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IV

No. 8.—NOMENCLATURE OF SOME POST CAMBRIAN AND CAMBRIAN CORDILLERAN FORMATIONS (2)

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CONTENTS

NOMENCLATURE

A number of new names have been given to sedimentary formations in connection with the study of sections of pre-Devonian formations in the Canadian Cordilleran trough of Alberta and British Columbia. One of these occurs in the Robson Peak district and others in the area about the headwaters of the Saskatchewan River, Alberta and elsewhere in the Cordillera of western America.

ROBSON PEAK DISTRICT

In my brief paper on the Cambrian formations of the Robson Peak District[1] the upper 3000 feet (914.4 m.) of the section in the Robson Peak massif was included under the Ordovician system in the Robson formation. There was not much opportunity to get at this portion of this section on Robson Peak and no detailed section of the formation was made or fossils systematically collected from it except near its base at Billings Butte.[2] During the field work of the past four years a formation has been delimited between the Upper Cambrian Lyell formation and the Ordovician Sarbach formation that was found to be characterized by a fauna, one zone of which could be compared with the fauna of the lower portion of the Robson formation. This led to a review that resulted in the decision to arbitrarily delimit the lower porton of the Robson formation as a distinct formation and name it the Chushina formation.

Chushina Formation

(ozarkian, lower)

Locality.—North slopes of Phillips and Lynx mountains[3] and Billings Butte, Robson Park, British Columbia, Canada.

Derivation.—From Chushina glacier.[4]

Character.—Bluish gray, thin-bedded limestones.

Thickness.—The base of the formation is placed at the lowest layer of rock containing the Hungia[5] fauna (locality 61q), although it is highly probable that the upper portion of the Lynx[6] limestones may contain a fauna that will include it in the Chushina formation. The upper limit is arbitrarily placed 1500 feet (457.2 m.) above where the shale and thin-bedded limestones give way to massive beds of limestone forming the main mass of the upper portion of Robson Peak.

Organic remains.—The fauna at Billings Butte includes several genera that may be referred to as typically Lower Ozarkian and post-Cambrian, *i. e.,* Orthoceras, Apatocephalus, Hungia, Symphysurina.

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[1] Smithsonian Misc. Coll., Vol. 57, No. 12, 1913, pp. 336-337.
[2] Loc. cit., p. 336.
[3] Loc. cit., pl. 58, fig. 2; pl. 59, fig. 2.
[4] Loc. cit., pl. 57, fig. 2.
[5] Loc. cit., p. 336.
[6] Loc. cit., p. 337.

GLACIER LAKE DISTRICT

In a preliminary outline of the Glacier Lake section,[1] which is about 48 miles (77.2 km.) northwest of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada, names are proposed for the following pre-Devonian formations:

Sarbach Formation

(ordovician)

Type locality.—Upper gray limestones and shales forming cliffs beneath the dark Devonian limestone on Mount Sarbach and the eastern and northern ridges of Mounts Outram and Forbes above Glacier Lake, which is about 48 miles (77.2 km.) northwest of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada.

Derivation.—From Mount Sarbach (10,700 feet, 3261.3 m.) which is directly east of the Glacier Lake section.

Character.—Thick-bedded 6 inches (15.2 cm.) to 16 inches (40.6 cm.), gray limestones, 700 feet (213.3 m.), and argillaceous shales with thin, irregular layers of limestone, 420 feet (128 m.).

Thickness.—Above Mons Glacier at head of Glacier Lake canyon valley 1120 feet (341.3 m.), of which the upper 700 feet (213.3 m.) is estimated.

Organic remains.—Lower Ordovician (Canadian).

Observation.—The Sarbach formation was recognized in the Clearwater section 33 miles (53.1 km.) southeast of Glacier Lake, where it has a thickness of 1172 feet (357.2 m.) and a well marked fauna at several horizons.

At Fossil Mountain, 18 miles (28.9 km.) southeast of the Clearwater section, the Sarbach has a thickness of 1090 feet (332.2 m.), and at Ranger Canyon in the Sawback Range 21 miles (33.8 km.) southwest of Fossil Mountain there is no trace of the Sarbach, the Devonian being separated from the subjacent Mons formation by a few feet of dark shale of undetermined age.

Mons Formation

(ozarkian, lower)

Type locality.—Alternations of calcareous shale forming steep and ragged slopes near the lower and southeast side of Mons glacier near the base of a northwest ridge extending down from Mount

[1] Smithsonian Misc. Coll., Vol. 72, No. 1, 1920, p. 15.

Forbes. About 48 miles (77.2 km.) northwest of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada.

Derivation.—From Mons Peak, 10,114 feet (3082.7 m.), and Mons Glacier.

Character.—Massive beds of calcareous shale with intercalated layers of gray limestone above with a massive-bedded dull gray limestone and calcareous shale below.

