The influence of Western Interior Seaway isotopic composition on paleoelevation estimates for Campanian western North America (**26-6**)

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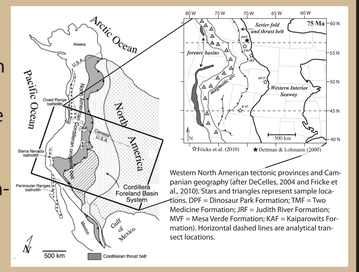
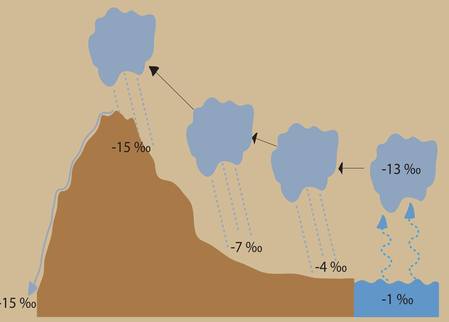
Development of the Sevier Fold and Thrust Belt

Geological evidence indicates that Cretaceous subduction of the Farallon Plate under North America resulted in extensive, thin-skinned thrusting and crustal shortening (DeCelles, 2004; DeCelles and Coogan, 2006). By the Late Cretaceous (~75 Ma) western North America was characterized by extensive highlands to the west and a low-relief coastal plain and shallow inland sea (the Western Interior Seaway [WIS]) to the east (Aschoff and Steel, 2011; DeCelles, 2004; Roberts and Kirschbaum, 1995).

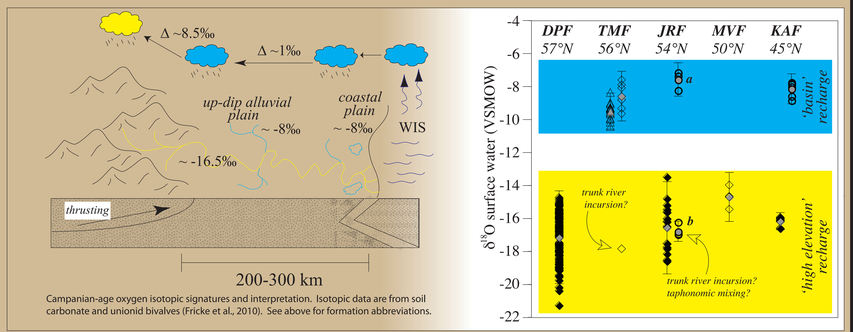


Western North American tectonic provinces and Campanian geography (after DeCelles, 2004 and Fricke et al., 2010). Stars and triangles represent sample locations. DPF = Dinosaur Park Formation; TMF = Two Medicine Formation; JRF = Judith River Formation; MVF = Mesa Verde Formation; KAF = Kaiparowits Formation). Horizontal dashed lines are analytical transect locations.



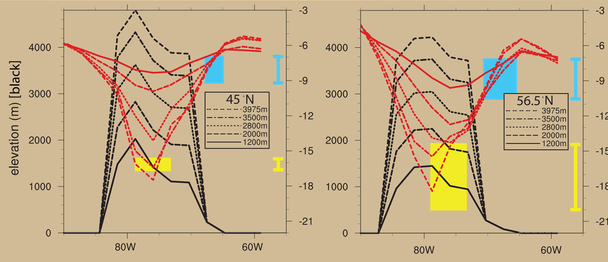
Paleoelevation of the Campanian-age Cordillera

The paleoelevation of the Campanian-age Cordillera is less well constrained than the extent and style of orogenesis. However, progressive cooling and subsequent condensation and precipitation of moisture from air masses as they are lifted over orogenic features results in distinctly different oxygen isotopic signatures for precipitation at high and low elevations along a given elevational transect. Those signatures are evident in soil water and, depending on the nature of drainage networks, may be maintained in surface runoff. Because the isotopic signatures of ancient soil and surface waters influence the isotopic composition of soil carbonate nodules and bivalve shells, measurement of these materials can qauntify the oxygen isotopic signature of ancient meteoric waters.



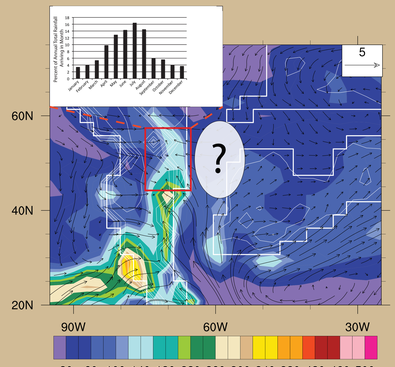
Campanian-age oxygen isotopic signatures and interpretation. Isotopic data are from soil carbonate and unionid bivalves (Fricke et al., 2010). See above for formation abbreviations.

