PART II

MINING, OIL-SHALE EXPERIMENTAL MINE, RIFLE, COLO.

Because suitable mining techniques for oil shale have been developed, the scope of work at the Oil-Shale Experimental Mine was greatly reduced during 1951. Emphasis was shifted from research investigations and demonstration mining to routine production of oil shale for use in the Bureau's Oil-Shale Demonstration Plant and elsewhere. Some small amount of research was possible during periods when requirements of the plant did not demand the efforts of the entire mine crew.

Major accomplishments during the year were: (1) Completion of the investigation of roofstone behavior, being conducted in the test room of the Selective Mine; (2) improvements in techniques for fabricating percussion-drill rods; (3) progress in the investigation of percussion-drilling fundamentals; (4) advances in knowledge of the sequence of events when rock is broken with explosives; and (5) progress in the program of rotary-drilling research. Other work, continued from previous years but curtailed somewhat in 1951, included planning and evaluation studies projecting data and technology obtained at the Oil-Shale Mine to large-scale commercial operations and investigations of the oil-shale resources of Colorado, Utah, and Wyoming.

Mine roads, surface excavations, erection of mine buildings, and provision of facilities were largely completed in 1947 (see fig. 2). An explosives magazine was erected in 1948, and a crib wall was installed in 1949 to improve the mine-road foundation and support a section of the mine yard. In 1950 a small physics laboratory was built and equipped, a new heating plant was installed at the rear of the mine office, and a 500-ton transfer bin was constructed opposite the haulage adit of the Selective Mine. No further surface construction was undertaken during 1951.

Oil-Shale Resources

Through the continued cooperation of oil companies, 25,088 feet of samples were collected during 1951 from eight wells drilled through the Green River formation in Colorado and Utah. From 1948 through 1950, samples had been obtained from 42 wells representing 50,735 feet of Green River formation. Data from samples collected in 1951 cannot be reported, as they have not been assayed.

In Utah the Green River formation covers about 5,200 square miles. The same formation covers about 9,200 square miles in Wyoming. Samples collected to date in these areas represent only a small section of the total area and, for the most part, are not too promising. However, one well in Utah showed a 90-foot-thick section averaging 25 gallons of shale oil per ton of shale. An area of about 12 square miles outlined in Wyoming contained a 21-foot section of plus-25-gallon oil shale.

The Green River formation in northwestern Colorado appears to be the richest in oil-shale values. Several oil companies and the Bureau of Mines have conducted extensive investigations of this area. These studies indicate a total of about 2,500 square miles covered by the Green River formation; of this, about 1,000 square miles is considered amenable to exploitation. This area includes a 500-foot-thick measure of oil shale averaging 15 gallons per ton. The lower segment of this measure, known as the Mahogany ledge, ranges up to 90 feet in thickness and averages 30 gallons of shale oil per ton.

Estimates of the partly blocked and inferred oil-shale resources in northwestern Colorado indicate a reserve of 126 billion barrels of shale oil from the Mahogany ledge and 494 billion barrels from the 500-foot measure. Reserve estimates are based on total oil yield and do not consider losses in mining and processing.

Selective Mine

In the past year, only 3,500 tons of shale was mined from the Selective Mine. Most of this production came from the test room, where problems associated with stresses in mine structures were being investigated.

The Selective Mine was developed early in 1946 to provide a source of oil shale for the Oil-Shale Demonstration Plant. Productive operation of the mine was terminated in April 1949, and since that date only minor amounts of shale have been mined. During the active life of the mine, 62,000 tons of oil shale was produced.

Methods employed for exploiting shale from the Selective Mine have been described in earlier reports. In brief, the shale is mined from a series of horizontal rooms adjacent to vertical raises that extend through the Mahogany ledge. The broken shale is drawn from chutes at the bottom of the raises into trucks operating in a haulage adit below the Mahogany ledge. Actually, shale has been mined from five of the eight divisions of the ledge. These divisions range in yield from 17 to 50 gallons a ton, and each has different retorting characteristics.

