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CAMBRIAN
GEOLOGY AND PALEONTOLOGY

No. 1.—NOMENCLATURE OF SOME CAMBRIAN
CORDILLERAN FORMATIONS

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CAMBRIAN GEOLOGY AND PALEONTOLOGY

NO. I.—NOMENCLATURE OF SOME CAMBRIAN CORDILLERAN FORMATIONS

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In connection with the preparation of the section on the stratigraphic distribution of the Cambrian Brachiopoda for Monograph LI, of the U. S. Geological Survey, I find that it is necessary to refer to many undefined Cambrian formations of the Cordilleran area. The present paper is published for the information of geologists and for the purpose of properly defining and characterizing the formations in question, as the first reference to these formations should be accompanied by more information than can well be included in the pages of the monograph.

CANADIAN ROCKY MOUNTAINS

Since reading, in 1886, Mr. R. G. McConnell's report of 1885 on his section across the Rocky Mountains in the vicinity of the 51st parallel,¹ I have had a strong desire to study the stratigraphy of the Cambrian portion of the section. It was not until the summer of 1907 that the opportunity came. Accompanied by Mr. Lancaster D. Burling as field assistant, a study was made of the typical Castle Mountain section of Mr. McConnell, the lower portion of the Mt. Stephen and Mt. Whyte sections, and the full section of Mt. Bosworth, on the Continental Divide, which proved to be the most complete.

Except where otherwise stated, the sections were carefully measured with rod and clinometer. The strata were so well exposed that it was rarely necessary to go any distance to avoid talus slopes and covered portions of the section. Collections of fossils were made at many horizons, but, owing to the limited time available, this part of the work was neither systematic nor exhaustive.

LOCATION.—The area examined is on the line of the Canadian Pacific Railway between the Sawback Range on the east and the Van Horn Range on the west. In this limited area there was only time for the examination and measurement of the strata of Castle Mountain and Mt. Bosworth, the lower 3,800 feet of the Mt. Stephen section, and the Lower Cambrian formations on the slopes of Mts. Whyte and St. Piran, in the vicinity of Lakes Louise and Agnes.

¹ Geol. and Nat. Hist. Survey of Canada, Ann. Rept., 1886, Part D, pp. 15D-30D, 1887.

FUTURE WORK.—It is desirable that the Lower Cambrian strata of Fairview and Saddle Mountains near Laggan should be studied carefully; also that the area northwest of Mt. Bosworth and west of Mt. Daly should be examined for Upper Cambrian and Lower Ordovician formations and fossils. Exhaustive collections should also be made at many stratigraphic horizons.

NOMENCLATURE.—Mr. McConnell proposed the name "Castle Mountain Group" for the great series of limestones and shales between the quartzitic sandstones and siliceous shales of the "Bow River Group" below and the superjacent Ordovician graptolitic shales on the west and Banff limestone on the east. This includes the upper portion of the Lower Cambrian fauna at the base and the lower portion of the Ordovician fauna at the summit. The term "Castle Mountain" is useful for the series, but I think that local names can be applied with advantage to several of the formations of the "Castle Mountain Group" as originally defined. The following table gives the relative positions and thicknesses of the new formation names herein proposed and defined for the Canadian Rocky Mountain section:

	Thickness (in feet).		
	Mt. Stephen.	Mt. Bosworth.	Castle Mt.
<i>Upper Cambrian:</i>			
Sherbrooke formation....	0	1,360	0
Paget formation.....	0	360	0
Bosworth formation.....	Not measured	1,855	0
<i>Middle Cambrian:</i>			
Eldon formation.....	Not measured	2,733	2,195
Stephen formation.....	562	640	366
Cathedral formation....	1,600-1,800	1,595	987
Mt. Whyte formation....	315	390	248
<i>Lower Cambrian:</i>			
St. Piran formation.....	300 +	300 +	500 +
Lake Louise formation..
Fairview formation.....

