bears this relationship to the Uinta thrust, increasing in distance from the thrust trace as stratigraphic throw and amount of overhang of the thrust increases. A plunging section of the South Granite Mountains fault system in the area of Ferris Mountain provides a downplunge cross section in which the collapse fault can be seen to join and "back down" the root zone of the thrust. Thus the outer thrust lip "hangs up" and is left standing higher than the core of the uplift. Distance between the two types of faults provides an estimate of the amount of overhang.

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Correlation of Ogden Thrust, Durst Mountain Thrust, and Allochthonous Precambrian Farmington Canyon Complex in North-Central Wasatch Mountains, Utah

The Precambrian Farmington Canyon complex crops out in the Wasatch Mountains between Ogden and Bountiful, Utah. Additional exposures are present at Durst Mountain and at Antelope Island.

East of Ogden, between Ogden Canyon and Strongs Canyon, the Farmington Canyon complex has been thrust eastward over Lower Cambrian Tintic Quartzite and Middle Cambrian shales and limestones of the Ophir Formation and Maxfield Limestone. This thrust is named the Ogden thrust. Similarly, at Durst Mountain, east of Morgan Valley, the Farmington Canyon complex has been thrust over Lower Cambrian Tintic Quartzite and Middle Cambrian shales and limestones. This thrust fault is the Durst Mountain thrust. If subsequent vertical offset of 2,000-4,000 ft (610-1,220 m) down to the west on the Morgan Valley normal fault is restored, it appears that the two similar thrusts involving the Farmington Canyon complex could once have been continuous. Such a reconstruction requires a minimum of 12 mi (19.3 km) of thrust displacement of the complex eastward over the sequence of basal Cambrian rocks.

This evidence is significant for two reasons: (1) the Farmington Canyon complex of the Wasatch Mountains may not be in place, but may be allochthonous above a decollement at depth; and (2) the Paleozoic-Mesozoic sequence east of Morgan may also overlie the same decollement, which would increase the potential for petroleum plays in the area north of Croyden.

Thus, the northern Utah uplift, proposed for this area by A. J. Eardley and discussed by M. D. Crittenden, may result from a sequence of Farmington Canyon complex thrust upsection eastward, rather than a vertical uplift of basement.

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Late Cretaceous and Paleocene Faulting in Rocky Mountain Foreland and Frontal Thrust Zone, Southeastern Montana

The Late Cretaceous and Paleocene structural pattern in southwestern Montana is comprised of three spatially and temporally overlapping sets of structures whose positions strongly reflect the influence of previous basement faults and whose kinematics imply dominantly west-to-east compressive forces.

The first of these patterns is a set of steep northwest-trending faults involving the metamorphic basement rocks of the Rocky Mountain foreland. Movement on these faults was oblique (left-reverse) and occurred as a reactivation of faults which developed initially in middle Proterozoic time. Net horizontal shortening by faulting and associated large-scale folding is 10-20 km (6-12 mi).

Another fault pattern within the foreland is a set of widely spaced, gently west-dipping thrusts. These thrusts also involve basement rocks and appear to have been controlled by previous zones of weakness within the crust. Movement is principally dip-slip and latest movement appears to involve tearing on the northwest-trending fault set. Shortening by basement thrusting and associated folding is 20-25 km (12-15 mi).

The other structural pattern is that of the frontal fold and thrust zone on the western boundary of the foreland and the zone of transverse thrusting on the northern boundary. These zones of impinging thrusts also involve basement rocks principally as slices that were "picked off" from underlying basement highs during ramping. As the thrusts of the frontal zone advanced to the east they impinged on northwest-trending foreland anticlines and were torn on the northwest-trending faults. The transverse thrust zone on the north involves right-reverse movement with about 20 km (12 mi) of west-east displacement. The zone is fundamentally a transverse ramp produced by deflection along the east-trending Willow Creek fault zone of Proterozoic age.

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Provenance Control of Fluvial Sandstone Diagenesis, Frontier Formation (Upper Cretaceous), Wyoming-Idaho-Utah Thrust Belt

Meandering stream channel sandstones and associated conglomerates of the Frontier Formation (Upper Cretaceous) in the Wyoming-Idaho-Utah thrust belt provide an excellent example of provenance (compositional) influence on diagenetic history. Fluvial sandstones in the southern thrust belt (northeastern Utah and southwestern Wyoming) are litharenites and sublitharenites dominated by chert, carbonate rock fragments, and monocrystalline quartz derived from erosion of Paleozoic strata exposed in thrust plates to the west.

Early diagenetic phenomena include compaction, as evidenced by deformed mudstone clasts and micas, and quartz overgrowth development. Subsequent diagenesis is variable and may include precipitation of sparry calcite, clay minerals (chlorite or kaolinite), or a combination of calcite and clay. Porosity values typically range from 3 to 15%. Porosity is dominantly secondary in origin and formed by dissolution of carbonate rock fragments and cement.

Frontier fluvial sandstones in the northern thrust belt (northwestern Wyoming and adjacent southeastern Idaho) are feldspathic litharenites, lithic arkoses, and arkoses derived from erosion of both sedimentary and volcanic terranes. Sedimentary detritus includes chert and carbonate rock fragments; volcanic detritus includes tuffaceous volcanic rock fragments and plagioclase. Diagenesis is characterized by extensive albite, chert, and kaolinite cementation and almost total concomitant porosity occlusion. Rarely, sandstones may possess several percent porosity due to secondary dissolution of detrital plagioclase.

Albite cement occurs as pore-filling aggregates of twinned euhedral crystals rather than as overgrowths, and it is interpreted to have been derived through dehydration reactions involving zeolite precursors such as heulandite or analcime.

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Tertiary Age Extension of Leppy Hills Area (Southwest Silver Island Mountains) Near Wendover, Nevada

In the Leppy Hills, a series of 11.6 Ma volcanic flows is separated from the underlying Permian limestone by an angular unconformity of about 15°, indicating the Paleozoic sedimentary rocks dipped gently and the area had low topographic relief as little as 11.6 Ma. Faulting ended by the Pleistocene, for Quaternary deposits overlap the faults.

Most of the rocks in the Leppy Range dip 10°-60° west. Normal faults are common and generally trend north. During extension, the limestone beds deformed brittlely and faulted while shaly beds were stretched ductilely. The fault surfaces range from distinct planar zones with narrow gouge zones to large brecciated zones. Commonly, breccia fragments are covered with concentric bands of fibrous calcite that indicate a cavity filling. Calcite-filled extension fractures increase in abundance toward fault zones. Locally, up to 25% of the rock volume is veined. Some faults up to 100 m (330 ft) long curve to become subparallel to bedding, producing a spoon-shaped geometry, with the bowl of the spoon facing upward. Multiple generations of faulting have subsequently rotated faults and beds. Space problems along curved faults on the tens of meters scale were accommodated by: (a) intense brecciation and formation of calcite-filled veins or voids, (b) cataclastic flowage of limestone or ductile flowage of shale into the space, or (c) antithetic faulting or "passive listric folding" of the hanging wall.

The extension in the Leppy Hills, calculated along the simplest cross section, is at least 70%. In summary, the complicated faulting history resulted from crustal extension since the Miocene.