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Geology of the Menominee Range Vicinity of Iron Mountain

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A PRELIMINARY GEOLOGIC SURVEY OF PART OF THE MENOMINEE IRON RANGE IN THE VICINITY OF IRON MOUNTAIN, MICHIGAN

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INTRODUCTION

The Michigan Geological Survey has been investigating the Menominee iron range in Dickinson County for several years, and in 1933 published Progress Report No. 5, which contains the major results of the work from 1937 to 1939 inclusive. During that time reconnaissance observations were made in numerous localities, but detailed geologic and magnetic data were compiled for an area which extended from Norway to Quinnesec only. Progress Report No. 5 is accompanied by a geologic map showing the interpretation of these field data. It also contains discussions of the distribution and structure of the rock formations and of the major geologic problems of the area.

The area investigated in 1940 is a belt five miles long and approximately one and one-half miles wide which extends northwestward from near Quinnesec, the western boundary of the previous season's work, to the Michigan-Wisconsin boundary along the Menominee River. Iron Mountain, the only town within this area, is located approximately in the center of it.

The general field procedure in 1940, similar to that of the previous season, included: (1) stratigraphic studies; (2) mapping of outcrops and structural features; (3) taking dip needle readings at intervals of 40 feet along a grid of north-south and east-west traverse lines one-eighth mile apart; and (4) compiling data from such mine maps and drill records as were available. Control was established by taping distances between section corners and setting markers every eighth mile.

The personnel of the field party in 1940 included, in addition to the writers, Mr. Irving Beckwith and Mr. Burton Westman as compass-men. Their services are gratefully acknowledged,

The geologic map accompanying the present report is only a preliminary map. It is realized that it may not he correct in all details, but the writers believe it represents those relations which seem to agree best with available geologic and magnetic data. All the faults shown on the map were definitely indicated by sheared and brecciated zones in outcrops, by magnetic data, by mine maps, or by drill records. Although the entire area within the sections mapped was studied in detail, the geology of only a relatively narrow strip is shown on the map. Due to the indefinite and incomplete character of the geologic information available for the other parts of the area, it is deemed advisable, at least for the present, to issue a map of only the narrow strip.

DISTRIBUTION AND STRUCTURE OF FORMATIONS

The area covered by the present report has many geologic features which are similar to those in the area from Norway to Quinnesec, described in the 1939 report.[3] Thus the general strike of the formations is north of west, the general dip is southward at high angles, and the oldest formation of the immediate area, the Randville dolomite, occupies the northernmost position and is succeeded southward by progressively younger formations. Locally, there are decided departures from these general conditions; i.e. dip may be northward, due to overturning; strike may vary considerably because of folding and faulting; and formations may he repeated or may he missing as a result of faulting. Likewise, although it is recognized that folding is an important factor in the regional distribution of formations, faulting evidently dominates their local distribution. Furthermore, a systematic orientation of faults is apparent, and a well-defined fault pattern comprising: (1) a conspicuous sot of faults with northeast-southwest trends, and, (2) less conspicuous sets trending (a) northwest-southeast, (b) nearly north-south, and (c) approximately east-west. Moreover, igneous activity in this area, is similar to that observed in the part of the Menominee range studied in 1939 and includes both basic and acidic intrusives. Evidence of igneous activity was observed at two localities. A small

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[3]Carl E. Dutton and Carl A. Lamey: A Preliminary Geologic Survey of Part of the Menominee Iron Range, Michigan, Michigan Geological Survey, Progress Report No. 5, 1939.

exposure of a diabasic rock is in the southwestern part of section 25, T 40 N, R 31 W, near the eastern boundary of the Iron Mountain golf course. Also, several pegmatite veins cut through the Curry iron formation in the southeastern part of the Millie pit at Iron Mountain. They are composed chiefly of quartz, with subordinate carbonate (ankerite ?), mica, and tourmaline, and smaller amounts of pyrite, chalcopyrite, and pink feldspar, probably microcline. If the trend of a fault which is east of the Millie pit were projected westward, it would pass very close to the pegmatites and be parallel to their strike. These conditions are somewhat similar to the parallelism of basic dikes and faults in the vicinity of Norway and suggest that the mineralizing solutions and molten rock moved along passageways produced by faulting.

The chief difference between the map in this report and the maps accompanying Monograph 46, United States Geological Survey, is that the newer map shows numerous faults. A less prominent difference is in the distribution and identity of certain formations. These differences are discussed briefly in the following paragraphs, faulting is considered first.

