NANOSCALE GRAIN BOUNDARY CHANNELS AND TRANSGRANULAR CRACKS AS FLOW CONDUITS IN FRACTURE CEMENTS OF TIGHT SHALE PLAYS

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Natural fractures in shale reservoirs are frequently filled with mineral cement without any residual fracture permeability that is visible under the petrographic microscope. These fractures are therefore thought to be impermeable for fluid flow. Preliminary scanning electron microscopy of calcite fracture cements, prepared using broad beam ion milling, provided evidence of potentially conductive grain boundary channels about 100 nm in width. They are difficult to observe using scanning-electron microscopy on conventional polished thin sections or rock samples because of mechanical damage imposed by grinding and mechanical polishing, and have thus been overlooked. Broad-ion beam milling employed in this study preserves sub-micron details of the fracture cement pore structure with a minimum of sample damage during sample preparation. Although partially healed, these nanoscale grain boundary channels are interpreted to allow flow across and along cemented fractures. I hypothesize that these grain boundary channels are ubiquitous in calcite and perhaps quartz cemented fractures in shale and in a variety of tight shale reservoirs that have undergone deep burial digenetic conditions, and that these channels are inherent to the cement fabric and not the result of exhumation or core handling. This study seeks to assess how common these grain boundary channels are, if they are limited to specific fracture cement minerals, under what depth and temperature conditions they occur, under which conditions they are preferentially preserved or healed by precipitation, and how effective they are in transferring fluids along and across otherwise completely cemented natural fractures.

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