lion Creek Formation in Montana, Wyoming, and South Dakota. The Bullion Creek Formation is composed primarily of flood-plain sediments, including unconsolidated sands, silts, and clays. Freshwater limestones and thin, discontinuous lignites (with the exception of the thick and laterally extensive HT Butte lignite which has been defined as the upper contact of the Bullion Creek) are also present. The carbonates are of two types: most common are the discontinuous pods of laminated lime mud, which are mudcracked at the top and may indicate evaporative ponds; more rarely, a gastropod-pelecypod-fishscale wackestone occurs near the top of the formation, and represents a small (≈ 1 mi^2, 3 km^2) lacustrine deposit.

Channeling in the Bullion Creek is of special interest. Paleochannels have a low width to depth ratio and appear laterally stable as evidenced by lack of lateral accretion or point bar deposits and vertical stacking. In map view, channels of equal stratigraphic position converge with and diverge from each other.

The preponderant flood-plain sediments, lignites, and carbonates, as well as channel configuration would seem to indicate deltaic sedimentation; however, the deposits contain fauna which are strictly fresh water, thereby making this interpretation tenuous. A possible alternative to this deltaic interpretation is the anastamosing fluvial model. This model, proposed by Smith and Putnam in 1980, has a dominance of vertical accretion, producing channel deposits which are thick, narrow, and laterally stable, as well as extensive inter-channel wetlands and lakes. Hanley and Flores in 1983 proposed a similar depositional picture for part of the Tongue River Member in the Powder River basin in northeastern Wyoming. Anastamosis in the Williston basin is probably the result of greater relative local subsidence of the basin than in the downstream reaches.

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Corals of Madison Group (Mississippian), Williston Basin, North Dakota

Coral faunas studied from subsurface cores of the Mississippian Madison Group in the Williston basin of North Dakota indicate that Sando's coral zones for outcrops in western North America can be extended into the subsurface of North Dakota. Coral zones II and III are recognized as corresponding roughly to lower and upper Mission Canyon strata, respectively. These data were obtained from 12 wells along the northern border of North Dakota in Divide, Burke, Renville, and Bottineau Counties, and two wells near the center of Williston basin in Dunn and McKenzie Counties.

Coral faunas appear to show a relatively low diversity of 13 species distributed among the following genera: *Syringopora*, *Vesiculophyllum*, *Sychnoelasma*, *Amplexizaphrentis*, *Lophophyllum*, *Cyathaxonia*, *Lithostrotion* (*Siphonodendron*), *Diphyphyllum*, *Michelinia*, and *Stelechophyllum*. *Vesiculophyllum*, *Sychnoelasma*, and *Syringopora* are the most abundant genera of the Madison Group in North Dakota.

Corals found in dark argillaceous crinoid-skeletal wackestones representing "deeper" waters are robust, and this may infer a hospitable environment for their growth. However, evidence from the coral and lithologic associations refute the pervading dogma that the occurrence of corals is strictly facies controlled. Abundant smaller corals have been found from buff-colored skeletal wackestones and algal mudstones which alternate with subaqueous anhydrites representing a marginal marine environment. In addition, corals have been found in buff-colored skeletal and peloidal grainstones of adjacent shoals and in brown pisolitic-oolitic packstones-wackestones of possible tidal ponds. These latter deposits may represent allochthonous accumulations, but the amount of time involved in transport of corals would not invalidate their usefulness as biostratigraphic tools.

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Paleotectonic Control of Depositional Facies, (Devonian), Southwest Montana

Deposition of the Jefferson Formation occurred on a shallow carbonate platform that extended westward to the Antler foreland basin. The distribution of facies and porosity trends was controlled by the structural trends imposed on the area during the late Precambrian and the relative movement of these paleostructural elements during Jefferson deposition. Isopach values (formation "thins") suggest the presence of paleohigh structural elements identified as the Alberta shelf, Tendoy high, and Beartooth shelf, separated by formation "thicks" in the paleolow structural elements (troughs), identified as the Central Montana trough and Ruby trough.

The Jefferson Formation is a moderately thick cyclical sequence of dolomitized carbonate rocks deposited in an extensive tidal flat-lagoonal environment similar to modern tidal flats of Andros Island and the sabkha-lagoonal regions of the Persian Gulf. Normal marine, restricted marine, and evaporite platform facies are recognizable in the Jeffereson, and occur in repetitious fining-upward cycles, which are generally capped by the evaporite facies. Evaporitic facies are predominant in the areas of paleohighs, whereas restricted and normal marine facies predominate in paleolows. Dolomitization was probably contemporaneous in areas of paleohighs, and resulted in microcrystalline dolomite associated with evaporites. Areas marginal to the paleohighs and in paleolows were originally the sites of restricted and normal marine limestone deposition. Subsequent dolomitization has locally destroyed all primary structures.

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Codell Sandstone, Denver Basin—Frontier Exploration in a Mature Basin

The Codell Sandstone Member of the Carlile Shale is a new exploration target for oil and gas in the northern Denver basin. The Codell interval ranges in thickness from a wedge edge to approximately 100 ft (30.5 m), the average being 15 to 20 ft (4.5 to 6.1 m). The Codell is well developed in the southern Denver basin, is absent in a broad northeast-trending area in the central Denver basin, and is sporadically developed in the northern Denver basin.

The variation in geographic distribution and thickness results from regional unconformities at the base and top of the Codell. The Carlile Shale (50 to 200 ft, 15.3 to 61 m, thick) in the Denver basin and marginal outcrop has four members which, in ascending order, are the Fairport Chalk, Blue Hill Shale, Codell Sandstone, and Juana Lopez Limestone. The unconformity at the base of the Codell Sandstone has a hiatus which increases in magnitude to the west across the basin. The sandstone is transitional with the overlying Blue Hill in central Kansas but it rests on Fairport equivalents over most of the Denver basin and underlying Greenhorn Formation along the northwest flank of the basin. The unconformity at the top places the Fort Hays Limestone Member of the Niobrara in erosional contact with either the thin (1 to 3 ft, 0.3 to 0.9 m) Juana Lopez or the Codell Sandstone.

Outcrop and core studies clearly show three types of sandstones which developed during sea level changes of late Turonian and early Coniacian age. The Codell is related to processes in three different environmental settings. (1) Marine (or shoreline) bars, which have a transitional base with the underlying Blue Hill Shale. The sandstones have good porosity and permeability and a sheetlike distribution. These sandstones occur in Kansas and the southern Denver basin and are not currently productive of petroleum. (2) Tight bioturbated and reworked marine shelf sandstones generally without a central-bar facies. These sands may also be associated with thin, irregular, relict, or palimpsest shelf deposits which locally are coarse grained and conglomeratic. Recent petroleum discoveries have been made in this sandstone facies in the west-central portion of the Denver basin. Productive depths range from 4,000 to 8,000 ft (1,219 to 2,438 m). Net pay ranges from 3 to 25 ft (0.9 to 7.6 m). Porosities range from 8 to 24%. Permeabilities are generally less than 0.5 md. Trapping of petroleum appears to be stratigraphic. (3) Tight sandstones of marine origin(?) filling large scour depressions (valleys?) which were eroded into underlying Fairport or Greenhorn strata. Although these sandstones are the thickest found in the Codell, they are generally tight and occur mainly in the Wyoming portion of the basin. Only minor production has been found in this facies.

Variation in thickness and reservoir quality is related to original environmental control, paleostructure which locally influenced the unconformities, fracturing, and diagenesis. Where fracturing is important to reservoir quality, the Codell and overlying Fort Hays Limestone may be a commingled reservoir.