

SVC007-P03

会場:コンベンションホール

時間:5月27日 10:30-13:00

Tectonic history of the Pacific-Izanagi-Farallon Triple junction before the formation of the Shatsky Rise

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Shatsky Rise is an oceanic plateau located about 1600 km east of Japan. The rise contains three large volcanic massifs that rise to depths of 3200-2000 m. All three have domes of Cretaceous pelagic sediments up to 1 km thick at their summits (Sager et al., 1999). The southern part of the rise has seismic velocity structures typical of oceanic plateaus: the layers are similar to oceanic crust but several times thicker (Den et al., 1969; Gettrust et al., 1980). The magnetic anomaly lineations from Late Jurassic to Early Cretaceous were identified around the rise (Nakanishi et al., 1999). The magnetic lineations are traceable through low parts of the rise between volcanic massifs, indicating nearly normal lithosphere, and between large volcanic edifices. Many lineations form bights near the rise axis and show former locations of the Pacific-Izanagi-Farallon triple junction. They indicate that the junction was in a ridge-ridge-ridge (RRR) configuration and closely followed the rise axis from chron M20 to chron M4.

Two histories of the formation of Shatsky Rise were proposed. One is that Shatsky Rise was formed by a mantle plume that captured a triple junction (Nakanishi et al., 1999). The appearance of a mantle plume caused a regional reorganization of the Pacific-Izanagi-Farallon triple junction. Simultaneously, the triple junction jumped northeast to the location of Shatsky Rise, annexing a piece of the Farallon plate and causing a short-lived microplate nearby. Subsequently, the triple junction remained near the mantle plume as shown by the confluence of magnetic lineations along the rise to chron M4. Shatsky Rise is the trace of the mantle plume on the Pacific Plate. The other is that Shatsky volcanism occurred because the triple junction jumped to a location underlain by a large volume of anomalously fusible shallow mantle (Sager, 2005). Decompression melting near the triple junction resulted from the reorganization of the plate boundaries.

To test plume head versus ridge tectonics models of the Shatsky Rise formation, it is necessary to expose detailed configuration of the plate boundaries among Pacific, Izanagi, and Farallon plates before the formation of Shatsky Rise. The geomagnetic and bathymetric measurements were conducted in three cruises by R/V Mirai in 1999, R/V Hakuho-maru in 2006, and R/V Yokosuka in 2008 to expose the plate boundaries configuration. Most of ship tracks were designed to identify magnetic anomaly lineations and to expose tectonic fabrics around Shatsky Rise. The detail bathymetric survey exposed the abandoned ridges southwest of Shatsky Rise. The new detailed identification of magnetic anomaly lineations revealed that the magnetic bights of lineations between chrons M22 and M21 do not exist. These observations indicate that the reorganization of the Pacific-Izanagi-Farallon triple junction started after chron M22 and did not synchronized with the formation of Shatsky Rise.

Keywords: Shatsky Rise, triple junction, mantle plume, Pacific Plate