vents, but heavy swinging panels are not so effective. For rapid explosions, as with aluminum powder, even vents closed by light swinging panels must have larger areas than unrestricted vents for equal effectiveness.

11. In using swinging panels, windows, or other hinged devices, care must be taken to prevent closure of the relief opening after the initial positive pressure wave of the explosion subsides, in order that destructively high negative pressures should not be developed in the explosion space.

12. The average and maximum rates of pressure rise and the impulses (pressure x time) in the experimental dust explosions decrease with increasing size of relief areas in about the same manner as do the maximum pressures.

Pressure-Relieving Capacities of Glass

In response to request for information on the pressure-relieving capacities of heat-absorbing glass panes to be used in a plant subject to explosion hazards, tests were conducted to determine the explosion pressures at which various types of glass break. The heat-absorbing glass and the double-strength, grade A glass panes were tested unscored, with a light diagonal scoring made with a diamond pencil on the outside surface of the glass (scoring started 2 inches from corners, and there was a 2-inch gap near the center), and also with a deeper diagonal scoring made with a diamond glass cutter. Tests were also made on ribbed glass panes that were not scored. All panes were 1/8 x 14 x 14 inches in size, fixed along all four sides in wood sash set in one wall of the explosion gallery. They were subjected to coal-dust explosions and to more rapid atomized aluminum-powder explosions. A few of the principal test data are given in the following table:

Type of glass	Minimum pressure at which glass broke, lb. per sq. ft.
(a) Coal-dust explosions	
Double-strength "A":	
Unscored	440
Lightly scored	185
Deep scored	70
Heat-absorbing:	
Unscored	260
Lightly scored	90
Deep scored	45
Ribbed glass	440
(b) Aluminum-powder explosions	
Double-strength "A":	
Unscored	250
Lightly scored	110

Technical Assistance and Service to Others

The Experimental Coal Mine and Dust Explosions Section cooperated with and assisted in the solution of technical problems of other sections of the Bureau, the Department of Agriculture, the War Department, several State agencies, and many national safety groups and industry. These activities included mining, pulverization, and sizing of coals for research in combustion and in synthetic fuels; design of demonstration galleries for dust explosions, and of testing rods for mine roofs; special tests of shale specimens from mine roofs and evaluation of convergence data from mines; furnishing data for design of pressure-release diaphragms and vents for drying ovens, film-processing tanks, dust collectors, and coal-storage bins; advice on explosion prevention in briquetting fine coal, in the manufacture of starch, and in pneumatic conveying of plastics powders; supplying drawings and specifications for construction of apparatus for research on dust explosibility; and preparation of reviews on explosion-pressure manometers and on factors affecting release of pressures in explosions.

Investigation of Coal Deposits

Coosa Coal Field, Alabama

Investigation, by diamond drilling, of the Wattsville Basin in the Coosa Coal Field of Alabama began in December 1945. Diamond drilling in this area indicates that the northern part of the Wattsville Basin may be underlain by a minable area of coal in the Fairview bed. No other coal beds in this area appear to be minable, although future drilling may develop minable reserves in the Broken Arrow and Marion beds in the southern part of the Wattsville Basin.

Analyses of cores of the coal beds in this field show calorific values ranging from 12,000 to 14,300 B.t.u. Agglutinating determinations indicate that the coals are coking. However, in some areas the ash and sulfur content is high.

The investigation was in progress at the end of the year.

Coal Reserves in Areas Where Fuel Supplies are Critical

Toledo Lignite Deposit, Lewis County, Wash.

The lack of sufficient supplies of oil, coal, and wood, the fuels normally used in the Pacific Northwest, caused a critical fuel shortage in that area during the war. Coal was shipped from mines in the Rocky Mountain Region, but the shortage would be relieved by the development of strip mines in this area. The objective of this investigation is to determine the minable reserves in a lignite deposit near Toledo, Lewis County, Wash., which appeared from a reconnaissance to be favorable for strip mining. At the time this investigation was undertaken, the Bureau of Mines had proved a large reserve of high-alumina clay in Cowlitz County, Wash., near the Toledo

lignite deposit, and the Defense Plant Corporation planned to construct a large plant to process this clay for alumina. A reserve of lignite that could be mined by strip methods would provide a supply of low-cost fuel for such a plant.

The area investigated by diamond drilling comprises sections 15, 16, and 22, T. 11 N., R. 1 E., Lewis County, Wash.

The investigation was conducted under agreements between the Bureau of Mines and the owners, who were private individuals, the State of Washington, and the Northern Pacific Railway Co., which owned the mineral rights in a small tract.

The area is approximately 9 miles east of Toledo, Wash., approximately 8 miles southwest of the Cowlitz, Chehalis & Cascade Railway, and approximately 5 miles north of the Weyerhaeuser Timber Co. railroad, which connects with the Columbia River, a possible rail-water transportation link to industrial centers.

