GUIDEBOOK OF EXCURSION
IN
CABARRUS COUNTY, NORTH CAROLINA
October 22-23, 1966

EXCURSION LEADERS

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GUIDEBOOK OF EXCURSION IN CABARRUS COUNTY, NORTH CAROLINA[1]

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INTRODUCTION

This field trip will be in the Piedmont Province of North Carolina and in the vicinity of Concord, Cabarrus County. Among the subjects to be observed or discussed are (1) geologic rock types and structures, (2) the syenite ring dike—its structural features and its weathering behavior, (3) a widespread granite-diorite complex, (4) results of geochemical reconnaissance for ore deposits, (5) subsurface profiles of the weathered zone, of the water table, and of the water-bearing fracture zone, and (6) geomorphology.

Such a wide variety of subjects to observe and discuss in the limited time for the trip requires some geologic perspective of the whole fabric of the region. This guidebook, therefore, is an attempt to provide a brief geologic background for various stops and discussions. All the illustrations except figures 4 and 6 have been published previously. The geologic maps were prepared for varied purposes and published several years apart and therefore differ. They, nevertheless, show a steady accumulation of geologic information.

Two facts stand out as influencing all aspects of the geology and topography in the Concord area. Neither one is well understood. The first is the complicated history and petrology of the igneous and metamorphic rocks. The second is the weathering of these rocks with all its ramifications in regard to geomorphology, soil, water resources, and ore deposits.

GEOLOGIC SETTING

by

Henry Bell

The area to be traversed is in the belt of plutonic rocks which P.B. King (1955) called the Charlotte belt. He described this belt as lying between the Carolina slate belt on the east and the Kings Mountain belt on the west. The rocks of the Carolina slate belt are a volcanic and sedimentary sequence including pyroclastics, lava flows, and finely layered sedimentary rocks. These have been the object of several recent trips of the Carolina Geological Society. To the west, the Kings Mountain belt characterized by schists, quartzites, and marble, borders the Charlotte belt from South Carolina into North Carolina, at least as far north as Lincoln County and perhaps farther. The Charlotte belt consists of widely fractured, sheared, and intruded plutonic rocks may of which have a distinctive granitoid texture. Locally, however, strong compositional layering suggests that others were derived from sedimentary or pyroclastic rocks. The boundaries of the Charlotte belt are not sharply delineated. Fro the Salisbury-Concord area southwestward to the South Carolina border the eastern boundary has often been placed at a fault originally recognized by Laney (1910) near the town of Gold Hill. Elsewhere in the Carolinas, however, this boundary is arbitrarily placed at the change from rocks of the greenschist facies to more plutonic rocks of the albite-epidote amphibolite facies and the amphibolite facies.

The broad outlines of the structure and rock types of the Charlotte belt are known from the reconnaissance studies of LeGrand and Mundorff (LeGrand and Mundorff, 1952; LeGrand, 1954; Mundorff, 1948). They divided the rocks of Cabarrus County into seven units. These are slate and undifferentiated volcanic rocks of the Carolina slate belt, granite, syenite, gabbro-diorite and allied basic rocks, two units of granite and diorite and greenstone (fig. 1). Their greenstone unit consists of a broad band of metamorphosed basic igneous rocks intruded by granite. It lies at west edge of the Carolina slate belt. Laney (1910, p. 42) thought these rocks to be a surface flow of basic lava and tuff. In Cabarrus County, however, this unit is extremely varied and includes many massive and foliated rocks which can be grouped together only for the purposed of reconnaissance mapping. The South Carolina, Overstreet and Bell (1965, A-B) on the basis of soil maps recognized that a similar belt of basic rocks occurs associated with rocks of the Carolina slate belt. They called it amphibolite and considered it to be a unit with stratigraphic significance. In writing about the crystalline rocks of South Carolina, they used the terms Carolina slate belt, Charlotte belt, and Kings Mountain belt as a convenience in describing the rocks but felt that, in South Carolina, at least, rock units in these belts had so many features in common that stratigraphic units probably extend across all these belts. The felt that the geologic belts of King were…"zones of different grades of regional metamorphis imposed on a great thickness of volcanic and sedimentary rocks much modified by folding and by the intrusion of igneous rocks."

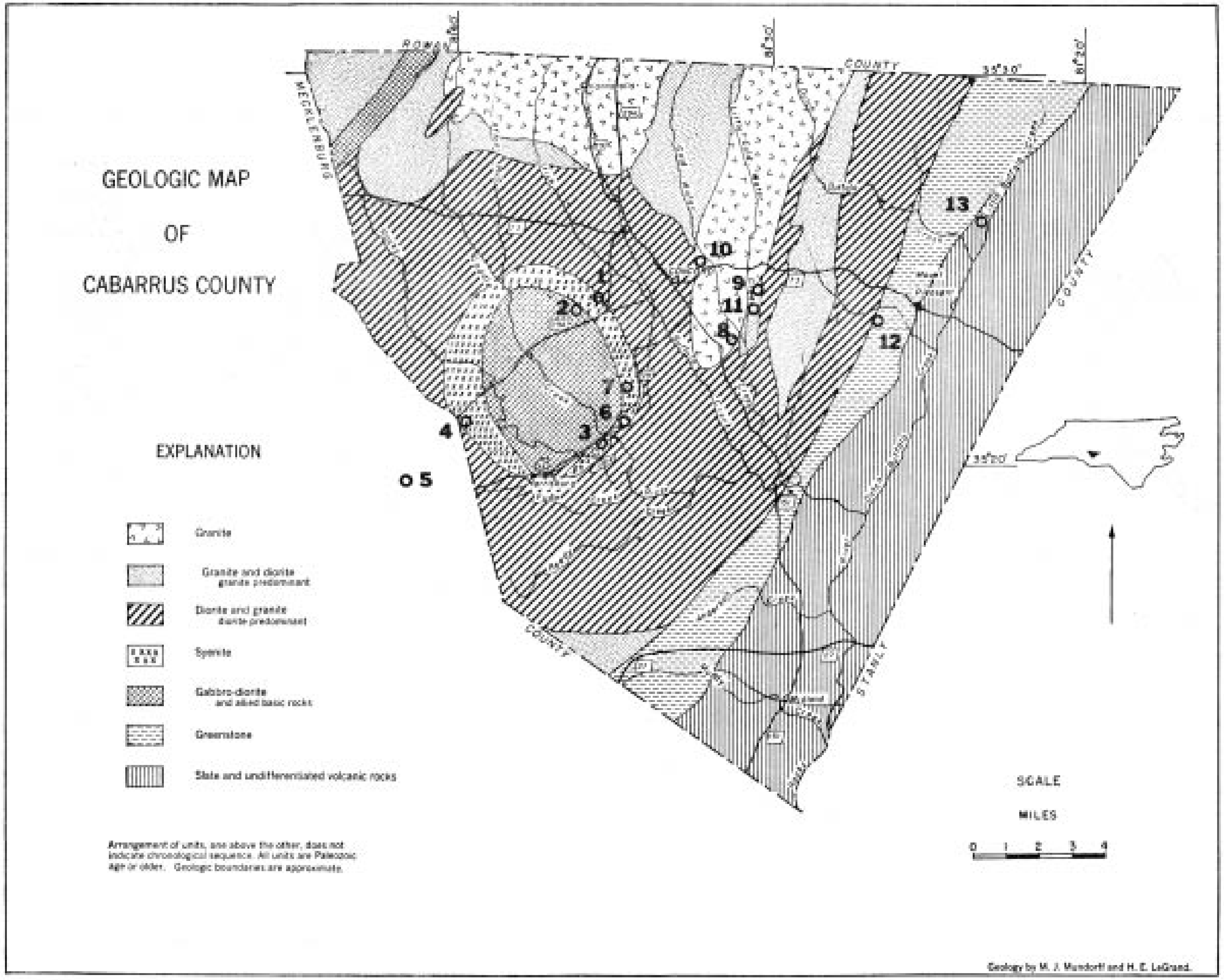

Figure 1. Geologic map of Cabarrus County, from LeGrand and Mundorff, 1952, showing approximate locations of field trip stops.

