

DEVONIAN STRATIGRAPHY
AND
CONODONT BIOSTRATIGRAPHY
FROM PORTIONS OF TWO CORES IN CENTRAL IOWA

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Devonian Stratigraphy and Conodont Biostratigraphy

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Introduction

During a temporary employment period (May 16 - September 15, 1980) with the Iowa Geological Survey, two cores were examined in order to better establish the stratigraphic relationships between geologic units in the central part of Iowa and those in other parts of the state. The examined intervals of the Peterson #1 core from northeastern Webster County, and the Hummell #4 core from southwestern Dallas County, Iowa (Fig. 1) are shown to be primarily of late Middle to early Late Devonian age. The lowest part of the Peterson #1 core that was examined, however, was found to be Ordovician. Nine lithologic units were recognized in the Peterson core. The Hummell #4 core is divided into 3 such units. In addition to lithologies each of these units was examined in terms of faunal content, depositional environment, and biostratigraphy. Each of these criteria will be discussed separately for each unit of the two cores.

Biostratigraphic interpretations were based primarily on conodont faunas. Not all recovered species had been identified at the time this report was written. Nevertheless, it is thought that the most biostratigraphically significant forms have been recognized, and further identifications will not greatly alter the interpretations presented herein.

Peterson #1 Core (Fig. 2)

Locality: NE1/4, NE1/4, NW1/4, sec. 10, T. 90N., R. 27W., Webster County, Iowa

Elevation: 1133 Feet

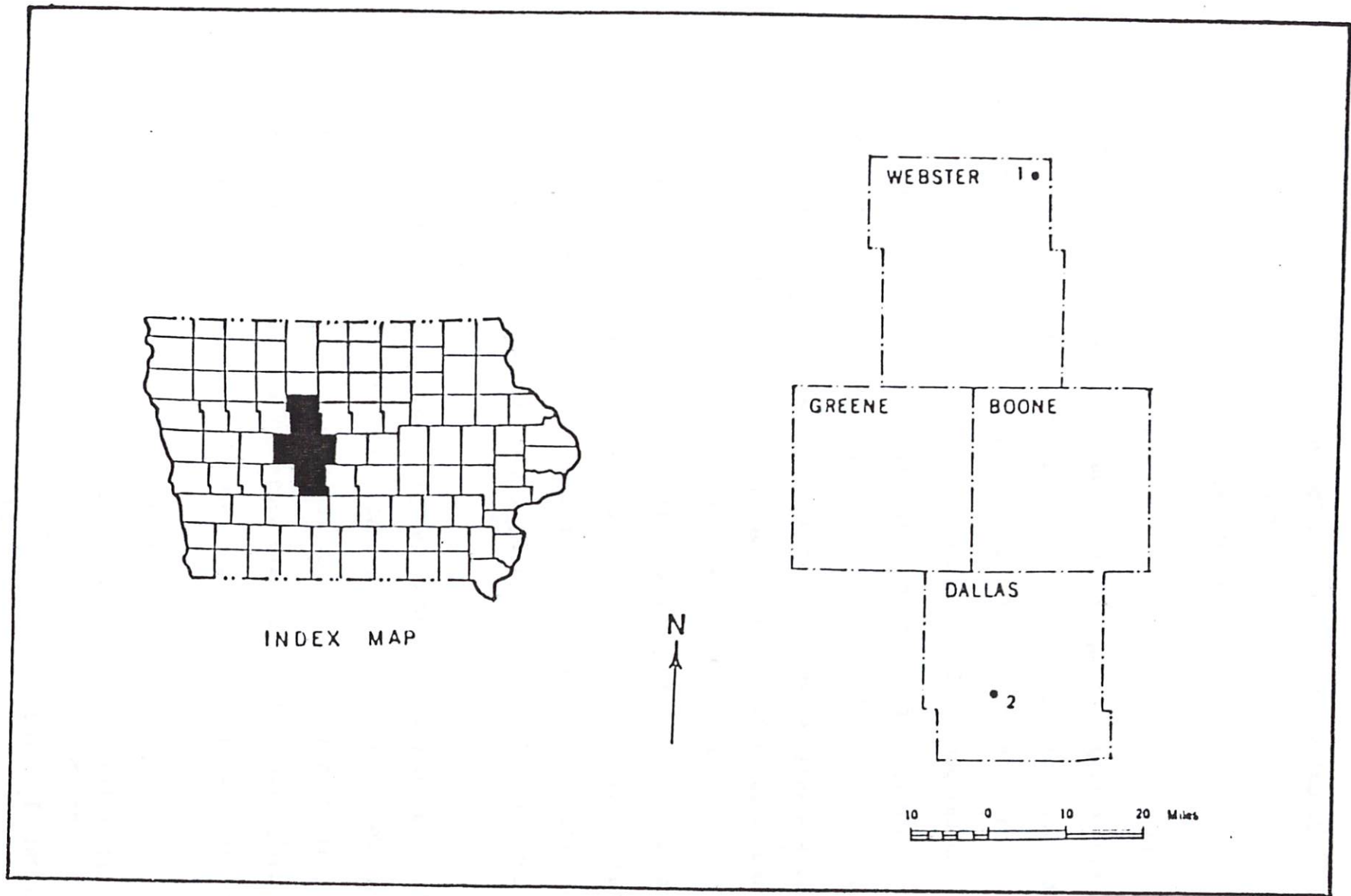


Figure 1 - Location map for the Peterson #1 (1) and Hummel #4 (2) cores.

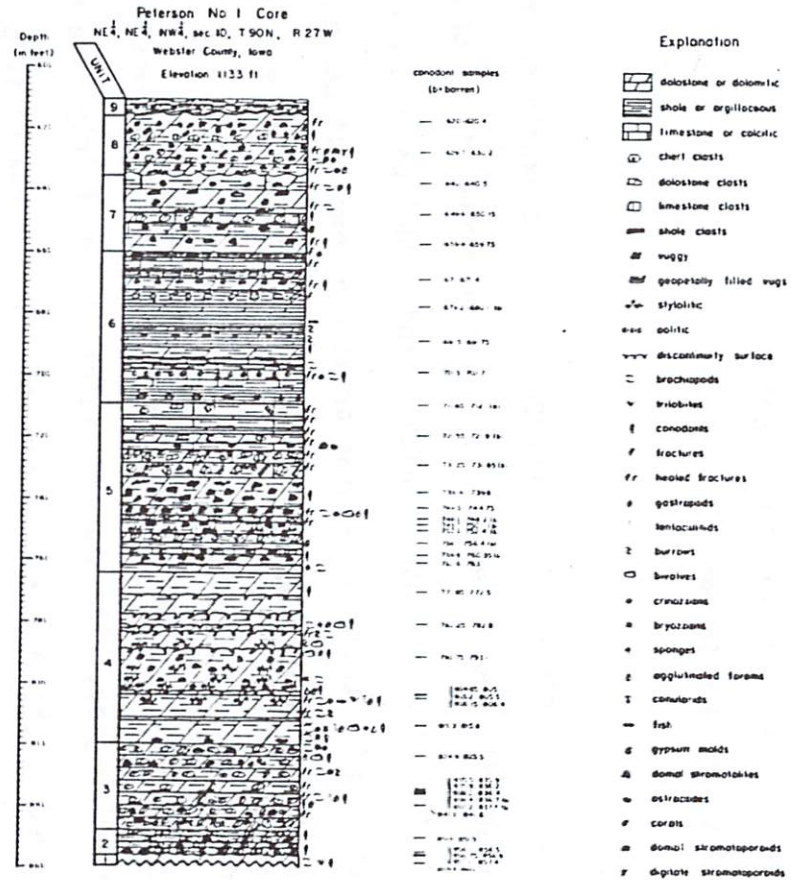


Figure 2 - Stratigraphic columns and conodont sample distribution of the examined intervals of the Hummell No. 4 and Peterson No. 1 cores.

Interval Examined: 613.5 to 860 feet

Core Diameter: 3.5 inches

Lithology

Nine lithologic units are recognized in the examined interval of the Peterson #1 core. These units represent groupings of generally similar lithologies. Contacts between individual units are commonly gradational and lithologies characteristic of one unit can occur in units higher or lower in the section. The characteristics of each unit are described below.

Unit 1 (858-): This, the lowest unit examined, consists of a light brownish-gray, fine-grained, fairly dense, fairly pure dolostone. It is marked by the presence of several solution channels, up to 0.3 inches in diameter, which cut through the unit. Only the upper two feet (858-860) of this unit were available for study. The unit is moderately fossiliferous.

Unit 2 (851.4-858): This unit is primarily a breccia consisting of gray to white chert clasts in a light to medium grayish-brown dolostone matrix. Some dolostone clasts are also present. Clasts are most abundant in the lower part of the unit and become less common and smaller upward to the point where the upper part of the unit is better termed a sandy dolostone than a breccia. Because of a gap in the recovered core, the nature of the contact between Units 1 and 2 could not be determined.

Unit 3 (822.6-851.4): Unit 3 is largely a conglomerate in which both matrix and clasts are argillaceous dolostones. Generally, the clasts show no preferred orientation. In some cases, however, they tend to be

arranged nearly horizontally. Vugs and fractures filled with calcite are common throughout this unit. Fossils are also fairly common throughout the unit. The contact between this and the underlying unit is gradational.

Unit 4 (763.95-822.6): This unit is composed mostly of light grayish-brown, fine-grained, argillaceous dolostone. Of particular interest is the presence, in the central portion of the unit, of a swarm of hardgrounds or discontinuity surfaces. Stylolites are common in the lower half of the unit as are vugs and some fractures healed with calcite. Fossils are abundant and diverse in this unit. The contact between units 3 and 4 is fairly gradational.

Unit 5 (711.2-763.95): Unit 5 is comprised of a series of relatively thin breccias, dolostones and limestones. In general, dolostones appear to be more important in the lower parts of the unit while limestones are more important in the upper portions. Clasts and matrix in the breccias may be either limestone or dolostone. Fractures healed with calcite are abundant throughout the unit. Stylolites and vugs are very common, especially towards the base of the unit. A narrow zone very near the base of the unit is characterized by a porosity apparently due to the dissolution of gypsum crystals. Some fossils are found in this unit but are not nearly as common as in Unit 4. The contact with Unit 4 is fairly sharp.

Unit 6 (~663-711.2): Unit 6 is dominated by shales and very argillaceous limestones and dolostones. The shales are commonly greenish-gray in color although pinkish-brown beds are also common. Some brecciated beds are also present, especially near the base and top of the

unit. A very thin layer near the center of the unit contains much phosphatic material, which is, at least in part, skeletal in origin. Fossils are uncommon in this unit. The contact between Units 5 and 6 is gradational.

Unit 7 (637.2-663): Unit 7 is composed of an alternating series of light to medium grayish-brown, somewhat argillaceous dolostones and limestones. Some thin brecciated and stylolitic beds occur near the middle of the unit. Vugs are common throughout the unit as are fractures which are generally filled with calcite. A narrow zone near the base is marked by a porosity apparently due to the dissolution of gypsum crystals. This unit is moderately fossiliferous, especially near the top. The contact between this and the underlying unit is somewhat gradational.

