MAP GQ-791

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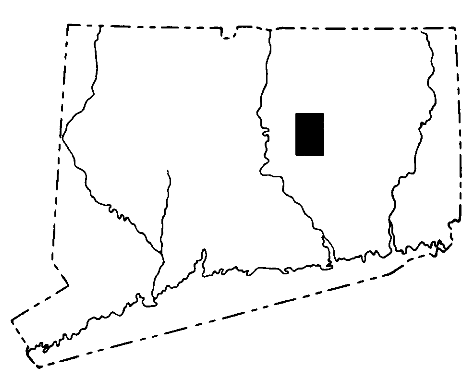
GEOLOGIC QUADRANGLE MAPS OF THE UNITED STATES

BEDROCK GEOLOGIC AND MAGNETIC MAPS OF THE MARLBOROUGH QUADRANGLE EAST-CENTRAL CONNECTICUT

By
George L. Snyder



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BEDROCK GEOLOGIC AND MAGNETIC MAPS OF THE MARLBOROUGH QUADRANGLE, EAST-CENTRAL CONNECTICUT

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INTRODUCTION

Several aspects of the geology of the Marlborough quadrangle, Connecticut, have regional stratigraphic and structural implications. Therefore, data from surrounding areas and more distant parts of New England are also discussed. Because of these regional implications, field mapping was supplemented by 1) magnetometer surveys to provide a more precise delineation of diabase dikes and 2) petrographic studies to provide a more precise delineation of metamorphic isograds within the quadrangle and mineralogical contours within the Glastonbury Gneiss, which is adopted herein. The petrography is based on 235 thin sections of samples collected by the writer and 116 thin sections used by Orville B. Lloyd, Jr. (1963) which were kindly made available through his assistance and that of Professors Peter Robinson and Oswald C. Farquhar, Department of Geology, University of Massachusetts.

MAGNETIC INTERPRETATION

In 1962, only 16 separate diabase outcrops in six main areas were known within the Marlborough quadrangle. This information, together with data from other outcrops along strike in the Moodus and Columbia quadrangles and from aeromagnetic profiles (locations shown on magnetic map) indicated only one or two dikes within the quadrangle.

At the suggestion of Gordon P. Eaton, U.S. Geological Survey, ground magnetometer studies were made in 1964 in cooperation with Connecticut State Geologist, Joe Webb Peoples, who made arrangements for use of Wesleyan University's precession magnetometer. Professor James R. Balsley, Wesleyan University, was most helpful in explaining the operation of the magnetometer equipment in the field. Later both Balsley and Eaton made helpful critical comments about this manuscript.

The ground magnetometer survey indicates a complex series of en echelon dikes. Many small separate pods or dikes are indicated by numerous isolated magnetic highs. Some highs, such as that in the area mapped as an amoeboid pod of diabase south of Woods Pond, are unconfirmed by any outcrops and may be caused by magnetite concentrations within the metasedimentary rocks. Others, like those southeast of the village of Marlborough, were confirmed by outcrops found during the magnetic survey. The mile-long dike west-southwest of Merrow Swamp is established both by magnetic measurements and by diabase erratics which litter the fields southeast of the dike. In several erratics, the diabase has two chilled contacts against metamorphic rock indicating intrusion. The erratics are, therefore, not derived from the diabasic lava flows to the northwest. The 3-mile-long dike near Gilead is not exposed, but is suggested by the long linear anomaly which "fits" the en echelon pattern of confirmed dikes.

The magnetic survey thus has provided a more accurate map of the diabase dikes which are potentially valuable sources of road-metal. The pattern of anomalies indicates that the diabase filled en echelon fractures, produced in the earth's crust by a general northwest-southeast tension in Mesozoic time. If the arrangement of fractures were controlled by a regional force couple oriented nearly parallel to the overall trend of the dike swarm, as the en echelon pattern suggests, it must have been a right lateral force couple. The overall trend of the dike swarm is roughly parallel to the fault bounding the east side of the central Connecticut Triassic basin. These two structures, the bounding fault and the dike fractures, can reasonably be assumed to have been contemporaneous and to have formed under the same general stress. If there were any horizontal or tear movement along this fracture system, it must have been right lateral.