Characteristic of the Charlotte belt are plutons and other intrusive masses of various sizes and shapes. In Cabarrus County, bodies of granite, gabbro, syenite, and numerous basic dikes and lamprophyres have intruded the metamorphic rocks. At the Isenhour quarry near Concord, Bell and Overstreet (1959) studied and mapped a small artificial exposure in saprolite (fig. 2) which has since been extensively mined and is now overgrown. There they found a complex sequence of tectonic and igneous events. Six episodes of intrusion accompanied by repeated fracturing and shearing were recognized. Dikes of several ages and compositions emplaced alternately in northwesterly and northeasterly trends were mapped. Complicated sequences of events such as those exhibited by the rocks at the Isenhour quarry are characteristic of much of the area underlain by the two units composed of various amounts of granite and diorite mapped by LeGrand and Mundorff (1952) in this part of the Charlotte belt. These rocks suggest a long history of successive igneous episodes which may be resolvable through the study of intrusive relationships among the dikes and between the dikes and the plutonic rocks.

Reconnaissance geologic mapping and geophysical investigations (Bell, 1960; Bates and Bell, 1965) in the Concord area have shown four stocks of light-colored granitic rocks (fig. 3). These occur at or near Mt. Gilead, Bogers Chapel, Newell, and in the northwest part of the town of Concord. The stock at Mt. Gilead is composed of gray, biotite-and hornblende-bearing, medium-to fine-grained granite which locally contains abundant square plagioclase phenocrysts. Many granite dikes and thin concordant bodies including the porphyritic granite at the Isenhour quarry are related to this stock. Lead-alpha age determinations on zircon from the dikes of this granite in the Isenhour quarry (Overstreet and others, 1961) indicate an Ordovician or Silurian age for the granite. The other granite stocks in this area re probably of the same age. Underlying parts of Kannapolis and with a center near Enochville, Rowan County, is a nearly circular pluton of coarse-grained porphyritic biotite granite. Undeformed porphyritic granites of this type have been recognized elsewhere in the Piedmont of the Carolinas. In South Carolina, lead-alpha age determinations of zircon indicates a Permian age for similar appearing plutons (Overstreet and others, 1961).

The most prominent geologic as well as topographic feature of Cabarrus County is the mass of gabbro and the associated arcuate bodies of syenite west of Concord. The syenite is a coarse-grained rock described petrographically by Watson and Laney (1906) as an augite syenite. It occurs as two large masses, and, at least, one smaller mass bordering a central mass of coarse-grained gabbro. The gabbro and syenite weather very differently. The gabbro forms a lo area surrounded by ridges held up by the syenite which crops out locally in large boulders and pedestal rocks. Field evidence suggests that these rocks are among the youngest intrusives in the Concord area, but their age relative to the coarse-grained granite at Enochville is not know.

PROFILES OF SUBSURFACE CONDITIONS

by

Harry E. LeGrand

Introduction

Many geological reports and county soil reports have references to soil profiles and to depth to the water table at specific places, but criteria have not been developed that lead to accurate predictions of these depths at specific sites. The purpose of the following discussion is to call attention to some of the subsurface conditions in the region.

Profiles of Subsurface Conditions

In the Southeastern States a veneer of porous residual material overlies the parent igneous and metamorphic rocks. The complex of sands, silts, and clays forming the residual materials is especially common interstream areas except locally where bare rock crops out. Along most streams narrow flood-lain deposits lie either on bare rock or on residual sands and clays. Almost everywhere in the region two contrasting types of media exists through which subsurface water may move—permeable sedimentary and residual material and fractured bedrock. Examination of several thousand well records and personal observations permit the construction bedrock surface, and base of the water-bearing fractures (fig. 4). The profile reveals many significant points, among which are the following:

1. The upper ground-water medium, in which water moved *en masse* through porous granular material, includes the soil, subsoil, and upper part of the saprolite (fairly soft rotten rock retaining the structure of underlying rock is called saprolite).
2. The lower medium, in which the movement of water is confined fractures, includes the lower part of the saprolite and no more than a few tens of feet of the fresh rock.
3. The water table generally lies in the saprolite but may lie in rock at some places and in soil at others; it also may rise or fall into the other of the two media during a year.
4. In the lower medium the fractures, and consequently the stored water, decrease greatly with increasing depth.

The average profiles offer norms from which local variations may be evaluated. As there is a wide range in the depth to the water table, the depth to hard rock, and in the depth to the base of interconnecting rock fractures, the averages may serve as a guide; yet a sincere effort to evaluate a complex group of pertinent factors must be made before predictions can be much better than guesses.

