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Seismic Profile Across Leading Edge of Fold and Thrust Belt of Southwestern Montana

The fold and thrust belt of southwestern Montana and east-central Idaho is the northern continuation of the thrust belt of Utah, Wyoming, and southern Idaho. The frontal fold and thrust zone, which the seismic profile transects, is in the same structural position and exhibits similar geologic relationships as the disturbed belt farther north in Montana and the part of the Utah-Wyoming thrust belt east of the Paris-Willard thrust. The seismic profile illustrates: (1) rocks of the Archean basement complex dip gently westward beneath the thrust belt, (2) the Phanerozoic section is thickened dramatically in the western part of the profile by thrusting and folding, (3) the principal decollement horizon is probably at the top of the Mississippian section, (4) at least one thrust involves basement rocks, (5) the basement surface is also cut by steep reverse faults, (6) Tertiary basins contain numerous steep normal faults which cut basement rocks, several of which can be projected to connect with steep northwest-trending reverse faults in the Ruby Range, and (7) Tertiary rocks in the Beaverhead Valley immediately overlie either a thin Paleozoic section or Archean basement indicating that most of the stratigraphic section was removed prior to mid-Tertiary normal faulting.

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Tectonostratigraphic Analysis of Powder River Basin, Wyoming

The Powder River basin of northeastern Wyoming is a basin of the broken foreland between the stable interior of the craton and the Cordilleran orogenic belt. The formation of the basin reflects the complex depositional history of both regions. The rock strata within the basin may be divided into tectonostratigraphic units that allow interpretation of basin evolution within a plate-tectonic context.

During Precambrian to Late Devonian time, the area occupied by the present-day basin was transitional between the craton and the rifted margin of the continental shelf to the west. The basin area occupied a complex setting peripheral to foreland basins and the stable continental interior during the Antler orogeny (Devonian-Mississippian), Humboldt orogeny (Pennsylvanian-Permian), Sonoman orogeny (Permian-Triassic), and Nevadan stage of the Cordilleran orogeny (middle Late Jurassic). After the beginning of the Sevier orogeny in the Late Jurassic, the area was within the Cretaceous retroarc foreland basin. The first indication of subsidence within the basin is late in Laramide time (Paleocene); subsidence continued through at least early Eocene time. Stream drainages in Paleocene to early Eocene time were dominated by rising highlands, which produced a north-flowing trunk stream. During much of the Paleogene, this drainage was connected to the Wind River basin on the southwest.

A-type subduction of the cratonic margin beneath the rising magmatic arc in the western batholithic belt, following collision of exotic terranes during a period of increased movement of the craton relative to the Pacific plate, was the most probable cause for events of the Cordilleran orogeny. Laramide-style basement-block uplifts express the extension of the thin-skinned tectonics in the western orogenic belt eastward into the thicker lithosphere of the foreland along the craton margin, possibly during overriding of an aseismic ridge on the Pacific plate by western North America. Uplift and erosion of the basin since early Eocene time may be due to thermotectonic uplift around the apices of the Snake River plain and the Rio Grande rift.

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Early Campanian Coastal Progradational Systems and Their Coal-Forming Environments, Wyoming to New Mexico

Ammonite zones (*Baculites obtusus-Scaphites hippocrepis*) in the marine facies associated with the Mesaverde Formation in the Bighorn basin, Wyoming, Star Point Sandstone and Blackhawk Formation in the Wasatch Plateau, Utah, and the Point Lookout Sandstone, Menefee Formation, and Crevasse Canyon Formation in the Gallup coalfield, New Mexico, indicate that these formations were deposited during early Campanian time (80-84 Ma).

The coal-forming environments of these early Campanian formations were located landward of wave-reworked coastal sand complexes of progradational systems along the western margin of the Cretaceous seaway from Wyoming to New Mexico. The Mesaverde coals accumulated in swamps of the lower delta plain and coeval interdeltaic strandplain environments. The Star Point-Blackhawk coals accumulated in swamps of the lower delta plains of laterally shifting, prograding deltas and associated barrier ridge plains. The Point Lookout, Menefee, and Crevasse Canyon coals formed in swamps of the lower delta plain and infilled lagoons behind barrier islands.

Although the common coal-forming environments of these progradational systems are back barrier and delta plain, the former setting was the more conducive for accumulation of thick, laterally extensive coals. Economic coal deposits formed in swamps built on abandoned back-barrier platforms that were free of detrital influx and marine influence. Delta-plain coals tend to be lenticular and laterally discontinuous and thus uneconomic.

The early Campanian coal-forming coastal-plain environments are analogous to modern peat-forming environments along the coast of Belize, Central America. Deltaic sediments deposited along the Belize coast by short-headed streams are reworked by waves into coastal barrier systems.

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Estimating Coal Quality from Borehole Logs

Evaluation of coal quality is traditionally done on borehole cores in the laboratory; it is expensive and time consuming. Now, using a microcomputer-based geologic work station, geologists can obtain inexpensively reliable coal-quality estimates in minimal time. Typical coal borehole logs (gamma, density, and resistivity) are calibrated with a few core analyses from a specific area by correlating dry BTU content (measured in the laboratory) with measured log values for each zone analyzed. Multiple regression techniques describe the relationship between logs and BTU content. The regression surface of BTU on gamma and density, or the regression hypersurface of BTU on gamma, density, and resistivity is used to estimate the BTU for user-specified depth zones in boreholes that have not been cored. Confidence surfaces nested around the regression surfaces and hypersurfaces bracket the estimated BTU values within preselected confidence intervals.

The estimated BTU content of a coal seam is expressed as an expected value per depth increment. Each is easily qualified with user-specified confidence limits. Expected values can be averaged over any zone of interest, either an entire coal seam or a zone within the seam. Expected coal-quality values for numerous boreholes can be contoured to produce a coal quality isograd map. The volume of coal within any isograd can then be estimated. With a stand-alone geologic work station, geologists can make estimates and relevant maps on site; they no longer need to wait for core analyses as results are immediate.

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Reinterpretation of Relationships Among Keystone Thrust, Red Springs Thrust, Contact Thrust, and Cottonwood Fault, Clark County, Nevada

The basin-range and Sevier tectonic events are well-documented in Clark County, Nevada. Other tectonic events have been interpreted from structural relationships in the Spring Mountains. These include an early thrust-faulting event and a high-angle faulting event that occurred between emplacement of the early thrust and emplacement of the Keystone thrust. The results of this study indicate that there was not an early thrust event nor was there high-angle faulting prior to the Sevier deformational event.

The Cottonwood fault and the Contact thrust in the Spring Mountains are interpreted here as a lateral ramp and floor thrust beneath a duplex fault zone. The Keystone thrust forms the roof thrust for the duplex fault