SHERBROOKE FORMATION

TYPE LOCALITY.—Western slopes of Mt. Bosworth, overlooking Sherbrooke Lake, Canadian Rocky Mountains, five miles north of Hector, on the Canadian Pacific Railway, British Columbia.

DERIVATION.—From Sherbrooke Lake, below the typical locality.

CHARACTER.—Bluish gray, arenaceous, dolomitic, massive, and thin-bedded to shaly limestones, with a few oolitic layers and cherty inclusions.

THICKNESS.—At Mt. Bosworth, 1,360 feet.

ORGANIC REMAINS.—Upper Cambrian, passing at summit into Ordovician.

PAGET FORMATION

TYPE LOCALITY.—Southeastern slope of Paget Peak, beneath the Sherbrooke formation, which forms the high cliffs of Paget Peak and Mt. Daly. The Paget formation breaks down more readily than the Sherbrooke, presenting a slightly broken cliff line. The most accessible locality found is on the east face of the west ridge of Mt. Bosworth (Sherbrooke ridge).

DERIVATION.—From Paget Peak, the type locality.

CHARACTER.—Bluish gray and oolitic limestones, usually thin bedded.

THICKNESS.—At Mt. Bosworth, 360 feet.

ORGANIC REMAINS.—Upper Cambrian fauna.

BOSWORTH FORMATION

TYPE LOCALITY.—Ridge extending northwest from Mt. Bosworth, and southeast base of Paget Peak and Mt. Daly.

DERIVATION.—From Mt. Bosworth, the type locality.

CHARACTER.—Arenaceous, dolomitic limestones, massive, thin bedded, and shaly, with bands of purple and gray siliceous shales.

THICKNESS.—At Mt. Bosworth, 1,855 feet.

ORGANIC REMAINS.—None observed; formation referred to Upper Cambrian.

ELDON FORMATION

TYPE LOCALITY.—Upper massive limestones of Castle Mountain, Canadian Rocky Mountains, Province of Alberta, one to two miles north of Eldon Switch, on the Canadian Pacific Railway.

DERIVATION.—From Eldon, opposite the type locality.

CHARACTER.—Massive, arenaceous, dolomitic limestones, with a few bands of purer bluish gray limestone.

THICKNESS.—In Mt. Bosworth section, 2,733 feet; at Castle Mountain, 2,195 feet.

ORGANIC REMAINS.—Middle Cambrian.

STEPHEN FORMATION

TYPE LOCALITY.—Bluish gray and greenish gray limestone and shale band about 2,700 feet up above railroad track on the north and east sides of Mt. Stephen, Canadian Rocky Mountains, British Columbia, above Field, on the Canadian Pacific Railway.

DERIVATION.—From Mt. Stephen, the type locality.

CHARACTER.—Limestones and shales, calcareous and siliceous.

THICKNESS.—In Mt. Bosworth section, 640 feet; on Mt. Stephen, 562 feet, with 150 feet of local development of Ogygopsis shales at the summit.

ORGANIC REMAINS.—Middle Cambrian: Ogygopsis fauna of Mt. Stephen and fauna below in the thin-bedded, dark bluish gray limestone.

CATHEDRAL FORMATION

TYPE LOCALITY.—Cathedral Mountain and Cathedral Crags, east of Mt. Stephen and southeast of Mt. Bosworth.

DERIVATION.—From Cathedral Mountain, the type locality.

CHARACTER.—Massive arenaceous and dolomitic limestone.

THICKNESS.—In Mt. Bosworth section, 1,595 feet; in Castle Mountain, 987 feet; in Cathedral Mountain and Mt. Stephen, 1,600-1,800 feet.

ORGANIC REMAINS.—Middle Cambrian.

MT. WHYTE FORMATION

TYPE LOCALITY.—Mt. Whyte, above Lake Agnes, and eastern slope of Popes Peak, southwest of Mt. St. Piran.

DERIVATION.—From Mt. Whyte, the type locality.

CHARACTER.—Alternating bands of limestone and siliceous and calcareous shale.

