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CONODONT COLOR ALTERATION INDEX (CAI) MAP AND CONODONT-BASED AGE DETERMINATIONS FOR THE WINCHESTER 30′ × 60′ QUADRANGLE AND ADJACENT AREAS VIRGINIA, WEST VIRGINIA, AND MARYLAND

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INTRODUCTION

Most of the conodont data presented in this report (table 1) were acquired to support 1:100,000-scale geologic mapping of the Winchester 30′ × 60′ quadrangle by the U.S. Geological Survey (USGS). Conodonts were chosen to provide a biostratigraphic framework for the Upper Cambrian to Mississippian marine carbonate rocks that make up about 25 percent of the Paleozoic strata exposed in the quadrangle (~ 2,130 m of the approximately 9,450 m) of Paleozoic strata exposed in the quadrangle). Thicknesses of stratigraphic units are from McDowell (1991), our own measurements, and from many of the stratigraphic reports and geologic maps listed in the references cited. Conodont biostratigraphic and color alteration index (CAI) analyses help identify stratigraphic units and structural discontinuities, particularly in the Upper Cambrian to Middle Ordovician chiefly carbonate rocks of the Shenandoah Valley and North Mountain fault zone. Conodont biofacies analyses provide additional information about the provincial affinities of the conodonts and the depositional environment of the rocks that contain them. Lithostratigraphic, biostratigraphic, paleoenvironmental, and CAI data for all conodont samples are given in table 1.

Conodonts are toothlike, relatively transparent, lamellar, apatitic microfossils (commonly 0.1–1 mm in size) that are biostratigraphic and organic metamorphic indices. Conodonts are the only known hard parts of an extinct group of primitive, probably jawless fishes that are found in marine rocks of Late Cambrian through Triassic age. They are among the foremost biostratigraphic indices throughout their geologic range. More than 100 conodont zones have been used to subdivide latest Cambrian through Mississippian time. At least 27 of these zones were recognized in the carbonate rocks of the Winchester quadrangle (see accompanying stratigraphic column). Conodonts are most easily recovered from carbonate rocks and poorly indurated clastic rocks, although their abundance generally varies inversely with the rate of sedimentation. About 75 percent of the Paleozoic rocks in the Winchester quadrangle are of inappropriate lithology for conodont extraction or are too old to contain true conodonts. These include indurated fine- to coarse-grained, relatively rapidly deposited siliciclastic rocks, rocks that formed in restricted marine and nonmarine environments, and rocks of Middle Cambrian age or older. Despite the great biostratigraphic utility of conodonts, their lifestyle(s) remains uncertain. The widespread occurrence of conodonts in marine rocks deposited in a variety of depositional environments has influenced many researchers to propose a pelagic mode of life for the conodont animal. Many taxa, however, are not obviously cosmopolitan or even provincial, and exhibit a spatial distribution influenced by poorly constrained, paleoenvironmental parameters. Undoubtedly, water temperature and chemistry, trophic resources, and turbidity were among the chief factors that influenced conodont distribution. The paleogeographic distribution of conodonts suggests they undoubtedly had more than one mode of life ranging from nektobenthic to fully pelagic.

Conodont elements grew throughout the life of the animal by periodic addition of a centrifugally deposited apatite layer followed by a layer of organic matter (e.g., Burnett and Hall, 1992). During heating, the organic matter sealed between transparent apatite lamellae undergoes carbonization that produces gradual visible color changes from pale yellow, to amber, light brown, dark brown, and black in the range of 50° to 300°C (Epstein and others, 1977). Above 300°C, conodonts change from black, to gray, opaque white, and, finally, to crystal clear as a result of carbon loss, release of water of crystallization, and recrystallization. All these color changes have been observed in natural collections and reproduced and calibrated by pyrolysis experiments in the laboratory (Epstein and others, 1977; Rejebian and others, 1987). Because conodonts are index fossils as well as organic metamorphic indices, they have been used to produce time-based isograd maps that can, in turn, be used to assess depth and duration of burial, hydrocarbon and mineralization potential, and timing of tectonic events (e.g., Harris and others, 1978, 1980; Burnett, 1987; Nowlan and Barnes, 1987; Read and others, 1992).

CONODONT COLLECTIONS

Most conodont samples in the Winchester 30′ × 60′ quadrangle and adjacent area were chosen to obtain biostratigraphic control and (or) CAI values and therefore have a biostratigraphic and structural bias. Samples were preferentially taken at tops and bottoms of formations and adjacent to structural discontinuities. Fourteen samples were collected along the North Mountain fault zone. Of the 198 conodont samples listed in Table 1, 181 were collected specifically for this study. Table 2 shows the distribution of conodont samples by stratigraphic unit as well as the distribution of CAI values in each unit. Some stratigraphic units, such as the Keyser Limestone, were abundantly sampled even though they were already biostratigraphically well constrained (Denkler and Harris, 1988a). These units were sampled preferentially because they consistently produce conodonts, thereby insuring a CAI data point. Alternatively, some units known to be poorly productive of conodonts and not well constrained biostratigraphically or biostratigraphically controversial were relatively abundantly sampled to establish age control (e.g., the Mahantango Formation and Harrell Shale).

All conodont samples, productive and barren, are shown on the map. The mapped area is divided into a matrix of 7.5-minute quadrangles that are designated by an alpha-numeric system. Map localities are numbered consecutively within each 7.5-minute quadrangle in order of decreasing age; these numbers are keyed to Table 1. The map symbol indicates the age and is accompanied by

the CAI value in **bold type** and an *italicized* quadrangle map number (see explanation on map). Table 1 gives the geographic and stratigraphic position, alpha-numeric designation, age, CAI value, faunal list, biofacies, depositional environment, sample and residue weights, and rock and heavy-mineral description for each sample.

CONODONT BIOSTRATIGRAPHY AND CAI

Stratigraphic units that were not sampled for conodonts are not discussed below; thicknesses for these units are given in the stratigraphic column.

Conococheague Limestone (uppermost Cambrian and lowermost Ordovician) [~750 m]

The Conococheague Limestone consists of laminated to ribbon limestone, dolostone and, near the top, minor sandstone to sandy carbonate and is locally stromatolitic (Butts and Edmundson, 1966). Overall, the unit is poorly productive of conodonts and, where possible, collections were taken from rare, finely bioclastic beds. The upper 100 m were preferentially sampled in order to refine the position of the Cambrian-Ordovician boundary. The Cambrian-Ordovician Boundary Working Group of the Subcommission on the Ordovician System of the Commission on Stratigraphy of the International Union of Geological Societies has recommended that conodonts be used to position the base of the Ordovician System (see Norford, 1988). Presently, the base of the *Cordylodus lindstromi* Zone is the favored level (see stratigraphic column). Orndorff (1988) recovered conodonts indicative of the *C. intermedius* Zone or *C. lindstromi* Zone at least 20 m below the top of the Conococheague in the Edinburg 7.5-minute quadrangle (about 15 km south of the central southern border of the Wardensville 7.5-minute quadrangle, E2). His collections indicated that the Cambrian-Ordovician boundary is either just below or above the top of the Conococheague, but did not confirm the presence of Ordovician strata.

Of 11 samples collected from the Conococheague Limestone, four were barren, including the only sample taken from the lower part of the formation (AG–1). A sample near the top of the Conococheague (WI–2) produced *C. lindstromi* and *Eoconodontus notchpeakensis*, among other conodonts, indicating the *C. lindstromi* Zone and confirming an earliest Ordovician age for beds near the top of the formation. Other biostratigraphically significant collections from the upper part of the Conococheague include: 1) the *P. muelleri* Zone or *Eoconodontus* Zone (WH–1a, ~70 m below top of formation); 2) the *Eoconodontus* Zone (BO–1 and WH–1b, ~60 m and ~67 m below top of formation; MA–1); and 3) the *Clavohamulus elongatus* Subzone of the *C. proavus* Zone (WI–1, ~100 m below top of formation).

CAI values in the Conococheague Limestone generally range from 4–4.5 to 4.5–5. One anomalously low value of 3.5–4 (TB–1) is from a fault slice in the North Mountain fault zone, suggesting derivation of the slice from a lower thrust sheet of lower prethrusting thermal maturity. A range of CAI values from 4.5 to 7 but exclusive of 5, occurs at locality WI–1, suggesting some bleaching of conodonts that may be related to hydrothermal activity. Some of the conodonts in this sample are deformed and severely fractured.

The average CAI value in the Conococheague Limestone is about 4.5, indicating these conodonts reached about 250°C. The stratigraphic succession and isopach trends in this part of the Appalachian basin suggest burial depths of at least 8 km (thicknesses of stratigraphic units are given below or in the accompanying stratigraphic column). Thermal maturity studies in the Appalachian basin (Harris and others, 1978; Harris, 1979) suggest average geothermal gradients for this part of the basin. According to Robert (1988), sedimentary basins have average geothermal gradients of 25° to 27°C/km. Using 25°C/km, a surface temperature of ~15°C, and a burial depth of at least 8 km, the Conococheague conodonts should have reached at least 200°C. Because CAI values in the Conococheague are somewhat higher, sedimentary and tectonic overburden were probably at least 10 km and (or) geothermal gradients may have been higher (see Beaumont and others, 1987).

Beekmantown Group

Stonehenge Limestone (lower Lower Ordovician) [90–250 m]

The contact between the Conococheague and Stonehenge Limestones is gradational and generally concealed, but can be approximately located by sandstone float that marks the upper part of the Conococheague. The Stonehenge is fine- to medium-grained, thick-bedded, locally laminated limestone that generally produces abundant, biostratigraphically diagnostic conodonts. All nine samples taken for this study produced index species. A sample near the base of the formation (IN–1a) contains conodonts of the *C. angulatus* Zone or *R. manitouensis* Zone. Another sample 100 m higher at the same locality (IN–1b) is indicative of the *R. manitouensis* Zone. It is likely that the lower sample is of *angulatus* Zone age because the upper part of the underlying Conococheague is as old as the *lindstromi* Zone and no younger than the *angulatus* Zone. All other samples from the Stonehenge are representative of the *R. manitouensis* Zone including a collection from near the top of the formation (BO–2).

Like the Conococheague Limestone, CAI values in the Stonehenge Limestone generally range from 4–4.5 to 4.5–5. This seems reasonable as only a few hundred meters separates most samples from the two formations. One sample has a CAI as low as 4.

Rockdale Run Formation (Lower and lowermost Middle Ordovician) [450–900 m]

The contact of the Stonehenge Limestone and Rockdale Run Formation is placed at the base of the first massive dolostone. The Rockdale Run consists of shallowing-upward cycles of limestone to dolostone; white chert and stromatolites are locally abundant. All but one of the 13 samples taken produced generally common to abundant conodonts. The lower part of the formation contains conodonts of the *R. manitouensis* Zone and low Fauna D (e.g., MI–3 and FR–1), the middle part contains Fauna D (WI–4) and *O. communis* Zone (WH–2) conodonts, and the upper part was not sampled. Our conodont collections (Repetski and Harris, 1986) from the upper 125 m of the Rockdale Run along the C & O Canal in the Williamsport 7.5-minute quadrangle (~15 km northeast of the northeast corner of the Winchester 30′ × 60′ quadrangle) indicate a *M. flabellum-T. laevis* to lower *H. sinuosa* zonal interval. The same interval occurs in the uppermost part of the Beekmantown Group at Tumbling Run in the Toms Brook 7.5-minute quadrangle (F1; TB–2). It seems likely that the upper part of the Rockdale Run in the Winchester quadrangle is of similar Middle Ordovician age.

CAI values generally range from 4–4.5 to 4.5–5 (table 2), identical to values in the underlying Conococheague and Stonehenge Limestones. Two collections having a somewhat lower CAI

value of 4 (TS–2, 3) are from a fault slice within the North Mountain fault zone.

Pinesburg Station Dolomite (lower Middle Ordovician) [~150 m]

The Pinesburg Station Dolomite, the highest formation of the Beekmantown Group, consists of massive, laminated, stromatolitic, generally saccharoidal dolostone. Solution collapse features and exposure surfaces are common. These rocks represent some of the most restricted marine deposits in the Beekmantown Group. Consequently, conodonts are relatively rare and large samples (~10 kg) should be processed for any chance of conodont recovery. Almost all collections are from the upper half of the formation and indicate the *H. holodentata* Zone into the *C. friendsvillensis* Zone (see stratigraphic column). *Phragmodus flexuosus* occurs in the uppermost beds at locality MI–5 indicating an age no older than the *C. friendsvillensis* Zone. At the type locality along the Potomac River in Maryland, the lower part of the formation extends into the *H. sinuosa* Zone (Repetski and Harris, 1986).

Background CAI values in the Pinesburg Station Dolomite are chiefly 4. At least two samples have a range in CAI values that include 4, 4.5, 5.5, and 6 as well as corroded conodonts. Conodonts from the Pinesburg Station in northern Virginia and Maryland are characteristically corroded and have a range in CAI values. A broad range of CAI values within a single sample generally implies hydrothermal alteration (Rejebian and others, 1987). Because CAI values of 4 and 4.5 occur with CAIs of 6, it is likely that relatively low-temperature brines produced the CAI 6 values by corroding some conodonts and oxidizing their organic matter. Solution collapse structures, combined with many features that indicate a restricted marine depositional regime for the Pinesburg Station Dolomite, suggest the likelihood of evaporite-bearing horizons that could have produced low-temperature saline solutions and permeable pathways for hydrothermal fluids.

New Market Limestone (Middle Ordovician) [~20 m]

This unit of medium- to dark-gray, irregularly thin-bedded to massive carbonate mudstone to micrite containing abundant fenestrae, local algal laminae, and gastropods, almost always yields conodonts (table 2). The conodonts are predominantly robust fragments of warm, shallow-water forms. Conodonts and sedimentary features suggest postmortem transport within or into an intermittently restricted environment. The presence of rare *Phragmodus flexuosus* from the base (MA–4) to the top of the formation indicates an interval from the *C. friendsvillensis* Zone into the lowermost *Pl. aculeata* Zone. A collection from the base of the formation in the Stephenson quadrangle (SS–2b) contains *Paraprioniodus costatus* which, combined with nearby occurrences of *Ph. flexuosus*, restrict the age of the base of the New Market to a level within the *C. friendsvillensis* Zone. The occurrence of *Baltoniodus gerdae* through the upper half of the succeeding Lincolnshire Limestone in the southeast part of the Winchester 30′ × 60′ quadrangle and in much of the Chambersburg Limestone in the northeast indicates that the top of the New Market is probably no younger than the *C. sweeti* Zone.

CAI values in the New Market Limestone are predominantly 4 and 4–4.5. This unit is at least 1 km higher in the section than the Conococheague and Stonehenge and has proportionately lower CAIs that indicate the host rock reached about 200° to 230°C. Once again, lower CAI values of 3.5–4 occur in two fault slices in the North Mountain fault zone (MF–3, WH–3).

Edinburg Formation (Middle Ordovician) [~160 m]

The Edinburg Formation consists of medium-dark- to dark-gray, irregularly nodular-bedded, argillaceous, bioturbated carbonate mudstone to wackestone containing abundant skeletal debris and minor calcareous shale. It overlies the more massive and less argillaceous Lincolnshire Limestone. Both units are restricted to the southeast part of the Winchester 30′ × 60′ quadrangle. The Edinburg consistently yields sparse to common conodonts (table 2). Conodonts from 17 m above the base of the Edinburg (TB–2c) represent the *Baltoniodus gerdae* Subzone of the Amorphognathus tvaerensis Zone and are Blackriveran. Those from the upper 0.5 m (MI–9) are of Middle Ordovician age, no younger than the lower Ph. undatus Zone.

CAIs are virtually the same as for the New Market (table 2), predominantly 4 and 4–4.5, and also somewhat lower (3.5 and 3.5–4) in fault slices along the North Mountain fault zone (TB–5, MF–4)

Chambersburg Limestone (Middle Ordovician) [~175 m]

The Chambersburg Limestone contains interbedded dark- to medium-gray, knobbly bedded, fossiliferous, fine-grained wackestone, thin-bedded to massive carbonate mudstone, and irregularly thin-bedded, argillaceous carbonate mudstone. The unit becomes increasingly argillaceous towards the top. The contact with the underlying New Market Limestone appears to be gradational over an interval of about 2–3 m. The Chambersburg Limestone is laterally gradational into the Lincolnshire Limestone and Edinburg Formation to the southwest. Where the Lincolnshire is absent, the knobbly and argillaceous limestone interval between the New Market Limestone and Martinsburg Formation is assigned to the Chambersburg. The Chambersburg occurs in the northeastern part of the Winchester 30′ × 60′ quadrangle, east of the North Mountain fault zone. The most complete exposure of the Chambersburg in the Winchester quadrangle area is in the Stephenson 7.5-quadrangle (I3). About 130 m of Chambersburg overlies the New Market and about another 40 m of the uppermost Chambersburg are covered (R. C. Orndorff, USGS, oral commun., 1993).

Conodonts are common to abundant in the Chambersburg but become less common toward the top of the formation as the unit becomes finer grained and more argillaceous. Several samples that produced abundant biostratigraphically diagnostic conodonts were taken from a roadcut that exposes at least half the formation (IN–5). Most of the succession is within the *B. gerdae* Subzone of the *A. tvaerensis* Zone (IN–5a–h), but the highest collection (IN–5i) contains representatives of *Periodon* aff. *P. grandis* that suggest a level above the *gerdae* Subzone. CAI values are predominantly 4 and, rarely, 4–4.5.

"Oranda" Formation (Middle Ordovician) [~230 m]

As originally defined (Cooper and Cooper, 1946), the Oranda Formation is too poorly exposed and too thin to map at a scale of 1:100,000 but is mappable at a scale of 1:24,000 (Rader and Biggs, 1976). The contact with the underlying Edinburg is at the base of the lowest calcareous siltstone. The Oranda of Cooper and Cooper (1946) consists of dark-gray shaly carbonate mudstone and lesser calcareous shale and siltstone. For mapping purposes in the Winchester quadrangle, the "Oranda" is provisionally modified to include the overlying platy carbonate-bearing interval that has been previously included in the Martinsburg Formation (Orndorff and others, 1993). Conodonts are rare and biostratigraphically relatively unrewarding in the "Oranda"(tables 1 and 2). The few

productive samples yielded coniform elements and rare phragmodids and periodontids that are probably postmortem winnows. The occurrence of *Phragmodus undatus* (TB–3) and a bentonite chemically fingerprinted as the Millbrig Bentonite Bed (S.M. Bergström, Ohio State University, oral commun., February 1993) in the lower 100 m of the formation restricts this part of the unit to the lower *undatus* Zone. CAI values are 4, 4–4.5, and 4.5.

Martinsburg Formation (Upper and Middle Ordovician) [~1,100–1,600 m]

The Martinsburg Formation consists of interbedded shale, silty shale, and lesser greywacke siltstone and greywacke sandstone. Calcareous intervals occur in the lower part of the formation. Greywacke-sandstone is commonly graded (fining upwards), lenticular, and becomes thicker bedded and more abundant in the upper part of the formation; it makes up less than 10 percent of the formation. Following Orndorff and others (1993), the interval of platy limestone interbedded with shale formerly included in the lower part of the Martinsburg is here included in the "Oranda" Formation. The contact between the Martinsburg and "Oranda" is gradational. Only one sample (WA–1), from the top of the Martinsburg near the axis of the North Mountain anticline (fig. 1), was calcareous enough to process for conodonts. The sample is from the *Orthorhynchula* bed and produced only long-ranging conodonts that merely indicate a Late Ordovician age. The CAI value at the single Martinsburg locality is 3.5–4.

McKenzie Formation (Upper Silurian; Ludlovian) [~25 m]

A carbonate bed that is questionably within the highest part of the McKenzie Formation was sampled for conodonts at one locality (YS—1). Alternatively the sample could be within the lower Wills Creek Formation. Farther west and south, strata assigned to the McKenzie Member of the Mifflintown Formation by Helfrich (1975) commonly contain carbonate beds which yield *Ozarkodina snajdri snajdri* in their upper part. The lower member of the Tonoloway Limestone also contains *O. s. snajdri* in addition to *O. s. crispa* indicating the Lower *O. remscheidensis* Subzone (Denkler and Harris, 1988b) of the late Ludlovian. It is likely that the upper part of the McKenzie Member of Helfrich (1975) represents the *snajdri* Zone. Our conodont collection that is questionably referred to the McKenzie Formation appears to be somewhat older as it contains only specimens of a bizarre form that we assign to aff. "*Ozarkodina*" cf. "*O.*" *douroensis* of Uyeno (Thorsteinsson and Uyeno, 1980). "*O.*" cf. "*O.*" *douroensis* is known from beds of early or possibly middle Ludlovian age in the Canadian Arctic islands and central Nevada. Paleontologic constraints and regional stratigraphic relationships in the central Appalachian basin, however, suggest this collection is of middle Ludlovian, possibly *P. siluricus* Zone age.

All conodonts collected from Upper Silurian and Lower Devonian rocks west of the North Mountain fault zone and east of Mill Creek Mountain in the Winchester 30′ × 60′ quadrangle have CAI values of 3.5–4 or 4. The collection from the McKenzie Formation is from this area and has a CAI of 4.

Wills Creek Formation (Upper Silurian; upper Ludlovian) [18–~80 m]

The Wills Creek Formation generally increases in thickness westward across the quadrangle. It consists of greenish-, reddish-, or dark-gray, calcareous shale containing interbedded argillaceous, generally laminated, carbonate mudstone to micrite. Of the two samples of Wills Creek collected, only one produced conodonts. This unit formed in a chiefly restricted carbonate mudflat environment (Denkler and others, 1983) and is poorly productive of conodonts (see Helfrich, 1975). The *Ozarkodina snajdri crispa* Zone occurs in the middle part of the Wills Creek at Pinto, Md., in the Cresaptown 7.5-minute quadrangle (C6) just north of the Winchester quadrangle (Helfrich, 1975). Conodonts in the one productive sample (YS–2) merely indicate a Ludlovian age and have a CAI of 3.5–4, typical for this part of the section in this area.

Tonoloway Limestone (Upper Silurian; upper Ludlovian and Pridolian) [15–180 m]

The Tonoloway Limestone thickens westward and consists of medium- to dark-gray, thin-bedded to massive, generally laminated carbonate mudstone, argillaceous micrite, and wackestone-packstone locally containing comminuted shell debris and, in the middle part of the formation, stromatoporoid biostromes. Conodonts are rare to common (table 2) but virtually absent in the laminated carbonate mudstones; large samples (~10 kg) are required for adequate yield. Conodonts from this and correlative units were described by Helfrich (1975) and Denkler and Harris (1988b). The lower member is within the Lower *O. r. remscheidensis* Subzone, the middle member within the *H. peniculus* Zone, and the upper member is within the *O. r. remscheidensis* Zone (Denkler and Harris, 1988b). The Ludlovian-Pridolian boundary appears to coincide with the boundary between the lower and middle members of the formation. The top of the formation is still within the Pridolian. Our most biostratigraphically diagnostic collection (WS–1), from the lower part of the Tonoloway, contains *O. remscheidensis remscheidensis, O. s. snajdri*, and *O. s. crispa* that indicate the Lower *O. remscheidensis* Subzone. CAI values are predominantly 3.5–4 and, less commonly, 4.

Helderberg Group

Keyser Limestone (uppermost Silurian and lowermost Devonian) [~20–40 m]

The Keyser Limestone is medium- to medium-dark-gray, chiefly irregularly bedded to locally crossbedded, medium-bedded to massive (locally thin bedded), fossiliferous, bioturbated, packstone/grainstone and lesser wackestone. This unit nearly always yields common to abundant conodonts so that it was preferentially sampled to insure CAI data points (table 2). Elsewhere in the Appalachian basin, the Silurian-Devonian boundary lies about 3 m below the top of the Keyser on the basis of conodonts (Denkler and Harris, 1988a). All but possibly two samples collected for this study are of Pridolian age. Sample CB–3c contains *Oulodus elegans* and *O. cristagalli*, indicating a very latest Pridolian age (Denkler and Harris, 1988a), and GC–2a contains *O. elegans* and *Icriodus* sp. indet. suggesting a probable earliest Lochkovian age. The latter is 3.6 m below another Keyser sample (GC–2b) which must also be of probable earliest Lochkovian age.

CAI values in the Keyser Limestone are predominantly 3.5–4, uncommonly 4, and rarely 3.5 (table 2) suggesting these rocks reached at least 180° to 200°C. Currently, at least 5 km of overburden lies on the Keyser in the central Winchester quadrangle which would account for burial of only about 150°C assuming average geothermal gradients. The CAI, however, suggests that at least 2 km of overburden were stripped from the area since the Paleozoic.

New Creek Limestone (lowermost Devonian; lower Lochkovian) [2–4 m]

This thin unit of medium-light- to medium-gray, medium-bedded to massive, planar- to crossbedded, fossiliferous packstone to grainstone consistently produces common to abundant, but generally abraded and fragmentary conodonts. Species assemblages include oulodids, ozarkodinids, coniform apparatuses, and icriodids. The occurrence of *Icriodus woschmidti* in the upper meter of the formation (KE–3) as well as in the uppermost part of the underlying Keyser Limestone restricts the New Creek Limestone to the earliest Lochkovian *I. woschmidti* Zone (see Denkler and Harris, 1988a). CAI values are 3.5 and, less commonly, 3.5–4.

Corriganville Limestone (lowermost Devonian; lower Lochkovian) [4–10 m]

The Corriganville Limestone is a fossiliferous (chiefly brachiopods and echinoderms), partly argillaceous, irregularly bedded, medium-gray packstone-grainstone to calcisiltite that characteristically contains medium- to light-gray chert nodules and lenses that form as much as 50 percent of the unit. Conodonts are rare to common; all four samples collected were productive. At one locality (LO–1) the unit contains *Icriodus woschmidti*, indicating an earliest Lochkovian age. Elsewhere, *Oulodus cristagalli* is common, suggesting that the formation is no younger than the middle Lochkovian *O. delta* Zone. CAI values are 3–3.5 and 3.5, slightly lower than in the underlying New Creek Limestone.

Licking Creek Limestone (Lower Devonian; Lochkovian and lower Pragian?) [~35 m]

The Licking Creek Limestone is restricted to the easternmost outcrop belts of Lower Devonian rocks west of the North Mountain fault zone. The lower member of the Licking Creek (Cherry Run Member) consists of fossiliferous, irregularly and wavy bedded packstone-wackestone to silty carbonate mudstone containing beds, lenses, and nodules of dark-gray chert to irregular beds of chert containing nodular limestone and rare calcareous sandstone and siltstone. The upper member is fossiliferous, massive- to medium-bedded, medium- to coarse-grained, locally quartzose packstone to grainstone. Conodonts are rare to common in the lower member but become increasingly abundant (chiefly icriodids) in the upper member. The basal meter of the Licking Creek yields *I. woschmidti* Zone conodonts (MF–6) and *E. s. sulcatus* or *E. s. kindlei* Zone conodonts in the upper member (GO–3). This unit appears to represent much of the Lochkovian. CAI values range from 3.5–4 to 4.

Shriver Chert (Lower Devonian; upper Lochkovian) [~50 m]

The Shriver Chert is a dark-gray, locally fossiliferous, cherty calcisiltite to nodular and irregularly bedded chert containing wackestone to carbonate mudstone nodules and lenses. Towards the top of the unit, silt- and sand-sized quartz becomes increasingly abundant. The contact with the overlying Oriskany Sandstone is gradational. Conodonts are not easily recovered from this unit because of pervasive silicification. Carbonate lenses and nodules produce rare to common conodonts. A sample 12.5 m below the top of the formation (ME–1c) produced conodonts of the late Lochkovian *P. pesavis* Zone. CAIs are 3–3.5 and 3.5.

Oriskany Sandstone (Lower Devonian; Pragian) [18–90 m]

In the eastern part of the Winchester quadrangle, the Oriskany Sandstone is a heterogeneous unit consisting of irregularly interbedded light- to medium-gray, thick-bedded, locally conglomeratic and crossbedded, brachiopod-bearing calcareous sandstone and quartzose wackestone to grainstone. Westward, siliciclastics and thickness increase and carbonate beds become rare. Conodonts are rare to common in the carbonate-rich beds and indicate a late Lochkovian or Pragian age. The unit is probably mostly Pragian in age because conodonts from the upper part of the underlying Shriver Chert and Licking Creek Limestone are of late Lochkovian and probable early Pragian age, respectively. Collections from the western part of the Winchester quadrangle contain redeposited conodonts of late Middle or Late Ordovician age (OF–2, RO–3, 4) indicating that beds as old as late Middle or Late Ordovician were exposed to the east and southeast and shed quartz-rich sediment and rare conodonts that were spread longshore during deposition of the Oriskany. CAI values range from 3.5 to 4.

