McGowan Creek Formation, New Name for Lower Mississippian Flysch Sequence in East-Central Idaho

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By CHARLES A. SANDBERG

CONTRIBUTIONS TO STRATIGRAPHY

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By CHARLES A. SANDBERG

ABSTRACT

The argillite sequence of Early Mississippian age in east-central Idaho that had been erroneously correlated with the Devonian Milligen Formation in central Idaho is here named the McGowan Creek Formation from exposures south of McGowan Creek on the west side of the Lost River Range. The McGowan Creek is dated and zoned on the basis of conodont faunas and its type section is described. It comprises a thick lower member, predominantly grayish-black argillite, as much as 1,000 metres (3,280 feet) thick, and a thin upper member, predominantly pinkish-gray-weathering calcareous siltstone, as much as 150 metres (492 feet) thick. Regionally, the McGowan Creek forms a westward-thickening wedge of flysch sediments that were deposited on the east side of the Antler foreland basin. Westward it correlates with the lower part of the Mississippian Copper Basin Formation near the axis of the foreland basin. Eastward it grades into the Lodgepole Limestone and lower part of the Mission Canyon Limestone on the cratonic platform in southwestern Montana.

INTRODUCTION

The argillitic flysch sequence of Early Mississippian age lying between the Three Forks Formation of Late Devonian age and the Middle Canyon Formation of Late Mississippian age in the Lost River and Lemhi Ranges and Beaverhead Mountains of east-central Idaho is here named the McGowan Creek Formation. Heretofore, this argillite sequence had been erroneously called the Milligen Formation on the basis of its correlation by Ross (1934, p. 967) with the type Milligen of the Wood River area in central Idaho, which Ross (1934, p. 972; 1962, p. 384) considered to be Mississippian. Ross' correlation appeared to be confirmed when the argillite sequence in the Lost River Range was found to contain Early Mississippian conodonts at its base by Sandberg, Mapel, and Huddle (1967). Subsequently, the usage of Milligen Formation for the argillite sequence of Early Mississippian age became firmly entrenched in geologic literature (for example, Mamet and others, 1971; Paull and others, 1972). Recently, however, the type Milligen Formation of the Wood River area was shown to be a relatively deep water transitional sequence of exclusively Devonian age that had an eastern provenance (Sandberg and others, 1975). Thus that name no longer is applicable to

the exclusively Lower Mississippian western-derived flysch sequence that is here named the McGowan Creek Formation.

The discrete areas in which the McGowan Creek and Milligen Formations are recognized are shown in figure 1. The type locality of the Mil-