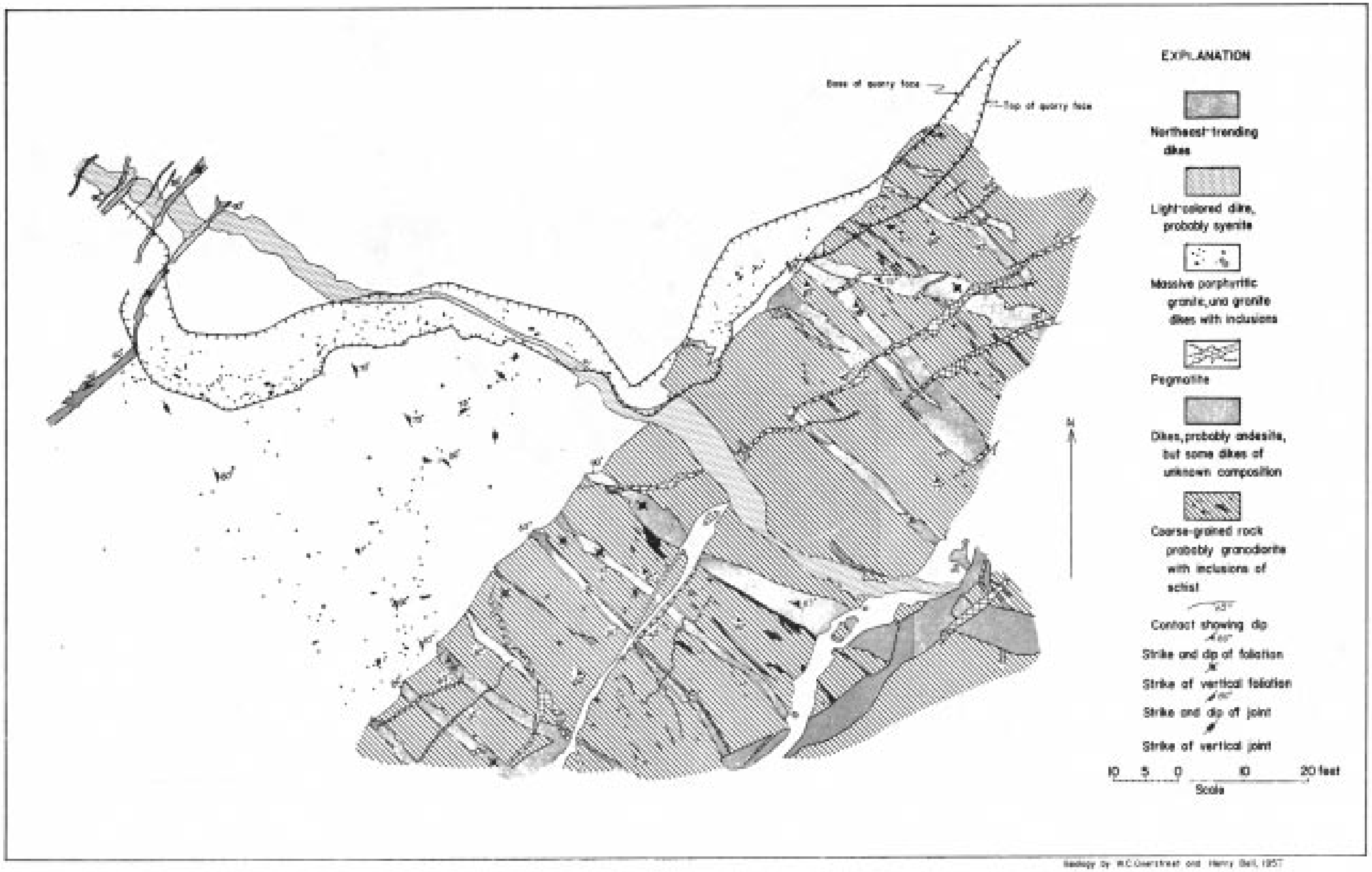

Figure 2. Geologic map of the Isenhour quarry, Cabarrus County.

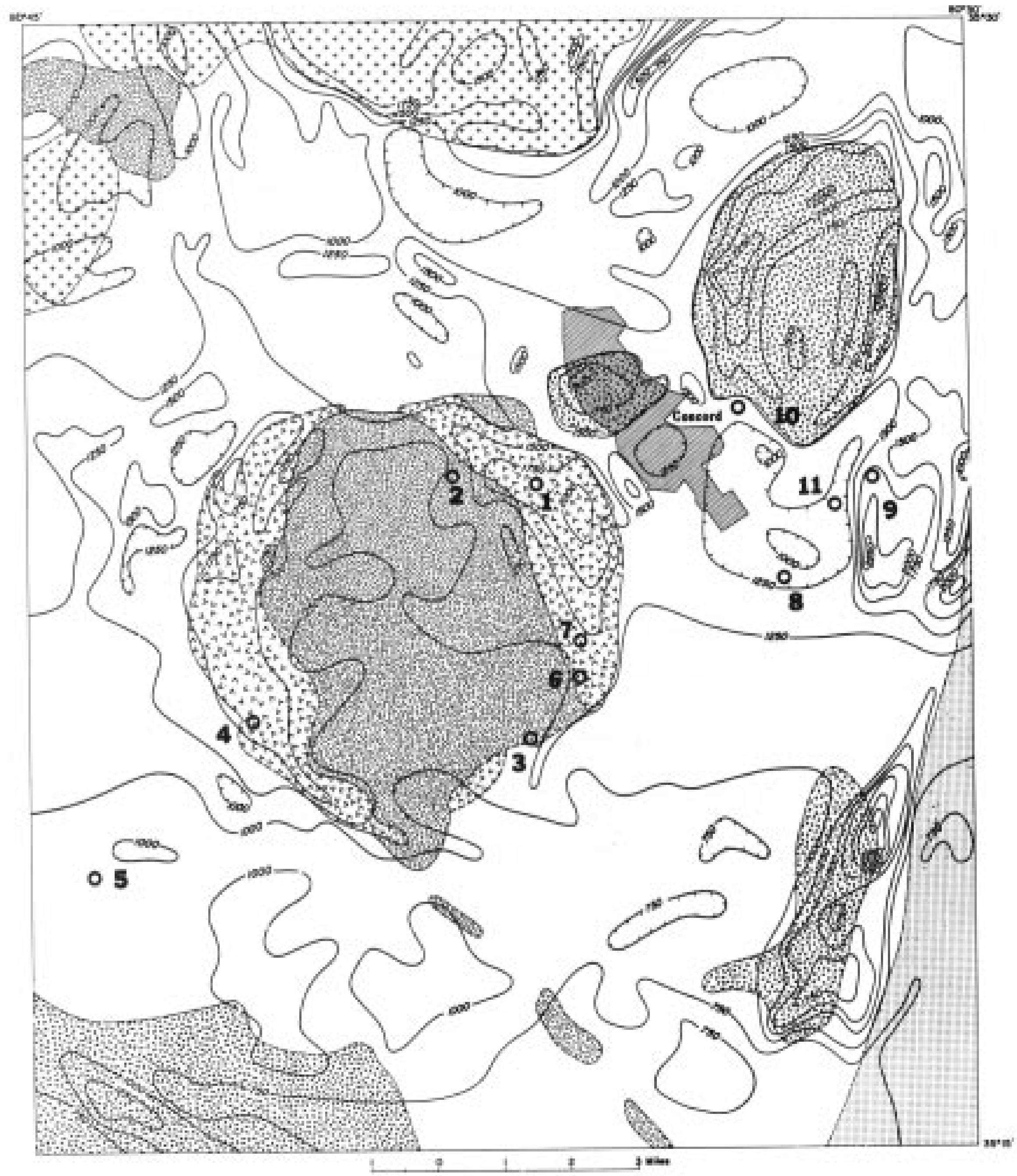

Figure 3. Geologic map of the Concord quadrangle showing radioactivity contours and approximate locations of field trip stops. Modified from Bates and Bell, 1965.

