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Charles C. Adams, *Director*

GEOLOGIC STRUCTURE OF THE DEVONIAN STRATA OF SOUTH-CENTRAL NEW YORK

By Arthur Albert Wedel Ph.D.

Cornell University

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FOREWORD

During the past few years there has been a great development of interest in prospecting for gas in south-central New York. Every available source of information has been called upon and a great number of requests for information on the geologic structures of the region have come to the State Museum, from both within and without the State. The present study by Doctor Wedel makes an important contribution to this subject, and at a time when his results are eagerly sought. The State Museum is pleased to make these results available to the scientific and general public as a contribution to the economic geology of the State.

CHARLES C. ADAMS

Director, New York State Museum

GEOLOGIC STRUCTURE OF THE DEVONIAN STRATA OF SOUTH-CENTRAL NEW YORK

By Arthur Albert Wedel Ph.D.
Cornell University

INTRODUCTION

That the rock strata of central and western New York dip gently toward the south has been known ever since the first attempts were made to solve the problem of their stratigraphy. That on this gentle regional dip, in the south-central part of the state, there are superimposed a series of low undulations or folds was also recognized a number of years ago. Vanuxem, Hall, H. S. Williams and others called attention to various examples of the individual flexures. Dr E. M. Kindle, however, in his discussion of the geologic structure of the Watkins Glen-Catatonk quadrangle (1909, p. 98), was really the first to make a special study of these folds over a fairly large area. He outlined, in a general way, the facts as to their location, trend, extent and probable origin.

The area studied in the field by the present writer is included between 75° 45′ and 78° 15′ west longitude and between 42° and approximately 42° 38′ north latitude. It is thus limited on the south by the New York-Pennsylvania boundary.

It is the purpose of this paper to consider in some detail the facts as to the geologic structure of south-central New York, and, in addition, to suggest their probable relation and origin.

Acknowledgments. This investigation was made possible through the Eleanor Tatum Long Scholarship in Structural Geology.

The writer wishes to thank Dr C. M. Nevin for his helpful suggestions and kindly criticism.

METHODS USED IN OBTAINING DATA

To obtain the data which form the basis of this paper, more than a thousand exposures, scattered more or less uniformly over the area, were tested, with respect to the direction and amount of dip, strike of joint planes and any other facts of structural significance. The dip readings were then plotted on an outline map of the area; and on the basis of the readings the locations of the axes of the folds could be more or less accurately determined, and approximate contours of the structure drawn. The adjoining area of Pennsylvania is represented on the same map in order to show the relation of the folds in New York to those farther south. The facts as to the structure of the latter area have been gleaned from various county reports of the Pennsylvania Geological Survey, and from several United States Geological Survey Folios.

DIP READINGS

Since the dip of the rocks is rarely greater than one or two degrees, an ordinary clinometer is not sufficiently sensitive for taking dependable readings. Nor would an ordinary hand level be accurate enough for this work, partly because the dips are frequently lower than 100 feet to a mile, and partly because the available exposures are quite often 60 feet or less in length. For example, if the dip were only 30 feet to a mile, a 50-foot exposure would have a difference in elevation between the two ends of only three-tenths of a foot, which is rather small to be detected by an ordinary hand level.

Moreover, the method of determining the structure by taking elevations on a key horizon is not feasible except over small portions of the area, because the Portage and Chemung formations, which constitute the surface rocks over most of the area, are almost devoid of horizons which could easily be traced with certainty for any distance.

For these reasons most of the field work consisted in taking dip readings with the telescopic level. During the early part of the field work a telescopic alidade and plane table were used, but this apparatus proved to be too cumbersome for rapid work. Therefore a telescopic stadia hand level with tripod was substituted for the alidade and plane table. This greatly increased the speed with which the work could be accomplished, without sacrificing accuracy.

In order to compensate for any instrumental error, the tripod is set up about half-way between the two ends of an exposed bedding plane, and the difference in elevation of the two ends is then read on the stadia rod. If the instrument is lower than either of the two ends, the rod may be held down from that end and the reading recorded as negative. The length of the outcrop is measured by the intercept of the stadia hairs on the rod, and this of course necessitates moving the tripod to either end of the exposure. All dip directions were determined with a Brunton compass. From these data the amount of dip may readily be calculated in feet to a mile.

The Portage and Chemung rocks usually consist of alternating shale and thin flagstone, and these flagstones form ideal bedding planes upon which to calculate the rate of dip. Where flagstones are absent, as is the case in certain portions of the area, less reliable horizons must be used, such as concretionary layers in shale, bedding planes in thick sandstone, fossiliferous layers in sandstone, bedding planes in limestone, partings in shale, etc. The massive sandstones are usually unsatisfactory because of their lenticular character, scouring and cross-bedding. This is well shown in the Oneonta-Ithaca beds on the eastern edge of the area, and this is one of the reasons why the investigation was not carried farther east. The Chemung formation, also contains several sandstone members in which it is difficult to find bedding planes suitable for dip readings.

The length of a bedding plane, its evenness and freedom from scour, and the accuracy with which it may be traced, must be taken into consideration in any appraisal of the dependability of dip readings. In general, the longer the outcrop the more dependable will be the dip reading, in as much as any local irregularities in the bedding surface would distort the result proportionately more in a short than in a long exposure.

Small local folds, slumping, minor faulting and other local departures from the normal structural conditions may give misleading results. For these reasons short isolated outcrops are to be used with great care if the dip determined from them is to be applied without further confirmation to any larger area. Small local folds of only a few hundred feet span may be present, and thus a short bed, if isolated, may indicate a reversal of dip where such reversal is present only on a minor scale. Of course, a long exposure (several hundred feet), or several closely spaced short exposures would prove such a fold to be local. An example of an isolated outcrop which gives a false idea of the dip relations is found on the Ithaca quadrangle, in a road cut two and one-half miles south of Newfield. Here the short bedding planes which are available indicate a north dip, whereas this point is about one mile south of the axis of the Alpine anticline as determined on reliable outcrops to the east and west.

Experience has shown that a length of 50 feet in flagstone is sufficient for accuracy in dip readings. In thick sandstones a greater length is required. But even where the dependable exposures were shorter than the above figure, dip readings were taken, since such data are better than none at all, and, in fact, may be quite accurate if several are secured in one locality and averaged. If nothing more, they at least indicate the direction of the apparent dip and its relative magnitude. Thus, bedding planes with lengths as short as 20 feet have been used by the writer in measuring dips in localities where longer exposures were not available.

In order to determine approximately the amount and direction of the true dip at any point, apparent dips were obtained in different directions wherever possible. If the apparent dips in two directions are known the true dip may be calculated, if the dipping surface is a true plane. Since usually the dipping surface in the present area is never quite a true plane, especially in long exposures, the true dip can seldom be determined with absolute accuracy. The fact that the dip in a given direction in contiguous outcrops is usually not exactly the same in amount, indicates that the dipping surface is rarely a true plane. Nevertheless an approximation to the true dip, sufficient for our purpose may be obtained. Care must be taken to use outcrops which are not too widely separated, since a radical change in dip may occur within a small area. As the field work progresses and as the interrelations of the dips throughout the area become better understood, it is possible to estimate how far the dip which is being measured is away from the true dip.

INSTRUMENTS USED IN READING DIPS

These instruments were: a Brunton compass, a telescopic stadia hand level with a light tripod, and a joined eight-foot stadia rod.

The level has a sensitivity of one-tenth of a foot in 100 feet, which is amply adequate for the present investigation.

The rod is eight feet long, made of basswood and marked plainly in feet and tenths.

The tripod for the support of the level is an essential part of the equipment, since it is practically impossible to hold the level steady enough by hand for accurate readings

DISTRIBUTION OF EXPOSURES SUITABLE FOR DIP READINGS

Available exposures may be found under a variety of conditions, and often the topographic maps mislead one who is trying to determine in advance where good outcrops are likely to occur.

In those portions of the area where the drainage profiles are steep and the valleys narrow a stream is likely to expose the bedrock in at least part of its course. This is especially the case with those streams (hanging valleys) which empty into the larger lakes of the area, as well as those which flow at times in postglacial gorges. If the stream is small and falls very rapidly, however, the outcrops may be too short for accurate determination of dip. Larger streams, on the other hand, often show few exposures, either because they have reached a local base level, or because they may be flowing in valleys once occupied by much larger streams and thus are unfavorable for rock exposures.

In some portions of the area the glacial débris is so thick as seriously to interfere with the drainage. In such areas exposures are few, the stream valleys being in large part marshy and choked with débris. In fact, the deposits left behind either directly or indirectly from the last ice sheet form a most serious obstacle to the correct determination of the structure.

All of the larger lakes which extend into the area from the north, such as Seneca, Cayuga and Keuka, have excellent exposures along their shores. Very often excellent exposures are found along road cuts, sometimes in the most unexpected places. In general, the cuts along newly improved roads are longer and fresher. Quarries are found in those portions of the area in which the near-surface rock is suitable for building stone or road material. Large quarries are found in the vicinity of Ithaca, Elmira, Owego, Horseheads, Watkins Glen, Corning, Bath, Hornell and other cities.

Ideal conditions for the study of the structure of the area would be the presence of a network of good exposures, distributed more or less evenly, with relatively small intervening spaces. Such a condition is approximated here and there throughout south-central New York. For instance, in the Watkins Glen-Catatonk quadrangles, the numerous hanging valleys, the many north or south flowing streams, occasional quarries and many road cuts provide a fairly good network of exposures. Even here, however, there are large areas in which the scarcity of outcrops makes the interpretation of the structure difficult.

West of the above-mentioned area conditions are somewhat less satisfactory, the exposures, although they may be numerous, tending to be somewhat localized. The most unsatisfactory portion of the whole area from the standpoint of exposures is, however, the northwestern. There the morainic material forms a heavy mantle over the bedrock, and besides, the area is one of relatively low relief. Therefore few of the streams have succeeded in cutting down to bedrock and the good exposures are scarce.

In the extreme eastern portion the difficulty lies not so much in the scarcity of outcrops as in the increasingly sandy and lenticular nature of the Ithaca-Oneonta beds which form the surface rock, and on which accurate reading of dips is almost impossible. For this reason, as well as for lack of time, the investigation was not extended much farther east than the meridian of Binghamton.

DETERMINATION OF LEVELS ON KEY HORIZONS

As previously stated, the method of determining structural features by tracing key horizons could not be applied to the area as a whole. This method, however, may be used locally in conjunction with rate of dip, and serves not only as a useful check, but may even supplant the other method where exposures are poor and scattered.

Along Cayuga and Seneca lakes the top of the Tully limestone may be used as a key horizon. This limestone is brought above the level of Cayuga lake by the Firtree Point anticline, beginning a few miles north of Ithaca. It constitutes a very convenient marker in the study of this fold, because of the ease with which it may be recognized. This limestone forms waterfalls in numerous gullies on the east and west shores of the lake. On Seneca lake its first appearance is somewhat farther north, and here again it can be used to advantage in determining the general attitude of the folding.

In the southwestern portion of the area, in parts of the Greenwood, Hornell and Woodhull quadrangles, a horizon was recognized in the Chemung which served fairly well as a marker. This horizon is the contact of a certain sandstone with overlying shale. This sandstone is distinctive enough in both faunal and lithological character to prevent its being confused with associated sandstones, and it has enough vertical variation to permit of a fairly approximate estimation of one's position in the section, even when the exact contact is not actually exposed. This sandstone member is about 125 feet thick. At the top it consists of ten feet of coarsely bedded sandstone which is quite fossiliferous. This grades downward into a calcareous-argillaceous sandstone of about 30 feet thickness, followed by one-foot layers of tough shell conglomerates which are separated by much greater thicknesses of sandstone. The very bottom part of the formation is composed of thin-bedded sandstone, which at the base grades into flags and shales.

The upper part of this member, and its contact with the overlying shale, are well exposed in the gorge at South Canisteo and as far south as the junction of Milwaukee and Dennis creeks. It is also exposed in most of the tributaries of Colonel Bill's creek, and in those of Bennets creek from Bennets north. Farther northwest, in the Hornell quadrangle, it may be recognized in Purdy creek and some of its tributaries. No attempt was made to trace it farther west, although it is probable that with careful correlation it could be recognized. East of the Greenwood quadrangle this horizon was recognized in several gullies, especially in the northwest corner of the Woodhull quadrangle, and at the summit of the hill just north of Cameron.

No attempt was made to trace any other markers in the area. With careful work in correlation, however, there is no reason why other horizons may not be used successfully, in localized areas. In this area such key beds are limited either to thin limestone horizons or else to contacts between thicker beds of distinctly different character. Examples of horizons which might be used as key beds are the Parrish limestone lentil, the Genundewa limestone, the Rhinestreet shale, the Cuba sandstone etc.

The Parrish is an impure concretionary limestone, interstratified with the Cashaqua shale about 25 feet from the top. It is best developed in the Keuka lake region, where its thickness varies from a few inches to almost three feet. As to its areal extent, Clarke and Luther state that it "appears first on the western boundary of the Naples valley and is continuous from there east as far as Big Stream and Glen Eldredge on Seneca lake" (Clarke and Luther, 1904, p. 31). It may thus be traced for about 30 miles east-west.

The Genundewa, or Styliola, limestone is a very persistent layer at the top of the Genesee shale which may be traced eastward as far as Seneca lake and westward to Lake Erie. The type locality is on the shore of Canandaigua lake, at the foot of Bare hill (Genundewa), where it consists of three layers of "rather soft and slightly shaly limestone" (Clarke and Luther, 1904, p. 27). The aggregate thickness of the limestone bands with their imbedded shales is 15 feet. Westward the individual limestone layers increase in thickness.

The Rhinestreet is a black, carbonaceous shale, which may be traced from Lake Erie on the west to Seneca lake on the east. It thickens rapidly westward; from one foot on Seneca lake it increases to 200 feet on Lake Erie. It overlies the Cashaqua shale and is in turn overlain by the Hatch shales and flags (Clarke and Luther, 1904, p. 33). As these members are considerably lighter in color than the Rhinestreet, there is no reason why the upper or lower contact could not be used as a marker, due allowance being made for thickening or thinning.

Among the disadvantages in the use of key horizons for determining structure in this area are their frequent lenticular character and the fact that the regional dip causes them to be soon covered.

PREPARATION OF THE STRUCTURAL MAP OF THE AREA

The best way to show the larger structural features of an area is by structural contours. Fortunately, the dip readings and other data collected during the course of the present investigation were sufficiently numerous and evenly distributed to allow fairly accurate contouring of most of the area. The direction of the dip was represented by an arrow, and the amount by a number giving the slope in feet to a mile. In addition, the elevations determined on key horizons were marked in their proper places on the map. After these data had been plotted, the synclinal and anticlinal axes could be approximately located.

The next step is the drawing of contour lines, which in the present instance show intervals of 100 feet, that is, each contour represents points which are at the same level, and each succeeding contour represents a change in elevation of 100 feet. The spacing of contours will therefore be governed by the rate of dip. The accuracy of the spacing, however, will depend upon the distribution and trustworthiness of the data as well as upon the ability to distinguish between true and apparent dip. Fortunately, the course of the contour lines in those areas on the map which are deficient in dip readings is partly governed by the data in adjacent areas. That is, the field work soon demonstrated that these folds are not integral units but are related parts in an orderly system. Therefore, once the larger features of the structure become apparent, such as the trends of the synclinal and anticlinal axes, the lack of data in any local area is not a serious handicap, since this local portion is in sympathy with the remainder of the structure and projection may be made without too great an error. Where several explanations are possible the one most reasonable from a geological viewpoint is used. Of course, the element of uncertainty can nowhere be entirely absent, and in the detailed discussion of the structure special mention is made of those areas where this uncertainty is very large.

Particular pains were taken to draw the contours in harmony with the elevations which were determined on the various key horizons mentioned above. Thus, in the area between Cayuga and Seneca lakes the contours were drawn in accordance with the determined elevations of the Tully limestone, and care was also taken to represent only as much closure in the folds as the stratigraphy indicated.

The evidence afforded by the position of the Tully horizon as shown in two deep wells was also taken into consideration in drawing the structure contours through the localities where the wells were drilled. One of these wells was drilled on the Fair Grounds south of Ithaca. According to the well record, the elevation of the top of the Tully is 44 feet below sea level (Ashburner, 1887–88, p. 941). The second well is one which was drilled two miles north of Richburg, in Allegany county, in 1928. In this well the horizon of the Tully was reached at a depth of 4010 feet (Hartnagel and Russell, 1929, p. 289, footnote). The elevation of the mouth of the well above sea level is approximately 2100 feet. This means that the Tully horizon at this locality is approximately 1900 feet below sea level.

In the area in which levels were determined on the previously mentioned Chemung sandstone horizon, the contour lines drawn on the basis of dip readings could also be corrected.

In addition, the Portage-Chemung boundary as represented on the areal map of the State was used as a means of correcting the contour lines in the northern part of the area. According to the areal map, the boundary at the Seneca lake meridian passes a few miles south of Millport and is at an elevation of about 800 feet; at Rheims, west of Hammondsport, it is at approximately the same level, and this is again true three and one-half miles south of Dansville. Farther west the strike of the boundary swings rapidly to the southwest. These facts have been taken into consideration in drawing the structural contours.

To what extent faulting of the rocks complicates the larger structural features is not known but it is probably of insufficient magnitude to affect the contours appreciably, and has been disregarded in the drawing of the map. Some discussion of the possibility of faulting is given in another part of this paper.

In view of the fact that a horizon contoured by the above method is an imaginary one, it was thought best not to assign actual elevations to the contours, but rather to number them, assigning the value of zero (0) to the lowest one on the map. That is, the contour marked *10* is 300 feet higher than the contour marked *7*, and is 500 feet lower than the one marked *15*.

Perhaps the contours based on the above method are not so accurate as those based on a key horizon, but they give a consistent view of the larger structural features. Whatever the relative accuracy may be, this method is the only one which can be readily used over the entire area, and within limits it is reliable.

RESULTS OF PREVIOUS INVESTIGATIONS

The general facts with regard to the regional dip and the folding superimposed upon it were recognized many years ago. Indeed, some of the individual folds were described almost a hundred years ago. Vanuxem in 1842 referred to the fold in the limestone at Shurger's point, and suggested that it was not a real flexure but only an apparent one "caused by a change in the direction of the lake to the southeast, the dip of the rocks being southwest" (1842, p. 167).

James Hall, in his Report on the Fourth District (1843, p. 212–13), discussed the undulations in the Tully limestone where it is exposed along Cayuga and Seneca lakes. He recognized several along Cayuga lake but his statements as to their location are rather indefinite. He mentioned the anticline at Firtree point on Seneca lake and another anticline several miles farther north. In an earlier report he refers to the north dip of the strata at Elmira (1839, p. 323).

In 1875, Sherwood, in the Bradford-Tioga counties (Pennsylvania) report, attempted to trace some of the Pennsylvania folds into New York State (1875, p. 94). He concluded that the Crooked Creek (Pine Creek) syncline, the Sabinsville anticline, and the Cowanesque syncline could be traced into the State as far east as the Chenango river. Owing to the fact that he made his observations along meridians 20 miles apart, and probably because he assumed that the trend of the folds remains the same as in Pennsylvania, his conclusions as to the location of these folds in New York are now known to be erroneous.

In 1882 H. S. Williams wrote a brief paper on the "series of nearly parallel folds trending about twenty to thirty degrees north of east, decreasing in strength from the Pennsylvania line to the northwest." He recognized the following synclines in the meridian of Ithaca, from the state line north: one several miles north of Waverly, another between West Danby and Spencer, a third five miles south of the head of Cayuga lake, a fourth at Ludlowville, and a few smaller ones still farther north.

About this time S. G. Williams (1883) calculated the probable regional dip of the strata in central New York by taking elevations on various exposures of the Tully limestone. He concluded that the regional dip varied between 30 and 50 feet to a mile to the south. In the same paper he gave a brief description of the fold at Shurger's point.

More recently (1905–11), Clarke and Luther, in various bulletins on the stratigraphy of portions of the area, included brief discussions of the structure, such as variations in amount and direction of dip, location of anticlines and synclines etc. In their bulletin on the Watkins and Elmira quadrangles they include a north-south cross section in the meridian of Seneca lake, indicating correctly the locations of the Elmira, Watkins and Firtree Point anticlines, but omitting the Alpine anticline (Clarke and Luther, 1905). In his discussion of the Geneva-Ovid quadrangles, Luther includes an east-west section crossing Cayuga and Seneca lakes (Luther, 1909). This section indicates that the two lakes are located in north-south synclinal troughs, a view which is not borne out by the present investigation.

The most complete discussion to date of the structure of the rocks of south-central New York is that by Dr E. M. Kindle in the Watkins Glen-Catatonk Folio (1909, p. 98). In this report Kindle maps the axes of the various folds and also gives some description of them, as well as of the other structural features. He recognizes the fact that the folds are more or less parallel to and continuous with the folds of the adjacent area in northern Pennsylvania. He discusses the probable origin of the folds, the regional dip, the joints and their interrelation. Beginning at the southern border of the State, he recognizes the following folds in the Watkins Glen-Catatonk quadrangles: Nichols syncline, Elmira anticline, Horseheads syncline, Van Etten anticline, Cayuta syncline, Alpine anticline, Corbett Point syncline, Firtree Point anticline. The folds are named after localities where they are well developed. In the present paper these names have been retained. Kindle made no attempt to analyze the folds in detail, nor to show the structure by contours. His location of the axes does not always coincide with that determined by the present investigation, although a comparison of the maps will show a general agreement.

