Quantification of sedimentation and diagenesis in tectonic settings

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Observations in sedimentary basins affected by significant amount of deformation shows that fault-induced accommodation space and associated diagenesis, at various spatial and temporal scales, is closely linked to sedimentation and basin kinematics. The sediment infill and related diagenetic processes reflect the history of deepening and shoaling facies controlled by the activation and changes in deformation offset rates. Simply stated, tectonics translates as shifting sedimentary facies towards the basin center or towards the source area in response to increasing or decreasing depositional space. We define a first-principle conceptual model for tectonic successions, controlled by the balance between the rates of creation of depositional space and sediment supply associated with significant changes in the evolution of sedimentary facies. These sediment bodies are bounded by succession boundaries and comprise basinward or sourceward shifting facies tracts that are separated at a point of reversal. Due to the relatively steep slopes associated with the evolution of faults, changes in sediment supply rates and mass-wasting is common phenomena in these systems and may complicate the normal rhythm of the shifting facies tracts. The related, time-independent, diagenetic facies and their extent in the subsurface defined as diagenetic facies tracts include the modified rock affected by a singular diagenetic fluid or process. The basinal diagenetic facies tract, compactional diagenetic facies tract, meteoric diagenetic facies tract and fracture-associated diagenetic facies tract are the main result of fluid-rock interactions. Their subsurface extent is controlled by the tectonic evolution, and we demonstrate that quantification and prediction is possible using the tectonic successions model. The efficacy of the new concept is illustrated by examples from extensional, contractional and strike-slip basins. The basic tectonic succession model is applicable at all temporal and spatial scales and whether the tectonics cause subsidence or uplift, and in all types of tectonic settings that drive the evolution of sedimentary basins. These attributes are critical for the large-scale screening and quantification of subsurface geo-resources, conventional and particularly important for the sustainable ones (e.g., geothermal energy) and geological storage (e.g., CO2 or energy) that are associated with enhanced fluid-rock interaction processes. We discuss the application of these concepts and how they can be quantified in a number of tectonic environments in the larger Mediterranean area and beyond in other worldwide basins.

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