

A review of the seismicity of the Cameroon Volcanic Line observed by two local seismic networks

Amanda Lough¹

¹Drexel University

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Abstract

The Cameroon Volcanic Line (CVL) is a linear feature of volcanism that begins off the western coast of Africa with several islands and continues on shore through Cameroon further into the African continent. Equatorial Guinea's Bioko Island is the largest and last of the CVL volcanic islands. It is home to three shield volcanoes: Pico de Basile, Pico Biao, and Gran Caldera de Luba. Eruptive history is only known for Pico de Basile which erupted within the past 100 years, and steam vents were observed as recently as 2012. There is no permanent seismic monitoring; the closest seismic stations are in Cameroon and have not reported data since 2015. The CVL is of scientific interest and has been studied by several groups. Most geophysical studies focus on the area around Mt. Cameroon, the most active volcano in the system. A network of seismic stations was installed across the entire country from 2005-2007. There has been no successful geophysical surveys of the island portion of the line. In Nov-2017 Drexel University, supported by the Bioko Biodiversity Protection Program (BBPP) and the Universidad Nacional de Guinea Ecuatorial (UNGE), installed 4 broadband seismometers on Bioko. Two stations were installed in March of 2019. Preliminary earthquake detection and location was completed with an automated STA/LTA algorithm. Initial locations use the global IASP91 model and events were relocated with a local model. Events cluster in 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 upper to mid-crust. Analysis of the entire data set yields 458 events with 367 near Bioko Island and 91 near Cameroon. The range in local magnitude is -0.28 – 3.86. Our preliminary results show seismicity associated with Bioko Island as well as Cameroon. Locations match well with events recorded by the regional network previously installed in Cameroon. In addition, the rate of seismicity recorded from 2017-2019 is comparable to what was observed from the Cameroon network when distance is taken into account. Data has been retrieved in Feb-2018, Nov-2018, and Mar-2019. The next service was scheduled Mar-2020 but the trip was canceled due to travel restrictions.

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A.C. Lough

Drexel University, Philadelphia, PA 19018

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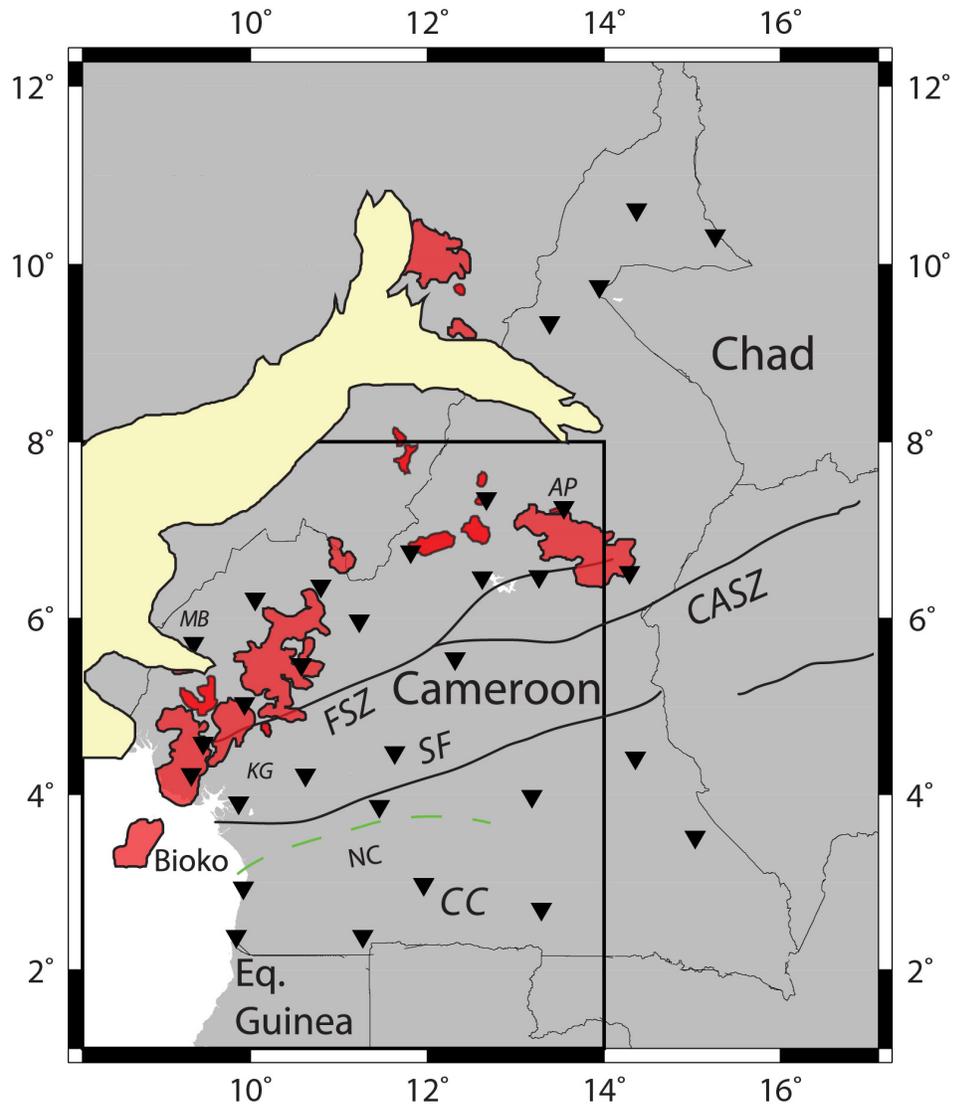