Thickness.—In the Glacier Lake section 1480 feet (451.1 m.), made up of calcareous shale 235 feet (71.6 m.), massive gray limestone 740 feet (225.5 m.), and calcareous shale below 505 feet (153.9 m.) thick. Thirty-three miles (53.1 km.) to the southeast, at the head of the Clearwater River, the Mons has a thickness of 1414 feet (430.9 m.), and at Ranger Canyon, 72 miles (115.8 km.) southeast from Glacier Lake, it is 1390 feet (423.6 m.) thick. It is absent in the section of the Rocky Mountains front at Ghost River 24 miles (38.6 km.) east of Ranger Canyon.

Organic remains.—A post-Cambrian pre-Ordovician fauna of Lower Ozarkian age.

Observations.—The Mons formation in all known localities is directly and, as far as known, conformable superjacent to a series of massive layers, 10 inches to 60 inches (25.4 cm. to 152.4 cm.), of magnesian limestone averaging over 1000 feet (304.8 m.) in thickness of the Upper Cambrian Lyell formation.

Lyell Formation

(cambrian, upper)

Type locality.—Massive-bedded gray and oolitic limestone at head of Glacier Lake canyon valley about 2 miles (3.2 km.) above head of lake and about 48 miles (77.2 km.) northwest of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada.

Derivation.—From Mount Lyell, 11495 feet (3505.6 m.), on the Continental Divide northwest of Glacier Lake. The Southeast Lyell glacier terminates at the head of Glacier Lake canyon valley.

Character.—Massive-bedded cliff forming rough weathering magnesian limestone forms the upper portion of the formation, with thinner-bedded gray and oolitic limestones beneath.

Thickness.—At the type locality in Glacier Lake canyon valley the upper magnesian beds have a thickness of 1270 feet (387.1 m.) subjacent to which the thick- and thin-bedded gray limestones extend down 430 feet (131 m.) a total of 1700 feet (518.1 m.) for the formation. Thirty-three miles (53.1 km.) to the southeast at the

head of the Clearwater River it has a thickness of over 1700 feet (518.1 m.), and at Ranger Canyon in the Sawback range 72 miles (115.8 km.) southeast from Glacier Lake, the great upper limestone is 1325 feet (403.8 m.) thick and the lower beds 335 feet (102.1 m.).

Organic remains.—An Upper Cambrian fauna is fairly well developed in the lower oolitic limestones.

Observations.—The Lyell formation corresponds in stratigraphic position to the Ottertail formation of the Kicking Horse River section southwest of Field, British Columbia.

Sullivan Formation

(CAMBRIAN, UPPER)

Type locality.—Gray limestone above with arenaceous shale and interbedded limestone on the north side of Glacier Lake canyon valley and the south cliffs and slopes of Sullivan Peak about a mile east of the foot of Southeast Lyell glacier. Glacier Lake is about 48 miles (77.2 km.) northwest of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada.

Derivation.—From Sullivan Peak, 7858 feet (2395 m.).

Character.—Hard, gray, rather thin-bedded semicrystalline limestone above, with arenaceous shales predominating below. The dominant feature is the development of arenaceous shales.

Thickness.—At the type locality in Glacier Lake canyon the upper limestone has a thickness of 325 feet (99 m.). The arenaceous shales and interbedded limestones continue down for 1115 feet (339.8 m.), making a total thickness of 1440 feet (438.9 m.).

Organic remains.—Upper Cambrian fauna of about the horizon of the Eau Claire formation of the northern Mississippi valley section.

Observations.—The Sullivan formation is strongly developed in the vicinity of Thompson Pass, 33 miles (53.1 km.) northwest of Glacier Lake, and it is present in part in the Ranger canyon section of the Sawback range.

Arctomys Formation

(CAMBRIAN, UPPER)

Type locality.—A bluish-gray laminated limestone superjacent to a series of siliceous shales on the lower, southern slope of Sullivan Peak above Glacier Lake about a mile east of the foot of Southeast Lyell glacier. Glacier Lake is about 48 miles (77.2 km.) northwest of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada.

Derivation.—From Arctomys Peak (9162′ (2792.5 m.)) which is 8 miles (12.8 km.) east-southeast of Mount Lyell, and above the head of Southeast Lyell glacier.

Character.—Bluish-gray irregularly laminated cliff-forming limestones which are more or less magnesian in some layers. This limestone is underlain by a series of arenaceous and silicious shales with bands of hard, finely laminated, dove colored limestone.

Thickness.—Upper cliff-forming limestone 520 feet (158.5 m.). The siliceous shales and limestone below have a thickness of 866 feet (263.9 m.) which gives 1386 feet (422.4 m.) for the formation.

Organic remains.—The character of the sedimentation appears to have been unfavorable for the presence and preservation of vegetable and animal life. The few fossils found indicate the Upper Cambrian fauna.

Observations.—The Arctomys formation in the Siffleur River section 25 miles (40.2 km.) east of Glacier Lake has a thickness of 725 feet (221 m.) and appears to have been a shallow water and probably a brackish water deposit. It is separated from the subjacent Murchison formation by a great disconformity resulting from the non-deposition of the Eldon formation, which has a thickness of 2728 feet (831.5 m.) on Mount Bosworth, 37 miles (59.5 km.) to the south.

