

Searching for Sub-Seismic Resolution Features in Mature Basins: Log-Based Sequence Stratigraphy of the Fox Hills and Lewis Formations

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Abstract

Sequence stratigraphy, pioneered in the 1950's and revitalized with the seismic tool in the 1980's, represents a powerful approach to the interpretation of geologic systems. By applying the discipline of careful time-line correlations and unconformity recognition it becomes possible to identify genetically related packages of rock that are most appropriate for subsurface mapping.

Sequence stratigraphy and time-stratigraphic correlations require the tracing of time lines from outcrop, well log, and/or seismic data. Continuous outcrop and seismic data offer opportunities to trace time lines and observe stratigraphic discordance directly. Well-log data requires the careful correlation of "marker events" in the log character, interpreted as time lines, over broad areas of the basin in order to reconstruct the time-stratigraphic, basin-fill geometries of the subsurface.

Well-log correlation work, and sequence stratigraphic methodology, are enhanced through the use of computer workstations capable of handling large numbers of well logs. By harnessing the power of cross-section software and raster well-log images geologists have the ability to establish very detailed regional correlation frameworks based on log character.

Examples of high-resolution sequence stratigraphy are offered from the Almond, Lewis, and Fox Hills Formations of the Eastern Green River Basin, where hundreds of well logs were correlated with as many as 50 correlations per 500-foot interval. This effort delineated subtle unconformities, faults, and basin-fill geometries that are below the resolution of seismic data in the area. One outcome is a new interpretation of lowstand deltas and "perched" submarine fans. Toplap disconformities, representing lowstand deltaic platforms, are encased within slope clinofolds of the Lewis Shale. Periods of sea-level rise subsequently drowned these deltaic platforms. Submarine fans later came to rest on top of the foundered lowstand deltas. One such "perched" fan forms the reservoir for the Desert Springs Field.

While this interpretation is possible using paper well-logs, the sheer volume of logs needed and the inefficiencies of paper-based methodologies prohibit stratigraphic studies of this detail for most workers. By leveraging the power of the computer, raster images, and the established methodologies of sequence stratigraphy, the industry has an opportunity to revisit mature basins to explore for "sub-seismic resolution" geologic features. Such features may be the basis for a new wave of discoveries in old basins.