One of the chief differences is in the southeastern part of the area, between the Vivian mine in section 34 and the Keel Ridge mine in section 32. In this locality the monograph map[4] indicates a local bend in the trend of both the iron formation and a magnetic crest, whereas the accompanying map shows a gap in the belt of iron formation resulting from faulting. The Randville dolomite on the north has been thrust upward and southward to such an extent that the westward continuation of the Curry iron formation passes underneath it. These relationships were indicated by a distinct magnetic high whose westward trend led into an area in which dolomite is known to be present from outcrops and test shafts. The relationships were confirmed by diamond drill records which show that vertical holes starting in dolomite passed through a zone of brecciation and then penetrated iron formation. Along one section of this fault, dolomite on the north apparently is adjacent to slates on the south. This is the major fault of the area, and apparently the entire block between this fault and the fault southeast of the Pewabic caved ground in section 32 represents

[4]W. S. Bayley: The Menominee Iron-bearing District of Michigan, U. s. Geol. Survey (1904), in pocket.

an upthrust segment. The relations shown are much like those in the vicinty of the Bryngelson shaft east of Quinnesec[5] and serve to emphasize again the similarity of the areas which have been investigated.

Other faults to the northwest of this great over thrust do not have the same magnitude and appear to be of a somewhat different type. Progressing westward, the chief faults are the two southeast and northwest of the Pewabic caved ground, and the faults in sections 25, 26, and 23. Some of these faults are oriented northeast-southwest but others trend northwest-southeast. However, in both systems the segment to the right of each fracture apparently has moved toward the observer and has produced an overlap in the formations. This uniformity suggests that the displacements were all produced by the same deforming force.

The long fault which passes through the Chapin caved ground and into the Bradley pit has produced some overlap also hut it is not apparent on the geologic map. This relationship is shown best near the west side of section 30 where the Traders iron formation is about 200 feet wide at the surface but, in the mine cross-sections below that region, it is represented as being approximately 325 feet wide. The greater thickness of the formation in the mine workings occurs wherever the overlapped segments are still adjacent to each other on opposite sides of a fault plane.

The most complex faulting represented on the map is that shown in the vicinity of the Ludington shaft, section 25. The dip needle data at this locality included a number of high readings so

[5]Section 2, T 39 N, R 30 W. Consult map accompanying Progress Report No. 5 (1939).

erratically distributed that no structural trends were evident. The arrangement was therefore interpreted as being the result of numerous faults which had cut the formations and had displaced the segments. This concept of complex faulting is substantiated by subsurface information which indicates the presence of a narrow block with faults through and on both sides of it.

A comparison of the fault patterns shown on the 1939 and the 1940 maps indicates that the major displacement in each area occurred where the Randville dolomite is faulted over the iron formation, and that displacements of less magnitude occurred to the northwest of these major breaks. The two major faults, near the Bryngelson shaft of the 1939 area and in the southeastern part of the 1940 area, apparently are related to a regional thrust from a northerly direction. The much larger number of smaller faults may be associated with the same general deformation, but at present their exact place in the history of the area is uncertain.

It is of interest that the abundance and importance of faulting shown by the 1939 and 1940 maps of the Menominee iron district is well in accord with faulting in the mines now operating in this district, and also with the faulting in the Marquette and Crystal Falls iron districts disclosed in recent years by detailed work of various persons. It is now evident that the general concept of structural conditions in these districts should be of complex folding and faulting rather than chiefly of complex folding.

In addition to the delineation of many faults, other differences, between the new map and the maps of Monograph 46 are the distribution and identity of certain formations, chiefly the iron formations, the Randville dolomite, and the Hanbury formation.

In the vicinity of the Keel Ridge mine one of the monograph maps[6] shows only the Curry iron formation. However, the quartzite which marks the base of the Traders iron formation has been found in test pits not far to the north. This information, therefore, either shows the need for a restudy of the identity of the iron formation or it indicates that faulting has brought the basal quartzite adjacent to Curry (?) horizons exposed in mine pits. Reidentification of the iron formation is considered advisable. Farther west, in the vicinity of the Pewabic caved ground and the Walpole mines, the distribution of iron formation differs considerably from the distribution shown by one of the monograph maps.[7] Moreover, in the monograph the statement is made that probably the Curry iron formation "is more widely spread over the district than either the Traders member or the Brier slate."[8] This generalization does not seem to conform with the interpretation of the evidence in the two areas which have been mapped during the present investigation.

It will be noted that the new map shows no Randville dolomite in sections 26 and 23, near the Wisconsin boundary, whereas a broad belt of this formation is shown by the general geologic map of the Menominee district.[9] The Randville dolomite may be present, but that area contains no outcrops and drill records show Randville dolomite only to the western part of section 25.

[6]Op. cit., Pl. 29, opposite p. 424.

