and a well-defined pattern of northeast-trending gravity and aeromagnetic anomalies underlying this part of central Montana and southwesternmost Saskatchewan.

Taken together, all these geologic features define a broad, northeast-trending zone at least 150 to 200 km (93 to 125 mi) wide and more than 1,000 km (620 mi) long. The zone is approximately colinear but not demonstrably continuous with the well-exposed boundary in eastern Saskatchewan and Manitoba between the Archean Superior and the Proterozoic Churchill provinces of the Canadian Shield. This boundary is also characterized by: high-angle faults, shear zones, and topographic lineaments; pronounced linear gravity and magnetic anomalies; igneous intrusions; and fault controlled depositional patterns and mineralization. That the Great Falls lineament is controlled by a similar Precambrian boundary between the Archean Wyoming province of southwestern Montana and early Proterozoic terrane to the north is speculative; however, the geologic features found along the Great Falls lineament share many common characteristics with features present along the Archean-Proterozoic boundary in Canada.

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Erosional History of Big Horn Basin: Mackin Revisited

The classic study of the erosional history of Big Horn basin is by Mackin in 1937. In it he studied the terrace levels which ranged in age from Late Tertiary to late Pleistocene. He postulated that the terraces were the product of stream captures or intervals of interglacial stability alternating with glacial incision. More recent studies have revised Mackin's classically simple model.

Detailed studies have increased the number of terrace levels, changed the timing of their stability episode, and estimated their ages. The number of terrace levels has been increased to nine along the Greybull and Bighorn Rivers and to six along the Shoshoni River. Because some of the different levels occur along each river, the number of unique levels within the basin is 12. The occurrence of a 600,000 and a 100,000 year old ash on two terrace levels allows the ages of the terraces to be estimated. The estimated ages range from 3 m.y. for the Tatman to 49,000 years for the Himes, which is the lowest level along the Bighorn River. Both ashes were deposited during river stability intervals and indicate that the Bighorn River and its eastern tributaries were stable late in the interglacial episodes. In contrast, the glaciofluvial gravels along the Shoshoni River at Cody indicate a late glacial stability episode for the western tributaries. The terrace cycles along the Bighorn River and its western tributaries are therefore out-of-phase. This relationship fostered the numerous stream captures recognized by Mackin, as well as some unusual terrace geometries. Comparison of the estimated terrace ages to termination in the marine isotopic record indicates that not all of the Pleistocene climatic cycles are preserved in the Big Horn basin terrace chronology. The present chronology is currently more complete than that of Mackin's pioneering work of the 1930s, but it has not changed his basic story.

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Seismic Data Acquisition Parameters, Northwest Montana

The Montana Overthrust area and adjacent Disturbed Belt are characterized by extremely complex geology and rugged topography. To date, several hundred miles of high quality seismic data have been acquired in this area. The first step in obtaining this data quality was to understand the physical characteristics of the rock properties for seismic signal and noise, then to apply this information in designing our data acquisition parameters.

At the commencement of each seismic specification program, a complete suite of experimental tests were run over carefully selected areas. These tests generally included noise and reflection analysis, geophone patterns, energy input patterns, offsets, expanding spreads, and specific problems (i.e., traffic, freezing, thawing). From these tests, appropriate field parameters were selected for various surface and subsurface geologic environments.

It is the scope of this paper to discuss the results of these tests and the subsequent fine tuning of both acquisition and processing parameters of this data.

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Late Jurassic Tectonism on West Side of Colorado Plateau, Utah and Arizona

Detailed sedimentologic studies in south-central Utah and north-central Arizona indicate that several major basins and uplifts as well as many smaller folds within them were actively growing during deposition of the Salt Wash Member of the Morrison Formation. The region lies outside that part of the Colorado Plateau underlain by thick Pennsylvanian halite deposits so the structures are not related to salt deformation. Tectonic activity in the region is inferred from several types of sedimentologic features which include thickness variations, facies distribution, cross-bedding parameters, and bedding ratios. Distribution of the various features studied indicates the Emery, Circle Cliffs, Echo Cliffs-Kaibab, Cow Springs, and Monument uplifts, as well as the Henry and Kaiparowits basins, were active during the Late Jurassic. In addition, several anticlines and synclines that were active at the same time can be delineated in or near the Henry and Kaiparowits basins.

The apparent absence of local angular unconformities in the Salt Wash near the positive structures suggests that most of the tectonic movements were the result of differential subsidence rather than uplift of the positive structures. It could not be determined if the San Rafael swell near the Emery uplift was active during Late Jurassic time. Also, the relationships are not entirely conclusive but suggest that the Cow Springs uplift may have extended southeast across Black Mesa and that downwarping may not have occurred there in the Late Jurassic.

Late Jurassic folds have essentially the same northwest to north-northwest trend as many of the Laramide and possibly younger folds in the region although the older folds tend to be less sinuous. Vertical repetition of lacustrine strata, deposited under conditions especially sensitive to slight tectonic movements, suggest that the movements were episodic. Comparison of the present amount of structural relief with the Late Jurassic structural relief indicates that approximately 3 to 7% of the present-day relief between several of the major basins and uplifts can be attributed to tectonic movements during deposition of the Salt Wash. Thus, it is erroneous to assume that all of the structural deformation in the region occurred during or after the Laramide orogeny.

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Mesozoic and Early Tertiary Paleostructure and Sedimentology of Central Wasatch Mountains, Uinta Mountains, and Uinta Basin

During latest Cretaceous-Eocene time, 5,000 m (16,000 ft) of beds were deposited in central and northeast Utah. In the Late Cretaceous, sediment derived from the Sevier-Laramide thrust belt was transported to the east and southeast. Southerly paleocurrent directions in the base of the Currant Creek Formation (Maestrichtian) raise the possibility that uplift of the Uintas may have begun by then. The thrust belt continued as a major highland during the early Paleocene, and major uplift of the Uintas occurred. By the middle Paleocene there was an extensive lake which regressed during the late Paleocene as uplift of the Uintas continued. Lake Uinta reached its maximum size during the middle Eocene. During the late Eocene, Lake Uinta regressed and, near the end of the epoch, the lake expired. Major sediment influx was from the east and southeast. Lower (early Duchesnean) and upper (Late Duchesnean) conglomeratic intervals record major episodes of uplift in the Uintas during latest Eocene.

Structurally, the Wasatch Mountains are part of a marginal foreland fold and thrust belt. In the northern Wasatch Mountains, pre-Late Cretaceous thrust fault plates were folded in part of a large, ramp-anticline that is cored by allochthonous, crystalline basement. Foreland thrust belt structures in the central Wasatch Mountains were folded about the east-trending Uinta axis as the Uinta Mountains formed. Eastward movement on the Hogsback thrust during the Paleocene was transferred onto the adjacent Uinta axis and Uinta Mountains structure, causing about 20 km (12 mi) of sinistral slip in the western Uinta Mountains. Deformation in the Uinta Mountains continued following cessation of movement on the Hogsback thrust system. A south-dipping fault ramp was located beneath the Uinta Mountains and extended to depths of 15 to 20 km (9 to 12 mi).