Murchison Formation

(CAMBRIAN, MIDDLE)

Type locality.—Thin-bedded bluish-black limestones in cliffs on southwest side of Siffleur River, 3.5 miles (5.6 km.) from Saskatchewan River and 40 miles (64.3 km.) north, 12° west, of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada.

Derivation.—From Mount Murchison, which is about 8 miles (12.9 km.) west of the Siffleur section.

Character.—Thin-bedded, hard bluish-black and gray limestones.

Thickness.—On the Siffleur the Murchison has a thickness of 497 feet (151.5 m.). At Glacier Lake 220 feet (67.1 m.) of the upper portion of the formation is exposed.

Organic remains.—A few Middle Cambrian species of the Stephen fauna.

Observations.—The Murchison occupies the stratigraphic position of the Stephen formation of the Kicking Horse Pass section, but it is not given that name as the contained fauna is not sufficient to closely identify it, and in an area where non-deposition of formations occurs

on such a great scale, strata separated by an interval of 38 miles (61.1 km.) may be a portion of some unknown formation or a portion only of the formation it most nearly resembles in that province.

KICKING HORSE CANYON

Glenogle Formation

(ordovician)

Type locality.—Glenogle Creek, Lower Kicking Horse Canyon, a little east of Glenogle station on the Canadian Pacific Railway, British Columbia, Canada. The section of the formation was studied by Dr. R. G. McConnell and Dr. John A. Allan[1] on Glenogle Creek and the next small creek to the west, both of which flow into the Kicking Horse River.

Derivation.—From Glenogle station and creek.

Character.—Argillaceous and with finely arenaceous shales, black, brown and gray in color and more or less fissile in thick bands.

Thickness.—About 1,700 feet (518 m.).

Organic remains.—Lower Ordovician graptolites.

Beaverfoot Formation

(silurian ?)

Type locality.—Crests of Beaverfoot Range east of Columbia River valley and south of Canadian Pacific Railway, British Columbia, Canada.

Derivation.—From Beaverfoot Range.

Character.—Thick-bedded gray dolomites and quartzites, with a few bands of interbedded arenaceous shale.

Thickness.—On the northern end of the Beaverfoot Range, 800 feet (243.8 m.). To the south it thickens up to 1,850 feet (563.9 m.).

Organic remains.—Silurian ? corals.

FRONT RANGE

Ghost River Formation

The type locality is about 51 miles (82.1 km.) west 20° north of Calgary, Alberta, Canada, in the first small canyon south of Ghost River canyon and opening on Ghost River as the river bends to the

[1] Ann. Rept. Geol. Sur. Canada (for 1886) 1887, Pt. D, pp. 22-24 D.
Geol. Sur. Can. Memoire No. 55, Geol. Ser. No. 46, 1914, p. 100.

south. At the Devil's Gap, about 2 miles (3.2 km.) further south the formation dips westward and disappears 1.75 miles (2.8 km.) east-northeast of the eastern end of Lake Minnewanka.

The formation includes 285 feet (86.8 m.) of thin-bedded and shaly, buff colored magnesian limestones lying conformably between the Middle Cambrian limestones beneath (Cathedral formation) and the superjacent Devonian beds (Intermediate limestone of McConnell). They are a very conspicuous formation on the summit of the outer cliffs for many miles along the Rocky Mountains front from the South Fork of Ghost River north to the Red Deer River, and the only representative of 23,960 feet (7,303.0 m.) of strata that occurs in the Kicking Horse Pass section, 50 to 60 miles (80.5 to 96.6 km.) to the westward between the Cathedral limestones and the Devonian.

The lower layers of the formation rest conformably on the Cathedral limestone of the Middle Cambrian, and in fact there is almost a gradation between the two except that the gray thin-bedded limestones of the Cambrian are not repeated above in the shaly magnesian limestones. The transition to the dark gray Devonian limestones above is abrupt and suggests a somewhat sudden and deep depression of the sea bed.

The interval between the Cambrian and Devonian along the line of the present Rocky Mountains front was largely one of non-deposition, as the evidence of erosion along the several miles of exposure of the contact between the magnesian limestones of the Ghost River formation and the Cambrian beneath and the Devonian above on Ghost River is almost negligible.

Fauna.—No fossils or traces of life were seen in or on the rocks of this formation.

Mount Wilson Quartzite

Clearwater River.—At the head of the Clearwater River canyon 54 miles (86.9 km.) northwest of the Ghost River section, there are a few layers of quartzite in the interval between the Devonian and the subjacent Ordovician Sarbach formation. They have a maximum thickness of 24 feet (7.3 m.) and were evidently a thin deposit of washed sand spread unevenly over the upper surface of the Sarbach formation.