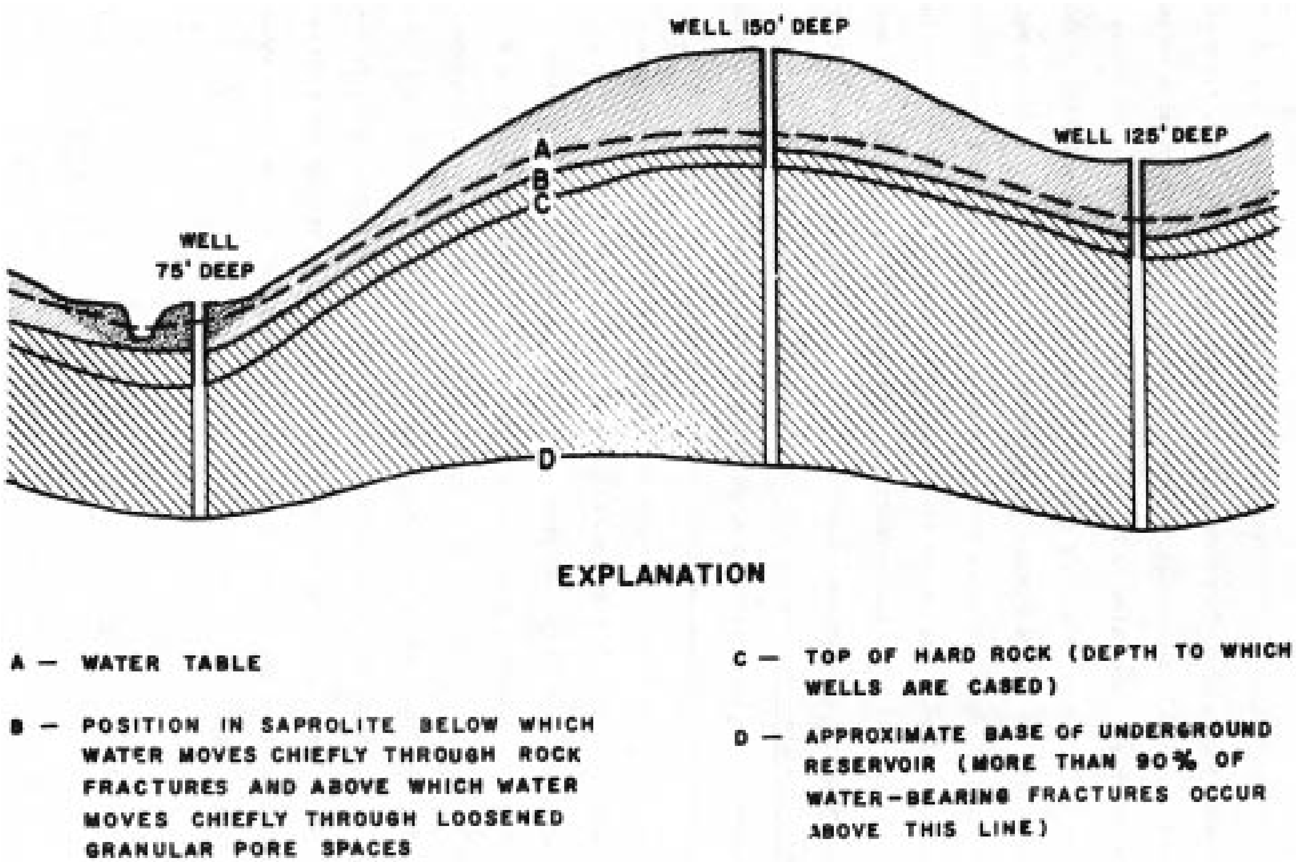

Figure 4. Sketch showing typical profile of underground conditions.

Depth to the Water Table

Major factors that control the depth to the water table on upland areas underlain by igneous and metamorphic rocks in southeastern United States are: Porosity-permeability conditions, frequency and type of precipitation, and topographic relief.

As the crystalline rocks have two contrasting types of media (1) fractured bedrock and (2) porous, somewhat granular weathered material – local variations in permeability are great. These two media have different permeabilities, but it is the permeability of the least permeable zone that tends to control the depth to the water table below uplands. A part of the weathered zone is basically a clay which has a low permeability, but tension fractures and other openings within the clay may be present to increase the permeability considerably.

We are all aware of the general rule that the water table is a sort of subdued replica of surface topography but with less relief. Thus, where hills stand appreciably higher than adjacent stream valleys the water table beneath the interstream area also is high relative to the stream valley. Yet, the water table may be relatively deep below the ground surface under hills and may be near the ground surface in stream valleys. Common depths to the water table beneath high hills are 30 to 50 feet and beneath low areas in valleys only a few feet. Between the high stage of the water table, commonly in late winter, and the low stage, commonly in late fall, the water table may fluctuate no more than 2 feet in the valleys and as much as 6 to 8 feel beneath hills.

Depth of Weathering

We are all familiar with the idea that the water table represents the level to which appreciable weathering may extend. This thought has merit when considering that some of the factors affecting the depth to the water table also affect the depth of the weathered zone; these include porosity-permeability features, climate, and topographic relief. However, other factors are to be considered. We know that solution is very much involved in weathering processes, but the extent of land subsidence as a result of solution tends to be underestimated in crystalline-rock terranes. The degree of subsidence beneath the surface of valleys and draws is greater than that beneath the convex surface of upland areas (LeGrand, 1952, p. 584). Moreover, there is a great contrast between subsidence beneath the surface of massive granites and of massive gabbros; this contrast will be demonstrated on the field trip.

The weathered zone considered herein includes the complete soil profile as described in soils reports and also partly decomposed rock that contains some structural features of the underlying fresh rock. The boundary between the weathered zone and underlying fresh rock is commonly gradational. The weathered zone ranges in thickness from zero where hard rock crops out to as much as 150 feet beneath some high interstream areas. More commonly it is 30 to 70 feet thick beneath the higher parts of upland areas and somewhat thinner beneath the lower slopes near stream valleys.

Thickness of Zone of Fractures

Ground-water studies throughout the region have shown by statistical methods that the yields of wells do not in general increase appreciably with increase of depth in the rock. From this and other facts it is well understood that in general the size and frequency of fractures decrease markedly with increase of depth. Except for data from wells and profile views of subsurface conditions in quarries and road cuts, knowledge of fracture patterns in the ground is not definite.

Although the distribution of fractures is essentially indeterminate, inferences from the following truism gives us insight into the problem; *high-yielding wells are common where thick residual soils and relatively low topographic are combined, and low-yielding wells are common where thin soils and hilltops are combined*. From this truism it can be inferred that beneath concave slopes, other than gullies and rills, fractures are either more numerous or larger than they are beneath convex slopes; also, thick soils are likely to overlie fractured rocks, whereas thin soils are not likely to overlie fractures.

Some igneous rocks, including large masses of nearly homogeneous granite and gabbro in areas of low topographic relief, contain relatively few discernible fractures; in such rocks the fracture zone may be absent. In contrast some gneisses and schists in areas of considerable topographic relief have a fracture zone beneath high interstream areas that exceeds 150 feet in thickness. The base of the zone of interconnected fractures is indefinite and arbitrary; it ranges in thickness from zero to more than 150 feet, but most of interconnected fractures are in a zone generally no more than 50 feet thick which includes the upper part of fresh rock.

GEOCHEMISTRY OF WATER

by

Harry E. LeGrand

The igneous and metamorphic rocks in the Concord area vary considerably in chemical composition, and consequently in solubility. Each major chemical type yields ground water having a distinctive chemical character; enough contrast generally exists for chemical analyses of ground water to be an aid in geologic mapping where outcrops are scarce. The rocks may conveniently be divided into two groups regarding their chemical composition and the composition of the water they contain. The first group includes granite, granite gneiss, mica schist, slate, and rhyolite flows and tuffs; these rocks approximate granite in composition. They are rich in silica, and poor in calcium and magnesium. The second group includes diorite, gabbro, hornblende gneiss, and andesite flows and tuffs; these rocks approximate diorite in composition. They have less silica and more calcium, magnesium, and iron. The granite group yields a soft, slightly acidic water that is low in dissolved mineral constituents; in contrast, the diorite group yields a hard, slightly alkaline water that is high in dissolved material.

Table 1 shows average chemical analyses of ground water from the granite group and from the diorite group. Included in the table is an analysis of water from a well in gabbro at the town of Harrisburg. Also included are analyses of water from the mine shaft at the Phoenix gold mine and of water from the Barnhart gold mine at Gold Hill in Rowan County. It should be noted that the water from wells at the mines are relatively high in mineral matter, especially in sulfate. The high sulfate content suggests mineralization from a sulfide zone.

Even though there is little evidence that chemical analyses of water have materially aided in the exploration of mineral deposits in the igneous and metamorphic rocks of the southern Appalachians, the potential use may be considerable (LeGrand, 1958, p. 186) (Price and Ragland, 1966). The prevalent contrast between the chemistry of a mineralized zone and that of the adjacent country rock may be reflected by corresponding contrasts in the chemical character of the water.

SOILS

by

Harry E. LeGrand

In the Piedmont Province the soils have an inherent relation to the underlying rocks. Some aspects of this relation are so striking that soil units can be used effectively in mapping general types of rocks. The following four groups of soils can be defined in the excursion area: those from acid crystalline rocks, those from basic crystalline rocks, those fro mixed acid and basic rocks, and those from rocks of the Carolina slate belt. Although there is a great local range in soil thickness throughout the area, in aggregate the soils tend to be thinner and less mature than those of much of the Piedmont Province of the Southeastern States.

