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Preliminary results of coring the Mesozoic diabase sheet near Reesers Summit, New Cumberland, Pennsylvania

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with a section on magnetic susceptibility investigations

by

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INTRODUCTION

Two continuously cored vertical holes 325 and 873 feet deep were started in May and completed in July, 1987 at New Cumberland, York County, Pennsylvania in the Steelton 7 1/2-minute quadrangle (fig. A1). The cores were cut at two sites on either side of Interstate Route 83 at Reesers Summit (fig. A2), where a roadcut section exposes the upper half of a tilted 1280 to 1650 ft (388-500 m)-thick diabase sheet in the northeastern part of the Gettysburg basin. USGS Reesers Summit No. 1, approximately 2000 ft (600 m) southwest of the I-83 roadcut (fig. A2), cored 325 ft (100 m) of the middle part of the diabase sheet (fig. A3). USGS Reesers Summit No. 2, approximately 1000 ft (300 m) north-northeast of the I-83 roadcut (fig. A2), cored 630 ft (190 m) of the lower part of the diabase sheet and 243 ft (75 m) of the underlying thermally metamorphosed Triassic rocks (fig. A3).

The diabase, partially exposed at Reesers Summit, is part of the York Haven sheet, a large (15 x 6 mi; 24 x 10 km) irregularly-shaped intrusive complex straddling the Susquehanna River south of the state capital, Harrisburg. The southern and eastern flanks of the sheet near York Haven are characterized by thick zones (as much as 2500 ft - 750 m) of cumulus orthopyroxene, whereas the northern and western portions (about 1000-2000 ft - 300-600 m thick) contain extensive zones of coarse-grained late-stage differentiates - ferrogabbro, granophyre, and pegmatoids. The late-stage differentiates are believed to be complementary fractions to and laterally continuous with the orthopyroxene-rich cumulate zones (Smith, 1973; Froelich and Gottfried, 1985). The southern flank of the saucer-shaped sheet is paraconformable with stratification of the enclosing Triassic sedimentary rocks that dip regionally northward at moderate angles (10-40 degrees) towards the normal border fault, whereas the other margins of the sheet cut across the bedding of the Triassic strata at steep angles. The northwestern margin, at Reesers Summit, dips southeastward at about 35 degrees.

The geochemistry of the cumulate part of the York Haven diabase sheet is documented extensively by Smith (1973) and Smith and others (1975). The chill margins of the sheet, at York Haven and at Reesers Summit, is characterized as a high titanium, quartz-normative tholeiite (HTQ). The tilted, iron-enriched gabbroic section with sparse sulfides exposed along I-83 was systematically sampled at 100 ft (30 m) intervals in 1984. Analyses for platinum (Pt) and palladium (Pd) at the U.S.G.S. Analytical Laboratory in Reston, Va. indicated an anomalous zone enriched in Pd almost 300 ft (90 m) thick about 350 ft (105 m) below the upper contact (Gottfried and Froelich, in press); this zone is largely coincident with magnetite-rich gabbros with locally high magnetic susceptibility. The coring sites were chosen to sample the lower part of the diabase sheet, which is largely concealed in this area, and to try to determine lateral changes in and near the ferrogabbroic part of the sheet away from the I-83 roadcut exposures.

The information contained in this report is preliminary and the core descriptions are based solely on megascopic determinations using 10 and 14 power hand lens. The rock descriptions are supplemented, however, by detailed magnetic susceptibility logs and by other geophysical logs. Final evaluation and mineralogical determinations will be based on petrographic examinations of thin-sections and on chemical analyses of selected representative samples.

REESERS SUMMIT I-83 NORTHEAST ROADCUT EXPOSURE

The road cut exposes approximately the upper-half of the 2050 ft (625 m) surface width of tilted diabase, with the top to the southeast (fig. A3). The calculated thickness of the tilted sheet ranges from about 1280 to 1650 ft (388-500 m). The amount of uncertainty depends on the inferred angle of dip (35-40 degrees), the slope of the road (about 3.5 degrees), local thickness irregularities, whether or not the concealed part of the sheet is duplicated or eliminated by concealed faults, and if the dip of the inclined sheet flattens or remains consistent with the dipping upper contact.

The roof of the York Haven diabase sheet exposed on the southeast at Reesers Summit is comprised of Triassic metaconglomerate with interbeds of hard, brittle quartzite and pebbly meta-arkose with a strike of N 45^{o}E, and a dip of 10^{o}NW. The metaconglomerate is poorly sorted, with pebble- to cobble-sized, subrounded clasts of quartzite and limestone, the latter converted to medium- to coarsesly-crystalline marble with lime- and yellow-green, coarse, euhedral garnet crystals. The intrusive contact with diabase is discordant to bedding (strike N 30^{o}E, dip 35^{o}SE). The chill margin of the diabase in a 2- to 3-ft-wide (1 m) zone below the upper contact is nearly black, aphanitic, brittle with hackly fractures, and cut by numerous joints. For the next 20 ft (6 m) the aphanitic diabase grades insensibly to microcrystalline to very fine crystalline to fine crystalline diabase, and about 30 ft (9 m) below the contact, is medium crystalline, dark gray diabase consisting of an interlocking mosaic of clinopyroxene and plagioclase with minor chlorite. From 30 to about 275 ft (9-84 m) below the upper contact, the diabase is predominantly medium gray, with a uniform medium crystalline subophitic texture consisting of subequal amounts of plagioclase and clinopyroxene; this part of the diabase is cut by numerous joints dipping 15, 30, 45, 60 degrees and near-vertical. From 275 to about 550 ft (84 to 168 m) the sequence is mainly a brownish-gray, coarse- to very coarsely-crystalline quartzose melanogabbro, with local pegmatitic and granophyric pods in the upper part. Coarse, subhedral, twinned, plagioclase laths are intergrown with very coarse twinned clinopyroxene, and both are enclosed by abundant interstitial magnetite, minor quartz, and rare sulfides, including pyrite and chalcopyrite. The ferrogabbro weathers to a dark red saprolite, and the bedrock is stained brown from limonite. Steep intersecting limonite-stained joints are common and are spaced 1 to 3 ft (0.3 to 1 m) apart. The coarsely crystalline ferrogabbro is underlain by coarse-to medium-crystalline, dark gray magnetite-rich melanogabbro from 550 to about 825 ft (168 to 252 m). From 825 to about 900 ft (252 to 274 m) medium gray, medium- to coarse-crystalline diabase with less abundant interstitial magnetite is more common than ferrogabbro. The continuous road cut exposure ends in a covered interval, but about 400 to 500 ft (120 to 150 m) below the last continuous road cut exposure, a ledge of medium-gray, medium crystalline diabase, similar to that in the exposed interval 30 to 275 ft, crops out through the cover.

The base of the sheet and lower contact are concealed at the northwest side, but hornfels and arkose of the floor is exposed about 100 ft (30 m) below the approximate base, striking N50°E, and dipping 10°NW.

LOCATION AND DESCRIPTION OF CORE HOLES

USGS Reesers Summit No. 1 - YMCA site

Core hole No. 1 was spudded on May 5, 1987 in medium- to coarsely-crystalline diabase of the York Haven sheet on the property of the West Shore Y.M.C.A. camp. Collar elevation was approximately 565 ft (171 m). Three-inch ID surface casing was set to 15 ft (4.5 m), and continuous core was taken with an NQ wireline coring system that provided 1 7/8 inch diameter core to 325 ft (100 m) total depth, reached on May 20, 1987. Below the zone of soil and weathered rock down to 13 ft (4 m), core recovery was excellent, with only minimal loss in a few sheared and brecciated zones, and a recovery of 98 percent. During the coring operation, the water level was approximately 4 ft (1.2 m) below ground surface; after standing at total depth for 24 hours, static water level was about 2 feet below ground surface. No geophysical logs were run in the core hole, which was plugged with cement after completion, but detailed logs of the magnetic susceptibility were prepared on the core at the U.S. Geological Survey laboratory in Reston, Va. (Daniels, this paper).

USGS Reesers Summit No. 2 - Hemlock Road site

Core hole No. 2 was spudded on May 27, 1987 in medium-to coarse-crystalline diabase of the York Haven sheet on the property of Peter J. O'Neill at the western dead end of Hemlock Road. Collar elevation was approximately 550 ft (168 m). Three-inch ID surface casing was set to 18 ft (5.4 m), and continuous core was taken with an NQ wireline coring system that provided 1 7/8 inch diameter core to 873 ft (266 m) total depth, reached on June 30, 1987. Below the 15 ft (4.5 m) zone of soil and weathered rock core recovery was excellent, with minimal loss in sheared and brecciated shattered zones in both diabase and metamorphosed Triassic sedimentary rocks; recovery was about 98 per cent. During the coring operation some water was lost in fractured zones and the static water level was below the length of casing. A full suite of geophysical logs was run by the Borehole Geophysics Research Project, Water Resources Division, of the U.S. Geological Survey, which determined that ten days after coring operations ceased, the static water level was 89 ft (27 m) below ground surface (Elevation 470 ft - 142 m). Detailed logs of the magnetic susceptibility were prepared from measurements on the core in the U.S.G.S. laboratory in Reston, Va. (Daniels, this paper).

RESULTS OF CORING

USGS Reesers Summit No. 1 - YMCA site

Core hole No. 1 encountered two distinct varieties of diabase in the middle portion of the York Haven sheet. The upper 223 ft (71 m) consist largely of alternating zones of: (1) medium- to dark-gray, medium- to coarsely-crystalline ferrodiabase grading to ferrogabbro, with clinopyroxene more abundant than plagioclase, and clusters of ilmeno-magnetite totalling 3-5 per cent of the rock; interlayered with (2) light- to medium-gray, medium- to coarsely-crystalline diabase, with plagioclase more abundant than clinopyroxene, and ilmeno-magnetite clusters ranging from 1 to 3 percent by volume. The light gray diabase is preferentially cut by chlorite-lined, calcite-filled fractures and zoned veins with calcite, prehnite, albite(?), chalcedony, zeolites and minor sulfides--mainly pyrite and chalcopyrite. Diabase adjacent to the calcite-bearing veins is generally recrystallized in acomplex diffusion front which is coarsely crystalline, with euhedral black clinopyroxene crystals (augite?) to 5 mm long, twinned, with Schiller iridescence and subhedral but fresh, bright, twinned plagioclase. Closely-spaced, intersecting, chlorite-lined fractures and fault breccia are common.

The lower 92 ft (28 m) are predominantly medium gray, medium crystalline, uniformly textured diabase with clinopyroxene subequal to or more abundant than plagioclase, interlayered with 5 cm thick light gray, medium crystalline diabase with plagioclase more abundant than clinopyroxene. Ilmeno-magnetite occurs as sparse skeletal crystal clusters ranging from 1 to 3 percent by volume. Chlorite-lined fractures are relatively sparse compared to the overlying zone. Breccia is rare, calcite-lined veins were not seen, and only a trace of sulfides were recognized in this part of the core hole. The lower 30 ft (9 m) are uniformly medium gray and slightly finer grained, and medium- to fine-crystalline in the terminal core.

USGS Reesers Summit No.2 - Hemlock Road Site

Core hole No. 2 encountered several varieties of diabase in the lower portion of the York Haven sheet. The upper 304 ft (91 m) consist of subequal amounts of: (1) medium- to dark-gray, medium- to coarsely-crystalline, ferrodiabase (locally ferrogabbro) occurring in zones or layers a few feet to as much as 40 ft (12 m) thick, with clinopyroxene subequal to or more abundant than plagioclase, and clusters of ilmeno-magnetite averaging 3-5 percent of the rock; interlayered with (2) light- to medium-gray, mottled and blotchy, medium- to coarsely-crystalline diabase in zones or layers a few feet to as much as 15 ft (4.5 m) thick, with plagioclase more abundant than clinopyroxene, and ilmeno-magnetite clusters ranging from less than 1 to about 3 percent in volume. Both types of interlayered diabase are cut by abundant chlorite-lined, intersecting fractures, by calcite-lined veinlets, and by zoned veins with chlorite, calcite, prehnite, albite(?), chalcedony, quartz, zeolites and minor sulfides, including pyrite, chalcopyrite, bornite and covellite. The diabase adjacent to the calcite-bearing veins is coarsely crystalline in a diffusion front with twinned, black, euhedral, clinopyroxene (augite?) crystals to 5 mm long, and fresh, twinned, interstitial plagioclase (albite?).

From 304 (91 m) to 507 ft (155 m) medium gray, medium crystalline, uniform-textured diabase predominates, with 1 to 2 percent ilmeno-magnetite, although a minor amount (about 10 percent or less) of light gray, medium- to coarsely-crystalline diabase is interlayered from 348.6 to 353 ft and from 435.5 to 451 ft. The medium gray diabase is uniformly fine- to medium-crystalline with less than 1 percent ilmeno-magnetite from 415 to 434 ft. The diabase is cut by a network of intersecting, chlorite-lined fractures, by calcite-lined veinlets, and by zoned veins of chlorite-calcite, prehnite, albite(?), chalcedony and zeolites, with minor sulfides, including pyrite and chalcopyrite. Diabase adjacent to the calcite-bearing veins is generally coarsely crystalline in a diffusion front. From 507 ft (155 m) to 532.5 ft (162 m) the originally medium- to dark-gray crystalline diabase is intensely fractured and is locally a healed breccia. An intersecting network of slickensided, chlorite- and serpentine-lined fractures and veinlets of calcite cut the section, and a zoned vein at 531 ft contains an outer selvage of chlorite, which encloses calcite-quartz-chalcedony-prehnite-albite(?), with an interior of sparry gypsum. Tiny crystals of bronze-colored orthopyroxene are present in the matrix of the diabase from 530 to 532.5 ft. From 532.5 ft (162 m) to 594.5 ft (181 m) the diabase is mainly dark gray, medium crystalline, and with a uniform texture, with fine- grained bronze orthopyroxene disseminated sparsely throughout the matrix of clinopyroxene and plagioclase. Skeletal ilmeno-magnetite crystal clusters total 3 to 5 percent of the rock, and the sequence is cut by intersecting chlorite-lined fractures, calcite veinlets and zoned veins flanked by coarsely crystalline diabase. From 594.5 ft (181 m) to 623 ft (190 m) the dark gray diabase is finely crystalline with very fine disseminated bronze orthopyroxene in the clinopyroxene-plagioclase groundmass, and is cut by steep chlorite-lined fractures and calcite veinlets. The diabase from 623 ft (190 m) to the chill margin at 630 ft (192 m) is very dark gray to almost black, very finely crystalline to aphanitic at the intrusive contact with shattered Triassic quartzite; the contact dips 35 degrees. The diabase is cut by chlorite- and serpentine-lined fractures and steep calcite-filled veinlets.