Mount Wilson.—At Mount Wilson on the north side of the Saskatchewan River and 84 miles (135.2 km.) northwest of the Ghost River section, a quartzite similar to that at the head of the Clearwater River forms a massive cliff beneath the Devonian and above the Sar-

bach formation. It is not the same lithologic formation as Ghost River magnesian limestones, but it occupies a similar stratigraphic position beneath the Devonian, and is a deposit in the Ghost River interval. It is an important stratum at Mount Wilson, where it has an estimated thickness of over 250 feet (76.2 m.) and it is prominent in the cliffs of Mount Murchison. It is named the Mount Wilson formation and correlated in stratigraphic position with Ghost River formation. No fossils were found in the great piles of quartzite blocks that had fallen from the precipitous cliffs high up on the mountain.

This quartzite thins gradually northward on the North Fork of the Saskatchewan River until opposite the mouth of Alexandra River it is not over 100 feet (30.4 m.) thick, and two miles further north it can only be distinguished by a few thick layers beneath the dark Devonian limestone.

On the south side of Mount Wilson facing the Saskatchewan River the quartzite caps the eastern half of the high cliffs, but it has been removed by erosion from the western half. It occurs on the north and west side of Mount Murchison, but it is not as thick as on Mount Wilson, and it becomes thinner on the northeast side of Mount Murchison.

As far as known, the Mount Wilson quartzite originally covered an area with a major axis of about 95 miles (152 km.) in a north-northwest by south-southeast direction, and a minor axis of 6 to 8 miles (9.6 to 12.8 km.), as indicated by known outcrops. It was a deposit of fine white sand in the shallow sea that preceded the Devonian coral reefs and black calcareous silt in which they were embedded.

OCCURRENCE IN SAWBACK RANGE

On Ranger Brook in the heart of the Sawback Range, 24 miles (38.6 km.) west of the Ghost River section, the dark fossiliferous[1] Devonian limestones rest with apparent conformity on light gray limestones of the Mons[2] formation of the Lower Ozarkian, and beneath the latter the Upper Cambrian Lyell[3] and upper portion of the Sullivan[4] formations, the section of which is broken by a fault that brings the limestones beneath the Sullivan formation against the

[1] Noted Stromatopora, Atrypa reticularis (Linn.), and numerous poorly preserved corals.

[2] Ante, p. 459.

[3] Ante, p. 460.

[4] Ante, p. 461.

Devonian. The Mons, Lyell, and Sullivan formations have a combined thickness of over 3,000 feet (914.4 m.) and do not occur beneath the Devonian in the Ghost River section, and the Ordovician Sarbach formation of the Clearwater Canyon section is not present between the Devonian and the Mons formation.

Another section on the east slope of Fossil Mountain near Baker Lake, 20 miles (32.1 km.) north-northeast of Ranger Canyon section and 38 miles (61.1 km.) west-northwest of Ghost River section, has on the east and south slopes of the mountain a fine outcrop of the lower strata of the Devonian carrying numerous fragments of Stromatopora and corals. Beneath the Devonian there is a series of thin layers of magnesian limestone with layers of chert one to two inches (2.5 to 5.0 cm.) thick which may be between the layers or form part of a layer. They are 35 feet (10.7 m.) in thickness and strongly delimited from the dark coarse Devonian limestones above and the light gray relatively soft Ordovician (Sarbach) limestones below by their lithological characters, but there is no evidence of a physical unconformity between them. They correspond in position and partly in character to the strata of the Ghost River formation and are without traces of fossils.

EUREKA MINING DISTRICT, NEVADA

Goodwin Formation

(OZARKIAN, LOWER)

Type locality.—Goodwin Canyon is northeast of the town of Eureka, and heads in the arenaceous and calcareous shales of the Dunderberg formation;[1] it descends over the limestones of the Pogonip Formation to where Shadow Canyon unites with it.[2]

Derivation.—From Goodwin Canyon in the Eureka Mining District.

Character.—The argillaceous and fine grained arenaceous shale of the Dunderberg shale formation with some interbedded calcareous shale pass gradually upward into purer bluish-gray limestones distinctly bedded, which were formerly included in the lower Pogonip formation.

Thickness.—In the Eureka District section both Goodwin and Shadow canyons cut across the Pogonip limestone which Hague esti-

[1] Smithsonian Misc. Coll., Vol. 53, No. 5, 1908, p. 184.

[2] See Atlas accompanying Geol. Eureka District, Nevada, Monogr. U. S. Geol. Surv., Vol. XX, 1883, Map No. 8.

mated to be 2,700 feet (822.9 m.) thick east of the Jackson mine. In the White Pine District the Pogonip was estimated to have a thickness of over 5,000 feet (1,524 m.). The portion of the Pogonip now referred to the Goodwin formation is 1,500 feet (457.2 m.) thick.

