PROGRESS REPORT 7

A DIP NEEDLE SURVEY OF THE WYANDOTTE-WINONA AREA, HOUGHTON COUNTY, AND THE CHEROKEE AREA, ONTONAGON COUNTY

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INTRODUCTION

In 1928 the Michigan Geological Survey initiated a magnetic ("dip-needle") survey of the Keweenaw series of the Michigan "Copper Country," and the field investigations since made have demonstrated that by this simple method of geophysical prospecting geologic structure can be determined in areas having scanty or poor rock exposure but which contain magnetic formations.

The writer was associated with the survey in the summers of 1937, 1938, and in 1939 was assigned the Wyandotte-Winona area of Houghton County, and in 1940 the contiguous Cherokee area of northeastern Ontonagon County. The areas are named for the principal mines in each.

Field procedure was the same in both areas. A checkerboard of control lines was marked out at one mile intervals, following the section lines as closely as possible. Dial compass was used for direction and lines were taped with a 200-foot steel tape. Along roads, abandoned logging railroads, and the Misery River trail, stadia traverses .were made. All other locations wore established by dial compass and pacing.

In the survey of the Wyandotte-Winona area, the writer was assisted by Messrs. P. Jones, D. Campbell, and E. Dobrovolny, and in the survey of the Cherokee area by Dr. J. Zinn, Messrs. D. Andrew and P. Jones.

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The writer is also grateful to Dr. A. C. Lane for much helpful criticism and advice, to Mr. F. L. Van Orden for information on the Wyandotte property, to Mr. R. Sector for maps of the Winona property, to Mr. F. L. Batcheller, Chief Engineer of the Copper Range Railroad, for right-of-way maps, and to Mr. John M. Wagner, of the Copper District Power Company, for the company's maps. Airplane photographs of the district helped materially in plotting lakes and checking geographical markers.

In the Wyandotte-Winona area dip-needle readings were taken every 20 paces (52.8 feet) along section lines and center lines of sections, and at quarter-mile intervals wherever more detailed information was required. Readings were taken along all stadia-surveyed routes. In the Cherokee area also, dip-needle readings were taken every 20 paces along control lines at one mile intervals, along the north-south lines through the center of the section, and along east-west lines at quarter-mile intervals. In some places detail work was done to determine local strikes and in other places certain zones wore followed by a zig-zag traverse.

All dip-needle readings wore calibrated to a standard to conform to work of previous years. Detail naps of each square mile were made on section paper, using 1 inch = 100 paces (2000 paces = 1 mile). These maps show dip-needle readings and all physiographic features. Photostatic copies of the field maps were reduced to a smaller scale from which composite maps of the region wore made and the geology interpreted from them.

THE WYANDOTTE-WINONA AREA

The area surveyed in the summer of 1939 is the Wyandotte-Winona area in sections 9 to 17, 19 to 22, and 28 to 31, Town 52 North, Range 36 West, Houghton County. The Winona mine is in sections 20, 29, and 30, and the Wyandotte in section 21. Other mines in the area are the King Phillip, which adjoins the Winona property on the southwest, the New Wyandotte in the western part of section 28, and a few shafts along Misery River in section 16.

No mines were operated in 1940. The mine machinery has been junked and removed, and all the mine buildings have been sold or torn down. Only the foundations and rock piles remain of what was once an active community.

A map showing the horizons of high dip-needle readings was completed in December 1939. A year later outcrops in the neighborhood of the Elm River mine, which were located in 1938, were plotted on this map, and information furnished by diamond drills and mine workings was added. With this information, the positions of the key conglomerates wore traced through and some of the fault zones were worked out.

Topography and Vegetation

In general, the area is a dissected sand-covered pene-plain having gently sloping but heavily eroded morainic knolls and ridges, among which are lakes and marshy basins. The glacial drift material of the knolls is mainly gravel and sand; the only clay observed is in section 27. No rock ridges were observed although many of the knolls have rock cores.

The dendritic streams have removed all but a remnant of the pene-plain. A natural amphitheater is at the head of each creek. Small springs are numerous, issuing from clay seams in the sand. The streams flow over falls and cascades where they have cut to bed rock. The rock ledges at Wyandotte location caused the 15-foot falls of Misery River, retarded the headward erosion of its valley, and have prevented the drainage of Lake Rowland and Lake Gerald. The net result of erosion is a highly dissected upland, with steep sand banks and treacherous quicksand bottoms- which is not the impression one gets when driving along highway M-26. The writer believes that the plains around Misery and Sleeping rivers are bays of the former glacial Lake Duluth.

