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For Immediate Release

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SSA Annual Meeting Tip Sheet on Special Session: New observations, data on Japan and New Zealand earthquakes

April 12, 2011 -- The Seismological Society of America will convene its annual meeting in Memphis, Tennessee, April 13-15. Due to the recent March 11 great earthquake in Japan, SSA has organized a special session to discuss the wealth of data captured by the extensive seismic network in Japan.

We are providing summaries of talks below. The summaries are based on preliminary abstracts submitted March 25, and the talks and posters will include additional and updated information and analysis.

All 49 abstracts are available online at:

http://www.seismosoc.org/meetings/2011/japan+nz/

The First 25 Minutes of the 2011 Tohoku Earthquake

Scientists have analyzed the first 25 minutes of the massive March 11 earthquake in Japan, providing a closer look at the stunning details behind the magnitude 9.0 event along the Japan Trench. Recreating the earthquake from seismic wave data collections, Eric Kiser and colleagues show that the rupture associated with the quake's mainshock was about 250 kilometers long and 175 kilometers wide. The mainshock lasted 220 seconds, although most of the energy released in the mainshock occurred in the first 110 seconds. Over the next 20 or so minutes, several other ruptures occurred away from the mainshock rupture area, many of them with a magnitude of 6.4 or larger. After comparing their data with the historical catalogue of earthquakes in the area, the researchers think that the 2011 earthquake and its main aftershocks ruptured five areas within the region that have previously ruptured as individual earthquakes. The size of the March 2011 quake was unprecedented in the recent 200-300-year history of the Japan Trench, and is one of the largest earthquake events ever recorded.

In a second analysis, Guangfu Shao and colleagues use several models with seismic and global positioning data to trace the great rupture as it formed and moved through the fault plane. They note that the first 3-4 seconds of the rupture were so weak that they were not correctly identified at many seismic stations. Their models suggest that the rupture began at a depth of 23 kilometers, began moving slowly in the first 20 seconds, and then accelerated rapidly.

Eric Kiser, Harvard Univeristy, kiser@fas.harvard.edu

Guangfu Shao, University of California, Santa Barbara, shao@umail.ucsb.edu

Tohoku's Surprising Size

The 2011 Tohoku earthquake took many seismologists by surprise, since there have been few other earthquakes larger than magnitude 8.0 in the area for the past 1200 years. But there were some signs of seismic strain for the area that may have been considered in assessing the possibility of a rare and devastating earthquake, says Hiroo Kanamori. In this overview of the Tohoku event, Kanamori outlines the broad details of the earthquake based on seismic, tsunami and global positioning system data. Preliminary analyses suggest that there was large ocean bottom deformation of the crust along the Japan Trench, where the Pacific Ocean basin tectonic plate collides and is pulled under the continental crust. The earthquake probably began in the Miyagi area, triggering a large slip in the up-thrust region near the trench. The large slip may have then triggered smaller slips in the Fukushima, Ibaraki, and possibly Sanriku areas.

Hiroo Kanamori, California Institute of Technology, hiroo@gps.caltech.edu

Massive Crust Movements in Japan Earthquake

The Tohoku earthquake was the largest earthquake ever recorded in and around Japan. But it was also one of the most closely observed earthquakes in history, thanks to a dense array of seismic and other sensing stations in the region. Takeshi Sagiya and colleagues used this wealth of data to trace the massive deformation of the earth's crust in Japan, including some startling large movements. Global positioning data recorded a horizontal movement of 5.4 meters to east-southeast -- and a sinking of 1.1 meters near the quake's epicenter at Ojika station. The entire northern Honshu island moved a meter to the east during the event. The pattern of fault slips during the earthquake suggest that historical records from the last 400 years might not provide a complete picture of the seismic possibilities along this tectonic plate boundary, the researchers note.

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Are We In an Age of Great Earthquakes?

Is the magnitude 9.0 Japan earthquake part of a larger global trend toward giant earthquakes? Several groups of researchers have been combing through 110 years' worth of global seismic records to determine whether we might be entering a new age of massive earthquakes and have arrived at different interpretations.

Richard Aster and colleagues looked at historical catalogs of earthquakes along with more recent estimates to create a long-term record of global seismic moment -- the cumulative size of earthquakes around the world. They suggest there were relatively low rates of big earthquakes during the periods 1907-1950 and 1967-2004. The rate of large earthquakes increased substantially during the period 1950- 1967 and appears to be increasing again since 2004, since the Sumatra-Andaman earthquake late that year.

In a second analysis, Charles Bufe and David Perkins update their conclusions reached in a 2005 BSSA paper in which they described "megaquakes" to describe five earthquakes of Mw 9.0. Three of these occurred in an 11.6 yr cluster between 1952 and 1964, and included the Mw 9.5 Chile earthquake of 1960. They found significant clustering of Mw 8.6 and larger earthquakes during 1950-1965 and documented a long period (beginning during 1965 and continuing to 2001) of significant global quiescence with no events of magnitude.8.4 or larger. In the 2005 paper, they speculated that the 8.4 in 2001 could mark the beginning of a new global sequence of larger earthquakes. In this present paper, Bufe and Perkins discuss the significance of the current 6.3 yr global cluster of great earthquakes, including the two recent megaquakes of 9 or greater.

A third analysis by Andrew Michael suggests that the recent increase in the rate of large earthquakes may just reflect random variation in global patterns of seismic activity. His statistical study found that the pattern of large, global earthquakes can be explained as a random fluctuation, once local aftershocks of the large earthquakes are taken into account. He notes that global predictions of earthquakes and the damage they inflict should use the longest possible historical record for an area, rather than just the record from the recent past.