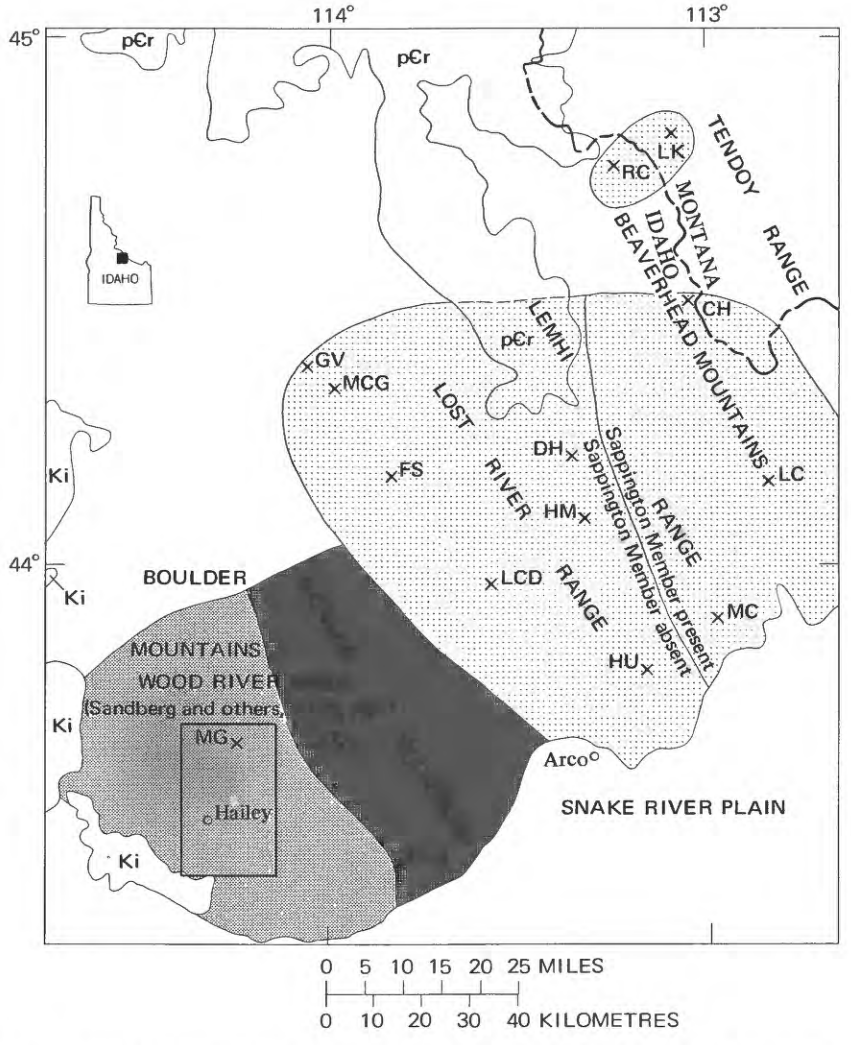

FIGURE 1.—Index map showing area of McGowan Creek Formation (light stippling) and distribution of directly underlying Sappington Member of Three Forks Formation, and areas of Copper Basin Formation (dark stippling) and Milligen Formation (medium stippling). Ki, Cretaceous intrusive rocks of Idaho batholith; pCr, Precambrian sedimentary and metamorphic rocks. Localities mentioned in text: CH, Chamberlain Creek; DH, Donkey Hills; FCR, Fish Creek Reservoir; FS, Freighter Spring; GV, Grandview Canyon; HM, Hawley Mountain; HU, Hurst Canyon; LC, Long Canyon; LCD, Lower Cedar Creek; LCO, Little Copper Creek; LK, Lake Canyon; MC, Middle Canyon; MCG, McGowan Creek (type section of McGowan Creek Formation); MG, Milligen Gulch (type locality of Milligen Formation); RC, Railroad Canyon.

ligen is Milligen Gulch. In the intervening area of the Pioneer Mountains, the Mississippian Copper Basin Formation contains in its lower part western equivalents of the McGowan Creek Formation. One of these, the Drummond Mine Limestone of Paull and others (1972) is demonstrated to be equivalent to the lower part of the McGowan Creek on the basis of similar conodont faunas. Figure 1 also shows the area where the Devonian part of the Sappington Member of the Three Forks Formation directly underlies the McGowan Creek and, to the west, the area where the Sappington is absent and the underlying Devonian Trident Member of the Three Forks directly underlies the McGowan Creek. Recognition of the paleogeology of the pre–McGowan Creek unconformity provides important information on the direction of sediment transport for the basal beds of the McGowan Creek. These beds contain largely eastern-derived sediments, whereas higher beds of the McGowan Creek contain predominantly western-derived flysch sediments that were shed from the Antler Highlands, which were composed in part of the Milligen Formation.

STRATIGRAPHY

The McGowan Creek Formation is here named for its exposures on the ridge crest south of McGowan Creek on the west side of the Lost River Range in the Doublespring quadrangle, where it was mapped as Milligen Formation by Mapel, Read, and Smith (1965). The following description of the type section of the McGowan Creek Formation is modified from their measured section.