It is anticipated that future requirements of the demonstration plant will be supplied from the Underground Quarry and that only small tonnages of selectively mined shale will be produced in the Selective Mine.

Underground Quarry

The Underground Quarry is developed on three levels to exploit a series of flat-lying beds 73 feet thick by room-and-pillar methods. The top 27 feet of the 73-foot bed is being mined as an advance heading. The initial opening is enlarged to 73 feet by mining two 23-foot quarry benches below the floor of the top level. The mine is developed on a checkerboard pattern (see fig. 3). All openings are 60 feet wide, and pillars supporting the overburden are 60 feet square.

From the beginning of its work on oil shale, the Bureau of Mines recognized that unusually low mining costs had to be attained before an oil-shale

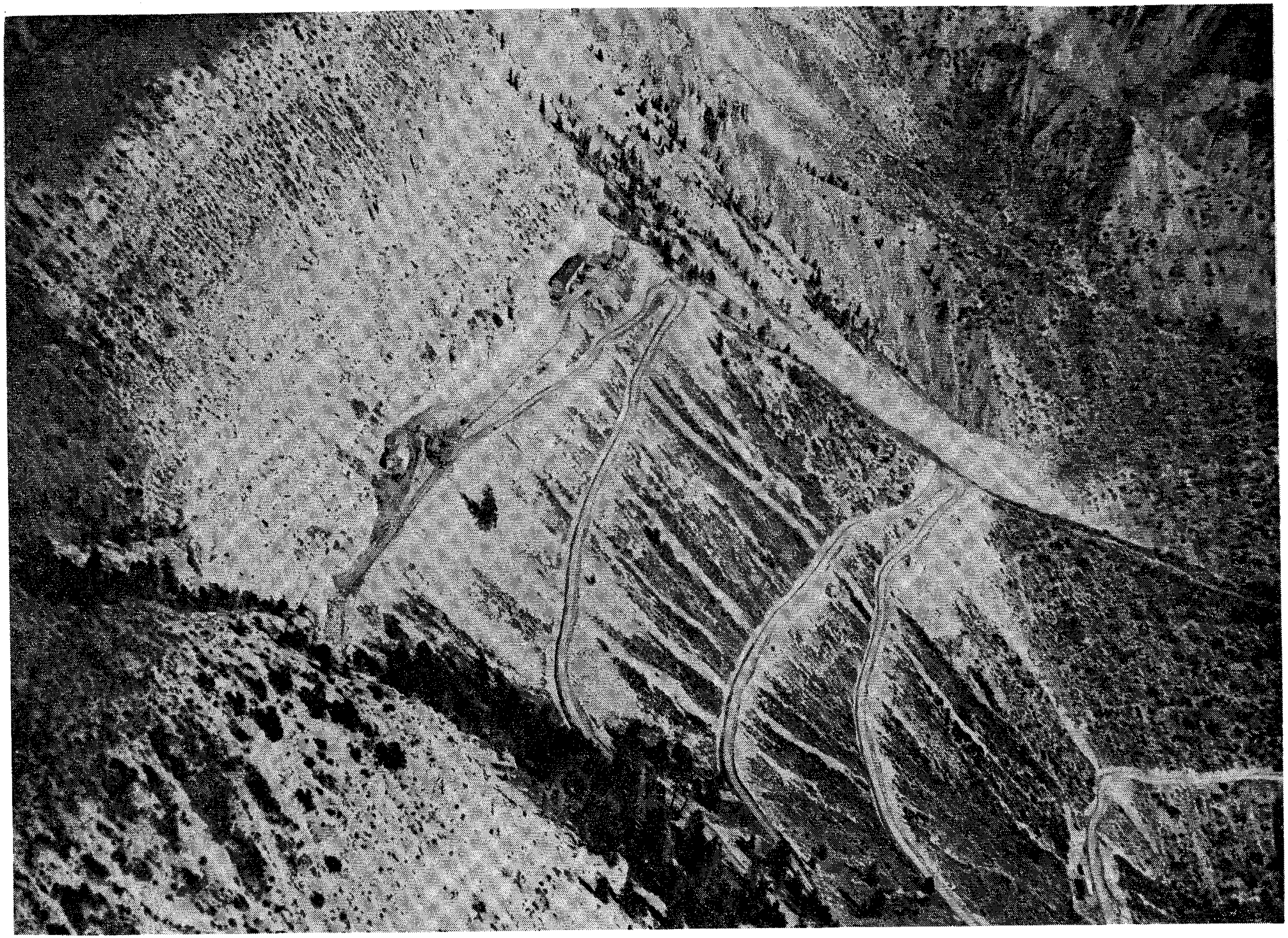

Figure 2. - Mine yard and road near Rifle, Colo., are carved in cliffs and talus slopes of oil shale. Road descends 5½ miles over zigzag course to processing plant thousands of feet below in Colorado River Valley.