The thermally metamorphosed Triassic sedimentary sequence from 630 ft (192 m) to total depth at 873 ft (266 m) consists of repetitive, upward-fining sequences of clastic rocks. The fining-upward sequences occur at all scales from a few feet to tens of feet. Pebble- to cobble-conglomerate layers with subrounded clasts of quartzite and limestone (now marble) are intercalated with and overlain by pebbly and coarse grained, crossbedded arkose which grades upward into variegated, medium- to fine-grained arkose succeeded by fine-grained quartzite and hornfels, derived by metamorphism of siltstone. Several zones of breccia were cored, two of which occur at the tops of upward-fining sequences; they contain gypsum and zeolites, and may represent collapse breccias rather than tectonic breccias or faults.

Magnetic susceptibility investigations of York Haven diabase at Reesers Summit, Pa.

D.L. Daniels

In conjunction with petrologic investigations of the York Haven diabase sheet at Reesers Summit, Pa., magnetic susceptibility measurements were made on a suite of samples obtained for chemical analysis. The samples came from a traverse of diabase and ferrogabbro exposed in a roadcut along highway I-83 (fig. A3). Only the upper half of the sheet is exposed in the roadcut, including the upper contact. The estimated outcrop width to the lower contact is 2050 feet. The sheet is thought to have a spoon shape and at this location dips southeast at about 35°, discordantly cutting across the bedding of the sedimentary rocks, which dip northwest. Measurements on the samples were made using a Scintrex SM-5 digital magnetic susceptibility meter. When the measurements were plotted as a profile, high values and high variability marked the exposures of ferrogabbro (Fig. B1). Diabase showed a relatively uniform "background" level, consistent with measurements from previous investigations of Mesozoic diabase.

Magnetic susceptibility of a rock is primarily a function of magnetic mineral content but also a function of the size, shape, composition, and dispersion of the magnetic mineral grains (Nagata, 1961, p. 128), factors which are generally not apparent without microscopic examination. Most of these variables are related to the mineral proportions in the rock, and to a lesser extent, its crystallization history. Magnetic susceptibility is therefore an easily measured petrologic index. Because a pattern was observed in the roadcut data, further detailed measurements on core from two planned coreholes was scheduled to determine if correlation between sites was possible. Both coreholes were drilled into diabase within 2000 feet of the I-83 exposures (Fig. A3).

Magnetic susceptibility of the core obtained from the two drill holes was measured using a more sensitive instrument, the Bison 3101 magnetic susceptibility meter with a special core measuring attachment. Checks on core with the Scintrex instrument showed values similar values to the Bison readings. The measurement interval, initially 0.1 feet, was expanded to about 0.5 to 1.0 feet after about 90 feet in order to complete the measurements within a reasonable time. The magnetic susceptibility of core from hole #1 is shown in Figure B2. The most significant feature of this profile is the level drop which occurs at about 230 feet. The lower level continued to the total depth of 325 feet with a small variability. This pattern showed no initial correspondence with the magnetic susceptibility profile measured on the I-83 samples.

Hole #2 was drilled through the lower part of the diabase sheet into the underlying sedimentary rocks, to a depth of 873 feet. The magnetic susceptibility level is similar to the upper part of corehole #1 but the variability is larger (Figure B3). In three zones, at 15, 165, and 575 feet, the magnetic susceptibility level is comparable to the high levels observed in the I-83 samples of ferrogabbro. Below the lower diabase contact the level drops to near zero. The few peaks observed below the contact result from magnetized hornfels layers immediately beneath the sheet. The number and amplitude of these spikes decreases to the bottom of the hole, probably reflecting a gradual decrease in metamorphic grade.

Direct comparison of the magnetic susceptibility profiles of the two coreholes and the I-83 roadcut is complicated because the coreholes are essentially vertical and the roadcut is nearly horizontal. The approximate geometric relationships are shown in Figure B4. Dip of the sheet is estimated at 35^{o}, and the local thickness is about 1280 feet. The slope of the roadway is about 3.5^{o}. In order to compare these profiles directly, they were projected onto a plane which is approximately perpendicular to the sheet and paralled to I-83. The projected profiles are shown in Figure B5.

Correlation among the three projected susceptibility profiles is ambiguous though somewhat suggestive. As the roadcut profile extends from the top contact downward, and corehole #2 extends from beneath the lower contact upward,and assuming the thickness and dip estimates are correct, the two sections should overlap. The single high spike at the top of the #2 corehole profile may represent the lowermost part of the central core of ferrogabbro. Using the road cut profile as a reference, the 2 corehole profiles have been shifted vertically to reflect this possible correlation (fig. B5).

Inherent in this attempt to correlate among these magnetic susceptibility profiles is the possibility that there is an igneous stratigraphy, with magnetically contrasting subunits, a result of continuous cumulate layering produced during differentiation and crystal settling during the solidification of the sheet. On the other hand, the ferrogabbro may have resulted from differentiation downdip (southeast) toward the center of the sheet, followed by updip intrusion of buoyant late stage crystal-liquid fluid. This would not necessarily require a laterally continuous igneous layer, but rather acontinuous gradation in composition and magnetic properties among the three profiles. The cluster of high values might grade to lesser values over the distance between the profiles

Evidence from aeromagnetic data

Aeromagnetic data (Bromery and Griscom, 1967) shows a magnetic high which largely follows the outcrop pattern of the York Haven diabase. The crest of the magnetic high is most closely associated with the upper contact of the sheet. The position of this magnetic high may be reflecting the largest vertical extent of the dipping diabase sheet. In addition to the diabase, the thermally metamorphosed sedimentary rocks adjacent to the diabase must be considered as a magnetic source as they are locally enriched in magnetite (Bromery and Griscom, 1967).

In the vicinity of Reesers Summit (Bromery and others, 1961) a short northeast-trending magnetic high coincides with the location of the corehole #2 and the upper part of the sheet along the I-83 roadcut and to a lesser degree, with the corehole #1 site (Figure B6). This anomaly may have its source partly in the highly magnetic ferrogabbro, although the resolution of the magnetic survey is not adequate to assure a positive correlation. If the magnetic anomaly reflects the distribution of the ferrogabbro, then it is limited to an area less than a half mile long and does not represent a laterally continuous layer.

Geophysical Logging Results at Reesers Summit No. 2

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An extensive suite of geophysical well logs was obtained at the USGS Reesers Summit No. 2 borehole. Water level was measured at 89 ft (27 m) below land surface and most logs extend to the total depth of 873 ft (266 m). Logs that provide information concerning lithology are presented as a composite in Figure C-1. Logs such as these have been used effectively as stratigraphic indicators (Barrash and Morin, in press) and the records shown in Figure C-1 clearly delineate the diabase sheet from the underlying sedimentary rocks. The natural gamma log shows a dramatic increase in activity for the arkosic deposits, and the neutron log depicts a lower count rate and, correspondingly, a higher apparent porosity in the sedimentary rocks below a depth of approximately 635 ft (194 m). This apparent porosity as calibrated from the neutron log reflects the sum of the effective porosity in coarse arkose and the non-effective porosity (bound water) in the shale fraction of the fine-grained arkose and siltstone. The two electric logs demonstrate a clear shift to lower resistivities in the sedimentary rocks, indicating increased conduction attributed to the combined effects of dissolved solids in pore spaces and the presence of conductive clay minerals. The density log, obtained from a compensated gamma probe, illustrates the abrupt transition from the diabase, with a density of approximately 3.1 g/cm^3, to the sedimentary rocks below. The densities through this lower sequence are highly variable and are in the range of 2.8 g/cm^3. The caliper log (not included in this report) shows an extremely uniform borehole diameter of 3.1 inches (7.9 cm); therefore, corrections to various tool measurements due to the disruptive effects of borehole rugosity were not required. Additional information on the general theory of geophysical logging is presented by Hearst and Nelson (1985); specific applications to ground water investigations are presented by Keys and MacCary (1971).

Information concerning the hydrogeologic characteristics of the formation can be obtained from the three logs shown in Figure C-2. A slight departure from linearity can be observed in the temperature log at a depth of about 700 ft (213 m); the temperature gradient log, which is a plot of the slope of the associated temperature profile, magnifies the location of this anomalous feature. This behavior indicates slight water movement entering or leaving the formation and identifies a possible transmissive zone for local ground water transport. This interpretation was confirmed by injecting water into the Reesers Summit No. 2 well and monitoring its movement. Water was injected at a constant rate of 1.5 gallons per minute and buildup of hydraulic head was measured with a pressure transducer submerged 20 ft (6 m) below static water level. Head buildup slowly increased and stabilized at 50 ft (15 m) after several hours of injection. Once flow and head conditions reached steady state, a heat-pulse flowmeter (Hess, 1986) was utilized concurrently with continued injection to obtain a profile of vertical fluid velocity travelling down the borehole. This log (Figure C-2) clearly delineates an interval where most of the injected water enters the formation. This permeable zone correlates closely with that identified by the temperature gradient log.

Inspection of Figure C-1 shows that the transmissive zone is marked by very high natural gamma activity, low neutron counts, low electrical resistivity, and low density. All of these characteristics indicate the presence of a porous arkose that, under this set of conditions, is also highly permeable. This is not always the case, however, since other intervals in the sedimentary section exhibit this same combination of log responses, yet did not accept water during the injection test. Although the logs depicted in Figure C-1 can provide insight into the lithology of the formation which, in turn, can be interpreted in terms of the local hydrogeology, they do not show a unique response to formation permeability. It is interesting to note that this hydraulically transmissive interval does not coincide with the lower diabase contact, but occurs about 65 ft (20 m) below in the sedimentary rocks. The entire section of diabase appears to be relatively impermeable.

The borehole acoustic televiewer (Zemanek and others, 1969) was also used in this study. This instrument provides a photographic image of the borehole wall processed in terms of acoustic reflectivity. In many applications, the resulting record may be correlated to lithology (Paillet and others, 1985). Where fractures are evident, fracture strike and dip can be determined (Paillet and others, 1987; fig. C-3), and where breakouts are identified, orientation of the local stress field can also be evaluated (Zoback and others, 1985). Representative examples of the acoustic televiewer log for this well are illustrated in Figure C-4. No evidence of breakouts was found in this log, but variably dipping fractures are seen in several sections of the diabase sheet. The interface between the diabase and the sedimentary rocks (630-635 ft; 192-194 m) is characterized by multiple, large aperture fractures. These steeply dipping (approximately 70 degrees) fractures mask the more subtle acoustic response associated with the more gently dipping (approximately 35 degrees) lithologic contact at this depth. Consequently, the televiewer log does not sucessfully quantify the local southeastward dip of the diabase. As stated above, these features do not appear to contribute to the local hydrologic system; even the permeable zone at 700 ft (213 m) is not readily distinguishable in terms of prominent fractures. The vertical stripes in this acoustic log are artifacts of the measurement caused by a slightly decentralized tool and are not representative of the true formation.

INTERPRETATION, DISCUSSION, AND GEOLOGIC SYNTHESIS

Preliminary interpretation of the data show that the York Haven diabase sheet at Reesers Summit, Pa. is a complexly zoned body with several distinctive layer, based on lithologic examination and magnetic susceptibility. The roadcut exposure along I-83 shows an intrusive, tilted, upper chill margin contact with Triassic roof rocks, an upper fine- to medium-crystalline diabase about 260 ft (78 m) thick that overlies a coarse-crystalline ferrogabbro about 350 ft (105 m) thick, above a poorly exposed, lower zone of medium crystalline diabase as much as 950 ft (288 m) thick. The ferrogabbro shows erratic, but generally high, magnetic susceptibility compared to the underlying and overlying diabase, and is relatively enriched in iron, copper, palladium and other metals.

Core hole No. 1, south of the roadcut exposure, penetrated 325 ft (98 m) of diabase, equivalent to 270 ft (82 m) of thickness assuming a consistent 35 degree dip of the sheet at this locality. The upper 223 ft (71 m) is medium- to coarsely-crystalline ferrodiabase overlying 92 ft (28 m) of medium crystalline, uniform diabase. The ferrodiabase shows erratic but generally moderate to high magnetic susceptibility compared to the underlying diabase.

Core hole No. 2, north of the roadcut exposure, penetrated 630 ft (191 m) of diabase, equivalent to 520 ft (158 m) of thickness at the assumed 35 degree dip of the sheet, above the intrusive, discordant, lower chill margin contact with Triassic floor strata. The upper 304 ft (91 m) is medium- to coarse-crystalline ferrodiabase with moderate to high magnetic susceptibility, especially in the uppermost 195 ft (59 m). The ferrodiabase overlies 203 ft (61 m) of mostly medium crystalline diabase with generally low magnetic susceptibility. From 507 to 532.5 ft (155 to 162 m) the medium crystalline diabase is mainly brecciated. The lower 100 ft (30 m) is characterized by fine- to medium-crystalline, dark gray diabase with disseminated orthopyroxene (opx) and more ilmeno-magnetite than the overlying diabase, reflected by moderate to high magnetic susceptibilities. The presence of sparse opx near the base of the sheet in core hole No. 2 supports regional field observations that the thick opx-bearing cumulate zone at York Haven passes laterally to diabase and ferrogabbro that overlie a thin but persistent opx-bearing basal zone at Reesers Summit.