Needmore Shale (Lower and lowermost Middle Devonian) [30–~140 m]

In most of the Winchester quadrangle, the Needmore Shale disconformably overlies the Oriskany Sandstone. Most if not all of the Emsian and probably part of the Pragian are absent. The Needmore consists of dark-gray to greenish-gray shale, silty shale, and calcareous shale containing, chiefly in the upper part, scattered, relatively thin carbonate mudstone beds and nodules. Of four samples collected from calcareous and carbonate beds only one sample (MF–8), 40 m above the base, produced conodonts. The conodonts and time constraints from the overlying Tioga Ash Bed, indicate an interval from the *Po. costatus patulus* Zone into the lower part of the *Po. c. costatus* Zone. The Lower-Middle Devonian boundary is positioned within the *Po. c. patulus* Zone so that the Needmore probably straddles the boundary. The Tioga Ash Bed lies within the *Po. c. costatus* Zone and at the base of the overlying Marcellus Shale in the eastern part of the Winchester quadrangle. Monazite crystals from the ash bed at its type locality in Union County, Pa., have $^{207}Pb/^{235}U$ ages of 390.0±0.5 Ma (Roden and others, 1990). The CAI value at sample MF–8 is 4.

Marcellus Shale (Middle Devonian; Eifelian) [~100–~150 m]

The Marcellus Shale is mainly dark-gray to grayish-black, pyritic, laminated shale containing carbonate concretions and rare carbonate mudstone beds, the most widespread of which is the Purcell Member. The base of the formation includes the Tioga Ash Bed. Eight conodont samples were collected (table 2); three were barren, two produced indeterminate fragments, two contained conodonts of Middle Devonian age, and one sample from the Purcell Member (SP–8) produced conodonts of the *Po. c. costatus* Zone. According to R.C. McDowell (USGS, oral commun., 1993) the Purcell occurs ~45 to 60 m above the base of the formation in the Mountain Falls 7.5-minute quadrangle. Dennison (1963) shows the Purcell in the lower one-third of the Marcellus in the Keyser 15-minute quadrangle. A sample (MF–9) from a calcareous interval that is apparently younger than the Purcell produced conodonts of late Eifelian or early Givetian (probably late Eifelian) age. Conodonts from the Marcellus have a range in CAIs of 3 to 4.

Mahantango Formation (Middle Devonian; Givetian) [~60–365 m]

The Mahantango Formation is composed largely of shale, mudrock, siltstone, and sandstone that is locally fossiliferous. Some beds are very slightly calcareous. Locally, a coralline, calcareous, sandy siltstone, the Pokejoy Member (0–2 m), occurs 1–2 m below the top of the Mahantango. Rugose corals as much as 3 cm in

diameter are abundant and are generally not in growth position. Conodonts are not readily recovered from the Mahantango. Fifteen samples were collected and all but one sample are from the Pokejoy or probable Pokejoy Member. Nine samples were barren, six produced conodonts of Middle Devonian age, and four of these constrained the age to the Givetian. One sample contains conodonts indicative of an interval from the Lower *Polygnathus varcus* Subzone to *S. hermanni-Po. cristatus* Zone (OF–3) and another is representative of an interval from the *Po. varcus* Zone to the *Klapperina disparilis* Zone (BU–4a). On the basis of regional relationships and sea level curves, the Pokejoy Member was probably deposited during the *Po. varcus* Zone (Weary and Harris, 1992). The Mahantango is disconformably overlain by the Tully Limestone or Harrell Shale in the western part of the Winchester quadrangle and is conformably(?) overlain by the Brallier in the eastern part of the quadrangle. CAI values are 3–3.5 and 3.5.

Tully Limestone (Middle Devonian; Givetian) [0–4? m]

An unconformity occupies the interval of the Tully Limestone in the Winchester 30′ × 60′ quadrangle. Beds and carbonate concretion horizons previously assigned to the Tully by Hasson and Dennison (1988) in the western part of the Winchester quadrangle are of earliest Late Devonian age and are part of the Harrell Shale. A thin interval of interbedded calcareous shale and faintly laminated, fine-grained wackestone to carbonate mudstone that occurs just west of the Winchester 30′ × 60′ quadrangle (RG–1) is, however, assigned to the Tully. The limestone beds are barren or poorly productive of conodonts; the few specimens recovered suggest a Givetian age. The conodonts are completely to partly coated with argillaceous material so that the CAI value can only be estimated at 3 to 4.

Harrell Shale (Upper Devonian; lower Frasnian) [0–64 m]

The Harrell Shale consists chiefly of medium-dark-gray to black, laminated shale and rare laminae, thin beds, and concretions of silty limestone to calcareous siltstone and mudrock. The interval containing black shale and carbonate, the Burket Shale Member, is at or near the base of the formation and is 0–20 m thick. The Harrell is limited to the western one-fourth of the Winchester quadrangle. Of the 16 samples collected from the formation, six were barren. Conodonts are rare to abundant. Virtually all abundant samples are from very thin carbonate lenses, laminae, or concretions. The conodont-bearing beds and laminae are tempestites, some of which were the source of carbonate that diagenetically formed concretions. The best section of the Harrell Shale in the Winchester 30′ × 60′ quadrangle is exposed in roadcuts along U.S. Rt. 50 just west of Burlington, W.Va. (BU–4). The Harrell section there is fault bounded. Conodonts are locally abundant; three of the eight conodont samples from locality BU–4 produced index species that restrict this part of the Harrell to an interval from the upper Lower *M. falsiovalis* Zone to the lower part of the *Palmatolepis transitans* Zone. Other localities that produced conodonts of similar age are KE–6 and ME– 2. Detailed regional relations of the Harrell Shale and overlying, underlying, and correlative units are given in Weary and Harris (1992).

CAI values are predominantly 3–3.5 and 3.5 indicating these rocks reached at least 150°C. Using stratigraphic thicknesses given in Dennison (1963) for the Keyser quadrangle, present overburden on the Harrell is 3.3 km including rocks as young as early Late Pennsylvanian in age. Assuming an average geothermal gradient of 25°C/km, present overburden can only account for a burial at about 100°C suggesting that at least 2 km of Pennsylvanian and younger rocks have been removed since the Paleozoic and (or) that geothermal gradients previously were higher.

Romney Shale (Middle and Upper Devonian) [305–580 m]

Because of poor exposure, complex structure, and lack of key beds and biostratigraphically diagnostic fossils, the Middle and lowermost Upper Devonian interval of chiefly siliciclastic rocks, from the base of the Needmore Shale to the top of the Harrell Shale, is locally assigned to the Romney Shale. Four samples that were barren or lacked conodont index species were assigned to the Romney. The two productive samples are of Middle Devonian age (HE–1 and SP–4). CAI values are 3.5 and ~4.

Chemung Formation (Upper Devonian; Frasnian) [365–1,150 m]

The Chemung Formation, with rare exceptions, is of inappropriate lithology for conodont extraction. It is composed of medium- to coarse-grained, thick-bedded, locally crossbedded and conglomeratic sandstone, medium- to thick-bedded siltstone, and minor shale. Beds are locally fossiliferous. Two collections made at different times from the same carbonate-rich brachiopod shell hash bed produced relatively diagnostic conodonts. Sample MF–12a produced a faunule that indicates an interval from the upper part of the Upper *M. falsiovalis* Zone to the Lower *Pa. hassi* Zone. Although the collections are from a low position in the Chemung and from the older eastern outcrop belt of the formation, the conodonts indicate an age somewhat older than expected. The Chemung of the eastern part of the Winchester quadrangle is not much younger than the Harrell Shale of the western part of the quadrangle. CAI values at the single locality are 3.5 to 4.

Greenbrier Limestone (Upper Mississippian; Chesterian) [~72 m]

The Greenbrier Limestone consists of medium-grayish-brown to greenish-gray, medium- to coarse-grained, well-sorted, crossbedded, sparsely fossiliferous, quartzose grainstone (Loyalhanna Limestone Member), overlain by medium-pinkish-gray, medium- to very coarse-grained, poorly-sorted, crossbedded quartzose grainstone (Deer Valley Limestone Member), followed by a thick reddish-brown siliciclastic unit (Savage Dam Member), and, finally, dark-brownish-gray to medium-light-gray, thin- to medium-bedded, nodular, brachiopod-rich, partly bioturbated, argillaceous lime wackestone to grainstone (Wymps Gap Member). The magnitude of the unconformity separating the Greenbrier from the underlying Pocono Formation is speculative as the age of the top of the Pocono is not well constrained within the Osagean and Meramecian (Brezinski, 1989). Six conodont samples were collected from a measured section just west of the northwest corner of the Winchester 30′ × 60′ quadrangle (Brezinski, 1989, loc. 8); all produced conodonts of Chesterian, but not late Chesterian age. The occurrence of *Hindeodus cristulus* and *Cavusgnathus unicornis* in the lower 0.5 m of the Greenbrier (WP–2a) restricts the base of the formation to the Chesterian. A sample from 1 m below the top of the formation (WP–2f) contains *H. cristulus, H. spiculus*, and *C. unicornis* indicative of a Chesterian but not late Chesterian age.

CAI values are 2.5–3 indicating the host rock reached about 100° to 130°C. Existing stratigraphy accounts for about 2 km of overburden and therefore burial at about 70°–80°C, using the same calculations outlined above for the Harrell Shale. Thus, once again, at least 2 km of Pennsylvanian and younger rocks have

been removed from the area since the Paleozoic or geothermal gradients were higher than average to account for CAI values of 2.5–3.

ANALYSIS OF CAI TRENDS IN THE WINCHESTER 30′ × 60′ QUADRANGLE

CAI values in the Winchester quadrangle are closely tied to overburden thickness, locally and regionally. Locally, on the west side of the Shenandoah Valley, just east of Winchester, Va., the lowest CAI values are in the highest part of the Old unit (in the "Oranda" Formation) both east and west of the outcrop belt of the Ocl unit, the youngest Paleozoic unit in the valley. CAI values increase through increasingly older stratigraphic units east and west of the Ocl outcrop belt. The CAI 5 isograd approximates the O€co-Old contact on the east side of the Ocl unit in the southeast corner of the Winchester quadrangle (Boyce 7.5-minute quadrangle; (I2) as well as on its west side in the Inwood (I4) and Tablers Station (I5) 7.5-minute quadrangles. Likewise, in the northwest corner of the Winchester quadrangle, southeast of Keyser, W.Va., the CAI 4 isograd approximates the SOcl-DScs contact and thereby outlines large-amplitude folds within these rocks. The CAI 3.5 isograd is within the DScs unit, and the CAI 3 isograd is within the succeeding Mississippian unit.

Regional trends in CAI values in the Winchester quadrangle can only be assessed for Silurian and Devonian rocks that crop out between the North Mountain fault zone and the west border of the quadrangle, a distance of about 60 km. CAIs in rocks of nearly the same Early Devonian age decrease about one-half index from the Mountain Falls 7.5-minute quadrangle (F2) to the Keyser 7.5-minute quadrangle (B5). CAI values in Lochkovian rocks are 3.5–4 and 4 in the east (MF–6, 7) and 3.5 and 3–3.5 in the west (KE–3, 4) On the basis of CAI temperature calibration (Epstein and others, 1977; Harris and others, 1978) and assuming an average geothermal gradient (25°C/km and a surface temperature of ~15°C), Lower Devonian rocks in the Mountain Falls quadrangle should have been buried about 1–1.5 km deeper than Lower Devonian rocks in the Keyser quadrangle (B5). Using a mathematical, geodynamic model, Beaumont and others (1987) calculated about 6 km of cumulative post-Alleghanian erosion in the Keyser area and about 7 km near the Mountain Falls area (also see Roden, 1991, fig. 8). Although their values for modeled Permian isopachs (7.6 km of Permian in the Keyser area) seem inordinately great, the isopach maps of Beaumont and others (1987) suggest that Pennsylvanian and Permian deposits were only about 1 to 1.5 km thicker in the Mountain Falls area than in the Keyser area. This difference in overburden is the right order of magnitude to account for a one-half index increase in CAI in Lower Devonian rocks from Keyser to the Mountain Falls area.

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TABLE 1. Conodont data from the Winchester quadrangle and adjacent area, Virginia, West Virginia, and Maryland

[Names of 7.5-minute quadrangles shown in bold type are within the boundaries of the Winchester 30' X 60' quadrangle.]

MAP NO.[1] FIELD NO.[2] (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA[3]	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT[4]	REMARKS
AN-1 NC8-7-84P (11737-SD)	39°22'08", 79°01'53"	Antioch (**A4**)	Mineral (West Virginia)	New Creek Limestone	Early Devonian Lochkovian	3.5	1 Pb *Oulodus cristagalli* (Ziegler) *Ozarkodina remscheidensis remscheidensis* (Ziegler) 20 Pa, 6 Pb, 7 M, 5 Sa, 2 Sb, 1 Sc 173 indet. bar, blade,and platform fragments	*O. r. remscheidensis* biofacies; high-energy, shallow-water, normal marine.	Lithology, sample and residue weights, and mineralogy are not available.
AG-1 8-12-90A	39°06'57", 77°59'52"	Ashby Gap (**J2**)	Clarke (Virginia)	Conococheague Limestone (lower part)			Barren.		Medium-light-gray- to grayish-orange-weathering, light- to medium-light-gray, fine-grained limestone with wispy silty layers in beds 1-2 cm thick. Heavy-mineral concentrate: iron-oxide flakes, weathered and fresh euhedra and euhedral clusters of pyrite, phosphatic brachiopod fragments, fluorite, minor dolomite (some euhedral) and rare muscovite and biotite. 9.4 kg; 600 g +20 mesh and 556 g 20-200 mesh insoluble residue.
BA-1 8-15-90A (12131-SD)	39°03'52", 78°40'04"	**Baker** (**D2**)	Hardy (West Virginia)	Tonoloway Limestone (middle part)	Late Silurian late Ludlovian into Pridolian, probably early Pridolian	3.5-4	*Ozarkodina remscheidensis remscheidensis* (Ziegler) 39 Pa, 12 Pb, 2 M, 4 Sa, 4 Sb, 6 Sc 36 indet. bar, blade, and platform fragments	*O. remscheidensis* biofacies; relatively shallow, nearshore, probably partly restricted marine.	Medium-gray-weathering, medium- to medium-dark-gray, fine-grained, mudstone/wackestone containing fossil hash and scattered, slightly to moderately domal stromatoporoids (5-6 cm in diameter) near top of 40-cm-thick massive bed. Heavy-mineral concentrate: iron oxides, phosphatic brachiopod fragments, and rare pyrite clusters and euhedral dolomite. 10.1 kg; 60 g +20 mesh and 93 g 20-140 mesh insoluble residue.
BA-2 7-15-73EA (12132-SD)	39°03'22", 78°43'30"	**Baker** (**D2**)	Hardy (West Virginia)	Tonoloway Limestone	Late Silurian	~4	4 indet. bar, blade and platform fragments 1 scolecodont	Indeterminate; deposition probably within very shallow, partly restricted marine environment.	Lithology, sample and residue weights, and mineralogy are not available.
BE-1 8-12-90B	39°12'31", 77°58'14"	Berryville (**J3**)	Clarke (Virginia)	Conococheague Limestone (upper part, near boundary with Stonehenge Limestone)			Barren.		Light-olive-gray-weathering, medium-light-gray, thick- to massive-bedded, fine-grained limestone. Heavy-mineral concentrate; mostly dolomite, fluorite, and weathered and fresh pyrite euhedra and pyritized spines and argillaceous flakes. 9.4 kg; 60 g +20 mesh and 82 g 20-200 mesh insoluble residue.
BE-2 4-1-91R (10873-CO)	39°11'03", 77°59'19"	Berryville (**J3**)	Clarke (Virginia)	Stonehenge Limestone	Early Ordovician (possibly *R. manitouensis* Zone but no older than middle Tremadocian)	4.5-5	1 M *Rossodus*? aff. *R. manitouensis* Repetski & Ethington 1 indet. coniform fragment	Indeterminate.	Medium-dark-gray, fine-grained, massive, bioturbated limestone. Heavy-mineral concentrate: fresh and weathered pyritized sponge spicules(?), iron oxides, minor euhedral dolomite and rare phosphatic brachiopod fragments. 10.6 kg; 80 g +20 mesh and 19 g 20-200 mesh insoluble residue.
BE-3 8-12-90D (10874-CO)	39°13'21", 77°58'10"	Berryville (**J3**)	Clarke (Virginia)	Stonehenge Limestone (within upper 20 m)	early Early Ordovician (*R. manitouensis* Zone)	4.5-5	2 "*Acanthodus*" cf. "*A.*" *lineatus* (Furnish) 78 *Clavohamulus densus* Furnish 2 *Cordylodus angulatus* Pander 1 rounded *Cordylodus drucei*? Miller 1 *Cordylodus intermedius* Furnish 26 *Drepanoistodus* sp. 2 New genus? sp. 2 "*Oistodus*" *triangularis* Furnish 8 *Rossodus*? n. sp. 9 *Scolopodus*? *sulcatus* Furnish 4 *Ulrichodina* n. sp. s.f. 26 *Variabiloconus bassleri* (Furnish) 42 indet. coniform fragments	Clavohamulid-variabilo conid biofacies; NAMP[4], shallow, warm, normal to possibly slightly restricted marine.	Grayish-orange- to light-gray-weathering, medium- to medium-dark-gray, fine- to very fine grained, wispy laminated to burrow-mottled limestone. Heavy-mineral concentrate: phosphatic brachiopod fragments, pyrite druses on argillaceous flakes, fresh and weathered euhedral pyrite, and minor euhedral and anhedral dolomite. 8.5 kg; 540 g +20 mesh and 38 g 20-200 mesh insoluble residue.

[1]Conodont sample localities are labeled alphanumerically; letters represent an abbreviation of the quadrangle name and are numbered consecutively within each quadrangle according to decreasing geologic age. Some localities represent several samples within a section or samples too closely spaced to show separately at the map scale. These samples are listed separately here and on the stratigraphic column by a lettered suffix (e.g., IN-5a through 5i). Samples can also be located by alphanumeric map grid number.

[2]Conodont samples collected chiefly by A. G. Harris and N. R. Stamm (e.g., field nos. 8-15-90A or prefixed 91NS) and D. J. Weary (field nos. prefixed 90, 91DW), and R. G. Stamm (field nos. prefixed 90RS).

[3]Responsibility for analyses of conodont collections is as follows: Late Cambrian and Early Ordovician, J. E. Repetski; Middle Ordovician to Early Devonian, A. G. Harris and N. R. Stamm; Middle and Late Devonian, D. J. Weary and A. G. Harris; and Mississippian, R. G. Stamm.

[4]NAMP indicates Ordovician biofacies representative of the North American Midcontinent province (= low latitude, chiefly warm, shallow-water faunal assemblages).

