Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)
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SSS01-05 Room:104 Time:May 25 10:00-10:15

Predictability of the 2011 Tohoku M9.0 Earthquake

ZHAO, Shuxian[1*], Li MA[1], Yongqing ZHANG[1]

[1]ICD, CEA, CHINA

On 11 March 2011, a M9.0 interplate earthquake occurred off the Pacific Coast of Tohoku, Japan. Before this earthquake, the seismicity patterns in the Japan Trench subduction zone(shorted for JTSZ) indicate long-term, middle-term and short-term predictability.

1 Mj>=7.0 earthquake quiescence area in the interplate seismic zone between 1925 and 2002

Fig.1 displays Mj>=3.5 earthquakes in the JTSZ and its vicinity during 1925-2002. The Mj>=7.0 earthquakes are denoted by red dots, the 6.5<=Mj<7.0 earthquakes by black dots, and the 3.5<=Mj<6.5 earthquakes by small gray dots.

An abnormal quiescence area of Mj>=7.0 earthquakes in the interplate earthquake zone can be found. Only one Mj7.0 earthquake occurred, and 6.5<=Mj<7.0 and 3.5<=Mj<6.5 earthquakes are also quiescent. The mainshock is located in the margin of the quiescence area.

Between 1925 and 2002, eight Mj>=7.0 intraplate earthquakes occurred in the JTSZ. Seven of them occurred in the overriding Okhotsk plate, and one in the outer rise region of the subducting Pacific plate. These eight events scatter along the Japan Trench.

2 Mj>=7.0 intraplate earthquake strip perpendicular to the Japan Trench during 2003-2010

Fig.2 displays Mj>=5.5 earthquakes in the JTSZ and its vicinity between 2003 and 2010. The Mj>=7.0 earthquakes are denoted by red dots, and the 5.5<=Mj<7.0 earthquakes by gray dots.

Three Mj>=7.0 intraplate earthquakes occurred in a great circle on the earth's surface perpendicular to the Japan Trench and a perpendicular intraplate earthquake strip formed (shorted for PIES, as shown in Fig.2). The first one (2003/05/26 Mj7.1) occurred in the intermediate depth region of the Pacific plate, the second one (2005/11/14 Mj7.2) in the outer rise region of the Pacific plate, and the last one (2008/06/13 Mj7.2) in the Okhotsk plate. Seven 5.5<=Mj<7.0 interplate earthquakes occurred along the great circle I in the quiescence area. Three (Mj5.9, Mj6.3, Mj6.3) occurred in August 2005, and four (Mj6.1, Mj5.5, Mj5.5, Mj5.5) in December 2008.

Two Mj>=7.0 interplate earthquakes occurred, and one of them (2005/08/16 Mj7.2) occurred in the PIES.

The mainshock is located in PIES, and also in the great circle II passing through the 2005/08/16 and 2005/11/14 earthquakes. The mainshock is located on the upper surface of the subducting Pacific plate, and the faults of the mainshock and 2005/08/16 earthquake are almost coplanar, as shown in Fig.3.

3 2011/03/09 Mj7.3 foreshock

On 9 March 2011, two days before the mainshock, a Mj7.3 foreshock occurred in the quiescence area, as shown in Fig.4. The foreshock is located between the great circle I and II, close to the great circle I. The faults of the mainshock and the foreshock are almost coplanar, as shown in Fig.3.

4 Closeness in local time of Mj>=5.6 generalized foreshocks two years before the foreshock

From March 2009 to the foreshock (after PIES appeared), 10 Mj>=5.6 earthquakes occurred in the JTSZ, and 9 of them occurred in only 6 hours (12-18 local time), as shown in Fig.5.

Mainshock occurred in the middle of this period.

5 Preliminary physical interpretations

An earthquake is caused by a sudden slip on a fault, and the slip needs enough stress and space. The seismicity, before the 2011 Tohoku M9.0 earthquake, indicates the formation process of the two conditions clearly.

The continual stress accumulation in the PIES, indicated by the long-term interplate seismic quiescence area during 1925 - 2002, and the stress transfer to the mainshock fault, indicated by the events in the PIES between 2003 and 2010, provide the stress condition for the mainshock slip.

The slips of the 2005/08/16 earthquake and the foreshock, weakened the deep and shallow portion of the mainshock fault respectively, provide the space condition for the mainshock slip.

The significant closeness in local time of the generalized foreshocks for two years prior to the foreshock might be a critical phenomenon correlated with the movement of the Sun.

Keywords: 2011 Tohoku M9.0 earthquake, earthquake prediction, quiescence area, earthquake strip, foreshock

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