was forced to import bauxite from Brazil and the Dominican Republic to supply the Paranam alumina plant. This was due to anti-government forces closing the

company's local bauxite mines at Moengo from November 1986 to September 1987.

In Western Australia, Worsley Alumina Pty. Ltd. poured its first gold bar in August 1987 from gold ore recovered from the Bod-dington bauxite mining operation.

Final agreement was reached between Greece and the Soviet Union on a new 600 kt/a (661,000 stpy), \$US550 million, alumina plant. Site preparation reportedly began late in 1987 near Thisvi, about 72 km (45 miles) west of Athens. The USSR was to supply equipment and engineering technology for the plant and is expected to purchase the entire output. ■



The US produced 36% of the 386 kt (425,000 st) of bromine produced in the world during 1987. Israel followed with 28%; the USSR, 18%; the UK, 8%; and other countries, 10%. Five US companies operated eight plants in Arkansas and Michigan.

Ethyl Corp. purchased the bromine assets of Dow Chemical. This included all brine field leases located in the Magnolia area of Arkansas, distribution equipment facilities and inventories around the world, and certain patents pertaining to Dow's bromine chemical technology. The agreement excluded a calcium bromine plant that was being sold under a US Department of Justice consent decree.

Dow closed brine operations in Midland, MI, which included one bromine plant. Dow continued to produce bromine from a plant in Mason County, MI.

Ethyl Corp. operated two plants in Magnolia County, AR. Great Lakes Chemical operated four plants in Union County, AR. This included a joint venture with PPG Industries Inc.-Arkansas Chemicals Inc. Morton Thiokol operated a plant in Manistee County, MI.

Total US nameplate capacity was 263 kt (580 million lbs).

Plant capacity does not reflect production capacity, which depends on brine supplies, concentration of the bromine in the brine, and individual plant extraction processes.

Bromine was being tested for leaching gold. About 20 small operators were believed to use a bromine reagent, which was recyclable.

Flame retardants represent about 30% of bromine consumption. Bromine is used as a synergist that enters into chemical reactions with antimony, ferric oxide, zinc oxide, and zinc borate during burning to produce a fire retardant product.

The Brominated Flame Retardant Industry Panel (BFRIP) is a group of bromine producers that continued research on decabromodiphenyl oxide and antimony oxide in high impact plastic styrene formulations that were reported in the Federal Republic of Germany to produce dioxins and furans when decomposed thermally.

A voluntary action by the German Verband Der Chemische Industrie to reduce and possibly eliminate the use of brominated diphenyl oxides in plastics was announced. BFRIP formulated a program to develop toxicity data and a test protocol for further evaluation. Studies are currently underway on the second phase of the program.

Ethyl Corp. reported a 2-cent price increase for elemental bromine to \$0.89/kg (\$0.40 per lb) effective Jan. 1, 1988 for bulk shipments.

Kali und Salz AG reported production of bromine from the bitterns of mined potash production at one mine at West Germany's Salzdettfurth mine. Capacity was reported to be 2.3 kt (5 million lb per year).

Brines in Alberta, Canada, reported a contained bromine content at 2800 parts per million. The brines occur in the Upper Devonian Beaverhill Lake formation in the south, and the Middle Devonian Elk Point group in the north.

The production of bromine at the Laizhou Bromine Works, Jinan, Shandong, China, continued from underground brine deposits. Brine reserves were estimated at about 600 Mm<sup>3</sup> (21 billion cu ft) containing around 363 Mt (400 million st) of salt. Bromine concentrations of the brine, however, were not available.

In Japan, bromine was produced from seawater by Toyo Soda Manufacturing Co. Ltd. at a 20-kt/a (44-million lb per year) plant at Tokuyama. Asahi Glass Co. Ltd. also produced bromine at a 4-kt/a (9-million lb per year) year plant at Kitakyushu. ■

## Boron

J.C. Norman,  
Geraghty and Miller Inc.

The United States was the world's largest producer and consumer of boron compounds during 1987. Boron mineral concentrate and chemical production in the US totaled an estimated 1.37 Mt (1.5 million st) last year for an estimated value of \$440 million. This was up from revised 1986 values of 1.25 Mt (1.4 million) and \$426 million, but slightly down from 1985 value of about \$447 million. The US still provides essentially all its own boron while maintaining a strong position as a source of sodium borate products and boric acid to foreign markets.

