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Permian Topography and Tectonics in the Wichita Mountains, Oklahoma

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The Wichita Mountains of southwestern Oklahoma expose a preserved Permian (Leonardian)-carved "tor" topography that is now being exhumed. The Post Oak conglomerate, which surrounds the eastern Wichitas, was recognized by Chase (1954) as a distinct stratigraphic unit. The conglomerate is directly related to the formation of the topography and interfingers with the surrounding Hennessey Shale. The existence of this "fossil" Permian landscape and the nature of the clasts in the Post Oak conglomerate reveal aspects of the last tectonic movement of this, most eastward, part of the Ancestral Rockies.

F I G U R E

TIMING OF TECTONISM

Chase (1954) noted in his description and definition of the Post Oak conglomerate that this sedimentary facies records a tectonic event. Thus, for some time, it has been known that since this facies is equivalent to the upper Garber Formation and the overlying Hennessey Group, the timing of formation of the conglomerate is Leonardian. This conclusion stands. Chase recognized that the clasts of the conglomerate were locally derived and formed 4 subfacies depending on whether the local source was granite, rhyolite, gabbro, or limestone. In this sense, the conglomerate was treated as a "tectonic" one. However, the nature of the clasts, and the character of the surface upon which the conglomerate was deposited, yield more information, and a somewhat different scenario, than the one Chase envisaged, and this will be discussed now.

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The following reasoning is based on the rounded clasts in the granitic facies and on the Permian tor topography. The granite clasts are rounded primarily from spheroidal weathering rather than transport. This process implies the prior existence of a low-relief landscape and deep weathering processes. The clasts are thus corestones released when the region was uplifted (erosion rates>>weathering rates). Presumably, a strong climate change (much increased rainfall) could also have contributed to, or caused, the increased erosion rates, except that all climatic indicators are toward increased aridity during this time span. A tor topography forms on a granitic substrate when a spheroidal weathering regime is interrupted by uplift, and this is exactly the kind of topography that was generated in the Permian. The Post Oak lies on clear examples of this concomitantly formed landscape. Finally, it is to be noted that the low-relief surface which existed before uplift can be used as a marker so that topographic relief generated during uplift and erosion is a measure of the amount of uplift in the event.

F I G U R E

STYLE OF PERMIAN REGIONAL DEFORMATION

Because there are no deformation features in the Post Oak or Hennessey, such as folding, the regional deformation during erosion and deposition is not compressive. What is implied is uplift (Gilbert, 1984; 2001; 2002) and lateral offset along the Meers Fault (Donovan, 1986). Uplift of >150m is needed to account for the thickness of the Post Oak, and perhaps of ~500m, if the thickness of the probable enveloping Permian section is considered. Lateral offsets of up to 2-3km may be necessary to account for some of the stratigraphic relationships in the limestone facies.

COMPARISON OF PENNSYLVANIAN AND PERMIAN DEFORMATIONS

Uplift of the Cambrian rift zone block (i.e., Southern Oklahoma Aulacogen) in the Pennsylvanian was accomplished by apparently strong compression and a combination of thrusting and strike-slip offsets (Donovan and others, 1989; McConnell, 1989). Vertical throws and horizontal offsets are each >10km. This is an order of magnitude greater deformation than exhibited by the Permian. However, even the lesser Permian offsets are not likely to be due to passive effects (i.e., "settling" or compaction in the deeper Anadarko Basin) because there is a distinct vertical component of uplift which simple subsidence to the north in the basin can not explain. It would seem that far-field crustal stresses are necessary.

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