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Estimation of sub-seismic fault populations

In order to characterize frequency distribution of sub-seismic (<10m throw) extensional faults in carbonate rocks we used outcrop maps derived from photo-mosaics or scanlines of well-exposed normal fault systems in Cretaceous strata from 4 locations in Texas. We calculated average extension direction, extension-parallel heave and fault frequency, and total fault-expressed extension. Three key observations from mapping are: (1) fault frequency increases with total extension, (2) small-displacement faults are more numerous in rocks with higher total extension, and (3) a few large faults accomplish most of the total extension. Scanlines from a 3D seismic reflection survey of faults in a carbonate reservoir exhibit lower fault frequency, and the proportion of small-displacement faults is very low compared with outcrop data. This data gap arises because small-displacement faults are not resolved by seismic images. One approach to correcting this data gap is to synthetically add faults of appropriate displacement into the seismic dataset. The basis for this correction is that total extension determines fault frequency, and the largest observed faults provide a good representation of the total strain. The difference between total extension and that accommodated by observed faults is the extension deficit. Using estimates of the extension deficit, the total number of faults that should be present can be calculated. The size distribution of all faults in the population can be determined using the total extension, the total number of faults, and an empirical power-law relationship between fault displacement and frequency.