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
BE-4 8-12-90C (10875-CO)	39°12'17", 77°58'44"	Berryville (**J3**)	Clarke (Virginia)	Rockdale Run Formation (lower 10 m)	late early Early Ordovician (Fauna D, probably low Fauna D)	4.5	Some conodonts are deformed and (or) have spaced fractures. 17 *Eucharodus parallelus* (Branson & Mehl) 40 *Glyptoconus quadraplicatus* (Branson & Mehl) 1 *Oneotodus*? sp. indet. *Rossodus* n. sp. (post-*manitouensis* form) 2 M & 18 coniforms 38 "*Scolopodus*" *gracilis* Ethington & Clark 11 unassigned coniform elements 19 indet. coniform fragments	Glyptoconid-"scolopodid" biofacies; NAMP, shallow warm, probably restricted marine with possible elevated salinity.	Medium-gray- to grayish-orange-weathering, medium - to medium-light-gray, burrow-mottled, partly laminated micrite and lesser calcareous dolostone. Heavy-mineral concentrate: euhedral and euhedral clusters of fresh and weathered pyrite, euhedral dolomite and subhedral to anhedral fluorite. 8.3 kg; 150 g +20 mesh and 34 g 20-200 mesh insoluble residue.
BP-1 8-2-73EC (12133-SD)	39°31'46", 78°03'01"	Big Pool (**I6**)	Berkeley (West Virginia)	Keyser Limestone	Late Silurian Pridolian	4	1 Sc *Oulodus elegans* (Walliser) *Ozarkodina remscheidensis remscheidensis* (Ziegler) 10 Pa, 1 Pb, 2 M, 1 Sb, 1 Sc (all broken) 13 indet. bar, blade, and platform fragments	Postmortem transport within or from *O. r. remscheidensis* biofacies; shallow-water, possibly partly restricted marine.	Lithology, sample and residue weights, and mineralogy are not available.
BO-1 8-12-90I (10876-CO)	39°06'05", 78°02'21"	**Boyce** (**I2**)	Clarke (Virginia)	Conococheague Limestone (no higher than 60 m below top of formation)	middle Late to late Late Cambrian middle Franconian-Trempealeauan (*Eoconodontus* Zone)	~4.5-5	1 *Proconodontus muelleri* Miller 2 *Proconodontus serratus* Miller 1 *Proconodontus* sp. indet. fragment	Indeterminate.	Grayish-orange- to light-gray-weathering, medium- to medium-dark-gray, laminated to thin-bedded, massive carbonate mudstone. Heavy-mineral concentrate: phosphatic brachiopod fragments, iron oxides, minor dolomite euhedra and rare pyrite euhedra. 11.6 kg; 320 g +20 mesh and 59 g of 20-200 mesh insoluble residue.
BO-2 8-12-90H (10877-CO)	39°05'22", 78°03'27"	**Boyce** (**I2**)	Clarke (Virginia)	Stonehenge Limestone (uppermost part)	early Early Ordovician (*R. manitouensis* Zone)	4.5-5	24 "*Acanthodus*" *lineatus* (Furnish) 10 *Acanthodus uncinatus* Furnish 2 *Chosonodina herfurthi* Muller 7 *Clavohamulus densus* Furnish 11 *Cordylodus angulatus* Pander 7 *Cordylodus intermedius* Furnish 1 *Drepanodus pseudoconcavus* Repetski s.f. 2 *Drepanoistodus* sp. 3 *Eucharodus parallelus* (Branson & Mehl) 4 *Loxodus bransoni* Furnish 8 "*Oistodus*" *triangularis* Furnish s.f. 18 *Protopanderodus*? n. sp. *Rossodus manitouensis* Repetski & Ethington 13 M & 14 coniforms 21 *Rossodus* n. sp. 46 *Rossodus*? n. sp. 7 *Scolopodus*? *sulcatus* Furnish 50 *Variabiloconus bassleri* (Furnish) 29 N. Gen. n. sp. 13 indet. coniform fragments	Variabiloconid-acanthodid-rossodid-protopanderodid biofacies; relatively warm, shallow water, normal marine.	Light-orange-gray- to light-gray-weathering, medium-dark-gray, laminated to thin-bedded, partly stromatolitic carbonate mudstone. Heavy-mineral concentrate: iron oxides, phosphatic iron-oxide grains, fresh and weathered single euhedra and euhedral clusters of pyrite, minor euhedral dolomite, and rare phosphatic brachiopods. 8.1 kg; 2.6 kg +20 mesh and 133 g 20-200 mesh insoluble residue.
BO-3 8-12-90J (10878-CO)	39°05'49", 78°06'28"	**Boyce** (**I2**)	Clarke (Virginia)	Edinburg Formation. Chambersburg Limestone, or Oranda Formation	late Middle Ordovician late Blackriveran-Rocklandian	4-4.5	3 *Ansella* sp. indet. *Dapsilodus*? *similaris* (Rhodes) 18 M & 6 S 21 *Drepanoistodus suberectus* (Branson & Mehl) 8 *Panderodus* sp. *Periodon grandis* (Ethington) 7 Pa, 3 Pb, 15 M, 1 Sa, 11 Sb, 11 Sc 2 S *Phragmodus* sp. indet. 2 *Protopanderodus liripipus* Kennedy, Barnes & Uyeno 10 indet. bar, blade and coniform fragments	Periodontid-coniform biofacies; cool, mid-shelf or deeper, normal marine (possible distal winnow).	Medium-light-gray-weathering, dark-gray, medium-bedded micrite. Heavy-mineral concentrate: phosphatic brachiopod fragments and whole valves (18 pedicle & 13 brachial acrotretid valves), iron oxides, common weathered and fresh euhedral pyrite clusters and rare dolomite. 5.8 kg; 60 g +20 mesh and 6 g 20-140 mesh insoluble residue.
BU-1 9-26-90C (12134-SD)	39°21'34", 78°59'58"	**Burlington** (**B4**)	Mineral (West Virginia)	Keyser Limestone	Late Silurian Pridolian	3.5-4	*Oulodus elegans* (Walliser) 3 Pa, 8 Pb, 8 M, 3 Sa, 2 Sb, 9 Sc *Ozarkodina remscheidensis eosteinhornensis* (Walliser) 22 Pa, 11 Pb, 2 M, 2 Sa, 6 Sb, 2 Sc 108 indet. bar, blade, and platform fragments	*O. r. eosteinhornensis*-oulodid biofacies; relatively shallow, moderate- to high-energy, normal marine.	Light-gray, irregularly thin- to medium-bedded, crinoidal, coarse-grained grainstone/packstone. Heavy-mineral concentrate: chiefly iron-oxide replaced bryozoan and lesser ostracode fragments, phosphatic brachiopod fragments, ichthyoliths and holdfasts. 10.0 kg; 210 g +20 mesh and 143 g 20-140 mesh insoluble residue.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
BU-2 9-26-90B	39°20'44", 78°59'17"	**Burlington** **(B4)**	Mineral (West Virginia)	Harrell Shale	Not determined.	Indet.	2 indet. bar or blade fragments	Indeterminate.	Medium-light-gray, fine-grained, calcareous siltstone to mudstone in cm-thick beds. Heavy-mineral concentrate: barite, phosphatic flakes, and rare limonitic grains. 6.3 kg; 5.2 kg +20 mesh and 202 g 20-140 mesh insoluble residue.
BU-3 9-26-90I	39°16'34", 78°58'28"	**Burlington** **(B4)**	Mineral (West Virginia)	Harrell Shale			Barren.		Very dark gray to black, slightly calcareous, siliceous mudrock concretion about 10 cm in maximum dimension. Heavy-mineral concentrate: barite, argillaceous grains with disseminated pyrite and iron oxides. 9.2 kg; 8.02 kg +20 mesh and 367 g 20-140 mesh insoluble residue.
BU-4a 90DW35 (12135-SD)	39°20'20", 78°55'23"	**Burlington** **(B4)**	Mineral (West Virginia)	Mahantango Formation; Pokejoy Member	Middle Devonian Givetian (*Po. varcus* Zone through *K. disparilis* Zone)	3.5	*Icriodus latericrescens latericrescens* Branson & Mehl 1 Pa, 18 Pa fragments 1 indet. mid-cone fragment	Icriodid biofacies; relatively shallow (reefal), high-energy, normal marine.	Medium-gray, argillaceous wackestone in 1-meter-thick bed containing toppled rugose corals, tabulate corals and scattered brachiopods. Heavy-mineral concentrate: fresh and weathered euhedral pyrite, iron oxides, phosphatic shell fragments, and dolomitic calcite. 6.2 kg; 2.9 kg +20 mesh and 209 20-140 mesh insoluble residue.
BU-4b 90DW16 (12136-SD)	39°20'20", 78°55'23"	**Burlington** **(B4)**	Mineral (West Virginia)	Harrell Shale; Burket Shale Member (3.3 m above base of measured section)	Late Devonian Frasnian (probably upper Lower *M. falsiovalis* Zone through lower 2/3 of *Pa.transitans* Zone)	3.5	4 indet. blade, bar, and platform fragments.	Indeterminate.	Dark-gray, calcareous siltstone in 1-cm-thick bed. Heavy-mineral concentrate: argillaceous fragments of quartz and disseminated pyrite, fresh euhedral pyrite, barite and minor iron oxides. 6.5 kg; 4.0 kg + 20 mesh and 137 g 20-140 mesh insoluble residue.
BU-4c 90DW17	39°20'20", 78°55'23"	**Burlington** **(B4)**	Mineral (West Virginia)	Harrell Shale; Burket Shale Member (0.8 m above 90DW16)	Late Devonian Frasnian (probably upper Lower *M. falsiovalis* Zone through lower 2/3 of *Pa.transitans* Zone)		Barren.		Medium-dark-gray, calcareous mudstone in 2-cm-thick bed. Heavy-mineral concentrate: argillaceous quartz silt and disseminated pyrite, small spherules of pyrite and minor iron oxides. 7.9 kg; 5.6 kg + 20 mesh and 107 g 20-140 mesh insoluble residue.
BU-4d 90DW18a (12137-SD)	39°20'20", 78°55'23"	**Burlington** **(B4)**	Mineral (West Virginia)	Harrell Shale; Burket Shale Member (3.5 m above 90DW17)	Late Devonian Frasnian (upper Lower *M. falsiovalis* Zone through lower 2/3 of *Pa.transitans* Zone)	3.5	*Ancyrodella rotundiloba* (Bryant) 90 Pa elements and fragments, 7 Pb & 7 Sc *Delotaxis* sp. indet. 6 Pb, 2 M, 5 Sa, 7 Sb & 7 Sc 1028 *Icriodus difficilis* Ziegler & Klapper 10 Pa *Polygnathus alatus* Huddle 318 Pa *Polygnathus dubius* Hinde 204 Pa *Polygnathus pennatus* Hinde 1 Pa *Polygnathus xylus* Stauffer UNASSIGNED ELEMENTS: 10 Pb (3 morphotypes), 5 M, 6 Sa , 3 Sb, 18 Sc (3 morphotypes) 147 indet. bar, blade, and platform fragments	Postmortem transport from icriodid-polygnathid-ancyrodellid biofacies; probably as distal rain from storms (tempestites). Deep-water, single high-energy event, normal marine.	Medium-dark-gray, *Styliolina* wackestone in 0.5- to 2-cm-thick bed. Heavy-mineral concentrate: quartzose argillaceous silt with disseminated pyrite, barite, baritic and pyritic steinkerns of *Styliolina* and gastropods, and iron oxides. 7.6 kg; 2.85 kg + 20 mesh and 96 g 20-140 mesh insoluble residue.
BU-4e 90DW18b (12138-SD)	39°20'20", 78°55'23"	**Burlington** **(B4)**	Mineral (West Virginia)	Harrell Shale; Burket Shale Member (3.5 m above 90DW17)	Late Devonian Frasnian (upper Lower *M. falsiovalis* Zone through lower 2/3 of *Pa. transitans* Zone)	3.5	*Ancyrodella alata* Glenister &Klapper 10 Pa & 4 Pb *Delotaxis* sp. indet. 7 Pa, 11 Pb, & 4 M 71 Pa *Icriodus difficilis* Ziegler & Klapper 104 Pa *Polygnathus dubius* Hinde 25 Pa *Polygnathus pennatus* Hinde UNASSIGNED ELEMENTS: 34 M (3 morphotypes), 15 Sa (3 morpho-types),12 Sb (3 morphotypes), 42 Sc (3 morphotypes) 3 indet. bar, blade and platform fragments	Postmortem transport from the polygnathid-icriodid-delotaxid biofacies; probably as distal rain from storms (tempestites). Deep-water, single high-energy event, normal marine.	Medium-dark-gray, lime mudstone and *Styliolina* wackestone septarian concretion with barite vein fillings (30 cm wide x 15 cm high). Heavy-mineral concentrate: barite, quartz silt with adventitious barite or disseminated pyrite, and sparse baritic *Styliolina* steinkerns. 7.5 kg; 1 kg +20 mesh and 71 g 20 -140 mesh insoluble residue.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
BU-4f 90DW10 (12139-SD)	39°20'20", 78°55'23"	**Burlington (B4)**	Mineral (West Virginia)	Harrell Shale; Burket Shale Member (10.3 m above 90DW18b)	Late Devonian Frasnian (upper Lower *M. falsiovalis* Zone through lower 2/3 of *Pa. transitans* Zone)	3.5	*Ancyrodella alata* Glenister & Klapper 117 Pa &10 Pb *Delotaxis* sp. indet. 8 Pa, 4 Pb, 7 Sa, 3 Sc 145 Pa *Icriodus difficilis* Ziegler & Klapper *Mesotaxis dengleri* (Bischoff & Ziegler) 41 Pa & Pa fragments 61 Pa *Polygnathus dubius* Hinde 19 Pa *Polygnathus pennatus* Hinde UNASSIGNED ELEMENTS: 31 M (4 morphotypes),17 Sa (3 morphotypes), 6 Sb (3 morphotypes), 40 Sc (4 morphotypes) 191 indet. blade, bar , and platform fragments.	Postmortem transport from icriodid-ancyrodellid-polygnathid biofacies; probably as distal rain from storms (tempestites). Deep-water, single high-energy event, normal marine.	Medium-dark-gray, *Styliolina* packstone in 1- to 4-cm-thick bed with small domal concretion (6 cm high x 10 cm wide). Heavy-mineral concentrate: quartz silt with disseminated pyrite, barite, abundant baritic and pyritic *Styliolina* steinkerns 14.4 kg; 6.1 kg + 20 mesh and 276 g 20-140 mesh insoluble residue.
BU-4g 90DW19 (12140-SD)	39°20'20", 78°55'23"	**Burlington (B4)**	Mineral (West Virginia)	Harrell Shale; Burket Shale Member (5.3 m above 90DW10)	Late Devonian Frasnian (upper Lower *M. falsiovalis* Zone through at least *Pa. transitans* Zone)	3.5	*Delotaxis* sp. indet. 1 Sa & 1 Sc 2 Pa fragments of *Icriodus* sp. indet. 1 Pa *Polygnathus dubius* Hinde UNASSIGNED ELEMENTS: 2 M & 1 Sb 30 indet. bar, blade, and platform fragments	Indeterminate.	Dark-gray, calcareous siltstone in 3-cm-thick bed. Heavy-mineral concentrate: barite, pyrite, quartz silt with disseminated pyrite, abundant baritic and pyritic steinkerns of *Styliolina* . 7.3 kg; 5.1 kg + 20 mesh and 112 g. 20-140 mesh insoluble residue.
BU-4h 90DW20	39°20'20", 78°55'23"	**Burlington (B4)**	Mineral (West Virginia)	Harrell Shale; Burket Shale Member (1.3 m above 90DW19)	no older than Late Devonian Frasnian (age constrained by collections from over- and underlying beds)		Barren.		Medium-gray, calcareous siltstone in 1- to 3-cm-thick bed showing soft sediment deformation features. Heavy-mineral concentrate: silt chips of quartz and disseminated pyrite. 8.5 kg, 5.2 kg + 20 mesh and 69 g 20-140 mesh insoluble residue.
BU-4i 90DW21 (12141-SD)	39°20'20", 78°55'23"	**Burlington (B4)**	Mineral (West Virginia)	Harrell Shale; Burket Shale Member (2.4 m above 90DW20)	No older than Late Devonian Frasnian (upper Lower *M. falsiovalis* Zone through at least *Pa. transitans* Zone)	3.5	1 Pa *Polygnathus* sp. indet. 12 indet. bar, blade, and platform fragments	Indeterminate.	Medium-dark-gray, crossbedded, calcareous siltstone in 2- to 3-cm-thick bed. Heavy-mineral concentrate: silt-sized flakes of quartz and disseminated pyrite, abundant microspherules of pyrite. 5.1 kg, 3.4 kg + 20 mesh and 83 g 20-140 mesh insoluble residue.
CB-1 9-27-90I (12142-SD)	39°20'23", 78°27'44"	**Capon Bridge (F4)**	Hampshire (West Virginia)	Keyser Limestone	Late Silurian Pridolian	3.5-4	*Ozarkodina remscheidensis remscheidensis* (Ziegler) 45 Pa, 5 Pb, 1 M, 1 Sa, 4 Sb, 3 Sc 89 indet. blade, bar, and platform fragments	Postmortem hydraulic transport within *O. r. remscheidensis* biofacies; relatively shallow, normal marine, possibly intermittently restricted.	Medium-dark-gray, medium-crystalline, irregularly thick- to medium- bedded, fossiliferous packstone. Heavy-mineral concentrate: iron oxides and minor argillaceous flakes with disseminated pyrite. 10.2 kg; 140 g +20 mesh and 140 g 20-140 mesh insoluble residue.
CB-2a 91NS-1 (12143-SD)	39°21'10", 78°24'26"	**Capon Bridge (F4)**	Hampshire (West Virginia)	Tonoloway Limestone or Keyser Limestone; probably Keyser Limestone (~38 m below 91NS-2)	Late Silurian late Ludlovian-Pridolian	3.5-4	1 S *Belodella* sp. indet. *Oulodus elegans* (Walliser) 2 Pa, 5 Pb, 1 M, 1 Sa 7 Pa *Ozarkodina remscheidensis eosteinhornensis* (Walliser) 86 Pa *Ozarkodina remscheidensis remscheidensis* (Ziegler) 24 Pa *Ozarkodina remscheidensis remscheidensis* (Ziegler) transitional to *O. r. eosteinhornensis* (Walliser) *Ozarkodina remscheidensis* spp. indet. 69 Pb, 44 M, 15 Sa, 43 Sb, 25 Sc ~1200 indet. bar, blade, and platform fragments	Some to considerable postmortem transport within *O. remscheidensis* biofacies; relatively shallow, moderate- to high-energy, normal marine.	Medium-light-gray-weathering, medium-dark-gray, irregularly thin- to medium-bedded, fine- to very coarse grained, bioclastic lime packstone with scattered articulated brachiopods, bryozoans, and crinoids. Heavy-mineral concentrate: phosphatic brachiopod fragments (mostly oxidized), iron oxides, ichthyoliths. 10.0 kg; 180 g of +20 mesh and 98 g 20-140 mesh insoluble residue.
CB-2b 91NS-2 (12144-SD)	39°21'16", 78°24'21"	**Capon Bridge (F4)**	Hampshire (West Virginia)	Keyser Limestone	Late Silurian Pridolian	3.5-4	*Oulodus elegans* (Walliser) 3 Pa, 3 Pb, 9 M, 9 Sb, 14 Sc *Ozarkodina remscheidensis remscheidensis* (Ziegler) 21 Pa, 11 Pb, 7 M, 1 Sa, 3 Sc 3 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) 91 indet. bar, blade, and platform fragments	Oulodid- *O. r. remscheidensis* biofacies; relatively shallow, high-energy, normal marine.	Light-gray-weathering, medium- to medium-dark-gray, fine- to very coarse grained, fossiliferous (brachiopods, bryozoans, crinoids, and scattered corals) lime packstone. Heavy-mineral concentrate: abundant iron oxides, common druses of weathered and fresh pyrite, and minor phosphatic brachiopod fragments, bryozoan zooecial linings, pyritized sponge spicules, ichthyoliths, brachiopod valves, and bryozoan pearls. 10.8 kg; 200 g of +20 mesh and 60 g 20-140 mesh insoluble residue.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
CB-3a 91NS-3 (12145-SD)	39°20'05", 78°29'57"	**Capon Bridge (F4)**	Hampshire (West Virginia)	Keyser Limestone (probably upper part; 0.7 m below 91NS-4)	Late Silurian Pridolian	4	Most conodonts are small and corroded fragments. 1 S *Belodella* sp. indet. *Oulodus elegans* (Walliser) 2 Pa, 3 Pb, 2 M, 1 Sb, 2 Sc *Ozarkodina remscheidensis remscheidensis* (Ziegler) 12 Pa, 7 Pb, 2 M, 1 Sc 135 indet. bar, blade, and platform fragments	Postmortem winnow from *O.r.remscheidensis*-oulodid biofacies; relatively shallow, moderate- to high-energy, normal marine.	Light-gray-weathering, medium-gray, irregularly wavy- to nodular- and massive-bedded, argillaceous lime wackestone with scattered articulated brachiopods. Heavy-mineral concentrate: iron oxides, pyrite euhedra and euhedral clusters. 8.0 kg; 240 g of +20 mesh and 381 g 20-140 mesh insoluble residue.
CB-3b 91NS-4 (12146-SD)	39°20'05", 78°29'57"	**Capon Bridge (F4)**	Hampshire (West Virginia)	Keyser Limestone (probably upper part; 2 m below 91NS-5)	Late Silurian Pridolian	3.5-4	Conodonts are fragmentary. *Oulodus elegans* (Walliser) 4 Pa, 5 Pb, 9 M, 2 Sa, 3 Sb, 14 Sc *Ozarkodina remscheidensis remscheidensis* (Ziegler) transitional to *Ozarkodina remscheidensis eosteinhornensis* (Walliser) 53 Pa, 9 Pb, 5 M, 3 Sb, 7 Sc 141 indet. bar, blade, and platform fragments	Postmortem transport within *O. remscheidensis* biofacies; relatively shallow, moderate- to high-energy, normal marine.	Medium-gray-weathering, dark-gray, thick-bedded, medium- to coarse-grained, fossiliferous (whole brachiopods, crinoids, bryozoans) packstone/grainstone with minor clay-partings and minor irregular stringers of black chert. Heavy-mineral concentrate: phosphatic and oxidized brachiopod fragments, bryozoan zooecial linings, sponge spicules, phosphatic hold-fasts, ichthyoliths, bryozoan pearls, and pyrite euhedra. 10.8 kg; 400 g +20 mesh and 164 g 20-200 mesh insoluble residue.
CB-3c 91NS-5 (12147-SD)	39°20'05", 78°29'57"	**Capon Bridge (F4)**	Hampshire (West Virginia)	Keyser Limestone; upper limestone member	Late Silurian latest Pridolian	4	*Oulodus* aff. *O. cristagalli* (Ziegler) 1 Sb, 2 Sc *Oulodus elegans* (Walliser) 28 Pa, 21 Pb, 13 M, 12 Sa, 21 Sb, 44 Sc 101 Pa *Ozarkodina remscheidensis eosteinhornensis* (Walliser) 24 Pa *Ozarkodina remscheidensis remscheidensis* (Ziegler) *Ozarkodina remscheidensis* spp. indet. 67 Pa, 52 Pb, 35 M, 5 Sa, 8 Sb, 7 Sc ~500 indet. bar, blade, and platform fragments	Oulodid- *O. r. eosteinhornensis* biofacies; relatively shallow, relatively high-energy, normal marine.	Light-gray-weathering, light-gray, massive-bedded, very coarse grained bioclastic grainstone with crinoids, whole and dissarticulated brachiopods, and minor shale partings at base of bed. Heavy-mineral concentrate: phosphatic brachiopod fragments (some oxidized), druses of fresh and weathered pyrite, iron oxides, bryozoan zooecial linings, bryozoan pearls, phosphatic brachiopod hold-fasts, ichthyoliths. 9.2 kg; 620 g of +20 mesh and 111 g 20-140 mesh insoluble residue.
CS-1a 8-14-90D (12148-SD)	39°08'00", 78°23'45"	**Capon Springs (F3)**	Frederick (Virginia)	Keyser Limestone (upper part; 8.7 m below 8-14-90C)	Late Silurian late Pridolian	3.5-4	1 Sb *Dvorakia* sp. indet. *Oulodus elegans* (Walliser) 2 Pb, 2 M *Ozarkodina remscheidensis remscheidensis* (Ziegler) 11 Pa, 4 Pb, 4 M, 4 Sa, 7 Sb, 2 Sc 41 indet. bar, blade, and platform fragments	*O. remscheidensis* biofacies(?); relatively shallow, normal marine.	Medium-light-gray-weathering, medium- to medium-dark-gray, massive, fossiliferous (chiefly brachiopods and crinoid ossicles), coarse-grained packstone/grainstone. Heavy-mineral bioclasts include, phosphatic bryozoan pearls and zooecial linings, ichthyoliths, phosphatic brachiopod fragments and pyritized sponge spicules. Heavy-mineral concentrate: iron-oxides, weathered and fresh pyrite clusters and minor dolomite. 7.9 kg; 230 g +20 mesh and 242 g 20-140 mesh insoluble residue.
CS-1b 8-14-90C (12149-SD)	39°08'00", 78°23'45"	**Capon Springs (F3)**	Frederick (Virginia)	Keyser Limestone (upper part; ~15 m below Healing Spring Sandstone)	Late Silurian late Pridolian	3.5-4	1 Sb *Dvorakia* sp. indet. 1 *Oulodus elegans* (Walliser) 7 Pa, 2 M, 6 Sc *Ozarkodina remscheidensis remscheidensis* (Ziegler) 76 Pa, 11 Pb, 4 M, 2 Sb, 5 Sc 8 indet. bar, blade, and platform fragments	*O. remscheidensis* biofacies; relatively shallow, probably normal marine.	Light-gray-weathering, medium- to medium-light-gray, irregularly bedded and massive siliceous calcisiltite. Heavy-mineral concentrate: iron oxides, pyrite, and rare dolomite. 11 kg; 30 g +20 mesh and 202 g 20-140 mesh insoluble residue.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
FR-1 8-13-90D (10879-CO)	38°59'22", 78°08'32"	Front Royal (**H1**)	Warren (Virginia)	Rockdale Run Formation	Early Ordovician early Arenigian (Low Fauna D)	4.5-5	Conodonts are severely fractured and moderately to extensively deformed. 4 *Drepanodus arcuatus* Pander 1 coniform element cf. *Juanognathus*? n. sp. 9 *Macerodus dianae* Fahraeus & Nowlan 1 ?"*Oistodus*" *triangularis* Furnish s.f. 1 cf. *Protopanderodus*? n. sp. 2 of Repetski, 1982 31 *Scolopodus floweri* Repetski 1 "*Scolopodus*" *filosus* Ethington & Clark "*Scolopodus*" *gracilis* Ethington & Clark 16 graciliform, 16 triangulariform 12 "*Scolopodus*" aff. "*S.*" *gracilis* Ethington & Clark 9 unassigned drepanodontiform elements 4 unassigned oistodontiform elements 243 indet. coniform elements and fragments	"*Scolopodus*" *gracilis* -*S. floweri* biofacies: warm, platformal, relatively open marine (NAMP).	Light-gray-weathering, medium-gray, thin- to medium-bedded, fine-grained carbonate mudstone with thin wispy argillaceous lenses. Heavy-mineral concentrate: fresh and weathered euhedral pyrite clusters and iron oxides. 10.7 kg; 20 g +20 mesh and 123 g 20-200 mesh insoluble residue.
FR-2 8-13-90E (10880-CO)	38°58'39", 78°10'49"	Front Royal (**H1**)	Warren (Virginia)	Pinesburg Station Dolomite (upper part)	early Middle Ordovician middle Whiterockian (upper *H. sinuosa* Zone-*H.holodentata* Zone)	4,5.5,6	Conodonts severely corroded and many are bleached suggesting post-depositional contact with warm? brines. 4 *Drepanoistodus basiovalis* (Sergeeva) *Neomultioistodus clypeus* (Mound) 3 Pa, 5 Pb, 3 Sb, 1 Sc 1 *Paraprioniodus costatus* (Mound) 1 *Pteracontiodus* sp. indet. 22 indet. bar, blade, and coniform fragments	Postmortem transport from or within neomultioistodid biofacies; very shallow, restricted marine possibly associated with evaporites.	Light-gray-weathering, light-gray, thick-bedded dolomudstone. Heavy-mineral concentrate: iron oxides and dolomite. 11.6 kg; 20 g +20 mesh and 9 g 20-140 mesh insoluble residue.
GO-1 8-16-90D (12150-SD)	39°16'07", 78°18'35"	**Gore** (**G4**)	Frederick (Virginia)	Tonoloway Limestone	Late Silurian late Ludlovian-Pridolian	3.5-4	*Ozarkodina remscheidensis remscheidensis* (Ziegler) 24 Pa, 2 Pb, 1 M, 1 Sa, 4 Sb, 4 Sc 68 indet. bar, blade, platform and coniform fragments	*O. r. remscheidensis* biofacies; shallow, probably partly restricted marine.	Grayish-orange-weathering, medium-dark-gray, slightly argillaceous, bioturbated, irregularly massive-bedded, carbonate mudstone. Heavy-mineral concentrate: anhedral and euhedral dolomite, iron oxides, weathered and fresh pyrite euhedra, and drusy pyrite clusters. 11.0 kg; 280 g +20 mesh and 338 g 20-140 mesh insoluble residue.
GO-2 RS89-14 (12151-SD)	39°16'36", 78°16'04"	**Gore** (**G4**)	Frederick (Virginia)	Licking Creek Limestone; upper Member (17 m below top of formation)	Early Devonian Pragian (lower *sulcatus* Zone - *kindlei* Zone)	4	1 *Belodella* sp. indet. 39 *Dvorakia* sp. *Icriodus claudiae* Klapper 67 P, 4 acodiniform Sb 38 icriodid P element fragments UNASSIGNED ELEMENTS: 1 M, 1 Sc	Postmortem transport within icriodid biofacies; relatively high-energy and shallow, normal marine.	Dark-gray, thin- to medium-bedded and wavy-bedded, silty carbonate mudstone/wackestone containing minor chert and argillaceous partings as well as floating quartz pebbles and silicified brachiopods. Heavy-mineral concentrate: chiefly phosphatic brachiopod fragments and lesser phosphatized trilobite spines and ichthyoliths. 8.12 kg; 460 g +20 mesh insoluble residue.
GO-3 (11935-SD)	39°17'06", 78°15'51"	**Gore** (**G4**)	Frederick (Virginia)	Licking Creek Limestone	Early Devonian Pragian (lower *E. s. sulcatus* Zone - *E. s. kindlei* Zone)	4	3 *Dvorakia* sp. indet. *Icriodus* aff. *I. claudiae* Klapper 64 P, 2 Sb 1 Oulodus sp. indet. *Ozarkodina* sp. indet. 3 Pa, 1 Pb 89 indet. bar, blade and platform fragments (95% are P fragments of *Icriodus*)	Postmortem concentration (lag concentrate) within or from icriodid biofacies; relatively shallow water, high-energy, normal marine.	Limestone (lithic description not available). Heavy-mineral concentrate not available. 10.8 kg: 384 g 20-140 mesh insoluble residue. Collected by R. B. Blobett.
GC-1 91DW14	39°31'42", 78°20'16"	Great Cacapon (**G6**)	Morgan (West Virginia)	Tonoloway Limestone			Barren.		Medium-dark-gray, argillaceous lime mudstone in 15-cm-thick bed. Heavy-mineral concentrate: abundant prismatic quartz with extremely fine adventitious pyrite, fluorite, iron oxides.
GC-2a 9-24-90H (12152-SD)	39°30'06", 78°17'49"	Great Cacapon (**G6**)	Morgan (West Virginia)	Keyser Limestone (uppermost; 3.6 m below 90MK43-GC)	Probably very earliest Devonian probably earliest Lochkovian (*I. woschimidti* Zone?)	3.5-4	*Icriodus* sp. indet. 1 P fragment & 2 Sb? coniform elements 2 S elements of *Pedavis* sp. indet. *Oulodus elegans* (Walliser) 1 Pa, 6 M, 3 Sa, 4 Sc *Ozarkodina remscheidensis remscheidensis* (Ziegler) 43 Pa, 8 Pb, 4 M, 3 Sb, 4 Sc 205 indet. bar, blade, and platform fragments	Postmortem transport within *O. r. remscheidensis* biofacies; relatively shallow-water, high-energy, normal marine.	Medium-dark-gray, irregularly and massive bedded, brachiopod wackestone/mudstone. Heavy-mineral concentrate: pyrite clusters, weathered pyrite, phosphatic brachiopod fragments, iron oxides, rare phosphatized ostracode steinkerns and ichthyoliths, and pyritized spines 10.2 kg; 210 g +20 mesh and 207 g 20-140 mesh insoluble residue.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
GC-2b 90MK43-GC (12153-SD)	39°30'06", 78°17'49"	Great Cacapon (**G6**)	Morgan (West Virginia)	Keyser Limestone (uppermost) (12.6 m above base of measured section; 0.4 m below covered interval)	Probably very earliest Devonian probably earliest Lochkovian (*I. woschimidti* Zone?)	3.5-4	2 *Decoriconis fragilis* (Branson & Mehl) *Oulodus elegans* (Walliser) 5 Pa, 9 Pb, 7 M, 1 Sa, 4 Sb, 14 Sc 5 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) 18 indet. bar, blade, platform, and coniform fragments	Possible postmortem winnow from oulodid biofacies (conodonts are very small); shallow, relatively high-energy, normal marine.	Medium-gray, irregularly thin-bedded, brachiopod-rich wackestone. Heavy-mineral concentrate: chiefly iron oxides, phosphatic annulated steinkerns, phosphatic brachiopod fragments, bryozoan pearls, and ichthyoliths. 4.0 kg; 210 g of +20 mesh and 149 g of 20-140 mesh insoluble residue.
HR-1 12-6-82A (10703-SD)	39°16'00", 78°32'30"	**Hanging Rock** (**E4**)	Hampshire (West Virginia)	Tonoloway Limestone (111 m below top of formation)	Late Silurian Pridolian(?)	4	1 Sc *Oulodus elegans* (Walliser) *Ozarkodina remscheidensis remscheidensis* (Ziegler) 29 Pa, 11 Pb, 5 M, 3 Sb, 2 Sc 63 indet. bar, blade, and platform fragments	*O. r. remscheidensis* biofacies--relatively shallow water, normal marine.	Medium-gray to light-dark-gray, thin- to medium- bedded wackestone containing finely comminuted fossil debris in faint cross laminations. Heavy-mineral concentrate: not recorded. 10.7 kg; 321 g +20 mesh insoluble residue.
HA-1 7-29-73EB (12155-SD)	39°14'48", 78°17'54"	**Hayfield** (**G3**)	Frederick (Virginia)	Tonoloway(?) Limestone (lower part)	Late Silurian Ludlovian	~4	*Distomodus*? *dubius* (Rhodes) 9 M & S 1 Pb ozarkodinid element 1 indet. bar fragment	distomodid biofacies; shallow-water, restricted marine.	Fossiliferous, partly burrowed limestone. 2 kg.
HA-2 8-14-90A (12154-SD)	39°11'08", 78°20'19"	**Hayfield** (**G3**)	Frederick (Virginia)	Keyser(?) Limestone	Late Silurian late Ludlovian-Pridolian	3.5-4	*Oulodus elegans* (Walliser) 1 M, 2 Sc *Ozarkodina remscheidensis remscheidensis* (Ziegler) 26 Pa, 6 Pb, 3 M, 2 Sb 22 indet. bar, blade, and platform fragments	Postmortem transport within *O. r. remscheidensis* biofacies; relatively shallow water, high-energy, normal marine.	Medium-light-gray-weathering, medium-dark-gray, fine-grained, irregularly medium-bedded mudstone/wackestone. Heavy-mineral concentrate: iron oxides, minor fluorite, dolomite, and sphalerite. 5.9 kg; 400 g +20 mesh and 114 g 20-140 mesh insoluble residue.