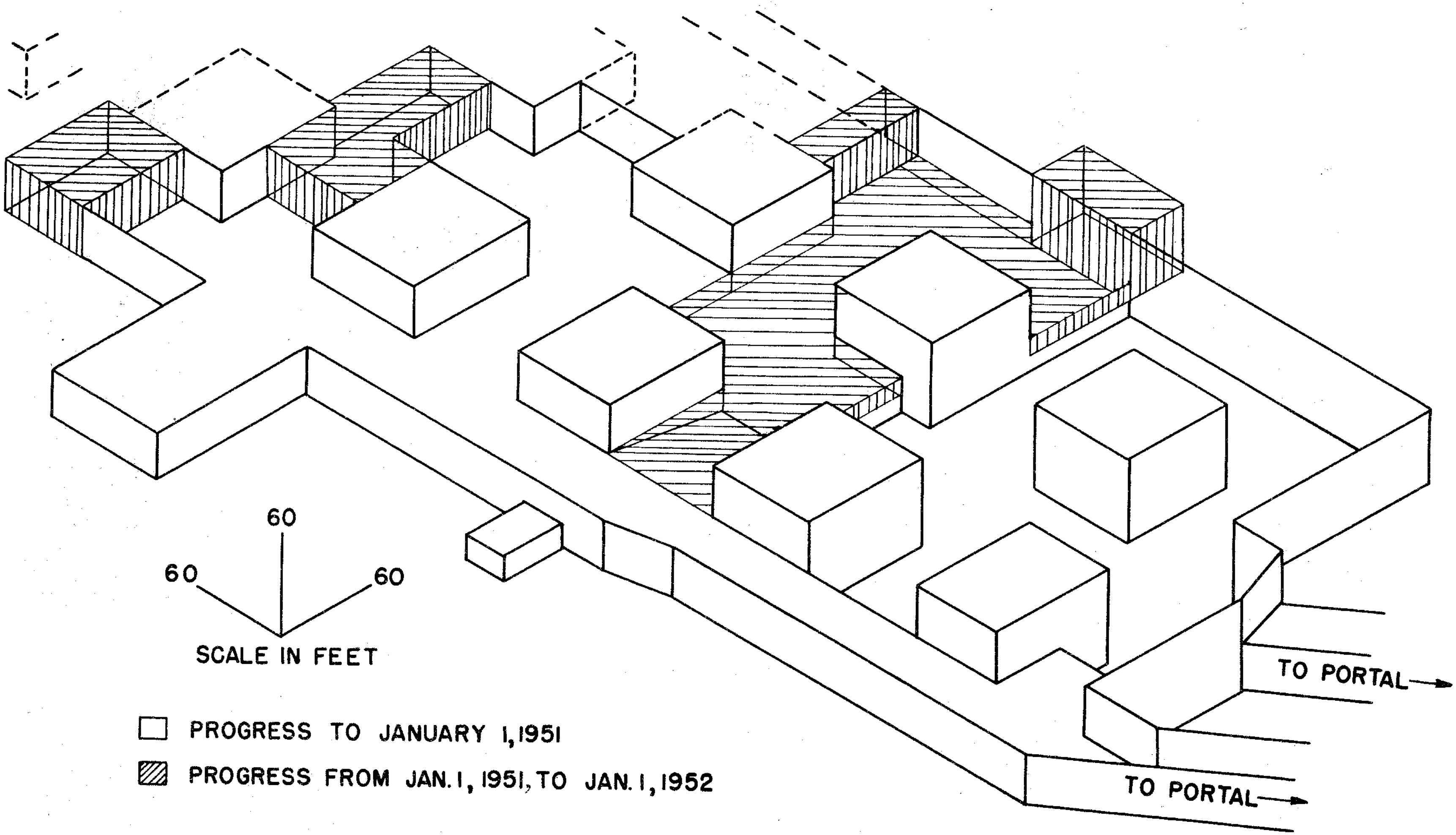

Figure 3. - Isometric drawing of Underground Quarry.