Unit 8 (618-637.2): Units 7 and 8 are very much alike except that limestone is a minor constituent of Unit 8, occurring only near the top. The dominant lithology is a light to medium grayish-brown, argillaceous dolostone. This unit is also brecciated in part. Vugs are common throughout the unit, as are fractures filled with calcite. Fossils are common, especially near the base of the unit. The contact between Units 7 and 8 is gradational.

Unit 9 (-618): Only the lowest 4.5 feet (613.5-618) of this unit were examined. It includes dolostones very similar to those of Unit 8, but also includes some greenish-gray dolomitic shales and argillaceous dolostones. Some vugs are present in the dolostones. No fossils were noted in the examined portion of this unit. The base of this unit is marked by a 1/2 foot thick, dolomitic, greenish-gray shale layer in sharp, but wavy contact with Unit 8.

Faunal Content

Unit 1: The only macrofossils found in Unit 1 were an orthid brachiopod and a fragmentary cephalon of a trilobite identified as Ceraurus sp. Both specimens are rather poorly preserved, dolomitic internal molds. A few fragmentary conodonts which are probably Panderodus gracilis (Branson and Mehl, 1933) were also recovered from this interval.

Unit 2: This unit is apparently lacking in macrofossils. Several conodonts, however, have been recovered. Specimens from near the base of the unit are fairly well-preserved. Those from near the top, however, are more fragmentary and somewhat rounded. Panderodus cf. P. gracilis (Branson and Mehl, 1933) again appears to be the dominant form. In addition, two specimens identified as Belodina compressa (Branson and Mehl, 1933) were also recovered.

Unit 3: The fauna of Unit 3 is much better developed than that of Unit 2. Fossils found in Unit 3 include brachiopods including Atrypa, Cyrtina, productids, and rhynchonellids; gastropods; bivalves, crinozoan debris; Tentaculites; bryozoans; and conodonts including Polygnathus, Icriodus, Synprioniodina, Acodina and several other forms. Some burrows are also found in this unit. In general, fossils seem to be more abundant and diverse towards the top of this unit.

Unit 4: Unit 4 has a better developed fauna in terms of abundance and diversity than any other in the section examined. This is particularly true of the lower half of this unit. Most, if not all, forms found in Unit 3 are also found in Unit 4. In addition, forms found only in this unit include conularids, sponge spicules, agglutinated Foraminifera and the trilobite Asteropyge cf. A. barrisi (Hall, 1888). Conodonts are generally abundant in samples taken from this interval.

Unit 5: Faunal abundance and diversity is markedly reduced in this unit, especially when compared with the underlying unit. A narrow zone near the base of the unit includes brachiopods, crinozoan, bivalve and gastropod remains. In the upper half of the unit, a layer containing domal stromatolites and ostracodes was noted. Conodont samples from Unit 5 are generally barren. Conodonts from the few productive samples processed were generally few and fragmentary.

Unit 6: As is the case with Unit 5, faunal abundance and diversity is low in this unit. Crinozoan debris and brachiopods occur in the lower part of the unit. Some fish remains have been recovered near the middle of this unit. Conodont occurrences are somewhat sporadic and specimens are generally few and fragmentary. One sample near the middle of the unit, however, produced a well-preserved fauna consisting almost entirely of the species Pandorinellina insita (Stauffer, 1940). Some burrowing was also noted in this unit.

Units 7 and 8: These two units are considered together because they show a general increase in the diversity and abundance of the fauna. The base of Unit 7 is poorly fossiliferous with only a few fragmentary conodonts being recovered. Brachiopods first occur near the middle of the unit and corals are found near the top. In the lower part of Unit 8, brachiopods, crinozoan debris, gastropods and domal and digitate stromatoporoids are commonly encountered. Conodonts are common in a sample near the top of Unit 8.

Unit 9: No fossils were found in the examined portion of this sample.

Depositional Environments

Interpretations of depositional environments in the Peterson #1 and Hummell #4 cores were based largely on ideas expressed in Irwin (1965), Heckel (1972), Kettenbrink (1973) and Anderson and Wiig (1974).

Unit 1: Although only about two feet of this unit were examined, the relatively pure, fine-grained dolostone containing trilobite and brachiopod fossils suggests deposition of this unit under normal marine conditions. Deposition of this unit appears to have taken place below effective wave base where clastic influx was of minimal importance.

Unit 2: Abundant subangular to subrounded chert pebbles and sand-sized grains are characteristic of this unit. Individual grains commonly show narrow weathering rhinds. Grains tend to become fewer in number, more rounded, and generally smaller towards the top of the unit. Three conodont samples were taken from this unit. The conodonts in the lowest sample were the best preserved while those from the highest sample were the most fragmentary and the fragments were generally rounded. All identifiable specimens from this unit appear to be Ordovician forms. This unit grades upward into Unit 3.

It is suggested that this unit represents transgression of the Devonian sea over the older, probably Ordovician terrain. The chert and conodonts were apparently reworked from the older strata into the younger strata. Winnowing in the shallow waters during this transgression would account for the rounding of the conodonts and chert grains. The winnowing and probably fluctuating conditions which existed during deposition of this interval apparently prevented the development of a fauna.

Unit 3: Chert grains are of minor importance in the lower part of this unit, and are wholly lacking in the upper part. Argillaceous dolostone is the dominant lithology and is commonly conglomeratic. The clasts in the conglomeratic parts are generally dolostones lithologically similar to the matrix. As discussed earlier, this unit is somewhat fossiliferous, including brachiopods, crinozoans, conodonts and burrows, especially in the middle to upper parts.

Deposition of this unit apparently took place under less agitated, more normal marine conditions than Unit 2. The conglomerates probably formed during short periods of greater agitation, such as during storms. A minimal amount of reworking would be necessary to round relatively soft dolostone clasts.

Unit 4: This unit is very similar lithologically to Unit 3 except that the conglomerates are lacking. Of particular interest is a swarm of discontinuity surfaces, apparently representing a series of hard-grounds, near the center of this unit. These appear as fairly level, dark colored pyritic and limonitic horizons penetrated by numerous borings and/or solution pits which are filled with the lithology of the overlying horizon.

The fauna of Unit 4 is the most diverse of any of the units examined. Organisms represented in this fauna include conularids, trilobites, sponge spicules, bryozoans, crinozoans, tentaculitids, fish remains and conodonts. The first three mentioned forms have not been found in any of the other Devonian units in this study. In addition to the above mentioned fossil forms, horizontal burrows are also commonly encountered in this unit.

This interval apparently represents a continued transgression of the Devonian seas with deposition taking place entirely below effective

wave base. This is suggested by the relatively fine-grained nature of the sediments, the abundant and diverse fauna, the apparently marine nature of the fauna, the common occurrence of horizontal burrows, and the presence of forms (e.g. bryozoans and sponges) which presumably require minimally turbulent conditions. Repeated intervals of nondeposition and/or solution are suggested by the discontinuity surfaces. It is thought that maximum transgression of the Devonian seas occurred during the development of these discontinuity surfaces. Perhaps these surfaces were formed as a result of the submergence of the clastic source area by the encroaching sea. Minor transgressions and regressions could account for the repetition of the discontinuity surfaces.

Unit 5: Breccias are very common in Unit 5. The origin of these breccias is not immediately obvious and, in fact, it may be that more than one process is responsible for their formation. Nevertheless, some of these breccias are made up mostly of flat pebbles which are generally aligned parallel to bedding. These breccias are thought to be due to ripup of underlying layers. Solution collapse is also possible, however, the only indication of any readily soluble minerals in this part of the section is a narrow interval near the base of the unit containing molds of an evaporite mineral, presumably gypsum. This interval is so narrow, and the crystal molds so scattered in the rock, it is thought that collapse is not a major contributor to breccia formation in this unit.

The fossil fauna is greatly reduced in both abundance and diversity in Unit 5. A macrofauna including brachiopods, small crinoid debris, gastropods and bivalves occurs in a narrow interval in the lower part of this unit. The only other macrofossil found was a domal stromatolite

near the middle of the unit. Ostracodes were abundant in the same layer as the stromatolite. Of the 11 samples processed for conodonts in this unit, only 3 were productive and even then rather poorly so.

The reduced abundance and diversity of the fauna, the occurrence of domal stromatolites, the presence of some evaporite minerals, and the occurrence of probable ripup breccias in this unit suggests a restricted shallow subtidal to supratidal environment, subject, at least occasionally to conditions of higher agitation as might have occurred, for example during storms.

Unit 6: The depositional environment of Unit 6 was apparently not much different from that of Unit 5. Some flat pebble breccias are found in this unit, especially near the top. An oolitic limestone occurs in the lower part of the unit.

A normal marine fauna is generally lacking in this unit with only a few occurrences of brachiopods and crinozoans in the lower part of the unit. Samples processed for conodonts were commonly barren and those that were not, usually produced only a few fragmentary specimens. One notable exception to this was a sample taken from just above the oolitic horizon. This sample produced a fauna dominated by the conodont species Pandorinellina insita (Stauffer, 1940) almost to the exclusion of other forms.

Sandberg (1979, p. 92) considered Pandorinellina insita to be a shallow water conodont living at depths of 10 meters or less. In addition to the presence of Pandorinellina insita, other evidence for fairly shallow subtidal to supratidal deposition of Unit 6 is the presence of breccias probably formed by ripup of previously deposited layers during storms.

The oolites near the base of the unit suggest winnowing conditions at or near the size of deposition.

Unit 7: A relatively narrow interval bearing molds of an evaporite mineral similar to that in Unit 5, occurs in the lower part of this unit. Conodonts are found throughout Unit 7 but are generally few and fragmentary. Some small, scattered crinozoan debris occurs near the base of this unit while brachiopods and corals are found near the top.

Unit 7 appears to have been deposited in a generally restricted environment, especially near its base. This is suggested by the scarcity of organic remains as well as the occurrence of evaporite minerals. Upward in the unit, however, the somewhat better developed fauna including brachiopods and corals suggests a trend to more normal marine conditions. Depth of water, however, was probably never very great as suggested by the presence of some flat pebble breccias.

Unit 8: This unit appears to represent a continuation of the trends established in Unit 7. The fauna in the lower part of the unit is better developed than that in the previous unit. Corals, brachiopods, crinozoan debris, gastropods, stromatoporoids and conodonts suggest near normal marine conditions. Water depth, however, may still have been fairly shallow as suggested by the presence of several brecciated horizons. Virtually no fossils have been recovered from the upper part of Unit 8 or from the lower part of Unit 9. Without examination of these and higher units, it is difficult to determine the major depositional trends in this portion of the section. It may be that the fairly well-developed fauna of upper Unit 7 and lower Unit 8 represents a minor transgression in an otherwise regressive sequence. It might also represent a more important transgression while the upper part of Unit 8 and the lower part of Unit 9 represent minor regressions within that transgressive period.