Type section of McGowan Creek Formation

[Section measured by Mapel, Read, and Smith (1965) along ridge crest south of McGowan Creek in N½ sec. 28 and E½ sec. 29, T. 12 N., R. 21 E. (unsurveyed), Custer County, Idaho (Doublespring 15-minute quadrangle). Lithologic descriptions modified by Sandberg on basis of reconnaissance measurements and sampling along crest of next ridge to south in N½ sec. 33 and SE¼ sec. 28]

	Thickness (metres)	Thickness (feet)
Middle Canyon Formation (Upper Mississippian).		
Gradational contact.		
McGowan Creek Formation (Lower Mississippian):		
Upper member:		
Siltstone, calcareous, dark-gray and pale-yellowish-brown, thin-bedded; interbedded with dark-gray silty micritic limestone. Weathers pinkish gray, light gray, and pale yellowish brown	143	470
Gradational contact.		
Lower member:		
Argillite, silty argillite, and siltite, carbonaceous, noncalcareous to slightly calcareous, grayish-black, thin-bedded, containing abundant terrestrial plant stems and debris and U-shaped worm trails. Interbeds, 0.3–15 m (1–50 ft) thick, of medium-gray to medium-dark-gray very fine to fine-grained sandstone and quartzite, in part gritty to finely conglomeratic, throughout sequence, and a few thin interbeds, 0.3 m (1 ft) thick, of dark-gray silty micritic limestone near top. Weathers dark gray, grayish black, and light gray	968	3,175
Total McGowan Creek Formation	1,111	3,645
Unconformity.		
Trident Member of Three Forks Formation (Upper Devonian).		

The lower member of the McGowan Creek Formation consists predominantly of interbedded grayish-black noncalcareous carbonaceous argillite, silty argillite, and siltite containing abundant macerated plant debris, crushed plant stems, as much as 2.5 centimetres (1 inch) wide, and common U-shaped worm trails. At Lower Cedar Creek (fig. 1), these lithologies characterize the basal 3 m (10 ft) of the formation, but the next higher interval, 3–8 m (10–26 ft) above the base, is mostly dark-yellowish-orange limonitic calcareous siltstone and subordinate sandstone that contain broken plates of phosphorite and abundant conodonts (Sandberg and others, 1967). Interbedded with the calcareous siltstone are several thin medium-dark-gray silty encrinite beds that contain silicified ostracodes, horn corals, and brachiopods and lithologically and faunally resemble the basal part of the Lower Mississippian Lodgepole Limestone in southwestern Montana. These encrinite beds also contain abundant conodonts—as many as 10,000/kg—that represent largely an indigenous fauna of the Kinderhookian Lower *Siphonodella crenulata* Zone and partly a reworked fauna of the very late Devonian Upper *Polygnathus styriacus* Zone. The same dark-yellowish-orange siltstone unit, without encrinite interbeds, forms the base of the McGowan Creek at Freighter Spring (fig. 1; Sartenaer and Sandberg, 1974, fig. 2). At Lower Cedar Creek, a slightly higher interval, 10–13 m (33–43 ft) above the base of the formation, comprises deeper water silty micritic limestone containing an indigenous conodont fauna of the Kinderhookian Upper *S. crenulata* Zone. Similar micritic limestone forms the faulted base of the McGowan Creek Formation at Donkey Hills (fig. 1) and a large part of the Drummond Mine Limestone of Paull and others (1972) at Little Copper Creek in the Pioneer Mountains (fig. 1).

In the northern part of the Lost River Range, thin to thick beds of light-gray- to medium-gray-weathering siltstone and fine-grained sandstone and quartzite, some of which are locally conglomeratic, are interbedded throughout the lower part of the McGowan Creek Formation. These interbeds are generally more resistant and form ledges, whereas the carbonaceous argillite and siltite are less resistant and form slopes. The ledge-forming interbeds are interpreted as eastward-thinning turbidite deposits. In the same area, thin interbeds of dark-gray silty micritic limestone are common near the top of the lower member of the McGowan Creek. At Donkey Hills (fig. 1), one of these interbeds yielded an Osagean conodont fauna.

