Kaikoura quake may prompt rethink of earthquake hazard models internationally

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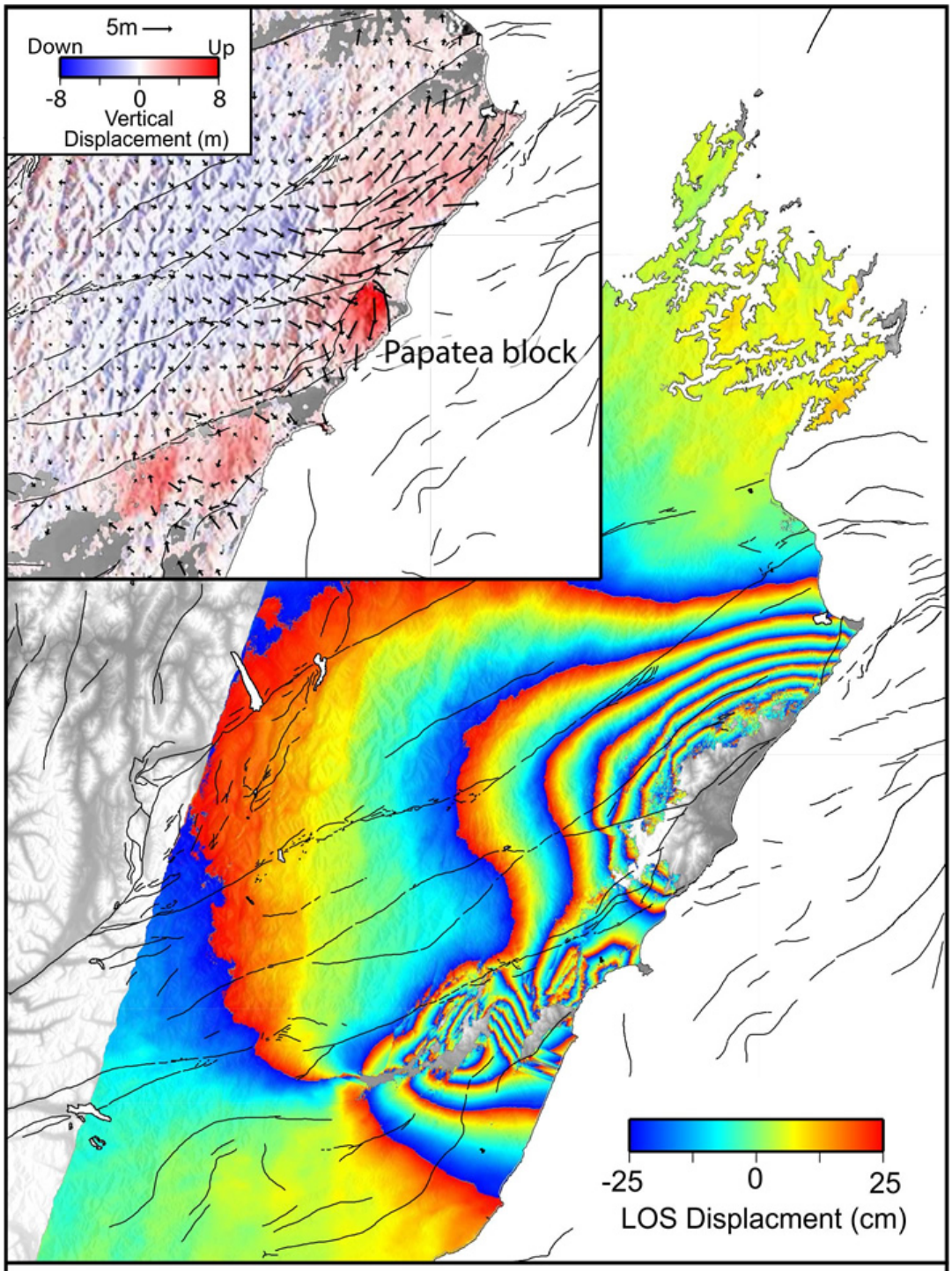

The main image is a radar interferogram mapping the deformation of the M7.8 Kaikoura earthquake on 14 November 2016. Each of the coloured contours shows 50cm of vertical displacement either towards or away from the satellite. The image in the top left shows the horizontal ground movement with the length of arrows proportional to the amount of movement. The coloured background shows the vertical movement. During the earthquake, parts of the upper South Island moved by about 6m horizontally with uplift of about 8m.

Credit: GNS Science

Last November's magnitude 7.8 Kaikoura earthquake was so complex and unusual that it is likely to lead to changes in the way scientists think about earthquake hazards in plate boundary zones worldwide, a new study says.

Not only was it a record-setter for its complexity, but it was also one of the best recorded large earthquakes anywhere in the world. This latter feature has enabled scientists to undertake analysis in an unprecedented level of detail.

The paper is the first of a number of studies to be published on the rich array of data collected during and immediately after the earthquake revealing its astonishingly complex nature.

Published today in the journal *Science*, the paper is titled 'Complex multi-fault rupture during the 2016 M7.8 Kaikoura earthquake, New Zealand'. Led by GNS Science and with 29 co-authors from 11 national and international institutes, it reports on the analysis of a range of quake data including satellite radar imagery, field observations, GPS data and coastal uplift data.

The authors say the quake has underlined the importance of re-evaluating how rupture scenarios are defined for seismic hazard models in plate boundary zones worldwide.

The study shows the quake moved parts of the South Island more than 5 metres closer to the North Island in addition to being uplifted by up to

8m.

The earthquake ruptured at least 12 major crustal faults plus another nine lesser faults and there was also evidence of slip along southern end of the Hikurangi subduction zone plate boundary, which lies about 20km below the North Canterbury and Marlborough coastlines.

The rupture started in North Canterbury and propagated northward for more than 170km along some well-known, and some previously unknown faults. It straddled two distinct active fault domains, rupturing faults in both the North Canterbury Fault zone and the Marlborough Fault system.

The largest movement during the earthquake occurred on the Kekerengu Fault, where pieces of the Earth's crust were displaced relative to each other up by to 25m at a depth of about 15km. Maximum rupture at the surface was measured at 12m of horizontal displacement.

"This complex earthquake defies many conventional assumptions about the degree to which earthquake ruptures are controlled by individual faults, and provides additional motivation to re-think these issues in seismic hazard models," the authors say.

Lead author, geodesy specialist Ian Hamling of GNS Science, said the complex and lengthy nature of the rupture hampered early attempts to determine an accurate magnitude of the earthquake, and this could potentially pose issues for earthquake early warning systems.

Dr Hamling said the earthquake had underlined that conventional seismic hazard models were too simple and restrictive.

"The message from Kaikoura is that earthquake science should be more open to a wider range of possibilities when rupture propagation models

are being developed."

However, he noted that insights from several large complex earthquakes worldwide during the past decade were starting to feed into seismic hazard models and helping to relax some of the existing assumptions about the way multi-fault ruptures can occur.

Owing to the long Kaikoura aftershock sequence, there is still an elevated risk of a damaging quake occurring in the central New Zealand region. The latest aftershock probabilities, published on the GeoNet website, show there is a 15% chance of a magnitude 6.0 to 6.9 quake in the next month. While the probabilities are trending down month by month, the figures are still at a level where it is worthwhile to continue with individual and community preparedness measures.

More information: Ian J. Hamling et al. Complex multifault rupture during the 20167.8 Kaikōura earthquake, New Zealand, *Science* (2017). DOI: 10.1126/science.aam7194

Provided by GNS Science