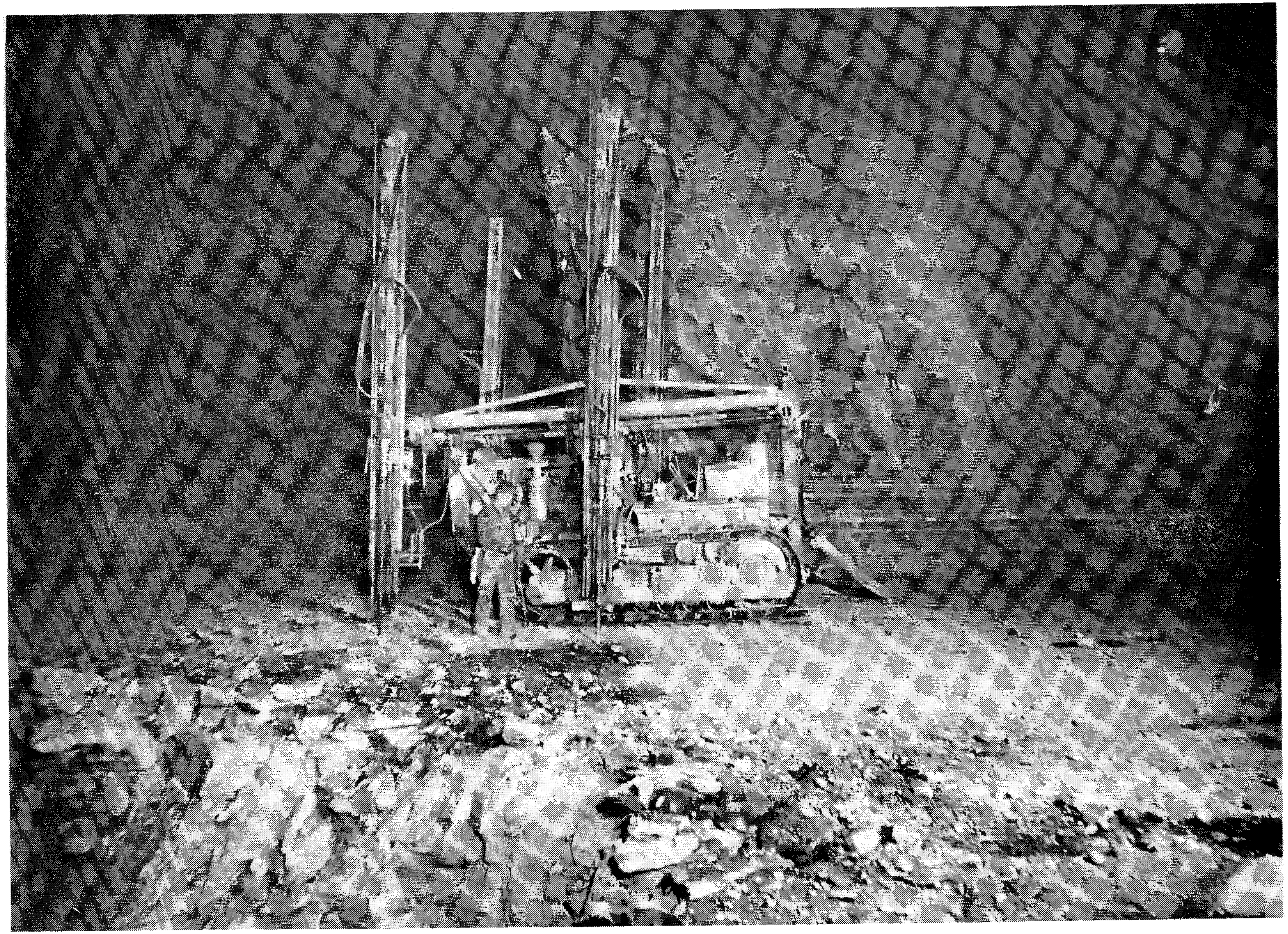

Figure 4. - Vertical blast holes for breaking bench level are drilled with this jumbo, which mounts four percussion-type air drills, each having a 15-foot feed carriage.