Biostratigraphic Correlations

The primary concern of this study was to establish a biostratigraphic framework for the examined sections based on the conodont faunas recovered. A total of 45 samples ranging from .92 to 2.94 and averaging about 1.75 lbs. each were acidized and examined for conodont content. Abundances varied from barren samples to one with over 2000 specimens. Preservation was equally variable, ranging from all fragmentary specimens to some preserving very delicate denticulation and processes intact. Individual faunas will be considered unit by unit below.

Unit 1: Only one sample was processed for conodonts from Unit 1. Four fragmentary specimens identified as Panderodus cf. P. gracilis (Branson and Mehl, 1933) were recovered from this sample. Panderodus gracilis is a long ranging form and is common in the Middle and Upper Ordovician strata of the Midwest.

In addition to the conodonts, this unit also produced a rather poorly preserved orthid brachiopod and a trilobite identified as Ceraurus sp. This again suggests a Middle or Upper Ordovician age for these strata. On the basis of stratigraphic position (see Witzke, 1980, Fig. 6), Unit 1 probably is assignable to the Elgin Member of the Maquoketa Formation.

Unit 2: Four samples from Unit 2 were processed for conodonts. Conodonts are present in each of these samples but are never abundant. Preservation varies from good in the lowest sample (857.1-857.4) to very fragmentary and rounded in the highest sample (851.4-851.9).

Sample 857.1-857.4 is dominated by Panderodus cf. P. gracilis (Pl. 1, Fig. 1). In the next sample (856.75-856.97) conodonts are generally

very fragmentary. However, one fairly well-preserved specimen identified as Belodina compressa (Branson and Mehl, 1933) (Pl. 1, Fig. 2) was obtained. The remaining two samples in this unit produced only fragments which are not specifically identifiable. Both Panderodus gracilis and Belodina compressa suggest an Ordovician age for this unit. Nevertheless, the fragmentary condition of the specimens recovered, the clastic nature of this unit, and the gradational contact of this unit with Unit 3 rather than Unit 1 suggests that these specimens have been reworked from the older Ordovician strata.

Unit 3: Of the seven samples processed for conodonts from this unit, only two were barren. However, the interval from which the barren samples were taken appears to be out of place in the core. The lithology of this interval is considerably different from that either above or below it. Also, the contacts with the overlying and underlying intervals are not known.

The remaining five samples all produced abundant, diverse, well-preserved conodont faunas. Biostratigraphically important forms recovered from this unit include Polygnathus ovatinodosus Ziegler and Klapper, 1976; P. alveoliposticus Orr and Klapper, 1968; P. xylus xylus Stauffer 1940 and Icriodus brevis Stauffer, 1940.

Both Polygnathus ovatinodosus (Pl. 1, Fig. 21-23) and Icriodus brevis (Pl. 1, Fig. 4-6) were recovered from the lowest sample taken from Unit 3. P. ovatinodosus ranges from the upper Middle Devonian (upper part of the Middle varcus Subzone of the varcus Zone) to the lower Upper Devonian (Lower asymmetricus Zone) [See Ziegler (ed.), 1977, p. 474]. P. ovatinodosus has been reported from the Solon and Rapid Members of the Cedar Valley

Formation in southeastern Iowa (Ziegler, et. al., 1976; 1980, Klapper, pers. comm.). I. brevis ranges through the varcus Zone into the Lower hermanni-cristatus Subzone (Ziegler, et. al., 1976). In Iowa, this species has been reported only from the Solon Member of the Cedar Valley Formation (Ziegler, et. al., 1976).

Polygnathus xylus xylus ranges through the varcus Zone apparently into the lower Upper Devonian Upper asymmetricus Zone [see Ziegler (ed.), 1973, p. 396]. In Iowa, P. xylus xylus has been reported from the Solon and Rapid Members of the Cedar Valley Formation and the Mason City Member of the Shell Rock Formation [see Ziegler (ed.), 1973, p. 396].

Polygnathus alveoliposticus is represented by a single specimen from near the middle of Unit 3. One other specimen which is probably a juvenile P. alveoliposticus was recovered from the highest sample taken from this unit. This species ranges from the Middle varcus Subzone of the varcus Zone to the lower dengleri Subzone of the dengleri Zone (see Ziegler et. al., 1976 and Klapper and Johnson, 1980). P. alveoliposticus has not been previously reported from Iowa.

The conodont fauna from Unit 3 suggests the placement of this unit no lower than the upper part of the Middle varcus Subzone to no higher than the Lower hermanni-cristatus Subzone. In addition, correlation with the Solon or Rapid Member of the Cedar Valley Formation in southeastern Iowa is suggested.

Unit 4: Seven samples were processed for conodonts from Unit 4. Conodonts are common to abundant and well preserved in all samples. One sample (805.2-805.8) from this unit produced more conodonts than any other sample examined in this study with over 2000 specimens/1.14 lb. (518 g.) of sample.

Despite the abundance, faunas recovered from this unit are generally not very diagnostic. Icriodus brevis remains a common form throughout most of the unit. Icriodus latericrescens latericrescens Branson and Mehl, 1938, first occurs in this unit. This species, however, ranges through the varcus Zone up into the Lower dengleri Subzone of the dengleri Zone. Polygnathus xylus xylus is still very common throughout most of this unit. No further refinement of the conclusions made for Unit 3 can be made based on the conodont fauna from Unit 4.

Unit 5: Of the eleven samples processed for conodonts, only three were productive. Abundance is low and specimens are commonly fragmentary in the samples that are productive. The best fauna examined is that from a sample near the middle of Unit 5 (739.4-739.8). This fauna is dominated by Icriodus subterminus Youngquist, 1947. I. subterminus (Pl. 1, Fig. 7-15) ranges from the Upper dengleri Subzone of the dengleri Zone into the lower Upper Devonian (Frasnian) Ancyrognathus triangularis Zone [see Klapper and Johnson, 1980 and Ziegler (ed.), 1975]. I. subterminus has been reported from the upper part of the Rapid and lower part of the Coralville (Klapper, 1975) and the State Quarry (1980, Klapper, pers. comm.) Members of the Cedar Valley Formation in southeastern Iowa. Youngquist (1947) originally described this species from the North Liberty beds of the Independence Shale.

On the basis of the conodont evidence alone, it is only possible to say that Unit 5 is probably correlative with the upper Rapid-State Quarry Members of the Cedar Valley Formation, or possibly the Independence Shale, of southeastern Iowa.

Unit 6: Three of the four samples processed for conodonts from this unit were productive. However, only the lowest sample (701.15-701.7)

produced a well enough preserved fauna to be useful biostratigraphically. This fauna is dominated by the form Pandorinellina insita (Stauffer, 1940), almost to the exclusion of all other forms. In North America, P. insita (Pl. 1, Fig. 24 and 25) ranges from the Upper dengleri Subzone of the dengleri Zone through the lower Upper Devonian Upper asymmetricus Zone (see Klapper and Johnson, 1980, and Sandberg, 1979). This form has also been reported from the North Liberty beds (Ancyrognathus triangularis Zone) but as may be the case with Icriodus lattericrescens lattericrescens, this form may be reworked [see Klapper in Ziegler (ed.), 1977, p. 438]. This species has also been reported from the upper part of the Rapid, the lower part of the Coralville, and the State Quarry Members of the Cedar Valley Formation in southeastern Iowa and northwestern Illinois [Klapper, in Ziegler (ed.), 1977, p. 438 and Klapper, 1975, p. 8 and 11]. The same conclusions drawn for Unit 5 can be applied to Unit 6.

Units 7-9: Five samples were processed from Units 7 and 8. Each of these produced a few fragmentary conodonts. No samples were processed from Unit 9. The conodonts recovered from Units 7 and 8 are so poorly preserved that no confident biostratigraphic interpretations can be made.

Hummell #4 Core (Fig. 2)

Locality: NW $\frac{1}{4}$, SW $\frac{1}{4}$, SW $\frac{1}{4}$, Sec. 18, T. 79 N., R. 28 W., Dallas County, Iowa.

Elevation: 1020 feet

Interval Examined: 1140?-1189.65 feet

Core Diameter: 3.5 inches

Lithology

Three lithologic units representing groupings of generally similar lithologies were recognized in the examined portion of the Hummell #4 core. These units are described below.

Unit A (1167-): This, the lowest unit examined in this core is characterized by light to medium grayish-brown, fine-grained, argillaceous dolostones. Some stylolites and cracks filled with calcite are found in the lower part of this core. Discontinuity surfaces apparently representing hardgrounds are noted at 1180.95 and 1175. Fossils are abundant and diverse in this unit. Only about 22 feet (1167-1189.65) were available for examination.

Unit B (1150.5-1167): This unit includes generally light to medium grayish-brown dolostones which may be fairly clean or argillaceous. Some rounded clasts are found in the lowest part of this unit while the upper part is brecciated. The lowest unit also appears to have scour and fill structures. Possible mudcracks are also found in the lower part of the unit. No fossilized organisms were recovered from this unit but some vertical boring was noted near the middle.

Unit C: (-1150.5): The examined portion of this unit consists of a medium to dark grayish-brown, fine-grained, dense to somewhat porous dolostone. Vugs and fractures, commonly filled with calcite, are common. Stylolites were also noted in this unit. This unit was also somewhat fossiliferous. Only about 10.5 feet (1140?-1150.5) were available for examination.

Faunal Content

Unit A: This unit had the most abundant and diverse fauna of the three examined in this core. Crinozoan debris was common to abundant throughout most of the unit. Brachiopods, fish, sponges, and bryozoans were only noted near the middle of the unit. The bryozoans were extremely abundant from 1175-1177.45 and give the rock in this interval a characteristic streaked appearance. The most commonly found form in this interval

was the branching Sulcoretepora. Conodonts were found throughout the unit.

Unit B: No fossils were recovered from this unit, with the exception of some vertical boring noted near the middle.

Unit C: Crinozoan debris, brachiopods and conodonts were common in the examined portion of this unit.

Depositional Environments

Unit A: This unit bears much similarity to Unit 4 of the Peterson #1 core. Features common to both units include generally fine-grained sediments, presence of discontinuity surfaces and a diverse and abundant fauna including bryozoans, sponges and crinozoans.

A similar interpretation of depositional environment is made for this unit. Deposition in fairly quiet waters below effective wave base is suggested by the fine-grained nature of the sediments and the apparently normal marine fauna including forms such as sponges and bryozoans which probably were not tolerant of high turbidities. Periods of non-deposition and/or solution are suggested by the apparent hardgrounds. A maximum transgression of the Devonian sea in central Iowa appears to have occurred during deposition of Unit A.

Unit B: Unit B is interpreted as having been deposited in very shallow water probably at or above effective wave base. This is suggested by the relatively coarse grained clean dolostone showing apparent scour and fill structures near the base of this unit. Slightly higher in the section, vertical burrows are found in an interval which also apparently contains mudcracks. Apart from the burrowing, no fossils have been noted in this unit. This also would be expected in a very shallow water deposit formed in an environment with fluctuating conditions in terms of salinity,

temperature, etc. Peak regression probably occurred sometime during deposition of Unit B.

