Kinematic Cyclostratigraphy: An Example from the Ridge Basin, Southern California

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Abstract

Upper Miocene sedimentary rocks of the Ridge Basin display a distinct cyclicity of sedimentation which has been interpreted to reflect contemporaneous deposition and movement of the San Gabriel Fault. Observed changes in stratal stacking patterns further suggests that the units of the Ridge Basin can be divided into depositional sequences or “kinematic cycles” related to cyclic fault movement. The beginning of each kinematic cycle is marked by a period of uplift and extension related to fault movement followed by tectonic quiescence. This tectonic cycle produces distinct parasequence set stacking patterns due to its influence on accommodation and sediment supply. Kinematic cycles can also vary in appearance within a given basin if relative sediment supply and accommodation are not constant, such as in the asymmetrically subsiding Ridge Basin. On the rapidly subsiding portion of the basin, the Violin Breccia is comprised of a lower progradational interval reflecting the initial period of high subsidence related to fault movement. Extremely rapid erosion of the uplifted footwall, though, produced more sediment than accommodation created by tectonic activity. Retrogradation of the Violin Breccia in each cycle occurred in response to waning tectonic subsidence and diminishing sediment supply from the uplifted footwall. In contrast, the kinematic cycles within the Ridge Route Formation, which is derived from the less tectonically active margin, appear out of phase. Kinematic cycles in the Ridge Route Formation are comprised of a lower retrogradational interval that reflects the initial tectonic subsidence. On this less tectonically active side of the basin, however, sediment supply does not exceed accommodation. Finally, in response to waning tectonic subsidence, the members of the Ridge Route Formation prograded into the basin due to decreasing accommodation.

Here, our tectono-stratigraphic framework demonstrates that: 1) stratal stacking patterns of transtensional setting can follow classic sequence stratigraphic models that consider the rate of accommodation and rate of sediment supply; and 2) such stratal stacking patterns can vary in three dimensions.