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Eichhubl, Peter (Department of Geological and Environmental Sciences, Stanford University, Stanford, CA)

FRACTURE FORMATION IN RESPONSE TO CHEMICAL ALTERATION IN MONTEREY-TYPE SILICEOUS MUDSTONE

Rock fracture is traditionally considered a brittle process involving mechanical breakage of bonds, without consideration of the effects of chemical mineral reactions on fracture growth. Two examples are presented suggesting that fracturing occurred in response to chemical mineral reactions. Fractures with characteristic blunt tips and large aperture to length ratios are observed in clinker that formed during natural combustion of hydrocarbons. Fractures of similarly large apertures are observed in opal-CT chert spheroids that are contained in opal-A diatomite. These fractures are partly cemented by chalcedonic quartz Fracturing of clinker is associated with the instability of opal-A and smectite and with the formation of high-temperature minerals. In chert spheroids, fractures are inferred to form in association with the opal-CT to quartz transition under early diagenetic conditions. In both cases, fracturing is interpreted to result from the reduction in specific volume of the porous rock, driven by the thermodynamic tendency of the material to minimize the surface free energy of pores. This decrease in specific volume resulted in a tensile sintering stress and failure by opening-mode fracture.

It is suggested that tensile sintering stresses, in addition to increases in pore fluid pressure due to dehydration reactions, are potentially significant in contributing to an effective tensile stress state in fine-grained sedimentary rocks of diagenetically reactive composition. In such cases, the formation of fractures during prograde burial is expected to correlate with distinct stages in mineral diagenesis such as the opal-A to opal-CT and quartz transition or the smectite to illite transformation.