Structural features other than the folding, such as joints, thrust faults, horizontal faults etc., have been mentioned in various papers, references to which will be given later, when the structure is considered in detail.

STRUCTURAL DETAILS BROUGHT OUT BY THE MAPPING

GENERAL STATEMENT

A study of the contour map of the structure reveals the fact that the strata have been deformed into a series of low, more or less parallel anticlines and synclines, the axial lines of which trend to the south of west. The most striking thing about these folds is their great persistency. This fact was noted by Doctor Kindle, but the folds appear to be much more persistent than he represented them. In the case of several of the folds the distribution of dip readings along the axes was complete enough to show definitely that the folds continue without a break across the entire area. For instance, the Van Etten anticline may be traced with very few gaps in the evidence from the Tioughnioga river, a few miles above Chenango Forks, to as far west as Troupsburg, a distance of almost 90 miles in New York State alone. The Alpine anticline is another example of a fold which can be definitely traced across the area.

In the absence of contradictory evidence there is reason to believe that most of the other folds have a similar persistency, and therefore they have been so shown on the map, even though gaps in the field data are sometimes quite large. A few of the folds, however, are quite short—only a few miles in length. Such folds are most numerous in the eastern portion of the area. In several cases two anticlines apparently merge and continue as one. This appears to be the case with the Alpine and Watkins anticlines, the merging occurring in the vicinity of South Canisteo.

Another striking fact is the general southwestward plunge of the axes of the folds. This pitch is especially strong in the area included between the Seneca lake meridian on the east and the meridian of Dansville on the west. Between these limits the pitch to the southwest appears to average about 40 feet to a mile. Evidence of plunge in this area is given by the consistently high westward components of the dips. West of the Dansville meridian the data collected were too meager to permit a very reliable estimate of the amount of pitch, but the probabilities are that it is considerably less than the figure for the preceding area. The fact that the strike of the strata, as indicated by the trend of the Portage-Chemung boundary, here changes to the southwest, would seem to show that the southwestward pitch does not continue much beyond this point.

In the area included between the Seneca lake and Cayuga lake meridians, the plunge of the axes is to the west, and is generally low, probably not exceeding 15 feet to a mile. Northeastward from Cayuga lake this pitch to the west seems to increase to about 40 feet to a mile.

The general westward and southwestward plunge of the folds throughout the entire area must be considered in any discussion of the regional dip. In other words, the regional dip over most of the area, instead of being due south, is somewhat to the west of south. This is especially true in the area included between the Seneca lake and Dansville meridians. To the east of these limits the westward component is small, and the regional dip is about 40 feet to a mile south. West of the Dansville meridian, the strike of the Portage rocks, as shown on the areal map of the State, is northeast-southwest, which probably indicates a regional dip to the southeast. If this is true, a broad north-south structural syncline is present, and, in fact, field work partly bears out this conclusion.

Another characteristic of the folding is a progressive change in the general trend of the axial lines from about 5 to 10 degrees north of east in the eastern part of the area, to about 25 to 30 degrees north of east in the western part. This change in trend of the axes is most abrupt in the southern part of the area at the meridian of Elmira. Here the axial lines of the Elmira anticlines and the Horseheads syncline show marked bending, which becomes progressively less abrupt in the folds to the north.

In addition to this progressive change in the general trend, any of the axes may show local irregularities; two adjacent axes may separate slightly in one locality and converge again in another.

Closures to the east which cause domes on the anticlines are not numerous, because of the usual southwestward plunge of the axes. It is worthy of note that the Seneca lake meridian appears to be a zone of high points on many of the folds. For example, the Elmira, Watkins, Firtree Point, and Lodi anticlines all show a tendency toward doming along this particular north-south zone.

The dips on the south flanks of the anticlines are usually much more pronounced than those on the north flanks, and as a rule the south flank is the broader. The net effect is the often mentioned regional dip to the south of some 40 feet per mile.

North of the Enfield syncline the folds are considerably less in height and width than those south of this trough. South of the state line and east of the Susquehanna river the anticlines do not differ much in height and steepness from those north of the state line;

but to the southwest these folds increase greatly in intensity. Kindle calls attention to this fact, stating that east of the Susquehanna the Wellsboro and Towanda anticlines do not differ notably from the folds of the Watkins Glen quadrangle in magnitude of dips, and have almost no effect on the topography, whereas to the west of the river the dips along these folds increase to 15°, 20° and even higher; that is, they become great enough to affect the topography very materially, the folds being bordered on each side by synclinal mountain ridges (1909, p. 105). This strengthening of the folds also becomes progressively more marked to the south.

The highest dips recorded in southern New York were read on the south flank of the Alpine anticline, and were as much as 700 feet to a mile, or 8°. Dips of over 300 feet to a mile, however are very rare.

THE ANTICLINES AND SYNCLINES

Having noted the characteristics of the folding considered as a whole, we may now proceed to discuss each of the folds individually, noting its trend, plunge and other features.

The Nichols syncline. This is the most southerly of the folds of the area. Its axis passes through the village of Tracy Creek, then trends a little to the north of west and passes about one or two miles north of Nichols. It crosses Cayuta creek three miles north of Waverly, and the Chemung river in the vicinity of Wellsburg. It is probably continuous with the Pine Creek syncline of Pennsylvania. This is not in accordance with Kindle's view as represented on his map of the southern New York and adjacent Pennsylvania folds (1909, p. 100). He represents the Nichols and Pine Creek synclines as being separated by the Sabinsville anticline. In this, however, he does not agree with his text in which he states that the Wellsboro anticline, which is the fold bordering the Pine Creek on the south, crosses the Susquehanna river between Milan and Athens (1909, p. 105). This means that the Wellsboro anticline is drawn much too far south on his map and should be even north of his location of the Pine Creek syncline. If the axes of the Wellsboro and Pine Creek folds are drawn according to Kindle's text and according to the Bradford-Tioga County Report (p. 51–72) the continuity of the Nichols syncline with the Pine Creek becomes quite obvious.

The north dips obtained on the south flank of the syncline vary between 40 and 250 feet to a mile. The north dips are quite high north and west of Waverly, and the corresponding dips on the north flank are also high. Therefore it is probable that in this area the trough becomes closed, and the contour lines have been drawn accordingly. The west dip at Wellsburg indicates that the syncline plunges to the southwest from that point westward.

The Elmira anticline. The axis of this fold was not traced much beyond Binghamton on the east edge of the area, but it may continue farther east. Passing through Binghamton the axis crosses the Susquehanna river south of Union and again one mile north of Apalachin. North of Nichols the axis swings somewhat to the northwest and crosses Cayuta creek north of Lockwood where it swerves somewhat southwest again. At South Elmira the axis takes a decided swing to the southwest, trending about 40° south of west, and continues in this direction across the state line.

Regarding the continuation of this fold into Pennsylvania Kindle says:

"The Elmira anticline doubtless represents the eastern extension of either the Harrison or the Sabinsville anticline of Pennsylvania, probably the former."

The evidence gathered by the present writer, however, decidedly favors the view that the Elmira anticline is continuous with the Sabinsville and the map has been drawn accordingly.

About half-way between Owego and Elmira there appears to be a long saddle in the fold, about 15 miles in east-west extent. This is indicated by the fact that north and west of Lockwood there is no reversal of the dip to the north where it is to be expected, but only a notable decrease in the amount of south dip (to about 20 feet to a mile). Just northeast of Lockwood there is some north dip but only over a very local area. Additional evidence of the saddle is furnished by the fact that the south dips south of the axes in the Cayuta creek meridian are much lower than is usual for this structure.

From Binghamton west the axis plunges only very slightly toward this saddle, but from Elmira east the pitch toward it is pronounced.

The contour lines have been drawn to indicate a large dome on this anticline at Elmira. Among the evidences of closure is the presence of the saddle at Lockwood, the occurrence of high dips on both flanks of the fold and the great breadth of the north flank on the Elmira meridian, the occurrence of east dips at Latty brook north of Elmira Heights, and a strong westward dip at Elmira. The contour lines show a closure on this dome of over 200 feet. If this figure is correct the Elmira dome is much the largest in the entire area. It is roughly triangular in plan, with one side of the triangle facing the west. South dips off the top of the dome are at the rate of 100 to 275 feet to a mile, and the corresponding north dips are at the rate of 70 to 150 feet to a mile.

The Horseheads syncline. From about three miles north of Binghamton the axis of this syncline trends in a general westerly direction as far as Cayuta creek. Crossing that stream about three miles north of Lockwood, it trends north of west as far as Horseheads and then takes a sharp swing to the southwest. Between Big Flats and Lindley no outcrops suitable for dip readings were found along the south flank, but in the vicinity of Lindley the numerous outcrops show that the axis passes a little to the north of the village. Thus the axis probably crosses the state line north of Elkland and continues in Pennsylvania as the Cowanesque syncline.

The axial line of the syncline shows little pitch from Binghamton to the vicinity of Horseheads, where an east pitch is encountered. Dips in the quarries of Latty brook show an east pitch of 35 feet to a mile, which is probably a reflection of the east dips off the Elmira dome. West of Horseheads the average plunge of the axis is at the rate of 40 feet to a mile to the southwest.

The south flank of the syncline at Horseheads is abnormally wide (about eight miles) and this is probably due to the high doming of the strata at Elmira.

For some distance south of the axis at Big Flats the dips are a little to the south of west instead of being the normal northwest. This fact causes the swing which is to be observed in the contour lines drawn through this area on the map.

The Union Center dome. North of the Horseheads syncline, with the axis a little north of Union Center, near the east limits of the area, is a short fold—not over nine miles in east-west extent—which is here called the Union Center dome. This structure appears to be a true dome, on which the amount of closure is probably less than 100 feet. The north flank is quite broad, the north dips continuing about three miles north of the crest. These dips vary between 10 and 100 feet to a mile, but the average is probably about 25 feet.

The Van Etten anticline. The relatively steep dips of this structure show that it is one of the major folds of the area and in a class with the Elmira and Alpine anticlines. The axis crosses the Tioughnioga river two miles north of Chenango Forks and probably does not continue much farther east. It passes through Tioga, Newark Valley, Spencer, and a little to the north of Van Etten and Sullivanville. It crosses the Seneca lake meridian about one mile south of Pine Valley, beyond which point it makes a swing to the southwest, and passes through Corning. Data are lacking on this structure west of Troupsburg, but the axis probably crosses the state line about four miles southwest of that village, and continues in Pennsylvania as the Harrison anticline. According to the Potter County Report (1880, map), it divides into two anticlines about eight miles southwest of the state line. The two branches are called the Roulet-Hebron-Bingham and the Ulysses-Homer anticlines in that report, and are separated from each other by the Coudersport Basin.

The length of the Van Etten anticline in New York is at least 95 miles. The dips on the flanks of this structure are relatively high except east of Candor, where the fold begins to die out.

Two closures of the contours are indicated on the map along this arch. One of these has its center about five miles east of Spencer. Here the evidence of eastward closure is the northeast dip at West Candor, the south-east dip in a corresponding position several miles to the south, and the saddle along the axis, east of Candor. West of the center the west dips indicate a rapid plunge toward Spencer. South of the indicated dome the south dips are quite high, ranging from 100 to 250 feet to a mile. From Candor east the field evidence indicates a pitch of the axis to the west for a few miles, then a return to a horizontal attitude for the remainder of the distance east. East of Newark Valley the dips on the north flank become very low and the flank becomes quite narrow, indicating that it is beginning to disappear.

From Spencer west to Pine Valley the westward pitch of the fold is slight, but west of the latter point the average westward pitch is about 35 to 40 feet to a mile, and is highest in the vicinity of Corning. Here the dip on the north flank of the fold has a small north component and a very large west component.

About three miles west of Addison another dome is indicated. Here the evidence in favor of eastward closure is the unusually high east component of the dips north of Freeman. No attempt was made to determine the amount of closure but the strong east dips indicate that the dome is fairly large.

The Cayuta syncline. The axis of this fold probably passes about one mile south of Cayuta, and from this point east the trend is almost due east. At Willseyville, 17 miles farther east, the syncline appears to divide into two branches. The northern branch passes through Upper Lisle, whereas the southern branch passes near Berkshire and dies out about three miles to the east of that village. In neither of these branches is there a marked trough, and both of them plunge rather rapidly to the west. Between these two synclines is a short westward plunging anticline which trends 10° north of east, passes through Center Lisle and appears to die out a few miles farther east. West of Millport the axis is rather irregular in trend. It passes to the north of Painted Post, through Rathbone and probably about two miles south of Whitesville, crossing the state line a little farther to the west. The fold continues through northwestern Potter county, Pennsylvania, where it is known as the Oswayo syncline.

The westward pitch of the fold is as usual very slight in the eastern part of the area, but increases very decidedly in the vicinity of Corning.

The Alpine anticline. This anticline is locally the steepest in the entire area. The greatest dips are to be found at Alpine, some as high as 8° having been read on the south flank, and as high as 290 feet to a mile on the north flank. Steep dips were also found near Brookton (up to 400 feet to a mile) and near Harford Mills (270 feet to a mile).

Regarding the effect of this fold on the stratigraphy, Kindle says:

"The steeper southward dip on the southern limb of the fold, which continues for several miles, results in an appreciable lowering of the strata for the whole region. This effective southward dip explains the descent of the base of the Chemung along the hills on the southern flank of this fold" (1909, p. 103).

The axis of the anticline could not be traced farther east than Marathon, because outcrops to the east of that village are scarce and those which are present are too lenticular and cross-bedded for dip determinations. It is probable, however, that the anticline dies out very soon east of the Tioughnioga river, as is indicated by the restricted area in which north dips occur. The axis crosses the river about one mile north of Marathon, and trends a few degrees south of west as far as Beaver Dams. Here it takes a more decided swing to the southwest, then back again to almost due west. At South Canisteo it appears to have merged with the Watkins anticline.

From Marathon on the east, to Brookton, the westward pitch of the fold is quite pronounced, about 35 feet to a mile. A little west of Brookton the axis rises to the west as far as the meridian of Ithaca, then dips to the west again to beyond Newfield. In other words, a dome is indicated to the north of Danby. The evidences in favor of the closure represented here are the northeast and northwest dips found in upper Buttermilk creek. These dips are quite high, almost 150 feet to a mile. If the data are interpreted correctly there is a small saddle in the fold just west of Brookton.

The unusually steep dips on both limbs of the anticline at Alpine indicates the presence of a pronounced dome, and the amount of closure shown has been estimated from the steepness of the dips.

From the center of the dome at Alpine the pitch to the west is quite steep as far as the Seneca lake meridian. At this point the axis apparently becomes nearly horizontal, and there is a possibility of closure, but in the absence of positive evidence no closure has been shown on the map. From Beaver Dams west, the axis pitches rapidly to the southwest (about 40 feet to a mile).

The Enfield syncline. This fold begins about three miles northeast of Marathon, and crosses Cayuga inlet about three and one-half miles south of the lake. At Montour Falls the axis may be exactly located. From here it continues through Monterey and Risingville, and finally dies out a few miles east of South Canisteo where the Watkins and Alpine anticlines merge.

The south limb of the syncline is usually less than three miles in width and the north limb is also relatively narrow, except east of Ithaca, where the dying out of the Watkins and Corbett Point folds leave it about seven miles in width.

The westward pitch along the axis varies from about 35 feet to a mile east of Ithaca; to almost zero between Ithaca and Montour Falls; to about 45 feet to a mile west of Montour Falls. Southeast of Ithaca a closure to the west is indicated by northeast and southeast dips occurring in the drainage of lower Six Mile creek.

The Watkins anticline. This fold is small compared with any of the three large anticlines to the south.

Crossing Seneca lake about one-third of a mile north of Watkins, it extends almost as far east as Cayuga Inlet valley, with a trend of 10° north of east. Eastward, beyond the west bank of the inlet the dips are all toward the south, indicating that the fold dies out before reaching Ithaca. On the uplands between the two lakes data on the fold are lacking, and the same is true of the area from Watkins west as far as Savona. The northwest dips between Savona and Bath indicate that the axis crosses the Cohocton river northwest of the former village, and numerous dips in the vicinity of Adrian and South Canisteo show that the axis passes a little south of the latter. As already stated, the Alpine anticline seems to merge with this fold in the vicinity of South Canisteo. From South Canisteo westward the data were sufficiently well distributed to permit tracing the fold into the Sharon anticline of Potter county, Pennsylvania.

From Ithaca to Watkins the fold does not appear to plunge westward as would be expected, but seems to pitch toward the east, thus causing a small dome at Watkins. This is substantiated by east dips in Excelsior glen, on the axis of the fold on the east side of Seneca lake. Additional evidence is afforded by the fact, noted by Kindle

(1909, p. 101), that a certain heavy bed of sandstone is 12 feet lower on the crest of the anticline on the east side of the lake than it is in a corresponding position on the west side. The total amount of closure on this dome is small. Using the sandstone bed already mentioned as a key horizon, Kindle ascertained that the difference in elevation between the crest of the anticline and the trough of the Corbett Point syncline to the north amounts to about 40 feet. The closure to the east is probably greater, and therefore 40 feet may be considered as the approximate amount of closure. The center of the dome is probably just north of Watkins, west dips occurring in the stream at Salt Point.

West of Watkins the fold pitches westward at the usual rate of 40 feet to a mile, almost as far as South Canisteo. A few miles to the east of South Canisteo the pitch flattens again and averages about 15 feet to a mile. At Hallsport and again farther west the north dips are high (more than 100 feet to a mile) and it is possible that there is some closure in this area.

The Corbett Point syncline. Crossing Seneca lake three miles north of Watkins, at Corbett Point, this syncline continues east almost as far as Cayuga lake, and dies out simultaneously with the Watkins anticline. West of Seneca lake there are no data on this fold for more than 20 miles, but in the vicinity of Bath the dips indicate that the axis passes through that village. Thence the axis may be traced across the Canisteo river about one and one-half miles northwest of Adrian and through Andover. It probably passes through Stannard's Corners and crosses the state line five to seven miles east of the westerly edge of the area.

Closure is shown along this syncline between Cayuga and Seneca lakes, because it seems to satisfy best the adjacent structural conditions, although no definte evidence of this closure was found in the field. To the west of Seneca lake the pitch of the fold is normal for that area.

The Firtree Point anticline. This fold is somewhat larger than the Watkins anticline, but does not compare in magnitude with the three anticlines farther south. Owing to the fact that the flexure is strikingly shown along Cayuga lake in the Tully limestone, this fold was one of the first to be recognized. The literature on it has already been mentioned.

The axis crosses Cayuga lake at Portland Point (Shurger's Point) about five miles north of the head of the lake. East of here the evidence which may be gathered on this fold is extremely meager, but dips on outcrops in line with the axis indicate that the fold dies out before reaching Cortland. Low north dips were found north of

McLean, about 12 miles east of Cayuga lake, and again at Peruville, four miles farther west. Outcrops are lacking in the uplands between Cayuga and Seneca lakes, but there is no reason for thinking that the fold is not continuous in this area. The axis crosses the west side of Seneca lake at Firtree Point. From the meridian of Dundee almost as far west as Hammondsport, outcrops are again very scarce, and the location of the axis is approximate. Beyond this point it may be traced without too many breaks in the evidence, across the Cohocton river south of Avoca, through Hornell, Alfred and Scio. Beyond the latter point, data for establishing the presence of the anticline are meager, but the contours have been sketched in on the assumption that it continues.

At Portland Point the Tully limestone outlines this fold very strikingly, and its height above the next syncline north may be approximately determined. On the east side of the lake the limestone does not quite disappear below lake level in the syncline to the north, but dips down to about 400 feet above sea level. The crest of the fold passes through the quarry at Portland Point, where the elevation of the Tully is approximately 640 feet. This gives a difference of elevation of 240 feet between crest and trough. This estimate, however, disregards the plunge of almost 90 feet to the west, which is shown by the fact that the elevation of the Tully on the crest in Willow creek (on the west side of the lake) is 554 feet. Therefore the true closure is in the neighborhood of 150 feet.

No closure is shown to the east of Portland Point. This does not mean that such closure may not actually be present, but in the absence of any definite evidence in its favor it was thought best to show a nose plunging to the west at the rate of 35 feet per mile. This rapid pitch does not continue westward more than a few miles. According to Williams and Kindle (1909, p. 52), the top of the Genesee shale rises about 35 feet above lake level at Firtree Point on Seneca lake. Allowing about 110 feet for the thickness of the Genesee shale, the top of the Tully limestone would then be 375 feet above sea level, or 276 feet lower than in the Portland Point quarry 20 miles to the east.

At Firtree Point the crest of the fold is about the same height above the troughs on either side, according to Kindle, and amounts to 115 feet (1909, p. 100).

The fact that east and northeast dips occur north of the axis at Reading Center, coupled with the fact that the formations opposite Firtree Point on the east side of the lake are lower in elevation than the same formations on the west side of the lake (Clarke and Luther, 1905, Areal Map), indicates the presence of a dome on the anticline in this locality.

