

Geologic Formations visible from the Vermillion Valley Viewpoint

Formation: The word “formation” usually is very narrowly defined in geology. In geology a formation is a mappable lithostratigraphic unit (a distinct rock layer or series of rock layers). Mappable means that its top and its bottom can be represented by two separate lines on a geologic map. The name of a formation consists of the word “Formation”, or the name of the dominant rock type in the formation, with a capital letter, preceded by a geographical name. For example, the Madison Limestone, where Madison refers to Madison Range in southwestern Montana where the formation was first described in 1893. The outcrop of this formation in the Madison Range is referred to as the type locality of the formation. Another example of a formation name would be the Chugwater Formation.

It is assumed that a formation, when it formed, extended continuously from the type locality to any place it is now found. For example, the Madison extends across Wyoming and Montana, into North and South Dakota, Idaho, and Utah. The same rocks even extend beyond but are known by different names, such as the Redwall Limestone in the Grand Canyon of Arizona. Locally, the Madison extends from the top of the Pryors down under the Bighorn Basin to the west and reappears standing vertically (“the Palisades”) along the Beartooth Front near Red Lodge .

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In this area the **Kootenai Formation** comprises the lower Pryor Conglomerate Member and the upper member of the Kootenai. The **Pryor Conglomerate** Member comprises brown conglomerate and pebbly sandstone 20 to 60 feet thick. The upper member of the Kootenai comprises reddish, purplish, and greenish shale interbedded with tan sandstone and thin gray limestone. The total thickness of the Kootenai is 200 to 250 feet. The sediments of the Kootenai were deposited in rivers and lakes during the early Cretaceous Period. Kootenai fossils include plants, freshwater mollusks, and dinosaurs. The dinosaur *Deinonychus*, a 10 foot long predator, was discovered in the Kootenai just a few miles from Pryor Mountain Road in 1964, and has been important in establishing the close relationship between dinosaurs and birds. The Kootenai Formation was named in 1885 after the Kootanie Tribe for rocks exposed in southern Alberta. In Wyoming the Kootenai is called the Cloverly Formation.

The **Morrison Formation** comprises tan sandstone, gray to reddish shale, coal, and thin gray limestone. These sediments of the Morrison were deposited in rivers, lakes and swamps during the late Jurassic Period. Fossil dinosaurs are common in the Morrison. Near Pryor Mountain Road, a large number of disarticulated bones of juvenile *Diplodocus*-like sauropods were found in the Morrison in 1994. These were interpreted as the remains of a herd of young animals of a single species. Here the formation is about 300 feet thick. The Morrison was named for outcrops near the town of Morrison, Colorado, near Denver, in 1896.

The **Swift Formation** is about 100 feet thick, comprising tan sandstone and some gray shale. These sediments were deposited nearshore in the late Jurassic sea. Common fossils include oysters and belemnites. The Swift Formation was named in 1945 for exposures along Swift Reservoir in Pondera County, Montana. In Wyoming, the rocks of the Swift are considered part of the Sundance Formation.

The **Rierdon Formation** is about 150 feet thick and is made up of mostly gray shale and thin gray limestones originally deposited offshore in the Late Jurassic sea. Fossils include abundant oyster-like mollusks and belemnites, as well as fish and ammonites. The Rierdon was named in 1945 for outcrops in Rierdon Gulch along the Rocky Mountain Front in Teton County, Montana. In Wyoming, rocks of the Rierdon are considered part of the Sundance Formation.

The **Piper Formation** comprises about 100 feet of reddish shale, gray shale, gray limestone and white gypsum. The reddish shale and some gray shale were deposited in fresh or brackish lakes. The limestones and other gray shales were deposited on the Middle Jurassic seafloor. The gypsum was deposited from highly saline water. Fossils include oysters and other bivalves, corals, and crinoids. The Piper Formation was named in 1945 for rocks exposed near Piper, Montana, on the north side of the Big Snowy Mountains.

The **Chugwater Formation** comprises about 500 feet of red shale, siltstone, and sandstone likely deposited in ephemeral, saline lakes, mud flats, and small streams during the Early Triassic. It is essentially without fossils. The Chugwater was named for rocks exposed along Chugwater Creek near Iron Mountain, Wyoming, in 1904.

The **Goose Egg Formation** comprises up to 30 feet of red shale and sandstone interbedded with gypsum and dolostone; likely deposited in a restricted arm of the sea or a saline lake. It is essentially without fossils. The Goose Egg was named in 1956 for the Goose Egg Post Office in east-central Wyoming.

This formation is found discontinuously in the Pryors, and is best seen to the east and southeast part of the Pryors.

The **Phosphoria Formation** here comprises less than 10 feet of pinkish gray limestone and hard tan sandstone embedded with gray chert masses. Fossils include brachiopods, clams, snails, and bryozoans. These sediments were deposited on a shallow sea floor during the Permian Period. The Phosphoria was named in 1912 for rocks exposed along Phosphoria Gulch in southeastern Idaho.

The **Tensleep Sandstone** is composed of about 200 feet of white to light tan, fine-grained, quartz-rich sandstone. The sand was deposited on a shallow seafloor nearshore and as wind laid dunes near the coast during the Pennsylvanian (Late Carboniferous) Period. It contains fossil foraminifera. The Tensleep was named in 1904 for rocks exposed in Tensleep Canyon, Wyoming. Crude oil is produced from the Tensleep in the subsurface of the Bighorn Basin.

The **Amsden Formation**, which is about 200 feet thick, comprises reddish shale, gray shale, and gray limestone. These sediments were deposited on a shallow seafloor from late Mississippian to early Pennsylvanian time. Fossils include brachiopods. The Amsden Formation was named in 1904 for outcrops along the Amsden Branch of the Tongue River west of Dayton, Wyoming.

The **Madison Group** comprises two formations exposed in Montana, an upper Mission Canyon Limestone, and a lower Lodgepole Limestone. Both of these formations consist of gray limestone, the Mission Canyon being massive and thick-bedded, the Lodgepole thin-bedded. The total thickness of the Madison in this area is about 1000 feet. Common fossils include brachiopods, crinoids, corals, and bryozoans. All of the Madison in this area was deposited on a shallow seafloor during the Mississippian Period. The Madison was named in 1893 for outcrops in the Madison Range in southwestern Montana. The Mission Canyon Limestone and Lodgepole Limestone were each named in 1922 for a canyon in the Little Rocky Mountains in northcentral Montana. Caves are common in the Mission Canyon Limestone. The Madison has been the most productive reservoir of oil and natural gas in the Bighorn Basin and the Williston Basin. On the southwest side of Big Pryor Mountain, Madison limestone is quarried as a source of chemically pure calcium carbonate.