Deformation mechanisms in a tectonic mélange of Amami-Oshima Island: Implications of seamount subduction at slow earthquake source depth

*Madison Frank[1], Kohtaro Ujiie[2], Ginta Motohashi[1]

1. Graduate School of Life and Environmental Sciences, University of Tsukuba, 2. Faculty of Life and Environmental Sciences, University of Tsukuba

Seamount subduction is believed to result in a conditionally stable frictional regime where complex fracture networks, increased fluid pressure, and lithologic heterogeneity allows for the occurrence of slow earthquakes and slip (Shaddox & Schwartz, 2019; Sun et al., 2020). Furthermore, it has been proposed that the rise in fluid pressure and fluid flow on the leading edge of a seamount during subduction results in tectonic tremor. However, the geological perspective of slow earthquakes related to seamount subduction remains elusive.

We examined seamount-related rocks in the Late Jurassic to Early Cretaceous accretionary complex of Amami-Oshima Island, Ryukyu Arc. Seamount-derived altered basalt and micritic limestone comprise the mixed rock, which was subsequently incorporated into the mudstone matrix of the mélange during subduction. The mudstone matrix displays pervasive S-C fabric with top-to-SE kinematics. Brittle deformation features include slickenfibres and polished surfaces as well as a complex quartz vein network of both foliation parallel and subparallel sheared extensional fractures with rare crack-seal texture. This may represent tremorgenic fluid flow along brittle fractures that occurred near the subducting seamount.

Pressure solution creep is the dominant deformation mechanism with widespread dark seams composed of muscovite, illite, and carbonaceous materials in the mudstone and chlorite, illite, and Fe-Ti oxide minerals in the mixed rock. In the mudstone, pressure solution seams mutually cross-cut quartz veins with bulging grain boundaries and undulous extinction. In the mixed rock, dark seams form an interconnected foliated network along the margin of limestone and basalt blocks and calcite veins with type II twins are cut and displaced by dark seams. Analysis of calcite twins using the Rybacki et al. (2013) piezometer indicates that slow slip rates are possible at temperatures > 280˚C. Raman spectra of carbonaceous material from mudstone samples gives a peak temperature of 290˚C ±15˚C. We therefore suggest that the exhumed section at Amami-Oshima Island is representative of the source conditions at the base of the seismogenic zone under which slow earthquakes occur during seamount subduction and that the rheology is strongly controlled by pressure solution creep in frictionally weak minerals derived from altered basalt.

Keywords: seamount, subduction, slow earthquakes, pressure solution creep, lithologic heterogeneity, Amami-Oshima Island