Unit C: This unit apparently represents a return to more normal marine conditions as suggested by the recurrence of a fauna including crinozoan debris, brachiopods and conodonts. Lithologically, this unit bears much similarity to Unit A. Because of the limited section, however, it cannot be definitely determined whether this unit represents a major transgression or whether it represents a short term return to more normal marine conditions during an otherwise generally regressive period.

Biostratigraphic Correlations

Unit A: All four samples from Unit A were productive of conodonts. Faunas, however, are generally small and specimens commonly fragmentary. Conodonts are fairly common and well preserved in a sample from 1179.8-1180.1 Icriodus brevis Stauffer 1940, is common in this sample. Two specimens of a Polygnathus (Pl 1, Fig. 19, 20) were recovered from this sample. As discussed previously (Unit 3 of Peterson #1 core), I. brevis ranges through the varcus-Zone into the Lower hermanni-cristatus Subzone of the hermanni-cristatus Zone. I. subterminus, in North America, ranges from the Upper dengleri-Subzone of the dengleri-Zone into the Ancyrognathus triangularis-Zone (see also discussion of I. subterminus in Unit 5 of the Peterson #1 core). Klapper (1980, pers. comm.) has informed me that the Polygnathus sp. (Pl 1, Fig. 19, 20) is a common form in the Rapid and possibly upper part of the Solon Members of the Cedar Valley Formation. The possible co-occurrence of I. brevis and I. subterminus in this sample appears to be somewhat of a problem. The specimen of I. cf. I. subterminus is somewhat damaged in that the posteriormost denticles of the middle row are broken. The height of these denticles relative to the others of the platform is important

in the distinction between I. brevis and I. subterminus. In I. subterminus the posteriormost two denticles are markedly higher than those on the remainder of the platform. In I. brevis this is not the case. Although in most aspects this specimen resembles I. subterminus, positive identification requires better preserved specimens. It is also possible that this specimen represents an I. subterminus which has been leaked stratigraphically from a somewhat younger deposit. Another possibility is that the ranges of I. brevis and/or I. subterminus are greater than presently understood. More study of the occurrences of these two forms in this area is needed.

The co-occurrence of I. brevis and P. sp. in this sample suggest that Unit A of the Hummell #4 core is correlative with the upper part of the Solon and possibly the Rapid Members of the Cedar Valley Formation in southeastern Iowa. In terms of conodont zonation, this unit probably falls within the Upper varcus-Subzone of the varcus-Zone or the Lower hermanni-cristatus-Subzone of the hermanni-cristatus-Zone.

Unit B: Only one sample from the middle of this unit was processed for conodonts. This sample was barren and no direct conclusions can be made on the biostratigraphic position of this unit.

Unit C: Three samples were processed for conodonts from Unit C. Conodonts were common but often fragmentary in these samples. Icriodus subterminus (Pl. 1, Fig. 13-15) is well-represented in these faunas. A Polygnathus similar to, if not conspecific with, P. angustidiscus Youngquist, 1945, is also present. These specimens are fragmentary, however, and positive identification must await better preserved material. The range of I. subterminus has been covered in the discussion on the biostratigraphy of Unit A. I. subterminus has been reported from the

upper part of the Rapid and lower part of the Coralville Members (Klapper, 1975) and from the State Quarry Member (1980, Klapper, pers. comm.) of the Cedar Valley Formation of southeastern Iowa. This species has also been reported by Youngquist (1947) from the North Liberty beds of the Independence Shale. With the limited fauna at hand, correlating with any one of these units is possible.

Summary and Conclusions

The Peterson #1 core is divided into 9 lithologic units. Unit #1 apparently represents the Elgin Member of the Maquoketa Formation based on lithology, fauna and stratigraphic position.

On the basis of faunal content, Units 2 through 9 represent strata of upper Middle to early Late Devonian age. Lithologies represented in this part of the core are generally unlike those of the better studied strata of similar age from the southeastern part of Iowa. For this reason, it is concluded that application of the lithostratigraphic terms used in the southeastern part of the state are presently unacceptable for similar age strata examined in the Peterson #1 core. Correlation of these two sets of strata, however, is attempted. This correlation is based on faunal content (primarily conodonts). Unit 2 probably correlates with the "salt and pepper" sands at the base of the Solon in other localities (see Anderson and Wiig, 1974; Kettenbrink, 1973). On the basis of conodonts, Units 3 and 4 represent the Solon-Rapid Member transition and no attempt is made, at this time, to define the intervals in the Peterson Core that correspond to these two Members.

Units 5 and 6 apparently correlate with the upper part of the Cedar Valley Formation (upper Rapid-State Quarry Members) and/or possibly the North Liberty beds of the Independence Shale. Poor faunas, however, preclude more refined biostratigraphic correlation.

Units 7 through 9 of the Peterson #1 core have produced such poorly developed conodont faunas that no attempt is made at correlation of these two units.

Three lithologic units are recognized in the Hummell #4 core. Conodont faunas and lithology suggest correlation of Unit A of the Hummell Core with Unit 4 of the Peterson #1 core and, in turn, with the Solon and/or lower Rapid Members of the Cedar Valley Formation in southeastern Iowa. Units B and C probably correlate with Unit 5 of the Peterson #1 core but better faunas and understanding of lithologic relationships are necessary to verify this.

Acknowledgements

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APPENDIX

Plate 1

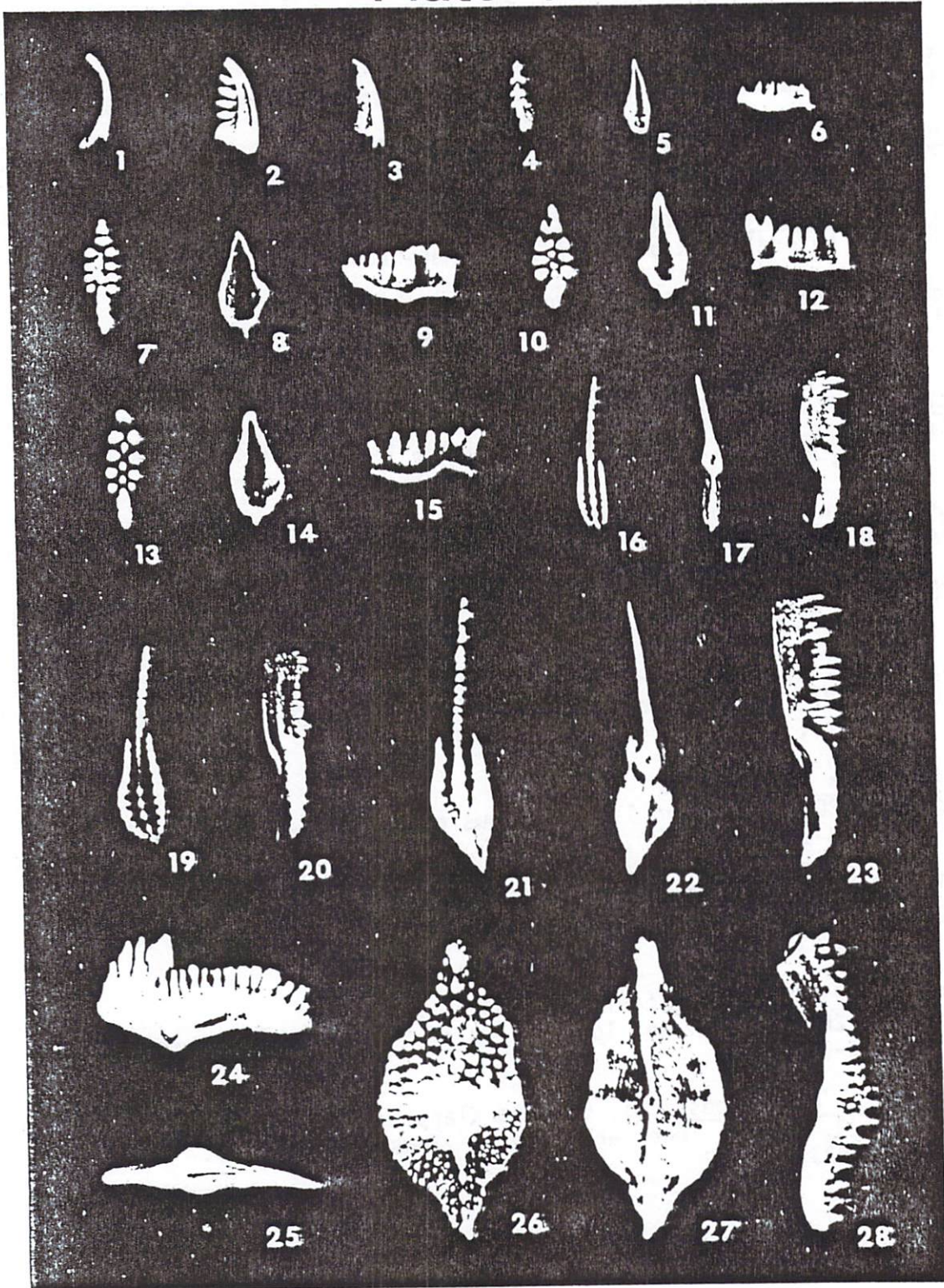


Plate 1

All magnifications are x 30

- Panderodus cf. P. gracilis (Branson and Mehl, 1933)
Fig. 1: Lateral view of SUI 47234. Peterson #1 Core; 857.1-857.4
- Belodina compressa (Branson and Mehl, 1933)
Fig. 2: Lateral view of SUI 47235. Peterson #1 Core; 856.75-856.97
- Belodella devonica (Stauffer, 1940)
Fig. 3: Lateral view of SUI 47240. Peterson #1 Core; 824.9-825.5
- Icriodus brevis Stauffer, 1940
Fig. 4-6: Upper, lower, and lateral views of SUI 47236. Peterson #1 Core; 841.3-841.6
- Icriodus cf. I. subterminus Youngquist, 1947
Figs. 7-9: Upper, lower, and lateral views of SUI 47243. Hummell #4 Core; 1179.8-1180.1
- Icriodus subterminus Youngquist, 1947
Figs. 10-12: Upper, lower, and lateral views of SUI 47241. Peterson #1 Core; 739.4-739.8.
Figs. 13-15: Upper, lower, and lateral views of SUI 47245. Hummell #4 Core; 1150-1150.35
- Polygnathus xylus xylus Stauffer, 1940
Figs. 16-18: Upper, lower, and lateral views of SUI 47238. Peterson #1 Core; 836.2-836.4
- Polygnathus sp.
Figs. 19, 20: Upper and lateral views of SUI 47244. Hummell #4 Core; 1179.8-1180.1
- Polygnathus ovatinodosus Ziegler, Klapper and Johnson, 1967
Figs. 21-23: Upper, lower, and lateral views of SUI 47237. Peterson #1 Core; 841.3-841.6
- Pandorinellina insita (Stauffer, 1940)
Figs. 24, 25: Lateral and lower views of SUI 47242. Peterson #1 Core; 701.5-701.7
- Polygnathus alveoliposticus Orr and Klapper, 1968
Figs. 26-28: Upper, lower and lateral views of SUI 47239. Peterson #1 Core 835.9-836.2