[7]Op. cit., Pl. 28, opposite p. 422.

[8]Op. cit., p. 331

[9]Op. cit., Pl. 9, in pocket

Farther, the new map, as well as the map of the area studied in 1939, shows no formations for some distance north and south of the central belt, although detailed field work was done throughout both areas. It is very probable that to the northward the Randville dolomite is more extensive than indicated by these maps, but the writers believe it possible that part of the northern area is occupied by-slates and quartzites which may be either an undescribed lower part of the Randville formation or an upper part of the Sturgeon quartzite. Therefore, lacking definite information of the exact northward extent of the Randville dolomite, it seems preferable to indicate its presence only where it is definitely known to exist. Also, it is altogether probable that the rocks in the areas south of the central belt are predominantly slates with some quartzites and ferruginous layers. Proof is in a few scattered outcrops west of Quinnesec and in Iron Mountain, and a few diamond drill records, which substantiate the presence of the slates and quartzites where shown on the accompanying map. However, the relationship of the slates, quartzites, and ferruginous layers which are north and south of the central belt to the other foliations of the area is not shown clearly and will be discussed more in detail under stratigraphic problems

STRATIGRAPHIC PROBLEMS

Geologic mapping in this area revealed the same problems concerning identification and succession of rock formations found in the areas previously mapped. The Tracers and Curry iron formations had to be separated and the various slates had to be distinguished from each other. The most difficult stratigraphic problem encountered thus far involves the exposures which other writers have designated as Hanbury slate.

A brief survey of the Hanbury slate problem was presented in the 1939 report, and attention was called to the fact that its solution was not an immediate objective of the survey. Neither in 1939 nor in 1940 was much time devoted to a study of this problem, attention being focused chiefly on the iron formations. However, it is a problem of considerable importance and one which, in the opinion of the writers, needs further consideration. Hence, it is more fully outlined in this report, with the hope that a statement of the writers' observations may be of some assistance in the future solution of the problem.

In the 1939 report it was stated that "examination of exposures in the vicinity of Hanbury Lake, at the type locality of the Hanbury, failed to reveal any strata which were distinctly different from those observed in other formations. Indeed, strata examined at the type locality could be matched with material from the Randville formation and from other horizons. Moreover, the rocks of the type locality have been involved in faulting of considerable magnitude which has occurred along the south side of this lake, and it is very probable that part of the exposures there actually are Randville dolomite and slaty phases of the Randville formation."[10] Also, it was stated that "within the area mapped, no rock exposures were observed with characteristics which would exclude them from being correlated with one of the horizons in the succession from Randville dolomite to Curry iron formation."[11] Due to these indefinite characteristics, and owing to the fact that no stratigraphic relations are shown at the type locality of the Hanbury formation whereby its relative age in the geologic succession may be determined, it is deemed advisable

[10]Carl E. Dutton and Carl A. Lamey, op. cit., p. 6.

[11]Ibid., p. 7.

not to use the designation "Hanbury formation." The 1939 map indicates the presence, <u>where shown on the map</u>, of rock of variable age and character, including slates of several types and also some iron formation and quartzite. This mapping seemed especially advisable, also, because the contact of these slates with other formations, which vary from Randville dolomite to Curry iron formation, is in many places apparently a fault contact. The 1939 report does not state, and was not meant to imply, that Upper Huronian slate is absent in the area.[12] It merely cites the fact that the characteristics and structural relations of the rock at the <u>type locality</u> of the Hanbury formation are not regarded by the writers as sufficiently distinctive and clear to

warrant designation of these rocks as a separate formation of Upper Huronian age.

The type Hanbury locality was revisited in 1940 and a traverse was made from Hanbury lake southward along the east line of section 16, T 39 N, R 29 W. The rocks exposed there consist of quartzite, dolomite, and slates (in part dolomitic and somewhat ferruginous), and some basic intrusives. The succession of quartzite, dolomite, and slate is repeated several times, but invariably a valley without any exposures lies between adjacent repetitions. These conditions strongly suggest several faults in addition to the fault indicated by contorted and sheared rocks in the cliffs along the south shore of Hanbury Lake, as cited in 1939. The succession of rocks south of Hanbury Lake resembles exposures in areas designated as Randville dolomite on the general map of Monograph 46. For example, part of the strata are not fundamentally different from certain exposures of the Randville formation in section 29, T 40 N, R 30 W, along the south shore of lake

[12]This statement is made to clarify some apparent misunderstanding of the intent of the 1939 report.

Antoine, and in section 34, T 40 N, R 30 W, along the county road north from Quinnesec.