1. ABSTRACT

The Cameroon Volcanic Line (CVL) is a linear feature of volcanism that begins off the western coast of Africa with several islands and continues on shore through Cameroon further into the African continent. Equatorial Guinea's Bioko Island is the largest and last of the CVL volcanic islands. It is home to three shield volcanoes: Pico de Basile, Pico Biao, and Gran Caldera de Luba. Eruptive history is only known for Pico de Basile which erupted within the past 100 years, and steam vents were observed as recently as 2012. There is no permanent seismic monitoring; the closest seismic stations are in Cameroon and have not reported data since 2015. The CVL is of scientific interest and has been studied by several groups. Most geophysical studies focus on the area around Mt. Cameroon, the most active volcano in the system. A network of seismic stations was installed across the entire country from 2005-2007. There has been no successful geophysical surveys of the island portion of the line.

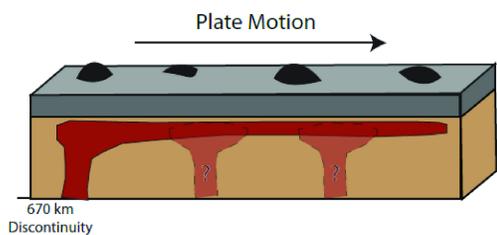
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2. CAMEROON SEISMIC EXPERIMENT

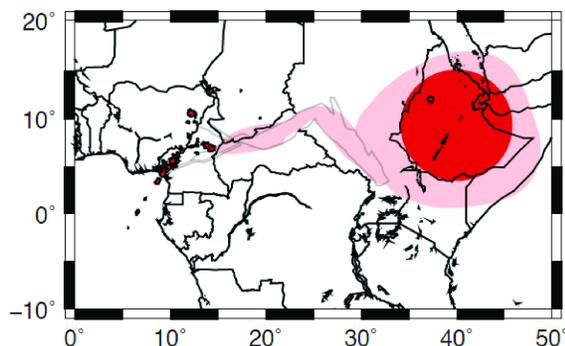


Map showing location of stations deployed as part of the Cameroon Seismic Experiment, 2005-2007. After Tokam et al., 2010.

