GUY CARPENTER

GC BRIEFING

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GUY CARPENTER STUDY CHALLENGES VIEWS OF SEISMIC RISK IN JAPAN

The Tohoku rupture of 2011 changed the market's understanding of seismic risk in Japan. The Mw 9.0 event occurred in an area where earthquakes of up to only Mw 8.4 were thought possible. Following the event there was increased publicity surrounding the so-called Tokyo Fragment theory and discussion around the potentially increased probability of earthquakes near Tokyo.

In order to bring objective balance to the discussion surrounding certain views on Japan earthquake risk in this post-Tohoku environment, Guy Carpenter & Company, LLC is sponsoring a review of the available relevant research literature by Professor Paul Somerville of Risk Frontiers. This briefing summarizes some preliminary observations arising from Professor Somerville's work.

Stress Accumulation and Release near Tokyo

As the Earth's crust deforms, it sustains enormous pressures that trigger fractures and cause the appearance of faults. An earthquake happens due to the sudden relative displacement of the sides of a fault; and this movement occurs when the stress between the sides is so high that it cannot be resisted by the existing frictional constraints. When an event takes place it causes sudden deformations that may impose additional stress on adjacent fault segments as well as on other faults. However the impact that stress may have on long-term risk depends on both the rate and the mechanism of dissipation.

While there is consensus among the scientific community that stress increases near Tokyo have occurred, there are divergent theories regarding how this increase in stress influences real risk.

Based on observations after Tohoku, four areas showed increases in stress near Tokyo: the volcanic regions of Hakone and Izu towards the west and southwest; and Chiba and Ibaraki towards the east and northeast. Izu and Hakone are characterized by crustal (shallow) faults while Chiba and Ibaraki are characterized by deeper earthquakes.

It has been widely publicized that Toda and Stein (2013)[1] suggest stress changes have long-term effects, increasing by a factor of x2.5 the probabilities of earthquakes with magnitudes higher than Mw 6.5 near Tokyo. What appears less well known is that these computations, which involve large uncertainties, are contested, for instance by Uchida and Matsuzawa (2013)[2] building on the previous measurements of Nishimura et al. (2007).[3]

The recent observations presented by Uchida and Matsuzawa (Figure 1) suggest that the **stress created by the Tohoku rupture is being released aseismically** by the steady and continuous slip of the faults. Consequently **Tohoku-induced stress changes would not be contributing to long-term increases in risk near Tokyo**.

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1 Toda, S. and Stein, R. (2013), The 2011 M=9.0 Tohoku-Oki earthquake more than doubled the probability of large shocks beneath Tokyo, Geophysical Research Letters, 40, doi:10.10002/grl.50524.

2 Uchida, N. and Matsuzawa, T. (2013), Pre- and post-seismic slow slip surrounding the 2011 Tohoku-Oki earthquake rupture, Earth and Planetary Science Letters, in press.

3 Nichimura, T., Sgiya, T., and Stein, R. (2007), Crustal block kinematics and seismic potential of the northernmost Philippine Sea plate and Izu microplate, central Japan, inferred from GPS and leveling data, Journal of Geophysical Research, vol. 112, doi:10.1029/2005JB004102.