The monograph map shows the region south of Quinnesec to he underlain by Hanbury slates, and therefore the exposures in section 11, T 39 N, R 30 W, were examined in an effort to determine, if possible, criteria which are characteristic of Hanbury rocks only. The predominant strata are slates, but quartzite and chert layers are common also. The only feature observed at this locality which might be of value in correlation is the character of the quartz grains, which are usually conspicuous because of their well rounded shape and good transparency. However, it is not known at the present time that such a lithologic characteristic is restricted to one portion of the geologic succession. Also, it mast be admitted that strata in these exposures have some resemblance to layers which are stratigraphically above the Randville dolomite but below the Traders iron formation and consequently classed as the “Footwall slates.”

Another phase of the Hanbury problem is represented by exposures northwest of Iron Mountain along the Chicago and Northwestern railroad. Here interbedded slate and quartzite layers are exposed in a cut along the railroad right-of-way in the northeast part of section 24, T 40 N, R 31 W, and crop out also toward the east for about 300 feet. The strata strike in an east-west direction and are upturned into a vertical position, exposures of a white to pink quartzite, without stratification, are in several knobs west of the cut, and to the east, but south of the slate, large angular blocks of this quartzite are abundant and conspicuous and extend almost as far as the slate and quartzite series which is on the north. On the general monograph map these rocks are designated a part of the Hanbury slate series. A description of the exposures is given,[13] but no statement is made concerning either the relative age of these two types of rock or the probable position of the series in the general succession of layers. These data evidently were not determined, and even yet remain unknown although all the outcrops were examined carefully for evidence which would indicate the top and bottom of the succession, but no positive criteria wore observed. The regional relation of these exposures to the Randville outcrops south of Lake Antoine is of some interest, particularly in view of the fact that quartzitic phases of the dolomite occur there which is not beyond the realm of possibility to assume may have some close relationship to the Randville formation.

A study underground of certain rocks designated Hanbury which was made possible through the courtesy of the Penn Iron Mining Company revealed other aspects of this problem. Among the rocks observed, the graphitic and pyritic slates appeared to be distinctive but others resembled various surface exposures designated Hanbury or otherwise. Also, some of the rocks designated Hanbury in surface exposures were not seen underground. Obviously, this apparent discrepancy does not necessarily mean that all these rocks are not of Upper Huronian age and part of the same formation, because the underground exposures may not belong to the same portion of the stratigraphic succession as the surface exposures. Moreover, faulting observed underground is a complicating factor.

In consequence of the foregoing observations, the present

[13]W. S. Bayley, op. cit., pp. 464-466.

investigation has not used the designation “Hanbury” for any strata. It is very probable, however, that the rocks of some exposures have a position in the general geologic succession and a distinctive lithologic character which would properly place them in the Hanbury series, but thus far no positive identification has been possible. To the writers, the term “Hanbury” seems objectionable because of the lack of definite age relations at the <u>type locality</u> of the Hanbury formation and because of the possibility that the Hanbury formation of the type locality is in reality a complex of several different formations. Also, it should be emphasized that the complete stratigraphic succession in the Menominee iron range, has not been determined because many of the contacts between formations are but imperfectly known and are complicated by faulting. Underground mining operations have revealed that fault surfaces usually separate the “Footwall” and Randville formations. It is possible that similar relationships exist also at the contact of the Curry and Hanbury (?) formations. So far as the writers have been able to ascertain, the contacts between (1) the Sturgeon and Randville formations, (2) the Randville and “footwall” formations, and (3) the Curry and Hanbury (?) formations have never been observed at the surface by any worker in this area.

EXPLORATION POSSIBILITIES

The changes in structure and stratigraphy indicated by the accompanying map should cause a reconsideration of the exploration possibilities of the area. Some of the chief points which deserve attention are here summarized.

The occurrence of ore bodies only in those parts of the area in which faults have been indicated by geologic or magnetic data resembles the conditions in the Quinnesec-Norway area and suggests one possible guide in exploratory work. Upon this basis, exploration of the iron formation northwestward from the Bradley pit in Iron Mountain seems advisable. A few investigations have been made along this strip, but its possibilities should receive further consideration.

Some general exploration in the vicinity of the Keel Ridge mines might also be warranted. No faulting is shown in that area on the accompanying map, but inasmuch as no Curry formation is shown in this vicinity, its absence may be the result of a fault. Moreover faulting may be merely incidental to the formation of ore bodies and not a necessary part of the process. It is likely that a combination of factors such as the sequence of faulting, the permeability of the formations, the temperature and volume of oxidizing solutions, or some other relationships also aided in the formation of the ore bodies.

Although no combinations of circumstances which caused the conversion of iron formation into iron ore are clearly indicated, the foregoing suggestions are made in order that they may be considered in exploration of the area.