It is possible that the three sections of the York Haven sheet at Reesers Summit described show stratigraphic overlap; however, on the basis of the available data, this cannot be proved. The roadcut exposure on I-83 has more than 600 feet (180 m) of the lower zone concealed, and the interval 507 to 532.5 ft (155-162 m) in core hole No. 2 is shattered and brecciated, both permitting, or possibly indicating, omission or duplication of the diabase section by faulting. Furthermore, as this is part of an intrusive sheet with discordant contacts, thickness irregularities are to be expected. Although the exposed intrusive contact at the top of the tilted sheet on I-83 has an attitude similar to that at the basal contact in core hole No. 2, (about 35 degrees) these are merely two local control points; internal layering in the two core holes and on the outcrop suggest broad intervals of much gentler dip. Thus the original calculated 1650 ft (500 m) thickness on I-83 may be excessive. If, however, this is a valid local thickness, then the true thickness of the section penetrated at core hole No. 2 (520 ft, 158 m) would show no overlap with the exposed ferrogabbro on I-83, but would underlie that sequence. It is tempting to suggest that the base of the highly magnetic ferrogabbro section exposed on I-83 at 650 ft (197 m) may correlate with the base of the 190 ft-thick upper magnetic ferrodiabase at 233 ft (71 m) in core hole No. 1 and with the base of the 157 ft-thick ferrodiabase at 195 ft (59 m) in core hole No. 2. If so, lateral lithologic changes in the ferrogabbroic zone both north and south of the I-83 roadcut exposure are indicated because the magnetic susceptibilities in the two core holes are considerably less than on the road cut. Certainly the paucity of veins in the roadcut and the abundance of zoned veins cutting the diabase in the two core holes argues for the likelihood that (1) both core holes underlie the anomalous quartzose ferrogabbro section exposed along the I-83 road cut, or (2) the ferrogabbro exposed in the I-83 road cut is a pod that is laterally enclosed by ferrodiabase cut by zoned veins, as shown by the upper part of both core holes. Possibly the results of the geochemical analysis and petrography may support or refute the likelihood of stratigraphic overlap in the three sections.

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Appendix - Core Descriptions

USGS REESERS SUMMIT NO. 1 - YMCA site - TD 325 ft

Alt. 565 ft; Lat. 40°12'00"; Long. 76°52'20"; York County, Pa.

(*21.5) - Sample for geochemical analysis and thin section, with depth in feet. Total - 22 samples.

Depth, in feet	
0.5	Soil, pale to dark yellow brown (10YR6/2) to moderate brown (5YR4/4), pebbly clay loam with weathered diabase fragments, gravelly and sandy at base
5-13	No recovery
13-15	Diabase, mottled gray and brown, weathered, limonite stain, medium- to coarse-crystalline; vertical fracture from 14 to 14.5 ft
15-24 (*21.5)	Diabase, light olive gray (5Y6/1), olive gray (5Y4/1) to dark greenish gray (5GY4/1), medium- to coarse-crystalline (2-4 mm); abundant chlorite-lined fractures at 15, 30, 45, 60 and 75 degrees, intersecting; thin veinlets of calcite at 23.5 ft with diabase recrystallized adjacent to veinlets with plagioclase (2-3 mm) fresh and twinned, clinopyroxene euhedral to subhedral, coarse (3-4 mm) and twinned with iridescent Schiller structure; trace magnetite or ilmeno-magnetite
24-27	Diabase, dark greenish gray (5GY4/1), medium- to coarse-crystalline, rude layering cut by intersecting chlorite-lined fractures at 30 and 60 degrees; broken 2 to 8 cm fragments at 25 to 26 ft. Clinopyroxene more abundant than plagioclase; minor ilmeno-magnetite in clusters
27-35.5	Diabase, light to medium-gray (N5), mottled and rudely layered with medium- to dark-gray (N4) diabase, medium crystalline (2 mm) except coarse crystalline (3-4 mm) for 1 to 2 cm adjacent to 60 degree veinlets lined with calcite and chlorite; plagioclase more abundant than clinopyroxene; sparse ilmeno-magnetite clusters about 1 to 2 cm apart
35.5-57.5 (*36.5) (*42) (*52.5) (*53.5)	Diabase, medium- to dark-gray (N4), medium crystalline, plagioclase and clinopyroxene subequal; ilmeno-magnetite in skeletal crystal clots about 5mm in diameter in optical continuity, spaced about 1-2 cm apart, 3-5 percent; healed chlorite-lined fractures throughout at 15, 30, 45, 60, 75 degrees and subhorizontal in an intersecting network 15 to 30 cm apart

57.5-97.5 (*66.5) (*76) (*86.5)	Diabase, alternating zones (layers?) of light-to medium-gray (N5) and medium- to dark-gray (N4) from 1 to 8 ft thick, averaging 3 ft; dark gray layers are mainly medium crystalline with clinopyroxene equal to or greater than plagioclase; light gray zones are medium- to coarse-crystalline and cut by 60, 75, and 85 degree veins and seams filled by calcite, prehnite; albite?, chalcedony?, zeolites?, and chlorite with sparse sulfides - pyrite, chalcopyrite; diabase is notably recrystallized adjacent to veins with euhedral clinopyroxene, fresh and twinned with iridescent Schiller structure. Both light- and dark-gray diabase are cut by intersecting chlorite-lined fractures at 15, 30, 45 and 60 degrees, also subhorizontal and subvertical.
97.5-116. (*98) (*106.5)	Diabase, medium- to dark-gray (N4), medium crystalline (2-3 mm) interbedded with 1 to 7 ft thick layers of light- to medium-gray (N5) and mottled, medium- to coarse-crystalline diabase, dip about 15 degrees; clinopyroxene and plagioclase subequal, skeletal ilmeno-magnetite crystal clots with parallel extinction about 3 percent and sparse sulfides between 102.6 to 110 ft. Sequence cut by chlorite-lined seams at 15, 30 degrees and subhorizontal.
116.-126. (*122.5)	Diabase, medium- to dark-gray (N4), medium crystalline with interlocking mosaic of subhedral plagioclase and clinopyroxene with scattered skeletal blebs of ilmeno-magnetite; sparse pyrite on widely-spaced chlorite-lined fractures intersecting at 30 to 60 degrees.
126.-160. (*131.5) (*145) (*149)	Diabase, medium- to dark-gray (N4), medium crystalline layers as much as 6 ft thick alternating with light- to medium-gray (N5) layers from 1 to 8 ft thick, with plagioclase and clinopyroxene subequal; ilmeno-magnetite clusters about 5 mm in diameter and 1 to 3 cm apart more abundant in medium gray layers; sparse sulfides, pyrite and chalcopyrite, on chlorite-lined fractures in light gray layers at 127 to 132.5 ft. Sequence cut by sparse chlorite-lined intersecting fractures at 30 to 60 degrees and near-vertical.
160.-165.5	Diabase,brecciated, medium- to dark-gray (N4), medium crystalline, cut by network of intersecting chlorite-lined veins.
165.5-190. (*172)	Diabase, medium- to dark-gray (N4), medium crystalline (2-3 mm), clinopyroxene more abundant than plagioclase, with scattered ilmeno-magnetite clots about 1 to 3 percent; cut by chlorite-lined seams at 30 and 60 degrees and subvertical.
190.-192.5	Diabase, brecciated, medium- to dark-gray (N4), medium crystalline, cut by network of intersecting chlorite-lined veins, with trace of sparse sulfides.
192.5-226. (*198.6) (*213.5)	Diabase, medium- to dark-gray (N4), medium crystalline, alternating with 5 cm thick layers of light- to medium-gray (N5), medium- to coarse-crystalline diabase. Overall plagioclase and

clinopyroxene subequal with clinopyroxene and ilmeno-magnetite clusters slightly more abundant in darker layers, but rarely more than 3 percent. Chlorite-lined healed and open fractures at 30, 45, 60 degrees and subvertical, with horizontally slickensided fractures and open joints at 216 to 221 ft.

226.-233.	Diabase, brecciated, light to dark-gray (N4, N5), medium- to coarse-crystalline, possibly recrystallized with euhedral clinopyroxene with Schiller iridescence and bright, well-formed plagioclase; healed by mosaic of chlorite-lined fractures from 226 to 229 ft; less fractured from 229 to 233 ft.
233.-325.(TD) (*239.5) (*276) (*298) (*318.8) (*323)	Diabase, predominantly medium gray (N5), medium crystalline, clinopyroxene slightly more abundant than plagioclase, generally uniform diabasic texture with interlocking crystals, sparse ilmeno-magnetite skeletal crystal clots 1 to 3 percent, sparse chlorite-lined fractures at 30, 45, 60 degrees and subhorizontal, locally slickensided fractures from 322.5-325 ft. From 273 to 305 ft, minor light gray more feldspathic diabase is interlayered at 15 to 30 degrees with prevailing medium gray diabase.

USGS REESERS SUMMIT NO. 2 - HEMLOCK Rd. Site - TD 873 ft.

Alt. 550 ft; Lat. 40°12'08"; Long. 76°52',00"; York County, Pa.
(*20) - Sample for geochemical analysis and thin section, with depth in feet, Total - 28 samples

Depth in feet	
0-15	No recovery
15-24.3 (*20)	Diabase, medium- to light-gray (N5), Medium crystalline (2-3 mm), slightly altered and weathered (feldspars dull); abundant chlorite-lined, healed, near-vertical fractures; ilmeno-magnetite skeletal crystal clots 1-3 mm in diameter, 10 mm apart in rude optical continuity; more discretely clustered from 23.5 to 24.3 ft.
24.3-47.5 (*45)	Diabase, medium- to dark-gray (N4, N5), medium-, coarse-, and very coarse-crystalline (2-5 mm); plagioclase bright, fresh, striated, and nearly euhedral intergrown with twinned clinopyroxene in bladed crystals 5 mm long with iridescent Schiller structure (texture looks like crystals grown in a fluid medium). Ilmeno-magnetite about 5 per cent as skeletal crystal clusters 3-4 mm in diameter, 10 mm apart, in optical continuity, in places with sparse disseminated sulfides (pyrite and chalcopyrite(?)). Closely-spaced, near vertical chlorite-lined fractures at 26 to 28 ft. with sparse pyrite; rare healed chlorite-lined fractures at 15 and 30 degrees at 33.9, 35.6 and 38.6 ft.

47.5-62.6	Diabase, dark- to medium-gray (N4), medium- to coarse-crystalline (2-4 mm); very coarse crystalline for 1 cm with bladed clinopyroxene with Schiller iridescence to 5 mm, adjacent to 1 cm wide, near-vertical, zoned vein of chlorite, calcite, albite(?), prehnite(?), quartz(?); and minor pyrite. Ilmeno-magnetite 3-5% as skeletal crystal clusters. Chlorite-lined, healed and open fractures at 30, 45, 60 and 75 degrees and near vertical, about 3 ft apart.
62.6-68.6	Diabase, medium- to dark-gray (N4), fine-to medium-crystalline (1-2 mm), uniform diabasic interlocked texture; scattered ilmeno-magnetite clusters; intersecting chlorite-lined fractures at 45, 60, and 85 degrees.
68.6-83 (*83)	Diabase, light gray (N5), blotchy and mottled, medium crystalline (2-3 mm) to 73.8 ft. Coarse crystalline 73.8 to 79.8 adjacent to 2 cm wide calcite-prehnite(?) veinlet at 45 degrees. Diabase is light gray, medium- to coarse-crystalline from 79.8 to 83 ft. Minor chlorite-lined fractures at 30 and 60 degrees.
83-88	Diabase, medium to dark greenish gray (5GY 4/1), medium crystalline; ilmeno-magnetite 3-5 per cent; sparse chlorite-lined fractures at 45 and 60 degrees every 1/2 ft.
88-102.3	Diabase, light gray (N5), blotchy and mottled, medium- to coarse-crystalline, abundant cloudy white to greenish plagioclase containing powdery black inclusions; clinopyroxene and ilmeno-magnetite (3-5 per cent) locally subhedral to euhedral; sparse disseminated sulfides: chlorite- and serpentine(?)-lined fractures at 30, 45, 60, 70 degrees and near-vertical every 3 to 6 in. Calcite-filled veinlet 1 mm wide inclined 60 degrees at 100.6' with minor sulfides.
102.3-127	Diabase, medium- to dark-greenish gray (5GY 4/1), looks slightly altered, medium crystalline; patches of skeletal ilmeno-magnetite crystal clusters 5 mm in diameter about 2 cm apart, about 3 per cent; trace disseminated golden sulfide at 108 and 119.2 ft. Chlorite-lined fractures at 15, 30, 45 and 60 degrees 6 in. to 1 ft apart.
127-131 (*128)	Diabase, light gray (N5) and mottled, medium- to coarse-crystalline with clinopyroxene twinned with Schiller iridescence, 4 mm long bladed crystals and bright plagioclase, possibly albite replacement; ilmeno-magnetite less abundant (1-3 per cent) in light-colored plagioclase-rich layers than in dark clinopyroxene-rich zones.

