Towards The Deep Seismic Structure of Volcán de Colima, Mexico

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Abstract

We present early-stage results from a novel seismic investigation at Volcán de Colima. The project is a collaboration between the Observatorio Vulcanológico de la Universidad de Colima and the University of Alaska Fairbanks. In January 2006, twenty broadband seismometers were deployed in a wide-aperture array around the volcano as part of the IRIS/PASSCAL-supported Colima Volcano Deep Seismic Experiment (CODEX). Stations were placed in January 2006; scheduled deployment time is 24 months. CODEX network contains 20 G久alp CMG40T sensors with Quanterra Q330 DAS from PASSCAL.

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Regional Seismicity

A total of 239 earthquakes occurring between January 25, 2006 and February 24, 2006 have been located by the authors using both CODEX and MARS stations (figure 4). Initial earthquake locations were found using the ASPI/ global 1-D velocity model.

Results show that seismicity around Colima is surprisingly well-distributed, with most events occurring south of the volcanic complex towards the Pacific coast. In figure 4, earthquakes occurring at approximate crustal depths (less than 40 km) are shown in warm colors and deeper slab-related events are shown in cold colors. It is clear that earthquakes occur throughout the crust all around Colima.

Volcanic Seismicity

Plotting the number of picked P-waves at each backazimuth at two stations, JANU and ALPI (figure 6) shows that ALPI has a large blind zone from 210 to 320 degrees while JANU seems to pick arrivals from all directions equally well. This discrepancy could be explained by the model presented in figure 7. Most arrivals coming from the same azimuth to the volcanoes at station ALPI are at distances of less than 100 km away, meaning that the first arrivals are Pwaves which travel exclusively through the crust. Most arrivals seen at JANU from the direction of the volcanoes are at distances greater than 100 km, meaning that the first arrivals are Pn waves traveling along the crust-mantle boundary. In this model, the Pg arrivals at ALPI are highly attenuated as they travel underneath the volcano, while the Pn arrivals at JANU are attenuated as they travel above the high attenuation area underneath the volcano. Such a model may also help explain the low pick success rates seen on stations to the east of the volcano.

Automated Earthquake Locations

In order to reduce the amount of man-hours required to analyze the data, the digitized and organized programs in the PASSCAL software package were used to develop a routine for picking phases and generating origin locations automatically. A 6 x 6 degree grid, divided into 301 x 301 nodes centered at the volcano, was used for locations. Due to high-resolution data available at many stations, a 10 - 0.1 Hz bandpass filter was applied to data prior to analysis. An STA/LTA time window of 0.7 seconds and an LTA time window of 6.0 seconds were used. A signal to noise ratio of 4 was required for a detection to be picked, and an event to be produced at least 6 picks were required.

Figure 8 and 9 show the statistical results from this automated program. As can be seen in figure 8, a large percentage of the earthquakes in the hand-picked catalog were able to be located by the automated program. Figure 9 shows the number of located earthquakes vs magnitude. The automated program does a good job (>90%) locating earthquakes of magnitude greater than 2.6. Figure 10 shows that the origins generated by the automated program overall match up well with those found by hand.

Conclusions and Future Work

During one month of time, the CODEX and MARS networks located 239 local and regional earthquakes around the greater Colima area. 74% of these earthquakes were able to be located by an automated routine. This routine was especially successful with earthquakes of magnitude 2.5 or greater. Averaged crustal velocities are about 6.5 km/s, mantel velocities calculated to be 8.0 km/s. Low pick success rates on stations to the west of the volcano may be explained by an area of high attenuation underneath the volcanic complex. The next step is to expand the regional catalog of the area using the efficient automated routine instead of hand-picking arrivals. This catalog can be used to develop a realistic velocity model of the area for use in tomographic imaging of the deep crust around the volcano and to refine our knowledge of what occurs in the deep crust underneath an active arc volcano.

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