Most of the area is covered with brush and a thick second growth of maple, balsam, and poplar. The trees have attained a diameter of two to six inches. Such cover interspersed with slashings and windfalls made the survey difficult. Only in section 16 and the northern half of section 17 are stands of virgin timber. These were lumbered in 1940.

Sources of Information

Outcrops The outcrops in the area are few and scattered. All show glacial striations. The rocks exposed are ophite, diabase, and associated amygdaloid and "felsite" conglomerates. The ophites occur in Misery River just below the conglomerate at the Wyandotte location, and also along the river in the central part of section 16. The diabases wore the most conspicuous rocks. They stand out as ridges and form the cores of the highest knolls of the area. The ophite and diabase are similar in appearance, but are easily differentiated. Diabases do not show cleavage flashes of the augite crystals, and the dip-needle readings on the diabase ledge were normal. The conglomerates stand out in knolls and arc also the beds of many streams. The picturesque V-shaped canyon in section 17 is cut in conglomerate. All the conglomerates are similar in appearance, pebble content, and cementation. The conglomerate at Wyandotte location is about 200 foot thick measured along the exposure, but the true thickness is probably about 160 foot, the greatest thickness of conglomerate noted by the writer.

Mines The Winona mine was the largest in the area covered by this report. It consisted of four shafts, which in thirteen years produced over 16,000,000 pounds of refined copper. The mine workings extend for a distance of about 9000 feet along the strike. The deepest workings are at 1500 foot. A shaft about 1500 feet northeast of Winona No. 1 shaft is evidently on the continuation of the Winona lode.

The King Phillip mine is southwest of the Winona mine. Its mine workings are connected with the Winona, and for many years the two properties were operated by the same company. In 1924 the writer was Mining Engineer at King Phillip No. 2 shaft. Tap 12th level at the bottom of the King Phillip shaft extended 400 foot to the southwest. If memory and notes are correct, the copper content of this level was about twelve pounds to the ton. A gouge zone of clayey material is in a crosscut into the hanging wall. Mr. R. R. Soober, former superintendent of the property, reported that this clayey zone was also found in the Winona mine and was used as a horizon marker.

The only prospecting north of the Winona mine other than drilling was in the southeastern part of section 19, where rock crops out and the overburden is shallow. Trenching exposed two conglomerates and some amygdaloids. A shaft was sunk on one of the amygdaloids, and the character of the material on the dump offers encouragement for future prospecting.

The prospect in section 28 was called the New Wyandotte. Believing that commercial copper was near the Keweenaw fault, a crosscut was driven to the south into a sandstone formation but commercial copper was not found. However, this crosscut is very interesting and the geological conditions shown in it haves contributed much to the general knowledge of the region.

At the Wyandotte No. 11 shaft in section 21, a long crosscut exposed many flows and amygdaloids. Some stoping was done but very little copper rock was shipped.

Three shafts were sunk in section 16 but commercial copper was not found, although in one of the three shafts (the so-called New 16 shaft marked No. 3 on the map) the ground looks encouraging. The material on the dump has large amounts of calcite, quartz, prehnite, epidote, and some copper. This shaft is only 65 feet deep - no drifting or crosscutting had been done.

Geologic Interpretations

The writer's interpretation of the geology of the Wyandotte-Winona area is based chiefly on dip-needle readings, outcrops, and personal knowledge of the region. Valuable information was derived from mine maps, drill records, and oral communications from miners and engineers in the district. A complete record of drilling in the area is in Lane's report on "The Keweenaw Series of Michigan," Michigan Geological Survey Publication 6, 1911, and in "The Copper Deposits of Michigan," Professional Paper 144, United States Geological Survey.

On the map accompanying this report, the high dip-needle readings are joined as they represent the ophitic flows or magnetic zones within the flows. Where the overburden is comparatively shallow, these belts (whether of one or more flows) were easily discerned, but where the overburden is thick, the individual zones of magnetic intensity seem to blend and the readings are uniform. Enough high readings have been obtained, however, to give the position of various key horizons.

The diabasic flows are not used as horizon markers. In places, however, they become ophitic and have high intensity, and the interpretations become difficult as the diabase may be joined with an ophitic flow either above or below its proper horizon. Detailed work along certain bolts in a zig-zag fashion eliminates errors duo to such changes in the flows.