The available aeromagnetic data suggest that the en echelon pattern of diabase dikes continues south and northeast of the Marlborough area. Only aeromagnetic profiles are available for the Moodus quadrangle; these suggest the pattern of offset dikes shown on the geologic index map. Philbin and Smith's (1966) aeromagnetic map of the South Coventry quadrangle shows an offset pattern of anomalies probably representing three main en echelon dikes.

Ground magnetic measurements were extended in traverses across the Monson Gneiss and Middletown Gneiss, as they also have aeromagnetic highs (see magnetic map). These units have a wide range in composition from felsic biotite gneiss to mafic amphibolite. Generally, resolution of magnetic anomalies from ground measurements is more exact than those from aerial measurements. The more exact ground magnetic map, however, was less useful as an aid to mapping the Monson and Middletown Gneisses than it was in mapping the diabase dikes. The Monson-Middletown belt contains abundant outcrops permitting delineation of main map units within these two structurally complex and lithologically variable formations. In addition, within this belt, detailed lithology correlates poorly with magnetic intensity measurements. In comparison, the diabase dikes crop out rarely, their lithology is uniform, they intrude rocks which have a strongly contrasting lower susceptibility, and the dikes are virtually undeformed.

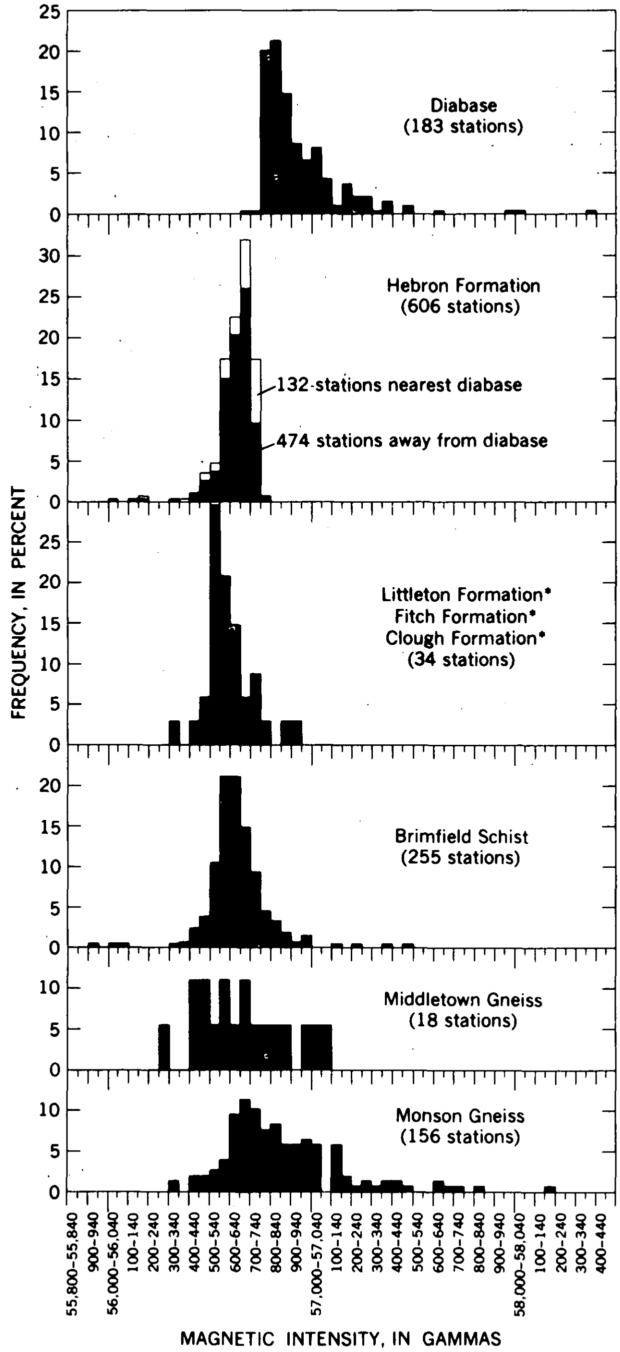

FIGURE 1.—Frequency distribution of ground magnetic intensity of some map units in or adjacent to Marlborough quadrangle. Measurements from 1,315 field stations in four quadrangles were available: Marlborough, 1,260; southeastern Glastonbury, 4; northwestern Columbia, 33; southern South Coventry, 18. Of these, 63 stations located over known or inferred contacts were excluded. Measurements over pegmatite are included within the units they intrude. Where possible, stations near units of high susceptibility are indicated. Data for the diabase dikes are strongly skewed and may be caused by 1) classification of some of the lower magnetic values in covered areas as surface diabase when they are in reality either over country rocks strongly affected by subjacent diabase or over country rocks strongly masked by till containing many diabase boulders, 2) variability in thickness of overlying surficial deposits, or 3) variable concentration of magnetite in diabase. *Indicates equivalents of Eaton and Rosenfeld (1960).

