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CENOZOIC GEOLOGY OF THE CANADIAN RIVER VALLEY, NEW MEXICO

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EARLY TO MIDDLE TERTIARY EVENTS

After the creation and filling of numerous local basins of deposition and volcanism early in the Cenozoic, uplift by broad warping and local normal faulting created the ancestral Sangre de Cristo Mountains and other uplands (Spiegel, 1960, 1962) which then shed debris both east and west, beginning in early Miocene time.

MIDDLE TO LATE TERTIARY EVENTS

During the Miocene and Pliocene the eastern flanks of the Sangre de Cristo Mountains were part of a broad, relatively stable platform extending to the steadily sinking Mississippi embayment. The embayment filled with sediments more rapidly than it sank, which caused a rising base level which in turn caused upstream aggradation by meandering tributary streams. The resulting blanket of moderately to well-sorted sand, with minor amounts of gravel, silt, and clay, is now called the Ogallala Formation. The Ogallala Formation is the time equivalent of part of the Santa Fe Group and other thick basin fills of the intermontane area, but is much thinner and more uniform in lithology because of its deposition on a relatively stable platform rather than in a complex of sinking basins. The source rocks of the Ogallala varied greatly through time and in spatial distribution, as erosion exposed successively the following layers that had accumulated prior to the Miocene upwarping: Eocene/Oligocene/Miocene basin sediments and volcanic rocks, Mesozoic sediments, a thick upper Paleozoic section, and in a few places, the Precambrian. No remnants of pre-Ogallala Tertiary sediment are known in northeast New Mexico east of the Sangre de Cristo Mountains.

Contours on the base of the Ogallala in Union County (Baldwin and Muehlberger, 1960, Fig. 12) show a low area in the southern part of the county, and spot elevations of outcrops of the base in other parts of the Canadian basin suggest that some post-Ogallala warping may have occurred. An anomalously thick section of gravelly sand at the Wooten Ranch, 4 miles southwest of San Jon may have been preserved in a collapse basin or structural trough related to pre-Ogallala northeast-trending faults. Trauger (1971, pers. commun.) has postulated post-Ogallala warping with north-northwesterly axial trends to account for the altitude variations of the based the Ogallala in Harding County. The writer agrees with this interpretation and ascribes the structures to the same tectonic forces which created numerous post-Ogallala normal faults elsewhere in the Canadian basin (see Mercer and Lappala, 1972, pl. 1). However, the low area in the southern part of Union County could have originated as a pre-Ogallala erosional valley (ancestral Canadian River?), an area of pre-Ogallala to post-Ogallala regional slumping into the Permian evaporite section, or by a combination of these factors. It has been noted by Trauger (oral commun., 1971) that the nearest Morrison outcrops north of the Canadian River at the time of the deposition of basal Ogallala probably were in the foothill hogbacks of the Sangre de Cristo Mountains, hence the Ogallala in Quay County north of the Canadian River could not be expected to contain many of the distinctive red chert pebbles produced by weathering of the Morrison Formation; according to Trauger and Lappala (oral commun., 1971) none have been identified in outcrops of definite Ogallala age north of the river.

LATE CENOZOIC EVENTS

In late Pliocene or early Pleistocene time, a broad east-west valley developed parallel to the present course of the Canadian River, with branches parallel to most of the present tributaries. The thalweg of the valley was eroded deep below the base of the Ogallala, then a thin veneer of reworked Ogallala plus other debris (including numerous Morrison chert pebbles from new exposures) was left on the post-Ogallala valley slopes. Post-Ogallala sediment locally overlapped onto the Ogallala, especially in the area east of the lower course of Ute Creek.

The initiation of the Pleistocene course of the Canadian River and its tributaries may have been related to the extensive early to middle Pleistocene system of normal faults which (as noted by Spiegel, 1960; Baldwin and Kottlowski, 1963, p. 68) outlined or influenced the present form of the Sangre de Cristo Mountains, Rio Grande trough, and other basin-and-range type structures of New Mexico and Colorado. Preservation of Ogallala, Santa Fe, and younger sediment in Cenozoic grabens or echelon tilted blocks is the only tenable hypothesis for the origin of anomalously thick bodies of alluvial sediments in Canadian River head-water valleys such as Eagle Nest and Mora. If Eagle Nest valley, the Colorado Parks, and bordering mountains were one mile lower, Fenneman and other physiographers might have classified the Southern Rocky Mountains properly as a part of the Basin-and-Range Physiographic province.

The Canadian River in Quay County has gradually shifted southward on a post-Ogallala valley floor, along with lower Ute Creek, which formerly flowed eastward 6 to 10 miles north of its present mouth. The channel deposits of the early Pleistocene Canadian River are coarse gravel and sand derived primarily from glaciated mountain sources, in contrast to the finer sands of equivalent Pleistocene terraces in Ute Creek valley. The extensive dune field east and north of Logan was derived primarily from fluvial erosion of sandstone of Mesozoic age in Ute Creek drainage. The writer's interpretation of the dunes is that ancestral Ute Creek brought down most of the sand, which was deposited with coarser sediments on a former floodplain terrace, then the sand was blown northeastward by strong prevailing winds. There are no extensive dunes upstream along the Canadian from the mouth of Ute

Creek, nor anywhere immediately south of the Canadian River. Present-day winds commonly whip up considerable amounts of sand from the river channel, and produce a few climbing dunes, especially where the river channel broadens near the state line. However, the present river channel is not the main source of sand for the upland dune field.

During a late stage of development of the broad Pleistocene terrace of Ute Creek and the Canadian River, deep inner channels were cut and backfilled about 60 feet by boulders, gravel, and sand, up to a terrace level about 100 feet above the present river channels (Fig. 1), in a belt up to 1 mile wide. The river meandered on this terrace for a time, then became entrenched between sandstone cliffs, in places in the same channels previously occupied, but generally in newly cut channels.

In the process of cutting down to its present position in the Logan area, the Canadian River carved several levels of terraces in the resistant sandstone of the Trujillo Formation, deepened its channel into the Tecovas Formation (which are here considered to extend into New Mexico), then aggraded its channel back to its present level. The depth of channel fill increases from about 25 feet at Conchas Dam to about 100 feet at the state line, and continues to increase southeastward. If the aggradation were a response to the post-Wisconsin rise in sea level, it could be expected that channel filling would continue. The recent construction of Sanford and Ute Dams assures and accelerates this trend.

Figure 1. Late Pleistocene buried channels on north terrace of Canadian River in Sec. 2, T. 13 N., R. 35 E. Sandstone is Trujillo Formation equivalent.

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