A few miles west of Seneca lake the pitch of the axis to the west, as usual, increases very quickly and continues thus to about three miles southwest of Hornell. The northeast dips at Alfred Station indicate that the axis rises to the west beyond this point. A closed contour line has been drawn on the fold between Alfred and Scio, but the evidence in favor of such closure is not very conclusive.

The Glenora syncline. The axis of the syncline north of Firtree Point crosses Seneca lake a little north of Glenora, and is therefore called the Glenora syncline. On Cayuga lake the lowest point on this fold is a little north of Frontenac Point, northeast of Trumansburg. The continuation of the fold west of Seneca lake is feebly indicated, and in the vicinity of Keuka lake its position, marked on the map by a dotted line, is largely hypothetical. West of Keuka lake its presence is indicated by dips in the vicinity of Avoca, Hornell and Almond.

Between Seneca and Cayuga lakes the dips on the north limb of this fold are in general quite low as shown by the very gradual rise of the Tully limestone above the trough. Between these two meridians the axis is almost horizontal. Westward from Seneca lake the pitch is the usual 40 feet to a mile to the west.

Folds occurring north of the Glenora syncline. Between the Glenora syncline and the north limits of the area there are several more anticlines, which are well shown in the Tully limestone along the west shore of Seneca lake.

The Severne Point anticline. This is the first of the folds to bring the Tully limestone above lake level. The anticline passes through Severne Point, about one mile south of Plum Point. According to Luther (1909, p. 24), the Tully here rises to a maximum height of 45 feet above the level of the lake. The same author states that the formations dip from the top of the arch westward at the rate of 150 feet to a mile. The limestone sinks below lake level again a little north of Severne Point, and remains under water for about one-fifth mile, then emerges five feet above water in a small anticline, passes below lake level again and remains so for about one-half mile (Luther, 1909, p. 24).

The probable continuation of the Severne Point fold westward is indicated by steep north dips (140 to 150 feet to a mile), which occur in Wagener glen, west of Keuka lake; by the northwest dips occurring between Arkport and Canaseraga; and by the 150 feet to a mile north dip occurring in the gorge near Angelica. These points are widely separated, and unfortunately few satisfactory outcrops were found in the areas between, partly because of the great thickness of glacial débris. At Angelica a closure has been drawn on the axis, because of the steep northward dip in this locality.

The Lodi anticline. The Tully limestone rises above lake level again a little north of Plum Point, and then returns to lake level about three-fourths of a mile north of this point. Its maximum height is 30 or 40 feet above the lake, which of course is too small to show on the 100-foot contour interval map.

The fold can be recognized on both sides of Seneca lake, and on the east side its axis appears to lie near Lodi glen. It probably continues as far east as Cayuga lake if the flattening of the dip of the Tully limestone is a true indication. To the west of Seneca lake the possible continuation of the axis is indicated by low north dips near Naples and by the due west dips south of Dansville.

One and one-fourth miles west of Plum Point the rocks dip toward the lake with an eastward component of about 45 feet to a mile, and west of this location there is a strong westward component. This indicates the presence of a dome, with a center about eight-tenths of a mile northeast of Himrod. The amount of closure is probably small, in as much as the east dip does not continue far east of Plum Point, as is shown by the fact that the Tully limestone is higher in Lodi glen on the east side of the lake than it is to the north of Plum Point, and was seen to dip west in the glen (Luther, 1909, p. 24). That there is another closure on the east side of the lake is very probable. It is indicated by the observations just mentioned and by the fact that one and one-half miles farther east, in Mill creek, the rocks have a strong eastward dip. No doubt both of these domes are small.

Farther north several more folds appear along Seneca lake, but these are beyond the limits of the area mapped.

In the northwestern district no additional east-west flexures were recognized. Here the strike of the Portage-Chemung boundary indicates that the regional dip swings around to the southeast, at least for a distance, and the contour lines have been drawn in to reflect this change. West of the Genesee river the westward component again becomes prominent in the dips, and the strike of the formations swings to the northwest. The reason for this rather abrupt change in strike is somewhat obscure. If the Clarendon-Linden fault is extended to the south, however, it will then pass within a few miles of this area, and departure from normal conditions may be attributed to a local effect of faulting.

POSSIBILITIES OF MAJOR FAULTING

Minor faulting in the Cayuga lake area has been discussed in various articles. Among these may be mentioned the papers by Eleanor Tatum Long (1922), Dr Pearl Sheldon (1929), G. C. Matson (1905), and Kindle (1909, p. 108).

In addition, there are some indications of possible major faulting, with throws as high as 100 feet. That such faulting is actually present a little west of the area is shown by the Clarendon-Linden fault, which passes near Batavia and trends a little to the west of south (Chadwick). Alling thinks that this fault may continue as far south as Bliss (1928, p. 80). The fault has a maximum throw of 300 feet, the west side being the downthrown side.

Just north of the present area there is some indication of a fault crossing Keuka outlet between Seneca Mills and Cascade Mills. At Cascade Mills the dip determined on the Tully limestone is about 75 feet to a mile S. 58° W. At Seneca Mills, almost a mile west, the Tully dips southwest at the rate of) 130 feet to a mile. The limestone at the latter place is 100 feet higher in elevation than at the former. This means either a very sharp flexure trending approximately north and south, or else a north-south fault with the east the downthrown side. The latter is the more probable explanation. How far south this condition extends was not determined. The possibility of this being a fault was first recognized by Wright (1884).

The above-mentioned author also refers to certain peculiarities in the stratigraphy a little farther west that may be due to faulting. He describes a certain heavy sandstone band (two feet thick), which, in a railroad cut two and one-half miles southeast of Penn Yan, shows a strong dip to the west. At its west end it is 840 feet above sea level, whereas in the Sartwell gully, two miles farther west, it is 40 feet higher, and dips northwestward (Luther, 1906, p. 54). If these two sandstone bands are really the same horizon, either a fault in a north-south direction or a north-south flexure is indicated.

More detailed future investigation will no doubt not only determine the true character of these apparent displacements, but will also disclose others of the same general type.

JOINTS

The strikes of joints were taken at many, although by no means all, of the outcrops visited. No exhaustive survey of the jointing was made, and care must therefore be taken not to draw too many conclusions from the data.

For a detailed study of joints over a limited portion of the area, the paper by P. Sheldon on jointing in the Ithaca region may be consulted.

The joints fall naturally into two groups or sets, namely, the strike joints and the dip joints, which are in general parallel respectively to the strike and dip of the beds. Apparently these two sets are conjugate and form a system.

In tabulating the joint readings, those which range in strike from N. 15° E. to N. 45° W. may be considered as dip joints, while those which range from N. 50° E. to N. 70° W. may be classed as strike joints. The former are approximately at right angles to the folds, the latter parallel with them.

For the sake of simplicity, each north-south tier of quadrangles was considered as a unit. The compass was divided arbitrarily into sectors, as N. 8–15° W., N. 16–25° W. etc., and the joints which had strikes falling into different sectors were classed as separate sets. The frequencies of occurrence of these sets were then estimated for each north-south tier with the following results:

Binghamton-Greene Tier

Dip-Joints		*Strike Joints*	
N. 5° E.—N. 5° W.	86%	N. 70—85° W.	57%
N. 6—15° W.	14%	N. 60—70° E.	28%
		N. 71—85° E.	15%

Appalachian-Harford-Cortland Tier

Dip Joints		*Strike Joints*	
N. 5° E.—N. 5° W.	29%	N. 60—70° E.	40%
N. 6—15° W.	67%	N. 71—85° E.	21%
N. 16—20° W.	4%	N. 70—85° W.	39%

Owego-Dryden-Moravia Tier

Dip Joints		*Strike Joints*	
N. 8—15° W.	14%	N. 65—70° E.	22%
N. 18—25° W.	83%	N. 70—85° E.	57%
		N. 70—85° W.	22%

Waverly-Ithaca-Genoa Tier (Sheldon, 1912, p. 66)

Dip Joints	*Strike Joints*
N.—N. 5° W., abundant	N. 70—80° E., abundant
N. 11—15° W., most abundant	N. 75—80° W., much less abundant

Elmira-Watkins-Ovid Tier

Dip Joints		*Strike Joints*	
N. 10° E.—N. 5° W.	20%	N. 60—70° E.	30%
N. 6—15° W.	10%	N. 71—85° E.	40%
N. 18—25° W.	16%	N. 70—85° W.	30%
N. 26—30° W.	34%		
N. 31—35° W.	15%		

Corning-Hammondsport-Penn Yan Tier

Dip Joints		Strike Joints	
N. 8—15° W.	12%	N. 60—70° E.	36%
N. 18—25° W.	12%	N. 71—85° E.	64%
N. 26—30° W.	6%		
N. 31—35° W.	24%		
N. 36—45° W.	55%		

Woodhull-Bath-Naples Tier

Dip Joints		Strike Joints	
N. 8—15° W.	22%	N. 50—55° E.	35%
N. 20—30° W.	10%	N. 60—70° E.	49%
N. 31—35° W.	11%	N. 71—85° E.	14%
N. 36—45° W.	55%		

Greenwood-Hornell-Wayland Tier

Dip Joints		Strike Joints	
N. 31° W.—N. 35° W.	14%	N. 50—55° E.	46%
N. 36—45° W.	86%	N. 60—70° E.	18%
		N. 71—85° E.	18%

Although the percentages given above would no doubt be somewhat different if a more complete survey of joints had been made, they probably have considerable significance. They indicate that the strike of the joints changes as one goes from east to west. For instance, the direction of the dip joints changes from about due north in the eastern part of the area to about N. 45° W. in the western; while that of the strike joints changes from about N. 80° W. to about N. 55 to 60° E. This progressive variation in the strike of the joints corresponds almost exactly with a similar change in trend of the axes of the folds. The possible bearing of these data on the stress relations will be discussed in a later paragraph.

It is interesting to note that in three of the western tiers of quadrangles the data show the presence of two major groups of dip joints about 15 to 20 degrees apart. This observation is in line with what Doctor Sheldon found for the Ithaca region.

ORIGIN AND INTERPRETATION OF THE STRUCTURAL FEATURES

The important structural features of south-central New York are the following:

1 The general regional dip of the strata southward at the approximate rate of 40 feet to a mile

2 The series of low, parallel and very persistent folds which are associated with this regional dip

3 The joints developed in remarkably uniform and persistent sets

4 The small thrust and horizontal faults

5 The more extensive north-south faults

In any adequate interpretation of the structure of this area the attempt must be made to determine the relationship between these various features.

Other peculiarities of the structure which merit explanation are: (1) the gradual change in trend of the axes of the folds from approximately S. 80° W. on the east to approximately S. 60° W. on the west, a change which appears to be sharpest in the Elmira meridian; (2) the strong pitch of the folds to the southwest, beginning especially at the above meridian.

THE ORIGIN OF THE FOLDS

Some 25 years ago, Kindle, speaking of the folds of southern New York, stated that "it appears certain that the comparatively insignificant structural features which have been described are of the same age and origin as the great open folds of the northern Alleghenies" (1904, p. 287). There appears to be little room for doubt that such is the case. The most southerly of the folds in New York may be traced without a break into northern Pennsylvania. Besides, all of the folds are approximately parallel to the Allegheny folds. They die out gradually northward from the Allegheny Front, some of the folds in Pennsylvania to the southwest of the Watkins Glen quadrangle being 2500 feet in height, while they become progressively lower to the north. Thus the Firtree Point fold along Seneca lake is only 115 feet in height from trough to crest, and farther north the folds become even less intense. To the east, in about the longitude of the Tioughnioga river, the folds in New York appear to die out, just as the folds in northern Pennsylvania gradually die out east of the Susquehanna river.

The writer is entirely in accord with Kindle when he says:

> From theoretical considerations it would appear improbable that the effects of the epeirogenic forces which have developed structures of such magnitude (as that of the Appalachian folds) should terminate abruptly at the north edge of a highly folded belt. Instead of abrupt change from highly folded to monoclinal or nearly horizontal structure, we find the mountain flexures subsiding gradually into the low, gentle swells which have been described (1904, p. 287).

If we ascribe this folding to the same forces which produced the Allegheny folds, there still remains the question as to how the stress which caused the folding could be transmitted across the distance which separates this area from the intensely folded zone of the Appalachians. According to Willis, a horizontal stress acting on rock strata can not be transmitted very far beyond an actively developing fold (1929, p. 255). Moreover, the sediments are inherently too weak to transmit a stress any considerable distance. If this be true, the stress which produced the succession of folds under discussion was not transmitted in the near-surface rocks. Since a succession of folds is present, showing that the stress was actually transmitted, it must have been accomplished in some other way. At the present time it appears to be the prevailing opinion that a stress which produces a series of open sedimentary folds is transmitted through the more rigid and stronger basement complex. In the upper stratified rocks this stress would induce folding along pre-existing lines of weakness. In that case, deformation must be at least somewhat, if not largely, of a rotational character. Since this stress would be gradually dissipated because of friction, the folds would be less and less intense the farther they originated from the source.

The great length of these low folds is an outstanding characteristic and presumably is connected with their origin. It is likely that the great length of the Appalachian folds, so familiar to all structural geologists, is a reflection of a similar cause, whatever it may be. Willis has suggested that beyond each active fold sufficient stress may be transmitted to induce a line of weakness which will localize the next succeeding fold (1929, p. 271). If the first fold is of great length, the next succeeding fold will tend to have a similar length. There is a possibility, therefore, that several more or less parallel and perhaps widely separated lines of weakness determined the position and extent of the early folds, which in turn guided the extent of later folding. Thus the characteristic length of the Appalachian folds, together with their extension as low folds in the area under discussion, may be an inherited feature.

TYPE OF THE FOLDING

Are these undulations, which have been recognized in the Upper Devonian and Carboniferous rocks, the result of competent folding in these rocks, or, are they the surface reflection of failure in deeper and stronger formations, such as the Cambro-Ordovician? The latter is more probably the case, although there may have been some degree of competent folding locally in the upper rocks. For instance, the Tully limestone at or near the surface at Portland Point shows a broad open fold, whereas the salt beds, over 1000 feet below the surface, have failed incompetently and are badly smashed and contorted. Presumably, still deeper down, the more competent formations would again show broad, open folding.

If the deeper strata have folded competently and thus lifted the overlying younger rocks, we should expect the folding to increase in intensity with depth, and, with future drilling for oil and gas, sufficient data to answer this question definitely should soon be available.

RELATION OF JOINTS TO THE STRESS WHICH CAUSED THE FOLDING

It is most likely that the stress which caused the folding also caused the various joint sets of the area, as well as the horizontal and thrust faults. There appears to be no reason for believing otherwise.

Kindle, in calling attention to the fact that the peridotite dikes of the Ithaca area are confined to north-south joint planes, appears to have leaned toward the view that the north-south joints were formed earlier than the strike joints, the latter having been formed after the intrusion of the dikes was completed (1909, p. 111). His alternative suggestion, however, that the dikes are confined to the dip joints because the strike joints were closed by pressure, seems to be more in accord with the field evidence. That is, all the joint sets were probably formed contemporaneously. In addition, the horizontal faulting occurred about the same time, as suggested by Doctor Sheldon (1912, p. 175). Movements along these horizontal faults undoubtedly furnished lateral relief, a factor which is essential in the development of any joints.

As Kindle pointed out (1909, p. 111), and as Doctor Sheldon later substantiated by her careful study of the joint planes of the Ithaca region (1912), one set of joints is parallel to the strike of the folds and the other set is approximately perpendicular to the same. That is, the joints do not lie in planes of maximum shear, if the stress is considered to have been approximately at right angles to the folds. Bucher, however, believes that the compressive forces must lie in a general N. 35° E. direction, this being the line which would bisect the angle between the two sets; that is, he places them in planes of maximum shear (1920, p. 724). To quote exactly: "The assumption is therefore justified that they (the joints) represent planes of shearing produced by compression in a northeast-southwest direction under general conditions of torsion."

The field evidence seems to show that throughout the entire area the joints are approximately either parallel with or at right angles to the folding, and do not lie in planes of maximum shear although they may be formed by shearing stresses. It is difficult to determine exactly the relation of the deformational stresses to these joints, because, undoubtedly, a considerable part of the stress was rotational in character.

RELATIVE AGE OF JOINTS, HORIZONTAL FAULTS AND THRUST FAULTS

Doctor Sheldon has shown that the joints were formed before the horizontal faulting, or at least before the movement along the fault planes had ceased, as is evident from the fact that these faults planes "uniformly displace the joints which they cross" (1912, p. 175). The joints were thus formed in the earlier part of the period of folding.

The small thrust faults that are present in the region were probably formed considerably later, near the close of the folding period.

BENDING OF THE AXES OF THE FOLDS

The progressive change in the trend of the folds has been described in preceding pages, and this change requires explanation. The bending of the axes appears to be somewhat more marked near the meridian of Seneca lake than elsewhere. This is especially true of the most southerly folds, and a similar change in trend is continued on southward into Pennsylvania.

When we consider the larger features of Appalachian structure, we are immediately impressed with several notable departures from the general trend of the folding. The origin of these salients, as Keith has named them, is one of the obscure, though important, factors of the deformation of the Appalachian trough, and whether they are a reflection of inherited weaknesses, or whether they represent localized adjustments at the time of deformation, is beyond the scope of this paper. One of these salients begins in the vicinity of Lockhaven, Pa., and here the folds leave their general northeast-southwest trend and make a huge sweeping curve to the east.

Undoubtedly, the change in trend of the folds in south-central New York, from a general northeast-southwest strike in the southwest part of the area to a nearly east-west strike in the eastern part, is related to and controlled by the above-mentioned salient of the Appalachians. The observational fact that these same folds appear to die out to the eastward may simply be the result of a diminished intensity of the stress beyond the Lockhaven salient. Reference to the structural map will show that practically all the folds either die out or decrease in intensity as the eastern limit of the area is approached. These relations strongly suggest that the stress which deformed the strata of south-central New York was at least in part of rotational character.

THE REGIONAL DIP AND ITS RELATION TO THE FOLDING

As already stated, the regional dip of the strata is not constant throughout the area, either in amount or direction. In the eastern portion, as far as the meridian between Cayuga and Seneca lakes, the strata dip practically due south, at the rate of approximately 40 feet to a mile. In a restricted zone in the central portion, namely between longitudes 76°45′ and 77°, the regional dip is still to the south but has decreased to about 20 feet to a mile. West of this zone, which incidentally contains some of the most pronounced doming in the area, the regional dip is almost as much west as it is south, the total dip varying between 35 and 40 feet to a mile. As a result, in the eastern part of the area the formations outcrop in bands striking east-west; and in the western part a decided swing to the southeast is indicated even on the small-scale areal map of the State.

This regional dip of the strata may have occurred in one of three periods with reference to the time of folding: (1) the tilting may have occurred before the folding; (2) it may have been contemporaneous with the folding, and a result of the same forces; and (3) it may have occurred after the folding.

The first possibility is the one often suggested. It is the view that Kindle expressed in his discussion of the origin of the structures of southern New York (1909, p. 99). According to him, the tilting was produced by the Canadian uplift which occurred presumably at the close of the Devonian.

If we assume that the absence of post-Devonian sediments over most of New York State means that deposition largely ceased at the close of the Devonian, then there must have been differential uplift during this period, which tilted the strata to the south and raised this area above sea level. This southward tilt would of course be accentuated by continued down-sinking of the Appalachian depositional trough, which is known to have been an area of sedimentary accumulation to the close of the Pennsylvanian, and, in places, even into the Permian.

If the above view is correct, it follows that the gentle folds of south-central New York were superimposed on an already present regional tilt, the folding occurring as an integral part of the Appalachian revolution.

A possible objection to this view is that the regional dip does not increase to the north as the center of uplift is approached, as might be expected. This is not necessary, however, as examples of regional dips on a large scale are known to have had no definite center of uplift, as, for instance, the Prairie Plains monocline of Kansas, Oklahoma and Texas.

The possibility that the regional tilting occurred at about the same time as the folding must not be neglected. It is not known at what period deposition in south-central New York ceased. Indeed, in the southwestern part of the State there are sediments of Mississipian age and even Pennsylvanian. The absence of Carboniferous sediments may well mean that these were removed by subsequent erosion. There is no way to estimate the thickness of sedimentary material which may have been thus removed, but since peneplains devėloped after the folding, as, for example, the Cretaceous erosion surfaces, have been traced from Pennsylvania quite a distance into New York, it would appear that a considerable overburden has been eroded.

If the regional dip was impressed on this area at the time of the folding, it must have been caused by differential stresses which in part at least were of torsional character.

Unfortunately, there is no field evidence which may be used to place definitely the time of the regional dip. In fact, as far as the attitude of the structures are concerned, it may well have been the last major deformation which affected the area. If the regional dip was produced after the folding had ceased, the tilting must have been completed before the Cretaceous peneplains were developed, since Fridley has shown that these erosion surfaces may be traced into Pennsylvania at an average slope of only a few feet to a mile (1929).

