Preliminary earthquake detections from seismic stations installed on Bioko Island, Equatorial Guinea

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Abstract

Equatorial Guinea's Bioko Island is located in the Atlantic Ocean off the west coast of Cameroon. Bioko is a volcanic island and the first off-shore expression of the Cameroon Volcanic Line. It is home to three shield volcanoes: Pico de Basile, Pico Biao, and San Carlos. Eruptive histories are not known for Pico Biao or San Carlos. Pico de Basile erupted within the past 100 years, and steam vents were observed as recently as 2012. Malabo, the capital city of Equatorial Guinea, sits in the shadow of Pico de Basile. There is no permanent seismic monitoring; the closest seismic stations are in Cameroon and have not reported data since 2015. In November 2017 Drexel University researchers, supported by the Bioko Biodiversity Protection Program (BBPP) and the Universidad Nacional de Guinea Ecuatorial (UNGE), installed 4 broadband seismometers. In February 2018, the data were retrieved, and stations serviced. Preliminary earthquake detection and location was completed using an automated STA/LTA algorithm. S wave arrivals were added manually. The initial locations use the global IASP91 model and events were relocated using a local model. The events detected cluster into two areas: those near Bioko Island and those near Cameroon. Between 12-Dec-2017 and 17-Feb-2018, 77 events were recorded. Local magnitudes range between 0.16 and 2.61. Of these events, 49 are located near Cameroon and 28 are near Bioko. Most of the depths are crustal, mostly upper to mid crust. Our preliminary results show there is seismicity associated with Bioko Island as well as Cameroon. The locations match well with events recorded by a local network installed in Cameroon in 2007. The four stations were serviced again in November 2018. One station failed due to water infiltration and one was vandalized within a week of the previous service. One station was still operational at service with only a few days down and the last station was operational until the height of the rainy season when power failed.

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1. Abstract

Equatorial Guinea's Bioko Island is located in the Atlantic Ocean off the west coast of Cameroon. Bioko is a volcanic island and the first off-shore expression of the Cameroon Volcanic Line. It is home to three shield volcanoes: Pico de Basile, Pico Biao, and San Carlos. Eruptive histories are not known for Pico Biao or San Carlos. Pico de Basile erupted within the past 100 years, and steam vents were observed as recently as 2012. Malabo, the capital city of Equatorial Guinea, sits in the shadow of Pico de Basile. There is no permanent seismic monitoring; the closest seismic stations are in Cameroon and have not reported data since 2015.

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2. First Generation Station

- 4 stations surrounding Pico Basile
- 20 Watt solar panel supported by 4 metal posts
- Centaur, charge controller, and battery buried in a plastic tote (child's play box)
- GPS mounted in a pelican case attached to a support post

3. Challenges

Locally available materials. Finding plastic totes was surprisingly difficult. We finally settled with small plastic children's play boxes. The lids did latch, but there were no seals or gaskets to prevent water infiltration. Water was the primary problem. One station failed in January because the charge controller (housed in a pelican case) suffered water infiltration. Another station failed one week after the February service, also due to water infiltration.

Sun availability. Surprisingly at the equator it can be difficult to get a full day of sun. Many days are quite hazy. It is also rather difficult on a tropical island to find clearings that offer good views of the sun. Vegetation grows quite fast and we provide a structure for vines to climb with our solar panels. Many clearings are also not appropriate for stations. For instance near the southern volcanoes, clearings tend to be lava flows.

Vandalism. We try to prevent vandalism by selecting sites less likely to be seen by passers-by. However we were apparently unsuccessful as station XB03 was vandalized about a week after servicing in February. The vandals stole the battery from the equipment enclosure. Luckily they pulled the cable from the battery and not from the Centaur, so our equipment seems to be in working order (further testing will determine if refurbishing is necessary). No solar panels have been stolen or vandalized at any of the stations.

4. Second Generation Design

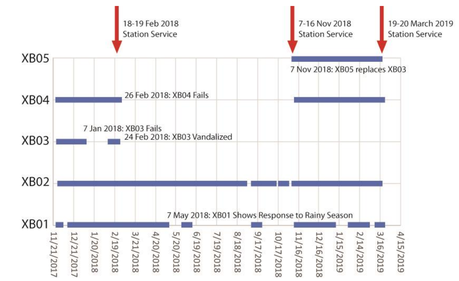
November 2018 | March 2019 | November 2018 | March 2019

- All materials except battery were shipped to Bioko
- Single post replaced four post design
- 20 Watt panel mounted on adjustable arm
- Centaur, charge controller, and GPS mounted in a NEMA box enclosure mounted on pole beneath solar panel
- Battery buried in battery box to stabilize pole
- Upgrade Solar Panel to 35 watt

BIOKO BIODIVERSITY PROTECTION PROGRAM

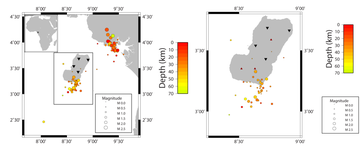
Drexel UNIVERSITY

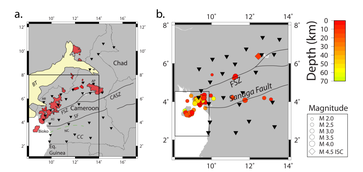
5. Data Retrieval



6. Preliminary Results

Data retrieved in February 2018 (recorded beginning in late November 2017) indicate a level of seismicity comparable to that previously recorded by stations located in Cameroon. Data collected in Cameroon (Lough, in review; bottom) shows that earthquakes are in a similar location (typically in the Southeastern region). Data collected in Bioko (top panels) also record similar earthquakes in Cameroon as data recorded near Mount Cameroon.





7. Future Work

- Analyze 2018 data using single station techniques
- Use Jan-Feb data as a test for robustness of single and dual station techniques
- Goals for 2019 data:
  - Tomography
  - Receiver functions
  - Shear wave splitting