

Strato-Tectonic Analysis: A Tectonic Integration Tool Used to Link Complex Orogenic Development of the Western U.S. Cordillera to Hydrocarbon Events

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The greatest challenge facing oil and gas exploration in the western U.S. is the region's complex geology. For example, the Sevier-Laramide Orogeny (125-43 Ma) records a bewildering series of diachronous (time-transgressive) tectonic and hydrocarbon events. The term diachronous has been traditionally used to describe "similar material in a sedimentary formation varying in age from place to place, usually due to transgression or regression" (Sloss, 1963). The sequence-stratigraphic approach was developed specifically to address diachronous sedimentation. This approach, however, limits analysis to sedimentary rocks and does not attempt to address the diachronous complexity of all tectonic events.

In contrast, the strato-tectonic approach synthesizes all tectonic and hydrocarbon events into a systematic framework. Strato-tectonic analysis incorporates structure, metamorphism, mineralization, magmatism, isotopic age dates, and plate-tectonic data into sequence-stratigraphy-like assemblages. The result is a better-constrained tectonic model for the orogenic events.

During the Sevier-Laramide Orogeny, the two-sided orogen migrated from west to east. The orogen expanded in area as a direct response to flattening of the angle of subduction. The analysis reveals four strato-tectonic assemblages associated with the Sevier-Laramide Orogeny. These are used to constrain the evolutionary sequence in detail. Orogenic events are also tied to multi-layered mantle and crustal-source regions that serve as a reference frame to link plate motions with the stratotectonic assemblages. Recent work has significantly refined the tool through recognition of oceanic slab segmentation and the correlation of hydrocarbon time-lines with specific strato-tectonic assemblages.

Poorly constrained data are also put into regional context on the time-distance columns by analogy with adjacent areas adding a testable specificity not found in other more generic tectonic approaches. This complete geologic data set, with varying degrees of confidence, is then integrated into regional tectonic models allowing use of data not normally used in basin analysis. The result is a more complete and dynamic basin model. Most importantly, time/space hydrocarbon events can be directly tied to strato-tectonic assembles. This provides insights into relationships between hydrocarbon development, regional structure, magmatic arc migration, plate motions, oxidation state and deep-seated earth processes.