The appearance of a westward component in the regional dip, thus causing the formations in the western part of the area to dip southwest, has been previously noted in the literature, but no reasonable explanation has so far been given. Luther attributed this westward component of the dip, which he found in the rocks of the Geneva-Ovid quadrangles, to thinning of the beds toward the west. A careful analysis of the data on thicknesses of the various formations indicates, however, that the westward convergence is not more than six feet to a mile for any stratigraphic interval above the Salina. The Salina itself shows little convergence westward. Moreover, in the Upper Portage and Chemung there is an actual thickening of some of the members westward. It would seem, therefore, that thinning alone is not of sufficient magnitude, nor in the right direction to account for the marked change in the regional dip in the western part of the area, and the cause must be sought elsewhere. Incidently, this marked increase in the westward component of the regional dip becomes evident about where the most marked change in trend of the axes occurs.

An obvious possibility, of course, is that this southwest dip is the result of irregular doming in the northeastern part of the State.

Another possibility is local down-warping, and this is suggested by the following statement from Hartnagel and Russell (1929, p. 283):

> The oil fields (of New York State) lie just east of the axis of the great Appalachian geosyncline. The axis inclines gently to the southwest, and the regional dip is in that direction.

There seems no good reason to doubt that the west component of the regional dip in New York may be the result of a differential subsidence of the depositional trough to the west.

NORTH-SOUTH FAULTS

Nothing definite is known about the time at which the Clarendon-Linden and other north-south faults were formed. No additional information was secured during this study. In view of the fact that this area has been uplifted several times since the close of the Paleozoic, this faulting may have been produced at any time over a considerable interval. Recent earthquakes, in fact, indicate that some of them may still be active.

POST-PALEOZOIC UPLIFTS

At least two major uplifts have occurred since the Paleozoic, besides several lesser ones. These uplifts are known to us through the evidence of erosion surfaces or peneplains. The two most marked peneplains which have been recognized in the northern Appalachian Highlands are the Kittatinny and the Schooley. That these two erosion surfaces are also present in southern New York is stated in a recent paper by Fridley (1929). In addition to these erosion surfaces there are several others which may be recognized, in Pennsylvania, below the Schooley, such as the Mine Ridge, Harrisburg etc. These show that there were several minor uplifts later than that which resulted in the Schooley peneplain. The uplift which raised the Kittatinny plain is thought to have occurred during Upper Cretaceous time; and that which resulted in the Schooley erosion surface probably occurred in Eocene time.

OIL AND GAS POSSIBILITIES OF SOUTH-CENTRAL NEW YORK

Although this paper is primarily concerned with structural conditions in south-central New York, the oil and gas possibilities have lately been so greatly enhanced that it would seem entirely in place not only to point out the possible structural relations to the accumulations of these industrially important products, but also to touch briefly upon the stratigraphy and sedimentation. These three factors — structure, stratigraphy, and sedimentation — are inextricably knit together in any discussion of oil and gas possibilities.

The majority of the formations in this area were deposited in shallow marine waters, an environment which is common to the oil and gas fields all over the world. In general, these formations consist of rock débris, originating to the east. Locally some of these sediments were brought in from the northeast, southeast and even from the west, but the usual coarsening to the east shows that the main source of supply lay in that direction.

In consequence of what has been said, it naturally follows that the formations finally become continental in character to the east. This environment is not suitable for the production of bituminous material on a large scale. The Salina was also deposited under a continental environment.

The sedimentary section shows an alternating series of limestones, sandstones and shales, the latter predominating. Of this group, the sandstones, because of their porosity and permeability, are usually the reservoir rocks for oil and gas. Sandstones are usually lenticular in character and thus localized in extent, and a majority of the sandstones in this area are no exceptions to this general rule. This makes profitable drilling extremely hazardous. Often limestones have sufficient porosity and permeability to serve as reservoirs, as, for example, the Onondaga and the Trenton. Occasionally the shale section is sufficiently jointed to be a suitable reservoir, as is shown, for instance, by the extensive occurrence of gas in the Marcellus. The so-called shale-gas is generally deficient in volume, but may last a long time.

Source beds from which oil and gas originally came are abundantly distributed throughout the central and western part of the area. Eastward, however, the bituminous content decreases, and although abundant organic material is present, it seems to be dominantly carbonaceous in character. This is especially true of the Devonian. In distillation tests carried on by E. W. Hard in 1929, he established the fact that the black shales of the Genesee and Portage formations vary in oil content from west to east. Eastward from Canandaigua lake, oil is almost lacking, whereas west of the same meridian it becomes increasingly abundant.

Drilling has been carried on in a haphazard fashion for 40 or 50 years in central and southern New York, and the oil and gas fields of Cattaraugus, Allegany and Steuben counties have been intensively developed. As a result, considerable information has accumulated as to the possibilities for oil and gas horizons.

Practically all of the oil horizons are found in the lower half of the Chemung. Whether oil will continue to be restricted to such a limited range is problematical, and deeper and more widespread drilling may develop other possibilities.

Among the known gas horizons are the Portage sandstones, the Marcellus black shales, the Onondaga limestone, the Oriskany sandstone, the upper part of the Medina, and the dark Trenton limestone. The most prolific horizon is the Medina. This horizon and the underlying Trenton lie at such great depth in south-central New York that they have not as yet been tested.

The recent excellent gas wells at Altay are either near or in the Oriskany sandstone horizon. It remains to be seen how important this new development will prove to be. In this connection it should be remembered that, along the outcrop, the Oriskany is usually thin (four feet or less) or absent, showing that it must have been deposited unconformably. Therefore the probability exists that the Oriskany horizon to the south, where it is covered sufficiently to form a reservoir, may be very spotty.

Coming now more particularly to the effect of structure, we find that, as a rule, oil and gas accumulations sufficiently large to be of economic importance are very often associated with structural domes and high points along anticlines. Among other favorable types of structure are noses, terraces and monoclinal dips. Faulting may affect any of the above types of structures, either increasing or decreasing their efficiency as reservoirs.

Applying these generalizations to south-central New York, we find that structurally there are many favorable localities. Among the domes which have been mapped, those in the vicinity of Elmira, Spencer, Altay, Lodi, Himrod, Addison, Union Center and Danby are favorable. Noses and plunging anticlines are more numerous than domes, and in the west-central part of the area they are the predominant type of structure. The crests of the anticlines as marked by their axes are more favorable than adjacent territory. In addition, it is likely that along these axes more doming is present than has been mapped. If this possibility proves to be correct, the number of noses and plunging anticlines will be considerably reduced. What effect faulting may have on the structure can not be determined in advance of detailed drilling. If north-south faults prove to be abundant, closure may in some cases be developed where they cross anticlinal axes.

The broader structural features of an area may often have as much significance as the more local attitude of the formations. In this area the following merit consideration:

1 The regional dip to the south in the eastern part of the area, and to the southwest in the central and western part, progressively lowers the formations in those directions. This not only adds to the cost of drilling, but also increases the water hazard as one goes down the dip. The plunging of the axes to the southwest, so well brought out by the map west of the Seneca lake meridian, illustrates how quickly formations become deeper down the dip.

2 The high area along the Seneca lake meridian, where so many of the domes are located, and where the regional dip to the south is relatively low, is one of the most favorable portions of the region.

All of the above generalizations on the structural relationships to oil and gas accumulations have been predicated on the assumption that water is present in the producing horizons. Presumably this is true for the recent gas production developed at Altay, because the discovery wells are located well up on the anticlinal fold. Of course, it is not known whether this is only of local application, although the Oriskany is found to be water-bearing in the southwest part of the state. The water conditions in the deeper horizons are also unknown.

If the oil and gas horizons are not water-bearing, the structural high points are no longer the most favorable territory. For instance, in the only commercial oil fields of the State, the oil is in general not found on the crests of the folds, but rather some distance down the flanks, and occasionally may even be in a syncline. These horizons are not water-bearing, and as a result the oil is forced far down the flank by the gas pressure.

As to the possible extension of western New York oil fields, Hartnagel and Russell state:

> During the long period since these fields have been opened, the limits of the productive areas have been rather well established by border drilling . . . It is not probable that there will ever be an important increase of productive territory.

To the north, the Chemung sands, in which the oil is found, soon reach the surface, and farther east these sands may thin out and disappear. Also, the west component of the dip will bring these horizons to the surface. Thus the chance of finding oil in the Chemung, very far east of the present field, is doubtful.

The possibility of developing gas production on a large scale, throughout south-central New York, is a very active question at present. Large areas have been leased, and considerable drilling is contemplated, to both shallow and deep horizons. It is unknown how well the subsurface structure will conform to that at the surface, but it is presumed that the intensity of folding will increase with depth. If this proves to be true, some, at least, of the noses and plunging anticlines will show closure on the oil and gas horizons.

Another factor which enters in, is the relative meagerness of competent strata near the surface. This, together with the extreme incompetence of some of the salt as well as some of the shales, makes it hazardous to project the surface structure very far downward. For instance, the Tully limestone at Portland Point forms a broad open fold at the surface, while 2000 feet below, mining operations have revealed sharp folding with many crenulations and some faulting.

The structural conditions for the development of oil and gas are excellent as far as surface conditions are concerned. Future drilling alone can determine whether the other requisites for commercial production are present.

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APPENDIX

DATA ON DIPS OF THE STRATA AND STRIKES OF JOINT PLANES

Binghamton Quadrangle

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42- 7-42	75-56-45	50	N. 15° E.	20	Good	N. 6° W., N. 14° E., N. 70° W.
42- 7-42	75-56-45	70	N. 20° E.	38	Good	
42- 8-42	75-57-12	70	N. 44° W.	30	Good	N. 14° E., N. 70° W.
42- 9-51	75-57- 3	70	S. 26° E.	14	Good	N. 3° W.
42-10- 6	75-54- 0	90	S.	65	Good	
42-11- 0	75-54-24	.....	....	....	....	N. 68° E., N. 5° W.
42-11- 9	75-54-12	160	S. 4° W.	53	Good	N. 10° E.
42-12-30	75-30-48	65	S. 40° E.	32	Fair	
42-12-18	75-50-27	150	S. 37° E.	45	Good	N. 3° W.
42-12-18	75-50-27	230	S. 35° E.	50	Good	
42-13-51	75-55-24	25	S. 35° E.	60	Poor	N. 5° W.

Greene Quadrangle

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi	QUALITY	STRIKE OF JOINTS
42-15-36	75-52-30	40	N. 57° W.	40	Fair	
42-15-42	75-52-30	45	N. 60° W.	40	Fair	
42-15-36	75-52-30	50	N. 50° W.	0	Fair	
42-15-30	75-52-18	40	S. 47° E.	32	Good	
42-16-54	75-53-48	200	S. 15° E.	3	Good	N.
42-16-18	75-53-18	160	S. 30° E.	30	Good	
42-16-13	75-53-18	200	S. 32° E.	16	Good	
42-16- 0	75-53- 3	60	S. 30° E.	52	Good	
42-17- 6	75-53-48	80	S. 50° E.	26	Good	N. 5° E., N. 8° W., N. 62° W.
42-17- 6	75-53-48	130	S. 60° E.	16	Good	
42-18-36	75-54-52	60	N. 15° E.	0	Poor	N. 15° W.
42-18-21	75-56-12	45	S.	68	Fair	N. 4° W.
42-18-36	75-54- 6	30	S. 3° E.	45	Poor	N. 3° W., N. 65° E.
42-18-48	75-54-37	85	S. 14° E.	55	Good	N. 16° E.
42-20- 6	75-56-42	185	S.	73	Good	N. 3° W.
42-20- 9	75-59-24	50	S. 45° E.	0	Poor	N. 8° W.
42-21- 6	75-58- 6	75	S. 20° W.	150	Good	N. 6° W., N. 85° E.
42-21-30	75-59-59	200	S. 12° W.	120	Good	N., N. 3° W.
42-21- 6	75-58- 6	34	S. 15° W.	240	Poor	N. 6° W., N. 85° E.
42-21-30	75-59-59	200	S. 12° W.	120	Good	N. 84° E.
42-21-36	75-59-59	200	S. 17° W.	52	Good	
42-21-42	75-59-59	150	N. 17° E.	17	Good	N. 0°-7° W.
42-25-48	75-56-54	110	S. 45° E.	19	Good	N. 0° W., N. 12° W., N. 85° W., N. 68° W.
42-25-24	75-57- 6	80	S. 20° W.	90	Good	N.
42-28-12	75-59-30	.....	....	....	....	N. 62° E., N. 70° W.
42-28- 3	75-53-30	.....	....	....	....	N., N. 60° E.

Apalachin Quadrangle

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42– 2–30	76–10–24	70	S. 55° W.	23	Good	
42– 3–42	76–14–12	65	S. 5° E.	130	Good	N. 15° W.
42– 3–36	76– 5–54	65	S. 3° E.	60	Good	N. 7° W.
42– 4–57	76–15– 0	110	S. 12° E.	85	Good	N. 8° W.
42– 5–30	76– 6–24	75	N. 12° W.	38	Good	N. 10°–15° W.
42– 5–30	76– 4–12	80	N.	40	Good	N. 15° W.
42– 6– 6	76–12–18	120	N. 40° E.	80	Good	N. 15° W., N. 84° W.
42– 6–54	76– 7– 6	70	N. 60° W.	15	Good	N. 12° W., N. 90° W.
42– 6–45	76–10–54	70	N. 30° E.	60	Good	N. 63° E.
42– 7–15	76– 7–24	80	S. 8° W.	60	Good	N. 15° W.
42– 7–42	76– 4–54	70	S. 56° W.	98	Good	
42– 7–42	76– 4–54	70	S. 60° W.	41	Good	
42– 7–42	76– 4–54	38	S. 35° E.	41	Poor	N. 8°–12° W.
42– 7–42	76– 4–45	62	S. 6° W.	17	Fair	
42– 7–42	76– 4–45	42	N. 55° W.	25	Good	
42– 7–42	76– 4–54	51	S. 45° E.	50	Fair	
42– 7–42	76– 4–54	60	S. 13° E.	80	Fair	
42– 8–36	76– 3–40	20	N. 82° E.	74	Poor	
42– 8–36	76– 3–40	42	S. 6° W.	110	Good	
42– 8–42	76– 3–20	45	S. 42° W.	45	Fair	
42– 8–42	76– 3–12	60	S. 64° W.	0	Good	
42– 8–36	76– 0–54	65	S. 25° W.	72	Good	N. 20° E.
42– 8–24	76–11–18	100	S. 10° W.	215	Good	N. 15° W., N. 70° E., N. 90° E.
42– 9–36	76– 2–45	60	N. 10° E.	90	Good	N. 12° W., N. 83° W.
42– 9–36	76– 2–45	90	N. 60° E.	0	Good	
42– 9–36	76– 2–45	210	N. 70° E.	70	Good	
42– 9–42	76– 6– 0	35	N. 12° W.	40	Poor	
42– 9–42	76– 6– 0	80	N. 30° W.	90	Good	N. 12° W.
42–10–18	76– 4–24	60	N. 60° W.	4	Good	N. 10° W.
42–10– 9	76– 6–18	110	N. 37° W.	25	Good	
42–10–48	76–11–39	.....	....	....	....	N. 12° W., N. 90° W.
42–10– 6	76–13– 0	35	S. 20° E.	75	Poor	N. 18° W., N. 10° W., N. 76° W.
42–10–18	76–13– 9	60	S. 13° E.	130	Good	
42–10–18	76– 4–36	95	S. 62° E.	20	Good	N. 12°–15° W., N. 86° W.
42–10–18	76– 4–36	50	N. 65° W.	40	Fair	
42–11–48	76– 4–18	75	N. 48° W.	28	Good	N. 12° W.
42–11–45	76– 4–24	60	N. 60° W.	4	Good	N. 10° W.
42–12–33	76–10–33	67	S. 33° E.	70	Good	
42–13–42	76–10–54	330	N. 35° E.	16	Good	
42–13–18	76–10–42	80	N. 12° W.	0	Good	N. 12°–14° W., N. 82° W.
42–14– 6	76– 4–30	109	S. 30° E.	120	Good	N. 68° W.
42–14–15	76– 0–21	30	N. 74° E.	40	Poor	
42–14–27	76–11–18	240	N. 27° W.	33	Good	

Harford Quadrangle

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42–15–18	76– 3– 6	90	N. 57° W.	25	Good	
42–15–33	76– 8–57	62	S. 70° W.	65	Good	
42–16–42	76–11– 0	60	N. 85° W.	60	Good	
42–16–57	76– 8–45	90	S. 70° W.	27	Good	N. 12° W.
42–16–57	76–14– 0	70	S. 70° W.	22	Good	
42–16–56	76–14– 0	60	N. 70° W.	50	Good	N. 15° W.
42–17– 0	76–00–18	110	S. 50° E.	84	Good	N. 12° W., N. 10° W.
42–18–42	76–11–48	120	N. 65° W.	0	Good	N. 14° W., N. 65° E.
42–18–39	76–12–36	27	S. 60° E.	25	Poor	
42–18–39	76–12–36	32	S. 36° E.	72	Poor	N. 4° E., N. 60° W.
42–18–12	76–12–00	75	S. 35° E.	85	Good	
42–18– 6	76–11–54	90	S. 45° E.	110	Good	N. 8° W., N., N. 85° W.
42–18–31	76– 9–12	220	S. 57° E.	40	Good	
42–21–24	76–10–36	50	S. 35° W.	11	Good	N. 14° W.
42–21–24	76–12–21	75	N. 6° W.	38	Good	N. 15° W.
42–21–42	76–12– 6	70	S. 21° W.	7	Good	N. 17° W.
42–21–42	76–12– 6	135	N. 10° E.	8	Good	N. 12° W.
42–21–21	76– 1–42	160	S. 83° W.	33	Good	N. 87° W., N. 3° W.
42–22–36	76– 4–27	85	N. 3° E.	18	Good	N. 12° W.
42–22–45	76– 0–24	75	S. 25° E.	14	Good	N. 3° W.
42–22–15	76–13–54	51	S. 25° W.	50	Good	
42–22–24	76–13–54	47	S. 30° W.	77	Fair	
42–24– 0	76– 1–30	80	S. 75° W.	57	Fair	N. 5° W., N. 3° E.
42–24– 9	76– 2– 6	143	S. 75° W.	10	Good	N. 77° W., N. 67° W., N. 67° E.
42–24–24	76– 2–45	45	N. 25° W.	35	Poor	N. 5° W., N. 87° W.
42–24–33	76– 2–45	120	S.	44	Good	N. 10° W.
42–24–24	76–12–18	140	S. 27° E.	165	Good	N. 10° W.
42–24–54	76–11–18	130	W.	76	Good	
42–24–54	76–11–18	33	S. 12° E.	225	Poor	N. 7°–12° W.
42–24–54	76–11–36	127	S. 25° E.	270	Good	
42–24–54	76–11–36	68	S. 63° E.	100	Good	
42–25–42	76–12–30	32	N. 29° E.	50	Poor	N. 67° E., N. 15° W.
42–25–42	76–12–30	25	N. 55° E.	60	Poor	N. 14° W.
42–25–12	76–10–54	55	N. 28° E.	0	Fair	N. 68° E., N. 14° W.
42–26–12	76–13–18	48	N. 40° E.	33	Fair	N. 15° E., N. 62° E.
42–26–12	76–13–18	40	N. 50° E.	60	Fair	N. 10° W., N. 67° E.
42–26–39	76–11–18	160	N. 23° E.	60	Good	N. 18° W., N. 10° W., N. 60° E., N. 68° E.
42–26–57	76– 8–42	40	N. 18° E.	78	Fair	
42–26–57	76– 8–42	53	N. 15° E.	42	Fair	N. 15° E.
42–26–33	76–10– 0	80	N. 62° E.	36	Good	
42–26–33	76–10– 0	30	N. 10° W.	90	Poor	N. 11° W.
42–26–54	76– 1–54	70	N. 30° W.	22	Good	N. 25° E., N.
42–26–54	76– 1–54	80	N. 70° W.	66	Good	N. 15° E.
42–26–48	76– 1–45	90	N. 48° W.	5	Good	N. 18° E., N. 80° E.
42–26–24	76– 4–21	80	S. 15° W.	68	Good	
42–26–42	76– 2–42	40	S. 48° E.	115	Fair	N. 5° E., N. 20° E.
42–26–42	76– 2–36	50	S. 45° W.	10	Good	N. 65° E.

Harford Quadrangle—*Continued*

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42–26–42	76– 2–36	50	S. 45° W.	10	Good	N. 65° E.
42–26–42	76– 1–51	75	S. 15° W.	120	Good	
42–26–42	76– 1–48	.....	....	....	....	N. 5°–12° W., N. 65° E., N. 62° E., N. 70° W.
42–27–39	76–14–12	25	N. 38° E.	0	Poor	
42–27– 6	76–11– 6	50	N. 6° W.	85	Fair	N. 14° W.
42–27–19	76–10–57	67	N. 33° E.	75	Fair	N. 10° W.
42–27–21	76– 8–42	82	N. 55° W.	80	Good	
42–28–30	76– 3–42	105	S. 40° E.	77	Good	
42–28–30	76– 3–42	105	S. 40° E.	77	Good	
42–28– 0	76–14– 3	23	N. 74° E.	0	Poor	
42–29–24	76– 4–18	260	S. 40° E.	100	Good	N. 7° W.
42–29–54	76– 4–54	95	S. 20° W.	0	Good	
42–30– 0	76– 4–54	125	S. 7° E.	70	Good	N. 7° W.
42–29–30	76– 6– 0	80	S. 55° E.	88	Good	
42–29–30	76– 6– 0	60	S. 6° E.	88	Good	N. 6° W.