131-139.6	Diabase, medium- to dark-greenish gray (5GY 4/1) to medium and dark gray (N4), medium crystalline, with 3-5 per cent skeletal ilmeno-magnetite crystals; abundant healed horizontal and 60 degree chlorite-lined fractures; also 0.5-1.0 cm wide calcite-prehnite(?) albite vein dips 60 degrees at 130 ft. Diabase is recrystallized in 2 cm wide diffusion front adjacent to vein, contains sparse scattered sulfides, and is medium-coarse crystalline.
139.6-143.8	Diabase, brecciated, healed, medium- to dark-gray (N4), medium crystalline, 3-5 per cent ilmeno-magnetite clusters, cut by 60 to 70 degree albite(?)-quartz(?)-prehnite vein 0.5-1.0 cm wide from 139.6 to 140.2 ft which cuts across healed breccia and chlorite-lined 30 degree inclined seams and fractures; diabase is medium- to coarse-crystalline adjacent to vein. Breccia comprised of intersecting network of chlorite-lined veins, fractures and joints at 30, 45 and 60 degrees.
143.8-151.2	Diabase, medium- to dark-gray (N4), medium crystalline, 3 to 5 per cent ilmeno-magnetite clusters, less fractured than above zone but still cut by 30, 45 degree and curving near-vertical intersecting chlorite-lined fractures.
151.2-158	Diabase, alternating light gray (N5) and medium- to dark-gray (N4) layers about 1 ft thick; light gray diabase is plagioclase-rich, mottled, medium- to coarse-crystalline adjacent to 2 calcite-prehnite(?)-albite veins that dip 75 degrees at 151.2 to 153 ft. Medium- to dark-gray diabase is clinopyroxene-rich and contains more skeletal ilmeno-magnetite crystal clusters (3-5 per cent).
158-164	Diabase, medium- to dark-gray (N4), medium crystalline, clinopyroxene more abundant than plagioclase, ilmeno-magnetite about 3 per cent in scattered clusters; cut by 45, 60 and 80 degree chlorite-lined fractures.
164-177.5 (*165) (*168)	Diabase, light gray (N5), mottled, medium- to coarse-crystalline, plagioclase subequal to or greater than clinopyroxene; ilmeno-magnetite 3 to 5 per cent in skeletal crystal clusters 1 cm apart. From 165.7 to 168 ft, large open fracture, 0.5 cm wide at 80 degrees, is coated with powdery calcite, lined with peacock-tarnished sulfides, possibly bornite or covellite with trace native copper(?) Diabase is very coarse crystalline and pegmatoidal for 5 cm in diffusion halos adjacent to veins, with clinopyroxene twinned with Schiller iridescence, as much as 1.5 cm long in prismatic crystals.

177.5-194.8	Diabase, medium- to dark-gray (N4), medium- to coarse crystalline, porphyritic in places with bladed twinned clinopyroxene crystals 5 mm long with iridescent Schiller structure. Steep chlorite- and calcite-lined veins at 179-181, 190.7-192.2; vein at 179-181 has abundant black augite(?) crystals adjacent for 1 cm, and vein is lined with gaudy peacock-tarnished covellite, bornite or chalcopyrite.
194.8-208.5 (*195)	Diabase, medium- to dark-gray (N4), medium- to fine-crystalline, very fresh and unaltered, uniform interlocking texture with clinopyroxene more abundant than plagioclase; ilmeno-magnetite crystal clots about 3 per cent; sparse fractures at 30, 60 degrees and near vertical spaced very 2 to 3 ft.
208.5-210.6	Diabase, light- to medium-gray (N5), medium crystalline, with slickensided fractures at 210.6 ft with sparse sulfides on chlorite-lined joints.
210.6-214.5	Diabase, brecciated, healed by greenish black chlorite or serpentine and mylonite; sharply divided by 1 to 3 mm wide calcite vein dipping 60 degrees, parallel to chlorite-lined fractures at 212.5 ft.
214.5-222	Diabase, medium- to dark-gray (N4), fine- to medium-crystalline, with skeletal ilmeno-magnetite crystal clots spaced at 1 to 2 cm intervals (about 3 to 5 per cent); cut by chlorite/serpentine-lined fractures at 45, 60 degrees and near-vertical.
222-239 (*229)	Diabase, alternating 1 to 3 ft layers of light gray (N5) and medium- to dark-gray (N4) with apparent dip of 30 degress; light gray layers are plagioclase-rich and medium- to coarse-crystalline with ilmeno-magnetite about 1-3 per cent; darker layers are clinopyroxene-rich with 3-5 per cent ilmeno-magnetite; chlorite/serpentine-lined fractures at 30, 45 degrees and subhorizontal spaced about each ft.
239-252.9 (*243)	Diabase, medium- to dark-gray (N4), uniform texture, fine- to medium-crystalline, ilmeno-magnetite crystal clots about 3 percent; cut by chlorite-lined fractures at 30, 60 and 85 degrees.
252.9-291 (272.5)	Diabase, alternating layers of 0.3- to 4 ft-thick of light-medium-gray (N5), medium- to coarse-crystalline and medium-to dark-gray (N4), fine- to medium-crystalline. Light gray layers are plagioclase-rich, locally cut by steep albite(?)-prehnite vein with trace of sulfides at 252.9 to 256.9 ft. Darker gray layers with 3 to 5 per cent skeletal ilmeno-magnetite crystal clusters about 2 cm apart. Sequence cut by chlorite-lined fractures at 30, 45, 60 and 85 degrees spaced about 1 ft apart.

291-301.7	Diabase, medium- to dark-gray (N4), medium crystalline, uniform interlocking texture with clinopyroxene and plagioclase subequal with sparse ilmeno-magnetite crystal clots about 2 cm apart. Shattered by chlorite-lined joints at 295 to 295.5 ft. with 1 cm wide albite(?)-prehnite(?) vein dipping 60 degrees at 301 to 301.5 ft.
301.7-304	Diabase, light- (N5) to medium- and dark-gray (N4) alternating medium-grained layers about 6 in thick; minor chlorite-lined fractures at 30 and 60 degrees.
304-395.5 (*319) (*352a) (*352b)	Diabase, medium- to dark-gray (N4), medium-grained, uniform texture, sparse (1-3 per cent) ilmeno-magnetite skeletal crystal clots. Chlorite-lined, healed, intersecting fractures at 45 and 60 degrees, subhorizontal and subvertical; also inclined veinlets of chlorite, calcite, prehnite(?) at 313 ft (1 cm wide), 321, 322, and 323 ft (0.5-1.0 cm wide at 45 degrees and subhorizontal), at 335 ft (0.5 cm at 60 degrees), at 348.6 to 348.8 (2-3 cm wide), from 351.3 to 353 (intersecting 1 to 2 cm wide vein system at 60 degrees); at 368 steep 1 cm wide albite(?)-prehnite vein); 2 to 3 cm wide albite-prehnite veins at 380, 384 and 394 ft. Diabase for 1 to 3 cm adjacent to veinlets is coarse crystalline in diffusion front, with subhedral to euhedral twinned black clinopyroxene, possibly augite, and bright plagioclase, possibly albite; possibly sparse, very fine sulfides locally, as at 394 ft.
395.5-399.5	Diabase, medium- to dark-gray (N4), medium grained, uniform,interlayered with light gray (N5), plagioclase-rich thin (2-3 cm) subhorizontal layers at 399.5, 398, 399, and 399.5 ft.
399.5-435.5 (*405)	Diabase, medium gray (N4), fine- to medium-crystalline, uniform interlocking texture, sparse (about 1 per cent) ilmeno-magnetite clots; rare, widely spaced chlorite-lined fractures at 60 degrees and minor calcite-lined fractures between 406 and 412 ft.
435.5-507 (*436) (*469.5) (*505)	Diabase, medium- to dark-gray (N4), medium crystalline, uniform interlocking texture with sparse (about 1 per cent) ilmeno-magnetite; interlayered with light- to medium-gray (N5) plagioclase-rich subhorizontal layers 0.2 to 0.5 ft thick at 435.5, 438, 449.5, and 450.6; cut by inclined calcite-prehnite(?)-albite(?) veins 1-5 mm wide at 438, 445, 455.8-456.5, 463, 471-475.2, 482.5-484, 487.5, 492, 493-495, 497, 505 and 506 ft. Diabase is recrystallized and medium- to coarse-crystalline for 1 to 2 cm adjacent to veins in diffusion front. Sparse sulfides (pyrite and chalcopyrite?) at 492-497, 505-506 ft. Entire sequence cut by intersecting network of chlorite-lined seams at 5-15, 30, 45, 60, 75 and 85 degrees.

507-532.5 Diabase, brecciated and fractured, originally medium- to dark-gray, (N4) medium crystalline, now cut by chlorite-serpentine-lined intersecting network at 15, 30, 45, 60, 75 degrees and subvertical. Breccia at 507-510.9, 529-532.5 ft. Steep, calcite-lined veins at 517, 520-521, 525-529, and 531 ft. Diabase is recrystallized and medium- to coarse-crystalline for 1 to 4 cm adjacent to veins in diffusion front. Vein at 531 ft is 5 mm wide, zoned, with outer selvage of chlorite, enclosing calcite-quartz-chalcedony-prehnite(?)-albite(?) with interior of clear sparry gypsum. Diabase contains traces of bronze-colored orthopyroxene from 530 to 532.5 ft.

532.5-594.5 (*540) (*564.5) (*577.3) Diabase, medium- to dark-gray (N4, N3), medium crystalline, equigranular, uniform interlocking texture, with fine (less than 1 mm), sparse, bronze-colored orthopyroxene disseminated in interlocking matrix with clinopyroxene more abundant than plagioclase. Skeletal ilmeno-magnetite crystal clots to 5 mm diameter 10 to 20 mm apart disseminated throughout, 3 to 5 per cent. Chlorite-serpentine-lined intersecting fractures at 30, 45, 60, 75, 85 degrees and subvertical; also steep chlorite-calcite-prehnite-albite?-veins at 539, 541 ft; dipping 75 degrees and 0.5 cm wide at 549 ft, 60 degrees at 557, 566.9, 568, 577.9, 583.3, 584.3, 585, 590, 591, 593, 593.5 and 594 ft, some with sparse fine sulfides, possibly pyrite or pyrrhotite. Diabase for 1-3 cm adjacent to veins is locally coarse crystalline with euhedral clinopyroxene, possibly augite, fresh recrystallized plagioclase, possibly with albite overgrowths, but some plagioclase is altered, dull and greenish gray.

594.5-613.5 (*599.5) Diabase, medium- to dark-gray (N3, N4), fine- to medium-grained, equigranular with fine, sparse bronzite in interlocking matrix of crystalline, skeletal ilmeno-magnetite crystals about 1 to 2 mm in diameter about 5 mm apart. Cut by rare chlorite-lined fractures at 45, 60 degrees and near vertical, and minor, calcite-lined 60 degree 1-3 mm wide veinlets at 605.3, 605.6, 606, 610 and 611 ft. Diabase adjacent to veinlets for 1 to 2 cm is medium- to coarse-crystalline, light- to medium-gray with euhedral clinopyroxene and fresh plagio-clase.

613.5-623 Diabase, dark gray (N3), fine crystalline, with very fine, disseminated,

(*618) bronze orthopyroxene in dense interlocking matrix of clinopyroxene and plagioclase. Cut by abundant, chlorite-lined, intersecting fractures at 45, 60 degrees and near vertical; two 1- to 5-mm wide, calcite-lined veinlets dip 60 degrees at 616 ft with adjacent diabase medium- to coarse-crystalline for 1 cm.

623-628.5 (*625.5) Diabase, dark gray (N3), fine- to very fine-crystalline, with fine euhedral clinopyroxene crystals; cut by chlorite-serpentine-lined seams at 45, 60 degrees and near-vertical.

628.5-630 (*629) (*630)	Diabase, dark gray (N3), very fine crystalline to aphanitic with chill margin contact dipping 35 degrees at 630 ft. At 629 ft a 1 cm wide fine crystalline seam cuts aphanitic diabase at 45 degrees. Abundant calcite and chlorite-lined seams cut unit at 60 degrees and near-vertical.

INTRUSIVE CONTACT AT 630 FT.

630-638	Quartzite, very fine grained, almost glassy, light brownish gray (5YR6/1) to medium light gray (N6), very hard and brittle, shattered by myriads of microfractures; mostly 1 to 3 cm pieces and shards, some of which are hornfels derived from metamorphosed siltstone.
638-640	Quartzite, gray (N5, N6), fine grained, cut by myriad of intersecting fractures.
640-641.3	Breccia of quartzite, fine grained, with calcite-filled veinlets and chloritic gouge.
641.3-659.2	Quartzite, medium (N5)- to light (N7)-gray, very fine- to fine-grained, well sorted, hard and brittle; silty in part, and light brownish gray (5YR6/1) with hornfels laminae at 656 ft dipping about 20 degrees. Abundant fractures at 45, 60 and 80 degrees, most lined with euhedral calcite and quartz or zeolites.
659.2-674.5	Arkose, light brownish gray (5YR6/1) to grayish orange pink (5YR7/2), fine grained from 659.2 to 663 ft, medium grained from 663 to 668.5 ft, conglomeratic and coarse grained at 668.5 to 669 ft with 1 to 3 cm pebbles; fine- to medium-grained calcareous arkose from 669 to 674.5 ft. Fractures at 6 in. intervals from 659.2 to 663 and 671 to 673 ft., in part lined with calcite. Faint layering dips about 15 degrees at 671 to 673 ft.
674.5-677.3	Conglomerate, medium- to light-gray (N6) and grayish pink (5YR7/2); mostly subangular quartzite pebbles 1 to 2 cm in diameter in coarse-grained arkosic sandstone matrix.
677.3-684.5	Arkose, light brownish gray (5YR6/1), pale red purple (5RP6/2) to grayish red purple (5RP4/2), fine grained, with scattered calcareous blebs (caliche?); apparent dip 40 to 45 degrees on local scour contact at 677.5 ft.
684.5-691.8	Arkose, mostly grayish brown (5YR3/2), fine, medium- and coarse-grained, with fine black spots, possibly specularite, partially oxidized; abundant intersecting fractures.
691.8-695	Conglomerate, variegated, in grayish red brown, arkosic, coarse grained matrix; mixed cobbles and pebbles, abundant fractures.
695-698	Breccia of arkose, very fine grained, and hornfels, silty, yellow brown (10YR6/2) to gray brown (5YR3/2), laminated to thin bedded with apparent dip of 35 to 45 degrees. Shattered, with vugs and open fractures lined with clear prismatic euhedral crystals 8 mm long, possibly zeolites, gypsum, and calcite.

