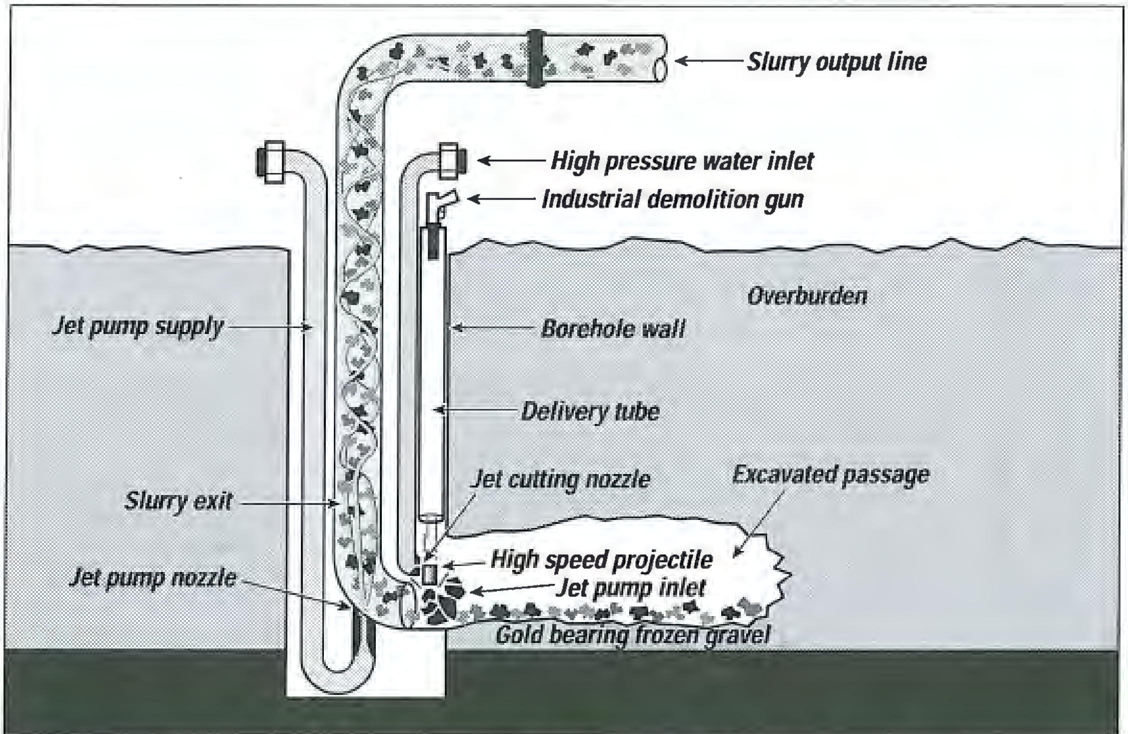

Figure 1.—Borehole placer miner excavating gold-bearing permafrost gravel

Prototype borehole miner selectively extracts gold from permafrost

Objective

Assess the technical feasibility of mining small and/or deeply buried frozen placer deposits from the surface through boreholes.

Approach

Placer deposits in permafrost often contain up to 15% cobbles and boulders. Because of erratic loading on the bit caused by elasticity and heterogeneity of the ice-and-gravel matrix, these deposits are extremely difficult to excavate. The approach taken in this research project was to mine only the ore-bearing portion of the deposit using a high-pressure water jet to thaw the gravel and a downhole hydraulic-lift-type pump to bring the ore to the surface as slurry.

Full-scale jetting tests in frozen gravel were completed, and the data were used to design a jet excavator. The excavator will deliver a water flow of 890 liters/min. (235 gal/min.) through a 15.7 mm (0.62-in) dia. nozzle at 6,900 kPa (1,000 psi). It can excavate -4° C (25° F) permafrost at a rate of approximately 9 mt/h (10 st/h) and drive a 0.1-m^2 (1-ft^2) horizontal heading a distance of 4.6 meters (15 ft) in approximately 10 min. The prototype slurry pump was designed to lift minus 15-cm (minus 6-in) gravel to the surface from a depth of 15 meters (50 ft).