THICKNESS.—North slope of Mt. Whyte, 386 feet; south slope of Mt. Bosworth, 390 feet; Mt. Stephen, above railroad tunnel, 315 feet; southeast slope of Castle Mountain, 248 feet.

ORGANIC REMAINS.—Lower Cambrian.

BOW RIVER GROUP

This name was proposed by Dr. George M. Dawson for the great series of arenaceous and siliceous strata beneath the Castle Mountain group of McConnell. This series will ultimately be divided into several formations. At present the upper portion may be separated into three formations in the vicinity of Lake Louise.

ST. PIRAN FORMATION

TYPE LOCALITY.—Southeast slope of Mt. St. Piran. The basins of Lakes Agnes and Mirror are both excavated in this formation.

DERIVATION.—From Mt. St. Piran, the type locality.

CHARACTER.—Mainly gray, quartzitic sandstones, with a few bands of siliceous shale.

THICKNESS.—At Mt. St. Piran, 2,640 feet.

ORGANIC REMAINS.—Lower Cambrian in the upper portion.

LAKE LOUISE FORMATION

TYPE LOCALITY.—On both sides of Lake Louise, at its upper end; well shown on the northwest and north sides of Fairview Mountain.

DERIVATION.—From Lake Louise, the type locality.

CHARACTER.—Siliceous shales.

THICKNESS.—At upper end of Lake Louise, 105 feet.

ORGANIC REMAINS.—Lower Cambrian.

FAIRVIEW FORMATION

TYPE LOCALITY.—Northeast slope of Fairview Mountain.

DERIVATION.—From Fairview Mountain, the type locality.

CHARACTER.—Gray, quartzitic sandstones.

THICKNESS.—On east slope of Fairview Mountain, 1,000 + feet.

ORGANIC REMAINS.—Unknown. No attempt was made to find fossils in this formation.

NORTHEASTERN UTAH AND SOUTHERN IDAHO

The section in Blacksmith Fork Canyon was first measured by Mr. F. B. Weeks, assisted by Mr. L. D. Burling, in a general reconnaissance of the northeastern and central parts of Utah made in 1905. In 1906 I established a permanent camp in the canyon and, assisted by Mr. L. D. Burling, spent nearly two months in detailed work upon the section and its faunas.

Near the close of the summer, camp was moved to Mill Canyon, in the Bear River Range, about 5 miles west of Liberty, Bear Lake County, Idaho, where Mr. R. S. Spence, of Evanston, Wyoming, had discovered a remarkable deposit of lower Middle Cambrian fossils. The section at this point was measured and found to agree quite closely with that in Blacksmith Fork; and the shale, which contained the rich fauna discovered by Mr. Spence, was called the Spence Shale horizon of the Ute formation from Spence Gulch, in which it has its great local development.

The following table gives a summary of the new formations defined, together with their thicknesses in each of the sections:

	Thickness (in feet).	
	Blacksmith Fork.	West of Liberty.
<i>Upper Cambrian:</i>		
St. Charles formation	1,225	1,197
<i>Middle Cambrian:</i>		
Nounan formation	1,041	814
Bloomington formation	1,320	1,162
Blacksmith formation	570	23
Ute formation	759	731
Spence shale	30	30
Langston formation	107	30
Brigham formation	1,250+	1,000+
	6,662	4,997

ST. CHARLES FORMATION

TYPE LOCALITY.—Bear River Range, west of the town of St. Charles, in the Bear Lake Valley, Bear Lake County, Idaho. The most accessible locality is in Blacksmith Fork Canyon, east of Hyrum, Cache County, Utah.

DERIVATION.—From the town of St. Charles, near the typical locality. The stream flowing through St. Charles passes over the formation.

CHARACTER.—Bluish gray to gray, arenaceous limestones, with some cherty and concretionary layers, passing at the base into thin-bedded gray to brown sandstones.

THICKNESS.—In Blacksmith Fork Canyon, 1,225 feet; in the section west of Liberty, 1,197 feet.