698-732 Arkose and siltstone hornfels, interbedded; pale yellow brown (10YR6/2), grayish brown (5YR3/2), pale brown (5YR5/2) and grayish orange pink (5YR7/2), mainly fine grained from 698 to 713 ft, fine- to medium- to coarse-grained from 713 to 732 ft; apparent dip 25 to 30 degrees, crossbeds 40 to 45 degrees; fairly well sorted in upward-fining sequences, with basal coarse grained arkose scoured into siltstone hornfels at top of underlying sequence in 5- to 10-ft thick packages. Generally hard and brittle, locally slightly calcareous, cut by steep fractures.

732-742.5 Conglomerate, variegated, mottled pale red to dark green, pebble to

(*737) cobble, looks matrix-supported, with dark green, chlorite-epidote matrix; clasts are quartzite and minor limestone, locally vuggy with calcite crystals; euhedral, red brown garnet crystals 0.5 to 1.0 cm at 734 ft.

742.5-751 Arkose, pale yellowish brown (10YR6/2), fine- to medium-grained, well sorted and subrounded to rounded in graded beds capped by hard siltstone; tight calcareous matrix; apparent dip of 30 degrees on siltstone-arkose contact at 747 ft, and 45 degree dip on apparent crossbeds. Common vertical to 80 degree fractures.

751-770.5 Arkose, mostly pale red (5R6/2 to 10R6/2), and greenish gray (5G6/1) from 762.2 to 770.5 ft, in part pebbly from 751 to 753.2 and with "floating" carbonate clasts partly replaced by epidote and garnet; vertical fractures in part filled by calcite 0.5 to 5.0 mm wide at 756.5 to 762.2 ft. Matrix tight, in part fine grained and silty.

770.5-786.5 Conglomerate, mottled grayish green (10G4/2) and medium- to light-gray (N6),interbedded with thin, very coarse grained, pebbly arkose layers; mostly quartzite pebbles with a few chloritic zoned pebbles and rare limestone pebbles, but mostly non-calcareous.

786.5-789 Arkose, light gray (N7), mostly medium grained but coarse- to very coarse-grained in contact with 1 to 3 in thick pebble conglomerate seams, hard, non-calcareous.

789-797 Conglomerate, light gray (N7, N8), pebble to cobble, mainly quartzite clasts, zoned grayish pink to greenish gray, non-calcareous; minor coarse grained arkose partings.

797-801.2 Arkose, pink to gray and pale red (5R6/2), medium- to coarse-grained and very coarse-grained to pebbly; with epidote clots, but non-calcareous. Bedding or crossbedding about 45 degrees.

801.2-804 Conglomerate, mottled grayish green (10G4/2) and pale red (5R6/2), poorly sorted, with zoned pebbles to 6 cm in diameter floating in chloritic, arkosic sandstone matrix.

804-805 Arkose, pale red (5R6/2), medium- to coarse-grained; faint relict bedding at about 30 degrees.

805-812	Conglomerate, mottled pink and grayish green, cobble to pebble (1 to 5 cm diameter), poorly sorted, quartzite and marbleized limestone clasts, in part chloritic matrix.
812-815	Arkose, grayish orange pink (5YR7/2), very coarse grained with scattered rounded pebbles with zoned metamorphic halos to 5 cm in diameter.
815-817.5	Conglomerate, grayish orange pink (5YR7/2), cobble to pebble, poorly sorted, subangular, imbricated, mostly marble with minor quartzite in a greenish-gray, talcose serpentine matrix.
817.5-822	Arkose, grayish orange pink (5YR7/2), medium- to coarse-grained, pebbly in places, with 1 cm long flattened clay clasts; cut by chloritic seams and fractures at 60 and 75 degrees, in part filled by veinlets of pink K-spar, fresh and recrystallized.
822-822.8	Arkose, conglomeratic, grayish orange pink (5YR7/2), coarse-grained; gradational upper and lower contacts.
822.8-825.2	Conglomerate, grayish green, mixed pebbles and cobbles in chloritic and calcareous cement or matrix.
825.2-826	Arkose, grayish orange pink (5YR7/2), coarse-grained, with apparent dip of 50 degrees, possibly crossbedded; fractures with slickensides at 45 degrees.
826-873(TD)	Conglomerate, variegated and mottled, pale red, pale green, and pale yellowish brown (10YR6/2), mixed cobbles (average diameter 5 cm) and pebbles in very coarse grained arkosic matrix with sparse calcite cement and veinlets; clasts are mainly quartzite, limestone, dolomite, subrounded to rounded, mainly clast-supported except where matrix is chloritic clay (rare interbeds). Conglomerate is compact, hard, and indurated but only slightly metamorphosed. Generally tight except for scattered discontinuous vugs and subhorizontal fractures and parting planes every 1 to 2 ft. Poorly sorted, with 17- to 20-cm diameter boulders at 845 and 857 ft, possibly defining base of crude upward-fining sequences.

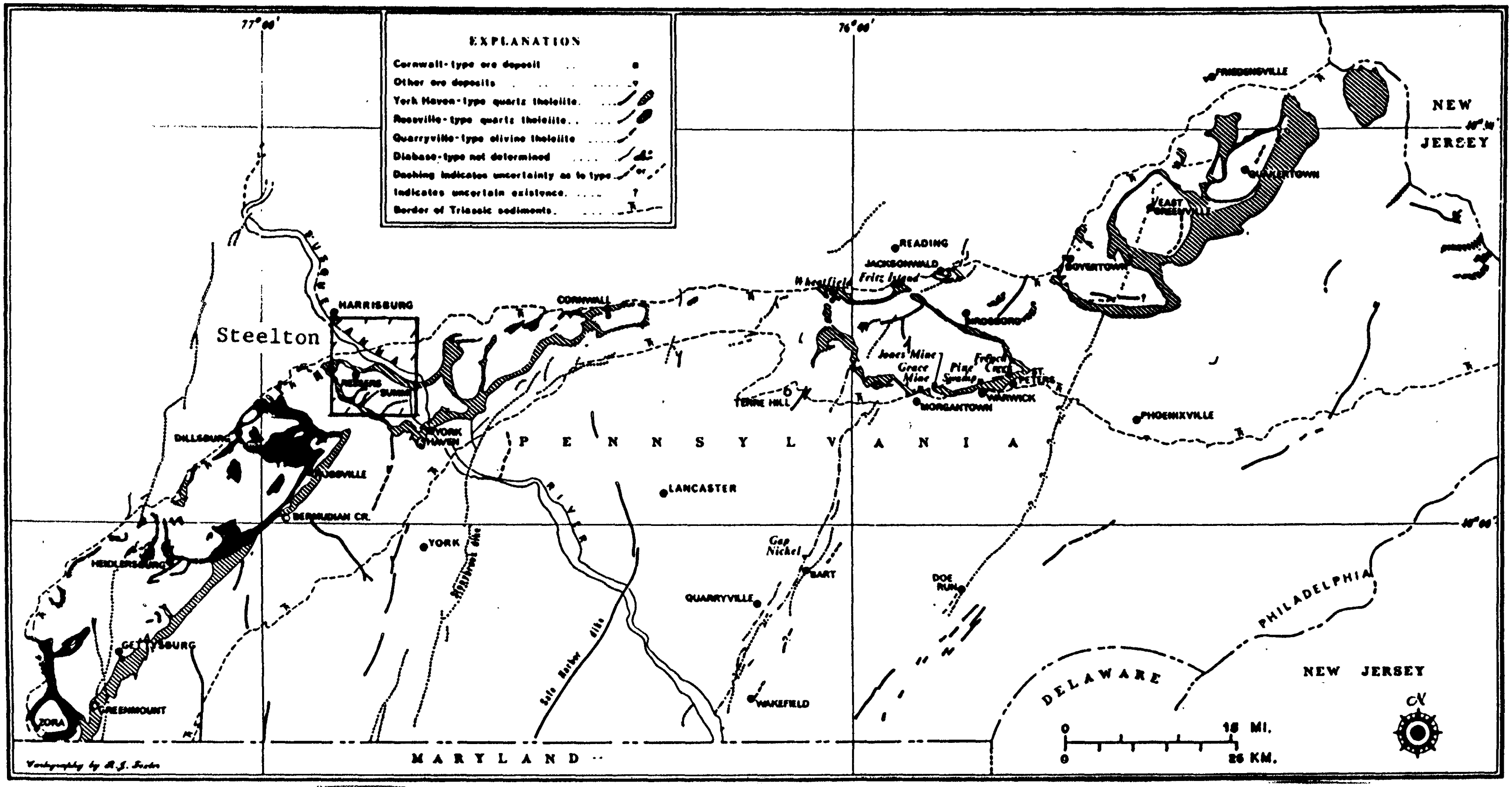

Figure A1. Index map of diabase in the Early Mesozoic basins of Pennsylvania

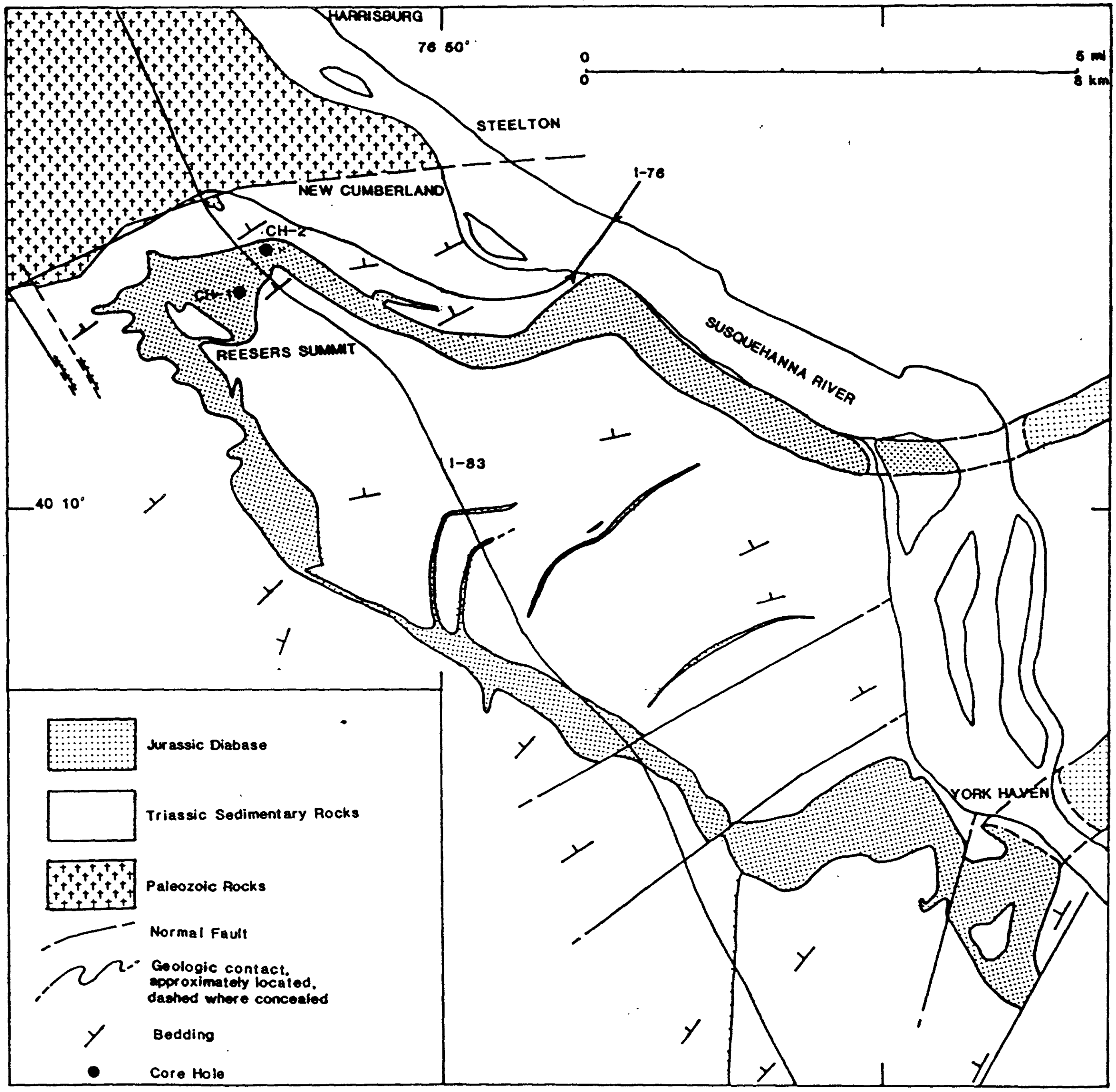

Figure A2. Regional geologic map showing location of northern Gettysburg basin, the York Haven diabase sheet, the York Haven locality, the Reesers Summit road cut exposures of ferrogabbro, and the location of coring sites at New Cumberland, Pennsylvania (Map modified from Stose and Jonas, 1939).