Cortland Quadrangle

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42–30–36	76– 7–36	60	S. 42° W.	80	Good	N. 6° W., N. 90° E.
42–30– 6	76– 7–42	60	S. 65° E.	17	Good	
42–31–42	76– 5–30	80	S. 3° W.	64	Good	
42–33–57	76– 7– 3	45	S. 22° E.	150	Poor	N. 2° E., N. 3° W.
42–33–48	76– 7– 0	60	N. 35° W.	9	Poor	N., N. 70°–78° W., N. 2° E., N. 72° W.
42–34–42	76–12–30	140	S. 45° W.	60	Good	N. 6° W., N. 70° E.

Owego Quadrangle

LATITUDE ° ′ ″	LONGITUDE ° ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42– 0– 6	76–23–12	40	N. 7° E.	13	Fair	N. 22° W.
42– 0– 6	76–23–12	125	N. 2° E.	50	Good	N. 18° W.
42– 0– 0	76–21– 6	290	N. 36° W.	57	Good	N. 17°–20° W., N. 10° E.
42– 0– 6	76–20–12	20	N. 25° E.	80	Poor	
42– 0– 0	76–20–12	20	S. 40° W.	26	Poor	

OWEGO QUADRANGLE—*Continued*

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42- 1-54	76-26-54	235	N. 80° W.	12	Fair	
42- 3-12	76-19-18	80	S. 20° W.	120	Good	N. 15° W.
42- 3- 6	76-19-18	60	S. 10° W.	170	Good	
42- 4-12	76-20-51	32	S. 17° W.	160	Poor	
42- 4-36	76-20-42	44	S. 15° W.	25	Fair	
42- 4-54	76-20-42	38	N. 5° E.	55	Fair	N. 20° W., N. 7° W.
42- 4-54	76-20-42	45	S. 10° W.	33	Fair	N. 18° W.
42- 4-54	76-20-42	48	S. 38° W.	5	Poor	N. 18° W.
42- 4-30	76-21- 9	426	S. 10° W.	100	Good	
42- 4-51	76-22-42	42	N. 25° W.	80	Poor	
42- 4-51	76-22-42	50	S. 2° W.	10	Poor	
42- 4-51	76-22-42	65	N. 2° E.	16	Fair	
42- 4-36	76-22-42	65	N.	56	Good	
42- 5- 0	76-18- 0	190	N. 72° E.	32	Good	
42- 5-48	76-15-42	95	N. 25° W.	48	Good	N. 10°-20° W.
42- 5-54	76-21-48	70	N. 25° E.	20	Good	
42- 5-54	76-21-48	70	N. 3° W.	45	Good	
42- 5-54	76-21-48	80	N. 12° W.	66	Good	
42- 6-54	76-16-12	65	N. 20° W.	17	Good	
42- 6- 0	76-10-30	90	N. 42° E.	50	Good	
42- 7- 0	76-19-15	50	N. 44° W.	40	Good	N. 15° W.
42- 7- 0	76-19-15	60	N. 26° W.	47	Good	N. 20°-22° W.
42- 7- 6	76-19-18	32	N. 68° W.	32	Poor	
42- 7- 9	76-26-30	37	S. 3° E.	20	Poor	
42- 7- 9	76-26-30	38	S. 3° E.	20	Poor	
42- 7-51	76-24-30	35	S. 18° W.	80	Poor	
42- 9-36	76-28-24	65	S. 42° E.	115	Good	
42- 9-27	76-28- 0	50	S. 25° E.	100	Good	
42- 9-27	76-28- 0	37	S. 3° E.	20	Poor	
42-10-36	76-15-39	70	S. 20° W.	112	Good	
42-10-36	76-15-39	37	S. 3° E.	20	Poor	
42-10-36	76-15-39	82	S. 50° E.	40	Good	N. 19° W.
42-10-57	76-18-18	40	S. 3° W.	235	Fair	
42-10- 0	76-19-36	70	S. 63° E.	7	Fair	
42-10- 0	76-21- 9	426	S. 10° W.	100	Good	
42-10-50	76-27-36	50	S. 25° W.	100	Fair	
42-11-48	76-15- 0	110	S. 52° E.	0	Good	
42-11-48	76-15- 0	93	S. 20° E.	90	Good	N. 18° W.
42-11-36	76-22-39	105	S. 2° E.	117	Good	
42-11-33	76-22-39	130	S. 4° E.	156	Good	
42-11- 6	76-23-21	40	S. 80° E.	20	Poor	
42-11- 6	76-23-21	30	S. 46° E.	80	Poor	
42-11-48	76-29-48	20	S. 15° E.	119	Poor	
42-11-48	76-29-48	33	S. 20° E.	40	Poor	N. 22° W., N. 86° W.
42-12-30	76-25-36	25	S. 5° E.	80	Poor	
42-12-30	76-25-36	33	S. 10° E.	80	Poor	
42-12-36	76-25-48	45	S. 15° E.	65	Fair	
42-12-36	76-25-48	50	N. 45° W.	5	Good	
42-12-36	76-25-48	90	S. 45° E.	32	Good	
42-12-48	76-26- 0	62	N. 50° W.	25	Good	
42-12-48	76-27- 6	50	S. 30° E.	75	Good	
42-12-48	76-27- 6	40	S.	90	Fair	
42-12-45	76-28-42	70	S. 12° W.	30	Good	
42-12-45	76-28-42	40	S. 50° W.	78	Fair	

Owego Quadrangle—*Continued*

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42-12-45	76-28-42	50	S. 82° W.	10	Fair	
42-12-30	76-18-42	32	S. 75° W.	48	Poor	
42-12-30	76-18-42	120	S.	167	Good	
42-12-48	76-27-48	90	N. 75° W.	33	Good	N. 23° W.
42-12-48	76-27-48	115	S. 15° E.	32	Good	
42-12-48	76-27-48	30	S. 80° W.	0	Poor	N. 4°-8° W., N. 88° E.
42-12-48	76-27-48	40	S. 5° E.	70	Poor	
42-12-49	76-27- 9	45	S. 68° W.	55	Fair	
42-12-36	76-10-42	32	S. 15° W.	90	Poor	
42-12-45	76-27-14	60	S. 56° W.	44	Good	
42-12-18	76-20-13	45	S. 21° E.	130	Good	N. 17° W.
42-12-12	76-20- 0	30	S. 30° W.	220	Poor	
42-13- 0	76-27-54	40	S. 64° W.	45	Fair	
42-13- 0	76-27-54	33	S. 64° W.	48	Poor	N. 18° W.
42-13- 6	76-26-48	50	N. 36° E.	0	Good	
42-13-54	76-25-48	40	N. 13° W.	85	Fair	
42-13-30	76-25-54	33	N. 2° E.	80	Poor	
42-13-36	76-26-48	32	N. 55° E.	25	Poor	
42-13-48	76-24-48	55	N. 35° E.	140	Good	
42-13-48	76-24-48	50	N. 50° W.	100	Good	
42-13-42	76-24-33	60	N. 70° E.	50	Good	
42-14-18	76-26-54	45	N. 42° E.	0	Poor	
42-14-18	76-26-54	62	N. 42° E.	0	Fair	
42-14- 8	76-24-36	90	N. 5° W.	66	Good	
42-14- 8	76-24-36	55	N. 45° E.	55	Good	
42-14- 6	76-19-18	25	S. 33° E.	20	Poor	
42-14- 3	76-25- 0	25	N. 15° E.	40	Poor	
42-14- 3	76-25- 0	25	N. 15° W.	80	Poor	

Dryden Quadrangle

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42-15-30	76-17-24	35	S. 10° E.	45	Fair	
42-15-24	76-17-24	32	S. 25° W.	50	Poor	
42-15-24	76-17-24	70	N.	22	Good	
42-16- 6	76-28-42	40	N. 20° E.	53	Fair	
42-16- 6	76-28-42	72	N. 15° W.	75	Good	
42-16- 6	76-28-42	50	N. 2° W.	52	Good	N. 23° W.
42-16-30	76-21-42	60	N. 3° W.	4	Good	
42-16-30	76-21-42	70	N. 15° E.	11	Good	
42-16-24	76-29-36	31	N. 11° E.	8	Poor	
42-16-54	76-21-36	40	N.	0	Fair	
42-17-30	76-21- 0	50	S. 30° W.	35	Good	
42-17-15	76-21-39	40	N. 42° W.	32	Fair	

DRYDEN QUADRANGLE—*Continued*

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42–17–24	76–29–36	31	N. 11° E.	8	Poor	
42–17–21	76–15–18	47	S. 3° W.	132	Fair	
42–17–24	76–15–24	50	S. 58° E.	0	Good	
42–17–24	76–15–21	80	S. 60° E.	0	Good	
42–17– 9	76–16– 3	50	S. 20° E.	70	Good	
42–17– 9	76–16– 3	135	S. 55° E.	28	Good	
42–17– 9	76–16– 3	45	S. 60° E.	44	Fair	
42–18–51	76–28–39	47	S. 37° E.	176	Fair	
42–18–54	76–28–39	36	S. 38° E.	160	Poor	
42–18–42	76–20–58	30	S. 30° E.	120	Poor	N. 67° E.
42–18–42	76–20–58	60	S. 30° E.	60	Fair	
42–18–24	76–23–54	40	N. 40° W.	6½	Poor	
42–21–54	76–20–48	68	S.	270	Good	
42–22–48	76–21–12	65	S.	400	Good	
42–22–54	76–23– 0	82	S. 67° W.	130	Good	
42–22–54	76–16–30	130	S. 60° W.	0	Good	
42–23–24	76–15–54	35	S. 8° E.	75	Poor	
42–23–30	76–15–54	50	S. 15° W.	52	Fair	
42–23–15	76–15–48	90	N. 72° E.	46	Good	
42–23– 0	76–22–36	88	S. 37° W.	153	Good	
42–23– 0	76–22–42	97	S. 68° W.	80	Good	
42–23–33	76–26–36	36	S. 60° W.	30	Poor	
42–23–39	76–26–27	58	N. 45° E.	58	Good	N. 45° W., N. 20° W.
42–24–24	76–26–42	25	N. 4° E.	20	Poor	N. 22° W.
42–24–24	76–26–42	30	N. 17° W.	35	Poor	
42–24–18	76–27–54	28	S. 26° W.	36	Poor	
42–24–12	76–27–54	70	N. 48° E.	68	Good	
42–24–33	76–25–12	50	N. 8° E.	94	Good	
42–24–24	76–25–18	30	N. 12° E.	85	Poor	
42–24–24	76–25–18	25	N. 15° E.	60	Poor	
42–24–18	76–25–24	35	N. 56° W.	135	Poor	
42–24–12	76–25–24	33	N. 82° W.	96	Poor	
42–24–51	76–19–42	45	N. 20° W.	64	Fair	
42–24–51	76–19–42	50	N. 20° W.	65	Fair	N. 18° W., N. 72° E.
42–24–52	76–19–42	82	N. 55° W.	100	Good	N. 70° E.
42–24–53	76–19–42	65	N. 3° E.	40	Fair	
42–24–30	76–19–42	66	S. 10° W.	100	Poor	
42–24–32	76–19–42	30	S. 12° W.	17	Poor	
42–24–24	76–19–42	46	S.	22	Fair	
42–24–12	76–19–48	30	S. 3° W.	50	Poor	
42–25– 6	76–27–50	87	S. 40° E.	3	Good	
42–25– 6	76–27–50	80	S. 45° E.	7	Good	
42–25– 6	76–27–50	190	S. 40° W.	5	Good	
42–25– 6	76–27–50	50	S. 67° W.	0	Good	
42–25–54	76–29– 0	115	N. 60° E.	16	Poor	
42–25–54	76–29– 0	90	S. 20° E.	64	Good	
42–25–42	76–28–42	180	S. 12° E.	58	Good	
42–25–48	76–26–30	80	N. 32° W.	30	Good	
42–25–48	76–27–30	44	S. 83° E.	42	Fair	
42–25–48	76–26–30	70	S. 52° E.	49	Good	
42–25–36	76–28–36	220	S. 56° E.	22	Good	
42–25–42	76–25–48	70	S. 5° W.	24	Good	
42–25–42	76–25–48	140	N. 66° W.	58	Good	N. 18° W., N. 78° W.
42–25–42	76–25–48	65	N. 24° W.	8	Good	

Dryden Quadrangle—*Continued*

Latitude ° ′ ″	Longitude ° ′ ″	Length of shot, feet	Dip direction	Dip amt. Ft/mi.	Quality	Strike of joints
42–26–36	76–29–36	120	S. 50° E.	75	Good	
42–26–36	76–29–36	180	S. 45° E.	30	Good	
42–26–36	76–29–36	108	S. 42° E.	70	Good	
42–26–36	76–29–36	125	S. 65° W.	28	Good	
42–26– 6	76–29–48	150	N. 90° E.	0	Good	
42–26–51	76–29–48	87	S. 10° W.	42	Good	
42–26–51	76–29–48	150	S. 3° W.	38	Good	
42–26–54	76–29–24	150	S. 20° E.	60	Good	
42–26–54	76–29–24	130	S. 20° E.	40	Good	
42–26–18	76–29–21	50	S. 20° E.	65	Good	
42–26–18	76–29–21	55	S. 72° E.	19	Good	
42–26–12	76–29–30	75	S. 25° E.	63	Good	
42–26–12	76–29–30	90	S. 46° E.	70	Good	
42–26– 6	76–29–18	190	S. 10° E.	94	Good	N. 20° W., N. 23° W.
42–26– 0	76–29–12	112	N. 80° E.	52	Good	
42–26– 0	76–29–12	134	S. 56° E.	68	Good	
42–26– 3	76–29–39	82	S. 30° W.	80	Good	
42–27–18	76–27–24	130	N. 85° W.	32	Good	
42–27–18	76–28–34	45	S. 25° E.	72	Fair	
42–27–18	76–28–34	220	N. 82° W.	44	Good	
42–27–12	76–29–54	150	S. 75° E.	21	Good	
42–28–36	76–29–54	50	S. 15° E.	40	Poor	
42–28–39	76–29–58	30	S. 90° W.	44	Poor	
42–28–12	76–21–24	30	S. 5° W.	60	Poor	

Moravia Quadrangle

Latitude ° ′ ″	Longitude ° ′ ″	Length of shot, feet	Dip direction	Dip amt. Ft/mi.	Quality	Strike of joints
42–33– 0	76–22–18	40	S. 80° E.	13	Poor	
42–33– 0	76–22– 3	60	N. 60° E.	60	Poor	
42–33– 0	76–22– 0	30	N. 35° W.	44	Poor	
42–33– 0	76–22– 0	42	N. 70° W.	25	Poor	
42–33– 0	76–22– 0	35	N. 5° W.	15	Poor	
42–33– 0	76–22– 0	145	N. 75° W.	28	Good	
42–34–54	76–17– 3	65	N.	9	Good	N. 83° W., N. 10° W.
42–39– 3	76–26–30	28	S. 50° W.	63	Poor	

Waverly Quadrangle

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42– 0–30	76–33–42	220	N. 25° W.	160	Good	
42– 0–36	76–43–34	75	N. 90° W.	65	Good	
42– 0–36	76–43–34	130	S. 76° W.	56	Good	
42– 1–24	76–31–15	46	N.	50	Good	
42– 1–18	76–38–24	350	N. 27° W.	157	Good	
42– 1–36	76–37–30	95	N. 65° W.	100	Good	
42– 1–48	76–43–12	65	N. 12° W.	36	Good	
42– 2–54	76–32– 0	93	N. 10° W.	110	Good	
42– 2–54	76–32– 0	154	N. 10° W.	150	Good	
42– 2–36	76–41–42	90	S. 20° W.	100	Good	
42– 3–24	76–32–12	80	S. 10° E.	43	Good	N. 23°–30° W.
42– 3–24	76–32–12	240	S. 10° E.	44	Good	
42– 3–24	76–32–12	168	N. 10° W.	15	Good	
42– 3–24	76–32–12	148	N. 10° W.	38	Good	
42– 3–48	76–36–24	45	S. 40° W.	130	Fair	
42– 3– 6	76–37–30	135	S. 20° W.	105	Good	
42– 3–12	76–39–12	100	S. 33° E.	110	Good	
42– 4–24	76–44– 0	160	S. 50° W.	70	Good	
42– 5–35	76–42–24	85	N. 50° E.	21	Good	
42– 5–32	76–43–12	65	N. 2° E.	9	Good	
42– 5–32	76–43–12	100	N. 10° E.	0	Good	
42– 5–30	76–43–12	105	S. 23° E.	45	Good	
42– 5–45	76–38–18	70	S. 35° E.	75	Poor	
42– 5–45	76–38–18	57	S. 35° E.	25	Good	
42– 5– 0	76–32–46	338	S.	90	Good	
42– 5– 0	76–32–46	237	S.	96	Good	N. 23°–30° W.
42– 6–24	76–33– 6	440	S.	36	Good	
42– 6–42	76–32–14	48	N. 43° E.	10	Fair	
42– 6–52	76–32– 0	100	N. 43° E.	100	Good	
42– 6– 6	76–34–24	65	S. 61° E.	32	Good	
42– 7– 6	76–33–26	60	S. 32° E.	26	Good	
42– 7– 6	76–33–26	65	S. 70° E.	16	Good	
42– 7–42	76–31–48	115	S. 18° W.	30	Poor	
42– 7–39	76–36–48	75	S. 20° W.	21	Poor	
42– 7–28	76–31–39	120	S. 20° W.	15	Good	
42– 7–36	76–32–54	267	S.	20	Good	
42– 7–42	76–32–55	350	S. 0° E.	40	Good	
42– 7–12	76–32–54	385	S.	4	Good	
42–10–18	76–33–30	265	S.	167	Good	N. 23°–30° W.
42–10–18	76–33–30	230	S.	161	Good	
42–10– 0	76–33–30	300	S.	50	Good	N. 32°–30° W.
42–11–36	76–33–21	115	S. 10° W.	28	Good	N. 23°–30° W.
42–11– 0	76–33–30	1250	S. 3° W.	83	Good	N. 23°–30° W.
42–12–48	76–38–10	80	N. 50° W.	46	Good	
42–12–33	76–31–36	70	N. 13° W.	105	Good	
42–12–33	76–31–36	70	N. 15° E.	93	Good	
42–12–33	76–31–36	55	N. 77° E.	22	Good	
42–12–30	76–33–18	40	N. 17° W.	130	Fair	
42–13– 8	76–30–36	55	N. 23° W.	135	Good	
42–13–24	76–35–51	55	N. 16° W.	150	Good	
42–13–30	76–36–42	85	S. 85° E.	18	Good	
42–13–30	76–36–42	60	N. 60° E.	22	Good	
42–13–24	76–37– 0	105	N. 20° E.	90	Good	
42–13–18	76–37– 6	50	N. 75° E.	0	Good	
42–14– 0	76–43–28	45	N. 8° E.	66	Fair	
42–14–42	76–36–42	85	N. 30° E.	18	Good	
42–14–42	76–36–42	140	N. 24° E.	50	Good	
42–12–42	76–36–42	120	N. 65° E.	35	Good	

ITHACA QUADRANGLE

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42–15–30	76–40–54	227	N. 25° W.	100	Good	
42–15–30	76–40–54	227	N. 25° W.	100	Good	
42–15–18	76–41– 9	68	N. 10° W.	110	Good	
42–15–48	76–31–24	60	N. 27° W.	48	Good	
42–15–54	76–31–42	50	N. 85° W.	80	Good	
42–15–54	76–31–42	81	N. 50° W.	50	Good	
42–15–30	76–37–36	100	N. 35° E.	25	Good	
42–16– 6	76–32– 6	90	N. 30° E.	42	Good	
42–16– 6	76–32– 6	45	N. 70° W.	34	Fair	
42–16–12	76–32–18	30	S. 25° E.	0	Poor	
42–16–24	76–32–30	60	S. 18° E.	120	Good	
42–16–24	76–32–30	35	S. 25° E.	70	Poor	
42–16– 6	76–38– 0	30	S. 20° E.	85	Poor	N. 20° W.
42–17–24	76–43–48	80	S. 64° W.	120	Good	
42–17– 6	76–44–12	220	S. 54° W.	120	Good	
42–17– 0	76–44–12	28	S. 81° W.	72	Poor	
42–17–15	76–41– 0	70	S. 60° W.	42	Good	N. 25° W.
42–17–15	76–41– 0	70	S. 22° W.	75	Good	
42–17–18	76–36–54	50	S. 67° W.	60	Good	N. 26° W.
42–18–30	76–41–12	.....	S.	400	Clin.	
42–19–18	76–42–42	85	S. 32° W.	294	Good	
42–19– 3	76–42–48	.....	S. 10° W.	530	Clin.	
42–19–54	76–43–24	85	N. 34° E.	60	Good	
42–19–54	76–39–42	70	S. 30° W.	120	Good	
42–19–36	76–39–06	75	S. 60° W.	35	Good	
42–19–24	76–10–36	.....	S.	400	Clin.	
42–19–42	76–36– 6	35	N. 10° E.	45	Poor	
42–19–42	76–36– 6	40	N. 10° E.	58	Fair	
42–19–18	76–33–18	50	S. 40° W.	100	Good	N. 25° W.
42–19–42	76–33–24	90	S. 25° W.	82	Good	
42–20– 6	76–33– 6	85	S. 7° W.	50	Good	
42–20–21	76–32–51	65	S. 28° W.	20	Good	N. 12° W.
42–20–21	76–32–59	60	S. 60° W.	57	Good	N. 24° W.
42–20–42	76–39–39	50	N. 29° E.	55	Good	
42–20–15	76–39–42	80	S. 26° E.	220	Good	
42–20–13	76–39–42	50	S. 21° W.	30	Good	
42–20– 0	76–43–15	110	N. 15° W.	150	Good	
42–20– 6	76–43–48	50	N. 43° W.	120	Good	
42–20–12	76–43–18	100	N. 4° E.	165	Good	
42–20–24	76–43–10	95	N. 27° W.	200	Good	
42–20–24	76–43–10	50	N. 90° E.	0	Good	
42–20–36	76–43–12	105	N. 24° E.	225	Good	
42–20–54	76–44– 0	70	N. 24° W.	225	Good	
42–20–54	76–44– 0	50	N. 30° W.	200	Good	
42–20–30	76–43–48	56	N. 12° W.	270	Good	
42–21–45	76–34–12	90	N. 31° W.	140	Good	
42–21–33	76–33–36	50	N. 25° W.	150	Poor	
42–21–51	76–35–12	40	N. 55° E.	40	Fair	
42–21–51	76–35–12	50	N. 48° E.	20	Good	
42–21–51	76–35–12	55	N. 3° W.	85	Good	
42–21–51	76–35–12	67	N. 70° W.	104	Good	
42–21–51	76–35–12	45	N. 50° W.	110	Fair	