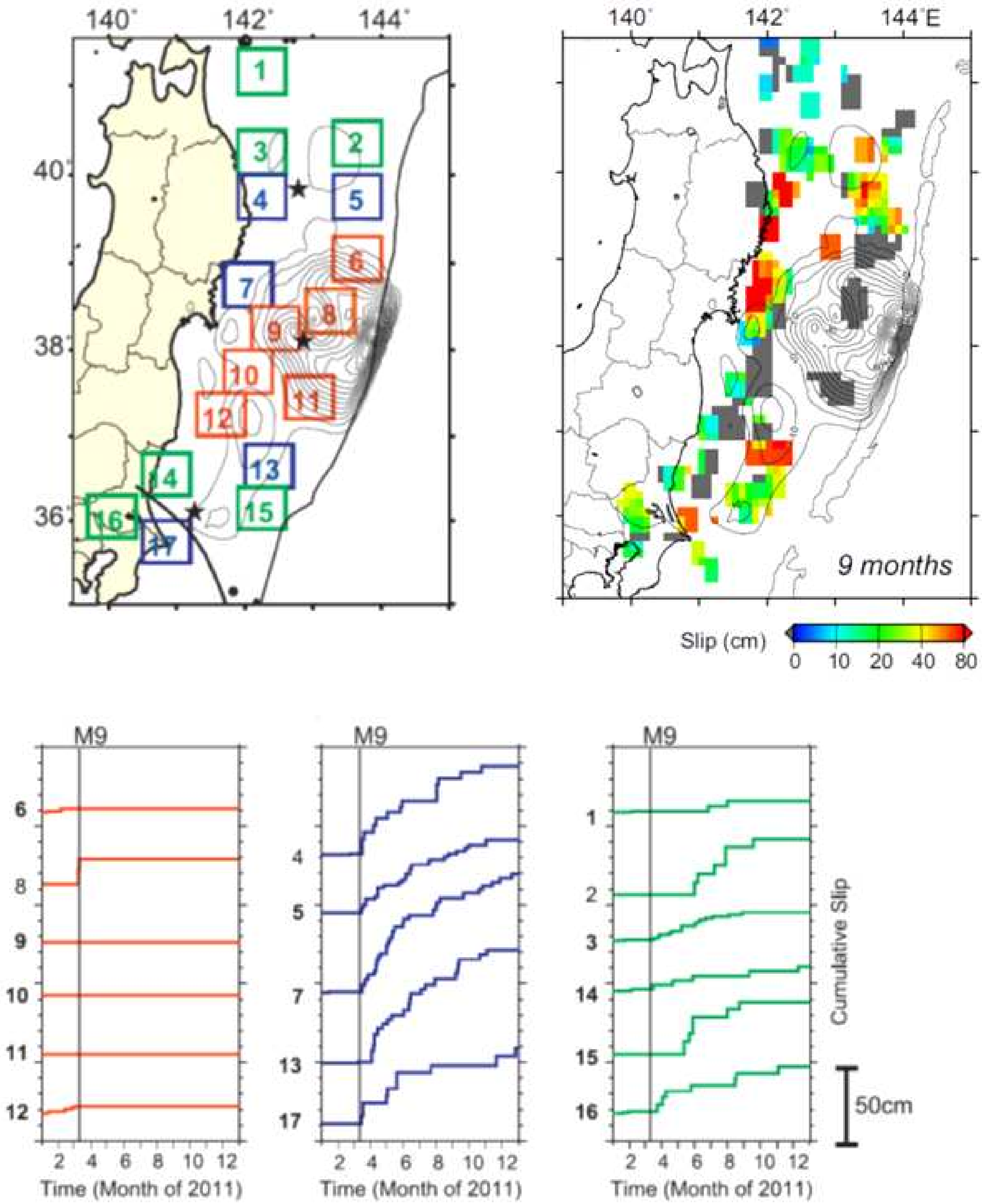

Figure 1: The top right panel shows the total creep that occurred in the 9 months following the Tohoku earthquake based on repeating small earthquakes. Lower panels show aseismic slip (creep) following the Tohoku earthquake in the various regions shown in the top left panel. There has been little post-Tohoku creep on the plate interface within the rupture zone of the Tohoku earthquake (shown in red), but significant post-Tohoku creep on the adjoining regions to the north and south (shown in blue and green).

Source: Uchida and Matsuzawa (2013)

The Tokyo Fragment Theory

There has also been considerable debate about the conjecture that a small plate fragment slides between the converging Ohkotsk and Pacific plates in the region just north of Tokyo, and that deeper earthquakes are concentrated in this region due to the fragment. This theory, which was proposed by Toda et al. (2008),[4] is contested, for instance, by the measurements and calculations presented by Uchida et al. (2010).[5] In this latter study no abrupt discontinuity was observed in the so far accepted geometry, which itself states that it is the northern tip of the Philippine Sea plate; not the fragment that is wedged between the Okhotsk and Pacific plates. In summary, there is so far no conclusive argument that would warrant a revision in our understanding of the tectonics directly affecting Tokyo.

Guy Carpenter will continue to assist its clients in their interpretation of the existing data as well as in the use of the findings to support modeling assumptions and reinsurance decision making.

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4 Toda, S., Stein, R., Kirby, S.H., and Bozkurt, S.B. (2008), A slab fragment wedged under Tokyo and its tectonic and seismic implications, Nature Geosciences, 1, 1-6, doi:10.1038/ngeo1318.

5 Uchida, N., Matsuzawa, T., Nakajima, J., and Hasegawa, A. (2010), Subduction of a wedge-shaped Philippine Sea plate beneath Kanto, central Japan, estimated from converted waves and small repeating earthquakes, Journal of Geophysical Research, vol. 115, B07309, doi:10.1029/2009JB006962.

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