Range. Marshall Kay's zeugogeosyncline of Colorado and northern New Mexico bounded the west side of the mildly positive ancient Apishapa Sierra Grande and the east side of the mildly positive Uncompahgre. In early Pennsylvanian time relatively small quantities of arkosic clastics were carried into adjacent seas from the ancient Apishapa Sierra Grande and the Uncompahgre. The Front Range, however, yielded vast quantities of arkosic débris toward seas on the east during Atokan and Desmoinesian time. Orogenic activity along the Front Range is recorded in the coarse clastic Fountain formation which grades laterally into early Pennsylvanian marine sediments as well as late Pennsylvanian marine sediments.

Shortly after Cherokee time a major alteration occurred in the tectonic framework of south-central and southeastern Colorado. The Uncompahgre was strongly uplifted along its east side and the ancient Apishapa Sierra Grande subsided to receive coarse arkosic clastics during late Pennsylvanian time. This writer believes the Sangre de Cristo formation in the Raton basin area is Missouri and Virgil in age, representing a near-source clastic deposit with few interfingering marine limestones. Subsidence of the Raton basin area during Missouri and Virgil time was not uniform. A subsiding east-west trough developed along the New Mexico-Colorado border in the Raton basin, connecting with the north-south subsiding Colorado and northern New Mexico zeugogeosyncline. The present configuration of the Apishapa and Sierra Grande uplifts developed during Missouri and Virgil time as linear features bounding the more rapid subsiding east-west trough along the Colorado-New Mexico border.

Uplift on the west side of the Uncompahgre near the close of the Pennsylvanian period caused regional tilting toward the east, producing an unconformity at the top of the Sangre de Cristo formation. Rocks of known Permian Leonard age do not interfinger with arkoses of the Sangre de Cristo formation but rest unconformably on Sangre de Cristo rocks and pinch out by onlap along the west side of the Raton basin.

Except for minor erosion during early Triassic time, the Raton basin area received sediments during the Mesozoic era until the late Cretaceous Laramide orogeny. The Colorado and northern New Mexico zeugogeosyncline was the center of strong Laramide uplift, creating the Sangre de Cristo Mountains, and minor Laramide uplift gave rise to the present Apishapa and Sierra Grande topographic features.

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Tectonics of Black Hills

During the decipherable part of Precambrian history, the Black Hills area was within an undefined geosyncline in which more than 20,000 feet of sediments accumulated. It can be inferred that the axis trended north-northwest, parallel with the isoclinal folding which occurred near the end of Precambrian time. Peneplanation followed the folding.

In early Paleozoic time, the Hills area was part of a stable shelf on the northwest flank of the Sioux arch. Seas encroached from the northwest. Increasing instability in Mississippian time is evidenced by evaporite cycles in upper Mission Canyon and Charles sediments. Post-Madison-pre-Pennsylvanian uplift left the present Hills area as a thumb-like projection extending northward from Siouxia.

With the disappearance of the Central Montana trough at the close of the Mississippian, seas no longer invaded from the northwest.

The Lusk embayment developed in early Pennsylvanian time. Evaporites in the Pennsylvanian sediments testify to instability of the shelf at that time. By late Pennsylvanian or early Permian time, the Black Hills first appeared as a weak but distinct positive element.

Western South Dakota and the surrounding area formed a broad, relatively unstable shelf during the redbed and evaporite deposition of Permian, Triassic, and early Jurassic time. Stable shelf conditions prevailed throughout the upper Jurassic. Local downwarping is indicated by exceptional thicknesses of Jurassic sediments in the southeastern part of the area.

Western South Dakota was near the geographical center of a wide, asymmetrical Cretaceous seaway. The Hills lay along a hingeline, with a wide shelf on the east and a subsiding trough on the west. With brief interruptions, Cretaceous deposition continued over the area through Fox Hills and probably through Hell Creek time.

Laramide doming of the Hills was due primarily to vertical uplift. Folding along the western side, and along the related Old Woman and Cedar Creek trends, suggests some horizontal forces. Effects of primary doming were modified in the Northern Hills by early Tertiary intrusions. By the close of Oligocene time, at least 6,500 feet of sediments had been eroded, and the Hills appeared as a low range of Precambrian rocks nearly engulfed by White River sediments.

Evidence of Miocene and younger folding and faulting occurs south of the Hills. Regional uplifts in the Miocene, Pliocene, and Pleistocene resulted in erosion, reworking, and redeposition of older Tertiary sediments.