Ongoing regional metamorphism beneath the Japanese Islands

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One of the significance of metamorphic petrology is that prograde P-T path of a regional metamorphic rock provide information about a subduction-zone geotherm, which is the crucial factor to discuss the formation of arc and continent. However, recent studies have suggested that metamorphic rocks only exhume under specific conditions of the subduction zone, e.g. ridge subduction and slab break-off. Hence, we only can get limited examples of subduction zone, which has specific natures, though metamorphism is ongoing in all subduction zones with various parameters. We present alternative way to estimate natures of the ongoing regional metamorphism beneath the Japanese Islands, on the basis of the dehydration-induced earthquake hypothesis. Thermal structures of the descending slabs of the Pacific in NE Japan and Philippine Sea (PHS) in SW Japan are estimated by linking the phase diagrams of MORB + water, pelitic-psammitic rocks, and of peridotite + water with hypocenter distributions in the subduction zones. A brute-force algorithm was employed to estimate the thermal structure. According to the estimated thermal structure, we can draw the metamorphic facies distribution of ongoing regional metamorphism and water circulation under the Japanese islands.

The distribution of metamorphic mineral assemblages along the Pacific subduction zone changes with depths to the dry eclogite in the depth range between 60-120 km. Progressive metamorphic condition traces counter clock-wise P-T path. Under the Kanto region, where cold lid of the Philippine Sea Plate prevents return flow in the wedge mantle, heating from hanging-wall mantle is limited therefore much colder, high-P low-T metamorphic facies could be present. SW-Japan subduction zone has been considered to have higher subduction geotherm because the Philippne Sea plate is younger than the Pacific plate. However, our analysis suggests a possibility that SW-Japan, except Kyushu region, could have similar metamorphic series to NE-Japan. Possible reason to course low-T metamorphic series in such a young-slab subduction is smaller subduction angle, which prevents return flow in the wedge mantle. This case, it means that the temperature of the surface of subducted slab is strongly controlled by return flow of the wedge mantle. If the subduction angle is high and the slab faces to open mantle wedge, the metamorphic series become higher-T type, as suggested for the Kyushu area. Previous observations of metamorphic rocks, as well as estimations in the present study, have shown that the prograde P-T path of subduction-collision metamorphism is counter-clockwise, which bent around 50-60 km depths. These bending depths of the P-T paths would correspond to a meeting point of the slab surface and return flow in the mantle wedge above.