Nevertheless, the belt of Monson Gneiss generally has a positive magnetic anomaly. Relatively low areas also occur within this belt, however, and no single gamma reading would necessarily indicate subjacent Monson Gneiss. In contrast, measurements greater than 56,750 gammas would be an almost perfect indication of subjacent diabase (fig. 1). Many Monson-related magnetic contours intersect contacts and there are several significant positive anomalies near but outside the map contact of the Monson; several of these were considered presumptive evidence for buried Monson anticlines (see sections).

PETROGRAPHY OF THE GLASTONBURY GNEISS

The internal phases of the Glastonbury Gneiss, named by Gregory, (1906, p. 114, 115, and map) have presented mapping problems. Several geologists (Aitken, 1955; Collins, 1954; Herz, 1955; and Lloyd, 1963) have mapped a variety of internal units but neither their units nor the contacts between units have been consistent with one another. This is surprising for two reasons: a) any individual outcrop of the Glastonbury seems to be quite uniform in composition except for volumetrically minor aplite dikes; b) widely separated outcrops of the Glastonbury have quite different compositions. One might expect that the regionally different phases would come into visible contact with one another. My observations, however, indicate that Glastonbury rocks change imperceptibly from outcrop to outcrop and that many different internal phases merge gradually with one another over large distances. Contours showing percent of total mafic minerals and percent of microcline, and letters showing localities of hornblende- and garnet-bearing rocks indicate that the internal mineralogical parameters of the Glastonbury Gneiss vary, largely independently of one another. These parameters have the widest variation or constitute the most obvious visual differences. Other parameters, such as the percent of epidote or quartz/plagioclase ratio, probably also have gradual internal variation. Thus, any given parameter could demonstrate the local uniformity but regional inhomogeneity of the Glastonbury Gneiss.

Figure 2 shows some mineral associations within the Glastonbury Gneiss in the Marlborough quadrangle. Some of the minerals have favored habitats: hornblende and epidote are more likely to occur in more mafic rocks and garnet and muscovite are more likely to occur in more felsic rocks. The map distribution of hornblende and garnet and the mineralogical contours also show that certain geographic areas are favored either with the presence of the less common minerals or with concentrations of the ubiquitous ones. None of the mineral suites, however, occur in bodies of Glastonbury Gneiss in sharp contact with one another.

