Neogene Evolution of the Central Texas Landscape and the Edwards Aquifers after Balcones Faulting

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ABSTRACT

The Edwards Plateau and the Balcones Fault Zone (BFZ) dominate the geology and physiography of Central Texas. The Edwards Plateau was formed during early Miocene time by uplift of the area west and north of the arcuate BFZ. The Albian Edwards Group was a continuous sheet of resistant shallow-shelf carbonate strata that covered all of Central Texas: the Edwards Plateau, BFZ, and subsurface of the Central Texas Platform. At the time of first Balcones faulting, the resistant Edwards Limestone was already widely exposed west and north of the BFZ. Regional headward erosion and dissolution following Balcones faulting progressively stripped away Edwards strata, leaving steep, ragged bluffs that delineated the boundaries of the Edwards Plateau. Just as geological maps outline the Edwards Plateau today, a reconstruction of past Edwards Limestone outcrop locations tracks the stages of westward and northern erosional retreat through Miocene, Pliocene, Pleistocene and Holocene times.

The sequential evolution of the Central Texas landscape is integrated with independent evidence from 6 related geological processes and events to generate a holistic account of Edwards Plateau and BFZ history since early Miocene time:

(1) Incised meanders of Edwards Plateau rivers and streams inboard and peripheral to the BFZ, which were probably inherited from early Paleocene settings, then greatly amplified by Balcones-related uplift.

(2) The entire Edwards (BFZ) aquifer (recharge, artesian, and saline zones) has operated as an integrated geohydrologic system, evolving under the influence of (a) the location of the eroding outcrop of the Del Rio Clay (the artesian aquifer top-seal); and (b) mixing of phreatic and saline formation waters along the saline water interface, which promoted hypogenic porosity creation.

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(3) High porosity and permeability of Edwards strata in the central sector of the Edwards (BFZ) aquifer are related to (a) a longer period of increased stream gradients and stream piracy in that sector; (b) a wider BFZ with greatest vertical displacement and more faults and fractures; (c) major discharge points at Comal and San Marcos springs, the lowest elevations in the central sector of the trend; and (d) hypogenic processes creating karstic porosity along the artesian/saline water interface.
(4) Between 14 and 10.5 Ma, the Colorado River formed its Great Bend, when it shifted its course about 35 mi north and east, after eroding through Cretaceous strata onto hard, northeast-dipping Paleozoic beds. This shift also generated the marked asymmetry of the Colorado drainage basin, with short tributaries on the east, and long straight tributaries on the west.
(5) Multiple levels of horizontal cave development (youngest downward) in the western Edwards Plateau suggest that the thickness of the unconfined Edwards Plateau aquifer was greatest immediately following Balcones faulting, and declined afterward in stages as erosion reduced the area of surface recharge and increased the number of headwater springs.
(6) The post-Balcones Medina Arch induced concave-upward stream profiles in streams originating around its apex: Pedernales, Blanco, Guadalupe, Medina, Frio, and East Nueces rivers.

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