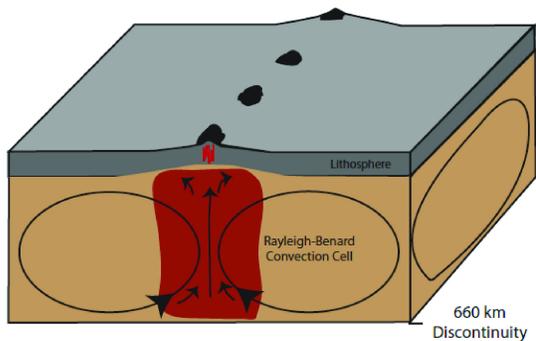
a) Hot Spot Model



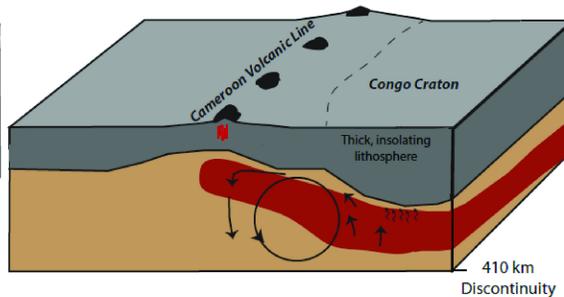
b) Pre-Existing Lithospheric Weakness Model