Interpretations of ancient oxygen isotopic values can be compared with simulated oxygen isotopic values to provide estimates of and constraints on paleoelevations (e.g. Ehlers and Poulsen, 2009; Poulsen et al., 2010; Insel et al., 2012).



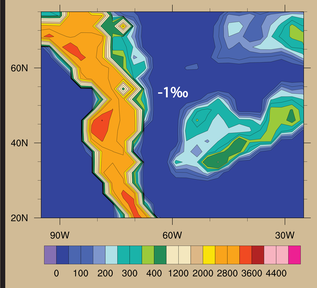
Oxygen Isotope Composition of the Western Interior Seaway

Because the Western Interior Seaway (WIS) is the moisture source for the majority of precipitation along the eastern front of the Campanian-age highlands, the isotopic composition of the WIS can influence the oxygen isotopic composition of precipitation over the mountain front and, thus, paleoelvation estimates for the highlands. Geochemical investigations of the WIS suggest that the oxygen isotopic composition could have been as light as -3.5 ‰ δ18O during the Campanian (e.g. Fisher and Arthur, 2002; Cochran et al., 2003; He et al., 2005).



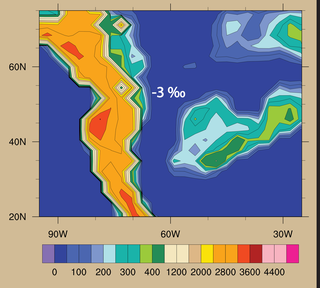
What influence would realistic changes in the oxygen isotopic composition of the WIS have on paleoelevation estimates of the Campanian-age Highlands?

We compare the results of two isotope-tracer-enabled AGCM (isoCAM3; Noone and Sturm, 2010) experiments to measured δ18O values.



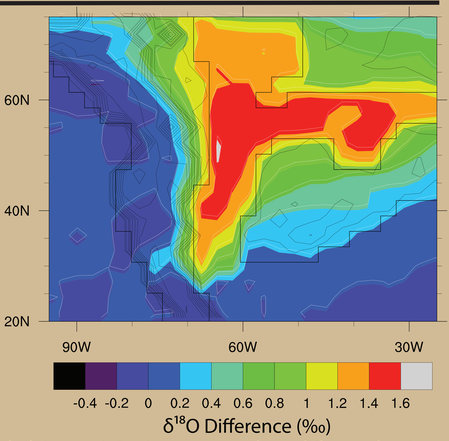
Invariant Model Parameters

Vegetation Distribution
(Fricke et al., 2010)
Global Topography/Geography
(Fricke et al., 2010)
pCO^2 *(1680 ppm)*
pCH^4 *(700 ppb)*
pN_2O *(275 ppb)*
Orbital Configuration
(Modern)
Solar Constant
(1355 W/m²)
Average Cordilleran Elevation
(2800 m)



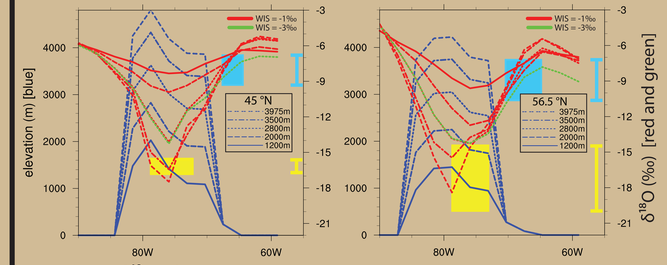
Comparison of Model Results

Comparison between simulations with the WIS δ18O composition specified at -1‰ and -3‰ (heavier WIS case minus lighter WIS case) show little change in the δ18O signature of precipitation. Volume-weighted precipitation at low elevations is lighter by 0.8 - 1.5 ‰ while that over higher elevations is lighter by only 0.0 - 0.6 ‰ when WIS δ18O = -3‰ .



Influence on Paleoelevation Estimates

The observed offset between coastal plain and high elevation δ18O is ~9 ‰. Reducing the δ18O value of the WIS by 2 ‰ reduces this offset by ~0.8 ‰. Thus, selection of the starting composition for the WIS may exert some influence on the estimated relief of the adjacent highlands. However, comparisons of simulated and measured δ18O of coastal plain precipitation suggest that while a reduction in the δ18O value of the WIS may improve the match between observed and simulated coastal plain δ18O of precipitation somewhat, it has negligible influence on the δ18O of high-elevation precipitation. Consequently, simulated δ18O of high elevation precipitation continues to match observed values best at Campanian-age Cordilleran average elevations in excess of 3500 m. These results indicate that, while variation in the δ18O value of the WIS influences the composition of low-elevation precipitation, the specified δ18O composition of the WIS is not a significant source of error in estimation of overall orogenic paleoelevation and the paleoelevation of the Campanian-age Cordilleran of North America approached 4000m.



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Acknowledgements

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