212685 O - 52 - 3

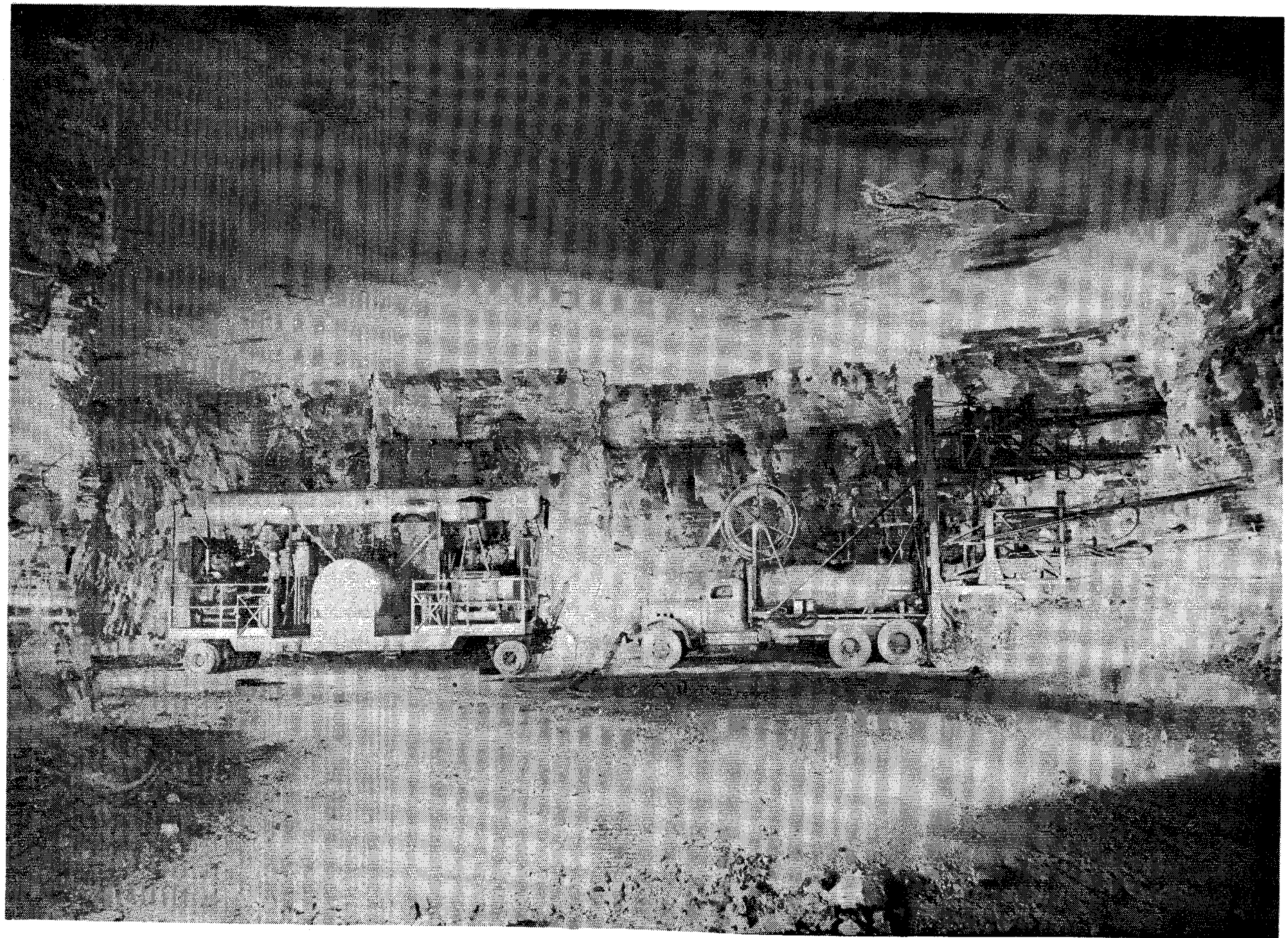

Figure 5. - This four-drill jumbo is used to drill horizontal blast holes in 27- by 60-foot headings of Underground Quarry. A mobile utility station (left) supplies necessary compressed air and water for drilling.

Figure 6. - Mobile blasters' platform, mounted on modified fork-lift truck, is used in top heading to elevate men into position for charging explosives into holes and for scaling loose rock from roof and pillars.