The soils map of Cabarrus County prepared in 1910 indicates that soils of the Cecil series underlie upland areas where granite is predominant. Soils of syenite are also

Table 1: Assorted Chemical Analyses Chemical constituents (in parts per million, except pH

Water Source	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (C1)	Fluoride (F)	Nitrate (NO_e)	Dissolved Solids	Hardness as $CaCO_3$	pH
1. Granite (Represents average of 29 analyses)	30	0.2	5	2	7	34	2	2	0.1	0.9	71	23	6.5
2. Diorite (Represents average of 23 analyses)	32	.2	38	12	11	127	17	14	.1	1.3	233	145	7.1
3. Well 79 feet deep in gabbro at Harrisburg	56	.06	32	16	25/1.1	203	10	13	.2	2.7	256	145	6.8
4. Phoenix gold mine, Cabarrus County (Water from mine shaft)	27	.02	73	26	20/3.9	212	147	8.2	.0	.1	427	200	7.7
5. Barnhart gold mine, Rowan County (Water from mine shaft)	--	--	--	--	--	70	200	12	--	--	--	215	7.3

placed in the Cecil series. The Cecil soils have a light colored surface layer and a slightly red subsoil.

Gabbro and diorite produce brown soils of the Mecklenburg and Iredell series. The subsoil is a firm clay, generally yellowish-red or brown. Soils of the Mecklenburg series typically occur in the large gabbro area between Stops 2 and 3 and Harrisburg. The Mecklenburg soils in this area are relatively low in permeability. In spite of subdued topographic relief, which is a factor tending to retard erosion, the soils are thin.

The close interspacing of rocks approximating granite in chemical character and of those approximating diorite in character lead to difficulty in mapping the boundaries of soils overlying these intermixed rocks. Except for the larger masses of granite, syenite, and gabbro, much of the county west of the Carolina slate belt is in this category

Soils underlying the Carolina slate belt belong chiefly to the Georgeville and Alamance series. The soils are low in mica and quartz content and are characteristically silty throughout their profiles. The soils derived from the slate belt are commonly gray in color, the Georgeville having a predominant red subsoil and the Alamance a predominant yellow subsoil. Fragments of slaty rocks are common in the subsoil (Lee, 1955).

GEOCHEMICAL AND HEAVY-MINERAL RECONNAISSANCE

by

Henry Bell

Gold has long been known in the Concord area. Many nuggets have been found, including a very large one of 28 pounds near the Reid Mine in 1803 (Pardee and Park, 1948). A large group of mines is near the boundary between rocks of the Carolina slate belt and the more plutonic rocks of the Charlotte belt. Many occur in the area through which the Gold Hill fault has been projected (Laney, 1910), and this area is called the Gold Hill district. Gold has been mined from placers and veins. The vein deposits in the Concord area contain scheelite and base metals as well as gold. Recent geochemical and heavy mineral reconnaissance has shown that the gold, scheelite, and possibly base metals are widely distributed in the Concord area and are not restricted to the vicinity of the contact between the Carolina slate belt and the Charlotte belt.

The geochemical reconnaissance (fig. 5) was made by collecting heavy mineral concentrates from alluvium and samples of alluvial clay and silt from streams having drainage areas of 0.1 to 1.5 square miles. The heavy mineral concentrates were inspected for visible gold and scanned with ultraviolet light for scheelite. The alluvial clay and silt were analyzed for copper, lead, zinc, nickel, and molybdenum in laboratories of the U.S. Geological Survey using

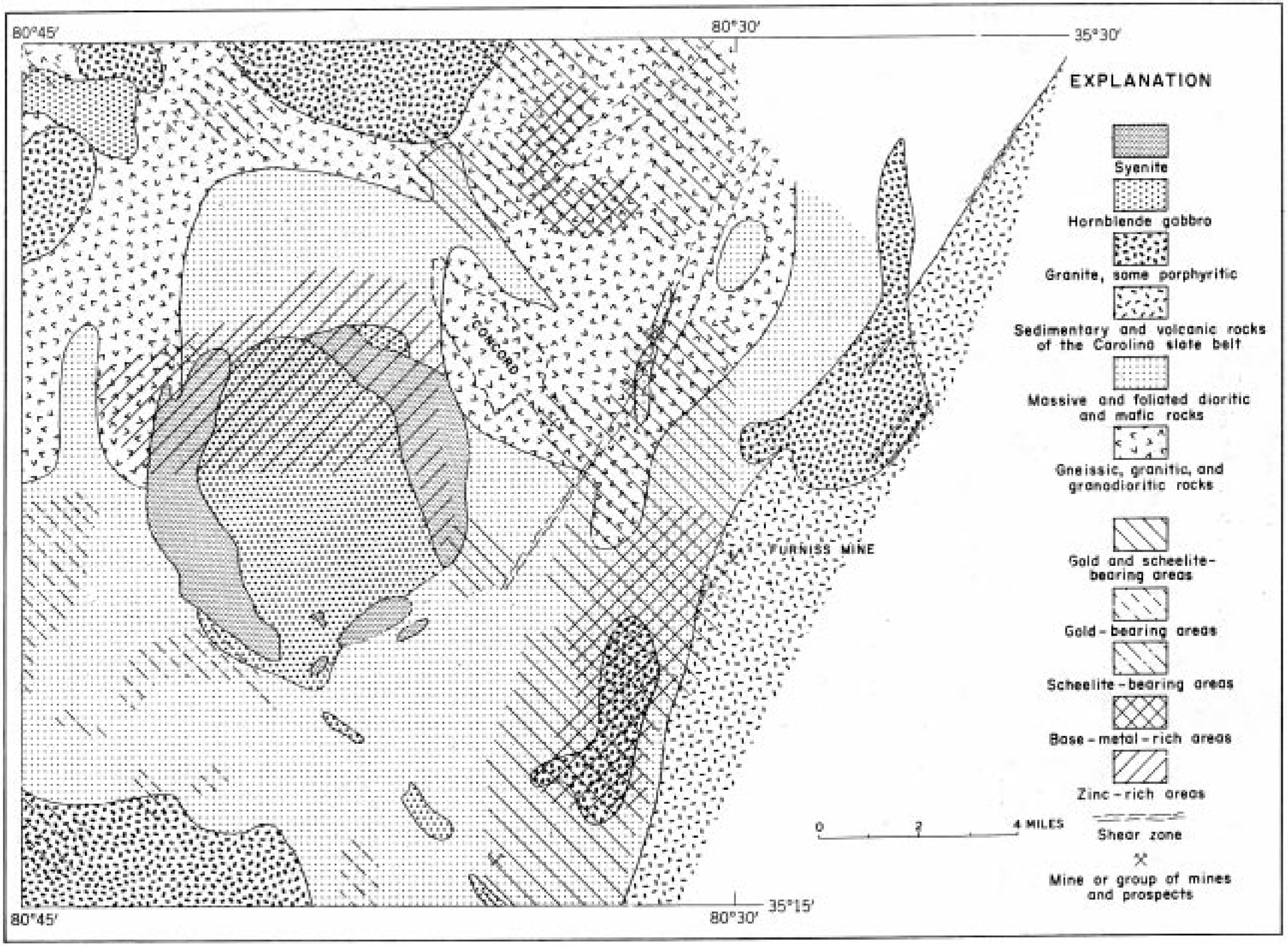

Figure 5. Map showing results of geochemical and heavy-mineral reconnaisance. From Bell, 1960.

rapid methods of analysis (Overstreet and Bell, 1960). The results showed the gold and scheelite to be widely distributed and the samples from certain areas, particularly the vicinity of Bogers Chapel, to be high in base metals in addition to containing gold and scheelite. No gold or scheelite was found in drainage basins confined to areas underlain by the gabbro-syenite ring structure, but samples of clay and silt from these areas did show high values for zinc and nickel. The base metal content of magnetite separated from heavy mineral concentrates panned from alluvium was examined and analyzed by P.K. Theobald and C.E. Thompson of the U.S. Geological Survey. The results showed comparatively high values for zinc in magnetite from concentrates collected from areas underlain by the gabbro-syenite ring structure where higher than average values for zinc occur in alluvial clay and silt. In other areas, the base metal content of magnetite is characteristically different and apparently does not show a close relationship with that in the alluvium.

