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# Fault rupture model of the 2008 Dangxiong (Tibet, China) Mw 6.3 earthquake from Envisat and ALOS data

Yang Liu, Caijun Xu *, Yangmao Wen, Ping He, Guoyan Jiang

*School of Geodesy and Geomatics, Wuhan University, 129 Luoyu Road, Wuhan 430079, China*

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**Abstract**

On October 6, 2008, an Mw 6.3 earthquake occurred in Dangxiong county, southern Tibetan Plateau. In this study, Synthetic Aperture Radar (SAR) images from Envisat ASAR C-band descending Track 176 and ALOS PALSAR L-band ascending Track 500 are processed to generate the coseismic deformation caused by the earthquake. To estimate the source model, a downhill simplex non-linear inversion method is used to determine the fault rupture geometry, and an automatic fault discretization technique is employed to divide the fault plane to construct the optimal slip model, in which the uncertainties of the fault parameters are assessed by a Monte Carlo method. The inversion results show that the earthquake strikes almost south–north and has a normal faulting focal mechanism with rake angle and slip of $-111.7°$ and 1.33 m, respectively. Peak slip of 2.15 m is located at a depth of 7.5 km. The estimated geodetic moment is $4.06 \times 10^{18}$ N m (Mw 6.37), 71.2% of which is released in the depth range 4.5–11 km. The slip model suggests that coseismic slip also takes place at some fault patches near the earth's surface and postseismic afterslip occurs below the coseismic rupture area after the earthquake.


*Keywords:* Rupture model; Dangxiong Mw 6.3 earthquake; Envisat; ALOS; Inversion

## 1. Introduction

On October 6, 2008, an Mw 6.3 earthquake struck Dangxiong county, Tibet province, China, in the Yadong-Gulu rift of the southern Tibetan Plateau (Fig. 1). This event was a shallow destructive earthquake, causing the largest economic losses (about $411 million) and the most serious casualties (up to 10 people) in Tibet in the last 50 years (Wu et al., 2009; Zhang et al., 2008). Geological field observation in southern Tibet (Armijo et al., 1986) indicated that transverse extension of the Yadong-Gulu rift is significant, which can be explained by a series of normal faults dipping to the east and west. GPS data surveyed between 1991 and 2000 demonstrated that the opening rate of the Yadong-Gulu rift is about $6.5 \pm 1.5$ mm/yr (Chen et al., 2004), which is much higher than the value of $1.4 \pm 0.8$ mm/yr estimated by Armijo et al. (1986). Gan et al. (2007) updated the GPS observations and determined a left-lateral slip rate of $0.7 \pm 1.1$ mm/yr and an opening rate of $2.0 \pm 0.6$ mm/yr for the Yadong-Gulu rift.

Ever since 1264 A.D., the Yadong-Gulu rift has experienced the very frequent earthquake activity. The historical earthquake catalogue (Earthquake Disaster Prevention Department of China Earthquake Administration (EDPD-CEA), 1995, 1999) shows that along the Yadong-Gulu rift, there have been at least 14 $M \geqslant 6.0$ earthquakes, of which the September 29, 1411 Dangxiong-Yangbajing M 8.0 earthquake and the August 18, 1952 Naqu-Gulu M 7.5 earthquake were located to the north of epicenter of the October 6, 2008 Dangxiong Mw 6.3 earthquake while the April 21, 1901 north Nimu M 6.8 earthquake, the August 14, 1924 Nimu M 6.0 earthquake and the July 30, 1992 Nimu-Angang M 6.7 earthquake were located to the south of the 2008 event (Fig. 1). Based on these events, Wu et al.

* Corresponding author. Tel.: +86 27 68778805; fax: +86 27 68778371.
*E-mail address:* cjxu@sgg.whu.edu.cn (C. Xu).

