Tectonic evolution of the southern Shikoku Basin and central Kyushu-Palau Ridge

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The Philippine Sea constitutes one of the best areas globally to study the complete tectonic evolution of a backarc spreading system, specifically the Shikoku Basin, which is bounded by the active Izu-Bonin arc to the east, and the Kyushu-Palau Ridge (interpreted remnant Eocene - Oligocene arc of the Proto-Izu-Bonin arc and backarc system) to the west. To investigate the development of the Proto-Izu-Bonin backarc system, in particular the nature of rifting, breakup, and backarc seafloor spreading, we have analyzed high-quality, deep penetration multichannel seismic reflection (MCS) data, in conjunction with swath bathymetry, satellite-derived free-air gravity, and marine magnetics, across the central Kyushu-Palau Ridge and southern Shikoku Basin.

In 2001, the Metal Mining Agency of Japan and Japan National Oil Corporation (currently JOGMEC) acquired MCS data across the southern Izu-Bonin arc, the Shikoku Basin, and the Kyushu-Palau Ridge using M/V Veritas Searcher, as a part of the 'Basic Research for Resources Exploration Technology in the Deep Sea Region' program. The MCS data were acquired using a 564-channel streamer of 7050 m length, and 71.1 l air gun seismic sources. The data set consists of five E-W oriented lines across the Kyushu-Palau Ridge.

Basement of the Kyushu-Palau Ridge has been deformed by normal faulting, forming small sedimentary basins and sediment ponds. Analysis of the structures suggests that the Kyushu-Palau Ridge formed as part of the active Proto-Izu-Bonin arc in early Tertiary time, and was separated from the active portion of that arc by rifting, breakup, and backarc seafloor spreading starting in Oligocene time. We propose the following model for the Cenozoic tectonic evolution of the Proto-Izu-Bonin arc and backarc system, incorporating previous Izu-Bonin tectonic reconstructions including ODP Leg 126 results: (a) middle-late Eocene time - submarine early arc (Proto-Izu-Bonin arc) volcanism formed the Ogasawara Ridge and Kyushu-Palau Ridge; (b) Oligocene time - 'intra-arc' rifting of the Proto-Izu-Bonin arc, crustal thinning, and continuing Proto-Izu-Bonin arc (Kyushu-Palau Ridge) volcanism; (c) submarine volcanism of the Oligocene volcanic front commenced. 'Intra-arc' rifting of the Proto-Izu-Bonin arc formed the Nishinoshima Trough. Subsequently, backarc seafloor spreading commenced, forming the Shikoku Basin. Our model suggests that migration of southward mantle flow has strongly influenced or controlled spreading; by the time that the mantle reached the southern Shikoku Basin, mantle temperatures had decreased, and the relatively cold mantle resulted in chaotic bathymetry and several oceanic core complexes of the southern Shikoku Basin. Formation of metamorphic core complexes and/or exhumation of sub-continental mantle may accompany continental rifting and seafloor spreading, and the southern Shikoku Basin oceanic core complexes probably formed analogously during intra-oceanic island arc rifting and nascent backarc seafloor spreading.