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

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).

Paleoerosion of the Campanian-age Cordillera
The paleoerosion of the Campanian-age Cordillera is less well constrained than the extent and style of orogeny. However, progressive cooling and subsequent condensation and precipitation of moisture from the 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 orogenic transect. These 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 quantify the oxygen isotopic signature of ancient meteoric waters.

Interpretations of ancient oxygen isotopic values can be compared with simulated oxygen isotopic values to provide estimates of and constraints on paleoerosion (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, paleoerosion estimates for the highlands. Geochemical investigations of the WIS suggest that the oxygen isotopic composition could have been as light as -3.5 ‰ 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 paleoerosion 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.

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‰. However, simulations of measured and simulated 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 3600 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 orogenically paleoerosion and the paleoerosion of the Campanian-age Cordillera of North America approached 4000m.

References
We thank David Noone for developing and