At the Heglar prospect near Mt. Pleasant, mineralized rock occurs that is of interest because the associated minerals indicate a type of mineralization not known elsewhere in the Gold Hill district (Sundelius and Bell, 1964).

Disseminated pyrite occurs there in an andradite-opal-chalcedony-quartz gangue associated with a significant amount of cerium and other rare earth elements. Higher-than-average radioactivity has been detected in this area. The association of unmetamorphosed low-temperature products of silicification such as opal and chalcedony within a group of deposits generally characteristic of mesothermal deposition suggests that mineralizing solutions have been introduced over a significant range of temperature and time in this area.

ROAD LOG[1]

Saturday

Colonial Motor Court, Concord, US 29 North
Departure time: 8:30 A.M.

Totall Mileage	Pt. to Point	
0.0		Leave assembly point heading south on US 29
2.3	2.3	Outcrop of granite on left.
3.3	1.0	Turn right on route 1414 at junk yard.
3.6	0.3	Turn right on gravel road “Kennedy’s Recapping sign. Note syenite boulders on left side of road. Tire shop on right.
4.1	0.5	**Stop 1:** Building and monumental stone is quarried here at intervals. The facing of the new North Carolina National Bank Building in Raleigh is fro this quarry. Note darkness of the stone relative to the more weathered syenite elsewhere on the trip.

1.See Figure 6.

The syenite forms a distinctive ring-shaped mas composed of two arcuate-shaped bodies. These bodies surround and locally cut a coarse-grained dark gabbro. Watson and Laney (1906) gives the following description of the syenite. It is…”microscopically, a coarse-textured, augite-hornblende-biotite syenite composed very largely of feldspar with slight quartz, and the accessories mentioned. The feldspars are orthoclase, microcline, microperthitic intergrowths, and subordinate plagioclase (oligoclase).

These are usually rimmed by a wide zone, or border, of a very fine grained mosaic of the feldspar as a result of extensive pressure metamorphism. The feldspars are further filled with minute closely crowded hair-like inclusions of rutile and small particles and granules of magnetite and minor accessories. Green augite (diopside) is the principal ferromagnesian silicate. Hornblende of green color exceeds biotite in amount. Both the hornblende and the biotite show some alterations. Considerable magnetite, some kaolin, and a few grains of pyrite, with minor microscopic accessories occur.”

No difference has been noted in the syenite from the two masses that would suggest independent origins or histories. The rock is quite uniform in grain-size even up to the contact with the metamorphic country rocks. Only one place is known where this contact can be seen. The contact with the coarse-grained gabbro can be located within a short distance, but no exposures have been found. The rock contains inclusions which can be seen particularly well in the rock near Jackson Training School and in the magnificent polished slabs facing the North Carolina National Bank in Raleigh. It is cut by diabase dikes of Late Triassic (?) age, several types of deeply weathered dikes, probably lamprophyres, and by thin pegmatite dikes. Field evidence indicates that the syenite and associated gabbro are the youngest intrusive rocks in the Charlotte belt with the exception of the dikes mentioned.

Age determinations of zircons give apparent lead-alpha ages of 305 and 540 million years for splits of a zircon sample from the syenite (Overstreet and others, 1961). These ages seem to contradict the field evidence. It is interesting to note that the syenite contains more zircon than any of the other bedrock samples reported by J.B. Mertie, Jr. (1958), in his study of zirconium and hafnium in the Southeastern Sates. He reports for the syenite 0.12 percent zircon in bedrock with a Hf-Zr ratio of 0.018 by spectrographic methods

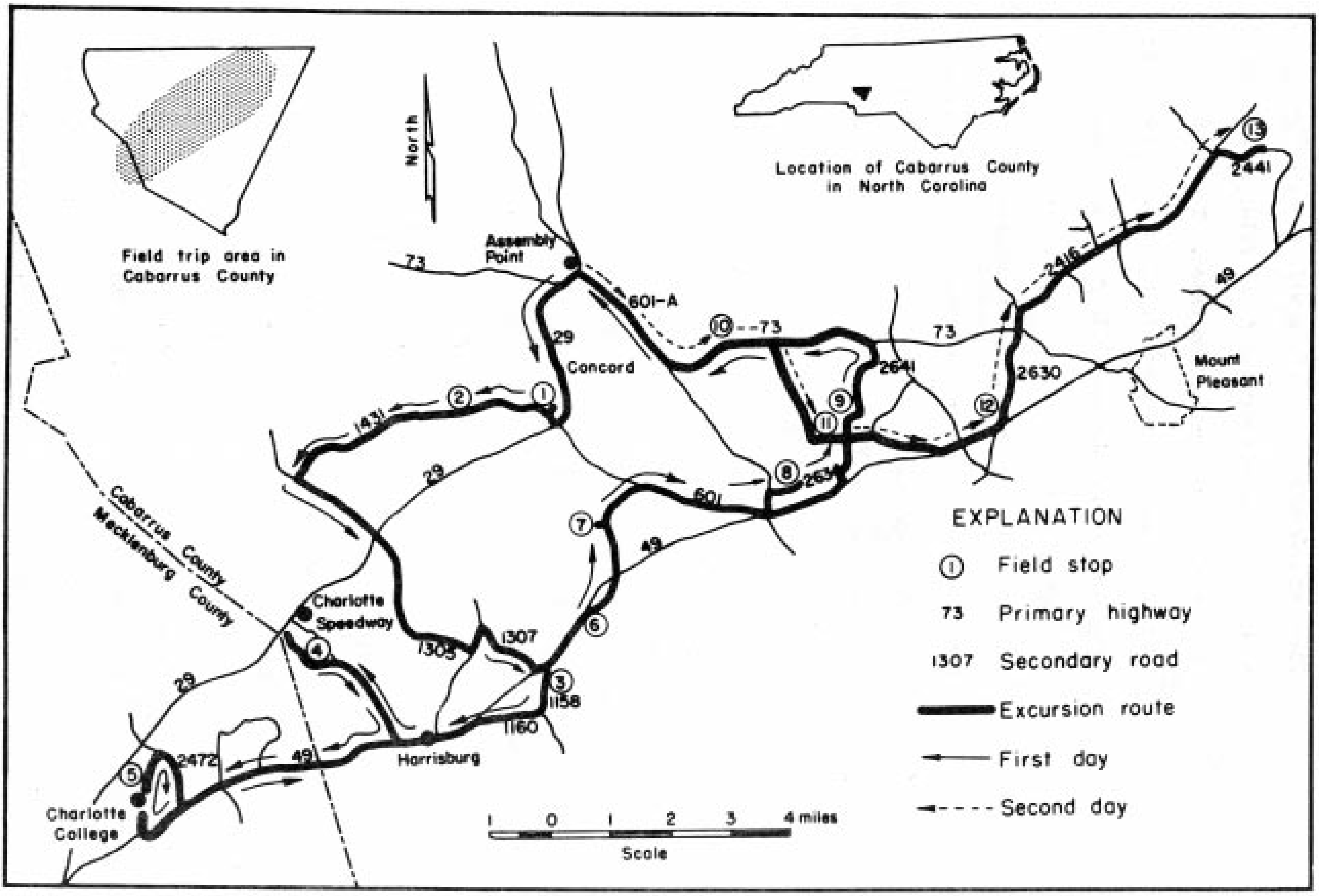

Figure 6. Excursion route and field stops.

and 0.016 by X-ray fluorescence methods. Low lead and alpha activity of the zircon from the syenite made analysis for age determination purposes difficult.

