Complexity of the 2016 *M* 7.8 Kaikoura, New Zealand, earthquake from seismic observation: inferences of overpressured fluid involvement

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The *M* 7.8 Kaikoura earthquake occurred in the northern South Island on 3 Nov., 2016, involving the rupture of > 20 faults. To understand the complexity of the Kaikoura earthquake, details of fault geometry, seismic velocity distribution and stress field are necessary. We have undertaken seismic tomography and stress tensor inversion using focal mechanisms along the c. 200 km length of the rupture zone.

Data from both 51 temporary stations and 22 GEONET stations were collected from March 2011 to December 2017. Hypocenter locations and the three-dimensional velocity structure were determined using the method of Zhang and Thurber (2003 and 2006).

The hypocenter of the Kaikoura earthquake and aftershocks near the Kekerengu fault locate along lineaments where seismic velocity changes horizontally.

In the uppermost crust, lower velocities occur beneath the Emu Plain and Cape Campbell. Higher velocities occur in and around Kaikoura.
In the middle to lower crust, high Vp/Vs occurs not only in and around the hypocenter but also along the northern part of the rupture zone.
In the lowermost crustal or uppermost mantle, high Vp occurs east of the Kekerengu fault and south of the Hope fault and beneath the Canterbury plains faults. This high Vp likely corresponds to the Pacific plate.

These complexities in the seismic velocity structure may relate to the multi-rupture character of the Kaikoura earthquake. In particular, spatial correlations between rupture areas and high Vp/Vs suggests

the involvement of overpressured fluid in the nucleation and propagation of rupture segments, which is also supported by the reactivation of unfavourably oriented strike-slip ruptures, many lying at c.70° to regional sigma-one stress trajectories.

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