The Mississippian Delle Phosphatic Member forms the basal member of seven different formations from southeastern Nevada, through Utah, to southeastern Idaho. The Delle is comprised of mainly dark organic-rich phosphatic mudstone containing large micritic limestone concretions, and bedded radiolarian chert, peloidal phosphorite, and cherty micrite. It was deposited in Osagean to Meramecian time within the eastern half of the Antler foreland trough in dysaerobic settings of the Deseret starved basin and adjacent lower foreslope of a carbonate platform. The Delle Phosphatic Member lacks conspicuous shelly megafaunas but contains a rich microfauna, consisting most importantly of conodonts, radiolarians, and agglutinate foraminiferans. Also present are fewer large planktonic, epiplanktonic, nektonic, and benthic animals, and floating marine and transported land plants. Knowledge of this diverse biota, recovered mostly from the large micritic limestone concretions, is important to an understanding of the source of hydrocarbons in the organic-rich sequence. Organic carbon values are inversely related to conodont alteration index (CAI) values, and comparison of maps of these two sets of values suggests areas where hydrocarbons are either overmature or at optimum maturation for petroleum generation. Models for hydrocarbon accumulation and maturation in the Delle are applicable worldwide to other dysaerobic deep-basinal dark rocks containing similar concretions—for example, the Devonian and Mississippian Bakken-Exshaw-Sappington-Leatham depositional complex and Permian Phosphoria Formation of the western United States, the Devonian Huron Shale Member of the Ohio Shale in Ohio, and the Upper Devonian sequence of western New York.

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New Biostratigraphic and Paleotectonic Interpretation of Devonian and Mississippian Rocks in Southwestern Montana Thrust Belt

The structurally complex area of previously undifferentiated Mississippian rocks below the Meramecian Kibbey Sandstone in the southwestern Montana thrust belt of the northern Tendoy Range actually comprises an unusual combination of Devonian and Mississippian basinal, slope, platform, and nearshore deposits. The lower part of this sequence comprised two widespread western Montana formations: the Devonian part of the Three Forks Formation over 65 m (213 ft) thick, containing all three members, and the basinal Kinderhookian and Osagean Paine Limestone, 228 m (748 ft) thick. However, the Paine is succeeded by an eastern tongue of the older, Osagean part of the lower-slope Middle Canyon Formation, 266 m (872 ft) thick. This tongue consists of clinoform cherty micrite and bedded chert, with some encrinite debris flows that increase upward in number and thickness. The overlying Osagean and Meramecian Mission Canyon Limestone comprises 102 m (335 ft) of an upper-slope encrinite lower member and 74 m (243 ft) of a mainly shelf-margin wackestone and encrinite upper member. Thus, the Mission Canyon here represents the distal part of a broad carbonate platform. Succeeding the Mission Canyon is 140 m (459 ft) of the newly named Meramecian McKenzie Canyon Limestone, which comprises a sabkha, back-mound, and lagoonal sequence of evaporite-solution breccia, micrite, dismicrite, and pelmicrite, with interbeds of crinoidal wackestone, encrinite, and bio-oopelsparite. This formation represents beds absent at an unconformity elsewhere in western Montana and western Wyoming. Thus, the sequence from the Paine through the McKenzie Canyon, constituting the newly named Tendoy Group is 810 m (2,657 ft) thick and represents one of the most complete records of Kinderhookian to Meramecian carbonate deposition in the northwestern United States, displayed in the predominantly upward-shallowing part of a eustatic megacycle. The reconstructed detailed biostratigraphy aids new structural interpretations and provides several new plays for petroleum exploration in the Montana thrust belt.

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Rediscovering an Abandoned Reservoir: Lakota Formation at Lost Soldier Field, Fremont County, Wyoming

Lost Soldier field (T26N, R90W) is one of several fields that parallel the Granite Mountains uplift. The subsurface structure at the Lakota level is a northwest-trending, doubly plunging anticline. The Lakota Formation at Lost Soldier field is a complex, fluvial-sand sequence, representing braided- and meandering-stream environments. Lakota channels have both podlike and sheetlike geometries, and grade laterally into crevasse splay and floodplain deposits.

