# Effect of Seismic Waves on Hydrothermal Systems: Examples from Long Valley, and Implications for Hydrologic Precursors

Evelyn Roeloffs

U. S. Geological Survey, 1300 SE Cardinal Court, Building 10 Suite 100, Vancouver WA 98683, USA
e-mail:evelynr@usgs.gov

That seismic waves trigger microseismicity in hydrothermal settings 100's of km from the epicenter is plausibly linked to seismic-wave-induced fluid pressure changes at these distances. Although fluid pressure decreases have been observed in diverse settings, detailed study of pressure variations in the hydrothermal system at Long Valley, California, reveals that seismic waves from earthquakes increase fluid pressure or discharge. Other published data support the idea that earthquake-induced pressure and discharge changes in hydrothermal systems have a strong tendency to be increases. Temperature increases in seafloor hydrothermal vents within days after earthquakes as distant as 220 km imply, moreover, that seismic waves can enhance the conductance of vertical fluid flow pathways.

The influence of seismic waves on hot, fluid-filled subsurface fractures could proceed by several mechanisms. Local fluid flow induced at crack walls could remove mineral seals. Spatially uniform acceleration can move gas bubbles relative to denser liquid and solid phases. Thermal expansion can elevate pressure around hot fluid that has penetrated upward.

By lowering effective stress and directly weakening fault planes that are themselves flow paths, seismic waves could initiate processes leading to other earthquakes where sufficient subsurface magma or elastic strain energy have previously accumulated. Although these processes probably occur at the base of the seismogenic zone, they might generate observable seismic, geodetic, hydrologic, geochemical, or electromagnetic precursors.