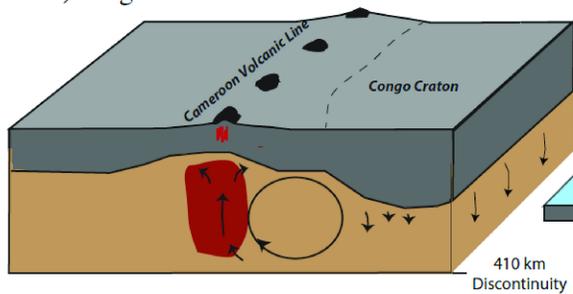
c) Convection Cell Model



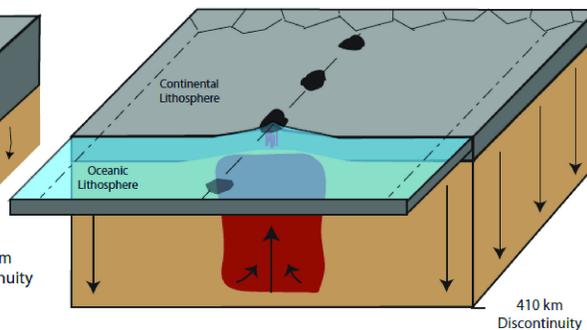
d) Edge Convection Model



e) Edge Convection Corner Flow Model

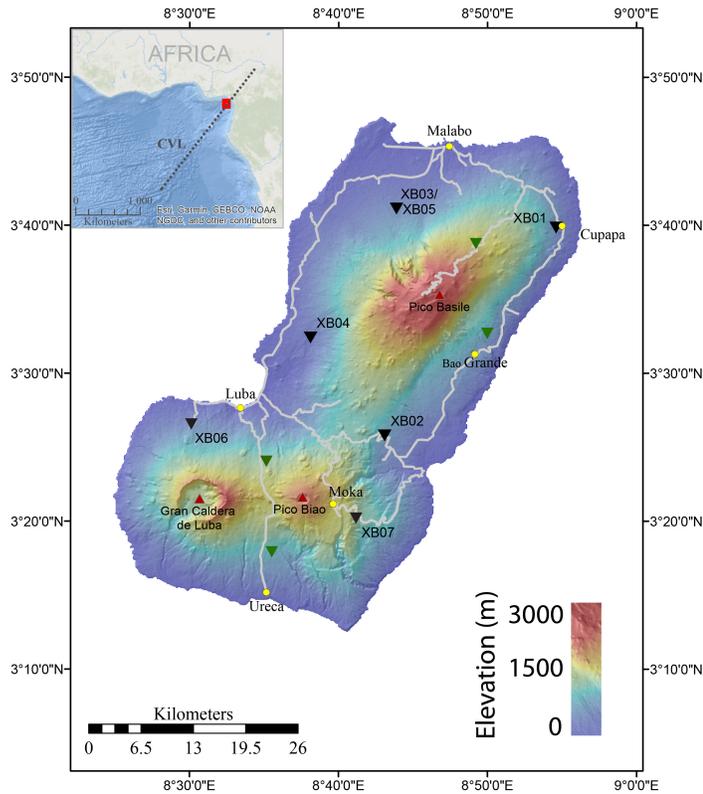


f) Lithospheric Instability Model

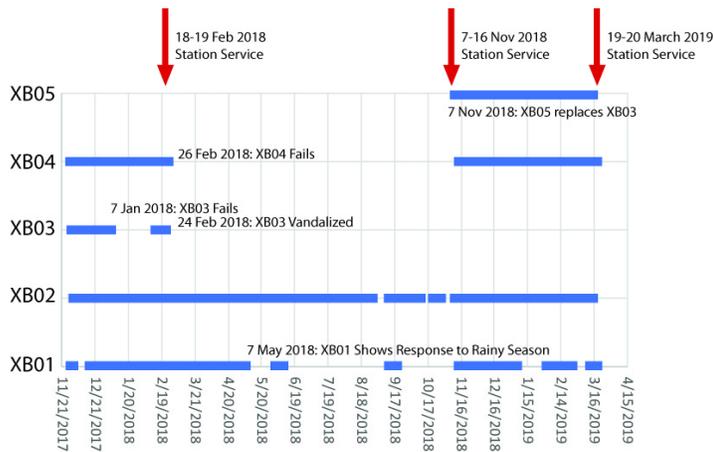


Current models explaining the Cameroon Volcanic Line (CVL). Most likely are models that invoke some form of convection or lithospheric instability or a combination. After Adams et al., 2015.

3. LOCAL BIKO NETWORK



Map of station locations for the local Bioko Network. Black inverted triangles are locations of current stations (2017-present). Green inverted triangles are potential locations for future stations.



Data return for stations services through March 2019. XB06 and XB07 were installed in March 2019. XB03 demobilized and replaced by XB05 during November 2018 service.