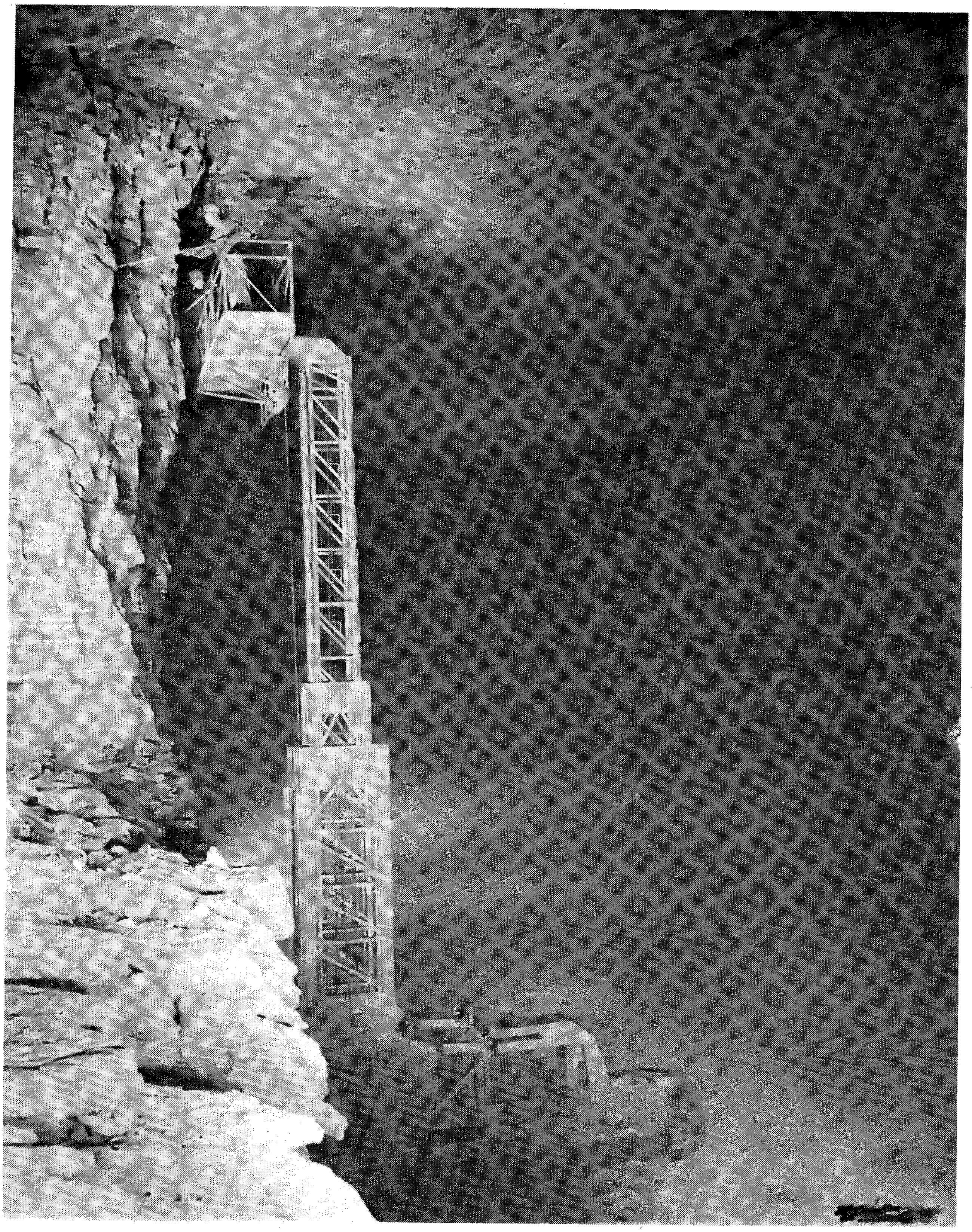

Figure 7. - A 65-foot telescoping platform partly extended for scaling roof and pillar walls from bench level.

