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Presents

Evidence for Damaging Induced Earthquakes in Southern California in the Early- to Mid-20th Century

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Several recent studies have presented evidence that significant induced earthquakes occurred in a number of regions during the 20th century related to either production or early wastewater injection. We consider whether the Mw6.4 Long Beach and Mw7.3 1952 Kern County earthquakes might have been induced by production in the Huntington Beach and Wheeler Ridge oil fields, respectively. The Long Beach earthquake occurred within nine months of the start of directional drilling exploiting offshore tideland reserves at depths of ≈1200 m; the well location was within ≈3 km of the preferred event epicenter. There was also a spatial and temporal association between other damaging moderate earthquakes in the Los Angeles basin between 1915 and 1932 and notable industry activities. The Kern County earthquake occurred 111 days following the first exploitation of deep Eocene production horizons within the Wheeler Ridge field at depths reaching 3 km, within ≈1 km of the White Wolf fault (WWF). While production in the Wheeler Ridge field would have reduced pore pressure, inhibiting failure on the WWF assuming a Coulomb failure criteria, we present a model based on analytical solutions with model parameters constrained from detailed industry data, whereby direct pore pressure effects were blocked by a normal fault that created an impermeable barrier close to the WWF, allowing the normal stress change associated with production to dominate, thereby promoting failure by unclamping the fault. Our proposed triggering mechanism is consistent with the observation that significant earthquakes are only rarely induced by production in proximity to major faults. Significant induced earthquakes in southern California during the early 20th century might have been associated with industry practices that are no longer employed (i.e., production without water re-injection).

BIO:

Susan Hough has worked as a research geophysicist at the US Geological Survey since 1992. Her areas of interest include earthquake ground motions, induced earthquakes, and seismic hazard. She led USGS Earthquake Disaster Assistance teams in Haiti following the 2010 earthquake and in Nepal following the 2015 Gorkha earthquake. She received an AB degree in geophysics from UC Berkeley in 1982 and a PhD in from UC San Diego in 1988. She has co-authored over 120 articles, and five books. She was elected Fellow of the American Geophysical Union in 2009.environmental restoration.

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