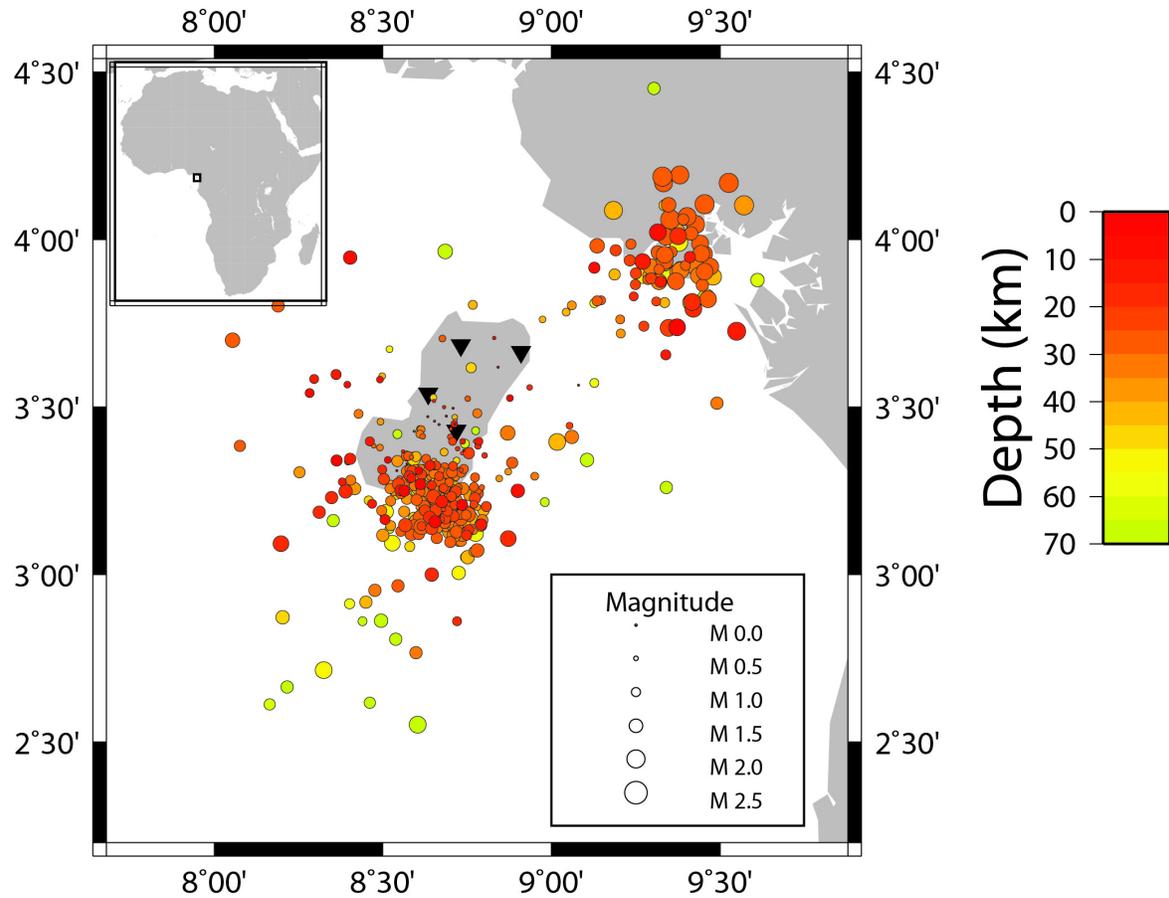


Left: First generation station. Stations suffered water infiltration, vandalism (pictured), and power outages.