The origin and history of the syenite and the coarse-grained gabbro are undoubtedly related. Morgan and Mann (1964) have suggested that,…"the syenite was emplaced in a fracture zone created by the intrusion of an earlier highly discordant gabbro stock," and this seems to fit the field evidence.

4.7 0.6 Return to paved road 1414. Turn right on 1414. We are traveling north on the northern rim of the syenite dike. Large valley underlain by gabbro to out left.

5.1 0.4 Turn left on road 1431.

6.2 1.1 **Stop 2:** Gabbro in ditches. Note low subdued valleys in gabbro (discussion of soil and subsurface conditions at this stop). Continue on road 1431.

Dark gabbro forms the central area around which the arcuate masses of syenite occur. Locally, the gabbro occurs outside the ring of syenite as near Concord where it is apparently cut by the syenite. South of Harrisburg, several small isolated masses occur along a southeast trend. The rock is predominately coarse grained hypersthene-bearing hornblende gabbro. Variations in mineral content and composition exist and probably account for the pronounced concentric pattern within the pluton revealed on aerial photographs (Ray, 1960). Little of a detailed nature has been published on the petrology of these rocks. Recently, however, attention has been called to numerous other similar shaped gabbro masses in the Piedmont of North and South Carolina (Overstreet and Bell, 1965B; Butler, 1965). Butler and Ragland (1966) report that these plutons…"contain rocks ranging from ultramafic crystal cumulates with 35 percent olivine to biotite-hornblende diorite with 11 percent quartz, although the complete range has not been found in any one intrusive. As a result of their work, they suggest that the syenite here and at Mt. Carmel, S.C., formed by differentiation of gabbroic magma. The Carolina Geological Society last year saw anorthosite associated with a similar gabbro in York County, S.C. The gabbro is cut by numerous quartz veins that produce a stony rubble in many fields. Less common are thin pegmatitic veins or dikes. Amethystine quartz of good color and in clusters of euhedral crystals has been found in the area. The amethyst was in vugs apparently in quartz-feldspar veins. Fragments of euhedral quartz crystals are occasionally found on the surface of certain stony fields. Some of these crystals are sagenetic. The included acicular crystals have not been positively identified but may be either goethite or rutile.

Geophysical data (Morgan and Mann, 1964; Bates and Bell, 1965) indicate that the gabbro is a steep-sided intrusive. Magnetic data show that the small isolated bodies of gabbro to the south of Harrisburg are connected with the main mass of gabbro along a narrow zone with a southeast trend. This trend, one of the two conspicuous trends of joints and dikes at the Isenhour quarry, suggests some structural control for the emplacement of the gabbro. A series of sharp, high-amplitude, discontinuous magnetic anomalies occur superimposed on the larger magnetic anomaly associated with the gabbro and syenite. These smaller high amplitude anomalies are parallel to the contacts between gabbro and syenite and the surrounding metamorphic rocks. An airborne radioactivity survey was made in conjunction with the magnetic survey by the U.S. Geological Survey. Higher-than-average radioactivity was observed over the two large syenite bodies of the complex (Bates and Bell, 1965).

9.0 2.8 Turn left on 1305.

10.5 1.4 Intersection of US 29. Continue south on road 1305.

12.9 2.4 Note brown soils of the Mecklenburg series and the subdued topography underlain by gabbro.

13.4 0.5 Turn left on road 1304.

13.8 0.4 Turn sharp right on road 1307.

Note broad valley or morass at road junction.

14.5 0.7 Boulders of gabbro and solution valley without perennial stream.

15.0 0.5 Junction of route 49. Turn left on 49.

15.2 0.2 Turn right on road 1158. **Be careful at railroad crossing.**

15.6 0.4 Turn left on 1159.

16.2 0.6 **Stop 3:** Boulder of gabbro along road and flat lying outcrop of gabbro nearby in field. Large morass underlain by gabbro in foreground. Walk south for 200 years to see granite-diorite complex. Continue south on road 1158.

16.6 0.4 Turn right on gravel road 1160 at Rocky River. The road surface is disintegrated syenite from quarry similar to that at stop 6.

17.9 1.3 Turn left on route 49.

19.1 1.2 Rest stop at Harrisburg.

19.1 0.0 Turn right on road 1300. Boulders of gabbro along this rock.

20.8 1.7 Turn left on gravel road 1302.

21.6 0.8 Note anvil rock on right.

21.9 0.3 Turn around noting large boulders.

22.4 0.5 **Stop 4:** Flat lying outcrops of syenite near road. Note thin soil composed largely of disintegrated feldspar crystals.

22.9 0.5 Return to route 49 at Harrisburg.

24.6 1.7 Turn right on road 49.

28.7 4.1 Turn right into Charlotte College on route 2834. Turn left to administrative and student building.

29.1 0.4 **Lunch at cafeteria.** Following lunch the group will assemble on road 2834 north of college at stop 5 where a demonstration of a heavy mineral panning technique will be conducted.

29.3 0.21 Turn left. Continue on route 2834.

30.0 0.7 **Stop 5:** Continue to small creek where a heavy-mineral panning technique will be demonstrated.

30.2 0.2 Continue on route 2834 to junction with road 2833; turn right.

31.0 0.8 Stay on road 2833 to highway 49; turn left.

32.1 1.1 Continue on highway 49 east past Harrisburg.

37.8 5.7 Cross Rocky River.

39.7 1.9 Turn right on concrete road 1157 and park near gravel pit.

Stop 6: Gravel pit operated by State Highway Department. Disintegrated syenite in form of feldspar crystals used for surfacing of secondary roads. Continue north on concrete road.

40.5 0.8 Intersection of 49. Continue north by Jackson Training School noting large syenite boulders and outcrops at the school

41.2 0.7 Turn left on road 1312 at cemetery.

41.3 0.1 **Stop 7:** Do not dismount. Observe slabby layers of hard syenite in gravel pit resulting from differential weathering. Notice the gross differential weathering and erosion between the syenite and the gabbro at our left, the syenite being more resistant to solutional erosion (Fig. 7 showing stops, 7, 6, and 3).

"Ring dike about 1 mile wide and an area of gabbro-diorite within the ring dike can be differentiated from surrounding areas primarily on the basis of the lesser tree coverage and greater land use within the ring-dike area. A ring structure is also suggested by the concentric pattern of trees, A, which may reflect structure within the igneous rocks. The contact of syenite of the ring dike and gabbro-diorite of surrounding areas cannot be identified in the stereoscopic model, and aerial photographs of this terrain serve primarily to differentiate anomalous features which then must be examined in the field. Note excavation in syenite of the ring dike." (Ray, 1960).

41.4 0.1 Turn right on 1313.

41.5 0.1 Turn left on road 1157.

41.8 0.3 Turn right on 1157. Junction of road 1335.

42.8 1.0 Turn right on US 601.

44.8 2.0 Turn left on 601 business

44.9 0.1 Turn right on road 2634.

45.7 0.8 **Stop 8:** Note considerable topographic relief in this area underlain by granite and diorite. The distinctive V-shaped valleys contrast with the broad subdued u-shaped valleys underlain by gabbro in the Harrisburg area. Return to 601.

46.5 0.8 Turn left on old 601.

46.6 0.1 Turn left on road 49 – 601.

46.8 0.2 Turn left on 49 north.

48.2 1.4 Turn left on road 2636.

49.0 0.8 Crossing of road 2635. Go north on road 2641. Broad sag in topography above head of steep valley.

49.5 0.5 **Stop 9:** Large man-made trench in diorite-granite complex near Lake Lynn Lodge.

51.4 1.9Travel north on road 2641. Junction of road 73.

