Heavy Mineral Assemblages from Upper Cambrian Formations as Exposed at Coon Valley and Victory, Wisconsin

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Introduction

The heavy mineral assemblages here described were extracted from specimens collected by Gilbert O. Raasch and the writer while Raasch was preparing a paper on the Croixian Series in Wisconsin, which was later incorporated in the Kansas Geological Society Guidebook for 1935. The section is a composite of two sections located in the Stoddard Quadrangle just south of La Crosse, Wisconsin. Formations exposed at Coon Valley, 14 miles southeast of La Crosse on U. S. Highway 14,[1] include the entire Galesville member of the Dresbach formation and the Ironton member of the Franconia formation through an almost continuously exposed thickness of 100 feet. Formations exposed in a ravine in the Mississippi River bluff 1½ miles north of Victory, Vernon County, Wisconsin, and about 20 miles south of La Crosse[2] include the Fronconia formation with the exception of the lower portion of the Ironton member, the Trempeleau formation, and the lower part of the Oneota Dolomite, and another almost continuously exposed thickness of 340 feet.

The relative age and sequence of the rocks exposed in the Coon Valley-Victory section are as follows (4).

	Thickness feet
Victory	
Ordovician	
Beekmantownian series	
Prairie du Chien formation	
Oneota Dolomite—lower 24 feet	24.0
Cambrian	
Croxian series	
Trempeleau formation—172.8 feet	
Madison member	19.5
Jordan member	109.3
Lodi member	29.4
St. Lawrence member	14.6
Franconia formation—182.1 feet	
Bad Axe member	24.1
Hudson member	83.0
Goodenough member	28.5
Coon Valley	
Ironton member	46.5
Dresbach formation—37.2 feet	
Galesville member	37.2
Total thickness	416.1

[1]Exact location: Cliff rising above County Highway T in northwest part of Coon Vernon County, Wisconsin; SW¼, NE¼, Sec. 21, T. 12 N., R. 7 W.

[2]Exact location: Ravine in Mississippi River bluff 1½ miles north of Victory. Vernon County, Wisconsin; SW¼, NE¼, Sec. 21, T. 12 N., R. 7 W.

The purpose of this study is to bring another check to bear upon the boundaries between upper Cambrian formations and their members. To date, these formations have been separated on the basis of paleontology and the megascopic characteristics of the sedimentary rocks. It is hoped that this study of the heavy mineral assemblages will aid in the location of their boundaries.

No heavy mineral studies comparable to this have been made in the region. Earlier work has always dealt with the horizontal and vertical distribution of heavy mineral assemblages within a single formation. Thus, Wilgus (5) has published the results of studies of heavy minerals in the Galesville member of the Dresbach formation in southern Wisconsin. He finds zircon generally dominant with minor amounts of tourmaline and titanium minerals. Garnet is rare or absent except to the west where the member is very thin.

Pentland (2) studied the heavy minerals of the Franconia formation in a triangular area in southwestern Wisconsin, whose approximate apices are Madison, La Crosse, and Prairie du Chien. He found garnet dominant, high tourmaline, and low zircon but made no mention of ilmenite and its alteration products.

Ockerman (1) indicates in his studies of heavy minerals in the Trempeleau formation that garnet is strongly dominant, particularly in the Jordan member.

The writer wishes to acknowledge his indebtedness to Mr. Gilbert O. Raasch, one-time curator of the museum in the Geology Department at the University of Wisconsin, who measured the sections and collected the material for the heavy mineral study. The writer also thanks members of the Geology Departments at the University of Missouri and DePauw University for aid in the preparation of this paper.

Preparation of materials.—Because the strata in the Coon Valley and Victory sections are usually well consolidated, the cementing material being calcareous or dolomitic, it was necessary to remove the cement with hydrochloric acid. The residues were sieved through Tyler screens. Fractions with diameters greater than 1/16 mm. were immersed in bromoform with a specific gravity equal to that of dolomite (2.9). No record was made of the ratio of the weight of the heavy minerals to the weight of the total sample. The amount of heavy minerals found varied extremely from specimen to specimen but was generally highest in the highly glauconitic green sands of the Franconia formation. After separation, the heavy mineral assemblages were mounted on slides with Canada balsam, either entire or after splitting with a Jones microsplitter, and were thus made ready for microscopic examination.

Heavy minerals.—The important minerals present in the assemblages studied are: garnet, tourmaline, ilmenite, zircon, leucoxene, anatase, rutile, pyrite, limonite, and a few possible grains of pyroxene.

All garnet grains are characterized by a rough, etched surface and are usually colorless to light pink with occasional red grains.

Tourmaline grains are well rounded, show the usual good absorption, and are dominantly tints of brown or green with a few blue and violet grains. Several opaque tourmaline grains are present.

Ilmenite occurs as well rounded opaque grains which show a coating of gray or brownish-gray leucoxene in reflected light. These grains may often be entirely altered to leucoxene but in that case are almost pure white in reflected light.

