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Effect of dry annealing on the mechanical properties of limestones

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Chemical and mechanical processes are coupled in many geological and geochemical environments. For example, reactive processes, from simple dry heating to replacement are expected to anneal defects and restructure grain boundaries of rocks, modifying their elastic properties such as the Young's and shear moduli and the levels of internal friction, and thereby properties of geophysical interest such as wave propagation rates and fracture behavior. The nature of these changes, however, is expected to be contingent on the initial state of the rock. In this study, impulse excitation (IE) has been used to noninvasively measure mechanical property changes as a function of increasing heating time at 300 ºC for three carbonates: Carrera marble, Carthage marble (Burlington Limestone) and Texas Cream limestone (Austin Chalk) with initial porosities ranging from ~1 to ~27 percent. Results showed that the Young's and shear moduli dramatically decreased during the first two hours of heating but changed little after that to a total of 256 heating hours. Correspondingly, Poisson's ratio also dramatically decreased during the first two hours of heating and then slightly increased after six hours of heating and remained nearly constant until the end of the experiments. However, internal friction measured from the of the fundamental in bending out-of-plane and torsion mode frequencies first increased and then decreased from the starting point until 64 hours of heating for all the samples. This latter is a direct function of grain boundary motions during vibration and reflects changes in bonding between grains cause by annealing. Changes in all three rocks showed qualitatively similar, but quantitatively different variations with time in the measured mechanical properties. Work is ongoing to further characterize the microstructural changes generating these changes in the emergent mechanical properties.