The lower member of the McGowan Creek Formation is present at all ten localities where the formation has been studied in the Lost River and Lemhi Ranges, southern Beaverhead Mountains, and just to the west of the Lost River Range at Grandview Canyon (fig. 1). It also is present at Railroad Canyon (fig. 1) in the northern Beaverhead Mountains (Ruppel, 1968) and at Lake Canyon (fig. 1) in the adjacent part of the Tendoy Range (M'Gonigle, 1965). At Chamberlain Creek, Long Canyon, and

Middle Canyon (fig. 1), the lower member of the McGowan Creek is less than 84 m (275 ft) thick and includes a basal limestone bed as much as 55 m (180 ft) thick. In the southern part of the Lost River Range (fig. 1), the lower member thickens northward from about 60 m (197 ft) at Hurst Canyon to 104 m (341 ft) at Hawley Mountain and westward to about 150 m (492 ft) at Lower Cedar Creek. Northwest of Lower Cedar Creek, the lower member forms a clastic wedge that thickens abruptly westward toward the axis of the depositional basin and attains a maximum thickness of about 1,000 m (3,280 ft) in the area between McGowan Creek and Grandview Canyon (fig. 1).

The McGowan Creek Formation rests unconformably on the Three Forks Formation, which is solely of Late Devonian (Famennian) age in the area where it is overlain by the McGowan Creek (fig. 1). The type Three Forks Formation at Logan, in southwestern Montana, consists, in ascending order, of the Upper Devonian Logan Gulch and Trident Members and the Upper Devonian and Lower Mississippian Sappington Member (Sandberg, 1965; Sandberg and Klapper, 1967). Westward from Logan, however, the Sappington is truncated beneath the Lodgepole Limestone so that only basal unit 1 of the Sappington, which is of very late Devonian (late Famennian) age, is preserved in Idaho (Sandberg and others, 1972, fig. 2). The McGowan Creek rests unconformably on unit 1 of the Sappington in the southern Lemhi Range and southern Beaverhead Mountains (fig. 1). In this area, unit 1 consists mainly of grayish-black chertified and silicified siltstone, as much as 23 m (75 ft) thick, and resembles the lower member of the McGowan Creek. Unit 1 had been misidentified as Milligen Formation (McGowan Creek Formation of this report) at Long Canyon (fig. 1) by Mapel and Sandberg (1968). Unit 1 of the Sappington, however, contains a basal lag sandstone and interbedded large limestone concretions, such as that illustrated as a pod of dolomite in the Milligen Formation by Mapel and Sandberg (1968, fig. 6). Both the lag sandstone and concretions at Long Canyon yielded indigenous conodont faunas of the very late Devonian Upper *Polygnathus styriacus* Zone.

In the area where the Sappington Member has been eroded, mainly in the Lost River Range (fig. 1), the McGowan Creek Formation rests unconformably on the underlying Trident Member of the Three Forks Formation (Sandberg and others, 1967). The unconformable contact is well exposed at Lower Cedar Creek and Freighter Spring (Sartenaer and Sandberg, 1974, fig. 2). Evidence of the truncation and reworking of the Sappington and of the eastern source of sediments in the basal beds of the McGowan Creek is provided by the reworked conodonts of the Upper *Polygnathus styriacus* Zone found in these basal beds at Lower Cedar Creek. There, in the interval 3–8 m (10–26 ft) above the base of the McGowan Creek, conodonts reworked from the Sappington comprise 30–42 percent of the total counted conodont fauna. That the eastern source of sediments abruptly diminished is demonstrated by the fact that

at 13 m (43 ft) above the base of the McGowan Creek at the same locality, conodonts reworked from the Sappington comprise only 0.6 percent of the total counted conodont fauna.