ORGANIC REMAINS.—Upper Cambrian, passing at the summit into Ordovician.

NOUNAN FORMATION

TYPE LOCALITY.—Bear River Range, east slope of Soda Peak, west of the town of Nounan, in the Bear Lake Valley, Bear Lake County, Idaho. The most accessible locality is in Blacksmith Fork Canyon, east of Hyrum, Cache County, Utah.

DERIVATION.—From the town of Nounan, near the typical locality, Nounan Creek Canyon cuts through the formation.

CHARACTER.—Limestones. Light gray to dark lead-colored, arenaceous limestones.

THICKNESS.—In Blacksmith Fork Canyon, 1,041 feet; in the section west of Liberty, 814 feet.

ORGANIC REMAINS.—A few traces of Middle Cambrian fossils in the lower part and numerous annelid borings throughout.

BLOOMINGTON FORMATION

TYPE LOCALITY.—Bear River Range, about 6 miles west of the town of Bloomington, Bear Lake County, Idaho. A second easily accessible locality is in Blacksmith Fork Canyon, east of Hyrum, Cache County, Utah.

DERIVATION.—From Bloomington Creek, which is near the type locality, and passes through the formation.

CHARACTER.—Bluish gray, more or less thin-bedded limestones and argillaceous shales. Small rounded nodules of calcite occur scattered irregularly through many of the layers of limestone.

THICKNESS.—In Blacksmith Fork Canyon, 1,320 feet; in the section west of Liberty, 1,162 feet.

ORGANIC REMAINS.—Abundant Middle Cambrian fossils.

BLACKSMITH FORMATION

TYPE LOCALITY.—In Blacksmith Fork Canyon, about 8 miles above its mouth and 15 miles east of Hyrum, Cache County, Utah.

DERIVATION.—From Blacksmith Fork, the type locality.

CHARACTER.—Gray arenaceous limestone in massive layers.

THICKNESS.—In Blacksmith Fork, 570 feet; in the section west of Liberty, 23 feet.

ORGANIC REMAINS.—Large, irregular annelid borings. Middle Cambrian age shown by position in section.

UTE FORMATION

TYPE LOCALITY.—Slopes of Ute Peak, near the forks of East Fork, east of Paradise, Cache County, Utah. This formation was given the name Ute limestone by the Fortieth Parallel Survey, but aside from the fact that it was stated to overlie the Cambrian quartzites and to be composed of 2,000 feet of limestones containing Cambrian fossils, it was not defined or limited. The beds here referred to the Ute formation contain the fossils mentioned by the Fortieth Parallel Survey as characterizing the lower portion of the Ute limestone. The formation is very easily accessible in Blacksmith Fork Canyon.

DERIVATION.—From Ute Peak, the type locality.

CHARACTER.—Blue to bluish gray, thin-bedded, fine-grained limestones and shales, with some oolitic, concretionary, and intraformational conglomerate layers.

THICKNESS.—In Blacksmith Fork, 759 feet; in the section west of Liberty, 731 feet.

ORGANIC REMAINS.—Abundant Middle Cambrian fossils.

SPENCE SHALE

TYPE LOCALITY.—Spence Gulch, a ravine running up into Danish Flat from Mill Canyon, about 5 miles west-southwest of Liberty, Bear Lake County, Idaho. This shale occurs at the base of the Ute formation.

DERIVATION.—From Spence Gulch, the type locality.

CHARACTER.—Argillaceous shales.

THICKNESS.—In the section west of Liberty, 30 feet; in Blacksmith Fork, 30 feet.

ORGANIC REMAINS.—An extremely abundant and varied lower Middle Cambrian fauna.

LANGSTON FORMATION

TYPE LOCALITY.—The most readily accessible locality for this formation is in Blacksmith Fork, but the strike of the beds (as shown on the eastern half of Map 3 of the Fortieth Parallel Survey) carries the formation into the valley of Langston Creek, and the formation is given that name.

DERIVATION.—From Langston Creek.