Part of the area has been cleared, and very little timber of commercial value remains on the land (fig. 5). The topography is rolling, and the surface is traversed by deep, narrow ravines, which have been gouged by streams.

Thirty-five diamond-drill holes yielding 2-1/8-inch cores showed that the lignite occurs in a lens comprising two minable benches. The upper and lower benches, separated by a gray-tuff parting about 10 feet thick, average about 25 and 12 feet in thickness, respectively. The reserve of lignite in the lens is estimated at 8,000,000 tons, of which 5,300,000 tons are considered recoverable.

Meta-Anthracite in Newport and Providence Counties, R. I.

The fuel requirements for industrial and domestic consumers in New England, in normal times, are supplied almost entirely by fuel oil, anthracite, and bituminous coal. A shortage of these fuels occurred during the war. Because of this critical fuel situation, an investigation was made of possible sources of fuel nearer to points of consumption in New England.

Meta-anthracite coal, which is a satisfactory fuel for some purposes, had been mined in Massachusetts and Rhode Island many years ago. The coal from mines in the vicinity of Portsmouth on Aquidneck Island, Newport County, R. I., had been used successfully for smelting copper ore and for fuel. The coal is meta-anthracite and does not burn freely. However, the introduction of freer-burning anthracite and bituminous coal into New England markets resulted in abandonment of these mines. With the present-day development of improved equipment for burning coal, methods of burning it probably could be devised, should minable reserves of coal be found.

Figure 5. - Part of area explored at Toledo, Wash.