ITHACA QUADRANGLE—*Continued*

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42–21–51	76–35–12	43	N. 42° E.	30	Fair	
42–21–42	76–35–30	60	N. 90° W.	80	Good	
42–21–42	76–35–30	130	N. 32° E.	16	Good	
42–21–42	76–35–42	53	N. 80° E.	14	Poor	
42–21–42	76–35–42	50	S. 80° W.	40	Poor	
42–22–24	76–44–30	30	N. 20° E.	34	Poor	
42–22–54	76–31–33	45	N. 30° W.	77	Fair	
42–22–54	76–31–33	40	N. 15° W.	140	Fair	
42–22–58	76–31–33	135	N. 25° W.	110	Good	
42–23–48	76–35–42	40	S. 12° E.	0	Poor	
42–23–54	76–35–30	75	N. 25° W.	56	Good	
42–23–48	76–33– 6	130	S. 72° E.	4	Good	
42–23–42	76–33– 6	130	S. 15° W.	24	Good	
42–23–42	76–33–36	140	N. 76° W.	22	Good	
42–23–42	76–33–36	30	N.	58	Poor	
42–23–42	76–32– 6	67	N. 23° W.	87	Good	N. 23° W.
42–23–42	76–32– 6	100	N. 16° W.	60	Good	
42–23–36	76–30–42	200	N. 20° W.	120	Good	
42–23–36	76–30–42	200	N. 10° W.	79	Good	
42–23–36	76–30–42	240	N. 10° E.	100	Good	
42–23–30	76–38–24	60	S. 62° W.	105	Good	
42–23–30	76–38–24	25	S. 25° W.	80	Poor	
42–24– 6	76–35–24	45	S. 23° E.	5	Fair	
42–24– 5	76–35–24	100	S. 20° E.	35	Good	
42–24– 5	76–35–18	50	N. 24° W.	60	Good	
42–24– 5	76–35–18	55	N.	76	Fair	
42–24– 0	76–35– 6	120	N. 75° W.	80	Good	
42–24– 0	76–35– 6	115	N. 4° W.	36	Good	
42–24– 0	76–35– 6	90	S. 80° W.	52	Good	
42–24– 0	76–35– 6	75	N. 85° W.	105	Good	
42–24– 6	76–35–30	102	S. 62° W.	70	Good	
42–24–18	76–35–42	100	S. 55° E.	17	Good	
42–24–18	76–35–42	61	S. 37° E.	31	Good	
42–24–27	76–31–42	35	S. 40° E.	120	Poor	
42–24–54	76–31– 6	170	S. 45° W.	6	Good	
42–24–54	76–31– 6	360	S. 10° W.	30	Good	
42–24–42	76–31– 0	200	S. 25° E.	78	Good	
42–24–42	76–31– 0	430	S. 15° E.	52	Good	
42–24–36	76–30–42	100	N. 4° E.	104	Good	
42–24–36	76–30–42	78	N. 85° E.	67	Good	
42–24–36	76–30–42	66	S. 80° E.	60	Good	
42–24–36	76–30–54	50	N. 85° W.	35	Good	
42–24–36	76–31– 0	168	N. 15° E.	135	Good	
42–24–36	76–31– 0	53	S. 90° W.	170	Good	
42–25–12	76–31– 0	115	S. 45° W.	27	Good	
42–25–36	76–32– 0	70	S. 45° E.	80	Good	
42–25–42	76–32– 6	100	S. 50° E.	15	Good	
42–25–48	76–32–18	62	S.	50	Good	
42–25–48	76–32–18	100	S. 27° E.	100	Good	
42–26–15	76–33– 0	130	S. 27° E.	20	Good	
42–26–15	76–33– 0	40	N. 20° W.	13	Fair	
42–26–15	76–33– 0	90	S. 85° E.	27	Good	
42–26–12	76–33– 0	50	N. 13° W.	25	Good	
42–26–21	76–33– 0	50	N. 45° W.	0	Good	

Ithaca Quadrangle—*Continued*

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42–26–21	76–33– 0	65	N. 21° W.	0	Good	
42–26–45	76–31– 6	125	S. 10° E.	17	Good	
42–27–36	76–31–18	85	S. 25° E.	18	Good	N. 25° W.
42–27–36	76–31–18	50	S. 25° E.	30	Good	N. 25° W.
42–27–36	76–31–18	170	S. 25° E.	18	Good	N. 25° W.
42–27–24	76–31–12	60	S. 25° E.	35	Good	N. 25° W.
42–27–18	76–31– 6	120	S. 20° E.	35	Good	S. 20° E.
42–27– 6	76–31– 3	100	S. 20° E.	15	Good	S. 20° E.
42–27–28	76–31–18	120	N. 23° E.	90	Good	
42–27– 0	76–31–12	90	S. 10° E.	0	Good	
42–27–12	76–31–12	50	S. 15° E.	30	Good	
42–27– 6	76–31–12	30	N. 15° W.	0	Poor	
42–29– 6	76–30–42	212	S. 5° E.	130	Good	

Genoa Quadrangle

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42–31–51	76–37– 0	65	S. 70° W.	61	Good	
42–31–51	76–37– 0	70	S. 74° W.	68	Good	N. 24° W., N. 65° E.
42–31–51	76–37– 0	66	S. 34° W.	168	Good	
42–31–54	76–36–48	180	N. 20° E.	46	Good	
42–31–54	76–36–48	50	N. 90° W.	40	Good	
42–31–54	76–37– 0	77	N. 13° W.	90	Good	
42–31–54	76–37– 0	130	S. 85° W.	44	Good	
42–32–36	76–36– 0	220	N. 44° E.	19	Good	
42–32–30	76–36–12	320	N. 4° E.	51	Good	
42–32–12	76–36–24	720	N.	61	Good	
42–32–35	76–36– 0	300	N. 70° W.	68	Good	

Elmira Quadrangle

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42– 1– 0	76–52–42	50	S. 10° E.	100	Good	
42– 1– 0	76–52–42	90	S. 10° E.	35	Good	
42– 1–36	76–50–30	47	S. 15° E.	66	Fair	N. 10° W., N. 30° W.
42– 1–36	76–50–30	40	S. 20° E.	130	Fair	N. 20° W., N. 26° W., N. 10° W

Elmira Quadrangle—*Continued*

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42– 2– 0	76–52–51	70	S. 80° W.	45	Good	
42– 2–21	76–52–21	52	N. 82° W.	20	Poor	
42– 2–27	76–53–18	70	N. 40° W.	52	Good	N. 32° W.
42– 2–28	76–56–18	23	N. 23° W.	60	Poor	
42– 4–45	76–53–16	80	S. 64° W.	125	Good	
42– 4–42	76–46–30	140	S. 20° E.	260	Good	
42– 5–42	76–53– 0	50	N. 85° W.	120	Good	
42– 5–54	76–52–54	65	S. 15° W.	8	Good	N. 12° W., N. 65° W.
42– 5–54	76–52–54	50	S. 8° W.	10	Good	N. 32° W., N. 73° E.
42– 5–48	76–47–12	290	N. 20° W.	70	Good	
42– 5–48	76–47–12	160	N. 90° W.	13	Good	
42– 6– 9	76–59–54	55	S. 20° E.	5	Good	N. 30° W.
42– 6–36	76–59–57	60	S. 10° E.	48	Poor	N. 30° W.
42– 6–24	76–54–18	55	S.	56	Fair	N. 30° W.
42– 6–44	76–54– 6	25	N. 15° W.	0	Poor	N. 30° W., N. 60° E.
42– 6–44	76–54– 6	40	S. 18° W.	40	Fair	N. 38° W., N. 32° W., N. 68° E.
42– 6–54	76–51–50	40	S. 66° W.	104	Fair	
42– 6–48	76–52–15	55	S. 77° W.	108	Good	
42– 6–36	76–52–33	50	S. 86° W.	100	Good	N. 85° W., N. 87° W.
42– 6–54	76–54–18	30	S. 25° E.	17	Poor	N. 30° W.
42– 7– 0	76–47–54	300	N. 13° W.	50	Good	
42– 7– 0	76–47–54	120	N. 45° W.	130	Good	
42– 7– 9	76–47–54	180	N. 10° W.	115	Good	
42– 8–54	76–47–54	80	S. 85° W.	53	Good	
42– 8–54	76–47–54	30	S. 75° W.	34	Poor	N. 70° E.
42– 8–54	76–47–42	38	N. 29° W.	0	Poor	
42– 8–54	76–47–42	85	S. 45° W.	6	Good	
42– 8–54	76–47–50	140	S. 85° E.	38	Good	N. 70° W., N. 27° W.
42– 8–54	76–47–42	55	N. 90° E.	36	Good	N. 25° W., N 30° W., N. 29° W.
42– 8–15	76–48–15	120	S.	4	Good	
42– 8–15	76–48–15	101	N. 19° W.	35	Good	
42– 8–15	76–48–15	74	N.	49	Good	
42– 8–48	76–50–54	60	S. 65° W.	86	Good	
42– 8–27	76–51–15	50	S. 30° W.	55	Good	N. 33° W., N. 29° W., N. 75° E.
42– 8–18	76–51–18	35	S. 20° W.	8	Poor	
42– 8–18	76–51–18	52	S. 3;° E.	0	Good	
42– 9–54	76–57–54	20	S. 40° E.	100	Poor	
42– 9–42	76–57–14	22	S. 85° W.	200	Poor	
42– 9–24	76–57– 6	290	S. 25° E.	75	Good	
42– 9– 6	76–50–12	145	N. 8° W.	50	Good	
42–10–18	76–56– 9	30	S. 10° E.	68	Poor	
42–10–18	76–56– 9	50	S. 25° E.	50	Good	
42–10– 0	76–57–54	45	N. 12° W.	44	Fair	
42–10–36	76–48–12	240	S. 30° E.	0	Good	
42–10–54	76–47–54	290	S. 72° W.	70	Good	N. 30° W., N. 75° E.
42–10–54	76–47–54	30	S. 65° W.	44	Poor	
42–11–24	76–54–12	25	N. 75° W.	50	Poor	
42–11–24	76–54–12	52	S. 85° W.	85	Good	
42–11–48	76–53–48	42	N. 75° W.	84	Fair	N. 10° W.
42–11–48	76–53–48	21	N. 50° W.	80	Poor	
42–11–27	76–52–18	55	S. 70° W.	108	Good	

ELMIRA QUADRANGLE—*Continued*

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42–11–27	76–52–18	27	S. 20° E.	90	Poor	
42–11–27	76–56–18	65	N. 90° W.	36	Good	
42–11–18	76–50–18	230	S. 19° E.	70	Good	
42–12–58	76–54–24	40	N. 42° W.	117	Fair	
42–12–58	76–54–24	45	N. 18° W.	60	Fair	
42–12–50	76–54– 0	50	N. 25° W.	70	Good	
42–12–30	76–53–48	27	N. 45° W.	100	Poor	N. 25° W.
42–12–58	76–54– 6	50	N. 17° W.	70	Good	
42–12–58	76–54– 6	65	N. 14° W.	56	Good	
42–12–18	76–53–20	82	N. 40° W.	13	Good	
42–12–18	76–53–24	23	N. 50° W.	80	Poor	
42–12– 0	76–53–24	50	S. 8° E.	70	Good	
42–12– 0	76–53–24	50	S. 8° E.	80	Good	
42–12–30	76–48–30	65	S. 44° W.	145	Good	
42–12–36	76–48–30	60	S. 26° W.	207	Good	
42–12–36	76–48–30	57	S. 6° E.	161	Good	
42–12–48	76–58–15	35	N. 27° W.	23	Poor	
42–12–48	76–58–15	20	N. 75° E.	26	Poor	N. 27° W.
42–12–39	76–59–28	130	N. 15° E.	17	Good	N. 30° W.
42–12–30	76–59–30	35	N. 17° W.	45	Poor	
42–12–46	76–57– 0	95	S. 30° E.	30	Good	
42–13–48	76–58–42	50	N. 40° W.	50	Good	
42–13–48	76–58–42	70	N. 26° W.	22	Good	
42–13–48	76–58–42	55	N. 25° W.	19	Good	
42–13–48	76–58–42	40	S. 15° W.	40	Poor	
42–13–18	76–53– 6	30	N. 8° E.	42	Poor	
42–13–18	76–53– 6	33	N. 33° W.	32	Poor	
42–13–51	76–45–54	13	N. 34° E.	20	Poor	
42–14–12	76–51–30	56	N. 43° E.	45	Good	
42–14–12	76–51–30	70	N. 30° W.	97	Good	

WATKINS QUADRANGLE

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42–15–54	76–58– 0	72	S. 70° E.	95	Good	
42–15–42	76–51–34	100	N. 74° W.	40	Good	
42–15–42	76–51–37	70	N. 60° W.	26	Good	
42–16– 0	76–52–30	65	S. 40° E.	100	Good	
42–16– 3	76–52–30	80	S. 32° E.	230	Good	
42–16–39	76–50–30	125	S. 25° E.	130	Good	
42–19–12	76–56–18	23	N. 18° W.	35	Poor	
42–19–12	76–56–18	25	N. 25° W.	120	Poor	
42–19–24	76–59–18	60	S. 42° W.	53	Good	
42–20–54	76–51–21	50	N. 22° W.	0	Good	N. 18° W.
42–20–42	76–51– 6	55	N. 12° W.	27	Good	N. 12° W.
42–20–18	76–52–18	130	S. 72° W.	24	Good	N. 70° E., N. 70° W.

WATKINS QUADRANGLE—*Continued*

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42–20–12	76–52–18	50	S. 23° W.	0	Poor	N. 26° W.
42–20–12	76–52–18	60	N. 20° E.	88	Good	
42–20–12	76–52–18	70	N. 10° E.	105	Good	N. 30° W.
42–20– 6	76–49–48	110	N. 48° W.	37	Good	
42–20– 6	76–49–48	64	N.	176	Good	
42–20–21	76–47–36	165	N. 89° W.	24	Good	N. 32° W., N. 69° E.
42–20–21	76–47–42	115	N. 90° W.	32	Good	
42–20–24	76–47–54	160	N. 63° W.	90	Good	
42–20–24	76–47–54	160	N. 50° W.	132	Good	
42–21–36	76–49– 6	140	N. 8° E.	7	Good	N. 75° W.
42–21–48	76–49– 6	110	S. 45° E.	37	Good	
42–21–15	76–48–18	100	N. 5° W.	85	Good	
42–21– 0	76–51–21	60	S. 30° E.	52	Good	N. 15° W., N. 20° W.
42–21– 6	76–51–23	94	S. 20° E.	10	Good	N. 20° W.
42–21–21	76–51–36	278	S. 20° E.	23	Good	N. 30° W., N. 60° E.
42–21–21	76–51–36	420	S. 20° E.	20	Good	N. 25°–27° W.
42–21–42	76–51–48	365	S. 20° E.	75	Good	
42–22– 6	76–57–18	50	S. 80° W.	30	Good	N. 25°–27° W., N. 80° E.
42–22– 6	76–57–18	90	S. 63° W.	16	Good	
42–22– 0	76–52– 0	360	S. 15° E.	20	Good	
42–22– 0	76–52– 0	242	S. 15° E.	50	Good	
42–22–12	76–50–51	150	S. 20° E.	72	Good	N. 18° W.
42–22–39	76–51– 6	1205	S. 15° E.	52	Good	
42–23–18	76–51–18	610	S. 10° E.	45	Good	
42–23–27	76–51–24	190	N. 90° E.	57	Good	N. 20° W., N. 5° E., N. 27° W.
42–23–30	76–51–30	175	N. 15° W.	12	Good	
42–23–30	76–51–30	120	N. 5° W.	0	Good	
42–23–50	76–51–36	371	N. 20° W.	25	Good	
42–24–12	76–51–42	190	N. 23° W.	18	Good	N. 20° W.
42–24–36	76–52– 0	220	N. 9° W.	50	Good	
42–24–54	76–52– 0	470	N. 4° W.	38	Good	
42–24–15	76–53–18	80	S. 53° W.	25	Good	
42–24–15	76–53–18	55	S. 85° W.	35	Good	
42–24–18	76–53–36	60	N. 8° W.	0	Good	
42–25– 6	76–52– 0	195	N.	40	Good	N. 30° W., N. 4° W., N. 10° E.
42–25–51	76–50–54	195	S.	80	Good	
42–25–51	76–50–54	300	S.	57	Good	
42–26–18	76–51–15	520	S. 15° E.	96	Good	
42–26–18	76–51–15	480	S. 16° E.	90	Good	
42–28–24	76–54–36	20	S. 80° W.	0	Poor	
42–28–24	76–54–40	30	S. 80° W.	28	Poor	
42–28–30	76–54–39	65	N. 85° E.	25	Good	
42–28–30	76–54–39	35	N. 63° E.	60	Poor	
42–28–42	76–54–45	50	N. 90° E.	0	Good	
42–28–51	76–55–48	130	N. 78° W.	0	Good	
42–28–51	76–55–48	120	N. 24° W.	97	Good	N. 24° W.
42–28–54	76–56– 0	75	N. 85° E.	39	Good	
42–28–54	76–56– 0	35	N. 76° E.	37	Poor	
42–28–54	76–55–18	65	N. 90° E.	0	Good	
42–28–54	76–55–13	75	N. 88° W.	0	Good	
42–28–54	76–55–13	145	N. 75° E.	32	Good	

Watkins Quadrangle—*Continued*

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42-29-48	76-52- 6	140	N.	8	Good	N. 2° E., N. 81° E.
42-29-18	76-55-42	170	N. 10° E.	23	Good	N. 5° E., N. 32° W.
42-29-18	76-55-42	300	N. 90° E.	20	Good	N. 75° E.
42-29-15	76-55-26	70	N. 63° W.	52	Good	
42-29-54	76-57-30	180	N. 23° W.	13	Good	
42-29-54	76-57-30	75	S. 50° W.	10	Good	N. 28° W.
42-29-54	76-57-30	80	N. 40° W.	45	Good	N. 70° E., N. 35° W.
42-29-15	76-55-24	70	S. 3° E.	4	Good	N. 2° E., N. 90° E.
42-29-15	76-55-24	65	S. 72° W.	32	Good	
42-29-15	76-55-24	42	S. 20° W.	50	Fair	
42-29-54	76-58-30	25	S. 75° W.	80	Poor	N. 10° W., N. 80° E.
42-29-54	76-58-30	75	S. 30° W.	70	Good	

Ovid Quadrangle

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42-30-18	76-58-24	65	N.	4	Good	
42-31- 9	76-58-33	135	S. 52° E.	28	Good	
42-31- 9	76-58-33	90	S. 20° E.	29	Good	N. 28° W., N. 33° W.
42-31-42	76-51-42	95	N. 77° W.	30	Good	
42-31-42	76-51-42	78	N. 80° W.	0	Good	
42-35-30	76-51-54	50	S. 70° W.	63	Good	N. 3° E., N. 3° W., N. 65° E.
42-35-30	76-51-54	45	N. 30° W.	180	Fair	
42-35-42	76-56-42	80	S. 70° W.	152	Good	
42-35-42	76-56-24	65	S. 15° W.	65	Good	N. 30° W., N. 5° E., N. 10° E.
42-35-42	76-56-24	100	N. 88° E.	46	Good	
42-35-30	76-56-18	50	N. 76° E.	42	Good	
42-35-30	76-56-36	75	S. 60° E.	28	Good	N. 75° E., N. 35° W.
42-35-28	76-56-39	39	S. 75° W.	241	Good	
42-35-28	76-56-39	50	S. 10° W.	160	Good	
42-35-28	76-56-39	43	S. 58° W.	209	Good	
42-35-45	76-55-39	50	N. 78° E.	40	Good	
42-36-42	76-50-54	70	S. 84° E.	200	Good	N. 76° E., N. 30° W., N. 1° E., N. 4° E., N.
42-36-12	76-55-24	150	N. 71° E.	60	Good	
42-36-13	76-55-24	120	S. 3° W.	4	Good	
42-37-42	76-55-24	130	S. 62° W.	40	Good	
42-39-54	76-59- 6	.....	S. 29° W.	130	True Dip	

