

Extensional collapse of the northern Taiwan mountain belt

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ABSTRACT

As an active collision zone between the Luzon arc and the China continental margin, the Taiwan mountain belt, particularly its south-central part, is undergoing crustal shortening and rapid uplift. The northern part of the orogen is, however, subjected to crustal stretching and rifting as a result of flipping of subduction from the northwest-facing Luzon arc system to the south-facing Ryukyu arc system. Taiwan and its neighboring southern Ryukyu used to be part of the rifted China continental margin before the collision started in late Miocene time. Engineered by the northwest movement of the Philippine Sea plate in the past 5 m.y., the north-south-trending Luzon arc obliquely overrode the northeast-southwest-trending continental margin and tectonized it into a collision orogen that progressively enlarged and migrated from northeast to southwest. Following the southwest-propagating collision, the north-dipping Philippine Sea plate, which was subducting beneath the Ryukyu arc, also extended westward and caused flipping of subduction in the northern part of the collision orogen. In consequence, the orogen lost the compressive support by the colliding plates and became subjected to lithospheric stretching induced by the trench suction. The collision orogen collapsed as a result of crustal thinning, and its central part foundered into a deep submerged basin. A whole spectrum of active tectonic scenarios, ranging from orogenic buildup by collision to orogenic collapse by rifting and subsidence, can be readily observed in the Taiwan-Ryukyu area and provides a vivid example for the process of orogenic collapse.

INTRODUCTION

Taiwan comprises a late Cenozoic mountain belt formed by the collision between the Luzon arc and the China continent (Ho, 1988; Teng, 1990). Owing to its youth and activeness, the Taiwan mountain belt has been widely regarded as an actualistic model for the orogenic wedge built up by accretionary processes (Dahlen and Suppe, 1988; Davis et al., 1983; Suppe, 1981). Despite the fact that collision is still active in central and southern Taiwan, the northern part of the mountain belt is no longer subjected to crustal shortening but to crustal extension (Lee and Wang, 1988; Suppe, 1984). The mountain belt itself reduces from 3000 m strong in central Taiwan to rolling hills in northeast Taiwan and becomes submerged in the offshore area farther to the east (Fig. 1). The diminution in altitude in association with crustal extension indicates that the northern Taiwan mountain belt has gone through the collision orogeny and is in the process of collapsing. This postcollision extensional collapse, which plays an important role in the late orogenic history of Taiwan, has, so far, received little attention. Although the extensional tectonism in northern Taiwan has been noted and interpreted in a few articles (Bowin et al., 1978; Lee and Wang, 1988; Suppe, 1984), the orogenic collapse and its underlying mechanisms have not been fully accounted for. In this paper, I outline the tectonic background of the northern Taiwan mountain belt and propose a geodynamic model for its collapse.

TECTONIC BACKGROUND

Located on the boundary between the Philippine Sea plate and the Eurasian plate, the island of Taiwan is the transform zone between the Ryukyu and Luzon arcs (Wu, 1978). The Philippine Sea plate has been moving northwest (Jolivet et al., 1990), subducting beneath the Eurasian plate under the Ryukyu arc but overriding the Eurasian plate under the Luzon arc. Engineered by this northwest movement, the northern segment of the Luzon arc collided with the China continental margin in the last 10 m.y. and pushed up the mountain belt of Taiwan (Teng, 1990). The main body of the collision orogen is believed to have reached a steady state with maximum altitude up to about 4000 m in central Taiwan (Suppe, 1981). Tectonized rock strata of both the China continental margin and the Luzon arc are exposed in the orogen as stacked west-facing folds and thrust sheets trending north-

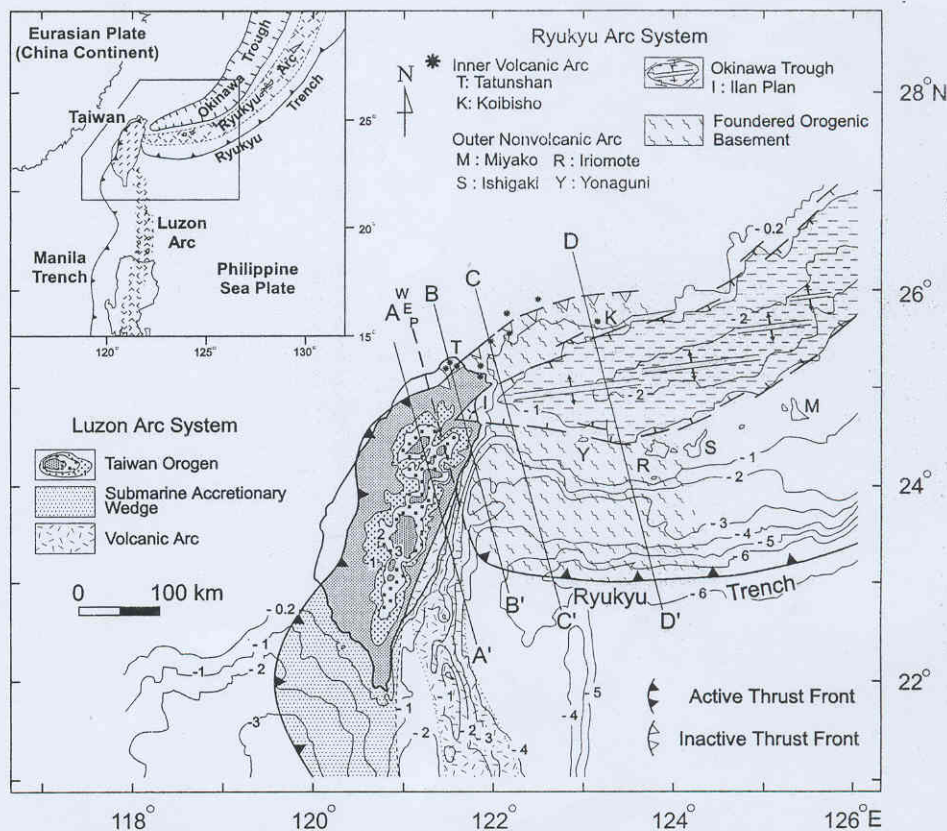


Figure 1. Tectonic framework of Ryukyu-Taiwan area. Note that across western edge of subducting Philippine Sea plate (WEP), polarity of plate convergence flipped from west-facing Luzon arc system to south-facing Ryukyu arc system. Compiled from Huang et al. (1992), Letouzey and Kimura (1986), Sibuet et al. (1987), and Teng et al. (1992). Contours in kilometres. Cross sections A-A', B-B', C-C', and D-D' shown in Figure 2.