

Subject offered for a contract starting october 2016

**SUBJECT TITLE:** The Seismic Cycle of the Ryukyu Trench (Japan) by using Coral Microatolls and Reef Terraces Records.

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Host lab/ Team : *please fill in and leave out meaningless information*  
**IPGP- Team Tectonics – UMR7154**

Financing: Doctoral contract with or without teaching assignment

International joint PhD with Earthquake Research Institute, University of Tokyo, Japan

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Presentation of the subject: (1 or 2 pages)

The Ryukyu trench (southern Japan) accommodates the northwestward convergence between the Eurasian and Philippines Plates at rate of  $\sim 7$  cm/yr. Although it has been recognized as a potentially substantial seismic and tsunami hazard, only two historical earthquakes have been reported in this region in 1771 (M8+) and in 1911 (M8). The 1771 earthquake was associated with a very damaging tsunami (Meiwa tsunami, run-up  $> 30$  m). By analyzing tsunami deposits, *Araoka et al. (2013)* demonstrate that the Ryukyu Islands have experienced tsunami events since at least 2400 yr ago, with a recurrence interval of  $\sim 150$ –400 yr, while *Goto et al. (2013)* claimed that the past tsunamis are localized.

The PhD project aims to better constrain the seismogenic potential of the Ryukyu trench by quantifying long term and short-term deformation of the Ryukyu Islands due to the seismic cycles at plate interface. To this goal we will use coral microatolls and reef terraces.



Figure 1: Porites microatolls in Ryukyu Islands (N. Feuille, March 2016)

A microatoll is a colony of coral, which is dead on the top but living around the perimeter (Figure 1). Its upward growth is constrained by sea level through prolonged exposure at the lowest spring tides. Coral microatolls act as natural recorders of sea-level changes due to climate and tectonics. They are the only geological markers able to record tectonic movements with a precision of few centimeters and over time scales ranging between one and several thousands of years. They can be used to reconstruct the timing, extent, and magnitude of past coseismic and interseismic deformation.

During a first exploratory field trip conducted in March 2016, we newly discovered numerous microatolls in all islands we visited. We plan to analyze those microatolls in all islands of the Ryukyu to reconstruct the seismic coupling, segmentation and earthquakes history of the trench.

Such studies require high-resolution imagery analysis, boat surveys to identify the most promising sites where microatolls are growing and theodolite mapping for further sea-level reconstruction. The corals are sampled with a hydraulic chain saw, sliced in very thin sections (1cm wide), X-rayed, and dated by U/Th to retrieve the history of relative sea-level changes. Analyses of the sea-level changes will include tectonic and climatic studies to retrieve the vertical deformation related to the megathrust behavior.

Elastic modeling of the vertical deformation recorded by the corals will be performed to estimate the size and segmentation of the coupled interface, the degree of interseismic coupling and the source parameters of past earthquakes.

We will also quantify the long-term deformation by analyzing the reef terraces (morphology and mapping with high resolution topography and imagery, dating) in all islands to get information on active structures of the upper plate and the geometry of the plate interface.

The PhD will be conducted within the framework of a collaborative project between IPGP and ERI-Tokyo University. The student will spend several weeks a year in Tokyo at ERI and in the field in Ryukyu Islands.

## ***Bibliography***

- Araoka et al., Tsunami recurrence revealed by Porites coral boulders in the southern Ryukyu Islands, Japan, *GEOLOGY*, v. 41; no. 8; p. 919–922.
- Goto et al., Localized tsunamigenic earthquakes inferred from preferential distribution of coastal boulders on the Ryukyu Islands, Japan, *GEOLOGY*, v. 41; no. 11; p. 1139–1142.
- Sieh et al., (2008). Earthquake supercycles inferred from sea-level changes recorded in the corals of west Sumatra. *Science*, 322(5908), 1674-1678.
- Weil-Accardo J., Feuillet, N. et al., 230 years of relative sea-level changes due to climate and megathrust tectonics recorded in Coral microatolls of Martinique (French West Indies), *Journal of Geophysical Research: Solid Earth*, 2016, in press
- Weil-Accardo, J, Feuillet, N et al., Relative sea-level changes during the last century recorded by coral microatolls in Belloc, Haiti, , *Global and Planetary Change*, Vol 139, pp1--14, 2016