HA-3 8-14-90B (12156-SD)	39°09'22", 78°22'09"	**Hayfield** (**G3**)	Frederick (Virginia)	Keyser Limestone (upper part)	latest Silurian late Pridolian	3.5-4	1 Sc *Dvorakia*? sp. indet. 1 Sc *Oulodus elegans* (Walliser) *Ozarkodina remscheidensis remscheidensis* (Ziegler) 12 Pa, 1 Pb, 3 M, 1 Sa, 2 Sb, 2 Sc 15 indet. bar, blade, and platform fragments	Postmortem transport from *O. r. remscheidensis* biofacies; relatively shallow, probably restricted marine.	Medium-light-gray-weathering, medium-gray, thin- to medium- irregularly bedded, medium-grained, brachiopod-ostracode grainstone. Heavy-mineral concentrate: weathered pyrite, argillaceous flakes with disseminated pyrite, iron oxides, dolomite and minor phosphatic brachiopod fragments, ichthyoliths and partly pyritized silicified ostracode valves (including *Aechmina* sp. and *Bollia* sp.). 5.9 kg; 500 g +20 mesh and 188 g 20-140 mesh insoluble residue.
HE-1 Head-24 (12201-SD)	39°22'48", 78°46'13"	**Headsville** (**C5**)	Hampshire (West Virginia)	Needmore Shale or Marcellus Shale (included in Romney Shale in table 2)	Middle Devonian middle Eifelian-Givetian	3.5	2 Pa *Polygnathus linguiformis linguiformis* Hinde γ morphotype 1 Pa fragment *Polygnathus* sp. indet. of middle Eifelian or younger Devonian morphotype 1 M element, unassigned 7 indet. bar, blade, and platform fragments	Postmortem transport within or from the polygnathid biofacies; normal marine.	Medium-gray interbedded calcareous shale and limestone. Heavy-mineral concentrate: chiefly ferruginous siltstone and mudstone fragments, minor barite and rare pyritized tentaculitid steinkerns. 6.9 kg; 2 kg +20 mesh and 80 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.
HE-2 Head-27UB [12202-SD]	39°23'41", 78°45'25"	**Headsville** (**C5**)	Hampshire (West Virginia)	Marcellus Shale; Purcell Member	Middle Devonian	3.5	2 small Pa fragments *Polygnathus* sp. indet.	Indeterminate.	Medium-gray, massive limestone. Heavy-mineral concentrate: chiefly silt- and clay-sized pyritic composite grains and fresh and weathered euhedral pyrite clusters. 1.9 kg; 820 g +20 mesh and 20 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.
HE-3 Head-21	39°22'37", 78°50'07"	**Headsville** (**C5**)	Mineral (West Virginia)	Mahantango Formation; Pokejoy(?) Member			Barren.		Medium-gray, massive, calcareous shale. Heavy-mineral concentrate: clusters of clay- and silt-sized clays with disseminated very fine pyrite. 3.4 kg; 2.9 kg +20 mesh and 126 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.
HE-4 9-25-90D	39°29'40", 78°45'31"	**Headsville** (**C5**)	Mineral (West Virginia)	Harrell Shale			Barren.		Medium- to medium-dark-gray, very fine grained, carbonate mudstone in a 1- to 5-cm-thick lensing bed in dark-gray to grayish-black shale. Heavy-mineral concentrate: barite and argillaceous grains with disseminated pyrite. 7.4 kg; 5.02 kg +20 mesh and 464 g 20-140 mesh insoluble residue.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
IN-1a 8-15-90C (10881-CO)	39°16'16", 78°06'52"	**Inwood** **(I4)**	Frederick (Virginia)	Stonehenge Limestone (lowermost)	early Early Ordovician Tremadocian (*C. angulatus* Zone or *R. manitouensis* Zone, probably *C. angulatus* Zone)	4.5-5	3 "*Acanthodus*" *lineatus* (Furnish) 7 "*Acontiodus*" *iowensis* Furnish s.f. 14 *Cordylodus angulatus* Pander 23 *Cordylodus intermedius* Furnish 3 M *Cordylodus* spp. 3 *Cordylodus* sp. indet. 10 *Monocostodus* sp. 4 "*Oistodus*" *triangularis* Furnish s.f. 26 *Scolopodus*? *sulcatus* Furnish, early form 9 *Teridontus* aff. *T. nakamurai* (Nogami) 21 *Variabiloconus bassleri* (Furnish) 2 *Utahconus*? sp. indet. 11 unassigned coniform elements 25 indet. bar and coniform fragments	Cordylodid-scolopodid-variabiloconid biofacies; shelfal, normal-marine environment.	Medium-light-gray-weathering, medium-dark-gray, slightly irregularly thin-bedded (beds 1-3 cm thick) micrite. Heavy-mineral concentrate: iron oxides, fluorite euhedra, euhedral clusters of fresh and weathered pyrite, phosphatic brachiopod fragments. 11.0 kg; 90 g +20 mesh and 124 g 20-200 mesh insoluble residue.
IN-1b 8-15-90D (10882-CO)	39°16'16", 78°06'52"	**Inwood** **(I4)**	Frederick (Virginia)	Stonehenge Limestone (100 m above IN-1a)	early Early Ordovician (*R. manitouensis* Zone)	4.5-5	1 *Drepanoistodus* aff. *D. pervetus* Nowlan 4 N. Gen., n. sp. 2 *Rossodus* sp. 4 *Scolopodus*?*sulcatus* Furnish, s.f. 14 *Variabiloconus bassleri* (Furnish) 13 indet. coniform fragments	Variabiloconid biofacies; warm, shallow, normal marine.	Medium-light-gray-weathering, medium-dark-gray, irregularly thin-bedded, carbonate mudstone to micrite. Heavy-mineral concentrate: mostly phosphatic brachiopod fragments, minor (6) scolecodonts, and minor druses of fresh pyrite and iron oxides. 8.4 kg; 600 g +20 mesh and 72 g 20-200 mesh insoluble residue.
IN-2 8-16-90E (10883-CO)	39°16'24", 78°01'09"	**Inwood** **(I4)**	Jefferson (West Virginia)	New Market Limestone (near base)	Middle Ordovician late middle-late Whiterockian (*C. friendsvillensis* Zone-*C.sweeti* Zone)	4	1 element fragment *Appalachignathus delicatulus* Bergstrom & others *Curtognathus robustus* (Branson & Mehl) 8 Pa, 5 Pb, 4 M, 8 Sb, 16 Sc 1 *Leptochirognathus quadratus* Branson & Mehl *Phragmodus flexuosus* Moskalenko 2 M, 1 Sb ~170 robust, chiefly curtognathid bar, blade, and platform fragments	Curtognathid biofacies; warm, very shallow, restricted to partly restricted marine.	Light-gray- to medium-light-gray-weathering, medium- to medium-dark-gray micrite. Heavy-mineral concentrate: chiefly euhedral clusters of weathered pyrite (minor fresh), iron-oxide flakes, quartzose prisms (most with pyrite euhedra in center), druses of weathered and fresh pyrite, and weathered and fresh pyrite euhedra. 7.9 kg; 300 g +20 mesh and 55 g 20-140 mesh insoluble residue.
IN-3 8-15-90E (10884-CO)	39°15'18", 78°05'16"	**Inwood** **(I4)**	Frederick (Virginia)	New Market Limestone	Middle Ordovician middle Whiterockian into Shermanian; probably middle-late Whiterockian on the basis of stratigraphic position	4	*Curtognathus robustus* (Branson & Mehl) 29 Pa, 31 Pb, 4 M?, 61 Sb & 108 Sc 2 *Leptochirognathus quadratus* Branson & Mehl ~199 robust, chiefly curtognathid fragments	Postmortem transport within curtognathid biofacies; warm, very shallow-water, partly restricted environment.	Medium-dark-gray, massive, carbonate mudstone to micrite. Heavy-mineral concentrate: not recorded. 9.6 kg; 35 g +20 mesh and 75 g 20-140 mesh insoluble residue.
IN-4 8-16-90F (10885-CO)	39°17'12", 78°01'02"	**Inwood** **(I4)**	Jefferson (West Virginia)	Edinburg Formation(?)	Middle Ordovician Rocklandian-early Maysvillian; probably Rocklandian on the basis of stratigraphic position	~4	1 M element *Periodon grandis* (Ethington)	Indeterminate; probably postmortem transport into cool, outer shelf or deeper water environment.	Medium-light-gray-weathering, dark-gray, irregularly-nodular-bedded (2-10 cm thick), carbonate mudstone. Heavy-mineral concentrate: fluorite euhedra, iron oxides, druses of weathered and fresh pyrite, and euhedral clusters of weathered pyrite. 6.1 kg; 120 g +20 mesh and 36 g 20-140 mesh insoluble residue.
IN-5a 4-1-91G (10886-CO)	39°21'12", 78°01'57"	**Inwood** **(I4)**	Berkeley (West Virginia)	Chambersburg Limestone; base of measured section.	Middle Ordovician Llanvirnian-early Caradocian probably early Caradocian	4	8 *Drepanoistodus suberectus* (Branson & Mehl) 2 *Panderodus* sp. *Periodon aculeatus* Hadding 1 Pa, 4 M & 1 Sc 5 indet. coniform fragments	Postmortem transport of cosmopolitan species into normal-marine moderate to deep water.	Medium-gray, knobbly-bedded, carbonate mudstone to fine-grained mudstone. Heavy-mineral concentrate: chiefly iron oxides, phosphatic brachiopod fragments, phosphatized crinoid and bryozoan fragments, druses of pyrite, minor barite and rare bryozoan pearls. 9.4 kg; 1.54 kg +20 mesh and 244 g 20-200 mesh insoluble residue.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
IN-5b 4-1-91I (10887-CO)	39°21'12", 78°01'57"	**Inwood** **(I4)**	Berkeley (West Virginia)	Chambersburg Limestone; 7 m above base of measured section.	Middle Ordovician earliest Caradocian (*Baltoniodus gerdae* Subzone of the *Amorphognathus tvaerensis* Zone)	4	*Baltoniodus gerdae* (Bergström) 7 Pa, 6 Pb, 10 M, 17 Sa, 7 Sc, 16 Sd 2 *Ansella* sp. adenticulate elements *Dapsilodus*? *similaris* (Rhodes) 2 Pa, 2 M, 2 S fragments ~100 indet. bar, blade, platform, and coniform fragments	*Baltoniodus gerdae*-pelagic coniform species biofacies; mid-shelf to upper slope, normal marine.	Medium-dark-gray, knobbly-bedded, fine-grained wackestone? to mudstone. Heavy-mineral concentrate: iron oxides, phosphatic brachiopod fragments (mostly oxidized), argillaceous flakes with disseminated pyrite, druses of pyrite, pyrite euhedra, pyritized phosphatic ostracode steinkerns, phosphatic bryozoan zooecial linings, inarticulate acrotretid pedicle valves. 12.9 kg; 80 g +20 mesh and 120 g 20-200 mesh insoluble residue.
IN-5c 4-1-91J (10888-CO)	39°21'12", 78°01'57"	**Inwood** **(I4)**	Berkeley (West Virginia)	Chambersburg Limestone; 12 m above base of measured section.	Middle Ordovician earliest Caradocian (*Baltoniodus gerdae* Subzone of the *Amorphognathus tvaerensis* Zone)	4	*Baltoniodus gerdae* (Bergström) 12 Pa, 3 Pb, 3 M & 3 Sc *Dapsilodus*? *similaris* (Rhodes) 11 M, 13 S 61 *Drepanoistodus suberectus* (Branson & Mehl) 36 *Panderodus* spp. 9 *Panderodus*? sp. with serrate posterior 1 M Periodon *grandis* (Ethington) 2 Pb *Phragmodus* sp. indet. ~44 indet. bar, blade, platform,and coniform fragments	*Baltoniodus gerdae*-pelagic coniform species biofacies; mid-shelf to upper slope, normal marine.	Medium-dark-gray, massive, fine- to very fine grained mudstone Heavy-mineral concentrate: phosphatic brachiopod fragments, phosphatic, pyritized & oxidized trilobite spines and fragments, ostracode valves, bryozoans, and gastropods, and minor iron oxides. 10.3 kg; 200 g +20 mesh and 62 g 20-200 mesh insoluble residue.
IN-5d 8-16-90H (10889-CO)	39°21'12", 78°01'57"	**Inwood** **(I4)**	Berkeley (West Virginia)	Chambersburg Limestone; 16.7 m above base of measured section.	Middle Ordovician earliest Caradocian (*Baltoniodus gerdae* Subzone of the *Amorphognathus tvaerensis* Zone)	4	Only the +60 mesh heavy-mineral concentrate was picked for conodonts; only one-half tray was picked for indeterminate fragments. *Amorphognathus tvaerensis* Bergstrom 5 Pa, 5 Pb *Baltoniodus gerdae* (Bergstrom) 201 Pa, 109 Pb, 16 M, 16 Sa, 10 Sc, 18 Sd 29 *Drepanoistodus suberectus* (Branson & Mehl) 1 *Dapsilodus*? *similaris* (Rhodes) 3 "*Oistodus*" *venustus* Stauffer s.f. 198 indet. bar, blade, platform, and coniform fragments	*Baltoniodus gerdae* biofacies--lag concentrate; cool, outer shelf-upper slope, moderate to relatively deep-water environment.	Medium-gray-orange-weathering, medium- to medium-dark-gray, coarse-grained packstone/grainstone. Heavy-mineral bioclasts include: chiefly silicified phosphatic brachiopod and trilobite fragments (some pyritized and oxidized), ostracode valves, articulate brachiopods, steinkerns, echinoderms, pyritized spines, and minor phosphatized pelecypod and gastropod steinkerns and rare ichthyoliths. Heavy-mineral concentrate: druses of weathered and fresh pyrite and iron-oxide flakes. 6.0 kg; 1.14 kg +20 mesh and 130 g 20-140 mesh insoluble residue.
IN-5e 4-1-91K (10890-CO)	39°21'12", 78°01'57"	**Inwood** **(I4)**	Berkeley (West Virginia)	Chambersburg Limestone; 21.6 m above base of measured section.	Middle Ordovician earliest Caradocian (*Baltoniodus gerdae* Subzone of the *Amorphognathus tvaerensis* Zone)	4	1 M *Amorphognathus tvaerensis* Bergstrom *Baltoniodus gerdae* (Bergstrom) 13 Pa (chiefly fragments), 12 Pb, 18 M, 6 Sa, 35 Sc, 25 Sd, 23 fragments 107 *Drepanoistodus suberectus* (Branson & Mehl) 13 *Dapsilodus*? sp. 21 *Panderodus* spp. *Periodon aculeatus* Hadding 4 Pa, 3 Pb, 9 M, 5 Sb, 3 Sc 188 indet. bar, blade, platform, and coniform fragments	Postmortem winnow from cool, outer shelf or deeper water depositional environment.	Medium-dark-gray, argillaceous, knobbly bedded mudstone to very fine grained wackestone; about 70% of interval covered. Heavy-mineral concentrate: chiefly bioclastic pyritized and (or) phosphatized trilobite spines, ostracode valves, bryozoans, sponge spicules and low- and high-spired gastropods and relatively abundant druses of weathered and fresh pyrite and pyrite euhedra. 11.7 kg; 2.44 kg +20 mesh and 435 g 20-200 mesh insoluble residue.
IN-5f 4-1-91L (10891-CO)	39°21'12", 78°01'57"	**Inwood** **(I4)**	Berkeley (West Virginia)	Chambersburg Limestone; 27 m above base of measured section.	Middle Ordovician early Caradocian (*Baltoniodus gerdae* Subzone of the *Amorphognathus tvaerensis* Zone)	4	*Amorphognathus* sp. indet. 2 Pa fragments, 2 Sb, 2 Sd *Dapsilodus*? *similaris* (Rhodes) 47 M, 16 S 9 *Dapsilodus*? sp. indet. 214 *Drepanoistodus suberectus* (Branson & Mehl) 21 *Panderodus* spp. *Periodon aculeatus* Hadding transitional to *P. grandis* (Ethington) 37 Pa, 9 Pb, 60 M, 5 Sa, 33 Sb, 41 Sc *Plectodina* sp. indet. 2 Sa, 2 Sc 1 *Pseudooneotodus mitratus* (Moskalenko) ~70 indet. bar, blade, platform, and coniform fragments	Periodontid-pelagic coniform biofacies; cool-water, outer shelf or deeper water, normal marine environment with minor admixture of warmer shallower water components.	Medium-gray to medium-light-gray, fine- to medium-grained, medium-bedded, flaggy limestone. Heavy-mineral concentrate: abundant iron oxides and weathered and fresh pyrite euhedra. Bioclasts include acrotretid brachiopod valves and fragments, silicified, phosphatized and pyritized trilobite spines and frills, ostracode valves and steinkerns of chitinozoans and gastropods. 10.1 kg; 1.18 kg +20 mesh and 368 g 20-200 mesh insoluble residue.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
IN-5g 4-1-91M (10892-CO)	39°21'12", 78°01'57"	**Inwood** **(I4)**	Berkeley (West Virginia)	Chambersburg Limestone; 34.5 m above base of measured section.	Middle Ordovician early Caradocian (*Baltoniodus gerdae* Subzone of the *Amorphognathus tvaerensis* Zone)	4	1 *Curtognathus* sp. indet. *Dapsilodus? similaris* (Rhodes) 15 M, 3 S 33 *Drepanoistodus suberectus* (Branson & Mehl) 22 *Panderodus* sp. *Periodon aculeatus* Hadding transitional to *P. grandis* (Ethington) 7 Pa, 1 Pb, 13 M, 3 Sa, 7 Sb, 7 Sc 11 indet. bar, blade, platform, and coniform fragments	Periodontid-pelagic coniform biofacies, cool, outer shelf or deeper water environment.	Medium-dark-gray to dark-gray, knobbly- to medium-bedded mudstone and minor calcareous shale. Heavy-mineral concentrate: trilobite spines and phosphatic brachiopod fragments, ostracode valves, minor barite, iron oxides and flakes, and minor oxidized bryozoans. 10.3 kg; 320 g +20 mesh and 107 g 20-200 mesh insoluble residue.
IN-5h 4-1-91 N (10893-CO)	39°21'12", 78°01'57"	**Inwood** **(I4)**	Berkeley (West Virginia)	Chambersburg Limestone; 37.5 m above base of measured section.	Middle Ordovician early Caradocian (probably *Baltoniodus gerdae* Subzone of the *Amorphognathus tvaerensis* Zone)	4	1 M *Curtognathus* sp. indet. 2 *Dapsilodus? similaris* (Rhodes) 23 *Drepanoistodus suberectus* (Branson & Mehl) 1 *Erismodus* sp. indet. 1 *Panderodus* sp. indet. *Periodon aculeatus* Hadding 1 Pa, 3 M, 1 Sc *Plectodina* sp. indet. 2 Pa, 3 Sb, 1 Sc(?) 13 indet. bar, blade, and platform fragments	Postmortem winnow of hydraulically mixed biofacies of predominantly cool, deeper water forms and a few warm, shallow-water forms; mid-shelf or deeper water depositional environment.	Medium-gray, thick-bedded micrite. Heavy-mineral concentrate: iron oxides, mica, barite, druses of pyrite, pyrite euhedra, phosphatic brachiopod fragments and ostracode valves. 10.6 kg; 240 g +20 mesh and 77 g 20-200 mesh insoluble residue.
IN-5i 4-1-91O (10894-CO)	39°21'12", 78°01'57"	**Inwood** **(I4)**	Berkeley (West Virginia)	Chambersburg Limestone; 49 m above base of measured section.	Middle Ordovician probably early Caradocian	4	2 *Curtognathus* sp. indet. *Dapsilodus? similaris* (Rhodes) 6 M, 1 S 17 *Drepanoistodus suberectus* (Branson & Mehl) 29 *Panderodus* sp. *Plectodina* sp. indet. 2 Pa, 2 Pb, 1 M, 1 Sa, 2 Sb, 9 Sc *Periodon* aff. *P. grandis* (Ethington) 1 Pa, 7 M, 1 Sb 1 Sc *Phragmodus* sp. indet. 21 indet. bar, blade, platform, and coniform fragments	Postmortem winnow of hydraulically mixed biofacies of predominantly cool deeper water forms and a few warm shallow water forms; mid-shelf or deeper water depositional environment.	From thin bed of medium-dark-gray, light-gray-weathering micrite in shale to slightly calcareous shale interval. Heavy-mineral concentrate: iron oxides, phosphatic brachiopod fragments and fresh and weathered druses and euhedra of pyrite. Minor bioclasts include brachial valve of acrotretid brachiopod , conularid fragments, and trilobite spine frills. 10.5 kg; 420 g +20 mesh and 82 g 20-200 mesh insoluble residue.
KE-1 9-27-90A (12157-SD)	39°23'29", 78°58'31"	**Keyser** **(B5)**	Mineral (West Virginia)	Tonoloway Limestone (middle to upper part)	Late Silurian late Ludlovian-Pridolian	3.5-4	*Ozarkodina remscheidensis remscheidensis* (Ziegler) 20 Pa, 3 Pb, 3 M, 1 Sa, 1 Sb, 1 Sc 77 indet. bar, blade, and platform fragments	Postmortem transport from *O. r. remscheidensis* biofacies; from or within a shallow, partly restricted environment.	Medium-dark-gray, medium- to thick- and irregularly bedded, very fine grained wackestone to mudstone. Heavy-mineral concentrate: iron oxides, minor phosphatic brachiopod fragments and minute pyrite clusters. 7.5 kg; 30 g +20 mesh and 49 g 20-140 mesh insoluble residue.
KE-2 WVA-SmD-3 (12158-SD)	39°26'13", 78°57'35"	**Keyser** **(B5)**	Mineral (West Virginia)	Keyser Limestone	Late Silurian Pridolian	3.5-4	*Oulodus elegans* (Walliser) 9 Pa, 8 Pb, 3 Sa, 19 Sb, 6 Sc 1 Pa *Ozarkodina confluens* (Branson & Mehl) *Ozarkodina remscheidensis remscheidensis* (Ziegler) 1 Pa, 1 Pb, 2 M, 6 Sc *Ozarkodina* cf. *O. excavata* (Branson & Mehl) 5 Pb, 1 M 104 indet. bar, blade, and platform fragments	Oulodid biofacies; high-energy, shallow-water, normal marine depositional environment.	Lithology, sample and residue weights, and mineralogy are not available.
KE-3 9-25-90E (12159-SD)	39°25'23", 78°56'38"	**Keyser** **(B5)**	Mineral (West Virginia)	New Creek Limestone (within uppermost 1 m)	Early Devonian early Lochkovian	3.5	9 *Belodella* sp. indet. 41 *Decoriconus* sp. *Icriodus woschmidti* Ziegler 5 Pa & 30 M & S coniform elements (including bidenticulate Sb & Sc elements) *Oulodus cristagalli* (Ziegler) 13 Pb, 7 Sa, 23 Sb, 10 Sc *Ozarkodina remscheidensis remscheidensis* (Ziegler) 42 Pa, 18 Pb, 16 M, 11 Sa, 24 Sb, 12 Sc 22 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) 280 indet. bar, blade, and platform fragments	*O. r. remscheidensis*-oulodid biofacies; relatively shallow-water, high-energy, shoal-water, normal marine.	Medium-light-gray, coarse-grained, massive, cross-bedded, bioclastic, stromatoporoid-rich grainstone. Heavy-mineral concentrate: iron oxides, weathered pyrite, argillaceous grains with finely disseminated pyrite, phosphatic grains, dolomite rhombs and minor bryozoan pearls and ichthyoliths. 9.6 kg; 220 g +20 mesh and 361 g 20-140 mesh insoluble residue.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
KE-4 9-26-90A (12160-SD)	39°28'06", 78°54'39"	**Keyser** (**B5**)	Mineral (West Virginia)	Shriver Chert (uppermost) or Oriskany Sandstone (lowermost)	Early Devonian Lochkovian	3-3.5	4 *Belodella* sp. indet. 1 coniform M element *Icriodus* sp. indet. *Oulodus cristagalli* (Ziegler) 1 Pb,1 M,1 Sc *Ozarkodina remscheidensis remscheidensis* (Ziegler) 44 Pa, 28 Pb, 20 M, 8 Sa, 15 Sb, 16 Sc (mostly juvenile elements) 127 indet. bar, blade, and platform fragments	*O. r. remscheidensis* biofacies; postmortem winnow from relatively shallow-water, normal marine.	Medium-light-gray, fine-grained, laminated to platy, quartzose limestone to limy, fine-grained sandstone to siltstone. Heavy-mineral concentrate: weathered euhedral pyrite clusters (many with attached quartz grains), minor phosphatic brachiopod fragments. 8.2 kg; 120 g +20 mesh and 216 g 20-140 mesh insoluble residue.
KE-5 9-25-90F	39°25'21", 78°56'35"	**Keyser** (**B5**)	Mineral (West Virginia)	Shriver Chert (about 20-25 m below top of formation)			Barren.		Medium-dark-gray, chert and carbonate mudstone to calcareous siltstone containing brachiopods. Beds irregularly ripple-bedded, cross- and planar-laminated. Heavy-mineral concentrate: iron oxides, argillaceous grains with disseminated pyrite, and sphalerite. 8.0 kg; 5.16 kg +20 and 229 g 20-140 mesh insoluble residue.
KE-6 9-25-90G (12161-SD)	39°26'53", 78°58'18"	**Keyser** (**B5**)	Allegany (Maryland)	Harrell Shale; Burket Shale Member	Late Devonian very early Frasnian (upper Lower *M. falsiovalis* Zone through 2/3 of the *Pa. transitans* Zone)	3-3.5	22 Pa *Ancyrodella alata* Glenister & Klapper *Delotaxis* sp. indet. 1 Pb, 1 Sb, 3 Sc 20 P *Icriodus difficilis* Ziegler & Klapper 2 Pa fragments *Mesotaxis* (?) aff. *M* (?) *dengleri* (Bischoff & Ziegler) 12 Pa *Polygnathus dubius* Hinde 2 Pa *Polygnathus pennatus* Hinde UNASSIGNED ELEMENTS: 2 Pb, 3 M, 1 Sa, 2 Sc	Postmortem transport from normal marine ancyrodellid-icriodid-polygnathid biofacies; probably as distal storm deposits (tempestites).	Medium-light-gray, cm-thick, pinch-and-swell laminated bed of quartzose limestone. Heavy-mineral concentrate: barite, argillaceous flakes with disseminated pyrite and baritic and pyritic steinkerns of *Styliolina*. 4.0 kg; 2.5 kg +20 mesh and 205 g 20-140 mesh insoluble residue.
LA-1 91DW13 (12162-SD)	39°24'12", 78°23'00"	**Largent** (**F5**)	Hampshire (West Virginia)	Tonoloway Limestone or Keyser Limestone (included in Keyser on table 2)	Late Silurian late Ludlovian-latest Pridolian	4	*Ozarkodina remscheidensis remsheidensis* (Ziegler) 75 Pa, 10 Pb, 12 M, 1 Sa, 7 Sb, 5 Sc *Oulodus elegans* (Walliser) 1 Sa, 2 Sc 119 indet. bar, blade, and platform fragments	Postmortem transport within the *O. r. remscheidensis* biofacies; shallow, moderate-energy, normal marine environment.	Medium-gray, bioclastic grainstone (crinoid columnals and favositid corals) in 10 cm bed. Heavy-mineral concentrate: argillaceous flakes with disseminated pyrite, dolomitic calcite, spheres of fine pyrite, pyritized spicules, iron oxides and phosphatic shell fragments. 9.1 kg; 110 g +20 mesh and 155 g 20-140 mesh insoluble residue.
LO-1 91NS-16 (12163-SD)	39°30'05", 78°53'01"	Lonaconing (**B6**)	Mineral (West Virginia)	Corriganville Limestone	Early Devonian early Lochkovian (*I.woschmidti* Zone)	3.5	1 *Belodella* sp. 1 *Decoriconus* sp. 6 *Dvorakia* sp. *Icriodus woschmidti* Ziegler 5 Pa, 4 Pb, 4 M, 1 adenticulate Sa?, 1 denticulate Sb?, 2 adenticulate Sb & 6 S 1 Pb & 1 Sb *Oulodus* sp. indet. fragments *Ozarkodina remscheidensis remscheidensis* (Ziegler) transitional to *O. r. eosteinhornensis* (Walliser) 20 Pa, 9 Pb, 5 M, 1 Sa, 2 Sb, 1 Sc 1 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) 1 unassigned Pb element 55 indet. bar, blade, and platform fragments	Postmortem winnow and hydraulically mixed biofacies from or within relatively shallow, high-energy, normal marine environment.	Light-gray-weathering, medium-light-gray, medium-knobbly-bedded, medium- (mostly) to coarse-grained, poorly sorted, slightly argillaceous encrinoidal packstone/grainstone with minor white chert. Heavy-mineral concentrate: dolomite, barite, minor iron oxides and sphalerite, trace weathered euhedral pyrite clusters and druses of weathered pyrite. 11.3 kg; 10 g of +20 mesh and 238 g 20-140 mesh insoluble residue.
MA-1 91DW41 (10895-CO)	39°26'30", 77°59'30"	Martinsburg (**J5**)	Berkeley (West Virginia)	Conococheague Limestone	Late Cambrian (*Eoconodontus* Zone)	4 or 5 (shown as 4.5 on table 2)	1 *Proconodontus serratus*(?) Müller 1 *Eoconodontus* sp. indet. or *Proconodontus* sp. indet.	Indeterminate; normal marine depositional environment.	Medium-light-gray and minor light-reddish-gray, slightly dolomitic, lime mudstone in beds 15 cm thick. Heavy-mineral concentrate: quartzose silt-size grains with oxidized and weathered euhedral pyrite and minor barite. 10.3 kg; 50 g +20 mesh and 122 g 20-200 mesh insoluble residue.
MA-2 4-1-91E	39°26'35", 77°59'43"	Martinsburg (**J5**)	Berkeley (West Virginia)	Conococheague Limestone (about 50-100 m below 4-1-91F)			Barren.		Medium- to medium-light-gray, ribbony carbonate mudstone (just below small swale of dolostone). Heavy-mineral concentrate: composition not recorded. 12.5 kg; 10.8 kg +20 mesh and 244 g 20-200 mesh insoluble residue.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
MA-2 4-1-91F	39°26'35", 77°59'43"	Martinsburg (**J5**)	Berkeley (West Virginia)	Conococheague Limestone (uppermost part)			Barren.		Medium-dark-gray, laminated to very thin-bedded, massive, slightly dolomitic, ribbony carbonate mudstone. Heavy-mineral concentrate: fresh and weathered pyrite euhedra and euhedral clusters, argillaceous flakes with finely disseminated pyrite and minor phosphatic brachiopod fragments. 14.6 kg; 1.3 kg +20 mesh and 301 g 20-200 mesh insoluble residue.
MA-3 4-1-91B (10896-CO)	39°28'49", 77°57'02"	Martinsburg (**J5**)	Berkeley (West Virginia)	Rockdale Run Formation	early Early Ordovician latest Tremadocian-earliest Arenigian (*R. manitouensis* Zone)	indet. probably 4-5 (shown as 4.5 on table 2)	1 *Scolopodus*? aff. *S.? sulcatus* Furnish	Indeterminate; very shallow water, probably hypersaline depositional environment.	Light-brownish-gray, abundantly bioturbated saccharoidal, massively bedded dolostone within shoaling upward cycles (darker colored at base) about 0.6-0.8 m thick. Heavy-mineral concentrate: dolomite euhedra, some iron oxides, trace weathered pyrite euhedra. 10.5 kg; 310 g +20 mesh and 241 g 20-200 mesh insoluble residue.
MA-4 91DW42 (10897-CO)	39°26'30", 77°58'08"	Martinsburg (**J5**)	Berkeley (West Virginia)	New Market Limestone (lowermost)	Middle Ordovician late Whiterockian	4	*Curtognathus robustus* (Branson & Mehl) and *C. typus* Branson & Mehl 11 Pa, 10 Pb, 3 M, 2 Sb 24 *Erismodus* sp. 1 *Leptochirognathus* sp. indet. *Phragmodus flexuosus* Moskalenko 1 P, 1 M, 1 Sa, 1 Sb, 2 Sc *Plectodina joachimensis* (Andrews) 1 Pa, 2 Sb UNASSIGNED ELEMENTS: 1 M, 1 Sb, 1 Sc 156 indet. bar, blade and platform elements (chiefly robust fragments of *Curtognathus*)	Curtognathid-erismodid biofacies; warm, shallow, intermittently high-energy, probably partly restricted marine depositional environment.	Medium-gray, fenestral micrite with algal laminae and gastropods in beds 0.5 m thick. Heavy-mineral concentrate: argillaceous flakes with iron oxides and finely disseminated pyrite and minor barite. 10.2 kg; 60 g +20 mesh and 55 g 20-200 mesh insoluble residue.
MA-5 9-24-90B (10898-CO)	39°23'40", 77°59'57"	Martinsburg (**J5**)	Berkeley (West Virginia)	Chambersburg Limestone	Middle Ordovician early Caradocian (*Baltoniodus gerdae* Subzone of the *Amorphognathus tvaerensis* Zone)	4	1 Pa *Baltoniodus gerdae* (Bergstrom) 1 *Panderodus* sp. indet. *Periodon aculeatus* Hadding transitional to *Periodon grandis* (Ethington) 2 Pa, 1 Pb, 1 M 1 indet. coniform fragment	Periodontid biofacies; cool, normal marine, outer shelf or deeper water environment.	Light-gray- to medium-light-gray-weathering, medium-dark- to dark-gray, massive, micrite to very fine grained limestone. Heavy-mineral concentrate: pyrite, argillaceous grains with pyrite euhedra, phosphatic brachiopod fragments, and iron oxides. 5.4 kg; 130 g +20 mesh and 43 g 20-140 mesh insoluble residue.
ME-1a 9-26-90G (12164-SD)	39°11'06", 79°00'06"	Medley (**A3**)	Hardy (West Virginia)	Keyser Limestone (22 m below base of Corriganville Limestone)	Late Silurian probably latest Pridolian	3.5-4	1 Sb *Belodella* sp. indet. *Oulodus elegans* (Walliser) 9 Pa, 15 Pb (2 morphotypes), 13 M, 3 Sa, 12 Sb, 28 Sc *Ozarkodina remscheidensis eosteinhornensis* (Walliser) (chiefly) and *O. r. remscheidensis* (Ziegler) 95 Pa, 37 Pb, 22 M, 6 Sa, 10 Sb, 8 Sc 143 indet. bar, blade and platform fragments	*O. r. eosteinhornensis*-oulodid biofacies; relatively shallow, moderate- to high-energy, normal marine.	Medium-light- to medium-gray, thick-bedded, fossiliferous (chiefly crinoid columnals), coarse-grained grainstone. Heavy-mineral concentrate: composition not recorded. 8.6 kg; 0 g +20 mesh and 256 g 20-140 mesh insoluble residue.
ME-1b 9-26-90F (12165-SD)	39°11'04", 79°00'03"	Medley (**A3**)	Hardy (West Virginia)	New Creek Limestone (1.8 m below top of formation)	Early Devonian early Lochkovian (no younger than *O. delta* Zone)	3.5	45 *Belodella* sp. 56 *Coelocerodontus* sp. 14 *Coelocerodontus* sp. indet. *Oulodus cristagalli* (Ziegler) 2 Pb_1, 3 Pb_2, 1 Sc *Ozarkodina remscheidensis* (Ziegler) 3 Pa, 1 M 77 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) 19 indet. bar, blade, and platform fragments	Pseudooneotodid-coelocerodontid-belodellid biofacies (=coniform biofacies); shallow to moderate depth, chiefly moderate-energy, normal marine with postmortem additions from the shallower water, higher energy, oulodid-ozarkodinid biofacies.	Light-gray, coarsely crystalline, very fossiliferous (crinoid columnals, brachiopods, trilobites, etc.), massive- to thick-bedded grainstone. Heavy-mineral concentrate: chiefly euhedral dolomite and phosphatic brachiopod fragments and lesser ferruginous argillaceous flakes and ichthyoliths. 9.8 kg; 100 g +20 mesh and 36 g 20-140 mesh insoluble residue.
