completed. The Missourian and Virgilian sequence includes about 132 m of carbonate rocks divided into 46 units for collection and description. Eighteen of these units yielded a silicified brachiopod assemblage totaling 21 strophomenids and 17 taxa of other orders. Fossil abundance is greatest in the lower part of the Missourian and from the topmost Missourian through the middle Virgilian. Correlation with the middle Virgilian of North Texas and, perhaps, the lower Missourian of the southwest is especially strong. Notable range extensions include: (1) *Paeckelmanella*? n. sp., an otherwise Arctic Permian taxon, in the Virgilian; (2) *Mesolobus euampygus* in the Early Missourian, an extension of generic range from the Desmoinesian; (3) *Paucispinifer* n. sp., a Permian genus occurring in the Missourian; and (4) *Neospirifer latus lateralis*, a Missourian species occurring in the Virgilian. In addition, *Calliprotonia* n. sp. is reported the second occurrence of this genus in the North American Virgilian.

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Kinematic Model for Evolution of Cordilleran Fold/Thrust Belt, Canada to Mexico

Cretaceous to early Tertiary shortening of the foreland region occurred along listric thrust faults bounded by conjugate wrench faults that cut through and ductilely deformed the underlying Precambrian basement. Oblique convergence on east-dipping B-type subduction along the western edge of the North American plate coupled with west-dipping A-type subduction along a zone east of the plate margin and marked by muscovite-bearing two-mica granites produced conjugate WNW-trending left-slip and NE-trending right-slip faults and the foreshortening evinced by the decollement faults of the Western Overthrust. Many left-slip faults split into right-turning splays that join other left-lateral faults, creating thrust systems with a regional Z-shaped bend (e.g., thrusts of the Sawtooth Range, Montana). Conversely, right-slip faults split into left-turning splays that join other right-slip faults creating S-shaped thrust systems. Conjugate pairs of strike-slip faults bound concave-westward zones of decollement thrust faults (e.g., thrusts of the Belt graben, Montana). Complex flower structures mark the loci of many wrench faults (e.g., Arizona and southwestern New Mexico). Late Tertiary to Holocene extensional deformation of western North America produced the north-trending listric normal faults of the Great Basin and reversed the sense of movement on many preexisting strike-slip and thrust faults. These regional relationships are clearly visible on digitally processed Landsat imagery.

This model also accounts for the synchronous intrusion of both two-mica (muscovite) and one-mica (copper porphyry type) granitic rocks in the region. This geologic paradigm will assist the exploration for hydrocarbons and minerals.

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Lithology and Depositional Environment of Ashern Formation (Middle Devonian), North Dakota

The Ashern Formation (Middle Devonian) is the basal unit of the Kaskaskia Sequence in North Dakota. It is unconformably underlain by the Silurian Interlake Formation, and overlain, generally conformably, by the Winnipegosis Formation of Middle Devonian age. The Ashern is present in the northwestern one-third to one-half of North Dakota. Beyond the limits of the overlying Winnipegosis Formation, the Ashern is indistinguishable on electric logs from the basal argillaceous members of the Dawson Bay and Souris River formations and, together with these, must be considered undifferentiated basal Devonian.

The Ashern Formation is composed of two members. The lower red member is predominantly an argillaceous microcrystalline dolostone, containing nodular anhydrite and thin shale partings. The upper dark gray member is predominantly a featureless microcrystalline limestone. Together, these two members range in thickness from about 10 m near the limit of the Ashern Formation to about 50 m near the center of the Williston basin.

The red member owes its color to a reworking of a lateritic soil on top of the Late Silurian/Early Devonian erosional surface. The fine-grained dolostone and its nodular anhydrite imply supratidal deposition in a sabkha environment. The featureless gray member was deposited in a low intertidal to subtidal environment. There is an occasional suggestion of bioturbation, though no fossils have been found. No porosity is evident in the formation, except for some partly anhydrite-filled fractures near the top in one core.

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Depositional Environment and Rock Fabric, Birdbear ("Nisku") Formation (Upper Devonian), Williston Basin, North Dakota

The Birdbear Formation was deposited as the upper part of a widespread marine carbonate and evaporite system prevalent in the Williston basin during the Middle and Late Devonian. Rock facies representing shallow-water and associated carbonate subenvironments are present in the Birdbear. Stillstands of subenvironments and frequency of transitions between subenvironments are similar to those in the underlying Duperow Formation. Evaporites are dominant in the uppermost part of the Birdbear.

Original depositional environments are recognized with subsequent diagenetic events evaluated. The development of interparticle and moldic porosity is outlined, in particular, with reference to dolomite.

Dolomites are prevalent in the upper section of the Birdbear Formation. Evidence suggests shallow intertidal and supratidal conditions with porosity development associated with the dolomites. Overlying limestones and anhydrites act as caprock.

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Origin of Dolomite, Red River Formation, Richland County, Montana

Distribution of limestone, dolomite, and anhydrite as determined from compensated neutron-density logs and core studies of the Ordovician Red River Formation in Richland County indicates that: (1) virtually all deposition, including the B and C zone anhydrites, occurred subtidally (contrary to previous interpretations invoking localized tidal flats on paleo-highs); (2) various rock units such as the anhydrites and B and C "laminated" zones have remarkable uniformity and lateral continuity over many tens of miles; and (3) dolomitization occurred in subtidal stromatolites, by primary precipitation, or by gravitational seepage of Mg-rich brines into normal marine subtidal carbonates. The lateral persistence of the A and B zone dolomites indicates they formed mainly by primary precipitation and/or dolomitization of subtidal stromatolites whereas the localized replacement dolomites of the C and D zones formed by gravitational seepage of dense brines.