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Proposed Compositional Classification of Fine-grained Sedimentary Rocks

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ABSTRACT: In fine-grained sediments and rocks (>50 percent weight or volume of particles less than 62.5 μm) the primary grain assemblage reflects grain generation processes at deposition and is also an important control on the evolution of bulk rock properties in diagenesis, and thus, is a practical basis for classification. Tarl (terrigenous-argillaceous) contains a grain assemblage with >75 percent of particles of extrabasinal derivation, including grains from continental weathering and also volcanogenic debris. Carl (calcareous-argillaceous) contains <75 percent of extrabasinal particles and among intrabasinal grains has a preponderance of biogenic carbonate particles. Sarl (siliceous-argillaceous) contains <75 percent of extrabasinal particles and has a preponderance of biogenic siliceous particles over carbonate grains.

These classes separate sediments of distinct depositional settings and contrasting organic matter content and minor grain types. Tarls dominate in thick mudrock successions characterized by high rates of sediment accumulation and typically contain little organic matter, much of it terrestrial. Carls and sarls are generally associated with thinner successions. The slower rates of accumulation for carls and sarls tend to favor generation of intrabasinal particles such as sediment aggregates (intraclasts, pellets, agglutinated allochems, etc.) and phosphatic debris. If organic-rich, carls and sarls tend to contain organic matter that originated in the water column.

In the subsurface, tarls are relatively unreactive and only manifest significant reaction of the grain assemblage at elevated temperatures (>80° C). Under ordinary geothermal gradients tarls tend to remain unconsolidated until around 2 km of burial or more. In contrast carls and sarls contain chemically unstable grain assemblages (including labile organic matter) prone to react with pore fluids early in burial. Reactive grain assemblages in carls and sarls cause cementation and the generation of brittle rock properties relatively early in the burial history.

Classification based on the grain assemblage is only the beginning of a complete rock description, but constitutes a valuable foundation for placing samples into the larger stratigraphic context and for making predictions about the post-depositional evolution of bulk rock properties.

Speaker Biography:

Kitty L. Milliken received a B.A. in geology (1975) from Vanderbilt University and M.A. (1977) and Ph.D. (1985) degrees from the University of Texas at Austin. Currently she is a Senior Research Scientist at the Bureau of Economic Geology. Her research focuses on the diagenesis of siliciclastic sediments and the evolution of rock properties in the subsurface. She has authored and co-authored around 80 peer-reviewed papers, over 100 abstracts, and also digital resources for teaching sandstone and carbonate petrography. She served as Associate Editor of the Journal of Sedimentary Research (1993-2000) and as Co-Editor (2004-2008). In 2006 she toured as a J. Ben Carsey Distinguished Lecturer for the AAPG; she was elected a Fellow of the Geological Society of America (2008). Her current work has a practical bent, focused on the application of electron microbeam imaging and analysis to interpret chemical and mechanical histories of mudrocks (oil and gas shales).

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