56.8 Take road 73 into Concord and 601 north to motel.

Sunday

Colonial Motor Court
Departure time: 8:45 A.M

Totall Mileage | Pt. to Point

0.0 Travel south on business 601 and 73 to the center of Concord.

2.1 2.1 Turn left on route 73 in Concord.

2.8 Granite-diorite complex on left in artificial exposure.

3.0 0.2 Deep weathering of gneissic granodiorite cut by dark colored dikes.

3.2 0.2 **Stop 10:** Turn in on left at the Stow A-way Fish House. This artificial exposure is across the road fro the Isenhour quarry which was mapped in detail by Overstreet and Bell, 1959, (fig. 2) and which is now much overgrown. Many of the same features can be seen here. The oldest rock here, as at the Isenhour quarry, is a gneiss, and probably granodiorite in composition. It is cut by at least two sets of dark-colored dikes. One set trends northwest and a younger set northeast. These are two of the sets mapped at the Isenhour property. The older set probably is of andesitic composition whereas the younger set rich in biotite may have lamprophyre affinities. The light-

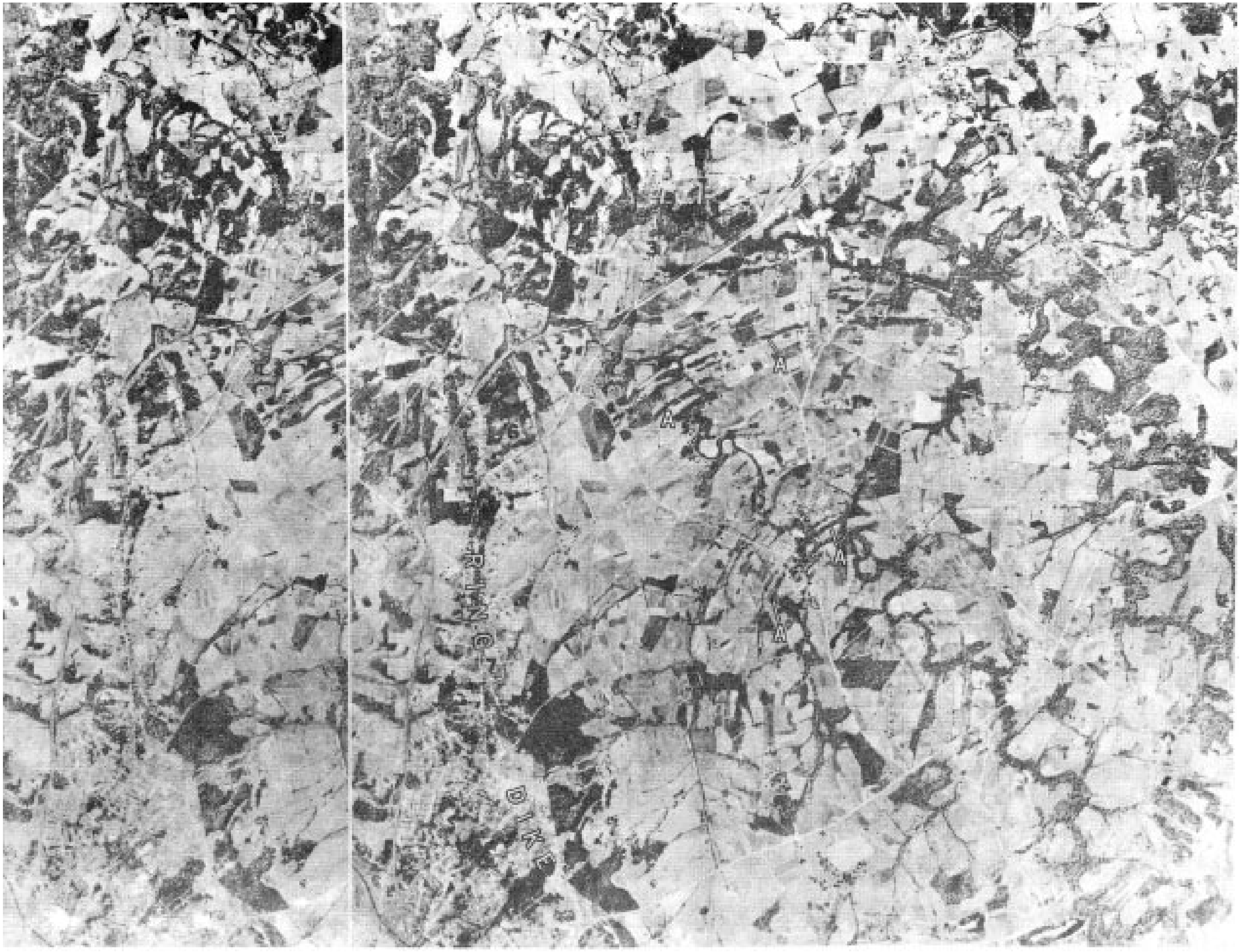

Figure 7. Air photo of ring-dike area south of Concord. (Approximate scale 1:58000) See description Stop 7, page 13.

colored dike, probably syenite, which has been found at the Isenhour quarry and elsewhere, is not seen here.

3.8 0.6 Continue on route 73 across Coldwater Creek to junction road 2408.

3.9 0.1 Continue straight on route 73 to road 2643; turn right.

5.8 1.9 Continue on road 2643 to road 2635; turn left.

6.1 0.3 Cross Little Coldwater Creek, stop on side of road;

Stop 11: This road cut exposes highly foliated and layered metasedimentary and metavolcanic rocks some of which are suggestive of rocks that occur in the Caroline slate belt, at least five miles farther east. The rocks here are part of a narrow belt that can be traced for a considerable distance to the northeast although discontinuous locally as in the vicinity of the Lake Lynn cut seen on Saturday. Elsewhere in the Concord quadrangle similar rocks have been noted, and they probably make up a significant but unknown proportion of the area shown as gneiss and schist on figure 3.

6.3 0.2 Continue on road 2635, cross road 2641.

8.0 1.7 Continue on road 2635 to highway 49, turn left.

9.1 1.1 Continue on highway 49, turn left on road 2630.

9.3 0.2 Continue and park on road shoulder,.

Stop 12: This road-cut expose rocks which occur in a significant proportion of the Concord area. They are part of a belt of metamorphosed basic igneous rocks which have been observed at the western edge of the Carolina slate belt in both North and South Carolina. Laney (1910, p.42) thought similar rocks to be formed from a surface flow of basic lava and tuff. They are, however, extremely varied not only in detail as in this exposure but also regionally.

10.6 1.3 Continue on road 2630 to highway 73.

10.7 0.1 Jog left on highway 73 to road 2414; note rocks similar to those at stop 12 in road cut on right. Turn right on road 2414.

11.0 0.3 Pass St. James Lutheran Church, turn right at road 2416.

13.1 2.1 Continue on road 2416 across road 1006.

15.3 2.2 Continue on road 2416 to road 2441, turn right.

16.5 1.2 Continue on road 2441, stop on shoulder of road.

Stop 13: The rocks at this outcrop are more characteristic of the Carolina slate belt than the more plutonic rocks of the Charlotte belt farther west in Cabarrus County. A similarity, however, may be noted between these rocks and those at stop 11. There is much evidence of shearing here and these rocks may be part of a fault zone. Laney (1910) projected the Gold Hill fault down the valley of Little Buffalo Creek which occupies the valley to the east. This valley also marks an abrupt change in topography, the area to the east being characteristic of the Carolina slate belt and the area to the west characteristic of the Charlotte belt. Air-borne geophysical studies also show a distinct change in the magnetic character of the area to the east compared with the western portion of the county.

16.8 0.3 Continue on road 2441 to road 2442; turn right.

18.3 1.5 Continue on road 2442 to highway 49. Field trip ends here.

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