Earthquake swarms following very low-frequency earthquakes in the central Ryukyu Trench

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Earthquake swarms occur frequently from Amami Island to Okinawa Island, near the axis of the central Ryukyu Trench. These earthquake swarms recur every few years and typically followed swarms of very-low frequency earthquakes (VLFE) that occur in a similar area. I have investigated the relationship between the VLFEs and the subsequent earthquake swarms in the central Ryukyu Trench, using the earthquake catalog provided by the Japan Meteorological Agency (JMA). For the VLFEs, I used the catalog by Nakamura and Sunagawa (2015) and the extended catalog to December 2018.

Results show that the VLFE swarms occurred approximately one month before the subsequent earthquake swarms began near the trench axis in this region. Previous noteworthy earthquake swarms occurred on August 2005 (with a maximum magnitude of 4.7), April 2009 (with a maximum magnitude of 5.1), May 2016 (with a maximum magnitude of 5.6), and September 2018 (with a maximum magnitude of 6.2).

Prior to the earthquake swarm that occurred in August 2005, a VLFE swarm started near Okinawa Island three months before and its activity moved intermittently from Okinawa Island to Amami Island. In the case of the earthquake swarm that occurred in April 2009, a VLFE swarm started near Amami Island and the subsequent swarm occurred two weeks after the start of the VLFE swarm. The location of the VLFE swarm moved intermittently closer to Okinawa Island. In the case of the earthquake swarm that occurred on May 2016, the VLFE swarm started near Amami Island and its active cluster moved intermittently towards Okinawa Island. The subsequent earthquake swarm started near the trench axis, approximately twenty days after the occurrence of the VLFE swarm. In the case of the earthquake swarm that occurred in September 2018, the VLFE swarm started near Okinoerabu Island (the midpoint between Amami Island and Okinawa Island) and the activity moved intermittently to Okinawa Island. The earthquake swarm occurred approximately twenty-five days after the start of the VLFE swarm. The location of the cluster of the 2018 earthquake swarm was slightly landward from the trench axis.

The faulting associated with these earthquake swarms was of normal type, corresponding to intra-slab earthquakes in the subducting Philippine Sea plate. I calculated the Coulomb Failure Stress (delta-CFS) assuming that a small slow slip event (SSE) occurred on the plate interface. Our results show that the positive delta-CFS that accelerated the normal faulting could not have occurred in the subducted slab near the trench axis until the slip of the SSE had reached close to the trench axis. This suggests that the SSE propagated from Amami Island to Okinawa Island accompanying the activation of the VLFE swarm, the slip of the SSE then propagated close to the trench axis, and the normal-faulting earthquake swarm in the slab was induced by the positive delta-CFS caused by the SSE.

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