When plotted on a map the high magnetic belts are shown to have a somewhat parallel arrangement and the strike of the beds is shown as changing gradually through a curved course. This curving or bending of the strike may be due to faults. Inasmuch as outcrops showing displacement wore not found, and detailed work was not done, it is deemed expedient to map a bend in the formation rather than to show repeated fault displacements. The mine workings and the drill records of the Now Wyandotte do not match. The bond in the crosscut was in brecciated material and the crosscut had to be timbered. The mine management believes the crosscut is in a fault zone. The position of the fault zone indicated on the map is only tentative as detailed work is needed to fix its exact location and to determine the relative displacement.

Due north of Lake Rowland, in sections 14, 15, 16, 10, and 11, a complicated fault zone is indicated. The crock in the area is intermittent and has sand banks 100 feet high. The overburden is probably over 200 foot thick, as indicated by the fact that dip-needle readings wore uniform and it was not possible to pick out any magnetic belts.

In the Elm River area (the southern part of the area surveyed in 1938) the outcrops terminate in a flat sand plain in which C. A. Lamey recognized a largo number of faults. The drilling in the area is extensive and information is obtained from a number of crosscuts and mine workings. Correlation is uncertain because some of the strata appear to be repeated, perhaps due to diagonal faulting and tear faults. To work out the exact locations of the faults and the formations, very careful detailed work needs to be done, the true location of the drill holes must be found, and a more sensitive geophysical instrument, such as a Hotchkiss superdip, will have to be used. The fault zone as indicated shows a large displacement.

The outcrop along the creek in section 17 is identified as the Great Conglomerate. No outcrops in this area were found by which to confirm the existence of flows above the conglomerate. Elsewhere in the Keweenaw Peninsula the Lake Shore traps occupy this horizon. The Outer Conglomerate crops out in the northwest corner of section 17.

The position of the Keweenaw fault in this area was not indicated by dip-needle readings. Its location was determined by drilling, mine exploration, and the relative position of the No. 6 Conglomerate. The location as shown on the nap is fairly accurate for most of its length.

The high dip-needle readings helped to establish zones, and when the mine and drill records were superimposed on the dip-needle readings it became possible to correlate the geology of the Wyandotte-Winona area with the area farther north.

Conclusions

The dip-needle map of the Wyandotte-Winona area, showing the key horizon markers as well as physical and nine development work, should be of value in future prospecting in the area.

The map shows that most of the exploration has been confined to the horizon of the Winona lode, which has the same stratigraphical position as the Isle Royale lode. Shaft No. 3 in section 16 is believed to be in the horizon of the Osceola lode. The shallow shaft in section 19 is near the horizon of the Calumet and Hecla conglomerate.

The rest of the region has not been prospected.

THE CHEROKEE AREA

The Cherokee area in sections 24 to 26 and 34 to 36, Town 52 North, Range 37 West, and sections 2, 3, 4, 8, 9, 10, 11, 15, 16, and 17, Town 51 North, Range 37 West, Ontonagon County, was surveyed in the summer of 1940. The Cherokee mine for which the area is named is in section 2, Town 51 North, Range 37 West.

Topography and Vegetation

The rugged topography of the Cherokee area is in marked contrast to the flat glacial lake bed topography of the Wyandotte-Winona area adjacent on the east. Only a small part of the southwestern section of the area was once covered by glacial Lake Duluth. The greater part of the area was above the level of the glacial lakes and is a typical well-drained glaciated surface of rocky knolls and ledges, in part surrounded and thinly covered by morainic sands and gravel. Some of the rock ridges in the southern part of the area rise 200 feet above the valleys. Glacial grooves and striae on many of the outcrops hear South 36° East, indicating ice movement from the Keewatin center. Few outcrops show the contacts between the conglomerates and lava flows but certain outcrops are of the same conglomerate and are very helpful in plotting related flows and in determining fault displacements.

The part of the area once covered by Lake Duluth is a white sandy bench. Gravel beaches mark the shoreline of glacial lakes Duluth and Algonquin. The gravel pits in section 9 have been opened in a fragment of one of those ancient beaches. Another bench at a level lower than Lake Duluth consists almost entirely of horizontally stratified clay. In section 17 the East Branch of the Fire Steel River has cut a channel 50 feet below the glacial lake plain of Lake Algonquin. Drainage in the areas of thick drift is haphazard.

A dense second growth of maple, poplar, and basswood, and slashings from recent lumbering operations make progress in surveying difficult end slow. None of the area is under cultivation and only one family can he considered as permanent residents.

Sources of Information

Outcrops Outcrops are numerous. Most of then were located, but due to the thick brush cover some probably were not discovered. The outcrops are red conglomerate beds and black lava, flows. No attempt was made to differentiate between the diabasic and ophitic flows - all are called traps.