Fauna.—At an horizon about 200 feet (60.9 m.) above the base (locality 201a):

Obolus (Westonia) iphis Walcott
Lingulella pogonipensis (Walcott)
Acrothele sp.
Acrotreta idahoensis Meek
Schizambon typicalis Walcott
Eoorthis hamburgensis Walcott
Syntrophia nundina Walcott
Tellinomya ? hamburgensis Walcott
Agnostus sp. ?
Apatokephalus finalis (Walcott)
Hungia eurekensis Walcott
Hungia flagricauda White
Hungia hamburgensis Walcott
Hungia inexpectans Walcott
Elrathia (?) annectans (Walcott)
Calvinella tenuisculptas Walcott
Ptychostegium cf. hecuba Walcott
Ptychostegium mccoyi Walcott
Symphysurina eurekensis Walcott
Symphysurina major Ulrich (Mss.)
Symphysurina mesleri Ulrich (Mss.)
Symphysurina spicata Ulrich (Mss.)
Eurekia sp. undt.

The next highest well marked fauna is about 800 feet (243.8 m.) above and contains (locality 203):

Syntrophia nundina Walcott
Ptychostegium congeneris (Walcott)
Hystricurus tuberculatus (Walcott)

OZARKIAN

This is not the place for a discussion of the Ozarkian system of Ulrich,[1] but I wish to briefly outline it in order that the position of the Sarceen series (p. 471) within it may be clear. As proposed, Ozarkian included a group of formations occurring in the Ozark

[1] Dr. Ulrich is now making a thorough study of the stratigraphy and faunas of the formations included by him in the system, and it is anticipated that all available data will soon be in the process of publication.

Mountains of Missouri and elsewhere, above the Upper Cambrian and below the Canadian. Some of the sections are as follows:[1]

EASTERN MISSOURI

CANADIAN

Disconformity.

OZARKIAN

	Feet	Meters
Gasconade.		
Cherty dolomite	265	80.8
Fauna.—Large number of gasteropods, etc.		
Proctor.		
Massive bedded dolomite	60	18.3
Eminence.		
Light colored cherty dolomite	200	61.0
Fauna.—Gasteropods, cephalopods, trilobites.		
Disconformity.		
Potosi.		
Light gray to dark bluish gray massive dolomite	300	91.4
Fauna.—Unknown.		
Of the above, the Potosi dolomite is referred to the Lower Ozarkian.		
	825	251.5

Disconformity.

In the southern Appalachians of Central Alabama, Ulrich distinguishes five formations which he includes in the Ozarkian as follows:

CANADIAN

Disconformity.

OZARKIAN

	Feet	Meters
Chepultepec.		
Cherty magnesium limestone	1200	365.7
Fauna.—Many species of gasteropods and cephalopods. Ulrich states that at least ten of the species occur in the Gasconade formation in Missouri and a number in the Oneonta of Wisconsin, Minnesota and Iowa.		
Copper Ridge.		
Cherty dolomite	2000	609.6
Fauna.—Fossils rare, mainly Cryptozoans.		

[1] Data taken from Ulrich, Bull. Geol. Soc. Amer., Vol. 22, 1911, pp. 630-632, and Vol. 24, 1913, p. 51.

Dr. Ulrich included the Roubidoux and Jefferson City formations in the Ozarkian as published in 1911. In 1912 he referred the Jefferson City to the Middle Canadian and the Roubidoux to the Lower Canadian in a paper not yet published (Bull. Geol. Soc. Amer., Vol. 24, p. 51), but from which Dr. R. S. Bassler took the data for the Ozarkian-Ordovician correlation published in 1915, Bull 92, U. S. National Museum, Vol. 2, 1915, plate 2.

	Feet	Meters
Bibb dolomite.		
Fine grained dolomite	500	152.4
Fauna.—Unknown.		
Ketono dolomite.		
Gray fine dolomite	600	182.9
Fauna.—Unknown.		
Briarfield dolomite.		
Silicious blue and gray dolomite	1250	381.0
Fauna.—Unknown.		
Maximum thickness	5550	1691.6

Disconformity.

The Chepultepec and Copper Ridge formations are referred to the Upper, and the Bibb, Ketono, and Briarfield to the Lower Ozarkian.

In the Northern Appalachians the central Pennsylvania section includes:

OZARKIAN

	Feet	Meters
Larke dolomite	250	76.2
Fauna.—Unknown.		
Mines cherty dolomite	250	76.2
Gatesburg dolomite	1750	533.4
A band of bluish black limestone named Ore Hill contains a large Lower Ozarkian fauna that may be compared with the lower Mons fauna of the Cordilleran area.		
Total Ozarkian	2250	685.8

The New York section of the Ozarkian is composed of the following formations:

Little Falls dolomite (Little Falls)	350	106.7
Hoyt limestone with a well-marked fauna (Saratoga)	120	36 6
Theresa dolomite	50	15.2
Potsdam sandstone	110	33.5
	630	192.0

The fauna of the Hoyt limestone and upper portion of the Potsdam sandstone is comparable with that of the lower Mons of Alberta and the Madison sandstone of Wisconsin.