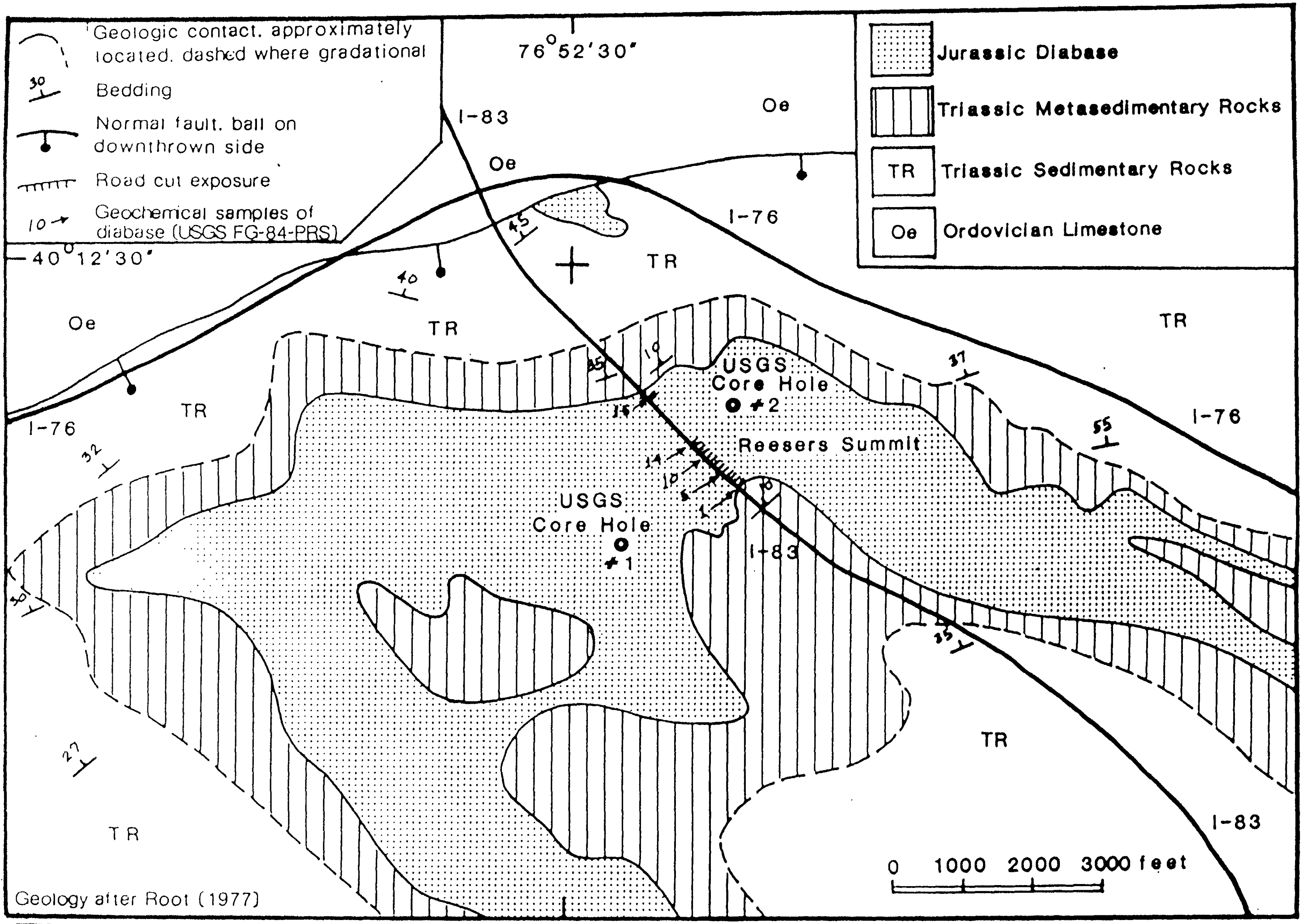

Figure A3. Simplified bedrock geologic map of the New Cumberland area showing the location of the USGS 1984 samples from the I-83 roadcut and USGS core holes 1 and 2 within the Mesozoic diabase sheet at Reesers Summit (Map modified from Root, 1977). Scale 1:24,000.

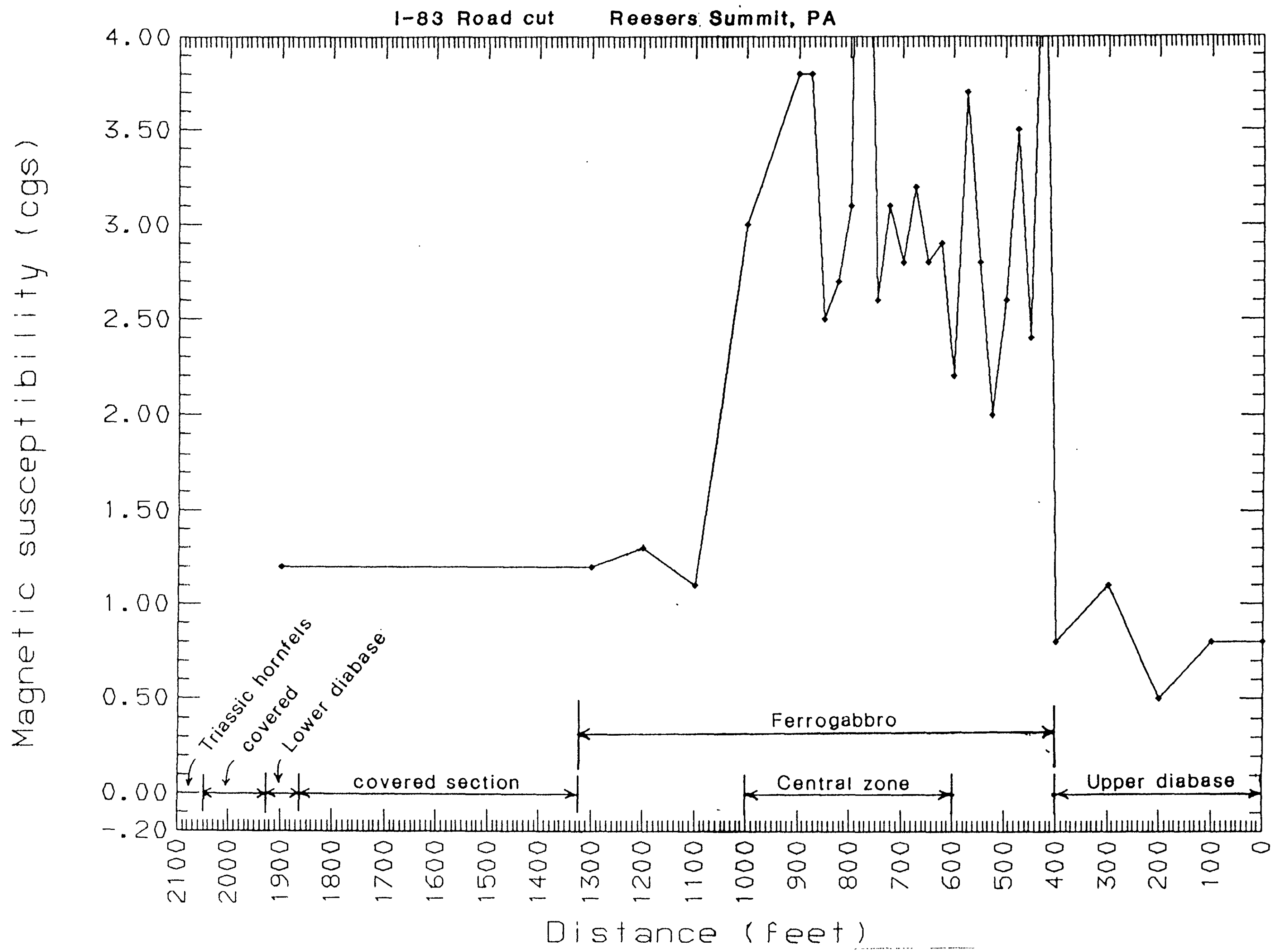

Figure B 1. Magnetic susceptibility of samples from the roadcut along I-83 at Reesers Simmit, Pa. (in cgs units X 10^{-3}). Measurements by M.L. Albertin. Offscale values 4.9 at 425 ft. and 7.1 at 775 ft.

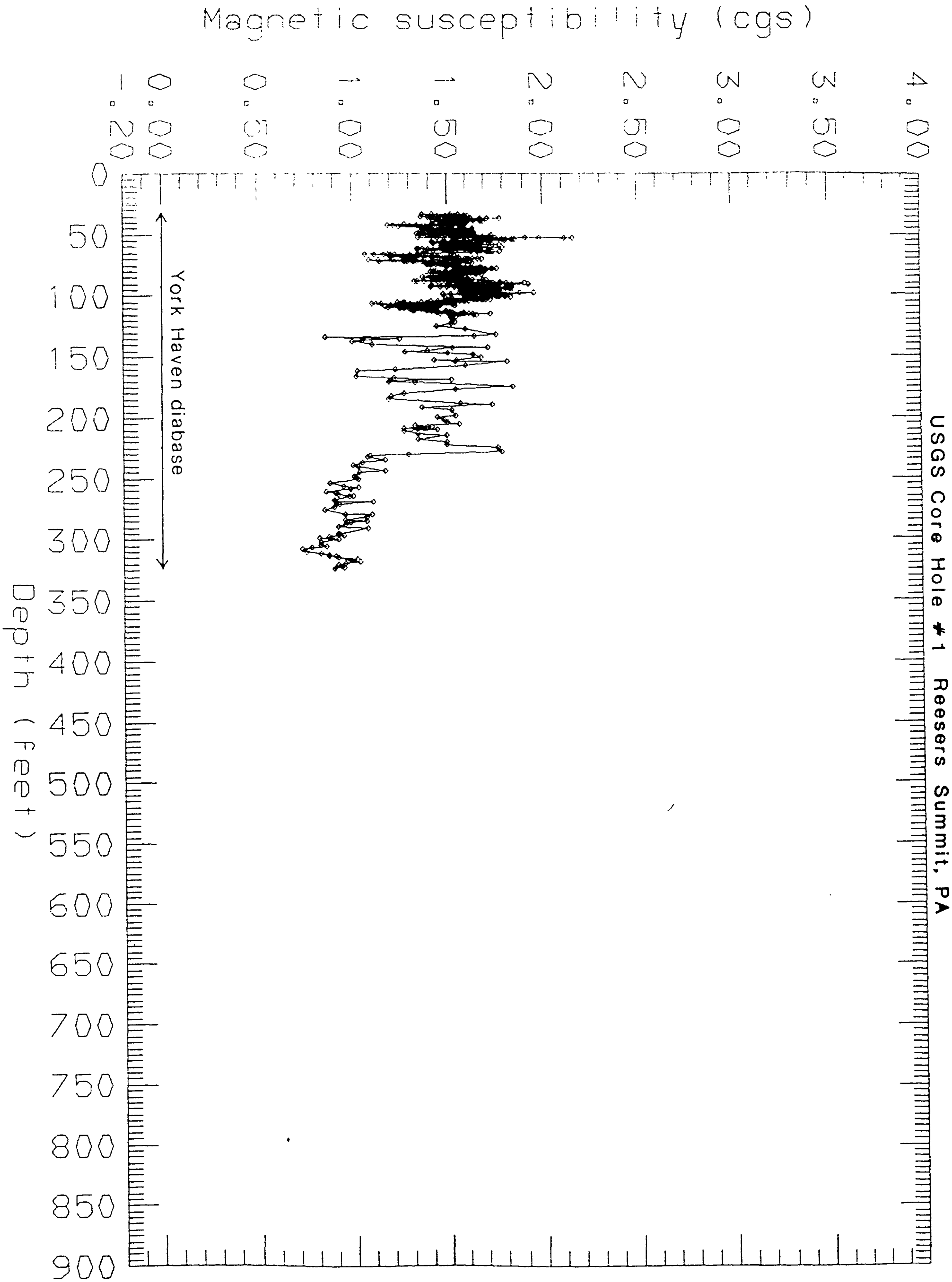

Figure B2. Magnetic susceptibility of samples from USGS corehole #1 (in cgs units x 10^{-3}). Measurements by D. Daniels and D. Price.

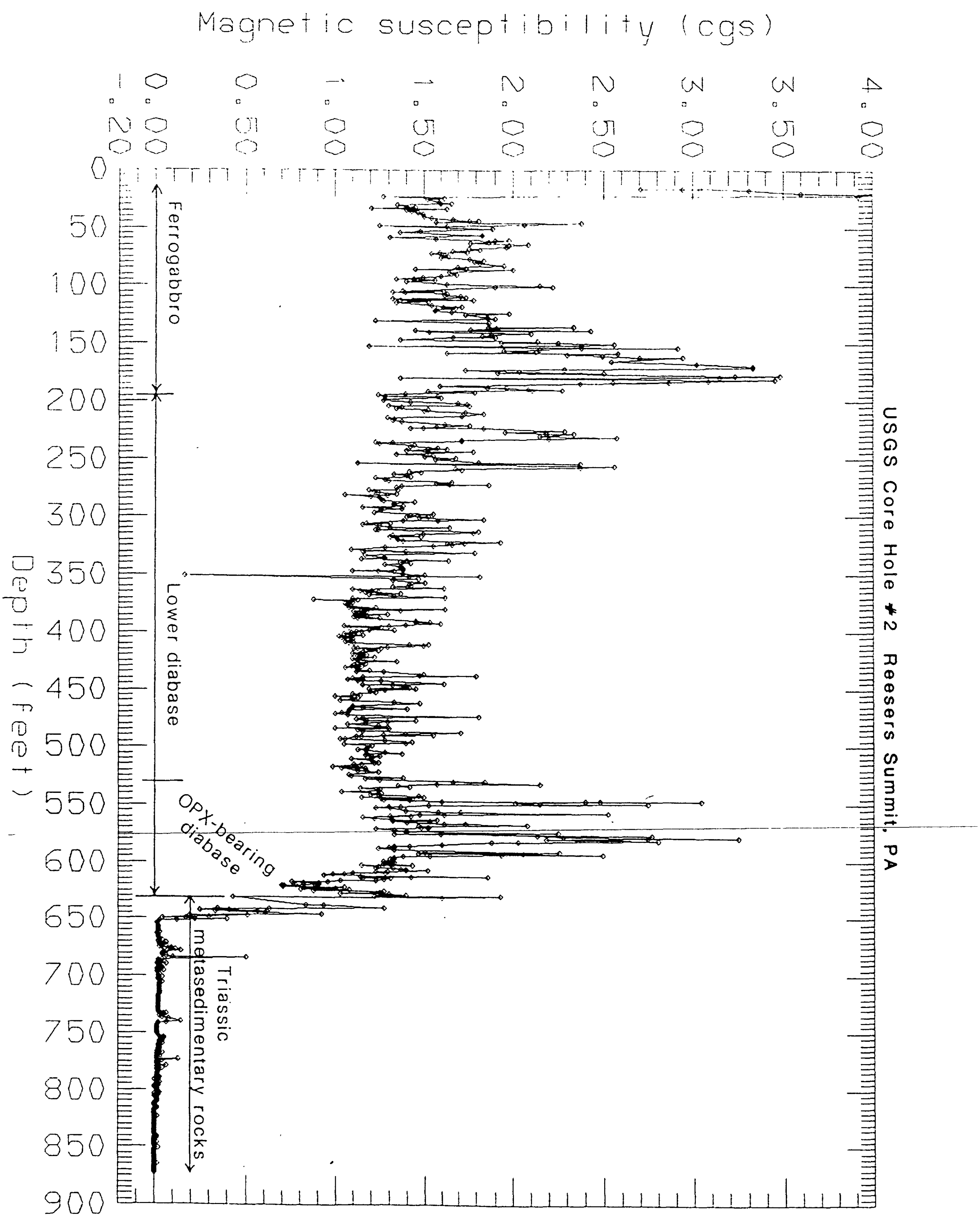

Figure B3. Magnetic susceptibility of samples from USGS corehole #2 (in cgs units x 10^{-3}). Measurements by D. Price.