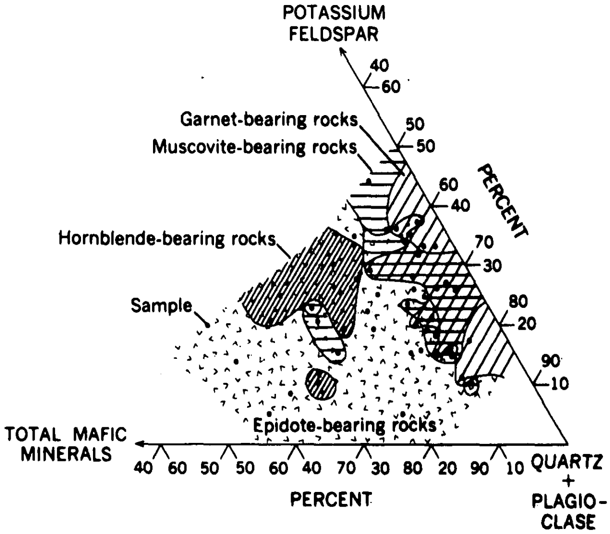

FIGURE 2.—Petrographic characteristics of 47 samples of Glastonbury Gneiss. In addition to the minerals shown, biotite is ubiquitous, and sphene, magnetite, ilmenite, or sulfides are important in a few rocks.

STRATIGRAPHY

Daly Swamp Member of the Brimfield Schist.—The name, Daly Swamp Member, is introduced herein for a medial member of the Brimfield Schist having calc-silicate affinities. The type locality is the extensive series of ledges south and southwest of Daly Swamp in the central part of the quadrangle. The rocks of the Daly Swamp Member are mainly biotite schist or biotite schist containing minor amounts of small actinolite crystals or large diopside crystals; locally the member is entirely calc-silicate rock. Thickness ranges from a feather edge west of Lake Terramuggus to 700 feet west of Merrow Swamp. The unit is overlain and underlain by pelitic schist of the upper and lower members of the Brimfield Schist. The age of the Daly Swamp Member is Middle(?) Ordovician or older.

The Daly Swamp Member is probably correlative with the medial Fly Pond Member of the Tatnic Hill Formation. The two members overlap throughout a broad range of composition but the average composition of the Fly Pond Member is more calcic than that of the Daly Swamp Member. The Fly Pond Member consists mainly of hornblende-diopside-scapolite-epidote calc-silicate rock containing minor biotite; locally, as in the central part of the Columbia quadrangle (Snyder, 1967), marble predominates. Both units are metamorphosed shaly limestone or limy shale, but the clastic/carbonate ratio in rocks of the Daly Swamp Member must have been generally higher than that in rocks of the Fly Pond Member. These two stratigraphic units are as little as 5 miles apart geographically (see geologic index map); this distance would be much greater if the intervening folds were flattened out. Thus, the two members may reasonably be regarded as sedimentary facies; the Daly Swamp Member is perhaps a more nearshore equivalent of the Fly Pond Member.

The Brimfield Schist or Tatnic Hill Formation of eastern Connecticut and Massachusetts is a probable equivalent of the Partridge Formation of New Hampshire, and the underlying Middletown Gneiss and Monson Gneiss are probable equivalents of the Ammonoosuc Volcanics. If so, the age of the Brimfield Schist would be Middle Ordovician and the Middletown Gneiss and Monson Gneiss would be Middle Ordovician or older (Harwood and Berry, 1967, p. 19, 22).

STRUCTURE

Possible fault.—The inferred fault separating the Clough Formation equivalent of Eaton and Rosenfeld (1960) and Glastonbury Gneiss is based on somewhat sheared rocks on either side of the contact and on a large exposure of mylonitized pelitic schist and quartzite between Glastonbury Gneiss and Clough Formation equivalent near the head of Roaring Brook in the northern part of the quadrangle. The shearing is especially noticeable in the quartzites of the Clough Formation equivalent, which, in the western belt, have cataclastic or semicataclastic textures. In the eastern belt the quartzites have the normal intergranular textures that have apparently been mechanically undisturbed since the last major metamorphic recrystallization. In addition, the eastern belt contains most of the outcrops where quartz pods or lenticles were observed; these pods probably represent former quartz pebbles and apparently shearing in the western belt has been too intense for many to be preserved. Gordon Eaton (personal commun., 1967) has structural evidence indicating that the rocks of the Glastonbury Gneiss have ridden up over the rocks of the Bolton syncline and it is notable that the mineralogical contours within the Glastonbury Gneiss in this quadrangle appear to be truncated along the eastern contact. Thus the faulting appears to have occurred after the intrusion of the Glastonbury Gneiss in Mississippian or Devonian time.