In section 17 a “felsite” outcrop was noted above a thick conglomerate bed, but the contact of the “felsite” with the conglomerate could not be found. (The term “felsite” is used in accordance with the custom of the Michigan Geological Survey.) This outcrop is at the level of Lake Duluth but almost impenetrable forest cover and slashings make it extremely difficult to gather much information concerning its relationship. The total area of the “felsite” is about two acres.

In a hand specimen the felsite is red with a dense groundmass in which arc embedded a large number of plagioclase phenocrysts about one-quarter inch in length, octohedrons of magnetite, and a few well-rounded quartz phenocrysts. The microscope revealed idiomorphic phenocrysts of oligoclase with a large amount of epidote in a trachytic groundmass of lath-shaped orthoclase and acid feldspar with magnetite and apatite. The secondary minerals are hematite, epidote, calcite, and chlorite.

In the area to the south similar rocks, known to be intrusive, crop out. When the survey extends to the southern area, the writer believes that the felsite may prove significant in unfolding the regional history of the Michigan Copper Country.

<u>Previous Explorations</u> A number of small pits, shafts, crosscuts, and drifts have been sunk and cut in the area. All are south of highway M-26 and north of the Copper Range Railroad. Very little is known about any of them as all workings, with the exception of the Cherokee mine, were abandoned about thirty years ago.

The Henwood mine in the northwestern part of section 15 consists of three shafts and one drift. It is on a rock outcrop that was probably a high point along the shore or on a bar of glacial Lake Duluth. The workings follow a small fissure about two inches in width, dipping 60° to the west. The vein material is mainly quartz and prehnite, with some native copper. Some of the vugs contain adularia crystals. The wall rock of this fissure is ophite in which the augite phenocrysts are ten millimeters in size. The exceptionally high intensity of dip-needle readings shows the presence of a largo amount of magnetite (probably secondary). As the dump material is of uniform character, it is doubtful if any crosscutting to the footwall or hanging wall was done.

In the woods north of the nine at the edge of a field is a shallow shaft with a 40° dip to the west. This shaft is in a well brecciated amygdaloidal zone.

Four shafts which probably follow a small fissure were sunk near the southeast corner of section 16 in the east side of a largo outcrop.

The Penn explorations in section 2 are in an amygdaloidal zone.

The Dunn shaft in section 2 is on a contact of a conglomerate and a flow.

Many other snail shafts, pits, and trenches, particularly in section 36, explore the Winona belt.

The Cherokee mine is the largest developments and concerning it Ben F. Sparks, Secretary-Treasurer of the Cherokee Copper Company, says, “The property was diamond drilled in the years 1911 and 1912, locating four copper-bearing lodes. Trenching was then done to open up the outcrop of the lode - the overburden being shallow (from 5 to 8 feet). A shaft was started on what was called the Winona lode. Copper was found in this area from the grass roots down to a depth of the prospect shaft 450 foot, and when the work was stopped on December 31, 1917, due to high cost of material and shortage of labor during the war, the shaft was then bottomed in copper.”

Some of the important diamond drill holes have been plotted, on the map of this report but all the drilling done is recorded on Map 12 of Professional Paper #144.

Geologic Interpretations

In the Cherokee area, as in the Wyandotte-Winona, the writer’s interpretations of the geology are based upon dip-needle readings, information from outcrops, and a personal knowledge of the geology of adjacent areas in the Copper Country. The map, Plate XIII by Meuche, in Lane’s report “The Keweenawan Series of Michigan,” Publication 6, Michigan Geological Survey, 1911, and the map on Plate XII of “The Copper Deposits of Michigan,” Professional Paper 144, United States Geological Survey, were also informative.

In the Michigan Copper Country certain well-defined conglomerates are used as horizon markers. These have been numbered and many have been named, usually for the nearest locality or mine, but unfortunately some conglomerates have been given more than one name. The amygdaloidal copper mines are placed in the section by referring their copper-bearing lode to the nearest conglomerate. The small diagram accompanying this report shows a typical cross-section of the Michigan Copper Country, showing the stratigraphic position of the conglomerates in question and of some the better known amygdaloidal producing belts.

Although the high dip-needle readings are not shown on the map accompanying this report, they were joined by lines that represent the ophitic flows or magnetic portions of flows. Where the overburden is comparatively shallow, these belts (whether of one or more flows) are conspicuous by their high intensities, but where the overburden is thick, the magnetic intensity seems to blend and the readings are more uniform.

