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Subsurface heterogeneity patterns that emerge from interacting depositional processes

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Emergent structures define organizational patterns that spontaneously develop due to interactions between component properties or behaviors of complex dynamic systems, rather than being a simple compilation of the individual parts observed within the system at any one time. Traditional facies models used to predict subsurface lithic variations focus on defining the distribution of depositional environments on Earth's surface and relating the hierarchy of preserved bedding units to different scales of surficial bedforms. It is increasingly recognized that such static models fail to predict the geometry and character of many types of preserved lithic bodies and discontinuity surfaces unless these observations are placed within the context of the overall evolving system. Numerical depositional process models are presented to show links between evolving depositional patterns and preserved facies patterns within different settings.

Channel deposit internal variations tend not to be channel shaped, but rather sweet spots within the deposit resemble a string of beads, each formed as individual channel segments meander. Mouth bar deposits generally do not to have the circular to elliptical shape of a modern channel-mouth bedform, but rather tend to be more elongate fingers cut by a diachronous channel filled as river flows are choked off by loss of gradient during progradation. Although the final channel basal erosion surface appears continuous, timelines cross this surface along the length of the deposit. Deltaic shorelines that look identical at a given time preserve very different deposits when the feeding river avulses at different frequency, a condition that can change within an individual deposit formed alternately during periods of sea level rise and fall. Even major stratigraphic surfaces, like lowstand fluvial incision surfaces and wave-ravined falling stage and transgressive surfaces, are likely to gradually emerge from the migration of localized areas of erosion that were never as extensive at any one time as the preserved surface. Such surfaces may be regionally diachronous, with deposits of the same age locally preserved variably above and below the surface. Understanding emergent lithic bodies and internal heterogeneity patterns are fundamental to understanding how deposition is recorded in the rock record and for facies models used to predict how subsurface fluids move through shallow marine deposits.