CONTINUING GROUND DEFORMATION STUDIES OF DOMINICA USING GPS GEODESY. R. Davidson,[1] P. Jansma[2], G. Mattioli[2] [1] University of Missouri-Rolla, Rolla, MO 65401. [2] Dept. of Geosciences, University of Arkansas, Fayetteville, Arkansas, 72701.

Introduction: Dominica, with approximately eight potentially active volcanic centers (see figure 1), stands as the most potentially volcanically active island in the eastern Caribbean. Located midway along the Lesser Antilles island arc, the island is also a prime location for studying the tectonics of the Caribbean region. The subduction of the North American plate under the Caribbean is fairly slow, subducting at approximately two centimeters a year (Simkins, *et al.* 1989).

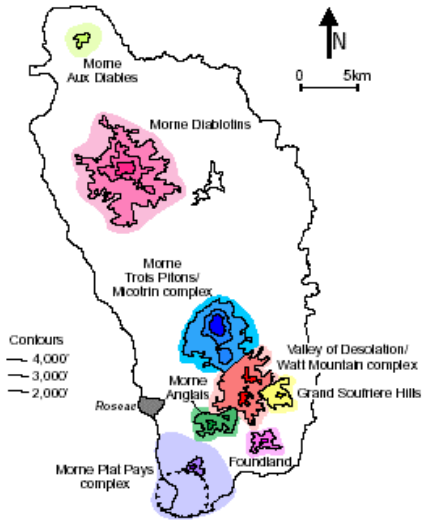

Fig. 1. Map showing volcanic centers on Dominica.

Past field expeditions in 2001 and 2003 resulted in 12 in-place sites and nine preliminary velocity vectors (Mischler and Mattiloi, 2004). These expeditions focused on the southern portion of the island due to a seismic swarm there; a new seismic crisis in the north in 2003 prompted this year's campaign to place additional sites to monitor the area. The cause of the seismicity is unknown – local or regional tectonics, the movement of magma, and a flux in the local geothermal system are all possibilities.

Methodology: Site selection involved finding an area of interest (i.e. in the north or on a volcano) with an exposure of bedrock or a sufficiently large boulder such that it is not likely to be affected to a large degree by soil creep. After drilling with a percussion drill into the rock, a stainless steel Bevis pin is inserted into the hole and cemented with epoxy. After several hours to cure, the new monument is ready to take observations.

For this field campaign, the data were collected using Ashtech choke-ring antennae and Ashtech Z12 receivers. These receivers collected position data every 30 seconds and were powered by a combination of gel-cell batteries, car batteries, and solar panels.

Analysis: After downloading the data from the receivers and the return to Arkansas, the data were analyzed with GIPSY-OASIS (GPS-Inferred Positioning System and Orbit Analysis Simulation Software) and processed to create a time-series integrating all past epochs (2001 and 2003). This time series shows velocity with respect to the stable Caribbean plate (ITRF00 model) by providing both the site movement rate and the projected plate movement (Demets *et al.*, 2000) In Figure 2, the velocity vectors have already had the motion of the Caribbean plate removed.

Nine sites had three epochs of data, two sites had two, and the six new sites had only positions. The site at SOIE (Pointe la Soie) had corrupted data, so this site also only has a position estimate from 2003. The sites with three epochs of data showed no significant deviation between the 2001-2003 and 2003-2004 epochs, indicating data reliability.

Velocities at CASS (Cass Roche), SCTT (Scotts Head), and BELV (Belvedere) suggest a constant generally westward motion. These sites show consistent motion in both epochs and are located such that they are not likely to be influenced by volcanic activity. The new sites at TETE (Tête Morne) and BRDX (Bordieux) were selected for their location between SCTT and CASS, both of which were moving rapidly to the west. The velocities of the new sites can confirm the velocities of the older ones; also, since TETE lies in the Morne Plat Pays (Fig. 1) volcanic

complex, it can act as an indicator and contrast to the other sites in the area.