The member of the Three Forks Formation that underlies the isolated patch of McGowan Creek Formation in the northern Beaverhead Mountains and northern Tendoy Range (fig. 1) has not been positively identified because of poor exposures and faulting. At Railroad Canyon, which the author has not visited, Ruppel (1968) did not differentiate the Milligen (McGowan Creek of this report) and Three Forks Formations. At Lake Canyon (fig. 1), the highest identified member of the Three Forks is the Logan Gulch, which is separated from the McGowan Creek by a bedding-plane thrust and fault breccia containing fragments of chertified and silicified grayish-black siltstone that probably were derived from unit 1 of the Sappington Member. The intervening Trident Member in this area apparently had been removed by erosion prior to Sappington deposition on the ancestral Southern Beaverhead Mountains uplift (Sandberg and others, 1972, fig. 2; Sandberg and others, 1975).

The upper member of the McGowan Creek Formation consists mainly of dark-gray and pale-yellowish-brown calcareous siltstone interbedded with subordinate silty micritic limestone. It is distinguished from the lower member by having a characteristic pinkish-gray weathering color, a slightly higher carbonate content, and a lower organic-carbon content. The contact between the two members is gradational, however, even where they are well exposed, as in the type section and on the two ridges to the south of the type section. Mamet and others (1971, p. 22) suggested the existence of a hiatus between the lower and upper members of the Milligen Formation (McGowan Creek of this report) but stated that there was no supporting physical evidence. The two members were mapped separately, mainly on the basis of different colored float, in the Doublespring quadrangle (Mapel and others, 1965), but they were mapped together in the Hawley Mountain quadrangle (Mapel and Shropshire, 1973). The upper member has been recognized only near Hawley Mountain and to the north and west of Hawley Mountain, in the area where the McGowan Creek is thickest. The upper member ranges in thickness from about 60 m (197 ft) to 150 m (492 ft). Its upper contact with the Middle Canyon Formation of Late Mississippian (Meramecian) age is gradational in the type section of the McGowan Creek Formation (Mapel and others, 1965). There and elsewhere in the Lost River Range, the upper member of the McGowan Creek is regarded as transitional lithologically and depositionally between the lower member and the Middle Canyon Formation. East of the Lost River Range, where the upper member is absent, the contact between the lower member of the McGowan Creek and the Middle Canyon is sharp and may represent an unconformity. The abrupt lithologic change across this contact at Middle Canyon in the Lemhi Range (fig. 1) is shown graphically by Huh (1967, fig. 5).

AGE

The McGowan Creek Formation is dated as Early Mississippian primarily on the basis of conodont collections from thin limestones at the base and top of the lower member. The ages range from middle Kinderhookian at the base to early Osagean at the top. The exact position of the Kinderhookian-Osagean boundary within the lower member is not known, however, because of the scarcity of limestone interbeds that yield datable conodont faunas in the thick sequence of argillite. Representative conodont faunas from three Kinderhookian zones near the base of the lower member of the McGowan Creek at Lower Cedar Creek (collections LCD-16, 19, and 22) and at Donkey Hills (collection DH-16) and from a horizon high in the equivalent Drummond Mine Limestone of Paull and others (1972) at Little Copper Creek (collection LCO-1) in the Pioneer Mountains (fig. 1) are listed in table 1.

The locality of the three collections from Lower Cedar Creek is at an altitude of 7,920 feet in the NE¼SW¼ sec. 2 (unsurveyed), T. 7 N., R. 24 E., Custer County, in the Mackay 15-minute quadrangle. The Lower Cedar

TABLE 1.—*Representative Kinderhookian conodont faunas from McGowan Creek Formation and Drummond Mine Limestone of Paull and others (LCO-1 only)*