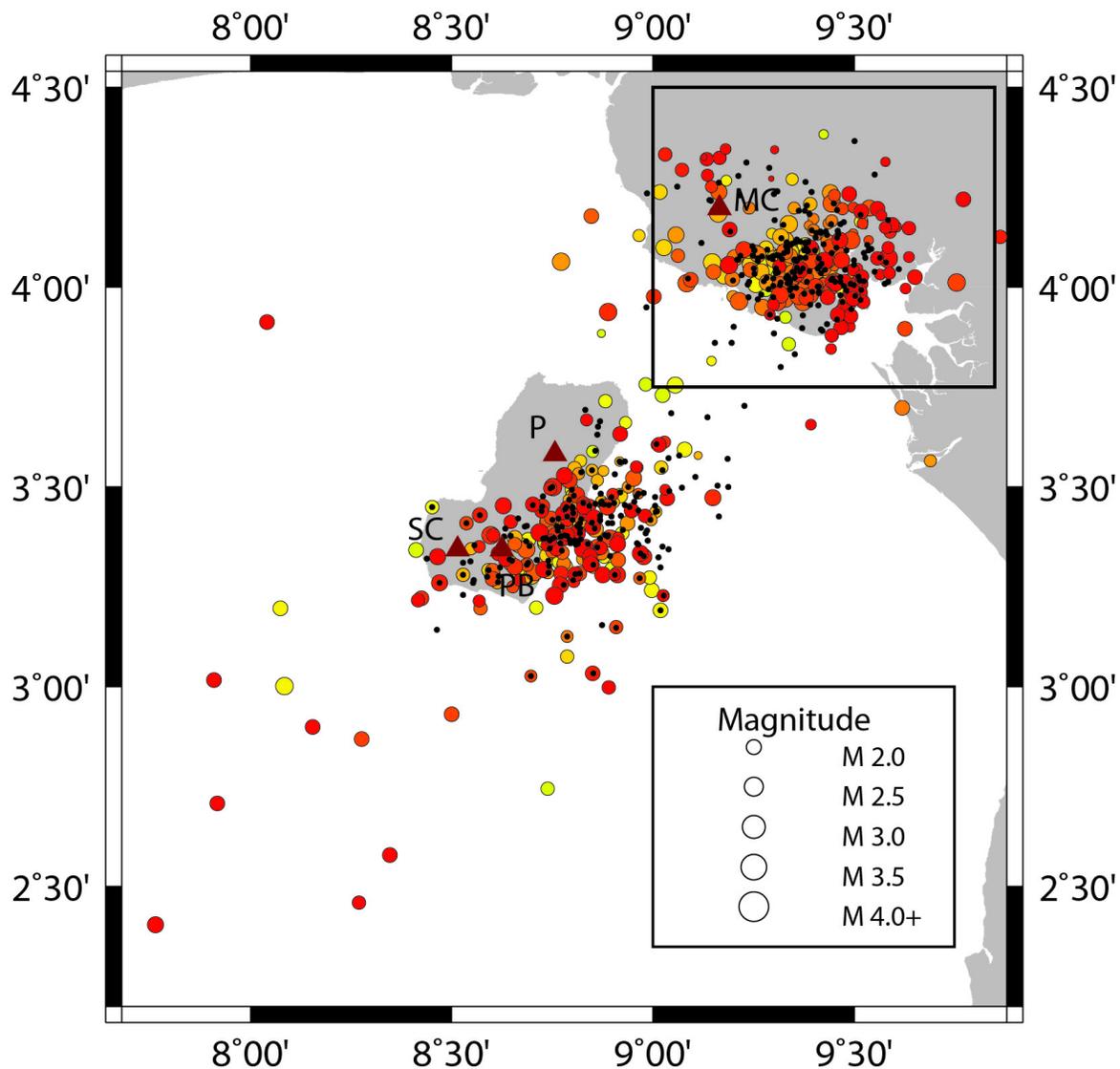
Middle: Second generation station equipment enclosure. New design prevented water infiltration.