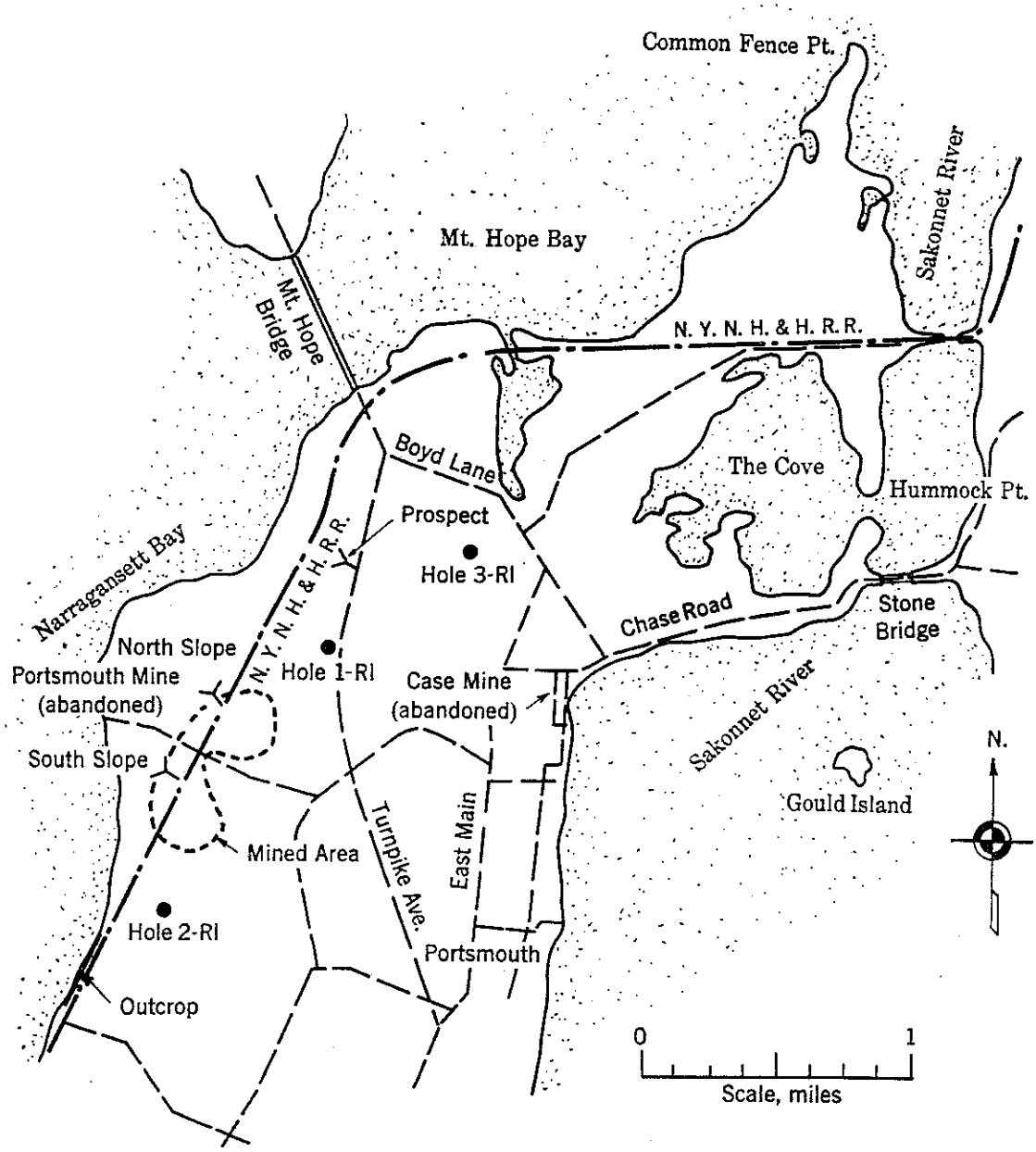

Figure 6. - Diamond-drill hole locations at Portsmouth, Newport County, R. I.

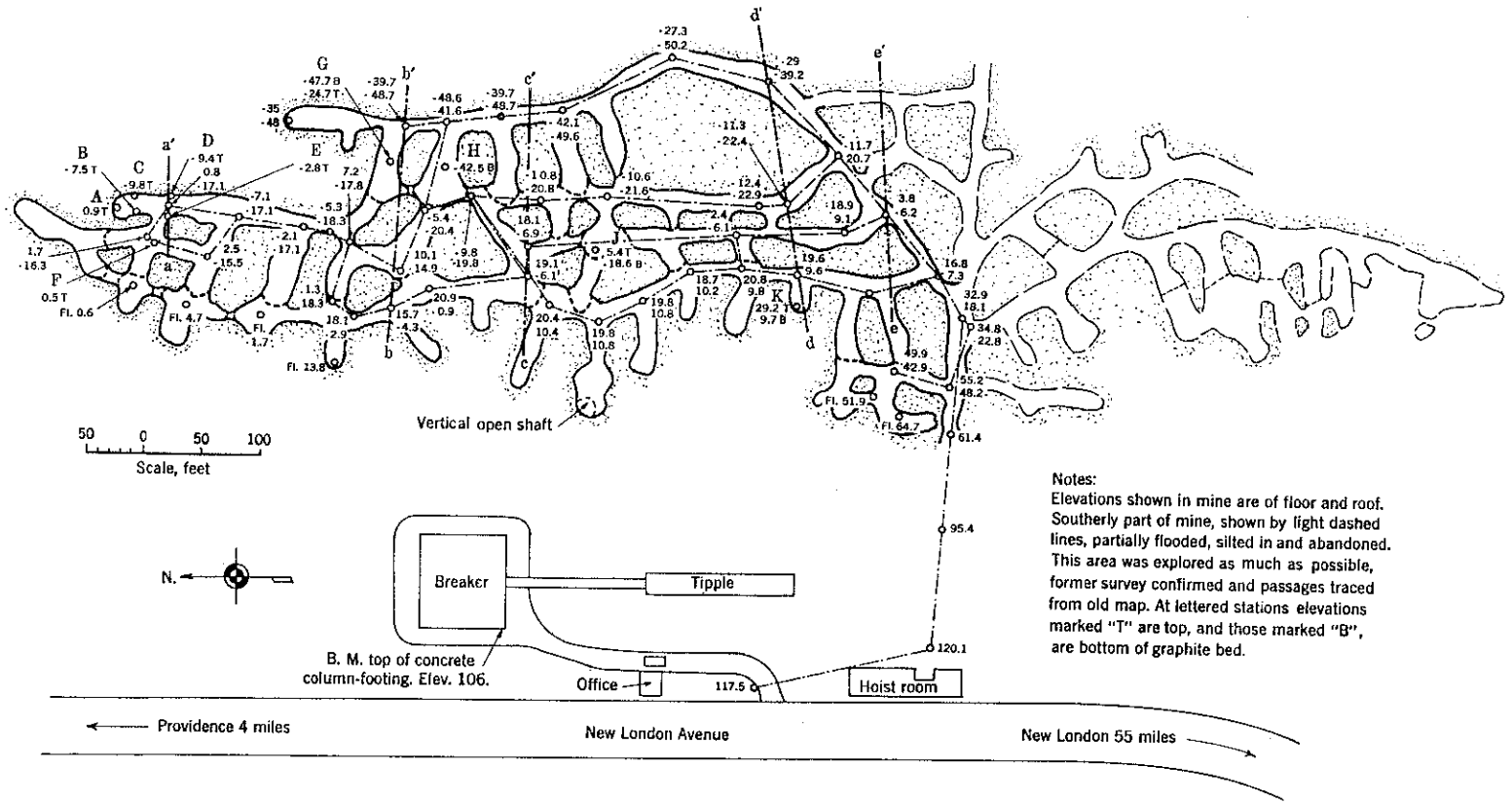

Figure 7. - Map of mine, Graphite Mines, Inc., Cranston, R. I. (From survey and map by F. O. Rose, Brown University, Providence, R. I.)