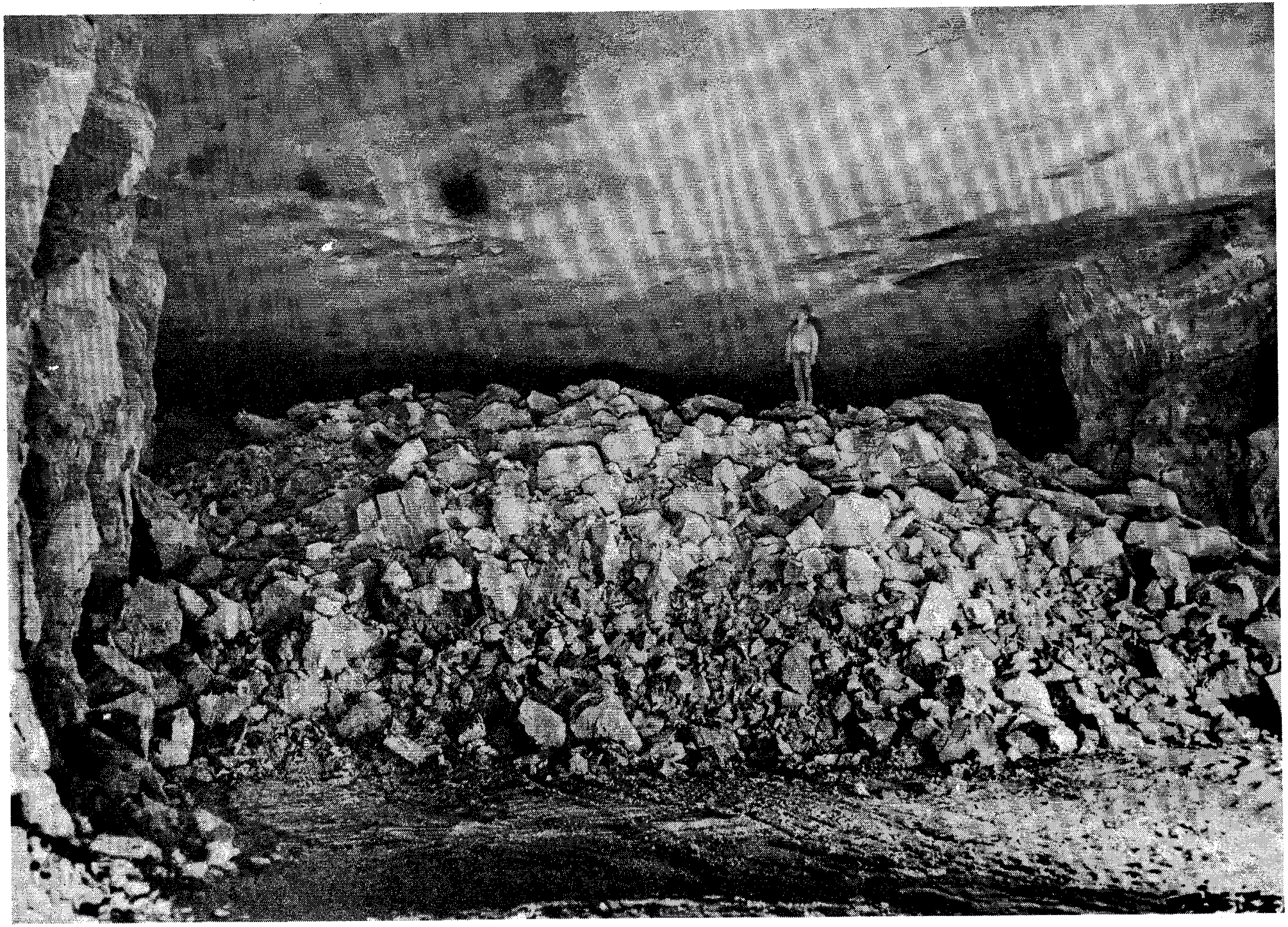

Figure 8. - 1,800 tons of broken oil shale.

enterprise could be commercially successful. As it was anticipated that one of the principal mining costs would be that for drilling blast holes, much of the early work was directed toward developing suitable drilling equipment. As a result, two multiple-drill carriages, each mounting four pneumatic rock drills, were designed and constructed. One of these machines (see fig. 4) is used to drill vertical blast holes into the quarry benches, and the other (see fig. 5) to drill horizontal blast holes into the headings on the top level of the mine.

Soon after these drilling machines were put into operation, it became apparent that the available stationary compressor plant did not have adequate capacity to supply a four-drill jumbo efficiently and still provide air needed for other mining operations. Therefore, an additional source of compressed air was necessary. Past experience had shown that the cost of supplying compressed air to underground areas through pipelines from stationary compressors on the surface is exceedingly high, owing to the cost of installing and maintaining the lines. It was decided, therefore, to design and construct a mobile compressor-utility unit that could be towed to any underground working area, thereby eliminating the necessity for installing pipelines (see fig. 5).

One of the problems in mining oil shale from the upper level of the mine is that of loading explosives into horizontal holes, some of them 25 feet above the mine floor. A special piece of equipment was designed and constructed for elevating men and explosives to position for charging these blast holes. This unit (see fig. 6) also is used as a scaling platform and has been fully described in earlier reports. Blast holes through the bench level are charged with explosives at the collar of each hole, and no special equipment is required.