DESCRIPTION OF PETERSON #1 CORE
(lower part)

NE $\frac{1}{4}$, NE $\frac{1}{4}$, NW $\frac{1}{4}$, sec. 10, T. 90 N., R. 27 W., Webster Co. Iowa

Curtis R. Klug

Depth of Interval
(in feet)

- 613.5 - 615.25 Dolostone, very argillaceous, laminated to mottled light to dark-greenish-gray; fine- to medium-grained; slightly porous; some normal microfaulting with offsets of .25 inch; laminae tend to be wavy showing "pinch and swell" structure; mottling is prominent around 613.5; contact with underlying unit gradational.
- 615.25 - 616.65 Dolostone, argillaceous, medium grayish-brown; fine- to medium-grained; vuggy with vugs generally less than 1 inch in diameter; vugs generally open but some partially filled with calcite crystals; contact with underlying unit gradational.
- 616.65 - 617.5 Dolostone, argillaceous, slightly calcitic, light to medium grayish-brown; fine- to medium-grained; somewhat porous ("pinhole"); somewhat laminated; contact with underlying unit gradational; (.25 foot interval missing between 616.75 and 617).
- 617.5 - 618 Shale, very dolomitic, very slightly calcitic; light to medium greenish-gray; slightly porous; laminated; some small calcite-filled cracks and holes; contact with underlying unit very sharp but wavy.
- 618 - 618.75 Dolostone, argillaceous, slightly calcitic, light pinkish-brown; fine- to medium-grained; somewhat porous; contact with underlying unit sharp.

Peterson #1 Core

- 618.75 - 618.85 Limestone, dolomitic, somewhat argillaceous; light brownish-gray to medium grayish-brown; fine-grained; dense; laminated; contact with underlying unit sharp but wavy.
- 618.85 - 619.05 Dolostone, calcitic, argillaceous; light to medium pinkish-brown; fairly fine-grained; somewhat porous; contact with underlying unit sharp and slightly wavy.
- 619.05 - 620.85 Dolostone, calcitic, argillaceous; mottled light to medium grayish-brown; fine- to medium-grained; fairly dense; some medium to dark brown argillaceous partings; some narrow calcite-filled cracks; a few fragmentary conodonts, contact with underlying unit gradational.
- 620.85 - 622.9 Dolostone, argillaceous; light to medium grayish-brown; fine- to medium-grained; vuggy with vugs generally less than $\frac{1}{2}$ inch and becoming smaller towards the top of the unit; vugs generally open but some partly filled with calcite crystals; some narrow, open vertical cracks; contact with underlying unit gradational.
- 622.9 - 625.2 Dolostone, argillaceous, slightly calcitic; medium grayish-brown; fairly fine-grained fairly dense; numerous argillaceous partings from 623.9 to around 624.5; contact with underlying unit gradational; (.25 foot interval missing between 623.2 and 623.45).
- 625.2 - 627.3 Dolostone, argillaceous; medium brownish-gray; fine- to medium-grained; very vuggy with vugs generally open and about 1 inch in diameter; some vugs partially filled with calcite crystals; contact with underlying unit gradational.
- 627.3 - 627.55 Breccia; Matrix: Dolostone, calcitic, argillaceous; medium grayish-brown; fine- to medium-grained; fairly dense, Clasts: Limestone, dolomitic, argillaceous; light to medium-grained; fairly dense; subangular to subrounded; no particular orientation of clasts noted; contact with underlying unit gradational.

- 627.55 - 629.0 Dolostone, argillaceous; medium grayish-brown; fine- to medium-grained; vuggy with vugs up to 1.5 inches in diameter; commonly open but around 627.9 filled with calcite; contact with underlying unit gradational.
- 629.0 - 629.2? Dolostone argillaceous; medium to dark grayish-brown; fine- to medium-grained; somewhat porous; laminated.
- 629.2? - 632.2 Dolostone, calcitic, argillaceous; mottled light to medium grayish-brown; medium- to fine-grained; somewhat porous; numerous vugs showing geopetal filling with dolomite and calcite crystals; some vugs incompletely filled; some calcite filled cracks; somewhat brecciated near base; fossiliferous including abundant corals, digitate stromatoporoids (cf. Amphipora) and some hemispherical stromatoporoids; conodonts were common but fragmentary in a sample taken from 629.7 to 630.2.
- 632.2 - 634.8 Dolostone, calcitic, argillaceous, light to medium grayish-brown; fine- to medium-grained; somewhat porous; somewhat brecciated near base; some argillaceous partings; some vugs up to 2.5 inches in diameter and partially filled with calcite; fossiliferous, corals abundant; some spiriferid and orthid brachiopods; some crinozoan debris; contact with underlying unit gradational.
- 634.8 - 636 Dolostone, slightly argillaceous; mottled light to medium grayish-brown; fine- to medium-grained; somewhat porous; some vugs and cracks filled with calcite; fossiliferous; brachiopods (mostly spiriferids) and crinozoan debris abundant; some gastropods, contact with underlying unit sharp but wavy.

Peterson #1 Core

- 636 - 636.9 Dolostone, somewhat calcitic, somewhat argillaceous, light to medium brownish-gray; fine-grained; somewhat porous; contact with underlying unit sharp but wavy.
- 636.9 - 637.2 Dolostone, argillaceous, mottled light to medium brownish-gray and light to medium grayish-brown; fine-grained; fairly dense; some thin vertical cracks; some stylolites (especially around 637); dark brown argillaceous partings common, contact with underlying unit sharp but wavy.
- 637.2 - 638 Limestone, dolomitic, slightly argillaceous; light to medium grayish-brown; fine-grained; dense; some vertical cracks filled with calcite; some argillaceous partings; some cavities partially filled with calcite; some pyrite.
- 638 - 639.9? Limestone, dolomitic, argillaceous; medium to dark grayish-brown; medium-grained; fairly dense; laminated with dark-brown argillaceous partings. (.4 foot interval missing between 639.5 and 639.9).
- 639.9 - 641.7 Dolostone, argillaceous; light to medium brownish-gray; medium-grained; numerous vugs up to 1 inch in diameter; fossiliferous; brachiopods abundant; conodonts were few and fragmentary in a sample from 640 to 640.5; contact with underlying unit fairly sharp.
- 641.7 - 642.4 Limestone, dolomitic, somewhat argillaceous; mottled medium to dark grayish-brown; fine- to medium-grained; slightly porous; argillaceous partings common; some thin cracks and cavities filled with calcite; some corals at 641.9; contact with underlying unit gradational.
- 642.4 - 645.25 Dolostone; light to medium grayish-brown; fine- to medium-grained; somewhat porous; some narrow calcite-filled cracks; numerous vugs, many of which show geopetal filling with dolomite and calcite crystals; slight bituminous odor when broken; contact with underlying unit gradational.

- 645.25 - 645.9 Dolostone, medium to light grayish-brown; medium-grained; somewhat porous; laminated; some dark brown argillaceous partings; some calcite-filled cavities; bituminous odor when broken; contact with underlying unit sharp.
- 645.9 - 646.75 Dolostone, medium to light grayish-brown; medium-grained; somewhat porous; some cavities partially filled with calcite; pyrite common; bituminous odor when broken; some brachiopods; contact with underlying unit gradational.
- 647.75 - 648.15 Dolostone, light to medium grayish-brown; medium-grained; somewhat porous; laminated; bituminous odor when broken; contact with underlying unit sharp but wavy.
- 648.15 - 649.6 Limestone, dolomitic; mottled light grayish-brown to medium gray; fine-grained; dense at base of unit but becoming more porous upwards; pores commonly filled or partially filled with calcite; some stylolites.
- 649.6 - 650.8 Breccia; Matrix: Limestone, argillaceous, dolomitic; light to medium gray; fine-grained; dense; Clasts: Dolostone, calcitic, argillaceous; light pinkish- to grayish-brown; fine-grained; dense; subangular to subrounded, some over 2 inches across; argillaceous partings common in this unit, conodonts were rare and fragmentary in a sample taken from 649.6 - 650.15.
- 650.8 - 651.3 This interval is represented by a bag full of green shale chips, the stratigraphic affinities of which are uncertain.

- 651.3 -653.4 Breccia; Matrix: Dolostone, argillaceous light to medium greenish-gray; fine-grained; slightly porous; Clasts: Dolostone, argillaceous, slightly calcitic; light pinkish- to grayish-brown; fine-grained; somewhat porous; angular to sub-rounded; some clasts over 2.5 inches across; contact with underlying unit gradational.
- 653.4 - 654 Dolostone, argillaceous, slightly calcitic, very light grayish- to pinkish-brown; fine-grained; somewhat porous; numerous argillaceous partings.
- 654 - 654.3 Dolostone, argillaceous, light to medium grayish-brown; fine-grained; somewhat porous; mottled with medium greenish-gray; contact with underlying unit fairly sharp.
- 654.3 - 654.6 Limestone, argillaceous, dolomitic; light to medium grayish-brown; fine-grained; dense; laminated; numerous dark brown argillaceous partings; narrow vertical cracks filled with calcite; contact with underlying unit gradational.
- 654.6 - 657.75 Dolostone, argillaceous; light to medium grayish-brown; fine- to medium-grained; somewhat porous; laminated; some narrow vertical cracks; argillaceous partings common in parts of the unit; some calcite-filled vugs; some pyrite; numerous pores resulting from dissolution of gypsum crystals between 657 and 658; contact with underlying unit gradational.
- 657.75 - 663? Dolostone; argillaceous, slightly calcitic; medium grayish-brown; fine- to medium-grained; fairly porous; numerous vertical fractures and angular vugs; vugs commonly filled with calcite and, to a lesser extent, pyrite; conodonts were rare and fragmentary in a sample from 659.4-659.75.
- 663? - 664.3 Breccia; Matrix: Shale, dolomitic; medium brownish-green to medium grayish-green; somewhat porous; Clasts: Shale (ripup), dolomitic; medium grayish-green to light

grayish-brown; somewhat porous; angular to subrounded; sand-sized to some over 2 inches across; crinozoan debris in parts.

- 664.3 - 664.8? Limestone, argillaceous; light pinkish-brown to medium greenish-gray; fine-grained; slightly porous.
- 664.9 - 665.15? Limestone, very argillaceous; light to medium grayish-brown; fine-grained; dense; numerous argillaceous partings.
- 665.6? - 666.5? Shale, very calcitic; dolomitic; light to medium grayish-green to very light grayish-brown; somewhat porous; some scattered pyrite crystals.
- 666.6? - 667.8? Limestone, very argillaceous, dolomitic; light greenish-gray to light grayish-brown; fine-grained; slightly porous; some vertical calcite-filled cracks (.4 foot interval missing between 666 and 668).
- 667.8? - 668.75? Shale, very slightly calcitic, dolomitic; light greenish-gray to medium grayish-green; dense; (.1 foot interval missing between 668.75 and 668.85).
- 668.75 - 669.2 Breccia; Matrix: Shale, calcitic; light pinkish- to grayish-brown; slightly porous; Clasts: Shale; light to medium grayish-green; slightly porous; angular to subrounded; sand-sized to some over 1 inch across; some small calcite-filled cavities throughout unit.
- 669.4? - 670.2? Shale, somewhat calcitic, light pinkish-brown to medium-gray; somewhat porous; some thin vertical cracks filled with calcite; somewhat brecciated in part (.2 foot interval missing between 669.2 and 669.75).

