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Structure of backarc inner rifts as a weakest zone of arc-backarc system: a case study of the Sea of Japan

Hiroshi Sato (1), Tasuya Ishiyama (1), Naoko Kato (1), Susumu Abe (2), Hideo Saito (2), Kazuya Shiraishi (2), Shiori Abe (1), Takaya Iwasaki (1), Mitsuru Inaba (3), Tetsuo No (4), Takeshi Sato (4), Shuichi Kodaira (4), Tetsuya Takeda (5), Makoto Matsubara (5), and Chihiro Kodaira (6)

(1) ERI, The University of Tokyo, Tokyo, Japan (satow@eri.u-tokyo.ac.jp), (2) JGI Inc., Tokyo, Japan, (3) Japan Petroleum Exploration Co., Ltd., Tokyo, Japan, (4) Japan Agency for Marine-Earth Science and Technology (JAMSTEC), (5) National Research Institute for Earth Science and Disaster Prevention, Tsukuba, Japan, (6) INPEX Corp, Tokyo, Japan

A backarc inner rift is formed after a major opening of backarc basin near a volcanic front away from the spreading center of a major backarc basin. An obvious example is the inner rift along the Izu-Bonin arc. Similar inner rift zones have been developed along the Sea of Japan coast of Honshu island, Japan. NE and SW Japan arcs experienced strong shortening after the Miocene backarc rifting. The amount of shortening shows its maximum along the backarc inner rifts, forming a fold-and-thrust of thick post-rift sediments over all the structure of backarc. The rift structure has been investigated by onshore-offshore deep seismic reflection/wide-angle reflection surveys. We got continuous onshore-offshore image using ocean bottom cable and collected offshore seismic reflection data using two ships to obtain large offset data in the difficult area for towing a long streamer cable. The velocity structure beneath the rift basin was deduced by refraction tomography in the upper curst and earthquake tomography in the deeper part. It demonstrates larger P-wave velocity in upper mantle and lower crust, suggesting a large amount of mafic intrusion and thinning of upper continental crust. The deeper seismicity in the lower crust beneath the rift basin accords well to the mafic intrusive rocks. Syn-rift volcanism was bimodal, comprising a reflective unit of mafic rocks around the rift axis and a non-reflective unit of felsic rocks near the margins of the basins. Once rifting ended, thermal subsidence, and subsequently, mechanical subsidence related to the onset of the compressional regime, allowed deposition of up to 5 km of post-rift, deep marine to fluvial sedimentation. Continued compression produced fault-related folds in the post-rift sediments, characterized by thin-skin style of deformation. The syn-rift mafic intrusion in the crust forms convex shape and the boundary between pre-rift crust and mafic intrusive shows outward dipping surface. Due to the post rift compression, the boundary of rock units reactivated as reverse faults, commonly forming a large-scale wedge thrust and produced subsidence of rift basin under compressional stress regime. Large amount of convergence of overriding plate is accommodated along the inner rift, suggesting that it is a weakest zone in whole arc-backarc system. The convergence between young (15 Ma) Shikoku basin and SW Japan arc produced intense shortening along the inner failed rift along the Sea of Japan coast. After the onset of subduction along the Nankai trough, the fold-and-thrust belt was covered by Pliocene marine sediment. Before the 2011 off-Tohoku earthquake (M9), several damaging earthquakes occurred along the backarc fold-and-thrust belt. These represents that a weak backarc inner rift is very sensitive for the stress produce by the subduction interface.