The Lakota reservoir was discovered in 1922. Between 1922 and the early 1950s, the reservoir produced about 5 million bbl of oil. The early Lakota wells were drilled mainly on the top of the structure and along lease lines. These early wells were all shut-in by the early 1950s when the Lakota reservoir, thought to be depleted, was abandoned.

During the late 1970s, following Amoco's purchase of Lost Soldier field, Amoco geologists noticed high-resistivity anomalies in the Lakota Formation. In 1979 a well was recompleted in the Lakota with an IP of 65 BOPD and 22 BWPD. The successful recompletion proved that the early Lakota producers had not completely drained the reservoir.

Since 1979 Amoco has completed or recompleted 22 Lakota producers. These wells have been drilled to define the oil-water contact for the Lakota, to develop a thick net-sandstone trend on the southern end of the structure, and to test the Lakota production potential in other parts of the field. It is estimated that the recent Lakota wells will produce about 1 million bbl of oil. The average IP for the wells is 67 BOPD and 104 BWPD.

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Erosional History and Possible Passive Uplift of Paris-Willard Thrust Allochthon, Wyoming-Idaho-Utah Thrust Belt

Stratigraphic distribution of clast lithologies in Sevier foreland basin synorogenic conglomerates in the southwestern Wyoming–southeastern Idaho–northeastern Utah thrust belt provides evidence of the erosional history of the Paris-Willard thrust allochthon. Conglomerates of the Upper Jurassic–Lower Cretaceous Gannett Group were deposited in response to initial movement along the Paris-Willard thrust system and are comprised of cobbles and pebbles of Ordovician through Jurassic strata, with upper Paleozoic and lower Mesozoic clasts most common. Thus, by conclusion of initial Paris-Willard thrust movement, the allochthon had been affected by widespread erosion of lower Paleozoic through lower Mesozoic strata.

Evidence for subsequent erosion to deeper stratigraphic levels is contained in the basal Hams Fork Conglomerate Member of the Upper Cretaceous–Paleocene Evanston Formation. This unit contains abundant Precambrian quartzite cobbles, which must have been derived from the Paris-Willard allochthon, the only thrust sheet that contains Precambrian quartzite units. Genesis of the Hams Fork Conglomerate has been related to latest Cretaceous major movement along the Absaroka thrust. Thus, either the Paris-Willard thrust was fortuitously reactivated at the same time as major Absaroka thrust movement or uplift associated with movement along the Absaroka thrust resulted in coeval uplift of the Paris-Willard allochthon.

One mechanism that could elevate the older Paris-Willard allochthon and allow for erosion to deep stratigraphic levels during major displacement along the Absaroka thrust would involve antiformal arching of the Paris-Willard allochthon as it was carried passively over a major footwall ramp of the Absaroka thrust. Folding and uplift of older "passive" thrusts carried piggyback by younger "active" thrusts might be an important mechanism in formation of source terranes for synorogenic foreland basin clastics.

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Integrating Geology and Geophysics in an Interactive Environment

Seismic data may be used to enhance well data in a prospect area. The method involves the generation of depth, time, and velocity surfaces, and manipulation of these surfaces to generate an integrated depth, structure, or isopach map.

The usual sequence is: (1) use well data to generate a depth surface, (2) use seismic data to generate a time surface, (3) divide the above two to obtain a velocity surface, (4) interpolate velocities for seismic data using the velocity surface, (5) calculate depth for seismic data, (6) merge depths from seismic data with those from well data, and (7) use combined depths to generate the enhanced depth surface.

There can be many variations to this procedure, yielding better results in some situations. Special handling is required when there are mis-ties or