The purpose of this investigation was to determine sources of additional fuel; and as coal mined at Portsmouth had been used with some success, diamond drilling was undertaken to determine the characteristics and continuity of the beds in this area.

Three vertical diamond-drill holes to recover 2-1/8-inch cores were drilled from surface locations on the north end of Aquidneck Island in the town of Portsmouth. (Refer to fig. 6.)

The Cranston mine, of Graphite Mines, Inc., also was examined. This mine was mapped (refer to fig. 7) for the Bureau of Mines under the direction of Franklin O. Rose, associate professor of engineering of Brown University.

The results of the investigation of the Portsmouth and Cranston areas are summarized as follows:

1. Investigation by diamond drilling and geological examination in the Portsmouth area on Aquidneck Island indicates that minable beds of meta-anthracite are not continuous over appreciable areas, and no estimate can be made of possible reserves in this vicinity.

2. The exposed faces in the workings of the Cranston mine of Graphite Mines, Inc., indicate that there is a recoverable reserve of meta-anthracite adjacent to the workings of this mine. The recoverable reserves cannot be estimated, because the structure and thickness of the bed may change sharply in any direction. The bed may "pinch" out or may be dislocated by faulting.

3. Petrographic examination of cores and mine samples shows that most of the coal of the Narragansett Basin has been subjected to intensive minor faulting and brecciation.

4. The dry ash ranges from 76.1 to 93.7 percent and total carbon from 1.8 to 19.5 percent. With a single exception, the analyses of the cores compared with analyses of meta-anthracite from Cranston and Portsmouth mines showed that the other cores cannot be classified as coal.

Coos Bay, Oregon

The construction of Army camps at Medford and Klamath Falls, Oreg., and the Naval Air Base at North Bend, Oreg., increased the demand for coal far beyond production of the small mines in the Coos Bay area. Coal must be imported from mines in the Rocky Mountain Region to supply any such increased demand and places a burden upon the railroads. The development of a nearby source of fuel would greatly relieve this transportation problem.

The Coos Bay Coal Field, adjacent to the many navigable sloughs extending from Coos Bay, an arm of the Pacific Ocean, and traversed by a branch line of the Southern Pacific Railroad, was a logical source of fuel.

Fifteen diamond drill holes to recover 2-1/8-inch cores were drilled in the Coos Bay area. Cores of the coal beds penetrated were analyzed at the Central Experiment Station, Pittsburgh, Pa. Based upon the results of this investigation, 1,020 acres of land were proved to be underlain with approximately 10,800,000 tons of coal, of which 8,600,000 tons are considered recoverable. An additional reserve of 6,193,000 tons is indicated and inferred, of which 4,955,000 tons are considered recoverable.

Alaska

Production of coal in Alaska still is less than demand. Greater production is needed for the Army and for industrial and domestic fuel. Investigation by the Bureau of Mines in the Matanuska Field has resulted in increasing reserves adjacent to the workings of the Eska mine, owned and operated by the Alaska Railroad. Diamond drilling in the Eska-mine area was begun by the Mining Branch and completed by the Bituminous Coal Mining Section. Three diamond-drill holes were drilled during the summer of 1945.

Based upon diamond-drilling results, it is indicated that the reserves in the area adjacent to the Eska mine have been increased by an additional 1,600,000 tons of coal in the No. 5, Lower Chapin, Emery (or No. 8), Shaw, and Martin beds. Nine hundred seventy thousand tons of this reserve are considered recoverable through the workings of the Eska mine.

Coaldale, Nev.

Technical Paper 687, titled "Exploration, Composition and Washing, Burning, and Gas-Producer Tests of a Coal Occurring Near Coaldale, Esmeralda County, Nevada," by Albert L. Toenges, Louis A. Turnbull, James M. Schopf, H. F. Yancey, K. A. Johnson, M. R. Geer and L. L. Newman, was published in 1946. (This investigation was discussed in the 1944-45 Annual Report.)

Mining Methods and Practices

Many comparatively small areas of coal suitable for strip mining exist, but these areas probably could not be mined profitably with large-capacity, modern, electrically powered machines because of the high cost-in-place of this equipment and the time and expense required to transport the machines to the mine site. Scrapers and light excavating equipment are mobile, and the investment cost is not great. These units have been used in mining small areas. A study to determine methods in vogue and the economic considerations involved in the use of this equipment was completed.

A Stripping Operation in Illinois

The operations of a coal strip mine in Illinois were studied. The coal bed at this mine ranges from 2 feet to 4 feet, 6 inches in thickness and contains two small partings. The overburden comprises principally soil and glacial drift. In some areas there are lenses of limestone ranging from 6 inches to 4 feet in thickness in the overburden. The ratio of overburden