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Deformation of the forearc region and along the Median Tectonic Line in southwest Japan during the opening of the Japan Sea

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It has been shown by Otofuji et al. (1985, EPSL) that the Japan Sea opening is caused by the rotation of both southwest and northwest Japan blocks, which behave as a rigid plate, respectively. However, this problem must be treated as 3-D deformation of the lithosphere, which constitutes the continental arc before the Japan Sea opening. On the problem of back-arc rifting, although little attention has been paid to tectonics in the drifted forearc, the forearc region experiences shortening while back-rifting prevailing. In Italy, the Tyrrhenian Sea had opened since 5 Ma in the back-arc region, while fold and thrust belts had grown and forearc basins as deep as 7 km had formed (i.e. shortening tectonics) in the forearc region at the same time. In the Japanese arc, in the Kii peninsula the 4000 m thick forearc basin deposit (Kumano Group) had accumulated, which had been strongly folded and covered unconformably by the post-Japan Sea opening sediments (Kumano acidic rocks, 15 Ma). In this way, back-arc extension and forearc shortening also occurred at the same time in the proto-Japanese arc.

Takeshita had once studied deformation in the southwest Japan through the deformation analyses of the Izumi, Kuma and Ishizuchi Groups distributed along the Median Tectonic Line (MTL) in Matsuyama-city. Furthermore, I study the deformation of the latest Lower Miocene Momonoki Group distributed in the Yamanashi Prefecture. As a result, the following facts have become clear.

(1) The age of the Kuma Group, which is distributed mostly in the south of the MTL, was once determined to be the Middle Eocene, but now has been determined to be the latest Early Miocene (18-16 Ma) based on zircon fission track ages (Kashima and Takechi, 1996, J. Mineral. Perol. Economic Geol.; Narita et al., 1999, J. Geol. Soc. Japan) and biotite K-Ar ages (Takeshita et al., 2000, Island Arc) of acidic tuff. The Kuma Group was deposited in an extensional basin bounded by the MTL at the north, and then experienced a strong shortening deformation along the MTL, where thrust faults which cut the MTL formed (i.e. inversion tectonics, Kubota and Takeshita, 2008, Island Arc). The folded Kuma Group was unconformably covered by the Ishizuchi Group (15 Ma, Takeshita et al., 2000, J. Geol. Soc. Japan).

(2) The rate of shortening of the Upper Cretraceous Izumi Group, which is more than 30 %, surpasses that of the Kuma Group. The MTL was also reactivated during the folding of the Izumi Group, the age of which is inferred to span between 45-25 Ma based on the ages of fault gouge (Takagi and Shibata, 1992, the Memoirs of Geol. Soc. Japan; Kubota and Takeshita, 2008, Island Arc). In these Paleogene periods, coal field Tertiary sediments also deposited in the northern Kyushu, showing another example of a pair of back-arc rifting and forearc shortening, which occurred at a age before the Japan Sea Opening.

(3) The latest Early Miocene Momonoki Group was strongly folded under the conditions of brittle-ductile transition (ca. 300 oC) around 15 Ma (Takeshita, 1995).

In summary, coeval back-arc extension and forearc shortening are considered to be a universal process, which can be accounted for by two models. One is that back-arc extension occurs when the horizontal component of trench suction force exceeds that of the compressional force due to the frictional force between the subducting slab and arc lithosphere, and then ridge push force can exert a compression in the arc when back-arc spreading starts (Chemenda et al., 2000, JGR). The other model is that back-arc extension is caused by the basal drag force resulting from the corner flow in the wedge mantle (Wdowinski et al., 1989, JGR). In this case, back-arc extension is naturally accompanied by forearc shortening, because the basal drag force brings materials toward the forearc region.