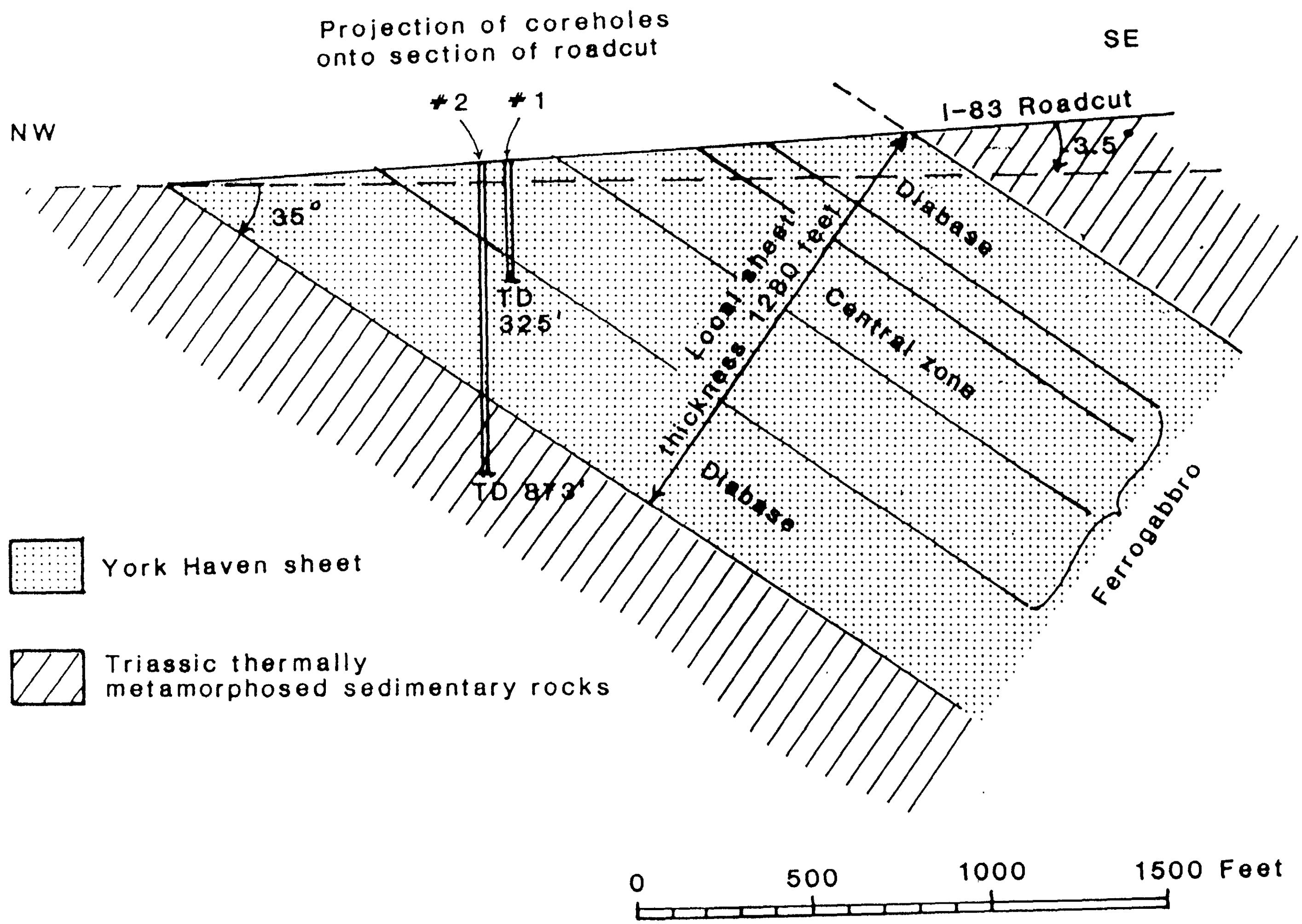

Figure B4. Geometric relationship between the roadcut exposure at Reesers Summit, the USGS coreholes, and the local thickness of the York Haven sheet.

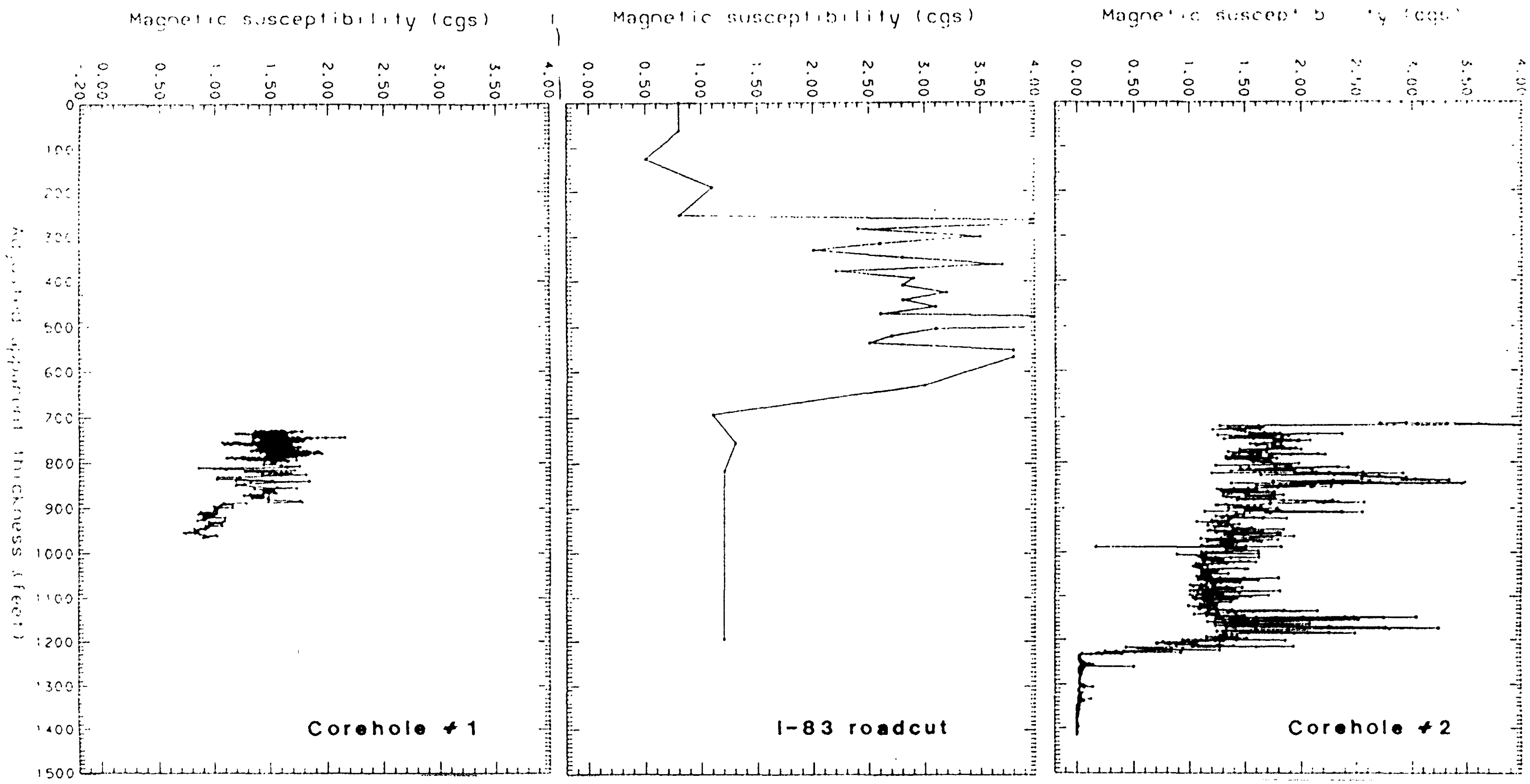

Figure B5. Magnetic susceptibility profiles of the I-83 roadcut and coreholes 1 & 2, projected onto a line normal to the sheet representing the local sheet thickness (in cgs units x 10^{-3}). Measurements from coreholes shifted downward 500 ft. (corehole No.1) and 700 ft. (corehole No. 2) to show possible correlations.

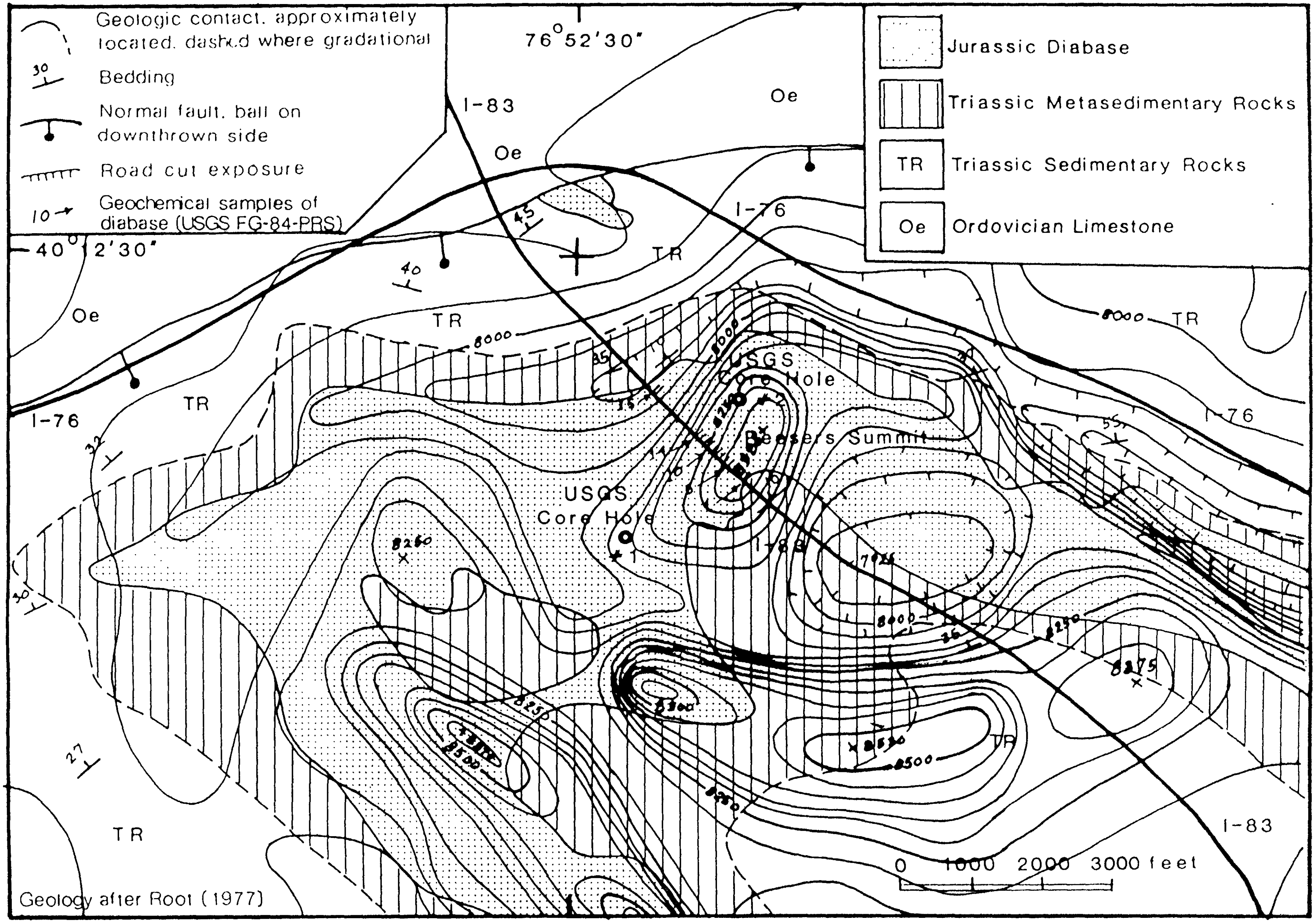

Figure B6. Aeromagnetic map of the Reesers Summit area (from Bromery and others, 1961) with geology from Root (1977). Scale 1:24,000.

