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報告番号	※　　第　　号

主　論　文　の　要　旨

論 文 題 目 Characterization of seismic rupture processes along the Colombian subduction zones
（コロンビアの沈み込み帯における地震破壊過程に関する研究）

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論　文　内　容　の　要　旨

Colombia, located northwest of the South American plate, is affected by northern and western subductions of the Caribbean and Nazca plates, respectively, and NE-SE convergence of the Choco-Panama block. These interactions have resulted in intracontinental deformation, characterized by the uplifting of the mountain chains along Colombia (Northern Andes), and the fault systems observed in the cordilleras and valleys of this Andean chain. Colombia is tectonically active. Several large earthquakes have ruptured in the Colombia-Ecuador subduction zone (CESZ) during the last century. Among them, the Colombia-Ecuador earthquake in 1906 (M_w 8.4) and the Tumaco earthquake in 1979 (M_w 8.3) generated destructive tsunamis. By contrast, in the Caribbean region, no large historical earthquakes have been reported to date.

It is important to characterize the seismic rupture processes and their relation with interplate coupling along the Colombian subduction zones. In the Colombia-Ecuador subduction zone, I searched for very-low-frequency (VLF) earthquakes and repeating earthquakes. In searching for these special types of earthquakes, visual searching across the continuous waveforms from broadband seismic sensors managed by the Colombian Geological Survey (SGC) was performed for VLF earthquakes, and waveform similarity analysis by estimating cross-correlation coefficients between earthquakes pairs recorded by broadband and short-period seismic sensors from the SGC seismic network was performed for repeating earthquakes.

I searched for VLF earthquakes within the continuous data in the time period from Jan 2016 to Sep 2017. However, I did not find VLF earthquakes in the region within this period. I provide three possible reasons to explain this fact: (1) the low detection capacity of the network because the stations used are sparse, (2) the possible

presence of materials in the accretionary prism characterized by low or no dehydration; the fluid cannot weaken faults and earthquakes with low drop stress are not generated, (3) the scarce occurrence of large earthquakes, which increase the VLF activity in neighboring regions to their hypocenters. Further searching for VLF activity through synthetic waveforms obtained by seismic waves propagation modeling with use of the matched filter is required in this region.

I searched for repeating earthquakes in the time period between 1993 and 2018. A threshold for the cross-correlation value of 0.9 was used to identify the waveform similarity and to select repeating earthquakes, in which sequences of events occurred in very short-time intervals were excluded because they may represent triggered events. Repeating earthquakes were found near the trench and beneath the coastal region. This distribution indicates that repeating earthquakes did not occur within the large slip of the 1979 Tumaco earthquake, where relatively large interplate coupling was estimated by Sagiya & Mora-Páez (2019). Those repeating earthquakes located offshore near the trench suggest that the interplate coupling in this region is low, which is in clear contrast to the large slip in the 1906 Colombia-Ecuador earthquake trench in the southern part of CESZ, since repeating earthquakes are not expected in large slip areas where strong interplate coupling exits. This suggests that rupture modes are different between the northern and southern parts of the CESZ near the trench.

In the southern Caribbean subduction zone, northwestern Colombia, repeating earthquakes were also searched within 1993 and 2018. I used a similar methodology used in CESZ for this region. Repeating earthquakes were found in the region corresponding to a low interplate coupling region or a slip excess region, estimated by Lizarazo (2020).

In Colombia-Ecuador subduction zone, I found repeating earthquakes but I did not find VLF earthquakes. The repeating earthquake distribution is consistent with the coupling model, and the intercoupling region represented by a heterogeneous pattern with a clear region of strong coupling surrounding by a wide homogeneous region representing weak coupling. This characterization of this subduction zone is comparable to the northeastern Japan subduction zone, since few VLF earthquakes have been found there, and the repeating earthquakes distribution are consistent with the bimodal coupling model estimated for that region.

In southern Caribbean subduction zone, I found repeating earthquakes; and searching for VLF earthquakes in this region is yet to be done. Similar to the Colombia subduction zone, the intercoupling region shows a heterogeneous pattern with a clear region of strong coupling surrounding by a homogeneous region which represents weak coupling. The repeating earthquake distribution is also consistent with this coupling model.

I found repeating earthquakes in the Colombia subduction zone and the southern Caribbean subduction zone, and they are the first repeating earthquakes reported in these subduction zones. These repeating earthquakes were located in regions surrounding the possible large asperities estimated by the coupling models or the rupture model. The distributions of these repeating earthquakes contribute to constrain the geometry of the asperity, which is important for seismic hazard estimation to determine the size of a possible forthcoming large earthquake.