Why Are Mudstones Dolomitized in Mississippian Midale Beds, Weyburn Oilfield, Saskatchewan?

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This study is focused on the Upper Midale Beds, Weyburn Oilfield, where bioturbated dolomudstones comprise reservoir strata. Abundance of bioturbate textures within muddy strata suggests widespread organism-sediment interactions played key roles in dolomitization and porosity evolution. Common trace fossils such as Zoophycos, Planolites and Chondrites, some Helminthopsis, Asterosoma, Teichichnus and Palaeophycus, and rare Siphonichnus define a diverse suite, characteristic of a distal-Cruziana ichnofacies. Predominance of deposit-feeding activities in fully-marine, offshore paleoenvironments has resulted in nearly complete pelletization of muddy substrates. Petrographic studies show fecal pellets define burrow-fabrics consisting of concentric and tangential alignments, and abundance patterns ranging from clustered-interpenetrating to homogenized textures. These fabrics are associated with bioturbate texture-selective dolomites, consistent with reservoir-scale diagenesis.

Dolomitization has been facilitated by extensive re-organization of muddy substrates into fecal pellets, and origin of intergranular voids within otherwise relatively impermeable substrates. Voids show two distribution patterns: (1) intraburrow-, and (2) interburrow-fabric porosity. Both types of biogenic intergranular voids facilitated percolation of dolomitizing fluids, and development of intercrystalline porosity. Such an evolution in porosity has influenced the origin of permeable conduits, where dissolution fluids leached skeletal fragments aligned in bioturbation. Accordingly, characteristics of enhanced reservoir quality are manifest in the arrangements of moldic voids. Therefore, alignment characterstics that define morphological elements of burrow-fabrics, including aspects of spreiten and wall-structures has resulted in increased connectivity of voids. Such bioturbate textural changes provided intrinsic controls on development of permeable conduits, and setup of a cross burrow-fabric fluid regime in diagenesis. Also, changes in textures have influenced crystallization dynamics in dolomitization of the fecal pellet material. For example, dolomite rhombs originated from transformation of pellets in growth-stages, such as nucleation, crystallization, and recrystallization. Furthermore, local variations in fabrics and distribution of intercrystalline porosity have resulted from both ingrowth (host-to-burrow) and outgrowth (burrow-to-host) mechanisms in dolomitization.