ME-1c 90MK32-PC (12166-SD)	39°11'04", 79°00'03"	Medley (**A3**)	Hardy (West Virginia)	Shriver Chert (12.5 m below base of Oriskany Sandstone)	Early Devonian late Lochkovian (*P. pesavis* Zone)	3.5	*Belodella* sp. 1 Sa, 1 Sb *Icriodus simulator* Carls 3 Pa, 1 M, 5 S 25 Pa fragments *Icriodus* sp. indet.	Postmortem transport from icriodid biofacies; moderate- to deep-water normal marine.	Dark-gray, irregularly thin- to medium-bedded, slightly quartzose carbonate mudstone containing about 50% dark-gray chert. Heavy-mineral concentrate: abundant phosphatic brachiopod fragments and lesser ferruginous argillaceous flakes. 10.0 kg; 4.94 kg +20 mesh and 140 g 20-140 mesh insoluble residue.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
ME-2 91DW40 (12167-SD)	39°11'52", 79°02'47"	Medley (**A3**)	Grant (West Virginia)	Harrell Shale	Late Devonian very early Frasnian (Probably upper Lower *falsiovalis* Zone through *transitans* Zone)	3.5-4	1 Pa *Ancyrodella* sp. indet. fragment 1 juvenile Pa. *Ancyrodella* sp. indet. 5 Pa *Icriodus* aff. *I. difficilis* Ziegler & Klapper 13 Pa *Polygnathus dubius* Hinde 3 Pa *Polygnathus pennatus* Hinde UNASSIGNED ELEMENTS: 1 Sb, 2 M, 2 Sa & 2 Sc 99 indet. bar, blade, and platform fragments	Postmortem transport basinward from polygnathid biofacies; shelfal, normal marine.	Dark-gray, silty limestone laminae in black, graphitic shale from structurally disrupted zone. Heavy-mineral concentrate: argillaceous flakes with finely disseminated and framboidal fresh and weathered pyrite, barite, baritized steinkerns of coralline fragments and pyritized steinkerns of *Styliolina* sp. indet. 10.1 kg; 7.4 kg +20 mesh and 565 g 20-140 mesh insoluble residue.
MI-1 8-13-90K	39°07'09", 78°18'27"	**Middletown** (**G2**)	Frederick (Virginia)	Not known. Fault slice along North Mountain fault zone.	Not determined; probably Cambrian		Barren.		Medium-dark-gray, irregularly laminated, lime mudstone. Heavy-mineral concentrate: phosphatic brachiopod fragments, fluorite and minor dolomite. 9.7 kg; 2.05 kg +20 mesh and 243 g 20-200 mesh insoluble residue.
MI-2 RO-292 (10899-CO)	39°03'52", 78°15'43"	**Middletown** (**G2**)	Frederick (Virginia)	Stonehenge Limestone (upper part)	Early Ordovician late early Ibexian (*R. manitouensis* Zone)	4.5	1 "*Acontiodus*" *iowensis* Furnish 1 *Cordylodus* sp. indet. 5 *Drepanoistodus pervetus* Nowlan 2 "*Oistodus*" *triangularis* Furnish 4 *Rossodus manitouensis* Repetski & Ethington 2 *Scolopodus*? *sulcatus* Furnish 10 *Variabiloconus bassleri* (Furnish) 4 indet. coniform fragments	Variabiloconid biofacies; warm, relatively shallow water, possibly intermittently restricted.	Dark-gray, medium- to thick-bedded, partly laminated carbonate mudstone. Heavy-mineral concentrate: argillaceous flakes with disseminated pyrite and minor dolomite. 5.1 kg; 300 g +20 mesh and 62 g 20-200 mesh insoluble residue. All data from R.C. Orndorff, U.S. Geological Survey.
MI-3 8-13-90I (10900-CO)	39°04'48", 78°15'59"	**Middletown** (**G2**)	Frederick (Virginia)	Rockdale Run Formation (lower part)	Early Ordovician late early Ibexian (*R. manitouensis* Zone probably high in zone)	4.5	*5 "Acanthodus" lineatus* (Furnish) 12 *Clavohamulus densus* Furnish 76 *Drepanoistodus*? n. sp. 20 *Loxodus bransoni* Furnish 3 *Rossodus manitouensis* Repetski & Ethington 50 *Scolopodus*? *sulcatus* Furnish 170 *Variabiloconus bassleri* (Furnish), advanced form 1 N. Gen.? n. sp. 66 indet. coniform fragments	Variabiloconid-drepanoistodid biofacies; shallow, warm-water, normal marine.	Medium-light-gray-weathering, medium-dark-gray, thick-bedded and irregularly wispy bedded, fine-grained limestone. Scattered ribs of outcrop in field. Heavy-mineral concentrate: dolomite with pyrite euhedra, euhedral clusters of fresh and weathered pyrite, iron oxides, and argillaceous flakes with disseminated pyrite. 10.5 kg; 180 g +20 mesh and 52 g 20-200 mesh insoluble residue.
MI-4 8-13-90G (10901-CO)	39°02'02", 78°16'52"	**Middletown** (**G2**)	Frederick (Virginia)	Rockdale Run Formation (upper part)	late Early Ordovician (*O. communis* Zone, probably upper *O. communis* Zone)	4-4.5	*Diaphorodus delicatus* (Branson & Mehl) 3 M, 3 Sa, 1 Sb, 1 Sc, 3 Sd 7 *Drepanodus concavus* Branson & Mehl 4 *Eucharodus parallelus* (Branson & Mehl) 1 *Oneotodus costatus* Ethington & Brand 1 *"Scolopodus" gracilis* Ethington & Clark 1 *Ulrichodina abnormalis* (Branson & Mehl) 23 indet. coniform fragments	Warm, possibly partly restricted, relatively shallow water.	Very light gray to light-gray, massive, burrow-mottled to laminated dolomicrite. Heavy-mineral concentrate: dolomite euhedra, very-thin pyritized curved spines?, and pyritic iron-oxide flakes. 10.6 kg; 420 g +20 mesh and 37 g 20-200 mesh insoluble residue.
MI-5 SI-75-OB (10464-CO)	39°00'33", 78°20'12"	**Middletown** (**G2**)	Shenandoah (Virginia)	Pinesburg Station Dolomite (from top of formation)	Middle Ordovician late Whiterockian (*C. friendsvillensis* Zone through *C. sweeti* Zone)	4	1 P *Appalachignathus delicatulus* Bergstrom & others *Curtognathus robustus* (Branson & Mehl) 8 Pa, 15 Pb_1, 8 Pb_2 35 *Erismodus asymmetricus* (Branson & Mehl) 15 *Leptochirognathus primus* Branson & Mehl 3 *Panderodus* sp. *Phragmodus flexuosus* Moskalenko 2 P, 5 S UNASSIGNED ELEMENTS 1 Sb, 1 Sc 570 indet. bar, blade, platform and coniform fragments (chiefly curtognathid fragments)	Curtognathid biofacies; warm, shallow water, intermittently high energy and probably intermittently restricted marine.	Lithology, sample and residue weights, and mineralogy are not available.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
MI-6 8-13-90H (10902-CO)	39°02'17", 78°18'17"	**Middletown** (**G2**)	Frederick (Virginia)	New Market Limestone (probably middle-upper part)	middle Middle Ordovician late Whiterockian (*C. friendsvillensis* Zone into lowermost *P. aculeata* Zone)	4-4.5	Conodonts exhibit spaced-fracturing and most are deformed. *Appalachignathus delicatulus* Bergstrom & others 2 Pa, 5 blade fragments *Curtognathus robustus* (Branson & Mehl) 2 Pa, 21 Pb, 13 Sb 2 *Drepanoistodus suberectus* (Branson & Mehl) 40 *Erismodus radicans* (Hinde) 15 *Panderodus* sp. *Phragmodus flexuosus* Moskalenko 1 P, 3 M, 8 Sb, 35 Sc *Plectodina joachimensis* (Andrews) 2 Pa, 3 Pb, 8 Sb, 12 Sc 2 unassigned alate coniform elements 239 indet. bar, blade, platform, and coniform fragments	Hydraulically mixed biofacies dominated by *Curtognathus* and *Erismodus*; shallow, normal marine.	Yellowish- and orangish-gray-weathering, dark-gray, massive micrite somewhat tectonically disrupted. Exposure in quarry. Heavy-mineral concentrate: argillaceous flakes with disseminated pyrite, weathered and fresh pyrit euhedra, euhedral clusters of pyrite, and druses of pyrite. 9.7 kg; 40 g +20 mesh and 7 g 20-140 mesh insoluble residue.
MI-7 RO451 (10955-CO)	39°03'42", 78°21'10"	**Middletown** (**G2**)	Shenandoah (Virginia)	New Market Limestone (probably in lower part of formation); in fault slice along North Mountain fault zone.	middle Middle Ordovician late Whiterockian (*C. friendsvillensis* Zone into lowermost *P. aculeata* Zone)	4-4.5	7 fragments of *Curtognathus robustus* (Branson & Mehl) 16 *Erismodus* sp. indet. fragments *Plectodina* sp. indet. 1 Pa fragment and 1 Sc 1 unassigned M element 32 indet. bar, blade, and platform fragments (chiefly curtognathids)	Postmortem transport within erismodid-curtognathid biofacies; warm, shallow-water, partly restricted marine.	Highly fractured, dove-gray, very fine grained, medium- to thick-bedded, light-weathering limestone. Heavy-mineral concentrate: very dark gray argillaceous flakes containing finely disseminated weathered and fresh pyrite and iron oxides. 8.3 kg; 70 g +20 mesh and 59 g 20-200 mesh insoluble residue. Collected by R.C. Orndorff.
MI-8 8-3-74A (10903-CO)	39°00'57", 78°19'36"	**Middletown** (**G2**)	Shenandoah (Virginia)	Edinburg Formation	late Middle Ordovician	4	1 P fragment *Baltoniodus*? sp. indet. 4 *Dapsilodus?* sp. indet. 3 *Drepanoistodus basiovalis* (Sergeeva) 1 *Panderodus* sp. indet. *Periodon aculeatus* Hadding 2 Pa, 1 Sc	Postmortem winnow into moderate- to deep-water normal marine environment.	Lithology, sample and residue weights, and mineralogy are not available.
MI-9 C6-A (10956-CO)	39°00'22", 78°18'52"	**Middletown** (**G2**)	Shenandoah (Virginia)	Edinburg Formation (uppermost 0.5 m of formation)	late Middle Ordovician (*A. tvaerensis* Zone)	4	1 M *Amorphognathus tvaerensis* Bergstrom 5 *Dapsilodus*? *similaris* (Rhodes) 26 *Drepanoistodus suberectus* (Branson & Mehl) 46 *Panderodus gracilis* (Branson & Mehl) 1 Sb *Periodon* sp. indet. 4 *Protopanderodus* sp. indet. fragments 1 unassigned oistodontiform element 7 indet. bar, blade, platform, and coniform fragments	Postmortem winnow into moderate- to relatively deep-water normal marine environment.	Highest knobbly-weathering, argillaceous carbonate mudstone in formation. Heavy-mineral concentrate: chiefly phosphatic brachiopod fragments and pyritized spines and very small euhedral clusters of pyrite. 6.8 kg; 300 g +20 mesh and 70 g 20-200 mesh insoluble residue. Collected by J. B. Epstein.
MI-9 C6-B	39°00'22", 78°18'52"	**Middletown** (**G2**)	Shenandoah (Virginia)	"Oranda" Formation (basal 1 m)	Not determined, but Middle Ordovician		Barren.		Very fine grained, very thin bedded to thin-bedded, medium-gray to grayish-black shaly carbonate mudstone. Heavy-mineral concentrate: argillaceous flakes containing pyrite euhedra. 6.0 kg; 1.12 kg +20 mesh and 300 g 20-200 mesh insoluble residue. Collected by J. B. Epstein.
MI-9 C6-C	39°00'22", 78°18'52"	**Middletown** (**G2**)	Shenandoah (Virginia)	"Oranda" Formation (between 1 and 45 m above base of formation and above C6-B)	Not determined, but Middle Ordovician		Barren.		Very fine grained, very thin bedded to thin-bedded, medium-gray to grayish-black shaly carbonate mudstone. Heavy-mineral concentrate: iron oxides and minor barite and pyrite euhedra. 6.0 kg; 2.76 kg +20 mesh and 424 g 20-200 Collected by J. B. Epstein.
MI-9 C6-D	39°00'21", 78°18'52"	**Middletown** (**G2**)	Shenandoah (Virginia)	"Oranda" Formation (between 1 and 45 m above base of formation and above C6-C)	Not determined, but Middle Ordovician		Barren.		Very fine grained, very thin bedded to thin-bedded, medium-gray to grayish-black shaly carbonate mudstone. Heavy-mineral concentrate: iron-oxide flakes and minor anhedral pyrite. 6.0 kg; 2.8 kg +20 mesh and 87 g 20-200 Collected by J. B. Epstein.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
MI-9 C6-E	39°00'20", 78°18'52"	**Middletown (G2)**	Shenandoah (Virginia)	"Oranda" Formation (between 1 and 45 m above base of formation and above C6-D)	Not determined, but Middle Ordovician		Barren.		Very fine grained, very thin bedded to thin-bedded, medium-gray to grayish-black shaly carbonate mudstone. Heavy-mineral concentrate: iron-oxide flakes and minor dolomite and barite. 6.0 kg; 1.7 kg +20 mesh and 186 g 20-200 Collected by J. B. Epstein.
MI-9 C6-F	39°00'20", 78°18'51"	**Middletown (G2)**	Shenandoah (Virginia)	"Oranda" Formation (about 45 m above base of formation)	Not determined, but Middle Ordovician		Barren.		Very fine grained, very thin bedded to thin-bedded, medium-gray to grayish-black shaly carbonate mudstone. Heavy-mineral concentrate: iron-oxide flakes, barite and minor dolomite. 6.0 kg; 0.5 kg +20 mesh and 70 g 20-200 Collected by J. B. Epstein.
MI-10 MF(MT)1133-MCD	39°04'54", 78°20'48"	**Middletown (G2)**	Frederick (Virginia)	Wills Creek Formation or Tonoloway Lime-stone (included in Wills Creek on table 2)			Barren.		Medium-gray, fine-grained, irregularly bedded limestone. Heavy-mineral concentrate: chiefly fresh pyrite euhedra and minor barite. 15.0 kg; 6.08 kg +20 mesh and 864 g 20-140 mesh insoluble residue. Collected by R.C. McDowell.
MI-11 8-13-90J (12168-SD)	39°05'41", 78°19'43"	**Middletown (G2)**	Frederick (Virginia)	Probably Tonoloway Limestone or Keyser Limestone; within fault slice along North Mountain fault zone (included in Keyser on table 2)	Late Silurian-very earliest Devonian late Ludlovian-earliest Lochkovian	4	Hydraulically broken and abraded very small fragments. 19 small, rounded, robust indeterminate fragments	Indeterminate biofacies; postmortem hydraulic transport and extensive abrasion.	Medium-light-gray, fine-grained, argillaceous limestone about 10 cm thick interbedded with calcareous shale. Heavy-mineral concentrate: anhedral dolomite (rarely euhedral), druses of pyrite, euhedral sphalerite (some anhedral), iron oxides, phosphatized brachiopod fragments, and partly pyritized scolecodonts. 10.6 kg; 1.22 kg +20 mesh and 592 g 20-140 mesh insoluble residue.
MW-1 4-1-91Q (10904-CO)	39°16'03", 77°59'26"	Middleway **(J4)**	Jefferson (West Virginia)	Chambersburg Limestone	Middle Ordovician early Caradocian	4-4.5	1 Pa fragment *Amorphognathus* sp. indet. *Dapsilodus? similaris* (Rhodes) 6 M, 6 S 2 *Drepanoistodus suberectus* (Branson & Mehl) *Periodon aculeatus* Hadding transitional to *P. grandis* (Ethington) 1 Pb, 2 M, 4 Sb, 2 Sc 1 *Protopanderodus* aff. *P. varicostatus* (Sweet & Bergstrom) 2 indet. bar fragments	Postmortem winnow of cool-water cosmopolites representative of outer shelf or deeper water depositional environment.	Dark-gray to grayish-black, very light gray- to buff-weathering micrite. Heavy-mineral concentrate: phosphatic brachiopod fragments, 1 acrotretid pedicle valve, druses of pyrite, and minor iron oxides. 10.1 kg; 210 g +20 mesh and 131 g 20-200 mesh insoluble residue.
MW-2 8-16-90G (10905-CO)	39°18'14", 77°59'18"	Middleway **(J4)**	Jefferson (West Virginia)	Edinburg Formation	Middle Ordovician early-middle Caradocian	4-4.5	1 Sa & 1 Sb *Periodon* sp. indet. 1 indet. fragment	Indeterminate biofacies; postmortem transport into cool, outer shelf or deeper water environment.	Medium-light-gray-weathering, dark-gray, irregularly laminated medium-bedded micrite. Heavy-mineral concentrate: iron oxides, partly pyritized and phosphatized, silicified articulated and dissarticulated (minor) ostracode valves, fresh and weathered pyrite euhedra, barite, and minor fluorite euhedra. 5.7 kg; 260 g +20 mesh and 63 g 20-140 mesh insoluble residue.
MW-3 4-1-91P (10906-CO)	39°20'43", 77°56'22"	Middleway **(J4)**	Jefferson (West Virginia)	Chambersburg Limestone (uppermost part; no more than 15 m below top of formation)	Middle Ordovician	4-4.5	1 *Drepanoistodus suberectus* (Branson & Mehl)	Indeterminate.	Medium-dark-gray, medium-bedded, even-bedded, carbonate mudstone and lesser calcareous shale. Heavy-mineral concentrate: iron oxides, minor phosphatic brachiopod fragments and rare silicified ostracode valves. 11.7 kg; 4.64 kg +20 mesh and 359 g 20-200 mesh insoluble residue.
MO-1 9-27-90C	39°01'53", 78°56'36"	**Moorefield (B2)**	Hardy (West Virginia)	Harrell Shale (lower part)			Barren.		Medium-dark-gray calcareous shale to mudrock pinch-and-swell concretionary layer as much as 15 cm thick; inner part coarsely crystalline. Heavy-mineral concentrate: prismatic barite in acicular masses, minor iron oxides and argillaceous chips with barite. 6.7 kg; 4.06 kg +20 mesh and 130 g 20-140 mesh insoluble residue.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
MF-1 8-14-90F	39°03'26", 78°22'55"	**Mountain Falls (F2)**	Frederick (Virginia)	Not known; in fault slice along North Mountain fault zone.	Not determined; probably Cambrian.		Barren.		Medium-gray-weathering, medium- to medium-dark-gray, wispy laminated, thin-bedded, fine-grained limestone. Heavy-mineral concentrate: fluorite euhedra, dolomite euhedra, druses of fresh and weathered pyrite, and iron oxides. 9.1 kg; 490 g +20 mesh and 606 g 20-200 mesh insoluble residue.
MF-2 MF1054-MCD (10852-CO)	39°03'40", 78°22'36"	**Mountain Falls (F2)**	Shenandoah (Virginia)	Stonehenge Limestone (uppermost) or Rockdale Run Formation (lowermost), probably Rockdale Run; in fault sliver along North Mountain fault zone (included in Rockdale Run on table 2)	early Early Ordovician (*R. manitouensis* Zone)	4-4.5	13 *Clavohamulus densus* Furnish 1 *Drepanodus* sp. 5 *Eucharodus* sp. 4 *Rossodus manitouensis* Repetski & Ethington 1 *Scolopodus* sp. indet. 4 *Variabiloconus bassleri* (Furnish) 3 indet. coniform fragments	Clavohamulid biofacies; warm, shallow to very shallow, intermittently partly restricted depositional environment.	Light-gray-weathering, dark-gray, partly silicified, brecciated micrite. Heavy-mineral concentrate: chiefly dolomite euhedra, minor druses of fresh and weathered pyrite, euhedra and euhedral clusters of fresh and weathered pyrite, and trace iron oxides. 11.3 kg; 40 g +20 mesh and 34 g 20-140 mesh insoluble residue. Collected by R.C. McDowell.
MF-3 8-14-90G (10907-CO)	39°03'01", 78°23'16"	**Mountain Falls (F2)**	Shenandoah (Virginia)	New Market Limestone; in fault slice along North Mountain fault zone.	Middle Ordovician Llanvirnian-early Caradocian middle Whiterockian-Blackriveran	3.5-4	All conodonts severely fractured. 1 M *Curtognathus* sp. indet. *Phragmodus* sp. indet. 2 P, 1 M? & 1 element fragment 1 unassigned oistodontiform element 46 indet. conodont crumbs	Indeterminate: warm, possibly partly restricted, shallow-water depositional environment.	Medium-light-gray-weathering, light- to medium-light-gray, recrystallized, coarse-grained metalimestone. Heavy-mineral concentrate: iron oxides, barite euhedra, druses of fresh and weathered pyrite and minor pyrite euhedra. 8.6 kg; 0 g +20 mesh and 1 g 20-200 mesh insoluble residue.
MF-4 MF1108-MCD (10853-CO)	39°02'34", 78°24'07"	**Mountain Falls (F2)**	Shenandoah (Virginia)	probably Edinburg Formation; in fault sliver along North Mountain fault zone.	Middle Ordovician Blackriveran early-middle Caradocian	3.5-4	1 Pa *Plectodina joachimensis* (Andrews)	Indeterminate.	Thin-bedded, fine-grained limestone. Heavy-mineral concentrate: argillaceous flakes with disseminated pyrite, barite, dolomite, and druses of fresh and weathered pyrite. 8.1 kg; 120 g +20 mesh and 119 g 20-140 mesh insoluble residue. Collected by R.C. McDowell.
MF-5 8-14-90E (12169-SD)	39°02'42", 78°28'55"	**Mountain Falls (F2)**	Frederick (Virginia)	Keyser Limestone (lower 1/3 of formation)	Late Silurian Pridolian	4	*Oulodus elegans* (Walliser) 1 Pa, 1 Pb, 4 Sa, 3 Sb, 3 Sc *Ozarkodina remscheidensis remscheidensis* (Ziegler) 33 Pa, 2 Pb, 2 M, 1 Sa, 2 Sb, 1 Sc 85 indet. bar, blade and platform fragments	*O. r. remscheidensis* biofacies; relatively shallow, normal marine.	Light-olive-gray-weathering, medium-gray, massive, coarse-grained packstone/grainstone. Heavy-mineral bioclasts: Phosphatic bryozoan zooecial linings. Heavy-mineral concentrate: iron oxides, weathered and fresh euhedral pyrite clusters, euhedral dolomite and rare phosphatized grains. 8.4 kg; 360 g +20 mesh and 162 g 20-140 mesh insoluble residue.
MF-6 10-17-90A (12170-SD)	39°06'37", 78°25'28"	**Mountain Falls (F2)**	Frederick (Virginia)	Licking Creek Limestone; Cherry Run Member (0.75 m above base of formation)	Early Devonian early Lochkovian (*I. woschmidti* Zone?)	3.5-4	*Icriodus* cf. *I. woschmidti hesperius* Klapper & Murphy 11 P, 32 M, 31 Sb acodiniform elements & 1 Sa, 86 Sb, 48 Sc rotundacodiniform elements 180 P *Icriodus* sp. indet. *Oulodus cristagalli* (Ziegler) 8 Pb, 1 Sa, 3 Sb, 1 Sc *Ozarkodina remscheidensis repetitor* (Carls & Gandl) 149 Pa, 42 Pb, 30 M, 15 Sa, 21 Sb, 9 Sc 1 S *Pedavis* sp. indet. element 12 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) 1 *Milaculum* sp. indet. ~250 indet. bar, blade, platform and coniform fragments	Icriodid-ozarkodinid biofacies; relatively high-energy, shallow-water, normal marine.	Wavy-bedded, fossiliferous (chiefly crinoids and brachiopods), calcareous sandstone and quartzose wackestone/packstone. Heavy-mineral concentrate: chiefly oxidized phosphatic brachiopod fragments and ichthyoliths, lesser bryozoan pearls, phosphatic bryozoan zooecial linings and ichthyoliths. 11.0 kg; 200 g +20 mesh and 489 g 20-140 mesh insoluble residue.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
MF-7 90MK57-RR (12171-SD)	39°07'24", 78°24'24"	**Mountain Falls (F2)**	Frederick (Virginia)	Licking Creek Limestone; Cherry Run Member (8.5 m below top of member)	Early Devonian Lochkovian (not earliest Lochkovian)-early Pragian	4	5 *Decoriconus* sp. indet. *Icriodus* sp. indet. (early icriodid but not of the *I. woschmidti-I. postwoschmidti* plexus) 6 P, 118 S & M coniform elements 84 P fragments *Icriodus* sp. indet. 1 Pb fragment *Oulodus* sp. indet. *Ozarkodina* cf. *O. remscheidensis repetitor* (Carls & Gandl) 22 Pa, 5 Pb, 5 M, 8 Sa, 13 Sb, 4 Sc 58 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) ~225 indet. bar, blade, platform and coniform fragments	Postmortem transport within or from the icriodid-ozarkodinid biofacies; relatively high-energy, shallow- to moderate-water depth, normal marine.	Medium- to light-gray, wavy-bedded, brachiopod-rich carbonate mudstone containing ~20% bluish-gray chert. Heavy-mineral concentrate: chiefly phosphatic brachiopod fragments and chert with finely disseminated pyrite euhedra. 10.0 kg; 1.9 kg +20 mesh and 621 g 20-140 mesh insoluble residue.
MF-8 91MCD846 (12124-SD)	39°07'15", 78°24'00"	**Mountain Falls (F2)**	Frederick (Virginia)	Needmore Shale (about 40 m above base)	latest Early-earliest Middle Devonian latest Emsian-earliest Eifelian *(P. costatus patulus* Zone into lower part of *P. costatus costatus* Zone)	4	13 *Icriodus corniger rectirostratus* Bultynck 17 *Icriodus* aff. *I. struvei* Weddige 16 P fragments & 9 M & S coniform elements of *Icriodus* spp. indet. 2 *Polygnathus cooperi cooperi* Klapper transitional to *P. costatus patulus* Klapper 2 *Polygnathus* aff. *P. c. cooperi* transitional to *P. costatus patulus* Klapper 15 *Polygnathus* sp. indet. *Polygnathus*? sp. indet. elements 2 Pb, 5 M, 2 Sa, 4 Sb, 4 Sc 73 indet. bar, blade and platform fragments	Postmortem transport basinward from an icriodid-polygnathid biofacies; a normal marine, relatively shallow to moderate depth shelfal or platformal environment. Nearly all but the most compact and sturdy conodonts are moderately to severely broken.	Light-olive-gray-weathering, dark-gray to grayish-black, slightly argillaceous, very fine grained wackestone containing brachiopod fragments and tentaculitids. Heavy-mineral concentrate: pyrite, weathered pyrite, pyritiferous argillite flakes, baritized(?) and phosphatized grains, steinkerns of tentaculitids and echinoderm spines, rare dolomite and ichthyoliths. 12 kg; 1.5 kg +20 mesh and 202 g 20-140 mesh insoluble residue. Collected by R. C. McDowell.
MF-9 MF1116-MCD (12125-SD)	39°00'15", 78°29'28"	**Mountain Falls (F2)**	Shenandoah (Virginia)	Marcellus Shale; Purcell(?) Member or younger	Middle Devonian middle Eifelian-early Givetian (no older than *T. kockelianus* Zone)	3.5-4	16 P & 2 S *Icriodus* of the *I. struvei* Weddige group 5 P *Icriodus* sp. indet. 4 juvenile Pa *Polygnathus* aff. *P. angusticostatus* Wittekindt *Polygnathus linguiformis linguiformis* Hinde 57 Pa, 17 Pb, 25 M, 15 Sa, 32 Sb & 69 Sc 67 Pa *Polygnathus* sp. indet. fragments 118 indet. bar, blade, and platform fragments	Polygnathid biofacies with postmortem admixture from the shallower water icriodid biofacies; normal marine, mid-shelf or deeper water.	Medium-dark-gray, argillaceous, very fine grained, silty carbonate mudstone. Heavy-mineral concentrate: argillaceous flaks with disseminated pyrite, barite, druses of fresh and weathered pyrite, and trace pyritized phosphatic brachiopod fragments. 7.1 kg; 780 g +20 mesh and 286 g 20-140 mesh insoluble residue. Collected by R. C. McDowell.
MF-10 MF1131-MCD (12126-SD)	39°05'24", 78°26'10"	**Mountain Falls (F2)**	Frederick (Virginia)	Marcellus Shale; Purcell(?) Member	Middle Devonian based on regional stratigraphic relations	3 or 4 (shown as 3.5 on table 2)	1 posterior Pa *Polygnathus* sp. indet. fragment	Indeterminate biofacies.	Brownish-medium-gray, argillaceous carbonate mudstone to calcareous mudrock. Heavy-mineral concentrate: iron oxides, euhedral clusters and druses of fresh and weathered pyrite, and rare phosphatized spines and spore steinkerns. 14.9 kg; 7.04 kg +20 mesh and 461 g 20-140 mesh insoluble residue. Collected by R. C. McDowell.
MF-11 MF460-MCD	39°05'17", 78°25'58"	**Mountain Falls (F2)**	Frederick (Virginia)	Mahantango Formation (basal part?)			Barren.		Medium-olive-gray, slightly argillaceous, fine- to medium-grained, calcareous silty mudstone. Heavy-mineral concentrate: barite and argillaceous flakes with disseminated pyrite. 14.5 kg;12.2 kg +20 mesh and 342 g 20-200 mesh insoluble residue. Collected by R. C. McDowell.
MF-12a 6-7-91-2A (12172-SD)	39°04'32", 78°24'57"	**Mountain Falls (F2)**	Frederick (Virginia)	Chemung Formation (near base)	early Late Devonian early Frasnian (upper Upper *falsiovalis* Zone-Lower *hassi* Zone; possibly *transitans* Zone)	4	14 (all incomplete or juveniles) Pa *Ancyrodella* aff. *A. alata* Glenister & Klapper 132 P *Icriodus symmetricus* Branson &Mehl 3 Pa *Mehlina gradata* Youngquist 5 Pa *Mesotaxis asymmetricus* (Bischoff & Ziegler) *Oulodus* sp. 3 Pa, 4 Pb 1 Pa *Pandorinellina insita* (Stauffer) 2 Pa *Polygnathus dubius* Hinde 7 Pa *Polygnathus* aff. *P. dubius* Hinde UNASSIGNED ELEMENTS: 12 M, 15 Sa, 7 Sb, 10 Sc 184 indet. bar, blade and platform fragments	Postmortem transport chiefly within or from the icriodid biofacies; shallow to moderate depth, moderate to high-energy, normal marine.	Brachiopod/bryozoan coquina (~10 cm thick) in calcareous siltstone to silty limestone within a siltstone to fine-grained sandstone sequence. Heavy-mineral concentrate; chiefly barite and lesser small euhedral clusters of pyrite. 5.76 kg; 2.12 kg +20 mesh insoluble residue. Collected by R.B. Blodgett.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
MF-12b MF-509 (12262-SD)	39°04'32", 78°24'57"	**Mountain Falls (F2)**	Frederick (Virginia)	Chemung Formation	early Late Devonian early Frasnian (upper Upper *M. falsiovalis* Zone-Lower *Pa. hassi* Zone; possibly *Pa. transitans* Zone)	3.5	1 Pa (juvenile) fragment *Ancyrodella* aff. *A. alata* Glenister & Klapper 10 Pa fragments *Ancyrodella* sp. indet. 57 P *Icriodus symmetricus* Branson &Mehl *Oulodus* sp. 2 Pa & 2 Pb 2 Pa *Pandorinellina insita* (Stauffer) UNASSIGNED ELEMENTS: 10 Pb, 7 M, 7 Sa, 2 Sb, 19 Sc 107 indet. bar, blade and platform fragments	Postmortem transport from chiefly icriodid biofacies; normal marine, relatively shallow-water.	Medium-gray fossiliferous limestone "hash" bed within calcareous shale. Heavy-mineral concentrate: barite, phosphatic brachiopod fragments, lesser iron oxides, and euhedral pyrite clusters. 5.5 kg; 540 g +20 mesh and 200 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.
OF-1 91NS-17 (12173-SD)	39°13'57", 78°59'13"	**Old Fields (B3)**	Grant (West Virginia)	Tonoloway Limestone or Keyser Limestone (included in Keyser on table 2)	Late Silurian-possibly earliest Devonian probably Late Silurian	3.5-4	Most conodonts are fragmentary. 1 *Belodella* sp. *Ozarkodina remscheidensis remscheidensis* (Ziegler) 76 Pa, 28 Pb, 4 M, 9 Sa, 18 Sb, 3 Sc 1 unassigned M element 500+ indet. bar, blade, and platform fragments	Postmortem transport from or within the *O. r. remscheidensis* biofacies; relatively shallow, relatively high-energy, normal marine	Medium-light-gray-weathering, medium-brownish-gray, medium-bedded, fine- to very coarse grained, poorly sorted, highly fossiliferous, slightly argillaceous lime packstone containing articulated brachiopods and crinoids. Heavy-mineral concentrate: euhedral clusters of weathered pyrite, phosphatic brachiopod fragments, minor iron oxides, barite, and trace fresh pyrite euhedra. 11.2 kg; 340 g +20 mesh and 220 g 20-140 mesh insoluble residue.
OF-2 9-27-90B (12174-SD)	39°10'00", 78°56'23"	**Old Fields (B3)**	Hardy (West Virginia)	Oriskany Sandstone	Early Devonian Lochkovian-Pragian, probably Pragian	4	1 coniform fragment *Dvorakia*? sp. 8 P *Icriodus* sp. indet. of Early Devonian morphotype *Ozarkodina*? sp. indet. 2 Pa, 2 Pb 3 indet. fragments REDEPOSTIED LATE MIDDLE-LATE ORDOVICIAN CONODONTS 1 S fragment *Phragmodus* sp. indet. *Plectodina* sp. indet. 2 M, 1 Sb	Icriodid biofacies; high-energy, relatively shallow, normal marine.	Medium- to medium-light-gray, planar-bedded, massive, brachiopod-rich (whole valves), fine- to medium-grained, quartzose wackestone/packstone. Heavy-mineral concentrate: abundant phosphatic brachiopod fragments and phosphatized grains, common weathered pyrite clusters, pyritized fossil fragments (spines, tentaculitids), and rare fluorite. 14.2 kg; 1.52 kg +20 mesh and 546 g 20-140 mesh insoluble residue.
OF-3 OLDF-4B (12197-SD)	39°14'55", 78°56'16"	**Old Fields (B3)**	Hampshire (West Virginia)	Mahantango Formation; Pokejoy Member (immediately below Burket Shale Member of the Harrell Shale)	late Middle Devonian Givetian (Lower *Po. varcus* Subzone through Lower *S. hermanni-cristatus* Zone	3-3.5	Nearly all conodonts are incomplete. 1 Sc *Dvorakia* sp. indet. 13 Pa *Polygnathus linguiformis linguiformis* Hinde γ morphotype 2 very robust Pa fragments *Polygnathus* sp. indet. of late Middle or younger Devonian morphotype 17 Pa fragments *Polygnathus* spp. indet. 3 unassigned M elements 54 indet. bar, blade and platform fragments	Postmortem transport within or from the polygnathid biofacies; shallow to moderate depth (no deeper than moderate depth because of the presence of *Po. l. linguiformis*), normal marine depositional environment.	Calcareous segregations within siltstone. Heavy-mineral concentrate: chiefly argillaceous iron oxide flakes, ferruginous silt- and clay-sized quartz clusters, weathered and fresh euhedral pyrite clusters, and barite. 1.4 kg; 140 g +20 mesh and 50 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.
