3-D Seismic Tomographic imaging in eastern Taiwan-southwestern Ryukyu regions

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Tectonic background in the southwestern Ryukyu arc

Taiwan

Ryukyu Trough

Ryukyu arc

Ryukyu forearc

Gagua Ridge

Philippine Sea plate
Tectonic framework (1)
Subduction of Philippine Sea Plate

- **Gagua Ridge**
  - **east of the Gagua ridge**
    - age: 40 Ma
    - crustal thickness: 6 km
    - (Deschamps, 2001)
  - **west of the Gagua ridge**
    - age: 115 Ma
    - crustal thickness: 12 km
    - (Deschamps, 2001)
Tectonic framework (2)

Seismicity in the Ryukyu forearc

Seismicity clusters

Low seismicity

Gagua Ridge
Tectonic framework (3)
Deformation of Ryukyu arc

- Clockwise rotation at NE Taiwan
- Shear or bending at the junction
- Anti-clockwise rotation at south Ryukyu arc

GPS horizontal velocity (Shanghai-fixed)

5 cm/yr
Tectonic framework (4)
South Okinawa Trough

cross-backarc volcanic chain (Sibuet et al., 1998)

Hydrothermal vent
Seismic Stations
Hypocentral distributions for JMA and CWB catalogues
Ryukyu arc - Taiwan junction

- forearc seismicity clusters
- bending of the Ryukyu arc
- cross-backarc volcanic chain

Related to the subduction of thick oceanic crust?

Relocated hypocenters distribution and seismic tomography would reveal the crustal and upper mantle heterogeneity between Taiwan and Ryukyu arc.

3-D seismic tomography and relocation of hypocenters using JMA and CWB data.
3-D seismic tomography

- Used events: 2736 earthquakes (2489 common events recorded by both JMA and CWB), M>2.5
- Stations: JMA (9 stations) and CWB networks
- Program code: simulps12
- Compute Vp and Vs

Previous 3-D tomography study in this region (Hsu et al., 2001)
Period: 1983-1994
Used events: 162 common events recorded by both JMA (5 stations) and CWB
Station distribution and initial velocity model
Grid Distribution

Node interval:
Horizontal: 25km
Vertical: 10km
Ray-paths and used events

Raypath distribution

123368 raypaths

Used events

2736 events
Depths of the JMA hypocenters are deeper than the relocated.

Epicenters of the JMA catalogue are distributed at the north of the relocated.

- hypocenter (relocated)
- hypocenter (JMA)
Hypocenters Distribution (CWB)

Depths of the CWB hypocenters at the east of Taiwan are shallower than the relocated.

- Hypocenter (relocated)
- Hypocenter (CWB)
Vp at the depth of 20 km

Distribution of low-Vp along the Ryukyu forearc: *basement of the Ryukyu forearc is imaged as low velocity area.*
Vp at the depth of 50 km

Low Vp beneath the Okinawa Trough

checkerboard resolution test
Low-Vp along the Wadati-Benioff zone

• Low-Vp and high-Vp/Vs along the Wadati-Benioff zone beneath the Okinawa Trough
dehydration from the subducted oceanic crust?
High-Vp along the Wadati-Benioff zone

122.00E N-S cross section

High-Vp along the Wadati-Benioff zone
Vp at the depth of 50 km and backarc volcanism

volcanoes
(Sibuet et al., 1998)
Schematic model

Schematic illustration along 122.5E. (Simplified seismic refraction model: from McIntosh and Nakamura 1999)
Shallow seismicity between E. Taiwan and S. Ryukyu arc

- Relocated (M > 2.5)
- JMA catalogue (M > 2.5)

- Seismicity clusters along the Trough axis
- Inactive at the volcanic area.
- Thinning of seismogenic layer?

**Ryukyu arc:**
- Inactive at the western area.
- Clusters at the eastern area.

**Ryukyu forearc:**
- Low V in the seismicity clusters
Conclusions

Okinawa Trough:

• Low velocity anomaly in the upper plate interface. 
  Related to the dehydration from subducted thick oceanic crust? 
  Related to the cross backarc volcanic chain?

• Low seismicity at cross backarc volcanic chain. 
  It would be caused by the thinning of seismogenic layer.

Ryukyu forearc:

• Seismicity clusters at the low velocity area along the forearc. 
  basement of the Ryukyu forearc would be imaged.