ELSEVIER

Earth and Planetary Science Letters 133 (1995) 517–532

EPSL

Tomographic imaging of lithospheric structures under Taiwan

Ruey-Juin Rau, Francis T. Wu

Department of Geological Sciences State University of New York at Binghamton, Binghamton, NY 13902, USA

Received 15 September 1994; accepted 23 March 1995

Abstract

Tomographic images of the crustal and mantle velocity structures under Taiwan are obtained by simultaneous inversion of local earthquake P-wave arrival times for hypocenters and P-wave velocity structures. In northern Taiwan, a high-velocity zone, coinciding with the Wadati-Benioff zone, can readily be identified as the subducted Philippine Sea plate. The imaged zone dips toward the north at an angle of 40° from a depth range of 20–55 to 100–130 km. An upper-mantle low-velocity wedge, ranging from 40 to 80 km in depth, exists above the subducted slab. Above this wedge is the Ilan Plain of northern Taiwan which lies at the west end of the Okinawa Trough, a well recognized back-arc basin; the crustal velocities under the Plain are also relatively low. The well-defined high-velocity zone and the low-velocity wedge provide some constraints on the thermal structures of the subduction system under northern Taiwan. In tomographic images across the central section of Taiwan, thickening of the crust and up-arching of the lower-crustal materials under the Central Range are commonly observed; the crust under the Western Foothills region is clearly thinner and the near-surface low-velocity layers are well developed. The structures under the Central Range show that although the Taiwan orogeny is quite young, a root, deeper in the north and shallowing to the south, has formed. The results of our tomography show that a significant portion of the lithosphere is involved in the Taiwan orogeny.

1. Introduction

The Taiwan mountain range was created by the collision between the Eurasian Plate and the Philippine Sea Plate (Fig. 1); the collision began at about 4 mybp [1]. The overall plate configuration in the vicinity of Taiwan, as defined by seismicity, is well understood [1,2]. The NW-dipping Ryukyu subduction zone becomes E–W-trending and N-dipping as it dives partially under northern Taiwan. The E-dipping North Luzon seismic zone extends northward to southern Taiwan. The central part of Taiwan, however, is underlain by only shallow seismicity (< 50 km) and a collision is taking place in this section. Near Taiwan, the relative plate motion between the Eurasian Plate and the Philippine Sea Plate is in the direction of N50°W and at an estimated rate of 7.1 cm/yr [3]. This motion is responsible for the collision tectonics of Taiwan.

The seismicity, the rate of uplift [4], and the geodetically measured deformation [5] all indicate that the ongoing tectonics in and around Taiwan is very active. Heretofore, relatively little was known about the crustal and upper-mantle structures, and, as a result, it is frequently assumed that the orogeny is a very superficial process, involving only the Cenozoic sediments in the upper part of the crust [6]. Previously, one-dimensional structures along several profiles were determined [2]; it was found that the crust under the eastern Coastal Range is relatively thin (20 km) and the velocities are close to those of a typical oceanic crust. In contrast, the crusts under the West-

SSDI 0012-821X(95)00076-3