Corning Quadrangle

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42– 0–42	77– 8–78	82	S. 75° W.	92	Good	
42– 0–42	77– 8–78	53	N. 66° E.	23	Good	
42– 0–42	77– 8–18	42	N. 20° W.	172	Good	
42– 0–42	77– 8–18	62	N. 3° W.	66	Good	
42– 0–42	77– 8–78	80	S. 60° W.	10	Good	N. 36° W., N. 65° E.
42– 1–42	77– 9–42	87	S. 57° W.	64	Good	N. 37° W.
42– 1–42	77– 8–51	40	S. 62° W.	51	Fair	
42– 2– 9	77– 6–45	94	N. 50° W.	42	Good	N. 35° W.
42– 2–12	77– 6–50	85	S. 70° W.	100	Good	
42– 2–18	77– 7–18	90	S. 77° W.	105	Good	N. 39° W.
42– 2–27	77– 8–18	310	S. 5° W.	46	Good	
42– 2–27	77– 8–18	220	S. 8° W.	53	Good	
42– 2–18	77– 8–18	195	S.	64	Good	
42– 2–36	77– 6–36	63	S. 20° W.	50	Poor	
42– 2–36	77– 6–36	117	N. 70° W.	121	Poor	
42– 2–36	77– 6–36	100	N. 75° W.	66	Fair	
42– 3–48	77– 7–33	90	N. 74° E.	0	Fair	
42– 3–45	77–10– 8	85	S. 25° E.	12	Good	N. 33° W.
42– 3–45	77–10– 8	80	S. 36° W.	90	Good	
42– 4–42	77–10–48	75	S. 20° W.	157	Good	
42– 4–30	77–10– 0	.....	....	....	....	N. 80° E., N. 36° W.
42– 5–24	77–13–48	75	S. 18° E.	196	Good	N. 10° W., N. 18° W.
42– 5–30	77– 2–30	70	S. 45° W.	60	Good	
42– 5–30	77– 2–30	85	S. 15° E.	143	Good	
42– 5–30	77– 2– 6	80	S. 36° E.	7	Poor	N. 23° W., N. 35° W.
42– 6–24	77–14–16	60	N. 76° W.	22	Poor	
42– 6–42	77–14–30	90	S. 15° E.	77	Good	
42– 6–48	77– 7– 6	120	S. 36° E.	66	Good	
42– 6–51	77– 3–27	85	S. 30° W.	186	Good	
42– 6–51	77– 3–27	75	S. 50° W.	105	Good	
42– 7–12	77–12–18	30	S. 40° E.	105	Poor	
42– 7–18	77–11–50	100	S. 20° W.	146	Fair	
42– 7–48	77– 2–48	75	S. 42° E.	160	Poor	N. 75° E., N. 30° W.
42– 7–48	77– 2–48	70	S. 68° W.	98	Good	N. 80° E.
42– 7–48	77– 2–48	110	S. 55° E.	132	Good	
42– 7– 0	77– 7–24	140	S. 42° E.	31	Good	
42– 7–12	77–12–18	30	S. 40° E.	105	Poor	
42– 7–18	77–11–50	100	S. 20° W.	146	Fair	
42– 7–36	77–10–54	65	S. 3° W.	228	Poor	
42– 7–30	77–10–54	30	S. 5° E.	150	Poor	N. 39° W.
42– 7–24	77–10–54	55	S. 22° W.	220	Poor	
42– 8–45	77– 8–54	140	S. 50° E.	4	Good	
42– 8–54	77– 4–42	210	N. 76° W.	110	Good	N. 90° E., N. 50° W., N. 15° W.
42– 8–30	77– 1–48	115	S. 53° W.	129	Good	
42– 8–39	77– 2– 9	220	S. 35° E.	154	Good	
42– 8–39	77– 2– 9	220	S. 20° E.	190	Good	
42– 9–42	77– 0–30	68	S. 57° W.	78	Good	
42–10–56	77– 2– 0	73	S. 52° W.	174	Good	
42–10–27	77– 2–36	205	S. 58° W.	61	Good	
42–10–20	77– 6– 6	121	S. 22° W.	67	Good	
42–11–24	77– 4– 9	120	S. 4° E.	42	Good	
42–11–30	77– 9–24	350	S. 30° E.	0	Good	N. 38°–45° W.
42–11–30	77– 9–24	200	S. 42° E.	0	Good	N. 24° W.

Corning Quadrangle—*Continued*

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42–11–42	77– 9–30	130	S. 10° E.	40	Good	
42–11–42	77– 9–30	320	S. 10° E.	21	Good	
42–11–48	77– 9–30	90	S. 5° E.	30	Good	
42–11–48	77– 9–30	280	S. 5° E.	32	Good	
42–11–54	77– 9–30	460	S. 15° E.	42	Good	
42–12– 0	77– 9–36	140	S. 20° E.	31	Good	
42–12– 0	77– 9–36	210	S. 25° E.	18	Good	
42–12–18	77–10–48	50	S. 55° W.	85	Good	
42–12–18	77–10–48	50	S. 55° W.	95	Good	
42–12–12	77–11– 0	75	N. 3° W.	14	Good	
42–14–45	77–10– 9	135	S. 70° W.	52	Good	

Hammondsport Quadrangle

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42–16–30	77–11– 0	60	S. 12° W.	9	Good	
42–17–30	77– 2–42	118	S. 80° W.	106	Good	
42–19– 6	77– 0– 3	70	N. 80° W.	70	Poor	
42–19– 6	77– 0– 0	120	N. 75° W.	50	Good	
42–23–51	77–13–12	130	S. 8° W.	110	Good	
42–24–42	77–13–36	182	N. 34° W.	59	Good	
42–24–45	77–10– 0	48	W.	105	Fair	
42–24–30	77–11–18	68	S. 30° W.	50	Good	
42–24–30	77–11–18	65	S. 85° W.	165	Good	
42–24–30	77–12– 6	160	S. 53° W.	81	Good	
42–24–30	77–12– 6	80	S. 53° W.	118	Good	
42–25– 6	77–12–33	95	S. 49° W.	70	Good	
42–26–30	77–11–29	47	S. 73° W.	110	Fair	
42–27–54	77–10–36	140	S. 15° W.	70	Good	
42–28– 0	77–10–36	33	S. 24° W.	60	Poor	
42–29– 6	77– 9–51	20	N. 10° W.	75	Poor	

Penn Yan Quadrangle

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42–30–27	77– 7–54	135	S. 14° E.	70	Good	
42–30–27	77– 7–54	390	S. 5° W.	65	Good	
42–30–27	77– 7–54		S. 2° E.	90	Good	
42–31–54	77– 9–36	.....	N. 52° W.	160	True Dip	
		95				
42–31–54	77– 9–36	48	N. 36° W.	90	Fair	

PENN YAN QUADRANGLE—*Continued*

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42–31–54	77– 9–54	118	S. 81° W.	63	Good	
42–31–54	77– 9–54	98	N. 85° W.	85	Good	N. 73° W.
42–31–54	77– 9–54	140	S. 70° W.	65	Good	
42–32–24	77–12–24	25	S. 72° W.	60	Poor	
42–37–32	77–11– 9	105	N. 85° W.	80	Good	
42–37–32	77–11– 9	60	S. 70° W.	35	Poor	
42–37–32	77–11– 9	58	N. 85° W.	18	Good	N. 70° E.
42–37–32	77–11– 9	75	N. 56° W.	14	Poor	
42–39–42	77– 0– 8	.....	S. 58° W.	75	True Dip	
42–40–13	77– 4– 0	77	S. 74° W.	68	Good	
42–42–30	77–12–42	90	N. 87° E.	18	Good	
42–42–28	77–13–24	80	S. 84° W.	54	Poor	
42–42–42	77–14– 3	100	S. 68° W.	35	Good	
42–42–42	77–14– 3	80	N. 90° W.	0	Good	

WOODHULL QUADRANGLE

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42– 2–48	77–16–54	75	S. 50° W.	50	Poor	
42– 4– 0	77–18–42	70	S. 5° W.	225	Poor	
42– 4–18	77–18–42	60	S. 80° W.	62	Poor	
42– 4–36	77–19–54	210	S. 60° W.	0	Good	
42– 4–54	77–21–42	100	S. 75° W.	0	Good	
42– 4–24	77–23–15	150	S. 76° W.	7	Good	
42– 4–24	77–16– 0	35	S. 5° E.	255	Poor	N. 40° W.
42– 4–24	77–16– 0	45	S. 25° E.	199	Poor	N. 56° E.
42– 4–24	77–16– 0	32	N. 65° E.	33	Poor	N. 65° E.
42– 4–12	77–17–12	45	S. 52° E.	105	Fair	
42– 5– 6	77–20–42	110	N. 64° W.	100	Good	
42– 5– 6	77–20–42	104	N. 82° W.	65	Good	
42– 5– 0	77–18–39	150	N. 46° W.	0	Poor	
42– 5– 0	77–18–39	130	S. 80° W.	40	Good	
42– 5– 6	77–22– 0	40	N. 65° W.	145	Fair	N. 62° E., N. 75° E., N. 40°–45° W.
42– 5– 0	77–15–42	150	S. 80° E.	140	Poor	
42– 5– 0	77–15–42	190	S. 87° E.	108	Poor	
42– 5–15	77–20– 0	33	S. 65° E.	88	Poor	
42– 6–48	77–15–51	50	S.	60	Fair	
42– 6–54	77–17–15	60	N. 28° E.	22	Fair	
42– 6– 9	77–16–45	20	S. 65° W.	104	Poor	
42– 7–30	77–23–42	60	N. 80° W.	0	Good	
42– 7–24	77–16–15	40	N. 48° W.	100	Fair	N., N. 25° W.
42– 7–24	77–16–15	20	N. 30° W.	180	Poor	N. 41° W.
42– 7–18	77–16– 6	48	N. 35° W.	53	Poor	
42– 7–12	77–16– 0	38	N. 55° W.	20	Poor	

WOODHULL QUADRANGLE—*Continued*

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42– 7–30	77–18–36	40	N. 3° W.	13	Poor	N. 60° E., N. 35° W.
42– 7–42	77–18–30	45	S. 50° W.	5	Good	
42– 7–42	77–18–30	30	N. 20° E.	105	Poor	
42– 7–21	77–17–21	35	N. 35° W.	127	Poor	N. 57°–63° E., N. 85° W., N. 16° W.
42– 8–21	77–19–36	150	S. 20° E.	10	Poor	
42–10–54	77–16– 0	70	N. 60° W.	37	Poor	N. 70° E.
42–10–36	77–19–48	45	N. 20° E.	0	Fair	
42–10–42	77–19–40	55	N. 15° W.	0	Poor	
42–10–48	77–19–36	35	N. 77° W.	105	Poor	
42–10–54	77–19–36	80	S.	86	Good	
42–11–54	77–27–21	27	N. 76° W.	49	Poor	
42–11–54	77–27–21	37	N. 80° W.	71	Poor	
42–11–54	77–27–21	55	S. 82° W.	48	Good	
42–11– 6	77–22–42	64	N. 45° W.	41	Good	N. 62° E.
42–11– 6	77–22–42	95	N. 68° E.	50	Good	N. 55° E., N. 36°–40° W.
42–11–42	77–20– 6	.....	....	....	....	N. 10° W.
42–12–32	77–24– 9	35	N. 35° E.	30	Poor	
42–12–24	77–24–12	45	S. 18° W.	58	Poor	
42–12– 6	77–24–18	76	N. 3° W.	25	Good	N. 36° E., N. 10° W., N. 45° E.
42–12– 0	77–20–48	80	N. 10° W.	43	Good	
42–12–12	77–26–30	70	N. 15 °W.	10	Good	
42–12– 0	77–25–54	48	N. 86° W.	110	Fair	N. 65° E., N. 40° W.
42–12– 0	77–25–54	20	N. 83° W.	80	Poor	
42–12–24	77–25– 0	85	N. 10° W.	71	Good	
42–12–36	77–20–45	80	N. 50° W.	33	Fair	
42–13–45	77–16–48	40	N. 8° W.	0	Poor	
42–13–24	77–15–45	36	S. 53° W.	140	Poor	
42–13–24	77–15–45	38	S. 34° W.	135	Poor	
42–13–30	77–15–50	38	S. 10° E.	13	Poor	
42–13–36	77–19– 0	100	S. 20° E.	275	Fair	
42–13–18	77–24–51	33	N. 40° W.	80	Poor	
42–14–48	77–19–27	65	S. 75° W.	105	Good	
42–14–48	77–19–27	84	S. 15° E.	50	Good	

BATH QUADRANGLE

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42–15– 0	77–27–15	97	S. 43° E.	25	Good	
42–15– 0	77–27–15	170	N. 45° W.	28	Good	
42–15– 0	77–27–15	290	N. 42° W.	15	Good	
42–18–33	77–16–20	120	N. 13° W.	105	Good	
42–19–21	77–20–36	50	S. 4° W.	65	Fair	
42–19–42	77–20–18	50	N. 15° W.	20	Good	N. 15° W., N. 60°–66° E.

BATH QUADRANGLE—*Continued*

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42–19–42	77–20–18	110	S. 15° W.	43	Good	
42–20–48	77–21– 0	50	S. 30° E.	10	Good	
42–20–48	77–21– 0	16	S. 55° W.	165	Poor	
42–20– 9	77–23–54	70	S. 12° W.	150	Good	
42–21–48	77–13–33	230	N. 70° W.	61	Fair	
42–21–48	77–13–33	130	N. 78° W.	76	Fair	
42–21–42	77–27–42	125	S. 80° W.	69	Fair	
42–21–21	77–20–30	50	N. 80° W.	50	Fair	
42–21–21	77–20–15	36	S. 23° W.	23	Poor	
42–21–54	77–21–54	195	S. 58° E.	62	Fair	N. 40° W.
42–22–30	77–18–30	120	S. 37° W.	145	Good	
42–23–42	77–25– 0	210	N. 48° W.	70	Good	
42–23–42	77–24–48	290	N. 45° W.	38	Good	
42–23–42	77–21– 0	40	S. 56° E.	6	Fair	
42–23–42	77–21– 0	58	S. 2° E.	157	Good	
42–23–42	77–21– 0	60	N. 40° E.	88	Good	
42–23–30	77–20–54	130	S. 52° W.	58	Good	
42–23–30	77–20–54	80	S. 22° W.	160	Good	
42–23–36	77–22– 0	42	N. 54° W.	0	Fair	
42–23–42	77–22– 6	80	S. 39° W.	65	Good	
42–23–42	77–22– 6	50	S. 76° W.	105	Good	N. 40° W.
42–23–42	77–22– 6	20	N. 40° W.	39	Poor	
42–24–54	77–24–54	17	S. 2° E.	60	Poor	
42–24–54	77–25– 0	45	S. 10° W.	47	Fair	
42–24–18	77–24– 6	35	S. 53° W.	75	Poor	
42–24–18	77–24– 6	62	S. 53° W.	68	Good	N. 36°–40° W.
42–24–30	77–21–36	.....	....	....	....	N. 36°–40° W.
42–25–27	77–17–39	50	S. 27° E.	30	Fair	
42–25–42	77–28–30	90	S. 36° E.	28	Good	
42–25– 0	77–24–39	88	S. 53° W.	53	Good	
42–26– 0	77–26–18	170	N. 30° W.	9	Good	
42–26– 0	77–25–36	80	N. 25° E.	3	Good	
42–26– 0	77–18– 9	75	N. 45° W.	70	Poor	
42–26–18	77–20–48	15	S. 72° W.	105	Poor	N. 34° W.
42–26– 3	77–20–36	40	S. 34° E.	9	Poor	N. 39° W., N. 35° E.
42–26– 3	77–20–36	30	S. 7° W.	12	Poor	

NAPLES QUADRANGLE

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42–35–52	77–23–30	70	S. 3° W.	52	Good	
42–35–52	77–23–30	50	S. 71° W.	30	Good	
42–35–52	77–23–30	120	S. 43° E.	40	Good	
42–35–52	77–23–30	45	S. 73° W.	22	Fair	
42–35–52	77–23–30	60	S. 78° W.	44	Good	
42–36– 9	77–24–21	52	S. 43° W.	45	Good	

NAPLES QUADRANGLE—*Continued*

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42-36- 9	77-24-21	135	S. 38° W.	72	Good	
42-36- 9	77-24-21	85	S. 13° W.	84	Good	
42-36-24	77-17-27	70	N. 68° W.	11	Good	
42-36-54	77-24-48	114	S. 80° E.	2	Good	
42-36-54	77-24-48	70	N. 38° W.	4	Good	
42-39- 9	77-15-33	120	S. 86° W.	35	Good	
42-39- 9	77-15-33	50	N. 48° W.	10	Good	
42-39- 9	77-15-33	55	S. 70° E.	13	Good	
42-39- 9	77-15-33	48	N. 60° W.	26	Good	
42-40-24	77-22-27	95	S. 5° E.	8	Good	
42-40- 9	77-22-24	82	S. 15° W.	50	Good	
42-40-51	77-21-24	250	S. 3° W.	8	Good	

GREENWOOD QUADRANGLE

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42- 1- 9	77-44-20	100	S. 80° W.	8	Good	
42- 1- 6	77-43-54	50	S. 52° W.	60	Good	
42- 1-56	77-32-24	80	N. 20° W.	66	Good	
42- 2-30	77-33- 0	75	N.	56	Good	
42- 2-30	77-33- 0	105	N. 56° W.	100	Good	
42- 3-18	77-40-42	32	N. 15° E.	300	Poor	
42- 3-24	77-44-12	75	S. 30° W.	84	Good	
42- 5- 0	77-43-39	82	S. 10° W.	195	Poor	
42- 5- 0	77-43-39	35	S. 20° W.	247	Poor	
42- 7-24	77-38-12	40	S. 10° W.	40	Poor	
42- 7- 0	77-39- 0	115	S. 18° E.	53	Good	
42- 7-54	77-38-48	300	S. 30° W.	44	Good	
42- 8- 6	77-38- 6	200	S. 50° E.	55	Good	
42- 8-21	77-39-48	70	N. 55° W.	37	Good	N. 47° W.
42- 8-30	77-44-12	90	N. 4° W.	29	Good	
42- 9-24	77-38-24	60	S. 75° W.	9	Poor	
42- 9-24	77-38-24	70	N.	8	Good	
42- 9-18	77-38-30	75	N. 45° E.	0	Poor	
42- 9-15	77-37-36	55	N. 20° W.	48	Good	
42- 9- 9	77-38-31	60	N. 44° E.	12	Good	
42- 9-54	77-40-15	37	N. 55° W.	13	Poor	
42- 9-54	77-40-15	100	N. 53° W.	5	Good	
42-11-12	77-37-36	126	S. 33° W.	4	Good	
42-11-12	77-37-37	70	N. 20° E.	11	Good	
42-11-20	77-33- 0	.....	....	....	....	N. 42°-47° W., N. 55° E.
42-11-36	77-32-42	20	S. 72° W.	80	Poor	N. 37° W.
42-11-54	77-33-24	100	N. 45° W.	105	Good	
42-11-54	77-33-24	60	N. 45° W.	88	Good	

GREENWOOD QUADRANGLE—*Continued*

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42–11–48	77–33–24	120	N. 30° W.	73	Good	
42–11–42	77–33– 6	47	N. 45° W.	45	Poor	
42–11–51	77–36– 6	80	N. 73° W.	45	Poor	
42–11–51	77–36– 6	85	N. 25° W.	6	Poor	
42–11– 0	77–32–16	320	S. 28° E.	85	Good	
42–11–24	77–32–45	70	S.	75	Good	
42–11–30	77–33– 6	130	S. 5° E.	12	Good	
42–11–30	77–33– 6	140	N.	0	Poor	
42–11–30	77–38–51	153	N. 90° W.	10	Good	
42–12–30	77–32–54	41	S. 55° W.	80	Poor	
42–12–12	77–33–24	50	S. 60° W.	63	Poor	
42–12– 0	77–34– 9	30	S. 60° W.	120	Poor	
42–12–36	77–33–54	30	N. 42° W.	100	Poor	
42–12–36	77–33–54	80	N. 21° W.	50	Fair	
42–12– 6	77–36–51	135	S.	17	Fair	
42–12– 0	77–34–12	....	. .. ..	..	..	N. 50° W., N. 42° W., N. 65° E.
42–12–33	77–32–54	.....	....	....	....	N. 45°–50° W., N. 40°–45° E.
42–12–33	77–33–24	.....	....	....	....	N. 42°–47° W., N. 55° E., N. 65° E., N. 33° W.
42–14–18	77–35– 0	290	N. 5° W.	100	Good	
42–14–42	77–35– 6	240	S.	22	Good	
42–14– 6	77–36–45	90	S. 50° W.	15	Good	
42–14– 6	77–36–45	47	S. 86° W.	50	Poor	
42–14– 9	77–36–18	60	N. 20° E.	0	Fair	
42–14– 4	77–42–15	95	N. 35° E.	10	Good	
42–14– 4	77–42–15	100	N. 26° E.	75	Good	
42–14–24	77–42–12	50	S. 27° W.	60	Good	
42–14–24	77–42–12	70	S. 50° W.	56	Good	

