Surface deformation and tectonic setting of Taiwan inferred from a GPS velocity field

Annemarie G. Bos and Wim Spakman
Faculty of Earth Sciences, Utrecht University, Utrecht, Netherlands

Marleen C. J. Nyst[1]
Delft Institute of Earth Oriented Space Research, Delft University of Technology, Delft, Netherlands

Received 6 December 2002; revised 27 May 2003; accepted 18 June 2003; published 1 October 2003.

[1] We have determined the present-day surface deformation of Taiwan by computing the velocity gradient field and fault slip from 143 GPS velocity vectors. In southern Taiwan the derived strain and rotation rates and fault slips are indicative of lateral extrusion toward the south. In northern Taiwan we infer the onset of gravitational collapse which is induced by the on-land extension of the Okinawa Trough. In the eastern Central Range the observed inverted NW-SE extension is consistent with geological observations and high heat flow measurements. This could be the result of exhumation of crustal material. The model further shows a significant decrease in slip rate northward along the Longitudinal Valley fault at 23.7°N. The northern Coastal Range shows high strain rates and two oppositely rotating blocks. By combining the surface deformation model with seismicity data and seismic tomography we are able to propose a coherent model for the present-day tectonic activity. Both seismicity and tomography show further evidence for active, southward propagating exhumation of a crustal slice in the eastern Central Range. Offshore east Taiwan we deduce strong evidence of a southward propagating crustal tear fault, accommodating most of the Philippine Sea Plate-Eurasian Plate convergence. The tear is the crustal response to incipient northwestward subduction of the Philippine Sea Plate. Thus the Ryukyu Trench is bending southward becoming almost perpendicular to the convergence direction, while subduction of the Philippine Sea Plate continues. In this setting a sudden rapid southward propagation of the afore mentioned tear is conceivable. *INDEX TERMS:* 1208 Geodesy and Gravity: Crustal movements—intraplate (8110); 8110 Tectonophysics: Continental tectonics—general (0905); 9320 Information Related to Geographic Region: Asia; *KEYWORDS:* tectonic setting, GPS data, Taiwan, surface deformation

Citation: Bos, A. G., W. Spakman, and M. C. J. Nyst, Surface deformation and tectonic setting of Taiwan inferred from a GPS velocity field, *J. Geophys. Res.*, *108*(B10), 2458, doi:10.1029/2002JB002336, 2003.

1. Introduction

[2] The island of Taiwan is a zone of active continental deformation located in an exceptional tectonic setting within the plate boundary zone between the Eurasian Plate (EUP) and the Philippine Sea Plate (PSP) (Figure 1). At Taiwan the PSP is moving toward the EUP at a rate of 70–80 mm yr^{-1} in the direction N306°E [*Seno et al.*, 1993] (inset of Figure 1). The complexity of Taiwan's tectonic setting arises from the fact that at the Ryukyu Trench the PSP subducts north-northwestward underneath the EUP, whereas at the Manila Trench the PSP overrides the EUP in a westward direction. Taiwan is located at the transfer zone between subduction and overriding of the PSP. The 150 km long, NNE trending Longitudinal Valley Fault (LVF) on the island of Taiwan is generally considered as the suture zone between the two plates [*Barrier and Angelier*, 1986; *Biq*, 1972] accounting for 25–30% of the total plate convergence [*Angelier et al.*, 2000].

[3] The still ongoing collision between the Luzon volcanic arc and the Chinese continental margin started at least 8 Myr ago [*Ho*, 1988; *Kao et al.*, 1998; *Lallemand et al.*, 2001; *Teng*, 1990] thereby creating and building the Taiwan orogen. Because of the oblique orientation of the strike of the arc relative to the strike of the passive margin, the collision at Taiwan has migrated southward, incorporating ever new portions of the Luzon arc [*Lewis and Hayes*, 1983; *Suppe*, 1981]. Details of the geodynamic evolution and present-day tectonic setting of Taiwan are by no means resolved. This becomes evident from the variety of contradicting models proposed in the literature [*Angelier et al.*, 1990; *Chemenda et al.*, 1997; *Lu and Malavieille*, 1994; *Suppe*, 1981; *Teng*, 1990; *Wu et al.*, 1997].

[4] These models focus on two closely related processes: the geometry and dynamics of the transition between the

[1]Now at U.S. Geological Survey, Menlo Park, California, USA.

0148-0227/03/2002JB002336$09.00