Pore Pressure and Seismicity—A Poroelasticity Point of View

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In 1972, Nur and Booker proposed "Aftershocks caused by fluid flow?" in a *Science* article. Nowadays the pore pressure effect is recognized in many seismic related events, including earthquake precursory effect and aftershocks, fluid injection and extraction induced seismicity, reservoir ponding caused earthquakes, the acoustic emission that allows the mapping of hydraulic fracture, and the seismoelectric and seismoelectromagnetic effects. The figure below shows a comparison of field observation of water level change in wells after a seismic event and the pore pressure induced by a solid slippage based on the poroelasticity theory.

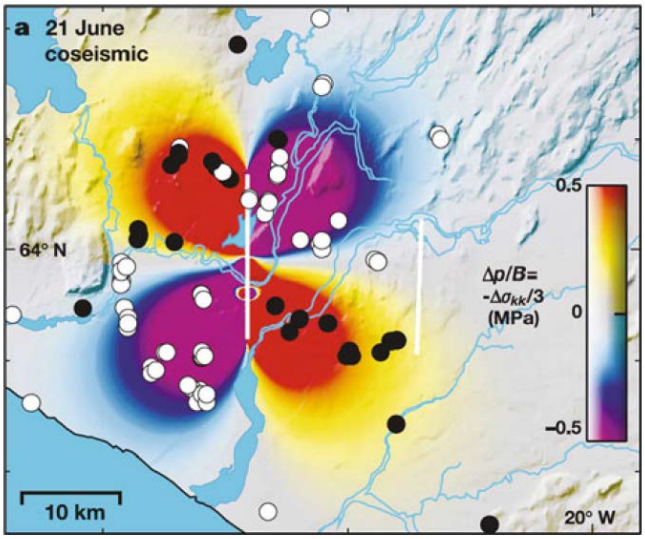

Fig. 1.7 Coseismic water level changes in geothermal wells in South Iceland. Water level increase is shown in black dots and decrease in white dots (From Jónsson et al. [136], with permission)

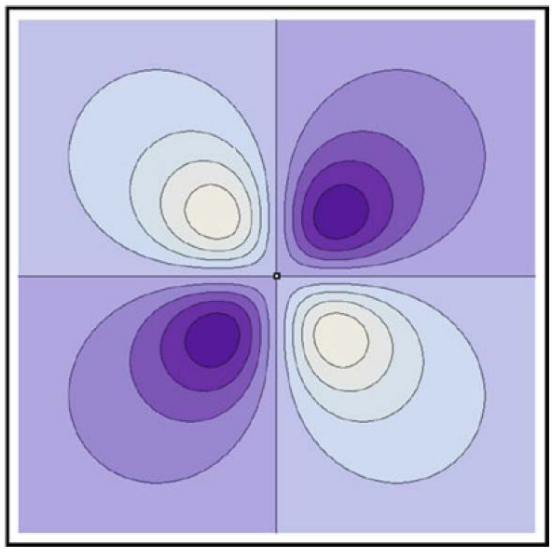

Fig. 1.8 Contour plot of pore pressure generated by a slipping displacement discontinuity

The theories of poroelasticity and poroelastodynamics were developed by M. A. Biot in 1940s and 1950s, respectivley. The dynamic theory predicts a second compressional wave, which is highly dissipative and short ranged, in addition to a compressional and a shear wave of the elasticity theory. The dissipation phenomenon, however, makes the seismic waves dispersive, that is, frequency dependent. It introduces an additional dissipation whenever a boundary or inhomoegneity is present. It is also responsible for the seimoelectric and seismoelectromagnetic effects.

This talk gives an overview of the physical phenomena and a brief coverage of the theory.

Reference: A.H.-D. Cheng, *Poroelasticity*, Springer, 877 p., 2016.