CHARACTER.—Massive bedded, bluish gray limestone with many round concretions.

THICKNESS.—In Blacksmith Fork, 107 feet; in the section west of Liberty, 30 feet.

ORGANIC REMAINS.—Lower Middle Cambrian fauna.

BRIGHAM FORMATION

TYPE LOCALITY.—West front of the Wasatch Range, northeast of Brigham, Box Elder County, Utah.

DERIVATION.—From Brigham, near the type locality.

CHARACTER.—Massive quartzitic sandstones.

THICKNESS.—At Brigham, 2,000+ feet; in Blacksmith Fork, 1,250 feet; and in the section west of Liberty, Idaho, 1,000+ feet.

The Brigham formation is the overlapping shore deposit of Middle Cambrian time along what is now the Wasatch Range. To the northwest, in the Belt Mountain region of Montana, the upper part

of the same relative horizon is called the Flathead sandstone. As the strata are followed to the northwest, the sandy beds occupy a lower stratigraphic horizon until on Gordon Mountain, at the head of the South Fork of the Flathead River, in Montana, the sandstones are of lower Middle Cambrian age. The Brigham formation should not be confused with the much older Prospect Mountain "quartzite" formation of central Nevada, which is of Lower Cambrian age.

ORGANIC REMAINS.—Annelid trails and trilobite tracks. Characteristic Middle Cambrian fossils were found in the upper portion of this formation west of Liberty, Bear Lake County, Idaho.

HOUSE RANGE, UTAH

The section exposed in the House Range was first studied by Dr. G. K. Gilbert, who made small collections of fossils from various horizons. These collections were so interesting that I visited the range in 1903. In 1905 I revisited the range, in company with Messrs. F. B. Weeks and L. D. Burling, measured the entire section carefully, and made further large collections of fossils. The section extends from well down in the Lower Cambrian to the base of the Ordovician, and is the best and most complete of the Basin Range sections so far studied. A map will be published with the detailed sections, giving the geographic localities referred to in the nomenclature of the formations of the House Range section.

The following table gives the relative positions and the thickness of the various formations defined in the following pages:

<i>Upper Cambrian:</i>	Feet
Notch Peak formation.....	1,890
Orr formation.....	1,825
<i>Middle Cambrian:</i>	
Weeks formation	1,390
Marjum formation	1,092
Wheeler formation	570
Swasey formation	238
Dome formation	355
Howell formation	640
<i>Lower Cambrian:</i>	
Pioche formation	125
Prospect Mountain formation.....	1,200+

NOTCH PEAK FORMATION

TYPE LOCALITY.—Upper portion of the main mass of Notch Peak, House Range, Utah.

DERIVATION.—From Notch Peak, the type locality.

CHARACTER.—Gray, arenaceous limestone in more or less massive layers.

THICKNESS.—1,890 feet.

ORGANIC REMAINS.—Upper Cambrian fossils occur in the lower portion, and the formation extends in its upper portion to the Lower Ordovician.

ORR FORMATION

TYPE LOCALITY.—Orr Ridge, a spur extending eastward from the main mass of Notch Peak, on the south side of Weeks Canyon, House Range, Utah.

DERIVATION.—From Orr Ridge, the type locality.

CHARACTER.—Gray, slightly arenaceous limestones and shales.

THICKNESS.—1,825 feet.

ORGANIC REMAINS.—Upper Cambrian fossils; in its lower part the formation extends to the shales of the Weeks formation, which carry Middle Cambrian fossils.

WEEKS FORMATION

TYPE LOCALITY.—North side of Weeks Canyon, north of Orr Ridge, House Range, Utah.

DERIVATION.—From Weeks Canyon, the type locality.

CHARACTER.—Thin-bedded shaly limestones, with a few bands of oolitic and arenaceous limestones.

THICKNESS.—1,390 feet.

ORGANIC REMAINS.—Middle Cambrian fauna.

MARJUM FORMATION

TYPE LOCALITY.—Cliffs on the south side of Marjum Pass, House Range, Utah.