	Lower *Siphonodella crenulata* Zone		Upper *Siphonodella crenulata* Zone	*Siphonodella isosticha–S. cooperi* Zone	
Collection no.	LCD-16	LCD-19	LCD-22	DH-16	LCO-1
Metres above base of formation	4	7	13	20±	700±
Number of identified conodont specimens					
Bispathodus stabilis	12	21	....	4	4
Dinodus fragosus	....	1	....	1	....
leptus	....	1	....	....	....
Elictognathus bialatus	....	2	....	....	....
laceratus	1	10	32	9	5
Falcodus angulus	1	5	....	3	....
Gnathodus delicatus	....	....	268	37	8
punctatus	....	....	39	2	1
Polygnathus communis communis	6	16	22	7	27
inornatus	11	10	6	....	2
longiposticus	12	8	....	2	....
Pseudopolygnathus dentilineatus	1	....	....	....	....
marginatus	2	5	....	....	....
multistriatus	....	....	....	....	2
triangulus triangulus	20	4	....	....	....
vogesi	4	....	....	....	....
Siphonodella cooperi	3	5	....	....	....
crenulata	8	12	4	....	....
isosticha	....	....	297	36	62
cf. *S. isosticha*	4	12	....	....	....
lobata	1	....	1	....	....
obsoleta	7	7	18	8	....
quadruplicata	19	39	...	....	....
sandbergi	2	1	....	....	....
Total indigenous specimens	114	159	687	109	111
Specimens reworked from Upper *Polygnathus styriacus* Zone	50	114	4	....	....

Creek locality was illustrated by Sandberg, Mapel, and Huddle (1967, fig. 2), who gave directions for reaching it. The locality of collection DH-16 from the Donkey Hills is at an altitude of 7,200 feet on a small spur on the north side of Dry Creek in the SE¼NW¼ sec. 16, T. 10 N., R. 25 E., Custer County, in the Hawley Mountain 15-minute quadrangle. The locality of collection LCO-1 from the Drummond Mine Limestone of Paull and others (1972) is on the ridge crest between North and South Forks of Little Copper Creek at an altitude of 9,750 feet in the SE¼SE¼SE¼ sec. 23, T. 4 N., R. 21 E., Blaine County, in the Muldoon Canyon 15-minute quadrangle. It is believed to come from approximately the 5,536-foot level in the graphic section of Paull and others (1972, fig. 8), which was measured about 1.6 km (1 mi) to the north.

The faunas from the lower 20 m (66 ft) of the McGowan Creek Formation provide a succession of three Kinderhookian conodont zones—the Lower *Siphonodella crenulata*, Upper *S. crenulata*, and *S. isosticha–S. cooperi* Zones (table 1). The faunas from the Lower *S. crenulata* Zone (collections LCD-16, 19), which represent approximately middle Kinderhookian time, are identical to faunas reported from the same zone at the base of the Lodgepole Limestone in Montana (Sandberg and Klapper, 1967, table 3).

The succeeding Upper *Siphonodella crenulata* Zone, which apparently represents a short time span, is defined primarily by the overlap of the upper part of the range of *S. crenulata* with the lower part of the range of *Gnathodus delicatus*. The only other North American locality from which the Upper *S. crenulata* Zone has been reported to date is Crowsnest Pass, Alberta, in the lower part of the Mississippian Banff Formation (Macqueen and Sandberg, 1970, p. 51, 54). *S. crenulata* is apparently a relatively deepwater species that is rarely found in the Upper Mississippi Valley area. There, the short time span of the Lower *S. crenulata* Zone probably is included in the lower part of the *S. isosticha–S. cooperi* Zone.

The highest Kinderhookian zone—the *Siphonodella isosticha–S. cooperi* Zone—represents a long time span in North America. It extends from above the last occurrence of *S. crenulata* to the highest range of *S. isosticha* at the top of the Kinderhookian. In east-central and central Idaho, the *S. isosticha–S. cooperi* Zone is characterized by the occurrence of *S. isosticha* and *S. obsoleta* as the only siphonodellids, with *Gnathodus delicatus* and *G. punctatus*.