Blasting in underground openings loosens rocks on the walls, pillars, and roofstone of the mine, presenting a condition that is hazardous and a menace to the safety of men and equipment. The problem arises of raising men and light tools into position for removing the loose rocks. During the development of the Bureau's Experimental Mine, scaling was done by miners standing on truck beds, using steel-tipped bars with aluminum handles. Miners worked from ladders to scale portions of the mine that could not be reached from truck beds. Manual scaling, makeshift scaling platforms, and ladders were time-consuming and inefficient. This led to the investigation of lift machines for rapidly placing workers in position for scaling. The equipment (see figs. 6 and 7) developed for this purpose has been described in previous reports.

Loading and transportation equipment in the oil-shale mine is like that in many of the country's quarries and open-pit mines. A Bucyrus-Erie 54-B electric shovel equipped with a 3-yard dipper is used for loading the broken shale (see fig. 8). The shovel has a special boom and shortened dipper sticks to allow operation under a 27-foot roof. Broken oil shale is loaded into 15-ton, rear-dump, Euclid Diesel trucks for transportation from the mine.

About 50,000 tons of shale was broken and transported from the Underground Quarry during 1951. Of this total, 27,000 tons was mined from the top level and 23,000 tons from the bench level of the mine. Approximately 19,000 tons was delivered to the processing plant.