DERIVATION.—From Marjum Pass, the type locality.

CHARACTER.—Gray to dark, more or less thin-bedded, arenaceous limestone.

THICKNESS.—1,092 feet.

ORGANIC REMAINS.—Middle Cambrian fauna.

WHEELER FORMATION

TYPE LOCALITY.—Center of Wheeler Amphitheater, southeast of Antelope Springs, House Range, Utah.

DERIVATION.—From Wheeler Amphitheater, the type locality.

CHARACTER.—Alternating bands of thin shaly limestone and calcareous shale.

THICKNESS.—570 feet.

ORGANIC REMAINS.—Middle Cambrian fauna.

SWASEY FORMATION

TYPE LOCALITY.—Slopes of Swasey Peak, House Range, Utah.

DERIVATION.—From Swasey Peak, the type locality.

CHARACTER.—Bluish gray, oolitic, and arenaceous limestone, with some calcareous and argillaceous shales.

THICKNESS.—238 feet.

ORGANIC REMAINS.—Middle Cambrian fauna.

DOMES FORMATION

TYPE LOCALITY.—At the head of Domes Canyon, House Range, Utah.

DERIVATION.—From Domes Canyon, the type locality.

CHARACTER.—Massive bedded, gray siliceous limestone.

THICKNESS.—355 feet.

ORGANIC REMAINS.—No traces of fossils, but referred to the Middle Cambrian because both overlaid and underlaid by rocks containing a Middle Cambrian fauna.

HOWELL FORMATION

TYPE LOCALITY.—In slopes of Howell Peak, on the west side of the House Range, about 5 miles west of Antelope Springs, House Range, Utah.

DERIVATION.—From Howell Peak, the type locality.

CHARACTER.—Dark, more or less massive limestone and pinkish argillaceous shales.

THICKNESS.—640 feet.

ORGANIC REMAINS.—Middle Cambrian fauna.

PIOCHE FORMATION

TYPE LOCALITY.—Southeast of the town of Pioche, Nevada, on road to Panaca, Utah.

DERIVATION.—From Pioche, the type locality.

CHARACTER.—Arenaceous and argillaceous shaly layers with some thin layers and bands of limestone more or less irregularly interbedded and limited in horizontal distribution.

THICKNESS.—At Pioche, Nevada, 210 feet. On the west face of the Highland Range, 18 miles west of Pioche, this formation

is 170 feet thick. In the Eureka District of Nevada, 135 miles northwest of Pioche, this formation lies between the Prospect Mountain quartzitic sandstone and the great limestone series and is about 200 feet in thickness. In the House Range section, 105 miles north-northeast of Pioche, the formation is 125 feet thick. In the Big Cottonwood section of the Wasatch range, about 125 miles northeast of the House Range, near the old shore line, the Pioche formation is represented by the lower portion of the arenaceous shales which are here 250 feet in thickness. The Pioche formation horizon is next met with to the north where the line of the Canadian Pacific railroad crosses the Continental Divide. At this place the formation is called the Mount Whyte formation.

ORGANIC REMAINS.—At all the localities mentioned except that of the House Range, where no fossils except annelid borings and trails have been found, the Lower Cambrian *Olenellus* fauna occurs.

PROSPECT MOUNTAIN FORMATION¹

TYPE LOCALITY.—Prospect Peak, Eureka District, Nevada.

DERIVATION.—From Prospect Peak, the type locality.

CHARACTER.—Gray to brown quartzitic sandstones.

THICKNESS.—At Prospect Peak, 1,500 feet. Estimated 1,200 feet on the western face of the House Range, Millard County, Utah, in the vicinity of Dome and Sinbad Canyons.

ORGANIC REMAINS.—Annelid trails and trilobite tracks. Lower Cambrian in age.

¹This formation was first named by Mr. Arnold Hague in 1882, in the Second Ann. Rept. U. S. Geol. Survey, p. 27, and defined in 1883, in the Third Ann. Rept. U. S. Geol. Survey, p. 254.