

# Preface to the Special Issue on “Geodynamics of Taiwan and the Philippines”

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## 1. INTRODUCTION

This special issue contains a collection of six papers dealing with the geology, geophysics, and tectonics of Taiwan and the Philippines. Most of these papers were presented at the fourth “Philippines-Taiwan Earth Sciences International Conference” in Manila, Philippines, 8 - 9 June 2013. The tectonics of Taiwan and the Philippines are controlled mainly by three plates: the Indian, Eurasian, and Philippine Sea Plates. Taiwan and the Philippines are located next to each other in terms of geography and also plate tectonics. Luzon Island originated from the interactions between the South China Sea and Philippine Sea Plates. Taiwan was also created by collisions between the Philippine Sea Plate and Eurasian Plates. The convergence of these plates also results in many earthquakes and volcanic activities in the region. Both Taiwan and the Philippines face similar geological hazards, such as earthquakes, landslides, volcanic eruptions, and tsunamis.

Collisions between the Indian and Eurasian Plates have occurred since ca. 45 Ma (Lee and Lawver 1995). The results include the initiation of seafloor spreading in the South China Sea in the Late Eocene period (e.g., Hsu et al. 2004). The Manila-Negros-Sulu-Cotabato Trenches mark the eastward subduction of the South China Sea - Southeast Sulu Sea - Celebes Sea Plates at the western margin of the archipelago. Shear partitioning along the Philippine Fault Zone occurred consequently to the archipelago's interaction with the Philippine Sea Plate and its collision with the thinned Sundaland margin (Fitch 1972). The Philippine island-arc system is an intricate amalgam of various terrains and in situ volcanic and sedimentary packages with still mostly unknown spatial and temporal relationships (Yumul et al. 2001). The Philippine archipelago has been and remains a complex puzzle for geoscientists trying to reconstruct its geological history. On the other hand, after the formation of the Luzon Arc the Philippine Sea Plate approached the East Asian margin northward and finally collided with the Ryukyu subduction zone. The consecutive evolution has built the Taiwan mountain belt since about 3 Ma (Teng 1990). The Taiwan arc-continent collision arguably represents one of the best-studied active orogenic belts in the world.

## 2. OVERVIEW OF THE DIFFERENT PAPERS

In this special issue geoscientists from the Taiwan and Philippines have examined geological and geophysical records in both Taiwan and the Philippines, on land or on the sea, in the deep sea or on the surface using geological and geophysical methods in an attempt to understand various aspects of the geodynamics in the region.

- (1) Many studies tried to identify a universal law for the seismogenic behaviors of great earthquakes, such as the changes in background seismic activity and focal mechanism pattern, the presence of seismic gap and the distribution of repeating earthquakes in past decades. Lin (this volume) examines the radial seismic moment tensors of earthquakes to understand the crustal deformation regime in the northern Philippine area, executing a comparison between the stress state of the Manila subduction system and the seismogenic characteristics determined from large earthquakes to estimate the seismic potential of the Manila Trench area.
- (2) Site-effects estimation has been a major issue in engineering seismology for the last two decades. This is due to the fact that seismic hazard is strongly influenced by site-effects. Site conditions strongly affect the frequency content and also the amplitude of ground motions. In order to reduce the standard deviation of the predicted ground motion in large earthquakes, Liu and Tsai (this volume) refined attenuation relationships by incorporating a site effect term related to  $V_{s30}$ , the average shear-wave velocity in the upper 30 m of sediments. In addition, they also investigate the variation in residuals with  $V_{s30}$  in order to construct a refined  $V_{s30}$  map for the entire Taiwan area.
- (3) It is very interesting to know why the young Eurasian plate was subducting beneath the old Philippine Sea plate and why there is no current westward subduction in Taiwan. Was there a westward subduction before? In order to know the possible answers, Lin (this volume) has carefully examined the deep earthquakes located by the Central Weather Bureau in the southern Taiwan area to find an eastward subduction zone. He also checked the difference in seismograms generated by two closed

- earthquakes for distinguishing where they exactly precipitated. Finally, he discussed when and why the westward Philippine Sea plate subduction was stopping.
- (4) The collision in the Central Philippines is one of the most investigated aspects of Philippine geology. However, very few studies focused on geophysical techniques to characterize the collision zone. Gabo et al. (this volume) employed a gravity method to identify larger-scale tectonic features in different tectonic settings and provide a subsurface image of the area affected by the collision between the Palawan Micro Continental Block and the Philippine Mobile Belt. The seismic refraction and electrical resistivity methods were conducted in Gabo's research to provide additional geophysical constraints, especially on the shallow subsurface structures of the Nabas Fault, the perceived terrain boundary in North-west Panay.
- (5) The Philippine fault zone is a system of active left-lateral strike-slip faults that stretch more than 1200 km throughout the whole of the Philippine archipelago from southern Mindanao to northern Luzon. However, a number of characteristics such as fault location, slip rates, deformation and history of the Philippine faults are uncertain. Doo et al. (this volume) compiled magnetic data including land, marine and aeromagnetic data to obtain a new magnetic anomaly map of East Asia which covers the Philippine fault zone and the bounding subduction systems of the Philippine archipelago. They present several analytical techniques to examine the magnetic data and discuss the features of the results in the Philippine fault zone context and the general tectonic characteristics in the Philippine island arc system.
- (6) The Philippines is made up of a collage of continental fragments, island arcs, mélanges, ophiolites, and ophiolitic units. Knowledge of the generation, evolution and emplacement of these ophiolite complexes could help us understand the tectonic history of the individual islands and their relationships. Manalo et al. (this volume) reported on the geochemical characterization of the Balud ophiolitic complex volcanic rocks in southwest Masbate, Central Philippines. This paper gives additional information that hopefully would contribute to the reconstruction and understanding of the Philippines evolution and this part of Southeast Asia. The geophysical characterization of the present subsurface configuration of the ophiolitic complex can also help in constraining our knowledge on the evolution of the Central Philippines.

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