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Charles Bufe, U.S. Geological Survey, geoling@gmail.com

Andrew Michael, U.S. Geological Survey, michael@usgs.gov

Could the Tohoku Earthquake Have Been Predicted?

Two days before the devastating Japanese earthquake and tsunami, there were foreshocks off the Pacific coast of Tohoku. Yoshiaki Fujii notes that the daily rate of small earthquakes (equal or more than magnitude 1.0) significantly increased two days before the main quake. A large number of these foreshocks were detected in Miyagi, Iwate and Fukushima, site of the dangerously crippled nuclear power plant. Although a major earthquake doesn't always follow these types of foreshocks, Fujii argues that they could have pointed to the need to prepare or at least go on alert for a major quake somewhere in Japan. Even with such a prediction, buildings and other infrastructure would have still suffered considerable damage. But Fujii notes that an earlier warning may have allowed thousands of people to safely evacuate with their valuables and emergency goods.

Yoshiaki Fujii, Hokkaido University, Sapporo, Japan, fujii6299@eng.hokudai.ac.jp

Big Earthquakes Bracketed by Earthquake Swarms

Earthquake swarms are episodes where a local area experiences many earthquakes over a short period without an initial "mainshock" of greater magnitude. Stephen Holtkamp and Michael Brudzinski suggest that large subduction zone earthquakes, such as the 2011 Tōhoku quake, are bracketed by earthquake swarms. They describe earthquake swarms from around the Pacific, and find that regions with a large gap between swarm areas are often the site of major earthquake ruptures. They note this tendency in the 2010 Chile earthquake, as well as earthquakes in Sumatra, Peru, Alaska, and Kamchatka. Although earthquake swarms are generally composed of many smaller magnitude earthquakes, they appear to indicate areas that do not accumulate large tectonic stresses, which could prevent large earthquake ruptures from continuing through the swarm area.

Stephen Holtkamp, Miami University (Ohio), stephen.holtkamp@gmail.com

USGS Response to Japan Earthquake

The US Geological Survey's National Earthquake Information Center runs a 24 hour/ 7 days a week service to rapidly determine the location and size of all major global earthquakes and rapidly disseminate this information to national and international agencies, scientists, and the general public. Gavin Hayes and colleagues offer a behind-the-scenes look at the NEIC response to the Tohoku earthquake. Much of the NEIC's early information focused on estimates of the earthquake's magnitude, maps of shaking, aftershock locations and other factors necessary to guide a humanitarian and scientific response to the massive quake.

Gavin Hayes, U.S. Geological Survey, ghayes@usgs.gov

Measuring the Magnitude of the Tohoku Earthquake

The great Tohoku earthquake was originally thought to be a magnitude 7.9 quake, but was later upgraded to a magnitude 9.0 earthquake. In this report, Teh-Ru Alex Song and colleagues discuss the analysis of free oscillation waves to determine the new magnitude. Free oscillation waves are vibrations of the entire planet, which in this case were perturbed by the Tohoku earthquake rupture. A model created using information from these waves confirms a Tohoku quake of 9.1, according to the researchers.

The-Ru Alex Song, IFREE, JAMSTEC, Yokohama, Kanagawa, Japan, tehrusong@gmail.com

Global Tremors Triggered by Tohoku Earthquake

The massive Tohoku earthquake in Japan triggered seismic tremors and microearthquakes around the world, according to analyses by Justin Rubinstein and colleagues. The Japanese earthquake triggered tremors mostly in places where they have previously been identified, including Southwest Japan, Vancouver Island, Washington and Oregon, Central California, Alaska, the Aleutians, Taiwan, and for the first time in Cuba. Zhigang Peng and colleagues further analyze these triggered tremors in several regions, discussing the timings of the triggered activities and the seismic waves from the Japan event. Most of the triggered earthquakes occurred in areas with high background levels of seismic activity, such as California's Geysers and Coso Geothermal Fields. Some triggered earthquakes also occurred in low-activity areas, such as central Nebraska, eastern Missouri, central Arkansas, and near Beijing, China. Several large earthquakes (magnitude 6.0 or higher) in Japan occurred well beyond the rupture zone of the Tohoku quake, and may have also been triggered by the giant seismic event.

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Slip Factors in Tohoku Tsunami

Why do some giant earthquakes produce a devastating tsunami, while other large earthquakes seem to cause much smaller tsunamis? Using data from the Tohuko earthquake and others, Andrew Newman suggest that the answer may lie in how shallow the fault slip penetrates during the event. Earthquakes such as the Tohuko quake and the 2004 magnitude 9.2 Sumatran earthquake may have triggered giant tsunamis because their fault slip extended beyond the upper limit of the normal seismic range—about 20

kilometers below the surface—and upward into the near-trench “tsunami-earthquake” environment. At these shallower levels, slip could be enhanced by weakened crust, the researchers suggest, drastically increasing the seafloor’s shake.

Andrew Newman, Georgia Institute of Technology, Atlanta, GA, anewman@gatech.edu

Tohoku Tsunami’s Effects on the California Coast

Three hours after the great Tohoku earthquake, the West Coast Alaska Tsunami Warning Center put the California coast on varying stages of alert for a tsunami. The warning/advisory forecasted a tsunami surge .3 to 2.5 meters in size, with the highest surge predicted for low-lying Crescent City. Lori Dengler and colleagues detail how the warning system went into effect, and discuss the damage caused in coastal harbors. Several tide gauges recorded large surges nearly 15 hours after the initial onset of the tsunami, when the tide was high. The fluctuating tides and very strong currents caused more than $50 million in damage to harbors in northern and central California, the largest damage estimates since 1964.

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