- 670.2? - 671? Breccia; Matrix: limestone, argillaceous, dolomitic; light to medium grayish-brown; fine-grained; slightly porous, Clasts: Shale, dolomitic, light pinkish-brown; slightly porous; angular to subrounded; some over 1.5 inches across; long axis of clasts generally horizontal.
- 671? - 674.5? Dolostone, argillaceous, calcitic; light to medium grayish-brown; fine-grained; somewhat porous ("pinhole"); some cavities and narrow vertical cracks filled with calcite; some argillaceous partings; conodonts were rare and fragmentary in a sample from 671 - 671.4 (.9 foot interval missing between 674.5 and 675.9; .3 foot interval missing between 673 and 673.75; .2 foot interval missing between 672.5 and 673).
- 674.5 - 679.35 Breccia; Matrix: Shale; medium grayish-green; Clasts: Shale; light grayish-green to light grayish-brown; fairly dense; angular to subrounded, clasts up to 1.5 inches across; some shaly layers in unit. (.65 foot interval missing between 677.35 and 680; .5 foot interval missing between 677.5 and 678).
- 679.7? - 681 Shale, dolomitic at base, calcitic at top; light to medium grayish-brown; slightly porous; some pyrite; conodont sample between 679.7 and 680.1 was barren.
- 681? - 686.6? Shale, dolomitic; grayish-green; fairly dense, a rather narrow zone including fish fragments at 685.5. (.4 foot interval missing between 684.3 and 684.7).
- 686.6? - 688 Dolostone, very argillaceous, somewhat calcitic; medium greenish- to brownish-gray; fairly dense, mottled with numerous small burrows; some argillaceous partings; some pyrite.

Peterson #1 Core

- 688? - 693 Shale, dolomitic, very slightly calcitic; medium greenish-gray; fairly dense; mottled with small burrows around 689.6; numerous $\frac{1}{2}$ to 1 inch calcite-filled cavities; a few fragmentary conodonts and abundant scolecodonts recovered from a sample from 691.5 - 691.75. (.4 foot interval missing between 689.4 and 690.3; .15 foot interval missing between 688.45 and 688.6).
- 695? - 697? Dolostone, very argillaceous, slightly calcitic; light to medium greenish-gray, somewhat mottled; fine-grained; fairly dense; somewhat brecciated in part. (.2 foot interval missing between 696 and 697; .1 foot interval missing between 695 and 692; 2 foot interval missing between 693 and 695).
- 697.2 - 698.35 Limestone, very argillaceous; medium greenish-gray; fine- to medium-grained; fairly dense; brachiopods abundant at 698.1 (.1 foot interval missing between 697 and 698).
- 698.35 - 699.35 Limestone, argillaceous; light to medium gray to light to medium grayish-brown; medium-grained; dense; argillaceous partings common; somewhat brecciated; contact with underlying unit sharp.
- 699.35 - 701.15 Limestone, argillaceous; light to medium gray to grayish-brown; medium-grained; dense; numerous argillaceous partings; vertical calcite-filled cracks common; some crinozoan debris; some brachiopods with shell preserved; possible hardground at 699.35; contact with underlying unit gradational.
- 701.15 - 704.3 Limestone, somewhat argillaceous; mottled light to medium grayish-brown; fine- to medium-grained; dense; oolitic near 702; some vertical fractures filled with calcite; some pyrite in fractures around 701.2; some scattered crinozoan debris, conodonts common and well preserved 701.15-701.7.

- 707.95 - 708.35 Shale, slightly calcitic; mottled light to medium greenish-gray, mottled with short dark streaks; somewhat porous, (.65 foot interval missing from 708.35-709).
- 709? - 710 Breccia; Matrix: Shale, very calcitic; light brownish-gray; fairly dense; Clasts: Shale, very calcitic; some light grayish-brown, others grayish-green; subangular to subrounded; sand-sized to over 3 inches across; no particular orientation noted.
- 710 - 711.1 Shale, calcitic; medium greenish-gray; fairly dense; some patches of light pinkish-brown limestone.
- 711.2? - 712.6? Limestone, argillaceous; medium gray to medium greenish-gray to light grayish-brown; fine- to medium-grained; dense; somewhat brecciated; no conodonts were recovered in a sample from 711.65-712. (about .4 foot interval missing from 712.6-713; .3 foot interval missing between 711 and 712).
- 713 - 713.45 Limestone, somewhat argillaceous; medium brownish-gray to medium grayish-brown; fine- to medium-grained; dense; layers slightly irregular (.5 foot interval missing from 713.45-713.95).
- 713.95 - 714.3 Limestone, somewhat argillaceous; medium grayish-brown, mottled; fine- to medium grained; dense.
- 714.4 - 714.9 Limestone, somewhat argillaceous; medium to dark grayish-brown; fine- to medium-grained; dense; some vertical calcite-filled cracks; contact with underlying unit very irregular. (.1 foot interval missing from 714.3 to 714.4).

- 714.9 - 715.3 Limestone, very argillaceous; medium greenish- to grayish-brown; fine-grained; dense; some vertical to near vertical fractures filled with calcite.
- 715.4? - 716.2 Shale, very calcitic, in part dolomitic; medium to dark grayish-green; fairly dense; some vertical to near vertical calcite-filled cracks; upper part somewhat brecciated with shale clasts in a calcite matrix.
- 716.2? - 716.3? Shale, very calcitic, somewhat dolomitic; light to medium grayish-brown; dense; some near vertical cracks filled with calcite; contact with underlying unit irregular.
- 716.3? - 716.6? Limestone, argillaceous, somewhat dolomitic; light pinkish-brown to light bluish-gray; fine-grained dense; some nearly vertical cracks partially filled with calcite; somewhat brecciated near base; medium greenish-gray argillaceous partings at base.
- 716.6? - 716.9? Limestone, argillaceous, dolomitic in part; mottled light to medium greenish-gray and light pinkish-brown; fine-grained; dense; laminated; some vertical calcite-filled fractures. (about .2 foot interval missing between 716 and 717).
- 716.9? - 717.4? Dolostone, somewhat calcitic, argillaceous; light pinkish-brown to light grayish-brown; fine- to medium-grained; somewhat porous; argillaceous partings around 717.4 and 717.
- 717.4? - 718.7? Limestone, argillaceous; light gray to light pinkish-brown; somewhat mottled; fine-grained; dense; somewhat laminated and brecciated in part.

- 718.7 - 718.9 Shale, very calcitic; light grayish-brown at base becoming dark grayish-brown upwards; dense; some narrow vertical fractures filled with calcite; some pyrite; grades into underlying unit.
- 718.9 - 719.1 Limestone, argillaceous; light to medium bluish-gray; fine-grained; dense; some argillaceous partings.
- 719.1 - 720? Breccia; Matrix: Limestone; light grayish-brown to light brownish-gray; fine-grained, dense; Clasts: Limestone, light gray to light grayish-brown to light pinkish-brown; fine-grained; fairly dense; generally subangular; sand-sized to about $\frac{1}{2}$ inch across; dark brown argillaceous parting around 720. (about .5 foot interval missing between 719 and 720).
- 720? - 720.1 Shale, very calcitic; medium to dark grayish-brown to light to medium brownish-gray; dense; contact with underlying unit sharp but irregular.
- 720.1 - 720.6 Limestone, argillaceous; medium to light grayish-brown; fine- to medium-grained; dense; numerous vertical cracks filled with calcite.
- 720.6 - 721.1 Limestone, argillaceous; medium to light grayish-brown; medium- to fine-grained; dense; irregularly layered; some subrounded clasts.
- 721.1 - 721.2 Shale, dolomitic; mottled light grayish-green, medium greenish-gray and medium grayish-brown; dense.

- 721.2 - 722.45 Dolostone, very calcitic in parts, argillaceous; light pinkish-brown to light to medium brownish-gray; fine- to medium-grained; slightly porous; some microfaulting (normal); argillaceous parting at 722.45; no conodonts were recovered from a sample from 721.55 - 721.9 .
- 722.45 - 722.6 Dolostone, argillaceous; irregular to mottled bands of light to medium grayish-brown to pinkish-brown; fine- to medium-grained; fairly dense; argillaceous parting at 722.6.
- 722.6 - 723.3 Breccia; Matrix: Shale, calcitic; medium grayish-green; very friable; Clasts: Dolostone; light pinkish- to grayish-brown and limestone, light grayish-brown to brownish-gray; all clasts subangular to subrounded and showing no particular orientation; some up to 2 inches across.
- 723.3 - 724 Dolostone, slightly argillaceous, very slightly calcitic; light brownish-gray to medium grayish-brown; fine-grained; dense; laminated; some vertical fractures filled with calcite; contact with underlying unit gradational.
- 724 - 725.3 Limestone, argillaceous; medium grayish-brown to dark grayish-brown; fine-grained; dense; laminated; numerous small vertical fractures filled with calcite, especially around 725; argillaceous partings at 725.15 and 724.3; somewhat conglomeratic around 724; stromatolites at 724.6.
- 725.3 - 726.35 Limestone, argillaceous; light to medium grayish-brown; fine-grained; dense; numerous horizontal and vertical fractures around 725.0, commonly filled with calcite; 1.5 inch calcite-filled vug at 725.85; some pyrite present; argillaceous parting at 725.35; contact with underlying unit sharp. (.45 foot interval missing between 725.35 and 725.8).

- 726.35 - 727.1 Conglomerate; Matrix: Limestone, argillaceous; medium greenish-gray, fine-grained; dense; Clasts: Limestone, argillaceous; light grayish-brown to light brownish-gray; subangular to subrounded; some up to 2 inches across; contact with underlying unit fairly sharp.
- 727.1 - 727.8 Breccia; Matrix: Limestone, argillaceous, dolomitic in part; medium brownish-gray to pinkish-brown; fine-grained; fairly dense; Clasts: Limestone; varied; light to medium gray; pinkish-brown, medium brown; largely flat-pebble; possible "scour and fill" at 727.25; argillaceous parting at 727.1; contact with underlying unit gradational.
- 727.8 - 730.3 Dolostone, argillaceous, very slightly calcitic; light to medium grayish-brown; fine-grained; fairly dense; laminated; some hairline cracks healed with calcite; brecciated in part; contact with underlying unit sharp but irregular.
- 730.3 - 730.6 Dolostone, somewhat calcitic, argillaceous; medium brownish-gray; fine-grained; fairly dense; somewhat brecciated near top with clasts less than .25 inch across; contact with underlying unit fairly sharp.
- 730.6 - 731.25 Breccia; Matrix: Limestone, slightly argillaceous; light to medium gray; fine-grained; Clasts: Dolostone; argillaceous, somewhat calcitic; light grayish-brown with numerous black flecks and streaks; fine-grained; dense; numerous stylolites with over 1 inch relief on some; argillaceous partings at 731.25 and 730.6; contact with underlying unit sharp.
- 731.25 - 732.8 Limestone, slightly argillaceous; light to medium brownish-gray; fine-grained; dense; numerous fractures, commonly healed with calcite; numerous medium to dark brown argillaceous partings; somewhat brecciated in part; conodonts were absent in a sample from 731.2 - 731.65.