In the upper Mississippi valley area the Ozarkian is not strongly developed:

Disconformity
Oneota dolomite
Great disconformity
Madison sandstone
Mendota dolomite
Disconformity

Ulrich correlates the Oneota dolomite with the Gasconade of Missouri and the Madison sandstone with the Hoyt limestone of New York.[1]

Using the correlation table of Ulrich in part as modified by Bassler, and inserting two columns to represent the sections of Alberta and British Columbia, the table (fig. 24) presents a broad correlation of the Ozarkian system in North America.

LOWER OZARKIAN IN ALBERTA

As my field studies progressed in western Alberta, Canada, it became more and more evident that there was a well-defined formation between the Upper Cambrian and the pre-Devonian Ghost River interval that was characterized by a fauna easily distinguished in its central and upper portions from the Upper Cambrian fauna by the presence of cephalopods, gasteropods and types of trilobites represented in the succeeding Canadian faunas of the Ordovician. In the lower part of the formation the fauna is predominantly Upper Cambrian, but trilobites of the genera Megalaspis, Niobe ?, Asaphellus, Hungia, Symphysurina, midway of the Mons Formation strongly foreshadow the change to the Ordovician fauna, and the change in sedimentation also aids in drawing a line of demarcation between the massive Lyell limestones of the Upper Cambrian, and the shales and thin-bedded limestones of the Mons formation of the Lower Ozarkian.

In the Glacier Lake section the Mons formation has a thickness of 1480 feet (451.1 m.) of which the lower 505 feet (153.9 m.) is composed of shales and thin-bedded limestones. Below the shales the thick-bedded limestones of the Lyell formation extend down for 1,270 feet (387 m.) forming a bold ridge terminating in high cliffs. Thirty-eight miles (61.1 km.) to the southeast of Glacier Lake at the head of the Clearwater River canyon the Mons formation has a thickness of 1,414 feet (430.9 m.) with shales and thin-bedded limestones in the lower portion. Below there is a series of massive-bedded magnesian limestones 910 feet (277.3 m.) in thickness of the Lyell formation. Forty miles (64.3 km.) southeast of the Clearwater section in the Ranger canyon section of the Sawback range, the Mons formation is directly beneath the Devonian limestones and has a thickness of 1,390 feet (423.6 m.) and a bed of thin layers of shaly limestone and shale form the lower portion of the formation. This is underlain by a series of thick-bedded arenaceous and magnesian limestones of the Lyell formation with a thickness of 1,325 feet

[1] See Ulrich, Bull. Geol. Soc. America, Vol. 22, 1911, pp. 627-647.

CAMBRIAN-OZARKIAN-ORDOVICIAN CORRELATION TABLE.

GENERAL TIME SCALE			Central Pennsylvania	Alabama	East Missouri	Wisconsin	Alberta Saskatchewan	Alberta and B.C.
ORDOVICIAN	UPPER	Bellefonte (Pa.)	Bellefonte dol.		Powell ls.	Shakopee dolomite	Sarbach	
		Axeman (Pa.)	Axeman ls.		Cotter ls.			
	MIDDLE	Nittany (Pa.)	Nittany dol.		Jefferson City ls.			
	LOWER	Stonehenge (Pa.)	Stonehenge ls.	Pelham ls.	Roubidoux ss.			
		Dictyonema bed	Represented ?					
OZARKIAN	UPPER	Gasconade (Mo.)		Chapultepec ls.	Gasconade ls. (Gunter ss. member)	Oneota dolomite		Goodsir ?
		Copper Ridge (Tenn.)		Copper Ridge ch.	Proctor dol.			
		Eminence (Mo.)			Eminence chert			
	LOWER	Sarcoxie	Larke	Bibb dol.	Potosi ls.		Mons	Goodsir
			Mines	Ketona dol.		Madison ss.		
			Gatesburg	Briarfield dol.		Mendota ls.		
CAMBRIAN	UPPER	St. Croixan	Warrior ls.	Nolichucky sh. Maryville ls. Rogersville sh.	Elvins form. Bonne Terre dol. Lamotte ss.	St. Croixan: Jordan ss. St. Lawrence f. Franconia ss. Dresbach ss. Eau Claire ss. St. Simon ss.	Lyell Sullivan Arctomys	Ottertail, Chancellor Sherbrook Paget Bosworth
			Pleasant Hill ls.					
	MIDDLE	Acadian	Waynesboro ?				Kurchison Cathedral	Eldon Stephen Cathedral Ptarmigan
	LOWER	Waucoban					Mt. Whyte St. Piran	Mt. Whyte St. Piran Lake Louise Fort Mt.

Fig. 24.

(403.8 m.). About 132 miles (212.4 km.) north of the Glacier Lake section at Mount Robson the Chushina formation has an arbitrarily assigned thickness of 1,500 feet (457.2 m.), but neither the upper nor lower limits have been determined.

