

Volcanogenesis and tectonics of back-arc rift basins of Niigata, NE Japan (Part 2) -Basin architecture and tectonic history-

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1. Syn-rift volcanism and the rift model of the NE Japan

The rift basin system of the NE Japan was investigated by using the offshore seismic records of JOGMEC and local geologic data in the land area. As a result, it was revealed that the back-arc opening of the NE Japan could be explained by simple shear model with double detachment fault system of Lister et al. (1986). This model is characterized by symmetrical arrangement of the half graben systems bounded by the continental ribbon made of thick remanent continental crust. In case of the NE Japan, the continental ribbon is constructed by the ridge system from the Sado Island to the Oga Pen. through the Offshore Niigata Ridge, the Awashima Ridge, and the Tobishima Ridge. In the west of the continental ribbon, the rift basins are composed of the half graben systems tilting eastward, and the maximum opening occurs at the Japan Basin. On the other hand, in the east of the continental ribbon, the rift basins are mainly composed of the half graben systems tilting westward, and the maximum opening occurs at the Sado Basin, the Niigata Basin and the Yamagata-Akita Basin.

Applying this model to the Niigata area where we investigated the rift basin system and its related volcanism by using a lot of petroleum exploration wells; (i) In the Niigata Basin corresponding to the maximum opening part of the east of the continental ribbon, a large amount of undifferentiated basaltic magma derived from depleted lower crust erupts through the thin arc crust, (ii) on the other hand, in the east of the Sado Basin characterized by typical half graben system, the arc crust is thicker than that of the Niigata Basin, so that a large amount of felsic magma generated by partial melting of the lower crust erupts through the listric faults of the half graben systems.

2. Difference of the rift model between the NE and SW Japan.

The back-arc opening of the Japan Arc was done by double door opening process. In this process, the rotation angle of the NE Japan is larger than that of the SW Japan, and thus the large right-lateral transtensional fault (Fossa Magna) develops at the boundary between the NE and the SW Japan. In the SW Japan, the rift basin system is characterized by the horsts and grabens bounded by high angle normal faults such as the Noto Pen., the Oki Bank, the Kita-Oki Bank, the Yamato Bank and the Kita-Yamato Bank. Therefore, the rift basin system of the SW Japan can be explained by the pure shear model in contrast to the NE Japan.

3. Tectonic history of back-arc opening of the NE Japan Arc.

The tectonic history of back-arc opening of the NE Japan Arc is summarized as follows.

(a) Land-arc Stage (35Ma-20Ma); The NE Japan Arc consists of a part of the eastern margin of the Eurasia Continent, are characterized by the continental margin volcanism.

(b) Initiation Stage of Syn-rift Stage (20Ma-18Ma); The back-arc opening starts by intrusion of asthenosphere, and alkali basalts erupted along the incipient rift valley.

(c) Rotation Stage of Syn-rift Stage (18Ma-16.5Ma); The asthenosphere mainly intruded into Fossa Magna area, and as a result the counterclockwise rotation of the NE Japan and the clockwise rotation of the SW Japan occurred. The asthenosphere intrusion also caused to the lower crust melting and thus a large amount of felsic magma was generated (ex. felsic volcanism in the Tsugawa-Aizu area).

(d) Parallel Rift to Drifting Stage in Syn-rift Stage (16.5Ma-13.5Ma); Main stage of back-arc opening without the rotation started and as a result the arc crust thinning proceeded with the eruption of a large amount of undifferentiated basaltic magma. After the collision of the Izu-Bonin Arc against the NE Japan Arc (15Ma), the rifting attenuated gradually with the progress of the cooling of the asthenosphere.