- 732.8 - 735.55 Breccia; Matrix: Limestone, somewhat dolomitic and slightly argillaceous; light to medium gray; fine-grained; fairly dense; Clasts: Dolostone, argillaceous; light to medium grayish-brown; fine-grained; fairly dense; angular to sub-rounded; some clasts up to 3 inches across, especially around 735; numerous argillaceous partings, upper part not as brecciated and showing more mottling and streaking with limestone and dolostone; contact with underlying unit somewhat gradational.
- 735.55 - 736 Dolostone, somewhat argillaceous, very slightly calcitic; light to medium grayish-brown; fine- to medium-grained; somewhat porous; somewhat streaked to mottled.
- 736 - 743.2 Dolostone, somewhat calcitic, argillaceous, medium grayish-brown; fine- to medium-grained; vuggy, especially around 738 with vugs commonly lined with calcite; many irregular argillaceous partings; somewhat stylolitic, conodonts fairly common 739.4 - 739.8.
- 743.2 - 744 Dolostone, argillaceous, slightly calcitic; light to medium grayish-brown; fine-grained; vuggy with some vugs partially filled with calcite; irregular argillaceous partings at 743.4 and 743.3; stylolitic around 743.2.
- 744 - 744.2 Breccia; Matrix: Dolostone, calcitic, argillaceous; medium grayish-brown; fine-grained; dense; Clasts: Dolostone, argillaceous; light to medium grayish-brown; fine-grained; dense; some up to 1.75 inches across; argillaceous parting at 744; contact with underlying unit somewhat gradational. A few fragmentary conodonts 744.5 - 744.75.
- 744.2 - 745 Dolostone, argillaceous; mottled light grayish-brown to medium brownish-gray; fine- to medium-grained; fairly dense; somewhat vuggy around 744.4; fossiliferous; 1 inch ga tropod at 744.7; some small crinoid debris and bivalves; fossils preserved as internal and external molds.

- 745 - 747.6 Dolostone, argillaceous, slightly calcitic; light to medium brownish-gray to light grayish-brown; fairly dense; conglomeratic in part; some vertical calcite-filled cracks; numerous vugs, especially from 745 to 746.4; vugs commonly filled with calcite; argillaceous partings at 745 and 746.5; poorly preserved internal and external molds of brachiopods from 745 to 746.4.
- 747.6 - 748 Dolostone, argillaceous, very slightly calcitic; light to medium greenish-gray with numerous streaks and flecks of dark gray to black; fine-grained; dense.
- 748 - 748.3 Limestone, argillaceous, possibly dolomitic; light grayish-brown to medium gray; somewhat brecciated in part; dense; crinkly laminae in part; argillaceous parting at 748, no conodonts 748 - 748.2.
- 748.3 - 748.5 Limestone, argillaceous, possibly dolomitic, light to medium grayish-brown; fine-grained; dense; coarsely and crinkly laminated; some small calcite-filled fractures; irregular argillaceous parting at 748.3.
- 748.5 - 748.75 Dolostone, argillaceous, calcitic; light to medium brownish-gray with numerous black flecks; fine-grained; dense; numerous calcite-filled fractures, stylolite at 748.6; argillaceous parting at 748.5.
- 748.75 - 749.1 Breccia; Matrix: Dolostone, argillaceous, slightly calcitic, light to medium brownish-gray; fine-grained; dense; Clasts: Dolostone, argillaceous, more calcitic than matrix; medium-gray; fine-grained; dense; subangular to subrounded; calcite-filled fractures cut through both clasts and matrix.

- 749.1 - 749.3 Dolostone, argillaceous, slightly calcitic; light to medium grayish-brown; fine-grained; dense; laminated; some calcite-filled cracks; contact with underlying unit irregular.
- 749.3 - 749.4 Limestone, dolomitic; light to medium brownish-gray to grayish-brown; fine-grained; dense; some argillaceous partings.
- 749.4 - 750.1 Limestone, slightly argillaceous, possibly dolomitic; light to medium grayish-brown; very fine-grained; dense; numerous fractures, commonly filled with calcite. (.3 foot interval from 749.4-749.7 missing), no conodonts 749.7 - 750.1.
- 750.1 - 751.4 Dolostone, argillaceous, slightly calcitic; light to medium grayish-brown with some streaks of gray; vugs with calcite and pyrite from 750.1 to 751; rock highly fractured around 751, fractures commonly healed with calcite.
- 751.4 - 753.2 Limestone, argillaceous, dolomitic; light to medium brownish-gray; fine-grained; dense; numerous argillaceous partings; stylolite at 753.1; somewhat brecciated in part, no conodonts 752.0 - 752.4.
- 753.2 - 756.1 Breccia; Matrix: Dolostone, very argillaceous, very slightly calcitic; medium grayish-brown; fine-grained; Clasts: Dolostone, argillaceous, slightly calcitic; light grayish-brown; angular to subrounded; sand-sized to over 6 inches across; possibly ripup from underlying unit.
- 756.1 - 757 Dolostone, argillaceous, very slightly calcitic; light grayish-brown; fine-grained, slightly porous; numerous argillaceous partings, no conodonts 756.1 - 756.4.

- 757 - 757.3 Dolostone, argillaceous, very slightly calcitic; light grayish-brown; fine- to medium-grained; porous in part due to dissolution of gypsum crystals.
- 757.3 - 758.5 Dolostone, argillaceous, very slightly calcitic; light grayish-brown; fine- to medium-grained; fairly dense; similar to underlying unit but not brecciated.
- 758.5 - 759.8 Breccia, Matrix: Limestone, white, Clasts: Dolostone, argillaceous, slightly calcitic; light brownish-gray; fine-grained; fairly dense; up to 2 inches across, 4 inch calcite-filled cavity at 758.8.
- 759.8 - 763.4 Dolostone, argillaceous, very slightly calcitic; mottled light greenish-gray and light grayish-brown; fine- to medium-grained; slightly porous; 2.5 and 3 inch vugs filled with brownish-orange calcite at 762.5; several small conodonts were recovered from a sample from 762.6-763; contact with underlying unit fairly sharp, no conodonts 759.85 - 760.35.
- 763.4 - 763.95 Dolostone, argillaceous, very slightly calcitic; light grayish-green to light grayish-brown; somewhat mottled; fine- to medium-grained; slightly porous; contact with underlying unit sharp.
- 763.95 - 764.35 Dolostone, argillaceous; mottled medium brownish-gray to light grayish-brown; fine-grained; fairly dense in medium-gray parts to somewhat porous ("pinhole") in light grayish-brown parts; contact with underlying unit fairly sharp.
- 764.35 - 765.65 Dolostone, argillaceous; light grayish-brown; fine-grained; fairly dense; laminated; small crinzoan debris and small Cyrtina? at 764.3; contact with underlying unit sharp.

- 765.65 - 766 Dolostone, argillaceous, light grayish-brown mottled with medium-gray; fine-grained; fairly dense although more porous in parts; some laminations; contact with underlying unit fairly sharp.
- 766 - 767 Dolostone, argillaceous; light grayish-brown to medium-grayish-brown; fine- to medium-grained; fairly dense; laminated; contact with underlying unit gradational.
- 767 - 773.75 Dolostone, argillaceous; light grayish-brown some black flecks but not nearly as prominent as in underlying unit; fine- to medium-grained; fairly dense; conodonts were abundant and well-preserved in a sample from 771.85-772.5. (.35 foot interval missing between 771 and 772).
- 773.75 - 776 Dolostone, argillaceous; light brownish-gray with prominent black flecks, fine- to medium-grained; fairly dense; possible hardground at 773.75.
- 776 - 779.6 Dolostone, argillaceous, light grayish-brown; fine- to medium-grained; fairly dense; possible hardgrounds at 776.9, 777.9 and 778.85.
- 779.6 - 784.4 Dolostone, argillaceous, very slightly calcitic; light grayish-brown, slightly mottled, possibly due to bioturbation; fine-grained; fairly dense; hardground at 779.6; possible hardground at 783.4; fragmentary brachiopod at 782.25; conodonts, sponge spicules, gastropods, spores and bivalves were recovered from a sample from 782.25-782.8.
- 784.4 - 784.9 Dolostone, argillaceous, very slightly calcitic, light brownish-gray, slightly mottled, possibly due to bioturbation; fine-grained; fairly dense; hardground with vertical boring at 784.4.

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- 784.9 - 787.8 Dolostone, argillaceous, very slightly calcitic; light brownish-gray, slightly mottled possibly due to bioturbation; fine-grained; fairly dense; slickenside and partly calcite-filled fracture at 786.5; hardground at 784.9; some small horizontal burrows; some poorly preserved brachiopods around 786.
- 787.8 - 790.6 Dolostone, argillaceous, very slightly calcitic; light brownish-gray, somewhat mottled, possibly due to bioturbation; fine-grained; fairly dense; some vugs over 2 inches partially filled with calcite; stylolites at 788.9 and 798.1; hardgrounds at 787.8 and 790.6; some slickensides; some horizontal burrows; small bivalve at 788.65.
- 790.6 - 794 Dolostone, argillaceous, very slightly calcitic; light to medium grayish-brown, mottled possibly due to bioturbation; fine-grained; dense; very argillaceous between 791.4 and 791.8; internal molds of small bivalves at 791.6; external mold of small gastropod at 791.6; conodonts, gastropods and bivalves were recovered from a sample from 792.75-793.1.
- 794 - 799.05 Dolostone, argillaceous, very slightly calcitic; light to medium grayish-brown; fine-grained; dense; stylolitic in part; some calcite-filled vugs up to 1.5 inches across; apparently bioturbated.
- 799.05 - 805.2 Dolostone, somewhat calcitic and argillaceous; light to medium grayish-brown, becoming flecked with black at 801.8; fine-grained; dense; highly stylolitic; some calcite-filled vugs up to 1.5 inches across; argillaceous parting at 805.1; fossiliferous; brachiopods and bryozoans common but generally small and poorly preserved; fossils apparently lie parallel to bedding, conodonts were abundant and agglutinated forams and gastropods common in a sample from 804.65-805.