The fauna of the Billings Butte beds of this formation may be compared to that of the lower portion of the Mons formation, but it will be necessary to make a detailed study of the section before a close comparison can be made between the Mons and the Chushina as my reconnaissance of 1912 did not take in the details of the formations above the Middle Cambrian.[1]

In the Kicking Horse Pass and River section the Mons formation has not been recognized, but its stratigraphic equivalent is indicated by the fauna in the lower portion of the Goodsir formation, which includes:

Obolus mollisonensis Walcott
Lingulella moosensis Walcott
Lingulella sp. undt.
Agnostus sp.
Agnostus sp.
Moosia degener Walcott
Moosia grandis Walcott
Sodalitia canadensis Walcott
Sodalitia allani Walcott

In the absence of fossils from other horizons in the Goodsir, and as the formation is practically a lithologic unit, I am placing the entire series in the Ozarkian. See notes under Mons, Chushina, and Goodwin in this paper.

SARCEEN

This term is proposed as a series name to include the various formations referred to the Lower Ozarkian on the North American continent. The type formation is the Mons, which occurs in the Rocky Mountains of western Alberta, Canada (ante, p. 459). The correlated formations in the Cordilleran trough of the Rocky Mountains are Chushina (ante, p. 458) on the north; Goodsir, at least in part, on the south in Canada; in the United States the St. Charles formation of Idaho and Utah; the Red Lion formation of Montana; the Goodwin formation (ante, p. 466) of Nevada, and the Notch Peak formation of Utah.

On the eastern side of the continent the most typical formations are the Potsdam sandstone and Hoyt limestones of New York and western Vermont; the Gatesburg dolomite of central Pennsylvania, and

[1] Smithsonian Misc. Coll., Vol. 57, No. 12, 1913, pp. 336-337.

the "Potosi," Ketona, Briarfield of Alabama. In the interior region the Wilberns formation of Texas; the Potosi formation of Missouri, and the Mendota, Madison and Devils Lake of Wisconsin.

Derivation.—From the Sarcee Indian tribe, which ranged in western Alberta north of the Blackfeet (Siksika) tribe and hunted up the river valleys to the Continental Divide.

Thickness.—In the Canadian Cordilleran region from 1,480 feet (451.1 m.) Mons to 6,040 feet (1,841.0 m.) Goodsir. In northern Utah, 1,311 feet (399.6 m.) St. Charles. In central Nevada 1,500 feet (451 m.) Goodwin formation.

In the Appalachian trough from 2,500 feet (762.0 m.) in Alabama to 350 feet (106.7 m.) in New York.

The Lower Ozarkian in Missouri is represented in part by the Potosi dolomite which is about 300 feet (91.4 m.) thick.

Organic remains.—The fauna of the Mons formation of Alberta is large and varied. The following genera and species occur in the limestones 18 feet (5.5 m.) below the summit of the formation (locality 64p):

Eoorthis cf. wichitaensis Walcott
Syntrophia isis Walcott
Ophileta leo Walcott
Eccyliomphalus josephus Walcott
Eccyliomphalus labeo Walcott
Bucaniella lelex Walcott
Raphistoma melius Walcott
Lophospira laodice Walcott
Hormotoma lamus Walcott
Straparollina isades Walcott
Orthoceras longus Walcott
Orthoceras robsonensis Walcott
Ptychostegium fulvia Walcott
Ptychostegium victori Walcott

At a lower zone, 60 feet (18.2 m.) below the summit of the formation the collection included (locality 66u):

Lingulella sp. undt.
Syntrophia
Eoorthis
Ctenodonta ? lucan Walcott
Platyceras lais Walcott
Megalaspis ? eucerus Walcott
Megalaspis ? sp. undt.
Maryvillia galeria Walcott

Near the base of the Mons formation in the Glacier Lake section the following species occur (localities 64f, 64n):

Cystid (fragment)
Eoorthis sp. undt.

Huenella sp. undt.
Scenella ?
Ptychaspis eurydice Walcott
Elvinia phyllus Walcott
Saukia ? glaucus Walcott
Obolus cf. leda Walcott 64n
Blountia sp. undt. 64n
Saukia splendens Walcott 64n

In the Clearwater canyon section 33 miles (53.1 km.) east-southeast of the Glacier Lake section, the following genera and species occur 288 feet (87.7 m.) above the base of the Mons (locality 65y):

Obolus sp. undt. (fragments)
Lingulella cf manticula White
Eoorthis iones Walcott
Agnostus sp.
Modocia ibicus Walcott
Hungia flacilla Walcott
Symphysurina eugenius Walcott
Acrocephalites gentius Walcott
Niobe ? nonius Walcott
Niobe ? phormis Walcott

About 100 feet (30.4 m.) from the base (locality 65w):

Cystid (plates)
Eoorthis iones Walcott
Straparollina sp. undt.
Irvingella ? undt.
Niobe ? echides Walcott
Amphion ?? sp. undt.
Symphysurina entellus Walcott
Rogeria ? ephorus Walcott
Asaphellus euclides Walcott

In the Robson Peak section the lower fauna of the Chushina formation corresponds in a general way to the lower fauna of the Mons formation (locality 61q):

Lingulella cf. desiderata Walcott
Lingulella ibicus Walcott
Obolus ino Walcott
Acrotreta cf. idahoensis Walcott
Acrotreta cf. sagittalis Salter
Eoorthis cf. desmopleura (Meek)
Eoorthis cf. wichitaensis Walcott
Straparollus ? lavinia Walcott
Bellerophon ? lavassa Walcott
Cyrtolites meles Walcott
Orthoceras robsonensis Walcott
Agnostus sp. undt.

