Data Repository for "Load-Induced Subsidence of the Ancestral Rocky Mountains Recorded by Preservation of Permian Landscapes"

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Construction of Subsidence Plot

For Permian thicknesses, we used the log record from the Weller No. 51-11, located in Caddo County, Oklahoma (section 11, T 8 N, R 12 W), published in Adkinson and Sheldon (1963; Figure 1). This log record begins at a depth of 140' (43 m) in the Permian Whitehorse Group and reaches a total depth of 17,823' (5422 m) in the Pennsylvanian Springer Formation. This well was chosen for its near-complete record of the Permian section near the depositional axis of the Anadarko basin. For the pre-Permian (Cambrian through Pennsylvanian) thicknesses, we used the log record from the Lone Star 1 Rogers Unit, located in Washita County, Oklahoma (section 27, T 10 N, R 19 W; Rowland, 1974a; Figure 1). This well was chosen for its complete penetration of lower Permian through Cambrian strata in the depositional axis of the Anadarko basin, within an area of minor erosional and structural disruption, and relatively near to the Weller No. 50-11. Where resolution of stage-level thicknesses was inadequate from this well's log, we estimated thicknesses from a nearby well (the Lone Star 1 Baden Unit, in Beckham county, section 28, T 10 N, R 22 W, 29 km west of the Lone Star Rogers well; Rowland, 1974b). Following the reasoning outlined in the text, we assumed approximately 1.5 km of overburden removed since Permian time (see text for references). This overburden is assumed to be primarily sandstone.

Relative ages for the Anadarko basin units were taken from Johnson (1989), except for the White Horse Group, for which we used relative ages determined in Newell (1940). Correlations of provincial chronostratigraphic ages (North American to European) for use in determining absolute ages from the international time scale was accomplished using Menning et al. (2006) and Wardlaw et al. (2009). Absolute ages were then taken from TimeScale Creator (www.stratigraphy.org), the most current available absolute ages from the International Commission on Stratigraphy.

Subsidence calculations were then done using the following procedure:

1. Decompact each time unit iteratively with the appropriate decompacted porosity to reach a cumulative decompacted thickness which is then used as the total subsidence;
2. Calculate the amount of sediment isostatic compensation;
3. Subtract from the total subsidence the isostatic compensation related to sediment and water (negligible as most units are subaerial to very shallow marine) and, where necessary, an adjustment of deviation from the modern sea level to arrive at the tectonic subsidence curve.

Equations Used in the Backstripping Process

Tectonic subsidence equation: $S_{tec} = S_{cor}-S_{iso}+Wd-\Delta SL[\rho_m/(\rho_m-\rho_w)]$

S_{iso} is sediment isostatic compensation, Wd = water depth, SL equals change in sea level from last interval, ρ_m is density of the mantle, ρ_w is density of sea water.

Decompaction equation: $S_{cor} = Z_D=[(Z_i)(1-\phi_i)]/(1-\phi_D)$

Where: Z_D is decompacted thickness, Z_i is compacted thickness, ϕ_i is the observed compacted porosity, ϕ_D is the predicted porosity at a certain depth as calculated below

$\phi_D = \phi_o e^{(-Z/CK)}$

where ϕ_o is the surface porosity (used as a constant), Z = depth of interest for porosity prediction specifically we used the depth value equal to the middle of the interval being decompacted to average the porosity through that interval, CK is a lithologic constant.

CK and ϕ_o are from Hegarty et al., 1988

Lithology	ϕ_o	CK	E_m
Sandstone	0.34	2500	2.66
Siltstone	0.50	3000	2.65
Shale	0.52	1429	2.70
Calcarenite	0.42	1800	2.80
Micrite	0.30	2457	2.86
Marl	0.41	5000	2.87

Sediment Isostatic Compensation Equation

$S_{iso} = [S_{cor}*((\rho_s- \rho_w)/(\rho_m- \rho_w))]$--Where ρ_s is density of the lithology within the interval.

Note: for mixed lithology intervals each step during backstripping accounted for the relative percentage of the variety of lithologies.

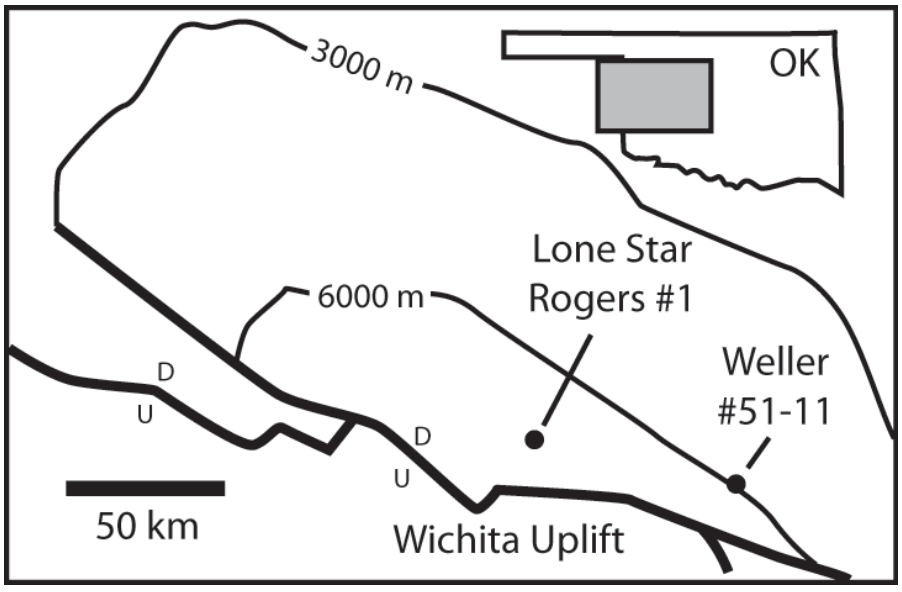

Figure 1: Location of wells used. Contours shown are subsurface depths of top Hunton Group.

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