Regional 2D Restoration As A Tool For Constraining Complex Basin History And Erosion Estimates

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Abstract

Objectives/Scope: Estimating the magnitude and timing of basin-scale erosion is crucial for basin analysis, and has major implications for source rock and basin modeling, and is routinely performed in 1D (i.e., at well locations). Here, 2D restoration is utilized to reconstruct the structural development of an Arabian basin that has undergone a complex geo-history, and estimate regional erosion magnitude and timing in 2D, with insights into the implications on hydrocarbon maturation over geologic time.

Methods, Procedures, Process: The restoration was conducted on a depth-converted, NW-SE, across-basin composite 2D seismic section, showing interpreted major faults and horizons. A layer-cake velocity model was used for the depth conversion, utilizing checkshots and sonic logs where available along the section. The restoration workflow involves sequential overburden removal, decompaction, restoring horizons across faults, and projecting eroded sections using underlying seismic stratigraphic geometries as a guide. The output of this workflow includes restored sections, erosion heights at different times corresponding to different unconformities, and 1D burial history plots at selected locations, which can be used as inputs for basin modeling.

Results, Observations, Conclusions: Over a basin-scale (i.e., >100 km), seismic interpretation and section flattening at different horizons indicate remarkable basin-center migration from NW to SE that testifies to the complex history of differential uplift (basin inversion), subsidence, and periods of erosion. This complexity is accentuated by unconformities cross-cutting relationships with faults, which are mostly concentrated over a 25km-wide area in the northwestern part of the section. Preliminary restoration results have demonstrated the basin migration and the role of compaction in the basin formation. These results also show clear variation in the restored eroded sections along the 2D line, which will be investigated more thoroughly with different scenarios of projected erosional heights that honor the underlying stratigraphic geometries. Furthermore, fault restoration indicates that the faults play a secondary role in the basin’s geo-history compared to the more regional uplift and erosion.

Novel/Additive Information: The 2D restoration results presented here assist in constraining the geo-history in this complex basin, and provide more coverage of erosion estimates (i.e., 2D) over well data (i.e., 1D) estimates as inputs for basin modelling.