Menomonia gyges Walcott
Blountia galba Walcott
Cyrtometopus ? sp. undt.
Moxomia hecuba Walcott
Hystricurus gallus Walcott
Hystricurus bituberculatus (Walcott)
Apatocephalus bröggeri Walcott
Apatocephalus fronto Walcott
Hungia articauda Walcott
Hungia billingsi Walcott
Hungia flacilla Walcott
Hungia laxicauda Walcott
Hungia striata Walcott
Hungia flagricauda (White)
Ptychostegium amplum Walcott
Ptychostegium robsonensis Walcott
Ptychostegium robsonensis valaltum Walcott
Ptychostegium canadensis Walcott
Ptychostegium spinosum Walcott
Symphysurina spicata augusta Walcott
Symphysurina canadensis Walcott
Symphysurina lynxensis Walcott
Symphysurina spicata major Walcott
Symphysurina numitor Walcott
Symphysurina perola Walcott
Symphysurina spicata Walcott

The St. Charles formation of northern Utah has a large and varied fauna. The upper zone includes (locality 185z):

Eoorthis cf. desmopleura (Meek)
Syntrophia sp. ?
Ctenodonta cf. lucan Walcott
Bucaniella ? isades Walcott
Bucaniella ? leos Walcott
Eccyliomphalus lacidos Walcott
Straparollina milo Walcott
Ophileta leo Walcott
Raphistoma menos Walcott
Orthoceras utahensis Walcott
Endoceras sp.
Hystricurus sp. undt.
Blountia sp. undt.
Asaphus ? sp. undt.
Ptychostegium idahoensis Walcott

About 75 feet (22.8 m.) below the following species occur (locality 54b):

Lingulella manticula (White)
Billingsella coloradoensis Meek
Syntrophia nundina Walcott
Hungia hera Walcott

Some 1,200 feet (365.8 m.) from the top, near the base of the St. Charles, the fauna has a very strong Upper Cambrian character (locality 4y):

Obolus wortheni Walcott
Lingulella desiderata Walcott
Acrotreta idahoensis Walcott
Acrotreta idahoensis sulcata Walcott
Billingsella coloradoensis Meek
Agnostus *a*
Agnostus *b*
Saukia marica Walcott (54u)
Saukia oneidaensis Walcott
Elrathia lycus Walcott (54u)
Elrathia sp. (54t)
Taenicephalus lycoria Walcott
Taenicephalus mutia Walcott (5a)
Maladia americana Walcott
Idahoia sp. undt. (5a)
Idahoia serapio Walcott
Idahoia licinia Walcott
Anomocare sp. undt. (54u)
Anomocarella lucius Walcott
Anomocarella macar Walcott
Anomocarella sp. undt.
Wilbernia fronto Walcott (5e)
Wilbernia (Ulmia) martha Walcott

In the Eureka District section of central Nevada, the Goodwin formation (=lower 1,500 feet (457.2 m.) of the Pogonip formation of the Fortieth Parallel Survey) carries a fauna which is partially listed under the description of the Goodwin formation (ante. p. 466).

Observations.—The preceding tentative faunal lists are given in order that the student may have some conception of the fauna characteristic of the Sarceen or Lower Ozarkian series in the Cordilleran area. It is now planned to publish illustrations and notes on the fauna in 1923.

The Sarceen series may be compared with the Tremadoc series of Europe; both the Tremadoc and Sarceen series of formations are above the typical Upper Cambrian and beneath the Ordovician; both series are well defined stratigraphically and by their contained faunas.

The term Sarceen if generally accepted will replace the term Saratogan as used by Ulrich,[1] who used it to include the formations of the Lower Ozarkian. Walcott[2] proposed Saratogan as a group term

[1] Bull. Geol. Soc. America, Vol. 22, 1911, pp. 332-3, 338.
[2] Jour. Geol., Vol. 11, 1903, pp. 318-319.

to include the Upper Cambrian formations, as at the time he considered the Potsdam sandstone and Hoyt limestone of the Saratoga New York section to belong to the Upper Cambrian. With the reference of these formations to the Ozarkian and the fact that no Upper Cambrian formation occurs at or near Saratoga, the name is not appropriate for the Upper Cambrian series of formations.

It is not improbable that as the faunas are more thoroughly studied by Dr. E. O. Ulrich, a middle division of the Ozarkian will be established to include the Eminence and related formations.