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Strain rates of opening-mode fractures in deep basinal settings

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Long-term strain rates for geologic processes are characteristically in the range of 10^{-13} to 10^{-17} s^{-1} as measured by a variety of techniques, including geodetic techniques, radiometric dating of tectonic and structural processes, and through stratigraphic correlations. Here, we present strain rates for populations of opening-mode fractures in sandstone in deep basinal settings. Fracture strain is obtained by collecting aperture-frequency data for microfractures along scanlines in weakly deformed sandstone. Opening durations of individual macrofractures in the same population are then obtained through detailed microthermometry of fluid inclusions in crack-seal fracture cement, combined with textural reconstructions of the fracture opening history. Temperature data are then correlated with known burial history models to obtain the duration of fracture opening and the fracture opening strain rate. Individual fractures in deeply buried sandstone of the East Texas basin, a passive margin setting, opened over 48 m.y. with a strain rate of 2x10^{-18} $s^{-1}$to 5x10^{-19} s^{-1}. Similar strain rates are obtained for fractures in the Piceance intermontane basin of Colorado. These ultraslow strain rates compare well to longterm intraplate seismic strain rates suggesting that rates of fracture opening are controlled by intraplate tectonic deformation processes.