Unconformities.—There is evidence for three unconformities within the Marlborough metasedimentary section: 1) beneath the Clough Formation equivalent of Eaton and Rosenfeld (1960), 2) beneath the Littleton Formation equivalent of Eaton and Rosenfeld (1960), and 3) beneath the Brimfield Schist. The first is probably the most important or represents the greatest time interval.

The pre-Clough equivalent unconformity is based on the truncation of units of the Brimfield Schist, Middletown Gneiss, and Monson Gneiss and the axial planes of folds involving these units at the base of the Clough equivalent. South of John Tom Hill, the Clough Formation equivalent strikes N. 15° E. and crosses the N. 45° E. strike of the "Omm" unit of the Monson Gneiss, so that the angle of truncation is as much as 30°. The Brimfield Schist, Middletown Gneiss, and Monson Gneiss are isoclinally folded in this area and the map evidence shows that at-least-gentle folding accompanied by uplift and denudation must have occurred prior to the deposition of the Clough Formation equivalent. Harwood and Berry (1967, p. 17) propose an analogous folding episode for correlative rocks. The isoclinal folding of the Clough equivalent and younger units must have been a separate event that was superimposed on and refolded the older rocks. Compression during both the earlier gentle folding and the later isoclinal folding was in a general northwest-southeast direction.

The unconformity beneath the Littleton Formation equivalent is based on the lenticular distribution of the Fitch Formation equivalent. It is suggested that the Fitch Formation equivalent, originally a shaly limestone, had a broader areal distribution above the Clough Formation equivalent than at present, and was partly eroded before the deposition of the Littleton Formation equivalent. Broad epeirogenic uplift would have been sufficient to cause the necessary erosion; therefore, neither folding nor a long period of erosion would have been required to produce this unconformity.

Regional considerations indicate a possible unconformity beneath the Brimfield Schist (Eaton and Rosenfeld, 1960, table 1). This is indicated locally by lenticular distribution of the Middletown Gneiss between the Brimfield Schist and Monson Gneiss. The equivalent of the Middletown Gneiss is mostly absent between the Tatnic Hill Formation and the Quinebaug Formation around the Willimantic dome (see geologic index map). This absence may be due to the postulated unconformity, but it could also be the result of local nondeposition of the volcanic rocks which are now the Middletown Gneiss.

Major structures and their significance.—The traces of the axial planes of the Monson anticline and Chester syncline pass through the Marlborough quadrangle. The overturned Brimfield in the Colchester nappe (geologic index map) may be considered as either the recumbent lower limb of the Monson anticline or the recumbent upper limb of the Chester syncline. This structural interpretation is based largely upon the map continuity of the Brimfield Schist and Tatnic Hill Formation in the core of the Chester syncline in the Old Lyme quadrangle (fig. 2 of Lundgren, 1962, 1963, 1964, and 1966), south of the area shown on the index map.

Many other folds are shown on the geologic index map and can be separated into at least two generations of folding. The truncation of folded beds on the south side of John Tom Hill indicates that the Bolton syncline is younger than the gentle folding that occurred prior to the deposition of the Clough equivalent of Eaton and Rosenfeld (1960). Two fold systems are also present in the Fitchville quadrangle (Snyder, 1964a) where isoclinally folded Scotland Schist and Hebron Formation are refolded. The tightness of the later folds increases from north to south toward the Honey Hill fault. These later Fitchville folds may be equivalent in age to the formation of the Bolton syncline, but this equivalence is dependent upon the age and correlation of the Scotland Schist. Table 1 shows two possible correlations for the Scotland Schist, and the implications of each.

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