- 805.2 - 805.65 Dolostone, very calcitic; medium to dark gray, mottled with pinkish-tan dolostone; medium- to coarse-grained; dense; some calcite-filled vugs; conodonts were abundant and fairly well-preserved in a sample from 805.2-805.5; sharp stylolitic contact with underlying unit.
- 805.65 - 810.7 Dolostone, argillaceous, somewhat calcitic; mottled medium to light grayish-brown; fine- to medium-grained; somewhat porous; large calcite-filled fracture around 810; fossiliferous with most fossils preserved as internal and external molds; brachiopods abundant, disarticulated but commonly unbroken; bryozoans, especially fenestrates, common, fish fragments at 807.2; fossils generally lie parallel to bedding; well-preserved conodonts and gastropods were recovered from a sample from 806.15-806.4.
- 810.7 - 812.6 Dolostone, argillaceous, calcitic; medium to light grayish-brown; fine-grained; somewhat porous; some small calcite-filled fractures; fossiliferous; brachiopods abundant; disarticulated but commonly unbroken; Chonetes and Atrypa common; fossils preserved as internal and external molds; some horizontal burrows at 811.75. (additional .3 foot interval between 810 and 811).
- 812.6 - 812.9 Dolostone, argillaceous; medium to dark grayish-brown; fine-grained; laminated; contact with underlying unit fairly sharp.
- 812.9 - 813.7 Dolostone, argillaceous, slightly calcitic; fine-grained; fairly dense; stylolitic at 813.4; slickenside at 813; fossiliferous, dominated by fragmentary brachiopods.
- 813.7 - 815 Dolostone, argillaceous, slightly calcitic; medium grayish-brown; medium-grained; porous; calcite-filled cavity at 815; fossiliferous, dominated by fragmentary brachiopods; some crinzoan debris, bryozoans and tentaculites; all fossils preserved as internal and external molds; contact with underlying unit sharp.

- 815 - 819.1 Dolostone, slightly calcitic, argillaceous; mottled light to medium grayish-brown, flecked with black; fairly dense; argillaceous parting at 817.75 and 818; slickenside around 817; very fossiliferous, brachiopods abundant, generally disarticulated but commonly not broken; bryozoans abundant especially fenestrates; conularid at 818.5; fossils generally preserved as internal and external molds, conodonts were abundant and well-preserved in a sample from 815.3-815.8; gastropods, sponge spicules, agglutinated forams and bivalves were also present.
- 819.1 - 820.3 Dolostone, slightly calcitic, argillaceous; mottled light to medium grayish-brown and flecked with black; somewhat porous; slickenside at 820; near horizontal fracture filled with calcite at 819.9; brachiopods common generally disarticulated but not broken, oriented parallel to bedding; preserved as internal and external molds.
- 820.3 - 822.6 Dolostone, slightly calcitic, argillaceous; light to medium grayish-brown; fairly porous; some vugs (some of which are external molds of brachiopods) over 1 inch across, partially filled with calcite crystals; fossiliferous; brachiopods abundant, generally disarticulated but not broken; bryozoans and crinozoan debris common; fossils preserved as internal and external molds and generally oriented nearly parallel to bedding.
- 822.6 - 836.4 Dolostone, argillaceous, slightly calcitic; mottled light grayish-brown and flecked with black; fine-grained; fairly dense; some fractures filled with calcite and pyrite; some dolostone clasts in some fractures; some vugs partially filled with calcite; fossiliferous; brachiopods abundant including Atrypa Cyrtina, productids and rhynchonellids; crinozoan debris common; all fossils preserved as internal and external molds; some burrows, conodonts common to abundant: 824.9 - 825.5, 835.5 - 835.9, 835.9 - 836.2, 836.2 - 836.4.

Note: The next three units are unlike the rock above and below them and are suspected of being out of place.

- 836.4 - 837.2 Conglomerate; Matrix: Dolostone, light grayish-brown; medium to coarse-grained; somewhat porous; Clasts: Dolostone; medium grayish-brown, greenish in some parts of unit; medium to coarse-grained; fairly dense; subrounded to subangular; oriented nearly horizontally; conglomeratic nature less well-defined in upper parts of unit; no conodonts from 836.4-836.7.
- 837.2 - 837.5 Dolostone; medium grayish-brown with darker crinkly laminae, especially near top; medium- to coarse-grained; fairly dense; no conodonts were recovered in a sample from 837.2-837.5.
- 837.5 - 838 Conglomerate; Matrix: Dolostone, somewhat calcitic, slightly argillaceous; medium brownish-gray; medium- to coarse-grained; slightly porous; Clasts: Dolostone; medium grayish-brown, medium- to coarse-grained; rounded; no obvious orientation of clasts.
- 838 - 839.6 Dolostone, argillaceous, slightly calcitic; medium brownish-gray; fine-grained; fairly dense; some calcite-filled fractures; conglomeratic in part; some brachiopods at 838.8 and 839.5.
- 839.6 - 843.5 Dolostone, argillaceous; mottled light to medium grayish-brown, flecked with black; fine-grained; dense; appears conglomeratic in part; conodonts were very common and well-preserved in a sample from 841.3-841.6; gastropods were also present.
- 843.5 - 847.7 Dolostone, argillaceous; mottled light to medium-gray; fairly dense; conglomeratic, especially toward base; some calcite-filled cracks and vugs.

- 847.7 - 848 Dolostone, somewhat cherty, and sandy; very light gray; some dark gray argillaceous material; fairly dense; some clasts.
- 848 - 851.4 Dolostone, argillaceous; light brownish-gray to medium to dark gray; somewhat conglomeratic, apparent "scour and fill" structure at 848.8.
- 851.4 - 856.5 Dolostone, argillaceous, some chert fragments; light brownish-gray; fairly fine-grained; slightly porous; some medium to dark brownish-gray argillaceous partings; somewhat laminated; 2 inch chert nodule at 854.1; a few fragmentary conodonts were recovered from a sample from 851.4-851.9, and 856.1 - 856.5.
- 856.5 - 857.1 Breccia; Matrix: Dolostone; light to medium grayish-brown; fine- to medium-grained; porous; Clasts: two lithologies: 1) Chert; gray to white; coarse sand to pebble size; subrounded to subangular; and 2) Dolostone; medium-gray; fine-grained; up to 1 inch across; a few fragmentary conodonts were recovered from a sample from 856.75-856.9.
- 857.1 - 858 Breccia; Matrix: Dolostone; light to medium grayish-brown; fine-grained; fairly dense; Clasts: two types: 1) Chert, white to gray; 2) Dolostone; gray; fine-grained; dense, angular to subrounded; some dark gray argillaceous partings; some vugs over .75 inch in diameter; a few fairly well-preserved conodonts were recovered from a sample from 857.1-857.4.
- 858 - 859.7 Dolostone; light brownish-gray; fine-grained; fairly dense; some solution channels lined with drusy calcite; fossiliferous including orthid brachiopods and trilobites (Ceraurus?); fossils preserved as internal and external molds.

859.7 - 860

Dolostone; light brownish-gray; fine-grained; fairly dense; solution channels up to .3 inch in diameter running horizontally and vertically; channels commonly filled with medium- to coarse-grained dolomite; some pyrite; some dark gray argillaceous partings; some brachiopods preserved as internal and external molds; a few fairly well-preserved conodonts were recovered from a sample from 859.8-860.

DESCRIPTION OF HUMMELL #4 CORE

NW $\frac{1}{4}$, SW $\frac{1}{4}$, SW $\frac{1}{4}$, sec. 18, T. 79 N., R. 28 W., Dallas Co., Iowa

Curtis R. Klug

Depth of Interval
(in feet)

- 1140? -1150.5 Dolostone, medium to dark grayish-brown; fine-grained; dense to somewhat porous ("pinhole"); highly fractured; some vugs; fractures and vugs commonly filled with calcite; some gypsum crystals in some vugs; stylolites at 1144.8 and 1146.9; crinozoan debris common; brachiopods, especially Atrypa between 1143 and 1147.6; conodonts were common but generally fragmentary in samples taken from 1140-1141, 1141-1142, and 1150-1150.35.
- 1150.5 -1160? Breccia; Matrix: Dolostone, argillaceous, light to medium grayish-brown, to medium gray limestone; fine-grained; numerous cracks and cavities filled with calcite; slickensides at 1159.6; Clasts: Dolostone and limestone, medium grayish-brown, light grayish-brown; light brownish gray and dark gray; all fine-grained, dense to porous; mostly angular but some rounded; some over 4 inches across; no preferred orientation noted.
- 1160? -1161.1 Dolostone, argillaceous, light to medium brownish-gray, fine-grained; somewhat porous ("pinhole") especially at base; no conodonts were recovered in a sample taken from 1160.4-1160.7; the acid-insoluble residue from this sample was found to consist mostly of finely disseminated celestite; contact of this unit with the underlying unit is rather gradational.
- 1161.1 -1163.5? Dolostone, argillaceous, light to medium grayish-brown streaked with laminae of medium to dark gray fine-grained, dense; possible mudcracks at 1162.25; some vertical burrowing.

Hummell #4 Core

- 1163.5? - 1167 Dolostone, light to medium grayish-brown; medium- to coarse-grained; somewhat porous, apparently shows scour and fill structures; a few rounded clasts of lithology similar to the underlying unit present; clasts generally less than .5 inches across.
- 1167 - 1174.4 Dolostone, argillaceous, light to medium grayish-brown; fine-grained; dense; some argillaceous partings; somewhat laminated; laminae in part disrupted by burrowing; scattered megaspores; a sample from 1169.85-1170.3 produced a few small conodonts.
- 1174.4 - 1175 Dolostone, slightly argillaceous; light to medium grayish-brown; fine-grained; somewhat porous ("pin-hole"); crinozoan debris abundant; bryozoans common; scattered megaspores; contact with underlying unit sharp.
- 1175 - 1177.45 Dolostone, argillaceous, slightly calcitic; light to medium grayish-brown streaked with short lines of medium to dark gray; fine-grained; slightly porous ("pinhole"); some pyrite coated and bored rounded clasts of medium to dark gray, fine-grained dolostone; clasts generally less than 1 inch across; hardground at 1175; bryozoans (mostly *Sulcorettopora*) abundant, causing the streaking mentioned above; brachiopods (including *Cyrtina*) common; crinozoan debris abundant; some fish fragments; fossils (except fish) preserved as internal and external molds; bryozoans generally oriented parallel to bedding.
- 1177.45 - 1180.95 Dolostone, argillaceous; light to medium grayish-brown mottled with streaks of medium-gray; stylolites at 1178.9 and 1180.65; argillaceous parting at 1179.05; 2.5-3 inch calcite-filled vugs at 1177.45 and 1180.65; scattered megaspores; conodonts and pyritized sponge spicules were common in a sample from 1179.8-1180.1; contact with underlying unit fairly sharp.
- 1180.95 - 1189.65 Dolostone, argillaceous; light to medium brownish-gray, somewhat mottled; fine-grained; dense; some stylolites; some hairline diagonal cracks healed with calcite between 1182 and 1183; slickensides at 1188.35; hardground at 1180.95; scattered megaspores and crinozoan debris; conodonts were few and fragmentary in samples from 1181.1-1181.3 and 1189.25-1189.65.