By relating a number of belts of high intensity to the outcrops, the continuity of the various key conglomerate beds was deciphered. Records of drill holes supplement and substantiate the information obtained by dip-needle observations. The discussion following is of the relationships of known outcrops, lodes, and conglomerates to dip-needle readings.

The position of the Keweenaw fault was not located by dip-needle readings. Its location was plotted from drill records and from its relative position to key horizons above it. Its exact location is not certain but it is probably not far from the position shown on the map.

The Baltic Lode is above the No. 3 Conglomerate but in the Cherokee area its position is unknown.

Between the No. 4 and No. 5 Conglomerates at least two ophitic flows are fair horizon markers. They crop out in several places but the dip-needle readings on them are not very consistent. Below the No. 4 Conglomerate a dense flow having such peculiar surface characteristics that it is readily distinguished from other flows, and on which dip-needle readings are normal, crops out. Where these relationships wore noticed Conglomerates No. 4 and No. 5 were plotted.

The No. 6 Conglomerate is the first definite horizon marker. Numerous outcrops are along its strike and its position was readily determined by the dip-needle readings.

The No. 8 Conglomerate was located by outcrops and by its relation to No. 6 Conglomerate. The Isle Royale Lode, where known to occur, is stratigraphically above No. 6 Conglomerate. In the Cherokee area it is known as the Winona Lode in which the Winona and King Phillip shafts are sunk. The Cherokee and the Penn explorations are also in the same belt.

The No. 9 Conglomerate, better known as the Wolverine sandstone, lies stratigraphically just above a zone of high readings.

The No. 12 Conglomerate, known also as the Kearsarge (the so-called Shawmut Conglomerate of the Cherokee area), is determined by its relation to a zone of persistant high readings which correspond in stratigraphic position to the Osceola Lode.

The No. 15 Conglomerate, also known as the Allouez Conglomerate, lies directly above a wide bolt of high magnetic intensities.

The No. 16 Conglomerate is in a zone of low intensity between two wide zones of high dip-needle readings.

The No. 18 Conglomerate is the upper margin of a wide magnetic zone of high readings. Conglomerates Nos. 15, 16, and 18, were identified in drill holes and outcrops.

The position of the Groat Conglomerate is located by outcrops, and marks the beginning of low readings characteristic of the thicker sediments.

As the survey was carried up in the geologic section (at places where the overburden is shallow) the increased intensity of magnetic readings is believed to indicate the probable location of the Lake Shore traps. Outcrops were found which verify this assumption. Most of these outcrops are amygdaloidal lava flows, but “felsite,” probably intrusive, is also in the belt.

The Outer Conglomerate was located by outcrops and in section 4, Town 51 North, Range 37 West, and section 33, Town 52 North, Range 37 West, the exposures arc very striking. That the Freda sandstone is present cannot be definitely stated, but several wide sandstone beds toward the end of the V-shaped gulch in section 4 probably mark the bottom of the Freda sandstone.

The conglomerate horizons were not plotted in sections, 15, 16, and 17, due to the lack of sufficient data. The dip-needle readings indicate deep overburden, and possibly in addition, considerable structural divergence from the normal trends. A survey of the area to the south will be necessary to work out the structure.

Only those faults that show horizontal displacement normal to the strike of the beds are drawn on the map. Bedding faults (strike and dip parallel or nearly so to the surface of the flow) are not shown. Some of the outcrops indicate such faults, but brecciation in the outcrops concealed their exact position and they could not be found by the dip-needle.

The dip of the conglomerate in the creek in section 11 is West about 20°. To the west and higher up in the series, the following dips were observed. Conglomerate No, 6 has a dip of 65°; the amygdaloidal zones which outcrop in the neighborhood of highway M-26 dip 50°; the Outer Conglomerate in Section 4, 25°. Whether this inconsistant dip is due in part to original irregularities in deposition or to faulting can not be definitely stated.

Conclusions

The “dip-needle” survey has established that belts of rock, both flows and conglomerates which elsewhere have produced the greatest amounts of copper, cross the Cherokee area and their positions are located. Those important zones have not been explored by the drill or by shaft, but it is believed they represent favorable ground for future prospecting. To emphasize this point, a diagramatic cross-section of the Keweenawan series has been prepared. It shows the zones of rock in which the great copper lodes are localized from place to place, and the relative value of copper produced from each.

The large map accompanying this report shows the key horizon markers of the Keweenawan series from the Keweenaw fault to the Outer Conglomerate, and also sites of exploration and certain physiographic features.