OF-4 OLDF-4C	39°14'54", 78°56'07"	**Old Fields (B3)**	Hampshire (West Virginia)	Mahantango Formation; Pokejoy Member(?)			Barren.		Medium-gray calcareous nodules containing rugose corals. Heavy-mineral concentrate: chiefly ferruginous silt- and clay-sized quartz clusters with very finely disseminated pyrite and lesser weathered and fresh euhedral pyrite clusters, pyritized bioclasts and barite. 4.0 kg; 2.32 kg +20 mesh and 40 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.
OF-5 OLDF-23	39°13'56", 78°54'55"	**Old Fields (B3)**	Hampshire (West Virginia)	Mahantango Formation; Pokejoy Member(?)			Barren.		Medium-gray calcareous nodules within medium-gray calcareous shales. Heavy-mineral concentrate: chiefly argillaceous composite granules of iron oxides and fresh pyrite, minor barite and pyritized steinkerns of *Styliolina*. 4.6 kg; 900 g +20 mesh and 265 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
OF-6 OLDF-24	39°13'57", 78°54'41"	**Old Fields** **(B3)**	Hampshire (West Virginia)	Mahantango Formation; Pokejoy Member(?)			Barren.		Medium-gray calcareous nodules within medium-gray slightly calcareous shales. Heavy-mineral concentrate: chiefly ferruginous and (or) pyritic silt- and clay-sized argillaceous grains and minor barite. 4.3 kg; 1.9 kg +20 mesh and 149 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.
OF-7 OLDF-37	39°13'31", 78°56'57"	**Old Fields** **(B3)**	Hampshire (West Virginia)	Mahantango Formation; Pokejoy Member(?)			Barren.		Medium-gray, 15 cm-thick pinch-and-swell limestone beds and calcareous concretions within siltstone. Heavy-mineral concentrate: ferruginous and (or) pyritic silt- and clay-sized argillaceous grains, minor barite and pyritized steinkerns of *Styliolina*, bivalves and gastropods. 4.3 kg; 260 g +20 mesh and 156 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.
OF-8 OLDF-70 (12200-SD]	39°12'23", 78°55'58"	**Old Fields** **(B3)**	Hardy (West Virginia)	Mahantango Formation; Pokejoy Member	late Middle Devonian Givetian	3-3.5	2 P element fragments of *Icriodus* sp. indet. of Early and Middle Devonian morphotype	Postmortem transport within or from normal-marine depositional environment.	Medium-gray, silty limestone with pinch-and-swell bedding and common to abundant rugose corals. Heavy-mineral concentrate: chiefly ferruginous and (or) pyritic silt- and clay-sized quartz clusters and fresh and weathered euhedral pyrite clusters and minor barite. 4.8 kg; 800 g +20 mesh and 213 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.
OF-9 OLDF-103 12263-SD	39°11'44", 78°58'03"	**Old Fields** **(B3)**	Hardy (West Virginia)	Mahantango Formation; Pokejoy Member(?),	late Middle Devonian Givetian	3-3.5	2 coniform elements *Icriodus* sp. indet. 1 Pa fragment *Polygnathus* sp. indet of late Middle Devonian morphotype UNASSIGNED ELEMENTS: 8 Pb, 3 M, 2 Sa, 1 Sb &1 Sc		Medium-gray, 15 to 30 cm-thick pinch-and-swell limestone bed above a zone of calcareous nodules. Heavy-mineral concentrate: ferruginous and (or) pyritic silt- and clay-sized argillaceous grains, minor barite and pyritized steinkerns of *Styliolina*, bivalves and gastropods. 4.7 kg; 540 g +20 mesh and 157 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.
OF-10 9-26-90D (12175-SD)	39°14'00", 78°54'57"	**Old Fields** **(B3)**	Hampshire (West Virginia)	Harrell Shale	Late Devonian	3-3.5	I Pa *Icriodus* sp. indet. 4 indet. bar, blade, and platform fragments 2 pyritized gastropod steinkerns, 1 *Styliolina*	Indeterminate.	Medium-dark-gray, very fine grained, silty, unbedded, shaly carbonate mudstone to calcareous mudstone/siltstone concretion 12x25x50 cm. Heavy-mineral concentrate: argillaceous grains with stringers of pyrite, barite, druses of fresh and weathered pyrite, pyritized steinkerns, gastropods, and spines, minor iron oxides, and trace fresh and weathered pyrite euhedra. 12.0 kg; 5.02 kg +20 mesh and 311 g 20-140 mesh insoluble residue.
RD-1 91DW12 (12176-SD)	39°22'46", 78°22'15"	**Ridge** **(D3)**	Hampshire (West Virginia)	Keyser Limestone	Late Silurian Pridolian	4	*Ozarkodina remscheidensis eosteinhornensis* (Walliser) with minor *Ozarkodina remscheidensis remscheidensis* (Ziegler) 37 Pa, 9 Pb, 5 M *Oulodus elegans* (Walliser) 1 Pa, 1 Pb, 1 M, 1 Sa. 1 Sb, 1 Sc 22 indet. bar, blade and platform fragments	Postmortem transport within *O. remscheidensis* biofacies; normal marine, fairly shallow-water depositional environment.	Medium-gray to medium-dark-gray, bioturbated packstone/wackestone in beds 4 to 10 cm thick; no apparent megafossils. Heavy mineral concentrate: iron oxides, euhedra and euhedral clusters of pyrite, argillaceous flakes with disseminated pyrite and dolomitic calcite. 9.4 kg.; 760 g + 20 mesh and 129 20-140 mesh insoluble residue.
RG-1 9-27-90D (12177-SD)	39°03'42", 79°01'30"	Rig **(A2)**	Hardy (West Virginia)	Tully Limestone	Middle Devonian Givetian	3 or 4 (shown as 3.5 on table 2)	Conodonts are coated with adventitious argillaceous material. 3 Pa *Polygnathus* sp. indet. fragments 1 Pa *Polygnathus* sp. indet. fragment of Givetian morphotype	Polygnathid biofacies; normal marine, shallow-to deep-water, shelfal environment.	Medium-dark-gray, faintly laminated, fine-grained wackestone to carbonate mudstone 2.3-2.4 m above base of interlayered calcareous shale and fine-grained limestone. Heavy-mineral concentrate: pyrite framboids, argillaceous grains with pyrite, and barite. 8.9 kg; 1.17 kg +20 mesh and 533 g 20-140 mesh insoluble residue.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
RG-2 9-27-90E	39°02'21", 79°02'42"	Rig (**A2**)	Hardy (West Virginia)	Harrell Shale			Barren.		Medium-light- to medium-gray, calcareous mudstone concretion (concretions mostly elliptical and 20-30 cm in maximum dimension) in dark-gray shale. Collection made from concretion horizon 10.3 m above base of exposure. Heavy-mineral concentrate: argillaceous chips with disseminated pyrite and iron oxides, sphalerite, barite, small masses of finely divided pyrite. 9.5 kg; 6.8 kg +20 mesh and 226 g 20-140 mesh insoluble residue.
RI-1a 91NS-18 (12178-SD)	39°07'52", 78°38'59"	**Rio** (**D3**)	Hampshire (West Virginia)	Tonoloway Limestone or Keyser Limestone; probably Keyser Limestone (about 27 m below 91NS-19)	Late Silurian late Ludlovian- Pridolian	3.5-4	Conodonts are fragmentary. *Oulodus elegans* (Walliser) 2 Pa, 2 Pb, 1 Sb, 4 Sc 1 Pa *Ozarkodina remscheidensis eosteinhornensis* (Walliser) 35 Pa *Ozarkodina remscheidensis remscheidensis* (Ziegler) *Ozarkodina remscheidensis* spp. indet. 11 Pb, 5 M, 5 Sb, 4 Sc 188 indet. bar, blade and platform fragments	Mostly postmortem transport within *O. r. remscheidensis* biofacies; relatively shallow, moderate- to high-energy, normal marine.	Medium-light-gray-weathering, medium-dark-gray, medium- to very coarse grained, poorly sorted, slightly fossiliferous, thick-bedded lime packstone/grainstone. Heavy-mineral concentrate: chiefly iron oxides, phosphatic spherules, minor phosphatic brachiopod fragments, dolomite euhedra, druses of fresh and weathered pyrite, and pyrite euhedra, trace bryozoan pearls and bryozoan zooecial linings. 13.7 kg; 50 g of +20 mesh and 112 g 20-140 mesh insoluble residue.
RI-1b 91NS-19 (12179-SD)	39°07'52", 78°38'59"	**Rio** (**D3**)	Hampshire (West Virginia)	Tonoloway Limestone or Keyser Limestone; probably Keyser Limestone (about 2 m below sandstone interval)	Late Silurian late Ludlovian- Pridolian	3.5-4	Conodonts are fragmentary. *Oulodus elegans* (Walliser) 8 Pb, 5 M, 1 Sa, 1 Sb, 10 Sc *Ozarkodina remscheidensis remscheidensis* (Ziegler) transitional to *O. r. eosteinhornensis* (Walliser) 48 Pa, 5 Pb, 2 M, 1 Sb, 1 Sc 65 indet. bar, blade and platform fragments	Postmortem transport within ozarkodinid-oulodid biofacies; relatively shallow, moderate- to high-energy, probably normal marine.	Medium-light-gray-weathering, medium-dark-gray, nodular-medium-bedded, medium- to very coarse grained, argillaceous, slightly fossiliferous lime packstone with minor silt Heavy-mineral concentrate: iron oxides, rare dolomite euhedra and phosphatic brachiopod fragments. 10.0 kg; 110 g of +20 mesh and 66 g 20-140 mesh insoluble residue.
RO-1 6-21-75I (12180-SD)	39°19'52", 78°48'10"	**Romney** (**C4**)	Hampshire (West Virginia)	Keyser Limestone	Late Silurian Pridolian	3.5-4	*Ozarkodina remscheidensis remscheidensis* (Ziegler) 8 Pa, 5 Pb, 1 M, 1 Sa, 1 Sb 9 indet. bar, blade, and platform fragments	*O.r. remscheidensis* biofacies; relatively shallow water, high-energy, possibly partly restricted.	Lithology, sample and residue weights, and mineralogy are not available.
RO-2 91NS-15 (12181-SD)	39°16'50", 78°51'14"	**Romney** (**C4**)	Hampshire (West Virginia)	New Creek Limestone (upper part; 0.7 m below Corriganville Limestone)	Early Devonian early Lochkovian based on regional stratigraphic relations	3.5-4	28 *Belodella* sp. 17 *Decoriconus* aff. *D. fragilis* (Branson & Mehl) 56 *Dvorakia* sp. *Oulodus cristigalli* (Ziegler) 4 Pa, 6 Pb, 2 M, 5 Sa, 6 Sb & 1 Sc *Ozarkodina remscheidensis remscheidensis* (Ziegler) transitional to *O. r. eosteinhornensis* (Walliser) 12 Pa, 11 Pb, 2 M, 3 Sa, 6 Sb & 7 Sc 122 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) 113 indet. bar, blade, platform, and coniform fragments	Coniform biofacies or postmortem winnow from moderate depth, moderate- to high-energy, normal marine.	Medium-light-gray-weathering, medium-gray, medium-bedded, fine- to coarse-grained, poorly sorted, highly fossiliferous grainstone containing abundant whole and current-stable brachiopods, crinoids, bryozoans, and occasional corals. Heavy-mineral concentrate: phosphatic brachiopod fragments, barite, crinoid columnals and fragments, minor chert with iron oxide lamellae, and acrotretid brachiopods. 12.9 kg; 80 g of +20 mesh and 53 g 20-140 mesh insoluble residue.
RO-3 (11936-SD)	39°19'40", 78°47'50"	**Romney** (**C4**)	Hampshire (West Virginia)	Oriskany Sandstone (lower half)	Early Devonian possibly Pragian	3.5	7 *Belodella devonica* (Stauffer) 24 *Dvorakia* sp. indet. *Icriodus* sp. indet. of Early (but not earliest) Devonian morphotype 13 P, 6 S or M (acodiniform elements), 19 S (rotundacodiniform elements) 1 Pb *Oulodus* sp. indet. *Ozarkodina* aff. *O. eberleini* Savage 69 Pa, 11 Pb, 5 M, 6 Sa, 7 Sb, 4 Sc 2 *Panderodus* sp. 55 indet. bar, blade, and platform fragments REDEPOSITED LATE MIDDLE TO LATE ORDOVICIAN CONODONTS *Plectodina* cf. *P. tenuis* (Branson & Mehl) 1 Pa, 1 M, 1 Sb, 6 Sc *Phragmodus undatus* Branson & Mehl 1 M, 1 S, many bar fragments	Ozarkodinid biofacies with postmortem admixture from icriodid biofacies; relatively shallow- to moderate-water depth and relatively low energy.	Calcareous nodules within siltstone beds. Sample from interval that contains silicified specimens of *Prionothyris* (abundant), *Leptocoelia* (common), and *Acrospirifer* (common). Heavy-mineral concentrate: composition not recorded.. 9.3 kg; 497 g 20-140 mesh insoluble residue. Sample collected by R. B. Blodgett; brachiopods identified by R. B. Blodgett.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
RO-4 90MK37-RO (12182-SD)	39°20'10", 78°47'10"	**Romney** **(C4)**	Hampshire (West Virginia)	Oriskany Sandstone (4.8 m below top of formation)	Early Devonian possibly Pragian	3.5	5 *Belodella* sp. indet. 10 *Coelocerodontus* sp. *Icriodus* sp. indet. 9 P fragments, 2 acodiniform & 4 rotundacodiniform elements *Ozarkodina* aff. *O. eberleini* Savage 15 Pa, 2 Pb 7 unassigned coniform fragments 42 indet. bar, blade, platform, and coniform fragments REDEPOSITED LATE MIDDLE TO LATE ORDOVICIAN CONODONTS *Phragmodus undatus* Branson & Mehl 3 P, 1 M, 1 Sc 2 Sb *Plectodina* sp. indet. and (or) *Aphelognathus* sp. indet.	Ozarkodinid biofacies with postmortem admixture from icriodid biofacies; relatively shallow- to moderate-water depth and relatively moderate energy.	Medium- to fine-grained calcareous sandstone containing robust, disarticulated brachiopods. Heavy-mineral concentrate: iron-coated quartz grains and lesser phosphatic brachiopod fragments, minor phosphatized steinkerns of gastropods and chitinozoans and phosphatized crinoid columnals. 5.05 kg; 2.5 kg +20 mesh and 902 g 20-140 mesh insoluble residue.
RO-5 Rom-99	39°20'17", 78°48'30"	**Romney** **(C4)**	Hampshire (West Virginia)	Needmore Shale(?)			Barren.		Medium-gray, calcareous shaly nodules within olive-gray limestone beds as much as 0.3 m thick. Heavy-mineral concentrate: ferruginous and nonferruginous to pyritic quartzose siltstone and mudstone fragments. 3.7 kg; 1.34 kg +20 mesh and 19 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.
RO-6 Rom-102	39°21'17", 78°47'40"	**Romney** **(C4)**	Hampshire (West Virginia)	Needmore Shale or Marcellus Shale (includeded in Romney Shale on table 2)			Barren.		Medium-gray, calcareous nodules within 15- to 20- cm-thick limestone beds. Heavy-mineral concentrate: chiefly ferruginous silt- and clay-sized quartzose siltstone and mudstone fragments and micaceous siltstone fragments and rare barititized tentaculitid steinkerns. 3.3 kg; 2.1 kg +20 mesh and 57 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.
RO-7 Rom-103	39°21'18", 78°47'42"	**Romney** **(C4)**	Hampshire (West Virginia)	Needmore Shale or Marcellus Shale (included in Romney Shale on table 2)			Barren.		Medium-gray, calcareous nodules within 15- to 20- cm-thick limestone beds. Heavy-mineral concentrate: very abundant baritic quartzose siltstone and mudstone, lesser ferruginous quartzose siltstone and mudstone, and rare barite. 5.1 kg; 4.2 kg +20 mesh and 77 g 20-140 mesh. Collected by R. A. Parker and T. D. Heibel.
RO-8 Rom-108 (12264-SD)	39°21'37", 78°47'50"	**Romney** **(C4)**	Hampshire (West Virginia)	Mahantango Formation; Pokejoy Member	Middle Devonian	3.5	2 P fragments *Icriodus* sp. indet of Middle Devonian morphotype 1 indet. bar or blade fragment	Indeterminate; postmortem transport.	Olive-gray mudstones and shales with calcareous nodules. Heavy-mineral concentrate: chiefly ferruginous and (or) pyritic silt- and clay-sized argillaceous grains, pyritized steinkerns of *Styliolina*, bivalves and gastropods, and minor barite. 1.4 kg; 540 g +20 mesh and 94 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.
RO-9 9-11-91 (12196-SD)	39°17'32", 78°51'25"	**Romney** **(C4)**	Hampshire (West Virginia)	Mahantango Formation; Pokejoy Member	late Middle Devonian	3-3.5	3 indet. bar and blade fragments	Indeterminate; postmortem winnow.	Calcareous segregations within thinly bedded siltstone. Heavy-mineral concentrate: chiefly argillaceous iron-oxide flakes, weathered and fresh euhedral pyrite clusters, fresh and weathered pyritized tentaculitid steinkerns and rare pyritized gastropod and pelecypod steinkerns. 4.8 kg; 1.06 kg +20 mesh and 190 g 20-140 mesh insoluble residue.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
RO-10 Rom-9	39°19'03", 78°52'21"	**Romney** **(C4)**	Hampshire (West Virginia)	Mahantango Formation; Pokejoy Member(?)			Barren.		Medium- to dark-gray shale and limestone bed 10 to 13 cm thick containing calcareous nodules. Heavy-mineral concentrate: chiefly clay- and silt-sized slightly ferruginous composite quartz grains with very fine disseminated pyrite, fresh and weathered euhedral pyrite clusters, and pyritized indeterminate bioclasts. 3.8 kg; 900 g +20 mesh and 300 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.
SE-1 9-26-90E (12183-SD)	39°14'07", 78°51'52"	**Sector** **(C3)**	Hampshire (West Virginia)	Tonoloway Limestone (upper part)	Late Silurian late Ludlovian-Pridolian	3.5-4	*Oulodus elegans* (Walliser) 2 Pa, 1 Pb, 1 Sc? *Ozarkodina remscheidensis remscheidensis* (Ziegler) 89 Pa, 35 Pb, 20 M, 10 Sa, 20 Sb, 28 Sc 379 indet. bar, blade and platform fragments	*O.r. remscheidensis* biofacies; relatively shallow water, high-energy, possibly partly restricted.	Dark- to medium-dark-gray, irregularly (mottled) massive-bedded, carbonate mudstone Heavy-mineral concentrate: phosphatic brachiopod fragments, minor dolomite, and rare iron oxides. 9.8 kg; 100 g +20 mesh and 36 g 20-140 mesh insoluble residue.
SP-1a 9-25-90C (12184-SD)	39°23'54", 78°44'25"	**Springfield** **(D5)**	Hampshire (West Virginia)	Keyser Limestone (about 35 m below base of Corriganville Limestone)	Late Silurian Pridolian, probably late Pridolian	3.5	10 S *Belodella* sp. indet. 1 Sb *Oulodus* sp. indet. *Ozarkodina remscheidensis eosteinhornensis* (Walliser) 7 Pa, 2 Pb, 3 M, 5 Sb, 2 Sc 31 indet. bar, blade and platform fragments	*O. r. eosteinhornensis* biofacies; relatively shallow, normal marine.	Medium-dark-gray, fine-grained, lumpy (burrowed), slightly argillaceous and siliceous wackestone/mudstone underlying grainstone beds. Heavy-mineral concentrate: euhedral dolomite, iron oxides, phosphatic brachiopod fragments, organic material with finely disseminated pyrite and weathered and fresh euhedral pyrite. 10.1 kg; 530 g +20 mesh and 215 g 20-140 mesh insoluble residue.
SP-1b 9-25-90B (12185-SD)	39°23'54", 78°44'25"	**Springfield** **(D5)**	Hampshire (West Virginia)	Keyser Limestone (upper part; 18 m below top of formation)	latest Silurian late Pridolian	3-3.5	*Ozarkodina remscheidensis remscheidensis* (Ziegler) 5 Pa, 1 M, 1 Sa, 4 Sb, 2 Sc 1 unassigned Sa 17 indet. bar, blade and platform fragments	Postmortem winnow from or within *O. r. remscheidensis* biofacies; shallow-water, partly restricted marine.	Light-gray, massive, cross-bedded, coarse-grained grainstone containing stromatoporoids (as much as 5 cm in diameter), crinoid columnals and brachiopods. Heavy-mineral concentrate: abundant bioclastic debris of phosphatized and iron oxide replaced bryozoan, brachiopod, and echinoderm fragments, pyritized gastropods and spines, and rare ichthyoliths, some weathered pyritic argillaceous flakes, and iron oxide grains. 8.8 kg; 410 g +20 mesh and 58 g 20-140 mesh insoluble residue.
SP-1c 90MK35-WA (12186-SD)	39°23'54", 78°44'25"	**Springfield** **(D5)**	Hampshire (West Virginia)	Corriganville Limestone (1 m above base of lower tongue of formation)	early Early Devonian Lochkovian	3-3.5	2 *Belodella* sp. 6 *Coelocerodontus* sp. *Icriodus* sp. indet. 4 P, 5 rotundacodiniforms (1 M, 3 Sb, 1 Sc) *Ozarkodina remscheidensis remscheidensis* (Ziegler) 23 Pa, 3 Pb, 1 M, 1 Sb 1 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) 17 indet. bar, blade and platform fragments	Postmortem transport within or from *O. r. remscheidensis* biofacies; shallow- to moderate-depth, normal marine.	Medium-gray, thick-bedded, fine- to coarse-grained packstone. Heavy-mineral concentrate: chiefly dolomite, phosphatic brachiopod fragments and fluorite. 9.5 kg; 0 g +20 mesh and 167 g 20-140 mesh insoluble residue.
SP-1d 9-25-90A (12187-SD)	39°23'54", 78°44'25"	**Springfield** **(D5)**	Hampshire (West Virginia)	Corriganville Limestone (upper part)	early Early Devonian Lochkovian	3.5	1 P *Icriodus* sp. indet. 5 Pa *Ozarkodina remscheidensis repetitor* (Carls & Gandl) 1 Sc unassigned 7 indet. bar, blade, and platform fragments	Postmortem transport from *O. remscheidensis* biofacies; relatively shallow to moderate depth, normal marine.	Medium-gray, siliceous (50-60% chert) calcisiltite to brachiopod wackestone with some beds packed with brachiopod shells. Heavy-mineral concentrate: chiefly ferruginous siliceous flakes, phosphatic bryozoan pearls, clusters of euhedral pyrite and lesser phosphatized tube fillings. 9.0 kg; 350 g 20-140 mesh insoluble residue.
SP-2 Spring-25	39°23'43", 78°44'02"	**Springfield** **(D5)**	Hampshire (West Virginia)	Needmore Shale			Barren.		Medium-gray, fine-grained, 25 to 30 cm-thick limestone bed within dark-gray shales. Heavy-mineral concentrate: iron oxides, clusters of weathered and fresh anhedral pyrite, euhedral dolomite and barite. 6.4 kg; 2.0 kg +20 mesh and 316 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
SP-3 Spring-41	39°25'40", 78°42'33"	**Springfield** **(D5)**	Hampshire (West Virginia)	Needmore Shale			Barren.		Medium-gray, massive, silty limestone. Heavy-mineral concentrate: chiefly sand- and silt-sized clusters of ferruginous clay minerals, phosphatized tentaculitid and gastropod steinkerns, and minor fresh euhedral pyrite clusters. 2.4 kg; 220 g +20 mesh and 110 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.
SP-4 Spring-50 (12265-SD)	39°25'32", 78°41'48"	**Springfield** **(D5)**	Hampshire (West Virginia)	Needmore Shale or Marcellus Shale (included in Romney Shale on table 2)	Middle Devonian	~4	2 Pa *Polygnathus linguiformis linguiformis* Hinde γ morphotype	Indeterminate.	Medium-gray calcareous nodules (25 to 30 cm. in diameter) below massive fossiliferous siltstone. Heavy-mineral concentrate: chiefly iron oxides, barite, pyritic and dolomitic composite grains, clusters of fresh and weathered anhedral pyrite, euhedral dolomite and pyritic spherules. 4.6 kg; 200 g +20 mesh and 79 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.
SP-5 Spring-53	39°26'45", 78°41'52	**Springfield** **(D5)**	Hampshire (West Virginia)	Marcellus Shale; Purcell Member			Barren.		Medium- to dark-gray, massive silty limestone. Heavy-mineral concentrate: chiefly barite euhedra and lesser ferruginous fine sand and iron-oxide flakes. 5.6 kg; 3.3 kg +20 mesh and 331 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.
SP-6 Spring-65 (12266-SD)	39°25'58", 78°42'52"	**Springfield** **(D5)**	Hampshire (West Virginia)	Marcellus Shale; Purcell Member(?)	Middle Devonian	4	1 Sb element 2 bar fragments	Indeterminate.	Medium-gray, fine-grained, 20- to 30- cm-thick limestone bed within dark-gray calcareous shales. Heavy-mineral concentrate: chiefly iron oxides, minor barite, weathered pyrite and euhedral dolomite. 5.1 kg; 700 g +20 mesh and 146 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.
SP-7 Spring-67	39°27'08", 78°41'31"	**Springfield** **(D5)**	Hampshire (West Virginia)	Marcellus Shale; Purcell Member(?)			Barren.		Medium-gray, 15- to 20- cm-thick limestone bed within dark-gray calcareous shales. Heavy-mineral concentrate: chiefly iron oxides and minor barite. 4.2 kg; 1.7 kg +20 mesh and 322 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.
SP-8 Spring-81 (12267-SD)	39°29'01", 78°39'53"	**Springfield** **(D5)**	Hampshire (West Virginia)	Marcellus Shale; Purcell Member	earliest Middle Devonian early Eifelian (*Po. costatus costatus* Zone)	3.5	*Icriodus* aff. *I. culicellus* (Bultynck) 2 P & 2 S coniform elements *Polygnathus costatus patulus* Klapper 17 Pa, 8 Pb, 4 M, 1 Sa, 5 Sb & 6 Sc UNASSIGNED ELEMENTS: 1 Pb 40 chiefly polygnathid bar and blade fragments	Polygnathid biofacies; normal marine, shelfal.	Medium-gray, fine-grained,15- to 20- cm-thick limestone bed within dark-gray calcareous shales. Heavy-mineral concentrate: iron oxides, dolomitic and pyritic composite grains, euhedral and anhedral dolomite, barite and rare pyritized steinkerns and bryozoan zooecial linings. 4.6 kg; 60 g +20 mesh and 55 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.
SP-9 Spring-105	39°26'03", 78°40'48"	**Springfield** **(D5)**	Hampshire (West Virginia)	Marcellus Shale; Purcell Member(?)			Barren.		Medium-gray, 15- to 20- cm-thick silty limestone bed Heavy-mineral concentrate: not recorded. 3.4 kg; 2.0 kg +20 mesh and 412 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.
SP-10 Spring-29	39°23'27", 78°42'40"	**Springfield** **(D5)**	Hampshire (West Virginia)	Mahantango Formation; Pokejoy Member(?)			Barren.		Medium- to dark-gray, massive sandstone and calcareous siltstone. Heavy-mineral concentrate: chiefly iron-oxide flakes. 5.2 kg; 4.6 kg +20 mesh and 126 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
SP-11 Spring-51	39°25'27", 78°41'46"	**Springfield (D5)**	Hampshire (West Virginia)	Mahantango Formation; Pokejoy(?) Member (below siltstone bed)			Barren.		Large calcareous concretions (15 to 20 cm in diameter). Heavy-mineral concentrate: clusters of clay- and silt-sized clays with fresh and weathered disseminated very fine pyrite and lesser fresh and weathered small euhedral pyrite clusters. 3.7 kg; 2.9 kg +20 mesh and 180 g 20-140 mesh insoluble residue. Collected by R. A. Parker and T. D. Heibel.
SC-1 8-3-74B (10908-CO)	39°03'03", 78°08'31"	**Stephens City (H2)**	Clarke (Virginia)	Upper part Beekmantown Group (upper Rockdale Run Formation or Pinesburg Station Dolomite)	early Middle Ordovician early Whiterockian (no younger than *H. holodentata* Zone)	4.5 & 6	Conodonts are extremely corroded and have mixed CAI values indicating hydrothermal alteration. 2 drepanodontiform elements 16 *Neomultioistodus clypeus* (Mound) 1 *Pteracontiodus* aff. *P. cryptodens* (Mound) 2 indet. coniform elements	Neomultioistodid biofacies; warm, very shallow, restricted marine.	Dark-gray micrite. Heavy-mineral bioclasts: 2 acrotretid pedicle valves.
SC-2 8-13-90C (10909-CO)	39°05'26", 78°13'40"	**Stephens City (H2)**	Frederick (Virginia)	New Market Limestone (middle part)	middle Middle Ordovician middle to late Whiterockian (at least *C. friends-villensis* Zone into at least *P. aculeata* Zone)	4-4.5	Conodonts are very tectonically fractured. *Curtognathus robustus* (Branson & Mehl) 3 Pa, 6 Pb 1 *Drepanoistodus* sp. indet. 4 *Erismodus radicans* (Hinde) fragments 2 *Erismodus*? sp. indet. 1 M element *Phragmodus*? sp. indet. 107 chiefly robust indet. bar, blade, and coniform fragments	Curtognathid biofacies; postmortem transport from or within warm, very shallow, restricted marine.	Grayish-orange-weathering, medium- to medium-dark-gray, massive, partly fenestrate micrite. Heavy-mineral concentrate: iron oxides, argillaceous flakes with disseminated pyrite, and euhedral and anhedral pyrite clusters. 5.3 kg; 80 g +20 mesh and 6 g 20-140 mesh insoluble residue.
SS-1 8-12-90G (10910-CO)	39°08'40", 78°00'52"	**Stephenson (I3)**	Clarke (Virginia)	Stonehenge Limestone (within upper half)	early Early Ordovician *(Rossodus manitouensis* Zone)	4.5-5	8"*Acanthodus*" *lineatus* (Furnish) 1 *Clavohamulus densus* Furnish 1 *Cordylodus angulatus* Pander 2 *Drepanodus arcuatus* Pander 21 *Drepanoistodus* cf. *D. pervetus* Nowlan 1 *Eucharodus parallelus* (Branson & Mehl) 3 *Loxodus bransoni* Furnish 3 "*Oistodus*" *triangularis* Furnish s.f. 1 M *Rossodus manitouensis* Repetski & Ethington 1 *Rossodus*? sp. indet. 6 *Scolopodus*? *sulcatus* Furnish 12 *Variabiloconus bassleri* (Furnish) 10 N. Gen., n. sp. 15 indet. coniform fragments	Drepanoistodid-variabiloconid biofacies; relatively warm, shallow water, normal marine.	Medium-light-gray-weathering, medium- to medium-dark-gray, fine- to medium-grained, massive, partly burrowed limestone. Heavy-mineral concentrate: phosphatic brachiopod fragments, weathered pyrite, iron oxides, phosphatized tubes and minor fresh pyrite. 5.4 kg; 250 g +20 mesh and 115 g 20-200 mesh insoluble residue.
SS-2a 8-12-90E (10911-CO)	39°14'04", 78°00'13"	**Stephenson (I3)**	Clarke (Virginia)	Pinesburg Station Dolomite (about 5 m below top)	early Middle Ordovician middle Whiterockian (upper *H. sinuosa* Zone to lower *C. friendsvillensis* Zone)	4	Conodont texture is sugary and etched. *Paraprioniodus costatus* (Mound) 13 Pa, 9 Pb, 3 Sb, 1 Sd, 56 indet. fragments	Paraprioniodid biofacies; warm, very shallow water, restricted (hypersaline), probably algal-rich.	Very light gray-weathering, medium-light- to medium-gray, massive, very fine grained, partly laminated dolomicrite. Heavy-mineral concentrate: chiefly weathered euhedral pyrite clusters and dolomite with disseminated euhedral pyrite. 11.7 kg; 530 g +20 mesh and 46 g 20-140 mesh insoluble residue.
SS-2b 8-12-90F (10912-CO)	39°14'04", 78°00'13"	**Stephenson (I3)**	Clarke (Virginia)	New Market Limestone (basal 0.5 m)	middle Middle Ordovician middle Whiterockian (upppermost *H. holodentata* Zone to lowermost *C. friends-villensis* Zone)	4	Conodont texture is sugary and etched. 4 *Leptochirognathus quadratus* Branson & Mehl 1 Sb *Paraprioniodus costatus* (Mound) 1 unassigned coniform element 13 indet. bar, blade and coniform fragments	Warm, shallow, restricted, hypersaline environment, probably algal-rich.	Very light gray-weathering, medium- to medium-light-gray micrite. Heavy-mineral concentrate: abundant iron oxides, dolomite, weathered and fresh euhedral pyrite clusters, and minor phosphatic brachiopod fragments. 6.3 kg; 120 g +20 mesh and 10 g 20-140 mesh insoluble residue.
SS-3 6-10-81-2 (9489-CO)	39°13'37", 78°07'14"	**Stephenson (I3)**	Frederick (Virginia)	New Market Limestone (10 m above base of formation)	middle Middle Ordovician late Whiterockian (upppermost *H. holodentata* Zone through most of *C. sweeti* Zone)	4-4.5	*Curtognathus robustus* (Branson & Mehl) 6 Pa, 7 Pb, 2 Sa, 3 Sb 21 *Erismodus radicans* (Hinde) *Plectodina* sp. indet. 1 Pa, 2 Sb 1 unassigned oistodontiform element 54 indet. bar, blade, platform, and coniform fragments (chiefly fragments of *Curtognathus*)	Curtognathid biofacies; warm, shallow, intermittently high-energy and intermittently restricted marine.	Lithology, residue weights, and mineralogy are not available. 3.2 kg; 0 g +20 mesh insoluble residue.