HORNELL QUADRANGLE

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42–15–12	77–35– 0	290	S. 18° E.	43	Good	
42–15–42	77–36–18	680	S. 10° W.	71	Good	
42–15–45	77–40– 6	75	S. 5° W.	105	Poor	
42–15–45	77–40– 6	75	S. 10° E.	77	Poor	
42–15–30	77–41– 0	105	S. 32° E.	45	Good	
42–15–30	77–41– 0	70	S. 80° E.	0	Good	
42–15–27	77–38–48	210	S. 80° W.	55	Good	
42–15–27	77–38–36	175	S. 43° E.	42	Good	
42–15–29	77–38–15	112	N. 86° W.	7	Good	
42–15–36	77–38–54	150	S. 46° E.	51	Good	
42–15–27	77–37–48	175	S. 50° W.	42	Good	

HORNELL QUADRANGLE—*Continued*

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42-15-27	77-32-12	110	N. 66° W.	52	Good	
42-15-48	77-32-30	.....	....	....	....	N. 48° W.
42-16-15	77-35-36	180	S. 60° E.	60	Good	
42-16-39	77-38-48	50	S. 8° W.	130	Poor	
42-16- 0	77-34-42	48	S. 30° W.	75	Poor	
42-16-27	77-34-27	105	S. 32° W.	51	Good	
42-16-24	77-33-36	105	S. 25° W.	43	Good	
42-16-39	77-33-24	140	S. 40° W.	100	Good	
42-16-48	77-31- 3	110	S. 63° W.	125	Good	
42-17-36	77-37- 0	92	S. 10° E.	83	Good	
42-17-18	77-36-21	70	S. 50° W.	60	Good	
42-17-18	77-36-21	110	S. 60° W.	70	Good	
42-17-35	77-36-51	200	S. 52° W.	78	Good	
42-17-36	77-38-40	100	N. 60° W.	8	Good	
42-17-54	77-41-21	130	S.	32	Good	
42-17-12	77-38-30	380	N. 59° W.	0	Good	
42-18- 9	77-36-36	125	S. 27° W.	61	Good	
42-18-14	77-36-30	110	S. 20° W.	90	Good	
42-18-18	77-42-28	52	S. 45° W.	55	Poor	
42-18-15	77-41-15	83	N. 3° E.	16	Poor	
42-18-30	77-41-54	110	S. 55° W.	85	Good	
42-18-37	77-40-51	140	S. 90° W.	85	Good	
42-18-48	77-40-30	85	S. 38° W.	35	Good	
42-18-48	77-40-30	145	S. 38° W.	25	Good	
42-19-54	77-41-00	160	N. 76° W.	66	Good	
42-19-54	77-40-54	100	N. 78° W.	63	Good	
42-19-54	77-40-42	150	N. 73° W.	70	Good	
42-19-42	77-39- 6	100	N. 25° W.	10	Good	
42-19-42	77-39- 6	100	S. 2° E.	15	Good	
42-19-16	77-38-54	120	S. 50° W.	40	Good	
42-19-54	77-37-30	125	S. 48° W.	105	Good	
42-19-54	77-37-30	48	S. 31° W.	16	Fair	N. 50°-55° E.
42-19-54	77-37-30	130	S. 56° W.	94	Good	N. 46° W.
42-19-45	77-37-48	55	S. 60° W.	90	Good	
42-19-45	77-37-48	70	S. 56° W.	93	Good	
42-19-18	77-38-18	70	N. 90° E.	26	Good	
42-19-18	77-38-18	25	N. 58° W.	20	Poor	
42-19-18	77-38-18	45	S. 35° E.	72	Poor	
42-19-15	77-38-42	65	N. 24° E.	10	Good	
42-19-15	77-38-42	80	S. 65° W.	130	Poor	
42-19-36	77-39- 0	26	N.	110	Poor	
42-19-24	77-38-36	15	N. 46° W.	140	Poor	
42-19-30	77-38-42	57	S. 25° W.	64	Poor	
42-19-36	77-38-42	24	N. 10° W.	75	Poor	
42-19-39	77-38-42	70	N. 6° W.	0	Good	
42-19-42	77-38-42	80	N. 51° W.	20	Good	
42-19-42	77-38-42	40	S. 47° W.	55	Fair	
42-19-42	77-38-42	60	S. 30° W.	13	Good	
42-20- 6	77-38-24	32	S. 50° W.	49	Poor	N. 45° W., N. 50° E.
42-20-15	77-38-18	28	N. 12° W.	39	Poor	N. 65° E.
42-20-30	77-42- 6	130	S. 46° E.	18	Good	
42-20-30	77-42- 6	80	N. 65° W.	10	Good	
42-21-18	77-39-28	120	S. 20° W.	48	Good	
42-21-18	77-39-28	100	S. 20° W.	37	Good	

HORNELL QUADRANGLE—*Continued*

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42-21-36	77-39- 6	75	S. 55° W.	80	Fair	
42-21-54	77-38-42	130	S. 75° W.	72	Fair	N. 45° W., N. 88° E.
42-21-54	77-38-42	160	N. 55° W.	13	Good	N. 60° E., N. 88° W.
42-22-42	77-44-24	125	S. 25° W.	48	Good	
42-22- 0	77-39-54	140	S. 3° W.	65	Good	
42-22- 0	77-39-54	50	S. 65° W.	30	Good	
42-23- 6	77-39- 0	110	N. 47° W.	0	Good	
42-23-12	77-43-33	120	S. 18° E.	75	Good	
42-23-12	77-43-33	205	S. 45° W.	38	Good	
42-23-48	77-42-48	110	N. 57° W.	72	Good	
42-23-42	77-42-31	110	S. 75° W.	100	Good	
42-26- 0	77-30-30	105	S. 85° E.	10	Poor	
42-28-42	77-39-28	100	S. 80° W.	93	Good	
42-28-42	77-39-28	97	S. 65° W.	103	Good	

WAYLAND QUADRANGLE

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42-31- 6	77-41-42	80	S. 37° E.	60	Poor	
42-31- 6	77-41-42	185	S. 20° E.	17	Good	
42-31- 6	77-41-42	120	S. 70° W.	35	Good	
42-32-54	77-35-42	140	S. 5° E.	7	Good	
42-32-57	77-34-24	72	S. 29° E.	0	Good	
42-32-57	77-34-24	40	S. 57° W.	39	Poor	
42-32-33	77-42-21	290	S. 5° W.	8	Good	
42-32-33	77-42-21	340	S. 13° E.	0	Good	
42-32-33	77-42-21	200	S. 84° W.	65	Good	
42-32-42	77-40-36	140	N. 73° W.	15	Good	
42-33-48	77-31-18	60	S. 86° E.	9	Good	
42-33-48	77-43-42	77	S. 20° E.	70	Good	
42-34-27	77-44-30	259	S. 18° W.	42	Good	
42-34-12	77-43-30	255	S. 33° E.	60	Good	
42-34-18	77-41-24	270	S. 22° E.	42	Good	
42-34- 6	77-41-12	320	S. 21° E.	25	Good	
42-36-42	77-43-30	100	S. 40° W.	0	Poor	
42-36-42	77-43-30	145	S. 46° W.	50	Good	
42-43-54	77-40-42	100	S. 48° W.	42	Good	N. 33° W.
42-43-54	77-40-42	70	S. 30° E.	26	Good	
42-43-54	77-41-18	140	S. 3° E.	19	Good	
42-43-54	77-41-18	280	S. 30° E.	44	Good	

Wellsville Quadrangle

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42– 0–48	77–45–30	60	S. 60° W.	154	Good	
42– 1–27	77–45– 6	72	S. 40° W.	44	Poor	
42– 1–27	77–45– 6	55	S. 40° W.	114	Good	
42– 1–54	77–45– 6	90	S. 63° E.	12	Good	
42– 1–24	77–49–42	38	S. 18° W.	115	Poor	N. 25° W.
42– 1–24	77–49–42	28	S. 3° E.	75	Poor	
42– 1– 0	77–57–18	15	N. 36° E.	35	Poor	
42– 1–30	77–56– 9	90	N. 25° W.	232	Good	
42– 2– 0	77–45–15	130	N. 80° W.	60	Good	
42– 2– 0	77–45–15	80	N. 42° W.	26	Good	
42– 2– 0	77–45–20	185	S. 87° W.	50	Good	
42– 2– 0	77–45–22	65	N. 55° W.	40	Good	
42– 2–56	77–42–12	92	S. 15° W.	100	Good	
42– 2–42	77–46–45	40	S. 3° E.	115	Poor	
42– 3– 6	77–45–30	80	S.	165	Good	
42– 4– 9	77–56–30	87	S. 50° W.	60	Good	
42– 4– 0	77–50–12	65	N. 30° W.	113	Good	
42– 8–30	77–55–12	40	S. 10° E.	103	Fair	
42– 8–30	77–55–12	55	S. 10° E.	117	Poor	
42– 8–12	77–55– 9	60	S.	62	Good	
42– 8–12	77–45–15	32	N. 18° W.	160	Poor	
42– 8–48	77–45–37	83	N. 46° W.	56	Good	N. 67°–70° W.
42– 8–51	77–45–12	40	S. 65° W.	20	Poor	
42– 9– 0	77–45–54	100	N. 85° W.	35	Good	
42– 9–48	77–48– 6	95	S. 33° E.	44	Good	
42– 9–48	77–48– 6	50	S. 38° E.	52	Good	
42– 9–18	77–47–12	90	N. 66° W.	9	Good	
42– 9–18	77–47–12	220	N. 66° W.	42	Poor	
42– 9–18	77–47–12	90	N. 66° W.	29	Good	
42– 9–24	77–52–54	35	S.	30	Poor	
42– 9–24	77–52–54	35	S.	90	Poor	
42–10–54	77–58–18	40	N. 10° E.	0	Poor	
42–10–48	77–58– 6	50	S. 85° W.	25	Poor	
42–10– 0	77–58– 0	89	N. 20° W.	58	Good	
42–10– 0	77–57–42	85	S. 80° E.	18	Good	
42–10–21	77–56–18	90	S. 90° W.	17	Good	
42–10–24	77–51– 6	40	S. 20° W.	132	Poor	
42–10–24	77–51– 6	27	S. 16° W.	80	Poor	
42–10–24	77–51– 6	110	S. 25° W.	96	Fair	
42–10– 0	77–51–24	70	S. 13° W.	90	Good	
42–12–56	77–47–33	120	S. 12° W.	87	Good	
42–14–26	77–59–30	70	S. 72° E.	60	Fair	
42–14–26	77–59–30	38	S. 87° E.	70	Poor	
42–14–26	77–59–30	80	S. 10° W.	165	Good	
42–14–24	77–59– 0	90	S. 67° W.	8	Good	
42–14–42	77–57–42	45	N. 78° E.	25	Fair	

Canaseraga Quadrangle

Latitude ° ′ ″	Longitude ° ′ ″	Length of shot, feet	Dip direction	Dip amt. Ft/mi.	Quality	Strike of joints
42–15–45	77–45–42	90	N. 20° W.	15	Good	
42–15–45	77–45–42	53	N. 50° W.	48	Good	
42–16–30	77–45–12	120	N. 25° E.	64	Good	
42–18–36	77–45–15	60	N. 80° W.	66	Good	
42–18–39	77–45–24	180	S. 25° E.	4	Good	
42–18–48	77–45–18	500	S. 35° W.	230	Good	
42–18–30	77–45–12	120	S. 14° E.	11	Good	
42–18–30	77–45–12	120	S. 57° E.	70	Good	
42–19–12	77–49–48	40	N. 85° W.	0	Fair	
42–20–51	77–55– 0	35	N. 90° W.	37	Poor	
42–21– 6	77–54–36	30	N. 60° E.	8	Poor	
42–22– 0	77–45–42	70	S. 68° W.	67	Good	
42–26– 0	77–48–42	105	N. 60° W.	5	Good	
42–26– 0	77–47– 6	185	N. 35° W.	50	Good	
42–26– 0	77–47– 6	90	N. 40° W.	90	Good	
42–26–51	77–47– 0	200	N. 3° E.	0	Good	
42–26–51	77–47– 0	80	S. 10° W.	20	Good	
42–27–42	77–50– 6	300	S. 40° E.	30	Poor	
42–27–42	77–50– 6	115	N. 50° W.	7	Good	
42–27–48	77–50–10	145	S. 30° E.	21	Good	
42–27–24	77–50– 6	110	S. 60° W.	42	Poor	
42–27–24	77–50– 6	27	N. 60° W.	0	Good	
42–27–54	77–49–54	70	N. 53° W.	0	Good	
42–28–36	77–50–42	200	N. 50° W.	26	Good	
42–28–36	77–50–42	375	S. 50° E.	5	Good	
42–28–12	77–52– 0	110	N. 17° W.	5	Good	
42–28–30	77–51–30	70	S. 25° W.	37	Fair	
42–28–24	77–51–24	120	W.	24	Good	

Nunda Quadrangle

Latitude ° ′ ″	Longitude ° ′ ″	Length of shot, feet	Dip direction	Dip amt. Ft/mi.	Quality	Strike of joints
42–31–42	77–46– 6	82	S. 43° W.	45	Fair	
42–31– 6	77–48–30	112	S. 70° E.	18	Good	
42–31– 6	77–48–30	70	S. 25° E.	63	Good	
42–31– 6	77–48–30	83	S. 12° W.	62	Good	
42–33– 6	77–58–42	57	S. 35° E.	45	Poor	
42–33– 6	77–58–42	57	S. 35° E.	27	Poor	
42–33–24	77–56–18	120	S. 10° E.	13	Good	
42–33–24	77–56–18	90	S. 15° E.	10	Good	
42–34– 0	77–56–42	130	S. 30° E.	8	Good	
42–36–48	77–46– 3	112	S. 42° W.	0	Good	
42–36–48	77–46– 3	62	N. 60° E.	33	Poor	
42–37–12	77–59–18	1800	S. 57° W.	36	Good	
42–37–30	77–51– 0	41	N. 53° W.	18	Fair	

Nunda Quadrangle—*Continued*

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42-37-33	77-51-26	175	S. 37° E.	30	Good	
42-37-33	77-51-26	135	S. 25° E.	43	Good	
42-37- 6	77-47-24	80	S. 85° W.	3	Good	
42-37- 6	77-47-24	75	S. 43° W.	70	Good	
42-37- 6	77-47-24	50	S. 10° E.	65	Fair	
42-37-42	77-46-28	70	S. 43° E.	7	Good	N. 43° W.
42-37-42	77-46-28	65	S. 60° W.	20	Poor	
42-37-42	77-46-28	65	S. 60° W.	32	Good	
42-38-45	77-52-54	90	S. 15° W.	50	Good	
42-38-45	77-52-54	.....	S. 58° E.	60	True dip	
42-36-27	77-49-21	40	N. 64° W.	32	Fair	
42-38-27	77-49-21	60	S. 11° E.	85	Poor	
42-38-36	77-49-39	90	S. 43° E.	46	Good	N. 43° W.
42-40- 0	77-42-18	170	S. 57° W.	36	Good	
42-40-42	77-50-12	150	N. 52° W.	0	Good	
42-40-42	77-50-12	275	S. 33° W.	140	Good	
42-40-15	77-50-18	82	S. 30° W.	100	Good	
42-40-26	77-50-12	150	N. 52° W.	0	Good	
42-40-26	77-50-12	275	S. 33° W.	140	Good	
42-42-42	77-57-42	170	S. 57° W.	36	Good	
42-42-42	77-57-42	90	N. 56° W.	56	Good	

Belmont Quadrangle

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42- 0-12	78-14- 6	70	S. 45° W.	109	Good	
42- 1- 6	78-14- 6	60	S. 58° W.	26	Good	
42- 2-48	78-12-42	90	S. 13° E.	20	Good	
42- 4-12	78- 7-12	100	N. 70° W.	10	Good	
42-10-24	78- 0- 6	50	S. 57° W.	130	Good	
42-10-24	78- 0- 6	60	S. 57° W.	61	Good	
42-12- 3	78- 7-27	73	N. 19° E.	7	Poor	
42-12- 3	78- 7-27	65	S. 8° W.	48	Fair	

Angelica Quadrangle

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42–17–36	78– 7–12	160	S. 11° W.	128	Good	
42–18–51	78– 6–30	115	S. 2° W.	135	Good	
42–18–42	78– 1–51	100	N. 38° W.	124	Poor	
42–18–42	78– 1–51	100	N. 70° W.	60	Good	
42–18–36	78– 9– 0	183	S. 74° W.	70	Good	
42–19–24	78– 6–27	250	S. 2° W.	80	Good	
42–21–51	78– 8–24	130	S. 55° W.	170	Good	
42–21–51	78– 8–24	70	S. 65° W.	52	Good	
42–21–45	78– 8–42	240	N. 75° W.	85	Good	
42–22–48	78–11– 0	280	S. 80° W.	28	Good	
42–22–48	78–11– 0	310	N. 67° W.	0	Good	
42–22–48	78–11– 0	180	N. 45° W.	6	Good	
42–23–12	78–10– 0	188	S. 72° W.	100	Good	
42–23– 0	78–10–42	940	S. 15° E.	55	Good	
42–24–12	78– 7–48	180	S. 10° E.	2	Good	
42–24–12	78– 7–48	140	S. 45° W.	38	Good	
42–24– 0	78– 8– 6	90	S. 88° E.	11	Good	
42–25–45	78– 2–54	65	S. 20° W.	57	True dip	
42–26–12	78– 4– 3	60	S. 55° W.	40	Good	
42–26– 0	78– 3–30	260	S. 75° E.	8	Good	
42–27–42	78– 6–42	324	S. 12° W.	60	Good	
42–28–54	78– 9– 6	125	S. 20° E.	22	Good	
42–28–54	78– 9– 6	92	N. 42° W.	3	Good	
42–28–54	78– 9– 6	95	S. 46° W.	80	Good	
42–28– 0	78–11– 0	100	S. 45° W.	45	Good	
42–28– 0	78–11–54	175	S. 85° W.	6	Good	
42–28– 0	78–11–18	110	N. 60° W.	70	Good	
42–28– 0	78–11–18	230	S. 60° W.	45	Good	

Portage Quadrangle

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42–30–18	78– 5–21	255	N. 75° W.	8	Good	N. 42° W., N. 60° E.
42–30–18	78– 5–21	140	S. 15° W.	32	Good	
42–30– 0	78– 7–14	.....	S. 43° W.	145	True dip	N. 55° E.
42–30– 6	78– 7– 0	210	S.	43	Good	
42–34–42	78– 2–54	295	S. 47° W.	10	Good	
42–34–54	78– 2–36	240	S. 32° W.	37	Good	
42–34–54	78– 2–36	130	S. 10° W.	60	Good	
42–35–12	78– 1– 6	240	N. 59° W.	95	Good	
42–41–36	78– 7–12	120	S. 73° W.	15	Good	
42–41–18	78– 7–24	160	N. 50° W.	0	Good	
42–41–21	78– 7–30	85	S. 55° W.	24	Fair	
42–41–21	78– 7–30	125	N. 70° E.	13	Good	

PORTAGE QUADRANGLE—*Continued*

LATITUDE ° ′ ″	LONGITUDE ° ′ ″	LENGTH OF SHOT, FEET	DIP DIRECTION	DIP AMT. Ft/mi.	QUALITY	STRIKE OF JOINTS
42-41-36	78- 8- 9	200	S. 67° W.	37	Fair	
42-42-48	78- 7-42	50	S. 10° E.	90	Good	
42-42-48	78- 7-42	125	S. 6° W.	44	Good	
42-42-24	78- 7-24	65	S. 20° E.	33	Good	
42-42-42	78- 8-42	152	S. 75° W.	6	Good	
42-43-36	78- 9-33	120	S. 68° E.	31	Good	
42-43-36	78- 9-33	160	S. 60° W.	0	Good	
42-43-36	78- 9-33	82	N. 60° W.	10	Good	
42-43-36	78- 9-33	75	S. 82° E.	35	Good	
42-43-48	78- 8-36	55	S. 82° W.	9	Good	
42-43-48	78- 8-36	85	S. 65° W.	34	Good	
42-44-21	78- 8-30	65	S. 81° W.	0	Good	
42-44-21	78- 8-30	100	S. 85° W.	7	Good	
42-44-21	78- 8-30	140	S. 85° W.	0	Good	
42-44-27	78- 7-34	115	S. 6° E.	19	Poor	
42-44-42	78- 7-36	65	S. 7° E.	60	Fair.	

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MAP 1 STRUCTURAL CONTOUR MAP OF SOUTH-CENTRAL NEW YORK
(By Arthur A. Wedel. N. Y. State Museum Bulletin 294)

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