Basin-Floor Channel Stacking and Evolution of the Brushy Canyon Formation in the Northeastern Delaware Basin

ABSTRACT

Deep-water deposits are some of the largest accumulations of sediment on earth. Deep-water depositional systems commonly show two end-member styles of stratigraphic architecture: more erosional, confined channel deposits on the slope and more depositional, unconfined distributary channel-lobe deposits on the basin floor. In between, a transitional stratigraphic architecture comprising scours and short-lived, low-sinuosity channels can form. This is controlled by decreasing confinement of the system and the composition, volume, and velocity of the flows responsible for erosional and depositional elements on the basin floor. This transitional stratigraphic architecture has been most commonly recognized on the modern seafloor where the components of deep-water depositional systems can be studied in full plan-view display. Outcrops of the Permian Brushy Canyon Formation in the Delaware Basin show 'weakly confined' channel deposits thought to be found in these transition zones. Brushy outcrops were described as sandy, high aspect ratio channel fills (hundreds of meters wide and up to 15 m thick) stacking in topographic lows between lobe deposits. Although outcrops provide high-resolution cross sections of the sedimentology and stacking of deep-water deposits, they lack the larger-scale, 3D context of seismic-reflection data and well logs used for basin-framework studies.

Here, I integrate a large quantity of well logs (1,366) and 3D seismic-reflection data (~30 Hz dominant frequency) covering ~500 km^2 in the northeast Delaware Basin, southeast New Mexico. I created a stratigraphic framework of the Brushy Canyon Formation and characterized the depositional architecture within the 'Hobbs' deep-water depositional system on the basin floor. I used a Python package, ChronoLog, which relies on the dynamic time warping algorithm to correlate well pairs. The resultant stratigraphic model shows layering and property trends (e.g., grain size), but cannot always resolve depositional features in fine detail as it correlates over distances as large as several to tens of kilometers between wells. In cross section, the lower part of the Brushy Canyon Formation consists of lenticular sand bodies, whereas the upper Brushy displays more continuous sand sheets. Log character of the lower part of the Brushy consists of blocky, isolated coarse-grained deposits bounded by thicker finer-grained deposits. Interstratified packages of coarse- and finer-grained deposits tend to be thinner in the upper Brushy. I used spectral decomposition and RMS-amplitude seismic attributes to better visualize the 3D stratigraphic architecture of the system. I observed relatively few, wide isolated channel bodies in the lower interval, and widespread, narrow channel bodies with distributive patterns in the upper interval. Both channel architectures show low-sinuosity and trend to the south and southwest.

The Brushy Canyon Formation reflects numerous avulsions of short-lived, 'weakly confined' channels similar to those found in other basin-floor settings. These evolve up section to narrow, distributary channel deposits representing a backstep of the depositional system. This backstepping stacking pattern has been previously recognized at multiple scales throughout the Brushy Canyon Formation. However, this is the first time that these patterns have been imaged in 3D seismic-reflection data and mapped in the subsurface. We propose that these stratigraphic architectures and stacking processes are common in other basin-floor successions, but not in relatively steep reaches of basin-margin slope environments.

Supervisor Signature Jacob Covault