Zircon is usually colorless, clear, and rounded enough to eliminate terminal faces but not enough to eliminate the prismatic elongation. Many zircon grains show zoning. An attempt to use zoning as a diagnostic feature of the zircon within a formation produced no results because there is just as great variation in the number of zoned zircon grains from bed to bed in one formation as there is from formation to formation.

Leucoxene and anatase usually occur together, the anatase apparently developing as an alteration product of the leucoxene or along with it and both of them derived from the ilmenite. Leucoxene is generally spongy, may occur in well rounded grains or in irregular masses, has a light gray to white appearance in reflected light, and is at times tinted yellowish-brown by limonite. Anatase usually occurs as well developed, tabular crystals, attached to grains of leucoxene, which show extreme dispersion with nicols crossed. The crystals are usually perfectly developed, indicating that they are authigenic.

Rutile occurs in very small amounts as rounded or somewhat prismatic grains of extremely high relief which are brown or reddish-brown in color and may show striations parallel to the elongation.

Pyrite ordinarily occurs as small, well developed octahedrons or as irregular, granular masses. It is abundant to the point of flooding the heavy mineral assemblages in the more shaly portions of the section and is present to some degree in the more dolomitic or calcareous portions. It is often highly altered to limonite.

Limonite is the most abundant iron oxide encountered. It occurs in extremely irregular opaque to semi-translucent grains which appear brown or yellowish-brown in reflected light. One or two well rounded grains, appearing steel blue in reflected light, may be magnetite but were included with the ilmenite because of the latter's great preponderance in numbers and because of the difficulty in making an exact differentiation.

Two or three grains of a moderate birefringence and relief, which were fairly well rounded, are found scattered throughout the section. They are thought to be pyroxene because of the lack of elongation and the dispersion shown. However, the data are meager since there were only a few grains, none of which showed good optic axis or bisectrix figures.

Heavy mineral assemblages.—The section studied shows the following assemblages of heavy minerals from the top of the section to the base.

The lower four feet of the Oneota dolomite of Ordovician age has the assemblage shown in figure 1. Garnet is outstanding, and tourmaline and zircon are present in small amounts.

The upper ten feet of the Madison member of the Trempeleau formation shows a dominance of tourmaline over zircon and garnet and considerable amounts of ilmenite and its alteration product, leucoxene.

Pyrite is present in very small amounts, probably due to its alteration to the large amount of iron oxide found in this portion of the Madison member (Fig. 2).

The lower eight feet of the Madison member has garnet again present in great abundance with tourmaline and zircon in much smaller amounts (Fig. 3). The Madison as a whole is a fine-grained, dolomitic sandstone 18.5 feet thick with a conglomeratic zone eight feet above its base.

The upper 93 feet of the Jordan member of the Trempeleau formation are consistently high in garnet, usually more than 75%, with tourmaline a very poor second and zircon in extremely small amounts (Fig. 4). This portion of the formation is made up of coarse-grained, poorly cemented sandstone.

The lower 18 feet of the Jordan member are quite shaly. Pyrite is the dominant mineral, varying from 41% to 92% of the heavies (Fig. 5). Garnet is second in importance, and all other minerals are present in extremely subordinate amounts.

The Lodi member of the Trempeleau formation is made up entirely of shale. Pyrite is the dominant heavy mineral, varying from 52% to 100% (Fig. 6). Garnet and other heavies are present in minor quantities.

The St. Lawrence or basal member of the Trempeleau formation is made up of dolomitic shale and sandstone and returns to the dominance of garnet in the heavy assemblages throughout the member, with pyrite a poor second and the appearance of appreciable amounts of ilmenite (Fig. 7).

The upper 51.5 feet of the Franconia formation, which include the Bad Axe member and the upper 28 feet of the Hudson member, are made up of shaly glauconitic sandstone and have a very characteristic assemblage of heavy minerals. Garnet varies from 38% to 69% and ilmenite from 14% to 45%; zircon is third in abundance and tourmaline fourth (Fig. 8).

The lower 54 feet of the Hudson member and the entire Goodenough member of the Franconia formation are made up of rocks similar to the upper portion of the formation but have an entirely different heavy mineral assemblage. Garnet is again the important mineral with zircon and tourmaline alternating in second position (Fig. 9).

The 1.5 feet of the Ironton member of the Franconia formation exposed in the section studied is a dirty, shaly sandstone. It has a heavy mineral assemblage exactly like that of the upper portion of the Franconia formation, the order of abundance being garnet, ilmenite, zircon, and tourmaline (Fig. 10).

Conclusions

Changes in heavy mineral assemblages agree with formation and member boundaries set up on paleontologic and megascopic lithologic criteria except in the case of the three upper members of the Franconia formation. The upper 51.5 feet of this formation have the assemblage shown in figure 8. The lower 54 feet of the Hudson member and the entire Goodenough member have the assemblage shown in figure 9. Therefore, on the basis of heavy mineral assemblages, there would be three members in the Franconia instead of four.