SS-4 8-3-74C (10913-CO)	39°14'33", 78°02'24"	**Stephenson (I3)**	Clarke (Virginia)	Edinburg Formation	Middle Ordovician	4-4.5	1 *Dapsilodus*? *similaris* (Rhodes) 1 *Drepanoistodus suberectus* (Branson & Mehl) 1 P *Phragmodus* sp. indet. acrotretid brachiopods: 2 pedicle & 2 brachial valves	Indeterminate; postmortem winnow from normal marine environment.	Lithology,sample and residue weights, and mineralogy are not available.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
SB-1 FR-24 (10986-CO)	38°59'35", 78°22'01"	Strasburg (**G1**)	Shenandoah (Virginia)	"Oranda" Formation (~8 m above transitional contact with Edinburg Formation)	middle Middle Ordovician late Whiterockian into Blackriveran	4-4.5	1 large, robust Pb (?) element of *Curtognathus* sp. indet.	Indeterminate; this single very shallow-water form conodont is considerably larger than the grain size of the host rock suggesting postmortem transport and subsequent "deposit" by a predator at considerable distance from the habitat of the conodont.	Calcareous shaly siltstone and lesser silty limestone containing scattered fossil debris. Heavy mineral concentrate: chiefly amorphous composite grains of iron oxide and minor sericite(?). 9.3 kg; 6.04 kg +20 mesh and 320 g 20-200 mesh insoluble residue. Collected by J. B. Epstein.
SB-2 64B27-3	38°59'49", 78°21'06"	Strasburg (**G1**)	Shenandoah (Virginia)	Oranda Formation (3 m above base of formation)	late Middle Ordovician	4	Not available.	Not available.	CAI data from S.M. Bergstrom, Ohio State University. Faunal list, lithology, sample and residue weights, and mineralogy are not available.
TS-1 9-24-90C (10914-CO)	39°24'36", 78°01'52"	**Tablers Station** (**I5**)	Berkeley (West Virginia)	Stonehenge(?) Limestone	early Early Ordovician (probably *R. manitouensis* Zone)	4.5-5	1 *Scolopodus? sulcatus* Furnish?	Indeterminate.	Light-tannish-gray-weathering, medium-dark-gray, laminated to thin-bedded to massive mudrock . Heavy-mineral concentrate: chiefly iron-oxide and phosphatic brachiopod fragments, lesser fine pyrite and dolomite and trace amounts of muscovite, biotite and fluorite. 8.9 kg; 50 g +20 mesh and 240 g 20-200 mesh insoluble residue.
TS-2 9-24-90D (10915-CO)	39°28'03", 78°02'02"	**Tablers Station** (**I5**)	Berkeley (West Virginia)	Stonehenge Limestone or lowest Rockdale Run Formation; in fault slice along North Mountain fault zone (included in Rockdale Run in table 2)	early Early Ordovician (*R. manitouensis* Zone-lowest Fauna D, probably *R. manitou-ensis* Zone)	4	2 "*Oistodus*" *triangularis* Furnish s.f. 8 *Variabiloconus bassleri* (Furnish) 9 indet. coniform fragments	Variabiloconid biofacies; shallow-water, normal to possibly restricted marine.	Medium- to medium-dark-gray, massive, mottled micrite in centimeter-thick beds. Heavy-mineral concentrate: fluorite euhedra, dolomite euhedra, argillaceous flakes with disseminated pyrite, and druses of weathered and fresh pyrite. 11.1 kg; 20 g +20 mesh and 61 g 20-200 mesh insoluble residue.
TS-3 9-24-90E (10916-CO)	39°27'30", 78°02'44"	**Tablers Station** (**I5**)	Berkeley (West Virginia)	Rockdale Run Formation; in fault slice along North Mountain fault zone.	late to latest Early Ordovician (*O. communis* Zone)	4	53 *Diaphorodus delicatus* (Branson & Mehl) 3 *Drepanodus concavus* Branson & Mehl 6 *Eucharodus parallelus* (Branson & Mehl) 1 *Oneotodus costatus* Ethington & Brand 44 indet. coniform fragments	Diaphorodid biofacies; warm relatively shallow water, restricted marine.	Very light-gray-weathering, light-gray, massive, saccaroidal, fractured dolomicrite. Heavy-mineral concentrate: dolomite euhedra, anatase, iron-oxide flakes with disseminated pyrite, and minor phosphatic brachiopod fragments. 11.2 kg; 1.5 kg +20 mesh and 185 g 20-200 mesh insoluble residue.
TS-4 9-24-90F	39°25'09", 78°04'06"	**Tablers Station** (**I5**)	Berkeley (West Virginia)	Rockdale Run(?) Formation; in fault slice along North Mountain fault zone.			Barren.		Medium- to medium-dark-gray, saccaroidal, very fine grained limestone with abundant cross cutting calcite-filled fractures. Heavy-mineral concentrate: chiefly phosphatic brachiopod fragments and biotite and minor muscovite and fluorite. 9.7 kg; 210 g +20 mesh and 128 g 20-200 mesh insoluble residue.
TS-5 9-24-90A (10917-CO)	39°22'38", 78°01'19"	**Tablers Station** (**I5**)	Berkeley (West Virginia)	Rockdale Run Formation	late Early Ordovician (highest Fauna D to *O. communis* Zone)	4-4.5	3 *Drepanoistodus* sp. 4 *Eucharodus parallelus* (Branson & Mehl) 4 *Oneotodus costatus* Ethington & Brandt 5 *Parapanderodus emarginatus* (Barnes & Tuke) 4 *Paroistodus parallelus* (Lindstrom) 2 *Scandodus*? sp. 12 *Tropodus comptus* (Branson & Mehl) 1 unassigned oistodontiform 60 indet. coniform fragments	Tropodid biofacies; shallow to moderate depth, normal marine	Very light-gray-weathering, medium-dark-gray micrite with fenestrae, minor mottling and rare small gastropods. Heavy-mineral concentrate: chiefly dolomite (some euhedral) and minor iron oxides. 11.3 kg; 40 g +20 mesh and 168 g 20-200 mesh insoluble residue.
TS-6 9-24-90G (12188-SD)	39°28'33", 78°05'16"	**Tablers Station** (**I5**)	Berkeley (West Virginia)	Keyser(?) Limestone	Late Silurian-earliest Devonian late Ludlovian-early Lochkovian	3.5-4	*Ozarkodina remscheidensis remscheidensis* (Ziegler) 1 Pa, 2 Pb, 1 M, 1 Sb?, 1 Sc? 6 indet. fragments	Washed in from *O. r. remscheidensis* biofacies; shallow-water, partly restricted marine.	Medium- to medium-dark-gray, medium-grained wackestone containing brachiopods and other bioclastic debris. Heavy-mineral concentrate: dolomite and minor weathered and fresh pyrite euhedra and pyrite clusters. 5.7 kg; 240 g +20 mesh and 53 g 20-140 mesh insoluble residue.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
TB-1 91NS-8 (10918-CO)	38°57'23", 78°29'56"	Toms Brook (**F1**)	Shenandoah (Virginia)	Conococheaque Limestone; in fault slice along North Mountain fault zone.	latest Middle Cambrian-earliest Ordovician; most probably Late Cambrian	3.5-4	4 *Phakelodus tenuis* (Muller) 2 *Phakelodus?* sp. 1 *Westergaardodina* sp. indet. 1 indet. coniform fragment	Indeterminate biofacies; normal marine.	Medium-light-gray-weathering, medium-dark-gray, medium- to thick-bedded lime mudstone with clay laminations in minor relief; interlayered with thinly crossbedded, medium- to coarse-grained packstone/grainstone with peloidal? grains and iron stained, very coarse grained, clay-rich intraclasts. Heavy-mineral concentrate: phosphatic brachiopod fragments, iron oxides, argillaceous flakes, minor phosphatic coniform elements, and euhedral clusters of pyrite. 10.5 kg; 240 g of +20 mesh and 414 g of 20-200 mesh insoluble residue.
TB-2a 9-4-77E (10919-CO)	38°58'50", 78°23'30"	Toms Brook (**F1**)	Shenandoah (Virginia)	Pinesburg Station Dolomite (86 m below top)	early Middle Ordovician middle Whiterockian (*H. holodentata* Zone)	4-4.5	*Neomultioistodus clypeus* (Mound) 2 Pb, 3 M, 4 Sb, 3 Sc *Paraprioniodus costatus* (Mound) 17 P, 10 M, 25 S 1 *"Scolopodus" gracilis* Ethington & Clark 35 indet. bar, blade, platform, and coniform fragments	Paraprioniodid-neomultioistodid biofacies; warm, very shallow, restricted marine.	Massive, medium-gray to medium-dark-gray, fenestral micrite with scattered laminations. 4.9 kg; 0 g +20 mesh insoluble residue.
TB-2b 6-4-77E (10920-CO)	38°58'50", 78°23'30"	Toms Brook (**F1**)	Shenandoah (Virginia)	New Market Limestone (6 m above base of formation)	early-middle Middle Ordovician late Whiterockian	4-4.5	6 bar fragments *Appalachignathus* sp. indet. 1 Sb *Curtognathus* sp. indet. 12 *Drepanoistodus basiovalis* (Sergeeva) 8 *Erismodus* sp. indet. *Phragmodus* sp. indet. 2 P, 2 Sc, 13 bar fragments *Plectodina* sp. indet. 1 Pa, 1 Sa, 1 Sb 2 tropodiform elements 2 unassigned oistodontiform elements 52 indet. bar, blade, platform, and coniform fragments	Indeterminate; postmortem hydraulic mixing of a variety of shallow-water biofacies species. Virtually all conodonts are incomplete and some are hydraulically abraded. Warm, relatively shallow water, probably normal marine.	Lithology, sample and residue weights, and mineralogy are not available.
TB-2c 10-31-78J (10921-CO)	38°58'50", 78°23'30"	Toms Brook (**F1**)	Shenandoah (Virginia)	Edinburg Formation (17 m above base of formation)	middle Middle Ordovician early Blackriveran (*B. gerdae* Subzone of *A. tvaerensis* Zone)	4-4.5	*Baltoniodus gerdae* (Bergstrom) 1 Pa, 2 Pb, 2 M, 2 Sc 14 *Dapsilodus? similaris* (Rhodes) 8 *Drepanoistodus basiovalis* (Sergeeva) 1 Sb *Periodon* sp. indet. 1 Pa *Plectodina* sp. indet. 4 indet. bar fragments	Indeterminate; postmortem hydraulic mixing of normal marine biofacies species that represent at least moderate depth.	Medium-dark-gray, wavy-bedded, massive, argillaceous, burrowed mudstone to wackestone containing abundant fossil debris. Heavy-mineral concentrate: contains some phosphatized steinkerns of brachiopods and gastropods. 3.5 kg; 44 g +20 mesh insoluble residue.
TB-3 5-12-81R (9418-CO)	38°58'30", 78°23'40"	Toms Brook (**F1**)	Shenandoah (Virginia)	"Oranda" Formation (within lower 80 m)	middle Middle Ordovician latest Blackriveran-Rocklandian (no older than *Ph. undatus* Zone)	4.5	1 belodinid 5 *Dapsilodus? similaris* (Rhodes) 5 *Drepanoistodus suberectus* (Branson & Mehl) 2 "*Oistodus*" *venustus* Stauffer *Periodon* sp. indet. 2 M, 2 Sc *Phragmodus undatus* Branson & Mehl 8 P, 4 M, 13 S 4 *Pseudooneotodus mitratus* (Moskalenko) 15 indet. bar, blade, and coniform fragments	Phragmodid biofacies; moderate or deeper water, normal marine.	Dark-gray carbonate mudstone. 12.2 kg; 316 g +20 mesh insoluble residue.
TB-4 91NS-7 (10922-CO)	38°58'59", 78°27'53"	Toms Brook (**F1**)	Shenandoah (Virginia)	New Market Limestone; in fault slice along North Mountain fault zone.	middle Middle Ordovician Probably late Whiterockian-early Blackriveran	4-4.5	Virtually all conodonts are very small and broken fragments. 17 *Curtognathus* sp. indet. 2 *Drepanoistodus suberectus* (Branson & Mehl) 6 erismodid fragments 1 Early Ordovician oneotodid element 5 *Panderodus* sp. indet. 9 P *Phragmodus*? sp. indet. *Plectodina* sp. indet. 3 Pa, 2 Pb, 8 Sb, 2 Sc 93 indet. bar, blade, and coniform fragments	Indeterminate; postmortem mixing of normal and restricted marine species.	Light-gray-weathering, medium- to dark-gray, medium- to thick-bedded lime mudstone with occasional lenses of coarse-grained bioclasts and mudstone lithoclasts in mud matrix (bio/lithopackstone); collection is bioclastic packstone. Heavy-mineral concentrate: iron oxides with weathered pyrite, dolomite, and organic flakes with disseminated pyrite. 7.6 kg; 0 g of +20 mesh and 10 g 20-200 mesh insoluble residue.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
TB-5 91NS-6 (10923-CO)	38°59'38", 78°27'05"	Toms Brook (**F1**)	Shenandoah (Virginia)	Probably Edinburg Formation; in fault slice along North Mountain fault zone.	Middle to Late Ordovician	3.5	1 midcone fragment of *Panderodus* sp. indet.	Indeterminate.	Light-gray-weathering, medium-dark-gray, massive to medium-bedded carbonate mudstone; contains fractures and calcite veins. Heavy-mineral concentrate: abundant iron oxides, druses of weathered and fresh pyrite, and anhedral dolomite. 7.4 kg; 460 g +20 mesh and 254 g 20-200 mesh insoluble residue.
WA-1 90DW32 (10924-CO)	39°03'16", 78°30'30"	**Wardensville** (**E-2**)	Hardy (West Virginia)	Martinsburg or Reedsville Formation (upper 30 m) (included in Martinsburg on table 2)	late Middle Ordovician to Late Ordovician. (no older than *Ph. undatus* Zone)	3.5-4	*Phragmodus undatus* Branson and Mehl 9 P, 13 M, 12 S *Plectodina* sp. indet. 3 Pa, 1 M, 3 Sb, 1 Sc 1 *Panderodus* sp. indet. 48 indet. bar, blade, and platform fragments.	Postmortem transport within the *Phragmodus undatus* biofacies; shelfal, but not shallowest; low energy?; normal marine.	Medium-gray sandy wackestone with brachiopods, crinoids, gastropods in 10- cm-thick bed. Heavy-mineral concentrate: phosphatic shell fragments, phosphatized steinkerns of gastropods and crinoid columnals, barite, anhedral pyrite, and phosphatic bryozoan zooecial linings. 7.2 kg; 1.3 kg +20 mesh and 186 g 20-200 mesh insoluble residue.
WA-2 91NS-13 (12189-SD)	39°01'35", 78°35'57"	**Wardensville** (**E2**)	Hardy (West Virginia)	McKenzie Formation or Tonoloway Limestone ; probably lower Tonoloway Limestone	Late Silurian late Ludlovian (*P. siluricus* Zone - Lower *O. remscheidensis* Zone)	3.5-4	*Distomodus*? *dubius* (Rhodes) 5 M, 1 Sa,1 Sb, 1 Sc denticulate elements, 22 M & S adenticulate elements, 10 unassigned coniform elements *Ozarkodina* cf. *O. wimani* Jeppsson 8 Pa, 4 Pb, 3 M, 2 Sa, 1 Sb, 3 Sc	Postmortem transport from or within distomodid biofacies; relatively shallow, probably restricted marine.	Medium-gray-weathering, dark-gray, medium-bedded, fine- to medium-grained lime wackestone/packstone containing brachiopods. Heavy-mineral concentrate: oxidized phosphatic brachiopod fragments and gastropods, dolomite euhedra, and trace druses of fresh pyrite, biotite, and zircon. 10.1 kg; 90 g of +20 mesh and 74 g 20-140 mesh insoluble residue.
WP-1 3-20-91B (12190-SD)	39°23'37", 79°00'30"	Westernport (**A5**)	Mineral (West Virginia)	Corriganville Limestone	Early Devonian early-middle(?) Lochkovian	3-3.5	*Oulodus cristagalli* (Ziegler) 7 Pb, 3 Sa, 3 Sb, 2 Sc *Ozarkodina* sp. indet. 4 Pb, 1 M, 2 Sa, 3 Sb, 2 Sc 1 S *Pedavis* sp. indet. 161 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) 34 indet. bar fragments	Pseudooneotodid-oulodid biofacies; hydraulically sorted postmortem transport by moderate- to high-energy currents in shallow to moderate depth (probably shallow) normal-marine waters.	Medium-light-gray, siliceous, fossiliferous, fine-grained, crossbedded to laminated, massive limestone containing light-gray chert. Heavy-mineral concentrate: chiefly phosphatic brachiopod fragments and lesser barite, dolomite, iron oxides and trace amounts of bryozoan pearls, ichthyoliths and sponge spicules; 141 acrotretid valves. 10.9 kg; 90 g +20 mesh and 71 g 20-200 mesh insoluble residue.
WP-2a 90RS-20A (31278-PC)	39°27'55", 79°01'10"	Westernport (**A5**)	Allegany (Maryland)	Greenbrier Limestone; Loyalhanna Limestone Member (basal 0.5 m of member)	Late Mississippian Chesterian, but not latest	2.5-3	*Cavusgnathus unicornis* Harris & Hollingsworth 13 Pa, 2 Pb, 7 M, 1 Sa, 2 Sb, 7 Sc *Hindeodus cristulus* (Youngquist & Miller) 4 Pa, 2 Pb, 2 M, 4 Sb, 4 Sc *Kladognathus* sp. 14 M, 8 Sb, 14 Sc *Lochriea commutata* (Branson & Mehl) 4 Pa, 7 M 177 indet. bar, blade, and platform fragments	Postmortem transport within cavusgnathid-kladognathid-hindeodid biofacies (all specimens nearly same size except a few moderately worn *Cavusgnathus* and *Kladognathus* elements). Relatively normal marine, shallow water.	Light-gray-weathering, medium-grayish-brown, very fine to medium-grained, medium-bedded, sparsely fossiliferous, argillaceous, lime packstone. Heavy-mineral concentrate: chiefly barite. 11.9 kg; 0 g +20 mesh insoluble residue.
WP-2b 90RS-20B (31279-PC)	39°27'55", 79°01'10"	Westernport (**A5**)	Allegany (Maryland)	Greenbrier Limestone; Loyalhanna Limestone Member (4 m above base of member)	Late Mississippian Chesterian, but not latest	2.5-3	Most conodonts are abraded. *Cavusgnathus unicornis* Harris & Hollingsworth 6 Pa, 2 Pb 10 abraded Pa *Cavusgnathus* sp. indet. (complete and fragmentary) *Hindeodus cristulus* (Youngquist & Miller) 1 Pa (juvenile) & 1 Pa fragment *Kladognathus* sp. 1 M, 1 Sb, 4 Sc 1 (juvenile) Pa *Vogelgnathus campbelli* ? Rexroad 6 indet. bar, blade, and platform fragments REDEPOSITED LATEST DEVONIAN-EARLY MISSISSIPPIAN CONODONTS 1 abraded Pa *Polygnathus* cf. *P. communis* Branson & Mehl	Postmortem transport within cavusgnathid biofacies. Shallow water, probably normal marine.	Light-gray-weathering, greenish-gray, medium- to coarse-grained, well-sorted, thickly cross-bedded, sandy lime grainstone. Heavy-mineral concentrate: chiefly barite. 3.0 kg; 0 g +20 mesh insoluble residue.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
WP-2c 90RS-21 (31280-PC)	39°27'55" 79°01'10"	Westernport (**A5**)	Allegany (Maryland)	Greenbrier Limestone; Deer Valley Limestone Member (1 m below top of member)	Late Mississippian Chesterian, but not latest	2.5-3	Conodonts show varying degrees of abrasion 6 Pa *Cavusgnathus unicornis* Harris & Hollingsworth 95 Pa *Cavusgnathus* sp. indet. (complete & fragmentary) 1 abraded Pa *Hindeodus cristulus* (Youngquist & Miller) 3 abraded Pa *Hindeodus spiculus* (Youngquist & Miller) 6 abraded Pa *Hindeodus* sp. indet. fragments *Kladognathus* sp. indet. 9 M, 1 Sa, 3 Sb, 17 Sc (abraded) 293 indet. bar, blade, and platform fragments REDEPOSITED LATEST DEVONIAN-EARLY MISSISSIPPIAN CONODONTS 3 abraded Pa *Polygnathus* cf. *P. communis* Branson & Mehl 1 abraded *Polygnathus*? sp. indet.	Postmortem transport within cavusgnathid biofacies. Shallow water, probably normal marine.	Light-pinkish-gray-weathering, medium-pinkish-gray, medium- to very coarse-grained, poorly-sorted, thickly cross-bedded, sandy lime grainstone. Heavy-mineral concentrate: chiefly barite. 10.7 kg; 0 g +20 mesh insoluble residue.
WP-2d 90RS-22 (31281-PC)	39°27'55", 79°01'10"	Westernport (**A5**)	Allegany (Maryland)	Greenbrier Limestone; Wymps Gap Member (1 m above base of member)	Late Mississippian Chesterian, but not latest	2.5-3	1 Pa *Bispathodus* sp.? fragment (probably redeposited) 13 Pa *Cavusgnathus regularis* Youngquist & Miller 41 Pa *Cavusgnathus unicornis* Harris & Hollingsworth *Hindeodus cristulus* (Youngquist & Miller) 23 Pa, 4 Pb, 5 M, 2 Sa, 5 Sc *Kladognathus* sp. 22 M, 5 Sa, 14 Sb, 25 Sc 2 Pa *Vogelgnathus campbelli* Rexroad UNASSIGNED ELEMENTS: 7 Pb, 2 M, 4 Sc ~88 indet. bar, blade, and platform fragments	Cavusgnathid-kladognathid-hindeodid biofacies. Relatively shallow water, probably normal marine.	Medium-gray-weathering, dark-brownish-gray, very coarse grained, poorly sorted, thick-bedded, fossiliferous, fetid lime grainstone. Heavy-mineral concentrate: chiefly barite. 11.3 kg; 0 g +20 mesh insoluble residue.
WP-2e 90RS-23 (31282-PC)	39°27'55", 79°01'10"	Westernport (**A5**)	Allegany (Maryland)	Greenbrier Limestone; Wymps Gap Member (6 above base of member)	Late Mississippian Chesterian, but not latest	2.5-3	7 Pa *Cavusgnathus regularis* Youngquist & Miller 26 Pa *Cavusgnathus unicornis* Harris & Hollingsworth *Hindeodus cristulus* (Youngquist & Miller) 27 Pa & 1 Sa 3 Pa *Hindeodus spiculus* (Youngquist & Miller) *Kladognathus* sp. 23 M, 7 Sa, 8 Sb, 22 Sc UNASSIGNED ELEMENTS: 11 Pb, 6 M, 2 Sa, 3 Sc ~112 indet. bar, blade, and platform fragments	Hindeodid-kladognathid-cavusgnathid biofacies. Relatively shallow water, probably normal marine.	Medium-gray-weathering, dark-brownish-gray, coarse- to very coarse grained, moderately well-sorted, thick-bedded, fetid lime grainstone. Heavy-mineral concentrate: chiefly barite. 11.9 kg; 0 g +20 mesh insoluble residue.
WP-2f 90RS-24 (31283-PC)	39°27'55", 79°01'10"	Westernport (**A5**)	Allegany (Maryland)	Greenbrier Limestone; Wymps Gap Member (1 m below top of member)	Late Mississippian Chesterian, but not latest	2.5-3	4 Pa *Bispathodus* sp. (probably redeposited) *Cavusgnathus unicornis* Harris & Hollingsworth 131 Pa, 22 Pb, 12 M, 5 Sa, 1 Sb, 7 Sc 2 juvenile *Gnathodus* sp. indet. *Hindeodus cristulus* (Youngquist & Miller) 97 Pa, 4 Pb, 15 M, 5 Sa, 6 Sb, 9 Sc 5 Pa *Hindeodus spiculus* (Youngquist & Miller) *Kladognathus* sp. 22 M, 5 Sa, 20 Sb, 50 Sc 10 Pa *Vogelgnathus campbelli* Rexroad ~225 indet. bar, blade, and platform fragments	Cavusgnathid-hindeodid-kladognathid biofacies. Relatively shallow water, probably normal marine.	Dark-brownish-gray, reddish-brown, thin- to medium-bedded, nodular, fossiliferous (abundant articulate brachiopods), argillaceous lime wackestone. Heavy-mineral concentrate: chiefly barite. 12 kg; 0 g +20 mesh insoluble residue.
WH-1a ROCP-2 (10931-CO)	39°15'25", 78°09'09"	**White Hall** (**H4**)	Frederick (Virginia)	Conococheague Limestone (~70 m below top of formation)	latest Cambrian Trempealeauan (*P. muelleri* or *Eoconodontus* Zone)	4.5	5 *Prooneotodus rotundatus* (Druce & Jones)	Proconodontid biofacies; very shallow, restricted marine.	Medium-light-gray, fine-grained, bioturbated wackestone 10 cm thick. Mineralogy of heavy-mineral concentrate not available. 3.3 kg; 200 g +20 mesh insoluble residue. All data from R. C. Orndorff, U.S. Geological Survey.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
WH-1b ROCP-1 (10932-CO)	39°15'25", 78°09'09"	**White Hall** **(H4)**	Frederick (Virginia)	Conococheague LImestone (~67 m below top of formation)	latest Cambrian Trempealeauan (*Eoconodontus* Zone)	4.5	1 *Cambrooistodus minutus*? (Miller) 2 *Eoconodontus notchpeakensis* (Miller) 10 *Proconodontus muelleri* Miller 19 *Proconodontus muelleri* Miller or *Eoconodontus notchpeakensis* (Miller) fragments 15 *Proconodontus serratus* Miller 1 *Prooneotodus rotundatus* (Druce & Jones)	Proconodontid biofacies; very shallow, restricted marine.	Medium-gray, bluish-gray-weathering grainstone in beds 5 to 10 cm thick with intervals of rip-up clasts in beds 3 to 5 cm thick. Mineralogy of heavy-mineral concentrate not recorded. 3.6 kg; 150 g +20 mesh insoluble residue. All data from R.C. Orndorff, U.S. Geological Survey.
WH-2 8-16-90A (10925-CO)	39°1515", 78°08'12"	**White Hall** **(H4)**	Frederick (Virginia)	Rockdale Run Formation	Early Ordovician late Early Ordovician (lower *O. communis* Zone)	4.5	5 "*Acontiodus*" *staufferi* Furnish s.f. 51 *Drepanodus concavus* (Branson & Mehl) 23 *Eucharodus parallelus* (Branson & Mehl) 2 *Eucharodus toomeyi* (Ethington & Clark) 47 *Glyptoconus quadraplicatus* (Branson & Mehl) *Oepikodus communis* (Ethington & Clark) 4 P, 4 M, 6 S 5 *Oistodus*? sp. 33 *Oneotodus costatus* Ethington & Brand 2 *Paroistodus* sp. 16 *Scandodus*? n. sp. 5 "*Scolopodus*" *gracilis* Ethington & Clark 21 *Tropodus comptus* (Branson & Mehl) 1 *Ulrichodina abnormalis* (Branson & Mehl) UNASSIGNED ELEMENTS: 2 M, 2 Sa 90 indet. coniform fragments	Drepanodid-glyptoconid-oneotodid biofacies; warm, shallow-water, normal marine.	Light-gray-weathering, medium- to medium-dark-gray, fine-grained mudstone with minor bioclasts. Heavy-mineral concentrate: dolomite, weathered and fresh pyrite and abundant conodonts; only one tray picked; about 90% of residue unpicked. 10.9 kg; 180 g +20 mesh and 162 g 20-200 mesh insoluble residue.
WH-3 8-16-90C (10926-CO)	39°19'37", 78°08'11"	**White Hall** **(H4)**	Frederick (Virginia)	New Market Limestone (probably middle to upper part); in fault sliver along North Mountain fault zone	Middle Ordovician middle Whiterockian-Shermanian, probably middle to late Whiterockian on the basis of stratigraphic position	3.5-4	All conodonts are severely fractured and most are small fragments. 3 erismodid fragments 3 *Panderodus* sp. indet. 14 indet. bar, blade, platform, and coniform fragments	Indeterminate; intermittently restricted to normal marine, shallow-water depositional environment.	Light-gray-weathering, medium-gray, massive micrite. Heavy-mineral concentrate: not recorded. 7.2 kg; 20 g +20 mesh and 15 g 20-200 mesh insoluble residue.
WH-4 8-16-90B (12191-SD)	39°18'12", 78°10'07"	**White Hall** **(H4)**	Frederick (Virginia)	Oriskany Sandstone (about 8-10 m below top)	Early Devonian Lochkovian-Pragian, probably Pragian	3.5-4	4 Sb *Dvorakia* sp. 12 P fragments *Icriodus* sp. indet. 1 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) 2 indet. fragments	Icriodid biofacies; shallow-water, high-energy, normal marine.	Medium-gray, fine- to medium-grained packstone/grainstone containing brachiopods. Sampled unit interbedded with calcareous, conglomeratic sandstone. Heavy-mineral concentrate: chiefly phosphatic brachiopod fragments, weathered pyrite clusters, and lesser iron oxides. 6.9 kg; 350 g +20 mesh and 264 g 20-140 mesh insoluble residue.
WI-1 8-12-90L (10927-CO)	39°07'49", 78°13'31"	**Winchester** **(H3)**	Frederick (Virginia)	Conococheague Limestone (upper part; about 100 m below top)	latest Late Cambrian (*Clavohamulus elongatus* Subzone of *C. proavus* Zone)	4.5, 5.5, 6, 7	Conodonts are fractured and deformed. 8 *Clavohamulus elongatus* Miller 8 *Cordylodus proavus* Muller 24 *Eoconodontus notchpeakensis* (Miller) 1 *Hirsutodontus hirsutus* Miller 62 *Teridontus nakamurai* (Nogami) 5 unassigned coniform fragments 69 indet. bar, blade and coniform fragments	Teridontid biofacies; relatively shallow, normal marine.	Medium-gray-weathering, medium-light-gray, massive, recrystallized micrite(?). Heavy-mineral concentrate: dolomite euhedra, iron-oxide flakes, fresh and weathered pyrite euhedra, fresh and weathered euhedral clusters of pyrite, fresh and weathered druses of pyrite, barite, zircon, and rare fluorite euhedra. 9.1 kg; 420 g +20 mesh and 252 g 20-200 mesh insoluble residue.
WI-2 8-12-90K (10928-CO)	39°14'01", 78°09'24"	**Winchester** **(H3)**	Frederick (Virginia)	Conococheague Limestone (upper part)	earlliest Early Ordovician (*C. lindstromi* Zone)	4-4.5	20 *Cordylodus lindstromi* Druce & Jones 20 *Cordylodus proavus* Muller 2 M *Cordylodus* spp. 43 *Eoconodontus notchpeakensis* (Miller) 13 *Monocostodus* sp. 8 *Teridontus nakamurai* (Nogami) 73 unassigned juvenile coniform elements 47 indet. bar and coniform fragments	Cordylodid-eoconodontid biofacies; moderate to relatively shallow, normal marine.	Grayish-orange- to medium-light-gray-weathering, dark- to medium-dark-gray, thin-bedded, whispy laminated micrite with some burrowing. 9.0 kg; 20 g +20 mesh and 27 g 20-200 mesh insoluble residue.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
WI-3 10-8-56-2 (4715-CO)	39°12'46", 78°09'50"	**Winchester** **(H3)**	Frederick (Virginia)	Stonehenge Limestone; 8.5 m above base of upper member	early Early Ordovician Ibexian (*R. manitouensis* Zone)	4	3 "*Acanthodus*" *lineatus* (Furnish) 1 *Acontiodus staufferi* Furnish s.f. 2 *Clavohamulus* sp. 13 *Cordylodus angulatus* Pander 17 *Cordylodus intermedius* Furnish 23 *Cordylodus lindstromi* Druce & Jones 32 *Cordylodus* spp. indet. 6 *Drepanodus* n. sp. 20 *Drepanoistodus* cf. *D. pervetus* Nowlan 5 *Eucharodus parallelus* (Branson & Mehl) 1 *Iapetognathus*? sp. 6 N. Gen.? n. sp. 21 "*Oistodus*" *triangularis* Furnish 1 *Oneotodus*? sp. 56 *Rossodus manitouensis* Repetski & Ethington 24 *Rossodus* n. sp. 16 *Scolopodus*? *sulcatus* Furnish 1 *Semiacontiodus*? sp. 12 *Teridontus* spp. 25 *Variabiloconus bassleri* (Furnish) 20 indet. coniform fragments	Cordylodid-rossodid biofacies; shallow, warm, normal marine.	Burrow-mottled, channeled stromatolitic limestone with abundant brachiopods. Sample and insoluble residue weights and mineralogy not recorded.
WI-4a 8-13-90B (10929-CO)	39°07'42", 78°12'17"	**Winchester** **(H3)**	Frederick (Virginia)	Rockdale Run Formation(?); about 300 m below 8-13-90A.(structurally repeated?)	Early Ordovician middle-late Early Ordovician (NAMP Fauna D)	4.5	2 *Drepanoistodus* sp. 1 *Glyptoconus quadraplicatus* (Branson & Mehl)	Probably very shallow water, restricted marine.	Medium-light-gray- and yellowish-gray-weathering (burrow mottled), dark- to medium-dark-gray, massive- to thick-bedded, carbonate mudstone. Heavy-mineral concentrate: very abundant single euhedra and euhedral clusters of pyrite, minor phosphatic brachiopod fragments, and minor argillaceous flakes with pyrite. 12.2 kg ; 620 g +20 mesh and 219 g 20-200 mesh insoluble residue.
WI-4b 8-13-90A (10930-CO)	39°07'42", 78°12'17"	**Winchester** **(H3)**	Frederick (Virginia)	Rockdale Run Formation	middle Early Ordovician (NAMP Fauna D)	4-4.5	20 *Drepanoistodus*? sp. 26 *Eucharodus parallelus* (Branson & Mehl) 64 *Glyptoconus quadraplicatus* (Branson & Mehl) 3 *Glyptoconus* sp. indet. 5 "*Scolopodus*" *gracilis* Ethington & Clark 1 "*Scolopodus*" cf. "*S.*" *parabruptus* Repetski 2 *Ulrichodina abnormalis* (Branson & Mehl) 2 *Ulrichodina deflexa* Furnish 2 *Ulrichodina wisconsinensis* Furnish	Glyptoconid biofacies; warm, shallow, partly restricted marine.	Medium-light-gray-weathering, medium-dark-gray, thick-bedded, wispy laminated to burrow-mottled dolomitic wackestone ; forms lower meter of two-meter package; upper part of package (not sampled) oncolitic slightly calcareous dolomicrite. Heavy-mineral concentrate: abundant pyrite, druses of pyrite on argillaceous and organic flakes, single euhedra and euhedral clusters of pyrite, iron oxides, and iron oxide replacements of ooids?. 9.9 kg; 360 g +20 mesh and 49 g of 20-200 mesh insoluble residue.
WS-1 91NS-12 (12192-SD)	38°59'10" 78°32'26"	Woodstock **(E1)**	Shenandoah (Virginia)	Tonoloway Limestone (lower member)	Late Silurian late Ludlovian (Lower *O. remscheidensis* Zone)	3.5-4	*Oulodus elegans* (Walliser) 1 Pb, 2 M, 1 Sc 156 Pa *Ozarkodina remscheidensis remscheidensis* (Ziegler) *Ozarkodina snajdri snajdri* (Walliser) & *Ozarkodina snajdri crispa* (Walliser) 158 Pa, 9 Pb *Ozarkodina* spp. indet. 49 Pb, 18 M., 4 Sa, 20 Sb, 12 Sc 250+ indet. bar, blade, and platform fragments	*O. r. remscheidensis-O. snajdri biofacies*; relatively shallow, moderate- to high-energy, normal marine.	Medium-gray-weathering, dark-maroon and dark-gray, flaggy-thin- to medium-bedded, slightly argillaceous, bioclastic lime wackestone/packstone with crinoids and whole and dissarticulated brachiopods. Heavy-mineral concentrate: weathered pyrite euhedra, quartzose prisms, dolomite euhedra, and argillaceous and pyritic flakes. 10.9 kg; 90 g of +20 mesh and 74 g 20-140 mesh insoluble residue.