Right: Second generation solar panel assembly.

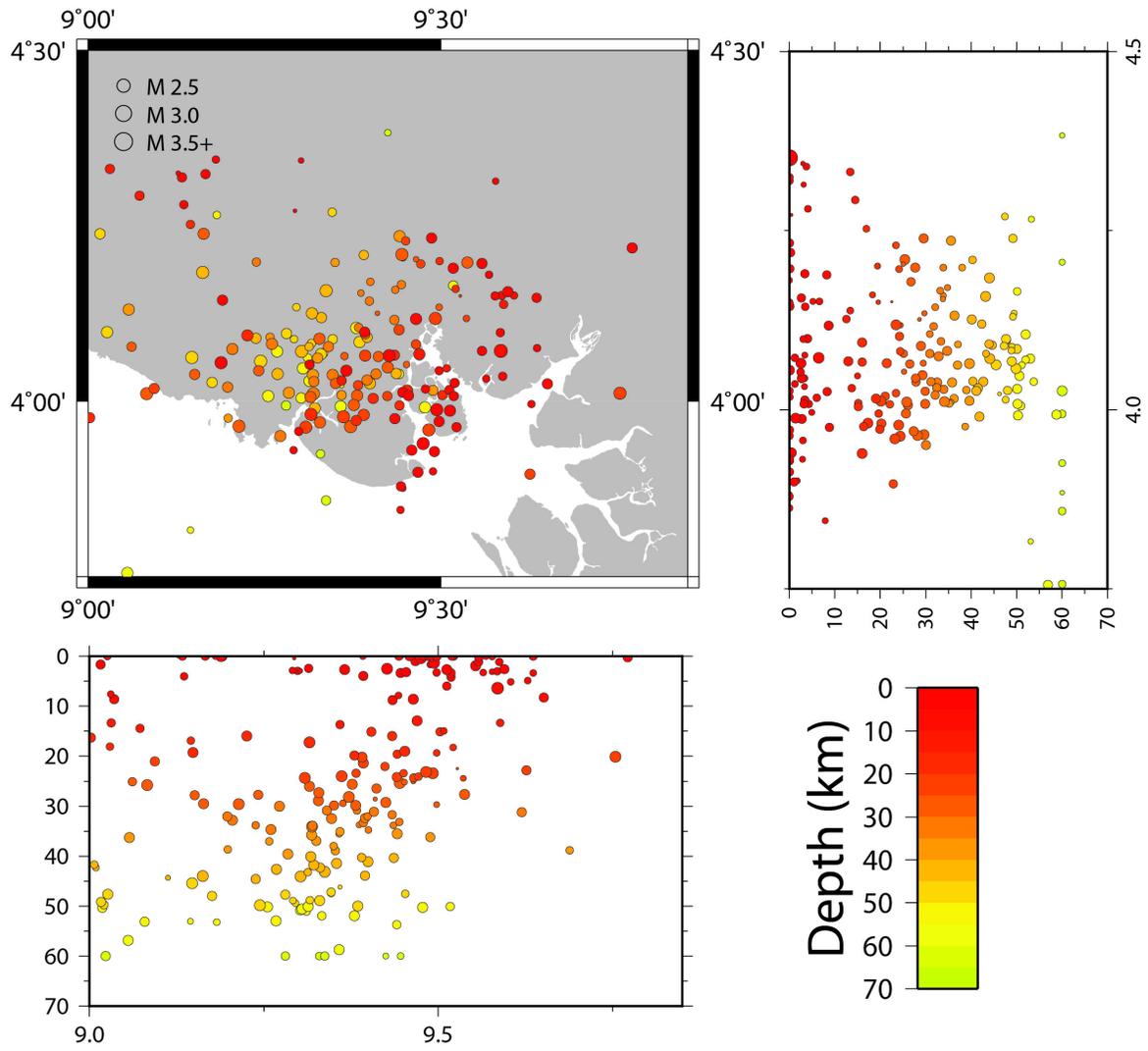
4. RESULTS



Earthquakes recorded by local Bioko network. Color indicates depth. Circle size indicates local magnitude. Events cluster in the southeast of the island and to the southeast of Mt. Cameroon, similar to what has been observed by the Mt. Cameroon Observatory.



Earthquakes recorded by the Cameroon Seismic Experiment. Color indicates dept. Circle size indicates local magnitude. Black dots in panel (a) are relative relocations of events. Earthquake locations show similar pattern to those observed by stations located in Bioko. Box shows extent of figure below.



Earthquake locations around Mt. Cameroon with depth slices. Figure extent shown by box in panel above.

5. CONCLUSIONS AND FUTURE WORK

- Earthquake patterns are consistent between data collected in 2005-2007 and 2017-present. These patterns are also consistent with reported event locations from the Mt. Cameroon Observatory network.
- More than 30 years of data (including anecdotal reports from Mt. Cameroon Observatory) show the same patterns.
- 458 events were located with the local Bioko network from 2017-2019.
- 367 near Bioko Island and 91 near Cameroon. The range in local magnitude is $-0.28 - 3.86$.
- 428 events were located with data collected by the Cameroon Seismic Experiment from 2005-2007.
- 190 events were located in Cameroon and 171 near Bioko. The range in local magnitude is $0.84-5.26$.
- Future work includes returning to Bioko to collect data recorded since March 2019.
- Future analysis includes: tomography, receiver functions, and shear wave splitting.

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The Cameroon Volcanic Line (CVL) is a linear feature of volcanism that begins off the western coast of Africa with several islands and continues on shore through Cameroon further into the African continent. Equatorial Guinea's Bioko Island is the largest and last of the CVL volcanic islands. It is home to three shield volcanoes: Pico de Basile, Pico Biao, and Gran Caldera de Luba. Eruptive history is only known for Pico de Basile which erupted within the past 100 years, and steam vents were observed as recently as 2012. There is no permanent seismic monitoring; the closest seismic stations are in Cameroon and have not reported data since 2015. The CVL is of scientific interest and has been studied by several groups. Most geophysical studies focus on the area around Mt. Cameroon, the most active volcano in the system. A network of seismic stations was installed across the entire country from 2005-2007. There has been no successful geophysical surveys of the island portion of the line.

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Tokam, A., Tabod, C., Nyblade, A., Julia, J., Wiens, D., and Pasyanos, M. (2010), Structure of the crust beneath Cameroon, West Africa, from the joint inversion of Rayleigh wave group velocities and receiver functions, *Geophys. J. Int.*, 183(2), 1061-1076.

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