The *Siphonodella isosticha–S. cooperi* Zone is recognized in the Copper Basin Formation and in the upper part of the Drummond Mine Limestone of Paull and others (1972) at Little Copper Creek (table 1, collection LCO-1). It also has been found in the upper part of the Drummond Mine at a nearby locality and in the lower and middle parts of the Drummond Mine at Fish Creek Reservoir (fig. 1) and five other localities in the Pioneer Mountains. Thus the *S. isosticha–S. cooperi* Zone apparently encompasses the entire Drummond Mine Limestone and is repre-

sented by at least 800 m (2,624 ft) of flysch sediments in the Pioneer Mountains.

The *Siphonodella isosticha–S. cooperi* Zone has been recognized in the McGowan Creek Formation as low as 20± m (66± ft) above the base at Donkey Hills (table 1, collection DH-16). In consideration of the large thickness of rocks representing this zone in the Pioneer Mountains, the zone may encompass at least two-thirds of the thick lower member of the McGowan Creek in the northern Lost River Range.

The only post-Kinderhookian conodont fauna from the lower member of the McGowan Creek Formation is in collection DH-126-9a, obtained from a sample collected by W. J. Mapel, from a limestone bed in the top 2 m (6 ft) of the lower member at the same locality as collection DH-16 in the Donkey Hills. Although many conodonts are silt coated, broken, and poorly preserved, the collection includes recognizable fragments of the form-species *Hindeodella segaformis*. In the Northern Rocky Mountains region, *H. segaformis* has its lowest occurrence in an early Osagean fauna from the lower part of the Lower and Upper Mississippian Brazer Dolomite in the Crawford Mountains, northern Utah. Thus the top of the lower member of the McGowan Creek is at least as young as early Osagean.

The upper member of the McGowan Creek Formation is presumed to be entirely of Osagean age mostly on the basis of its gradational contact and hence presumed continuous deposition with the lower member, which contains Osagean conodonts at the top. This presumption is strengthened by a single conodont collection, DH-126a-4, obtained from a sample collected by W. J. Mapel, from 28 m (92 ft) above the base of the upper member in the Donkey Hills, near the locality of collection DH-16. The fauna of collection DH-126a-4, although most of the conodonts are poorly preserved and heavily silt coated, includes *Polygnathus communis communis*. The presence of this subspecies is a certain indication of an Osagean age, as the subspecies does not range as high as the top of the Osagean.

The age of the Middle Canyon Formation, which overlies the McGowan Creek Formation, is clearly Meramecian on the basis of foraminifers reported by Mamet and others (1971, p. 24–25) and a conodont collection obtained from a sample collected by W. J. Mapel, from 1.5–2 m (5–7 ft) above the base in the Donkey Hills. This collection, DH-240-5, contains an association of *Cavusgnathus* sp. with *Gnathodus texanus*. This association has its lowest occurrence in the upper part of the Meramecian St. Louis Limestone in the Upper Mississippi Valley area.

CORRELATION

The McGowan Creek Formation is correlative on the basis of conodont faunas to all of the Lodgepole Limestone and the lower part of the Mission Canyon Limestone in southwestern Montana. Gradational and intertonguing relations between the McGowan Creek and Lodgepole

have been observed in the Beaverhead Mountains (Sandberg and others, 1967, p. C130; Ruppel, 1968). The McGowan Creek is correlative to the lower part of the Copper Basin Formation in the Pioneer Mountains. It is equated on the basis of conodont faunas to all of the Drummond Mine Limestone of Paull and others (1972) and may be partly equivalent to their overlying nonfossiliferous Scorpion Mountain Formation. The deeper water silty micritic limestone that yielded conodont collections LCD-22 and DH-16 at Lower Cedar Creek and Donkey Hills had a western source, judging by the greatly diminished content (0–0.6 percent) of eastern-derived reworked Devonian conodonts (table 1). This limestone probably represents an eastward-thinning tongue of the Drummond Mine Limestone that extends into the lower member of the McGowan Creek Formation.

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