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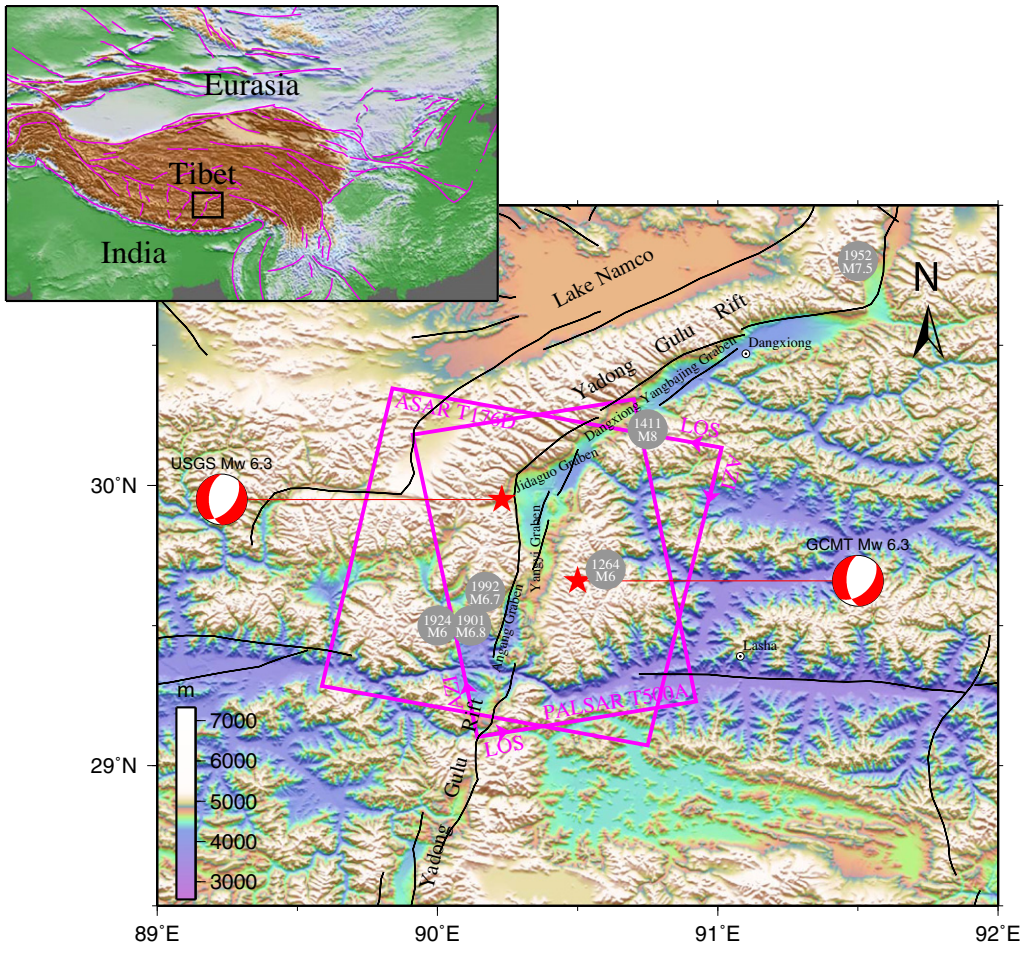


Fig. 1. Tectonic Setting of the October 6, 2008 Dangxiong Mw 6.3 earthquake. Purple rectangles delimit the extents of the Envisat ASAR (Descending Track 176) and ALOS PALSAR SAR data (Ascending Track 500) with AZI and LOS referring to satellite azimuth and look direction, respectively. Thin black lines denote the Quaternary active faults (Deng et al., 2003). Two red beach balls demonstrate earthquake source mechanisms from USGS and GCMT. Gray solid circles with the time and magnitude labeled display historical earthquake events (EDPDCEA, 1995, 1999) occurred here. Inset map shows the study area with the major tectonic faults (Peltzer and Saucier, 1996) .

(2009) deduced that the strong earthquakes have been migrating southward along the Yadong-Gulu rift into the Yangyi and the Angang Grabens after the 1952 event. Determination of the source parameters for the 2008 event can improve the understanding of the regional tectonic evolution, and contribute to estimation of the potential for a future devastating earthquake around the Yadong-Gulu rift.

After the Dangxiong Mw 6.3 earthquake, USGS announced its focal mechanism online with a strike angle of 180°, a dip angle of 48°, a rake angle of -119°, and a magnitude of Mw 6.3 ($3.4 \times 10^{18}$ N m) (http://earthquake.usgs.gov/earthquakes/eqarchives/epic/, last accessed on 7 March, 2012), values of which are slightly different from the published Global Centroid Moment Tensor (GCMT) solutions (http://www.globalcmt.org/CMTsearch.html, last accessed on 7 March, 2012). Using broadband seismograms from China Earthquake Networks Center (CENC) and Incorporated Research Institute for Seismology (IRIS), Gao et al. (2010) estimated that the rupture fault plane has a strike of 183.3°, a dip of 49.5°, and a seismic moment of $2.84 \times 10^{18}$ N m (Table 1), which is about 20% smaller than those from GCMT and USGS.

By assuming uniform stress drop over the slipping area of the fault and using Envisat SAR image data only, Sun et al. (2011) determined the fault dip of 45° and a slip distribution with ~1.13 m of maximum slip, in which the fault strike and location are directly fixed by the pattern of the interferogramic fringes but not inverted by the InSAR displacements. Based on descending Envisat ASAR observations only, Feng et al. (2010) found that this event occurred on a secondary fault in the eastern margin of the Yangyi graben, dipping to west with a strike of 178° and a dip of 58°. Qiao et al. (2009) estimated the fault parameters by inverting the Envisat decsending InSAR observation, which differ markedly from those of other results based on InSAR data.

These past InSAR studies of the October 6, 2008 Dangxiong Mw 6.3 earthquake used only Envisat SAR images to invert for the slip model. Owing to the rugged topography,