How it works

The prototype borehole placer miner is shown schematically in figure 1. The mining sequence is as follows. Two borehole placer miners are placed in boreholes approximately 7.5 meters (25 ft) apart. Each miner cuts a long, horizontal passage approximately 0.1 m^2 (1-ft^2) in cross section toward the other miner until the two passages meet. The cutting jet of one miner forces slurry toward the inlet of the slurry pump on the second miner at high velocities, which keeps the gold in suspension. The slurry pump then lifts the slurry to the surface. The jetting and pumping sequence alternates between the two boreholes until the ore-bearing horizon is mined out. If a large cobble clogs the inlet, a vacuum sensor alerts the operator, who can fire a projectile to clear the blockage.

Field test results

Initial field tests of the borehole mining concept were conducted at a mine on Tenderfoot Creek, 43 km (27 miles) northwest of Delta Junction, AK. The gold-bearing gravel at this site is about 0.3 meter (1 ft) thick and lies immediately adjacent to bedrock under approximately 13 meters (43 ft) of overburden.

The first field trial of the borehole placer miner involved three boreholes and took place in two phases. In the first phase, single borehole mining, the only force inducing the gold to flow into the slurry pump was pump suction. In the second phase, one "production" borehole was excavated until a connection was cut in the pay zone that linked the production hole with an auxiliary hole 4 meters (13 ft) away. Then a cutting jet with a 15.7-mm (0.62-in) nozzle was lowered into the auxiliary hole and directed toward the borehole miner in the production hole. This jet was operated at pressures from 700 to 5,500 kPa (100 to 800 psi) and rotated in the horizontal plane to flush material into the sump of the production hole. The jet pump in the production hole was operated for the duration of the test.

The two-hole arrangement produced three times as much gold as single-borehole mining, although only about 1.5 m^3 (2 yd^3) of material was excavated from the gold-bearing zone. Thus the total amount of gold produced (7 gm [1/4 oz]) was small.

Clogging of the slurry inlet and presence of large (30- to 35-cm [12- to 18-in.] diam.) boulders were the main problems hindering production during field testing. These problems will have to be overcome before borehole gold mining can become commercially feasible.

Present status

A second field trial was completed and the results published in the proceedings of the Water Jet Technology Association conference, August 1995. Research was discontinued when the U.S. Bureau of Mines closed in 1996. Final reports and a video summarizing the work are still available from Art Miller and George Savanick at the following addresses.

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As of October 1996, the safety and health research functions of the former U.S. Bureau of Mines are located in the National Institute for Occupational Safety and Health (NIOSH).

History of metal mining in Maine

Probably the earliest commercial operation in Maine was the mining of bog iron in Newfield, a small scale operation that continued for many years. Other enterprises in the mid-1800s included a lead mine near Lubec and the Katahdin Iron Works north of Brownville Junction. A mining boom swept Maine from 1879 to 1882. In a great flurry of excitement small mines and prospects were opened in many areas, primarily along the coastal volcanic belt from Blue Hill to Lubec. Iron, silver, copper, lead, and zinc were mined, milled, concentrated, and smelted. A sudden drop in prices in 1883 caused most of the mines to close as fast as they had opened. Sporadic activity continued until 1918 when production of base metals in Maine ceased for almost 50 years.

During World War II, the federal and Maine governments launched an intensive exploration program for manganese, an element on the War Department's "strategic list," that had been discovered in Aroostook County in the mid-1800s. This effort showed that a large amount of manganese is present, but the ore was never mined because an efficient process for extracting the ore was not available.

