TECTONICS, VOL. 17, NO. 6, PAGE 859-871, DECEMBER, 1998

Plate-boundary strain partitioning along the sinistral collision suture of the Philippine and Eurasian plates: Analysis of geodetic data and geological observation in southeastern Taiwan

Jian-Cheng Lee,[1] Jacques Angelier,[2] Hao-Tsu Chu,[3] Shui-Beih Yu,[1] and Jyr-Ching Hu[1]

Abstract. Crustal deformation and strain partitioning of oblique convergence between the Philippine Sea plate and the Eurasian plate in the southern Longitudinal Valley of eastern Taiwan were characterized, based on geodetic analysis of trilateration network and geological field investigation. The Longitudinal Valley fault, one of the most active faults on Taiwan, branches into two individual faults in the southern Longitudinal Valley. These two active faults bound the Plio-Pleistocene Pinanshan conglomerate massif between the Coastal Range (the Luzon island arc belonging to the Philippine Sea plate) and the Central Range (the metamorphic basement of the Eurasian plate). A geodetic trilateration network near the southern end of the valley shows a stable rate of the annual length changes during 1983-1990. The strain tensors for polygonal regions (including triangular regions) of the Taitung trilateration network reveal that there are two distinct zones of deformation: a zone of shortening (thrusting) between the Pinanshan massif and the Central Range on the west, and a strike-slip movement between the Pinanshan massif and the Coastal Range on the east. The analysis of a discontinuity model consisting of three-rigid-blocks separated by two discontinuities has been carried out. The results show that the deformation in this region can be characterized by two major faults. A reverse fault is located between the Plio-Pleistocene Pinanshan massif and the metamorphic basement of the Central Range, with a shortening rate of about 12 mm/yr in the direction N280°E. A strike-slip fault is located principally along the river between the Pinanshan massif and island arc system of the Coastal Range with an purely strike-slip component of about 22 mm/yr in the direction N353°E. The analysis of the geodetic data analysis further suggests that substantial deformation (probably strike-slip in type) occurs within the Pinanshan massif. Geological evidence of deformation in the Plio-Pliestocene Pinanshan conglomerate includes regional folding, conjugate set of strike-slip fractures at the outcrop scale, and morphological lineaments related to fracturing, all indicating that the Pinanshan massif is being deformed within a transpressive stress regime. Regional kinematic data indicate that a significant portion of the 82 mm/yr of motion between the Eurasian plate and the Philippine Sea plate is absorbed in the southern Longitudinal Valley by the decoupling of two distinct major faults. The geometry of the oblique convergence and the rheology of the rock units (the well-consolidated Plio-Pleistocene conglomerate and the sheared mélange formation) play the two important factors in the partitioning of crust deformation.

[1]Institute of Earth Sciences, Academia Sinica, P.O. Box 1-55, Nankang, Taipei, Taiwan, R.O.C.

[2]Géotectonique (URA 1759), Univ. P. & M. Curie, 4 pl. Jussieu, T26-25-E1, 75252 Paris, France.

[3]Central Geological Survey, P.O. Box 968, Taipei, Taiwan, R.O.C.

Paper number 98TC02205.
0278-7407/98/98TC-02205$12.00

1. Introduction

Deformation adjacent to large crustal-scale strike-slip faults within a region of transpressive stress has been interpreted in two different manners [Mount and Suppe, 1992]. The first interpretation involves wrench tectonics with relatively strong coupling along fault systems [Wilcox *et al*., 1973] leading to oblique slip. In contrast, the second model involves decoupling of oblique convergence into components of thrust and strike-slip faulting [Fitch, 1972], which results in partitioning of stress and strain. Regions of decoupling of active transpressive faulting are often characterized by the major strike-slip fault and associated compressional structures which generally show a high angle between the principal stress direction and the major fault orientation. Analyses of stress fields [Mount and Suppe, 1987, 1992; Zoback *et al*., 1987] effectively revealed the common presence of decoupling across active transpressive plate boundaries, such as observed along the San Andreas fault, Great Sumatran fault, Alpine fault, and Philippine fault. In this paper, we aim at presenting the characteristics of strain partitioning and decoupling of strike-slip faulting and thrusting in an active suture zone in eastern Taiwan. This partitioning is caused by the convergence between the Luzon island-arc system of the Philippine Sea plate and the Chinese continental margin of the Eurasian plate (Figure 1), which is oblique to the plate boundary. This study presents geophysical and geological evidence, which includes analysis of geodetic trilateration measurement, field structural analysis, and morphological study based on remote sensing data.

The Taiwan orogenic belt is the product of the convergence between the Philippine Sea plate and the Eurasian plate. The relative plate motion is 70 km/My in the direction N310°E according to Seno and others [1987]. Recent estimates of the displacement between the islands of the Philippine Sea plate (Lutao and Lanhsu) and those of the Taiwan Strait (Penghu) has revealed a velocity of 8.2 cm/yr in the N309°E direction [Yu *et al*., 1997] (Figure 1a).

The recent mountain building process resulted from this plate convergence in the Taiwan area began about 5 Ma and is still active. The Longitudinal Valley (Figure 1b), trends NNE-SSW in eastern Taiwan; it has commonly been interpreted as the active suture zone [Ho, 1986], which links the Ryukyu trench-arc system to the north with the Luzon arc-Manila trench system to the south. To the west of the Longitudinal Valley, Pre-Neogene (mostly late Paleozoic/Mesozoic basement) metamorphic rocks belong to the Central Range. To the east, the Miocene volcanic arc and overlying Plio-Pleistocene sediments form the Coastal Range. The Longitudinal Valley forms a narrow zone from one to several