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Preliminary map of bedrock surface under parts of Boston, Cambridge, and Brookline, Massachusetts

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Description of map

The accompanying map of the bedrock surface under parts of Boston, Brookline, and Cambridge (scale 1 inch = 500 feet, or 1:6000) is being issued in preliminary form at this time in response to public interest. It is planned to publish this map, but with information added on the geology of the bedrock, at a later date. The present map shows only the topography of the surface insofar as it can be deduced from scattered borings.

The data used in making this map are bedrock elevations determined from foundation-boring logs and from ground observations of the outcrop areas in the southwestern corner of the map. Borings logs were collected from various sources. Many have now been published by the Boston Society of Civil Engineers (1961, 1969).

"Bedrock," as here used, includes the soft, weathered or kaolinized rock (Kaye, 1967) as well as the typical hard rock, consisting mainly of argillite and conglomerate. The bedrock topography is shown by means of contours but only in places where there are sufficient subsurface data to justify contouring. Where the data are too sparse for sufficient control, the areas are not contoured, although such boring data as exist are indicated. Where the bedrock surface is contoured, elevations from individual borings are not given, but locations of the borings are shown.

The contour interval is 10 feet, and the zero-datum is mean sea level (MSL). Contours below MSL are shown by minus numbers. Contour lines at 50-foot intervals are heavier and are numbered. In addition, the ends of some contour lines of intermediate values are numbered to facilitate map reading, particularly in areas where contouring is fragmentary. Depression contours are hachured where closure can be deduced. As our knowledge of the bedrock surface extends, undoubtedly we will find that some of the now unhachured contour lines mark closed depressions.

Many map users will want to convert the elevations of the contours on the map from the MSL datum to one of the local engineering bases (e.g., Boston City Base, Brookline Town Base, and Cambridge City Base). To do this, the following formulae can be used:

Boston City Base (BCB) elevation = map elevation (MSL) + 5.65 feet

Brookline Town Base elevation = map elevation + 5.78 feet

Cambridge City Base elevation = map elevation + 10.84 feet

Thus, Boston City Base falls 5.65 feet, Brookline Town Base falls 5.78 feet, and Cambridge City Base falls 10.84 feet below MSL (U. S. C. & G.S., 1929 datum). Here are a few examples of the conversion of the MSL altitudes of the map to Boston City Base (BCB): the -20-foot contour line on the map is -14.35 feet BCB; the 0-foot contour line is 5.65 feet BCB; the 10-foot contour line is 15.65 feet BCB.

Of the many thousand borings available only about 3,520 contain information useable in making this map. The borings used can be classified into three types: (1) those that cored into rock for a minimum distance of one foot (1,430 borings); (2) those that ended at refusal[1/] (1,858 borings); and (3) selected borings that did not meet rock but whose bottom-hole depth provides a minimum depth to rock in areas where better control is lacking (232 borings). The three types of borings are shown by different symbols on the map.

Limits of accuracy

It is important for the map user to understand the limits of reliability--or accuracy--of the map and the factors controlling it.

The accuracy with which the bedrock surface can be determined is a direct function of the density of pertinent borings, and particularly the core borings. The closer the spacing between borings, the more

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1/ "Refusal" means that the driller made no progress by conventional driving methods and in consequence terminated the hole.

accurate the picture. Where data are sparse, contouring the bedrock surface becomes largely subjective. The reader, therefore, can gage reliability of the contouring by the density of control points shown on the map.

Another factor influencing accuracy is the reliability of the boring information itself. The major uncertainties of the boring data are:

(1) The locations of some borings are known only to within 150 feet. This is true of many boring logs that lack location plots.

(2) The elevation of the top of hole is not given in some boring logs. For such borings in Boston the elevation of the top of hole was estimated by using the contour maps of the Boston Redevelopment Authority (BRA) on a scale of 1 inch = 100 feet and contour interval of 5 feet. For borings in Brookline and Cambridge, the topographic map of the U.S. Geological Survey, at a scale of 1 inch = 2,000 feet and a contour interval of 10 feet, had to suffice for lack of larger scale topographic maps of these communities. Therefore the top elevations of many borings in Brookline and Cambridge are accurate only to $\pm$ 5 feet. It is also probable that some borings were made from cellars or excavations, and this could not be read from the topographic map.

(3) For some borings there is uncertainty as to which of several engineering datum planes used in the area was used as the base. Inasmuch as these datum planes vary as much as 10.84 feet in elevation, substantial errors may be involved.

(4) For refusal borings, it commonly cannot be determined whether the boring ended on bedrock, a boulder or cobble, or even in some instances on a manmade obstruction. Only where refusal holes are densely interspersed with core holes is it possible to judge. In some areas it is clear that boulder-bearing sediments, such as till or coarse gravel, are responsible for most refusals. In others, it is equally clear that most holes met refusal on bedrock. In making the map, some of the refusals were accepted as bedrock but others were rejected.

Where core holes are sparse or absent there is no way of telling the significance of refusal. Thus, in parts of Brookline, Cambridge, and East Boston, areas are not contcured even though there are many refusal borings.

(5) From some log descriptions it is difficult to distinguish kaolinized, weathered, or broken bedrock from Pleistocene deposits. Undoubtedly a few borings that reach bedrock were omitted because of the inadequacy of the log notations.

(6) Most core borings that penetrate a foot or more into rock are in bedrock, but some may have cored sizeable boulders. Thus, some bedrock-penetration elevations on the map may not show the bedrock surface.

(7) It must also be recognized that the depths and/or the material descriptions of some boring logs are simply wrong. It is seldom possible to recognize these logs, but some erroneous logs were identified and discarded.

Base map

The base map, or street map, used is an enlargement of the northern part of the South Boston quadrangle topographic map, U.S. Geological Survey. The street layout on this map dates from 1956 and is therefore obsolete in recent redevelopment areas, such as Government Center and the West End. A revision of the topographic map is being made at the present time (1970).

Characteristics of the bedrock surface

The best picture of the buried bedrock surface is obtained where spacing of borings is densest, namely, downtown Boston, the Prudential Center-Copley Square area, and the MIT campus. In all three areas the picture conveyed by the data is of a topography of numerous small irregular hills and many closed depressions. Hills differ in size but commonly range in height from 25 to 50 feet and in length from 150 to 500 feet. There is no apparent topographic grain. Here and there is evidence of very steep to vertical slopes, and in a few places

deep narrow vertical clefts cutting into or across the hills. This buried topography resembles the surface topography in many rocky areas about Boston, such as parts of Middlesex Fells Reservation and along the North Shore coastal belt.

A notable feature of the buried bedrock topography of Boston is the deep trough that crosses the map from northwest to southeast. This feature has been noted by earlier writers (Crosby, 1903; Chute, 1959; Upson and Spenser, 1964), all of whom suggested that it is a buried preglacial river valley. The present map depicts its shape in more detail than ever before. The trough appears to have depths well in excess of 200 feet below mean sea level and to have several ramifications, or tributaries. One ramification underlies the old course of Muddy River, another more or less underlies upper Fort Point Channel, and others occur under the Back Bay and the Charles River. It will be noted that the irregular hilly topography is largely absent in the trough, whose sides are shown as fairly smooth slopes. This difference is probably more apparent than real and is the result of the general sparseness of borings. In all likelihood the sides of the trough are irregular.

The only sizeable area of rock cropping out at the surface is in the southwest part of the map area. Three bedrock hills rise steeply 300 feet or more above the bottom of the trough. They are formed of hard resistant conglomerate. Some evidence suggests that the two valleys separating the conglomerate hills overlie northeast-trending bedrock faults.

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