

## Seismicity and volcanism in the southwestern Okinawa Trough (northeast Taiwan)

### Abstract

Most of the volcanic activities observed in the Okinawa backarc Basin are linked to the subduction of the Philippine Sea plate (dehydration, upwelling of asthenosphere). We have analyzed data acquired from a passive OBS experiment and available geophysical data (magnetic anomalies, seismic profiles and onland earthquakes) to determine the depth of magnetic sources, earthquake locations, crustal and lithospheric 3D velocity models, spectral analysis of *P*-wave velocity and seismic tomography.

The calculations of the top and bottom of magnetic sources were performed in the East China Sea and in the southern Okinawa Trough. In the East China Sea, the estimated depths for the top of magnetic sources are consistent with the distribution of the acoustic basement established from industry seismic data. The heat flow values calculated from the estimated thickness of the magnetic crust correspond approximately to the measured heat flow values. In the southern Okinawa Trough, this analysis shows the presence of a thin crust near 123.3°E longitude and a thick crust beneath a volcanic area (Cross Backarc Volcanic Trail (CBVT)). Such estimation of crustal thickness in three dimensions allows us to illustrate large structures, in particular in the areas where geophysical data are poor.

A N-S trending high magnetization feature appears along the 123.3°E meridian, in the northern prolongation of the Gagua Ridge. On each side of this boundary, the lithospheres are characterized by different crustal thicknesses and rheologies and the two portions of slab display different strain patterns and dipping angles on each side of this boundary, suggesting the presence of a slab tear along the 123.3°E meridian.

In November 2003, 15 ocean bottom seismometers (OBS) were deployed during a period of 12 days in the southwestern Okinawa Trough. Amongst the main results: A new generation of ocean bottom seismometers (MircOBS) was successfully tested, showing the same quality than other OBSs but better facilities in data transmission and battery recharge. During this passive OBS experiment, more than 3300 earthquakes were localized and 20 of them were simultaneously recorded by land stations. According to the distribution of the 2823 relocated hypocenters, four clusters of earthquakes were recognized. The seismicity is essentially restricted to the central part of the southwestern Okinawa Trough and terminates abruptly against the N-E trending prolongation of the Lishan fault. Most of the microearthquakes are aligned along the E-W trending normal faults, showing where the present-day active normal faulting occurs and how it accounts for the N-S extension in the Okinawa Trough. According to the P-wave velocity spectra estimated from some deep earthquakes located beneath the CBVT, the existence of a lower crustal / upper mantle magma chamber is suggested by the presence of low frequency earthquakes in the 3 - 10 Hz bandwidth. During this cruise, two wide-angle seismic reflection profiles with three OBSs on each profile were acquired, showing a crustal thickness of 10 km in the axis of the basin.

Based on numerous earthquakes recorded by land stations and the microseismicity acquired during this cruise, two tomographic inversions were performed: (1) A low  $V_p$ ,  $V_s$  but high  $V_p/V_s$  sausage-like body, about 30 km in diameter, lies within the Eurasian mantle wedge, on top of the western Ryukyu slab extremity, at depths ranging between 20 and 125 km. We suggest partial melting and/or a H<sub>2</sub>O-rich

component formed by dehydration processes from subducting sediments, oceanic crust, and serpentized mantle above the Ryukyu slab and along the vertical portion of the slab edge might explain the presence of this sausage-like body. A low  $V_p$ ,  $V_s$  but high  $V_p/V_s$  channel rises obliquely from the sausage-like body from a depth of 40 km in direction of the andesitic Kueishantao Island. We propose that the melt and/or a  $H_2O$ -rich component rises up from the sausage-like body and interferes with the Okinawa Trough backarc basin magmas formed in the upper mantle/lower crust. Then, magmas propagate upward within the upper brittle crust through veins and/or narrow conduits. (2) A mantle inflow characterized by low  $V_p$ ,  $V_s$  and high  $V_p/V_s$  passing through the slab tear was imaged. This melt and/or fluid component is rising obliquely from the slab tear in direction of the CBVT, of the northern slope of the southern Okinawa Trough and north of Iriomote Island. In addition, the asthenospheric intake is also imaged by an inclined chip-like high  $V_p/V_s$  and low  $V_p$ ,  $V_s$  body dipping northerly, which might be linked to the slab retreat.

$b$ -values estimations give more credit to magmatic activities illustrated by tomographic results. High  $b$ -values were observed around the low  $V_p$ ,  $V_s$  but high  $V_p/V_s$  anomalies above and along the slab tear, in the CBVT area, under the sausage-like anomaly located in the western extremity of the Ryukyu slab, and along the magma supply conduit to Kueishantao Island.