The similarity of assemblages in the upper part of the Jordan and the lower part of the Madison may indicate considerable reworking of the Jordan sandstone before the source of the sedimentary materials changed. This condition is indicated in figures 2, 3, and 4.

Pentland's studies of the heavy mineral assemblages in the Franconia formation show no titanium minerals present. In the Victory section of the Franconia formation the upper 51 feet of the formation and the Ironton member show ilmenite second only to garnet and in amounts varying from 14% to 45%.

A study of heavy mineral assemblages extracted from deep well samples in Indiana might be an aid to more definite correlation of the Cambrian formations that are encountered.

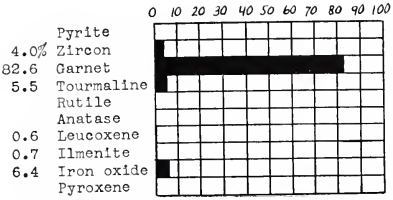

Fig. 1. Oneota Dolomite, Victory, Wisconsin, lower 4 ft.

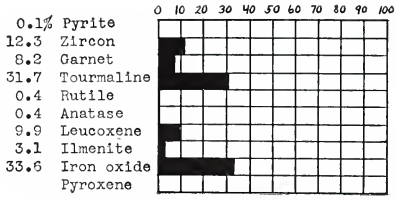

Fig. 2. Madison member of Trempeleau formation, Victory, Wisconsin, upper 10 ft.

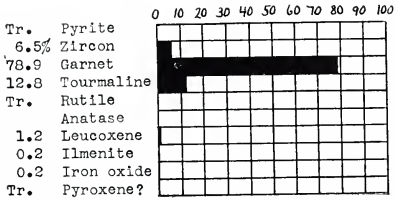

Fig. 3. Madison member of Trempeleau formation, Victory, Wisconsin, lower 8 ft.

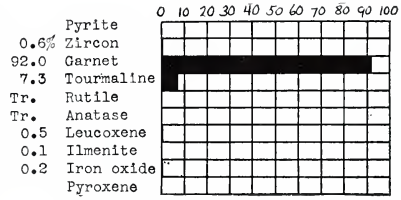

Fig. 4. Jordan member of Trempeleau formation, Victory, Wisconsin, 49 ft. to 74 ft. above bottom of Jordan.

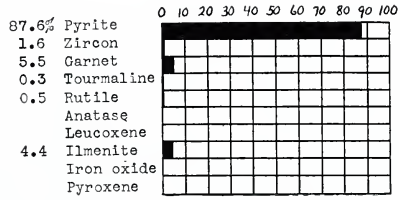

Fig. 5. Jordan member of Trempeleau formation, Victory, Wisconsin, 3 ft. to 10 ft. above bottom of Jordan.

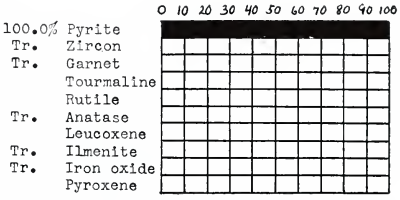

Fig. 6. Lodi member of Trempeleau formation, Victory, Wisconsin, lower 10 ft. of Lodi.

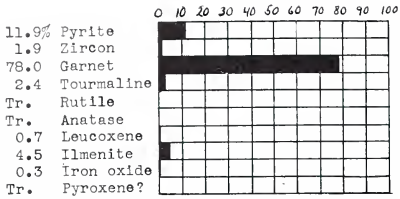

Fig. 7. St. Lawrence member of Trempeleau formation, Victory, Wisconsin, lower 5 ft. of St. Lawrence.

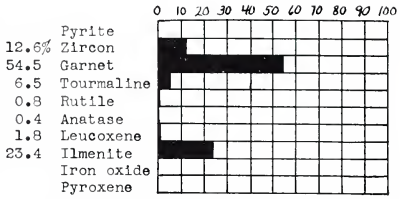

Fig. 8. Hudson member of Franconia formation, Victory, Wisconsin, 54 ft. to 65 ft. above bottom of Hudson.

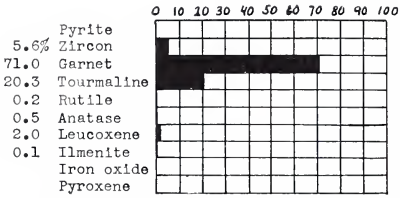

Fig. 9. Hudson member of Franconia formation, Victory, Wisconsin, 8 ft. to 12 ft. above bottom of Hudson.

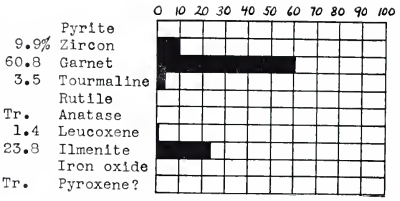

Fig. 10. Ironton member of Franconia formation, Victory, Wisconsin, upper 1.5 ft. of the Ironton.

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