Table 1 continued

MAP NO. FIELD NO. (USGS COLLN. NO.)	LAT. N., LONG. W.	QUADRANGLE (MAP GRID NO.)	COUNTY (STATE)	FORMATION	AGE	CAI	CONODONT FAUNA	CONODONT BIOFACIES AND DEPOSITIONAL ENVIRONMENT	REMARKS
YS-1 91NS-14 (12193-SD)	39°09'11", 78°35'39"	**Yellow Spring** **(E3)**	Hampshire (West Virginia)	McKenzie Formation or Wills Creek Formation (included in McKenzie in table 2)	Late Silurian latest Wenlockian-middle Ludlovian; probably Ludlovian (probably *P. siluricus* Zone)	4	aff. "*Ozarkodina*" cf. "*O.*" *douroensis* Uyeno 7 Pa, 4 Pb, 3 M, 3 Sa, 1 Sc 4 indet. bar, blade, and platform fragments	"Ozarkodinid" biofacies; shallow-water, possibly restricted marine environment.	Medium-gray-weathering, dark-gray, medium- to thick-bedded lime mudstone within thinly laminated to thin-bedded sequence. Heavy-mineral concentrate: argillaceous flakes with disseminated pyrite, druses of fresh and weathered pyrite, minor barite and dolomite euhedra, pyritic spherules, iron oxides, and rare ostracode carapaces. 13.5 kg; 120 g of +20 mesh and 51 g of 20-140 mesh insoluble residue.
YS-2 91NS-20 (12194-SD)	39°11'05", 78°32'32"	**Yellow Spring** **(E3)**	Hampshire (West Virginia)	Wills Creek Formation (upper part) or Tonoloway Limestone (lowermost); probably upper Wills Creek Formation	Late Silurian Ludlovian	3.5-4	All specimens are broken. "*Ligonodina*" *confluens* n. sp. (apparatus is same as species included in *Ligonodina* Jeppssen, 1972) 2 Pa, 1 Pb, 9 Sa, 9 Sb, 5 Sc 77 indet. "*Ligonodina* " fragments 1 ozarkodinid Sc 1 unassigned Pa fragment	"*Ligonodina*" biofacies; very shallow, partly restricted marine depositional environment.	Light- to light-browninsh-gray-weathering, medium-dark-gray, thin-bedded to laminated, fine- to coarse-grained, fossiliferous dolomudstone containing brachiopods and crinoids. Heavy-mineral concentrate: organic flakes with disseminated pyrite, barite, and druses of fresh and weathered pyrite. 12.9 kg; 20 g of +20 mesh and 50 g 20-140 mesh insoluble residue.
YS-3 9-27-90H (12195-SD)	39°14'53", 78°31'28"	**Yellow Spring** **(E3)**	Hampshire (West Virginia)	Tonoloway Limestone (probably)	Late Silurian late Ludlovian-Pridolian	3.5-4	*Ozarkodina remscheidensis remscheidensis* (Ziegler) 75 Pa, 24 Pb, 9 M, 1 Sa, 15 Sb?, 12 Sc 59 indet. bar, blade, and platform fragments	*O. r. remscheidensis* biofacies; shallow-water, possibly partly restricted marine, barely subtidal.	Medium-dark-gray, irregularly bedded, fine-grained (burrowed), carbonate mudstone. Heavy-mineral concentrate: phosphatic brachiopod fragments and ichthyoliths, common iron oxides, and rare weathered pyrite euhedra and bryozoan pearls. 8.0 kg; 180 g +20 mesh and 72 g 0-140 mesh insoluble residue.

[1]Conodont sample localities are labeled alphanumerically; letters represent an abbreviation of the quadrangle name and are numbered consecutively within each quadrangle according to decreasing geologic age. Some localities represent several samples within a section or samples too closely spaced to show separately at the map scale. These samples are listed separately here and on the stratigraphic column by a lettered suffix (e.g., IN-5a through 5i). Samples can also be located by alphanumeric map grid number.

[2]Conodont samples collected chiefly by A. G. Harris and N. R. Stamm (e.g., field nos. 8-15-90A or prefixed 91NS) and D. J. Weary (field nos. prefixed 90, 91DW), and R. G. Stamm (field nos. prefixed 90RS).

[3]Responsibility for analyses of conodont collections is as follows: Late Cambrian and Early Ordovician, J. E. Repetski; Middle Ordovician to Early Devonian, A. G. Harris and N. R. Stamm; Middle and Late Devonian, D. J. Weary and A. G. Harris; and Mississippian, R. G. Stamm.

[4]NAMP indicates Ordovician biofacies representative of the North American Midcontinent province (= low latitude, chiefly warm, shallow-water faunal assemblages).

TABLE 2. Distribution of conodont samples and CAI values in stratigraphic units in the Winchester 30' X 60' quadrangle

STRATIGRAPHIC UNIT[1]	SAMPLES		CAI[2]														
	BARREN	PRODUCTIVE	2.5-3	3	3-3.5	3.5	3.5-4	4	4-4.5	4.5	4.5-5	5	5.5	6	6.5	7	indet.
Greenbrier Limestone		6	6														
Chemung Formation		2				1		1									
Romney Shale	2	2				1		1									
Harrell Shale	6	10			2	6	1										1
Tully Limestone		1				1											
Mahantango Formation	9	6			4	2											
Marcellus Shale	3	5				3	1	1									
Needmore Shale	3	1						1									
Oriskany Sandstone		4				2	1	1									
Shriver Chert	1	2			1	1											
Licking Creek Limestone		4					1	3									
Corriganville Limestone		4			2	2											
New Creek Limestone		4				3	1										
Keyser Limestone		27			1	1	18	7									
Tonoloway Limestone	1	10					7	3									
Wills Creek Formation	1	1					1										
McKenzie Formation		1						1									
Martinsburg Formation		1					1										
"Oranda" Formation	5	3						1	1	1							
Middle Ordovician carbonate (BO-3)		1							1								
Chambersburg Limestone		12						10	2								
Edinburg Formation		8				1	1	3	3								
New Market Limestone		12					2	4	6								
Pinesburg Station Dolomite		4						3	1				**1**	**1**			
Rockdale Run Formation	1	12						2	4	5	1						
Stonehenge Limestone		9						1		1	7						
Beekmantown Group (SC-1)		1								1				**1**			
Conococheague Limestone	4	7					1		1	4	1		**1**	**1**		**1**	
Uncertain	2																
TOTAL NUMBER OF SAMPLES	**38**	**160**															

[1]Stratigraphic units arranged, from bottom to top, in general order of decreasing age. Unsampled units are not shown in table.

[2]Bold number indicates a range in CAI values within a single sample. Such values generally indicate hydrothermal alteration.