ABSTRACT:

Slope-building processes and sediment partitioning in mixed carbonate-siliciclastic sediment routing systems are poorly understood but are important constraints on the spatial and temporal distribution of reservoir-forming elements. The Bone Spring Formation, Delaware Basin, west Texas is a mixed carbonate-siliciclastic system that consists of cyclic slope-to-basin hemipelagites, turbidites, and debrites that were sourced from the Victorio Peak Formation carbonate shelf margin and Bone Spring Formation slope during Leonardian time (~275 Ma). Much research has focused on the basinal deposits of the Bone Spring Fm., but there has been little research on the proximal, upper slope segment of the Bone Spring sediment routing system. In this study, we constrain the stratigraphic architecture of the Bone Spring Fm. that outcrops in Guadalupe Mountains National Park in order to delineate the slope clinothem geometry and the dynamics of carbonate and siliciclastic sediment delivery to the basin. We record the outcropping Bone Spring Fm. upper-slope as composed predominantly (~90% of the study area) of fine-grained carbonate hemipelagites and sediment gravity flows containing a high biogenic silica content (i.e. chert). Interbedded within the carbonate slope facies at various scales are detrital terrigenous hemipelagic and sediment gravity flow deposits, carbonate mass-transport deposits, and carbonate submarine channel deposits. We identify ten slope-building clinothems that vary...
from siliciclastic-rich to carbonate-rich and show significant variability in slope propagation direction. Clinothems are truncated by slope detachment surfaces that record large-scale mass-wasting of the shelf margin and upper slope. X-ray fluorescence (XRF) data indicates that slope detachment surfaces contain a higher-than-normal proportion of terrigenous siliciclastic sediment, suggesting failure is triggered by accommodation or sediment supply changes at the shelf margin. Dip attitude variations from clinothem to clinothem indicate that clinothem geometries are likely lobate and three-dimensionally complex. Furthermore, the distribution of calciturbidites and mass-wasting features in relation to clinothem orientation indicate that clinothem morphology is likely a control on coarse-grained entry points to the basin. A well-exposed siliciclastic-rich clinothem is encased within a prograding carbonate-rich package, indicating that carbonate and terrigenous siliciclastic sediment were deposited contemporaneously, suggesting both autogenic and allogenic processes influenced the Bone Spring Fm. slope architecture. This mixing of lithologies at multiple scales and the prevalence of mass-wasting act as a primary control on the stacking patterns of siliciclastic and carbonate lithologies on not only the Leonardian shelf margin and upper-slope, but also in the distal portion of the Delaware Basin.