The reason for the generally westward movement of these sites with respect to the stable Caribbean plate is unknown. The Caribbean plate is moving to the east, so a potential answer could be strain accumulation. However, a firmer answer cannot be given until more data has been collected, both from the older sites at SCTT and CASS and the newer sites of TETE and BRDX.

The sites at GOMM (Gommier Stewart Estate) and WOTT (Wotten Waven) also pose an interesting question. In the 2001-2003 epoch, the velocities of these two sites were pointing firmly at each other. However, in the 2003-2004 epoch, the sites were both pointing to the west such that the overall motion is roughly perpendicular. As with other sites, further epochs of observation will help give a clearer picture of what is going on.

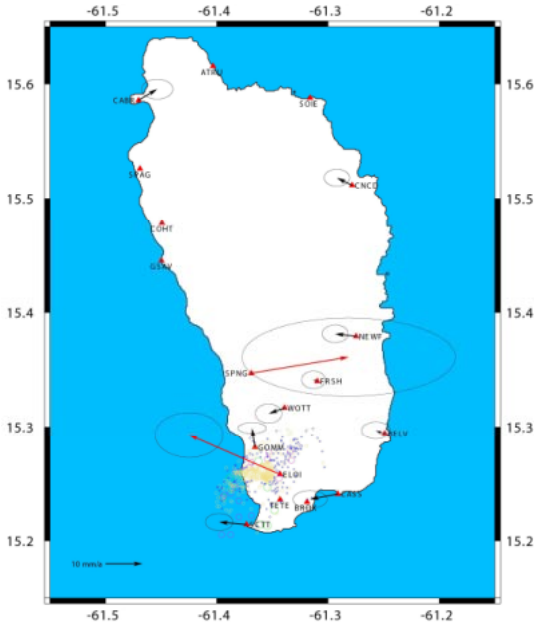

Fig. 2. 2001-2004 velocity map with error ellipses and the seismic swarm in the south of the island.

ELOI (Morne Eloi) presents, potentially, an anomaly. Located on the northwest flanks of the Morne Plat Pays volcanic complex, this site's motion could be an indicator of volcanic activity in the area. However, the site's velocity is still taking it to the west, and it could be a tectonic motion. Future observations from this site will help constrain this site's motion and more data from other site will help create a better overall picture of the island.

Finally, SPNG (Springfield) also poses several questions – the rapidity of its movement and the direction in which it moves both raise problems. Yet again, further epochs of data will help constrain the movement of this site.

Conclusions: The data currently reflects a need for further observations (see Future Campaigns). Although suppositions can be made from the velocities computed, no scenario can be put forth with certainty until several more epochs worth of data have been collected.

Future Campaigns: Future campaigns to the island can continue to monitor the now eighteen existing sites and install still more sites in the north and east quadrants of Dominica. Also, if possible, the installation of new sites in the interior of the island an in the Valley of Desolation/Morne Watt area (around the Boiling Lake) would greatly improve coverage of the island. The latter, in particular, would offer invaluable information about the highly geothermally active area around the Valley of Desolation, the site of the most recent volcanic eruption on the island (a phreatic eruption in 1997).

Another potentially powerful method of observation, although currently cost-prohibitive, would be the installation of a continuous site (or multiple sites) on the island. This would be of particular use in or around the volcanic complexes – with a year in between observations, we currently do not know what sort of dynamics are occurring between observation periods.

With further epochs of observation, the data reliability will increase and more concrete conclusions can be drawn about the highly complex system – including the magmatic, tectonic, and geo/hydrothermal systems – that Dominica represents.

References: [1] University of the West Indies Seismic Research Unit website, Windward Islands:http://www.uwiseismic.com/SRU_Site01/Documents/Workshop/Windward%20Island%20Volcanoes.pdf. [2] Mischler and Mattioli, 2004. [3] Demets *et al.*, 2000.