The Holmes Safety Association BULLETIN

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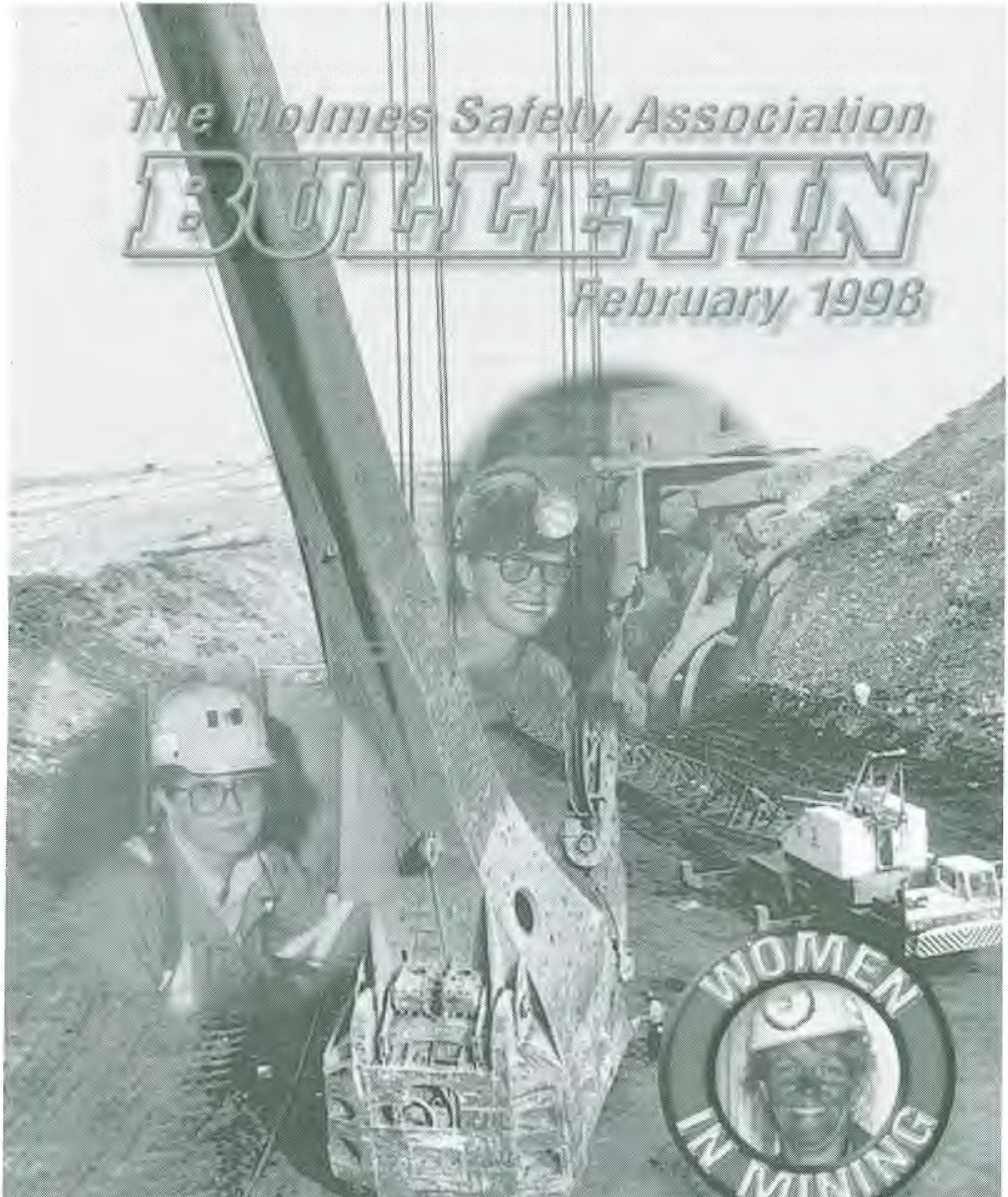

contents:

The ***Holmes Safety Association Bulletin*** contains safety articles on a variety of subjects: fatal accident abstracts, studies, posters, and other health- and safety-related topics. This information is provided free of charge and is designed to assist in presentations to groups of mine and plant workers during on-the-job safety meetings. For more information visit the *MSHA Home Page* at ***www.msha.gov***

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COVER: This month's cover is an electronically enhanced montage of images from the editor's collection. [If you have a potential cover photo, please send an 8" x 10" print to the editor, Fred Bigio, MSHA, 4015 Wilson Blvd., Arlington, VA 22203-1954]

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