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Quantifying Mechanisms of Porosity Decline in Mudrocks

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Models for porosity evolution in sand and sandstone are highly refined and predictive. Understanding of porosity evolution during burial of fine-grained sediments and rocks is less advanced and is currently a topic of vigorous investigation. Recent technologies for sample preparation and imaging of specimens with electron microbeam instrumentation have opened new possibilities for observation of pores, grains, and other constituents in muds and mudrocks. In particular, preparation of flat surfaces by Ar-ion cross-section polishing and related techniques has produced unprecedented views of pores and organic matter in mudrocks. It is now clear that processes of compaction, cementation, grain replacement, and secondary pore formation operate in mud and mudrock, much the same as in sand and sandstone. The important concept of intergranular volume (IGV) that is central to models of porosity evolution in sandstone can now be defined and measured in mudrocks. Even in the early stages of burial (10s of meters) where total porosity remains high (>50 percent) the primary intergranular pores in muds are small, generally less than 1 micrometer, placing an important constraint on sizes of potential cement crystals that can form in mud during burial. The volumetric assessment of IGV components in muds (primary pores and cements) that is enabled by high-resolution imaging allows the causes of porosity decline in muds to be quantified and partitioned between compaction and cementation. Much characterization work remains to be done, but it seems evident that compaction is the dominant cause of porosity decline in mud. Pore loss dominated by cementation is uncommon in muds and is primarily associated with relatively early diagenetic reaction of grain assemblages rich in unstable carbonate and biosiliceous particles.

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