Reconstruction of the relative sea-level changes over the past centuries by using coral microatolls in the Ryukyu arc.

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The Ryukyu subduction zone, where the Philippine Sea Plate is subducting beneath the Eurasian Plate at rate of 8 cm/yr, may have the potential to generate large megathrust earthquakes. However, only few M8+ earthquakes were reported in the arc over the last 350 years and the GPS data indicate that this subduction zone is likely aseismic. We know however that the interseismic strains rate may vary through time and we need longer records to better characterize the behaviour of subduction zones. Toward this goal, we started to investigate the coral microatolls along the Ryukyu arc. Coral microatolls act as natural tide gauges by recording relative sea-level (RSL) changes with a precision of a few centimeters over several centuries or millennia. They are the only geological marker filling the gap between short-term deformation measured by instrumental geodesy and longer-term deformation recorded by older geological markers.

We found plenty of microatolls between Okinoerabu and Okinawa, where we observed a large variability in shape, from cup-shaped corals indicating submergence at Ie-jima to hat-shaped corals indicating emergence at Yoron. After detailed topographic surveys, we performed a first sampling fieldwork in Itoman and Onna (south and west part of Okinawa, respectively) and in Yoron. We sampled two living corals at each analysed site and an 8-m-diameter fossil microatoll in Yoron. We then reconstructed the RSL changes over the last century with living microatolls and inferred more than three centuries of record from the fossil microatoll of Yoron. In Onna and Itoman, we inferred a slight emergence trend of at best 1 mm/yr over the last 55 years and interrupted by few die downs around 1986, 1995, 2004, and 2016. The longest record observed was in Itoman, where we identified a major submergence trend of about 7 mm/yr that started around 1906. In Yoron, the corals recorded periods of slight to pronounced emergence, alternating with periods of submergence since 1928. Although the inner part of the fossil microatoll in Yoron is very smoothed due to erosion, we inferred a slow submergence of at best 1 mm/yr over about 270 years followed by a major submergence increase over the last decades of the record.

The satellite altimetry indicates a homogeneous regional sea-level rise in the Ryukyus of 3 mm/yr since at least 1992 (probably since 1950 according to sea-level reconstruction*s*) that contrasts with RSL changes recorded by the microatolls of Yoron and Okinawa and with the morphology variability observed among microatolls from the islands we visited. This regional sea-level variability highlighted with microatolls is also supported by the six longest available tide gauges in the Ryukyus whose submergence trends vary between 0.5±0.7 mm/yr at Naze and 4.4±1.5 mm/yr at Nakanoshima over the last 50 years. These first data (corals and tide gauges) collected in the Ryukyu arc imply an additional signal to the absolute sea-level rise that could generate subsidence or uplift at the scale of the arc. This signal may be due to volcanism, local crustal active faults or to the megathrust seismic cycle. The latter source is preferred because volcanoes are far from the studied areas and crustal active faults usually generate a local signal. This signal may be due to interseismic strain accumulation and silent earthquakes. The emergence trend

over the past 55 years could be due to interseismic loading on the megathrust interface that would generate uplift on the surface of few millimeters per year, while the submergence events could be related to coupling changes on the interface (possibly slow events). Finally, we showed that the records from Okinawa differ from those of Yoron. This could be explained by the existence of a long-term seismic barrier between the two islands. Such barriers could be due to the entrance in subduction of submarine ridges, facture zone (Luzon-Okinawa Fracture Zone) and seamonts in front of the area investigated.

Keywords: microatoll , relative sea level , megathrust , Ryukyus