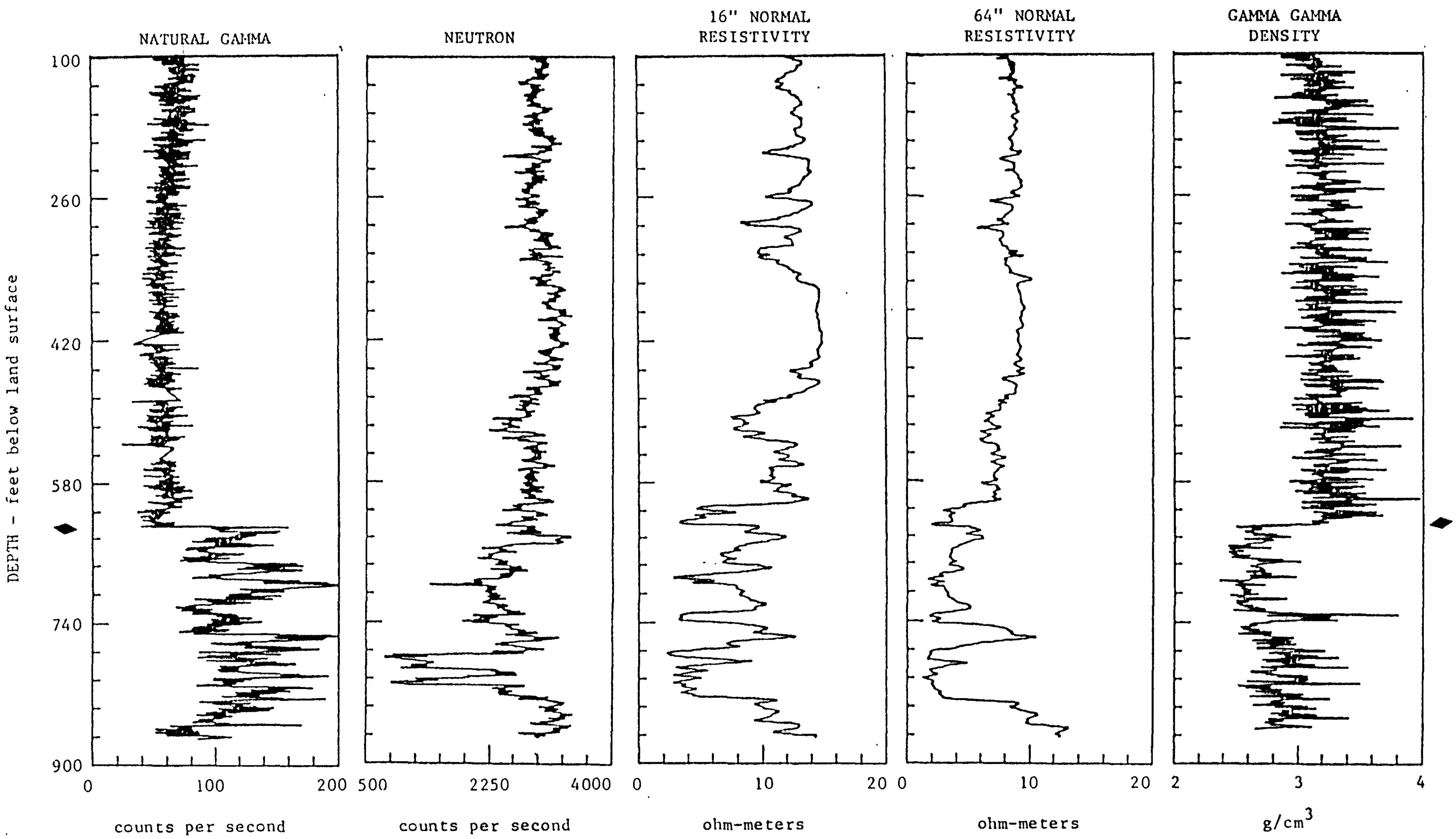

Figure C-1. Geophysical logs for stratigraphic correlation.

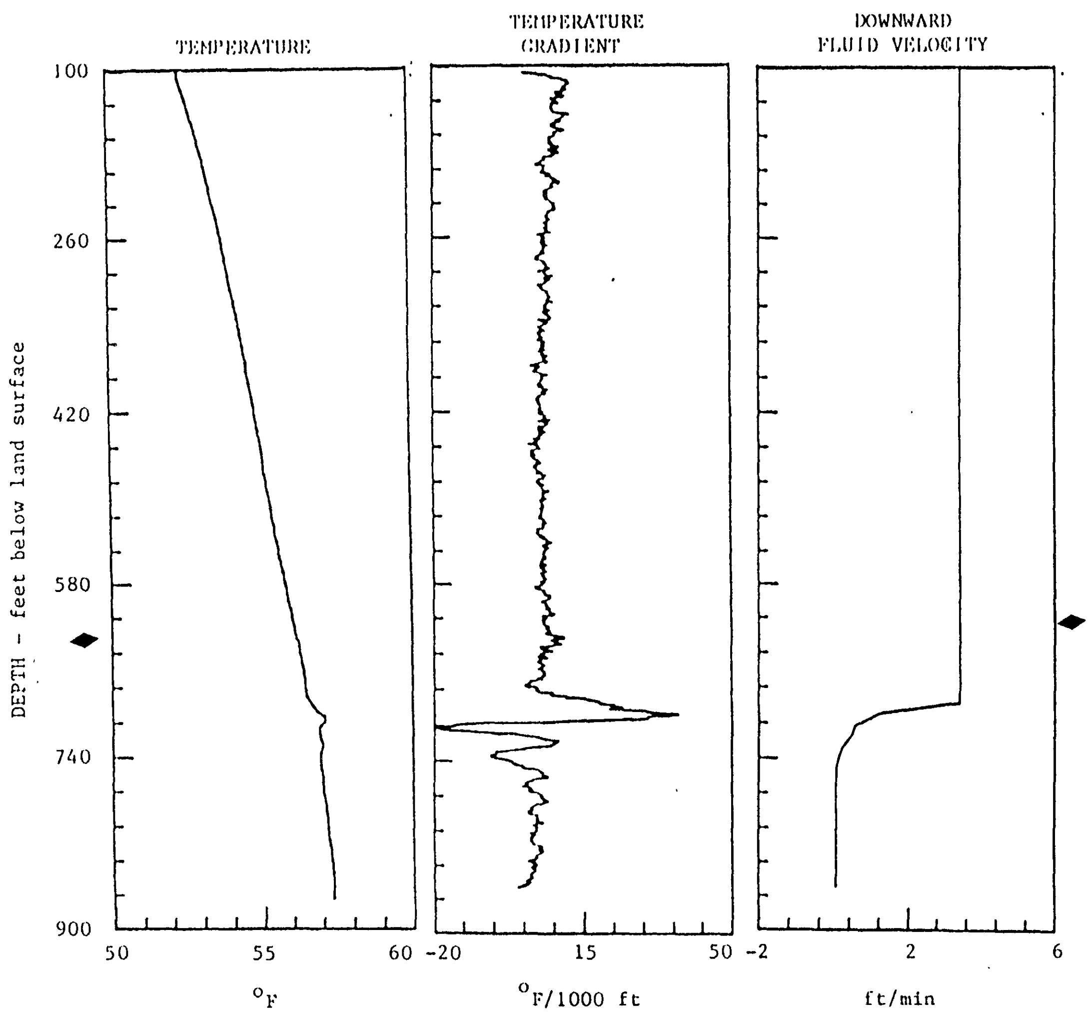

Figure C-2. Geophysical logs for hydrogeologic correlation.

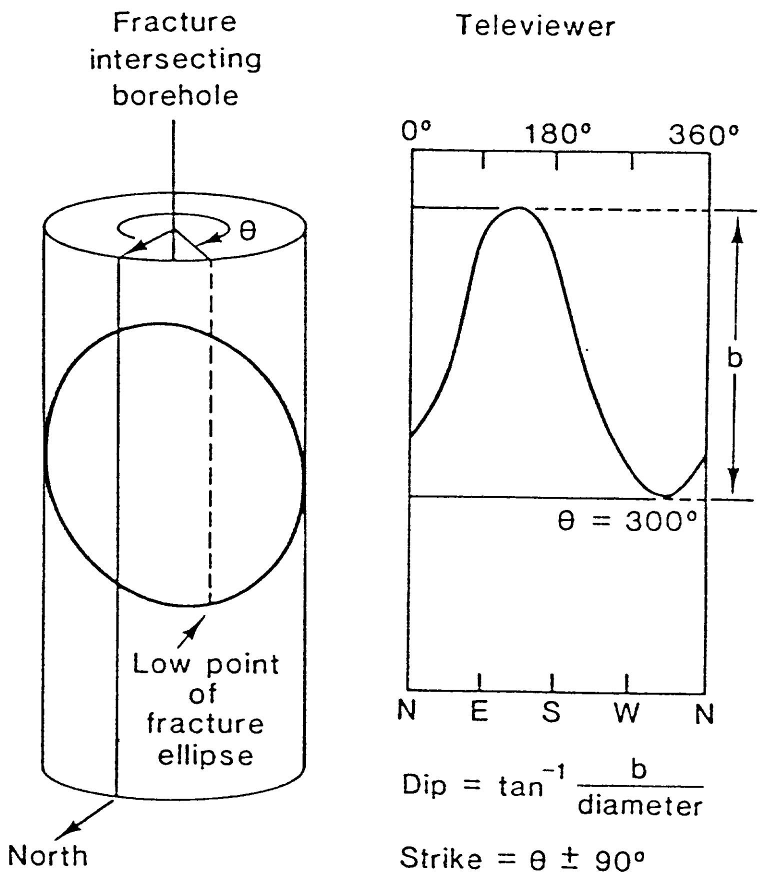

Figure C-3. Illustration of fracture strike and dip determination from televiewer log (from Paillet and others, 1987).

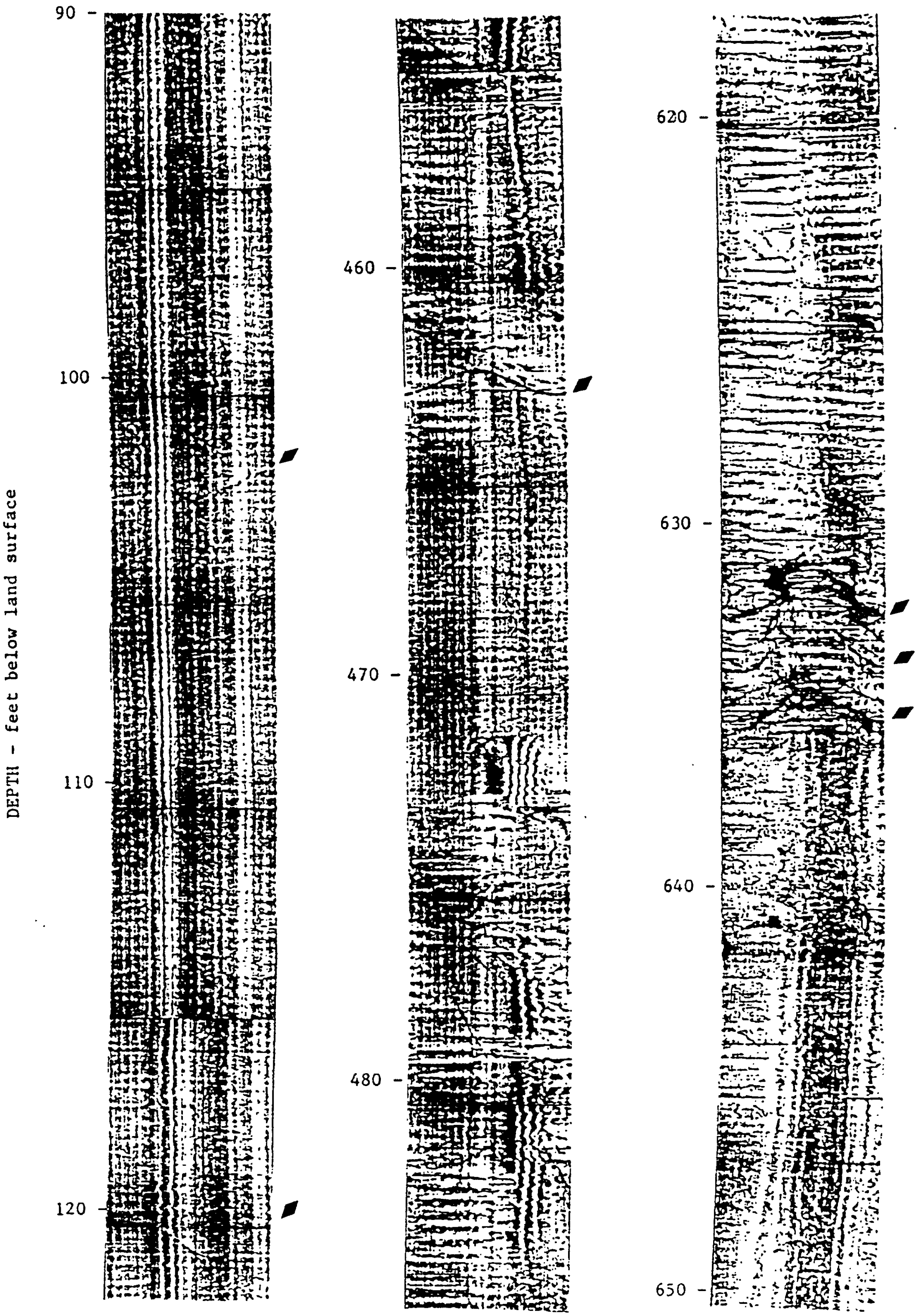

Figure C-4. Representative examples of acoustic televiewer log.