Domestic employment in the mining and beneficiation of boron products decreased about 3.8% in 1987 to about 1250 people.

Total world production of boron products in 1987 was estimated by the US Bureau of Mines at 1.2 Mt (1.3 million st) B<sub>2</sub>O<sub>3</sub>. This corresponds to an estimated total

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The US still provides essentially all its own boron while maintaining a strong position as a source of sodium borate products and boric acid to foreign markets. The outlook for US boron is for an average 3.2% growth through 1990.

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mineral concentrate and chemical tonnage of about 3 Mt (3.3 million st).

### Production

Mines and processing operations in southern California are the only current domestic sources of boron mineral concentrates and chemicals.

US Borax and Chemical Corp. operates a large open pit kernite and tincal mine at Boron, CA. It produces boric acid and borax products. Kerr-McGee Corp. produces boric acid and borax products as coproducts from chemical operations at Searles Lake, CA.

US Borax and Chemical Co. is the world's largest producer of boron minerals and refined products. USB mines tincal and kernite ores from a massive open pit operation located about 160 km (100 miles) northeast of Los Angeles.

Tincal is used to produce sodium borate ore concentrates and refined products. The ore body contains some ulexite and colemanite, which are mined along with the sodium ores, but are not marketed by USB. A processing plant near the mining operation uses kernite ore to manufacture boric acid. Boric acid capacity is estimated at about 160 kt/a (176,000 stpy). Total product capacity is about 660 kt/a (728,000 stpy) B<sub>2</sub>O<sub>3</sub>.

Occasionally, kernite is hydrated for use in producing refined sodium borate products. A second processing plant located at Boron uses kernite to produce a technical grade boric acid to compete with imported colemanite in glass manufacturing markets.

Reserves of sodium borate ores in the Kramer ore body have been reported by the Bureau of Mines at 140 Mt (154,000 st) at 25% B<sub>2</sub>O<sub>3</sub>.

Kerr-McGee Chemical Corp. recovers borates from two chemical plants at Searles Lake. Borates are recovered as coproducts along with other salts from the lake brines.

The brines of Searles Lake have been estimated to contain 40 Mt (44 million st) of sodium borate. Of that amount, about 11 Mt (12 million st) of B<sub>2</sub>O<sub>3</sub> are recoverable. Total productive capacity at the Searles Lake facility is reported to be about 115 to 130 kt/a (127,000 to 143,000 st) of boron-bearing products, containing about 62 to 75 kt (68,000 to 83,000 st) of B<sub>2</sub>O<sub>3</sub>.

American Borate Co. mines and mills shut down in 1986. The mine that was the sole domestic supplier of colemanite — a calcium borate mineral — ceased operations in early April and the last production from the mill took place in June 1986.

The grinding and packaging plant at Dunn, CA continues to operate as a custom grinding facility for talc, clays, volcanic rock products, and zeolites. The stated reasons for ceasing borate production were the strong US dollar and the increased world supply of borates. Now Turkey's Etibank is the sole major world supplier of colemanite.

ABC continues to import and market Turkish borate ores and refined products, including colemanite, ulexite, Etibor 46, and boric acid, in the US and throughout the world. Imports are received at either Norfolk, VA or Charleston, SC for processing and distribution from its east coast facilities. ABC reported higher import volumes in 1987.

### Other US developments

Mountain States Engineering and Blackbird Resources formed a joint venture to build a semi-commercial plant at the Hector deposit near Barstow, CA. The plan is to confirm the viability of the in situ acid leaching of colemanite and subsequent recovery of boric acid and possibly calcium sulfate.

The consortium is completing a feasibility study. The next step is reported to be the construction of a 10-kt/a (11,000-stpy) semi-commercial boric acid plant. Reported reserves of the deposit are 147 Mt (162 million st) at 6% B<sub>2</sub>O<sub>3</sub>, using 5% B<sub>2</sub>O<sub>3</sub> as a cutoff grade.

Anaconda Minerals is marketing its rights to the southern section of Searles Lake, which adjoins the Kerr-McGee operation.

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