Diking on Montserrat and Possible Diking on Europa

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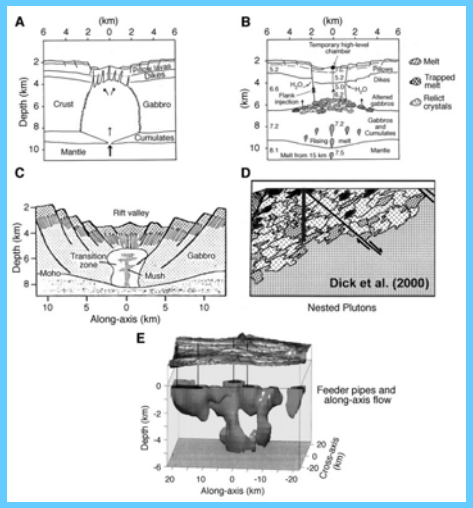
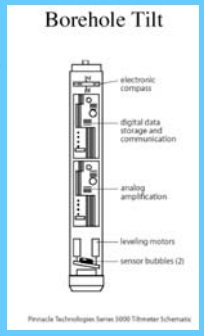


Left: Schematic of tectonic processes showing dike formation.
Below: Picture of equipment used on Montserrat. Equipment includes Ashtec antenna, Ashtec receiver and Q330 6 channel A -> D system.
Far Right: Schematic for Borehole Tilt

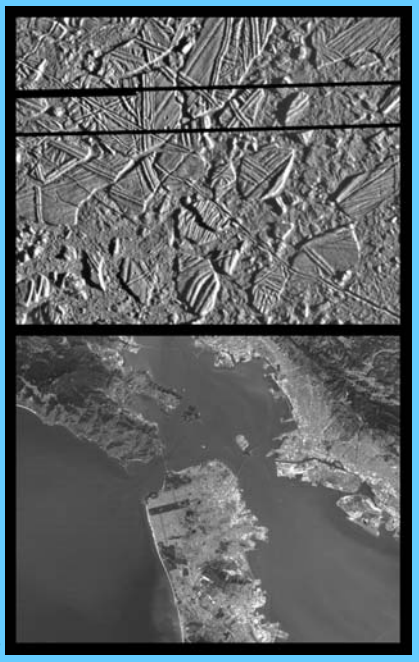
Why Montserrat?

Montserrat is a good test case for diking because it has the active Soufriere Hills volcano that has been erupting since 1995. Soufriere Hills has been well monitored with GPS since 1996, we are returning to Montserrat to install additional equipment in 2003. Each station has instruments located in a 200 meter bore hole, deep enough to minimize signal to noise ratios, and is equipped with a seismometer, tiltmeter, dilatometer and a surface CGPS. The sights are distributed as shown on the map below.



Why Diking?

I would like to refine models of dike intrusion on Montserrat using previously collected data. I would then like to examine the differences between dike intrusion on Montserrat and other planetary bodies. Mars and Venus both have evidence of dike intrusions and are thus good candidates. Venus has giant radiating dike swarms, thought to be analogous to dike swarms formed on Earth that have sense been eroded. Mars too has diking around its main volcanoes. Diking is common throughout the Solar System as it is a process native to volcanic activities. A less obvious example of diking can be found by looking at Jupiter's icy moon Europa. These dikes would form within the lithosphere of Europa, and would be invisible at the surface.



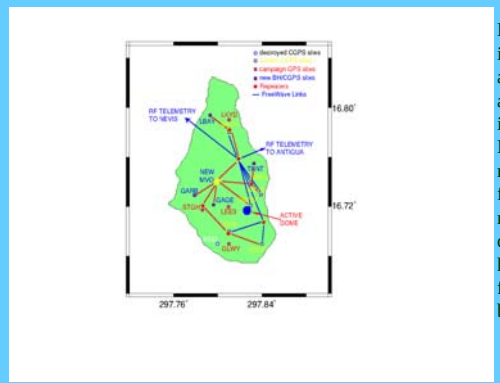
Above: PIA00597: Europa Ice Rafts and similar scales on Earth. Area of 34X42 km, resolution of 54 m, top is Chaos Terrain, bottom is San Francisco Bay.

Below: PIA01177: Chaotic Terrain on Europa in Conamara Chaos. Resolution of 9 meters, area is 4X7 km.

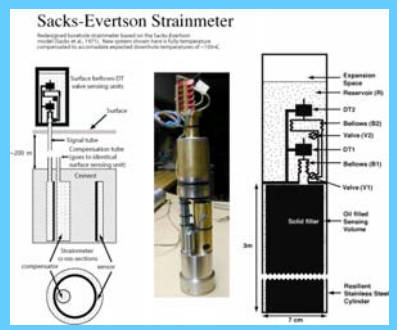
Europa's crust is a salty ice surface layer on top of a clean ice layer. The salty layer is a stagnant lid a few km thick, and it lies on a convecting sub layer that could be as thick as 10 km. A plume of warm (almost 273 K) clean water ice impinging on the bottom of this salty layer (eutectic MgSO4-water) which melts at 269 K could form a body of molten brine trapped in the top layer of Europa's crust. The formation and migration of this brine might be what's needed to "lubricate" the moving, sliding, and disintegrating blocks in the chaos. The diking question is: how much brine can you accumulate in the ice before it fractures the underlying ice, making dikes that drain the brine down into the ocean?

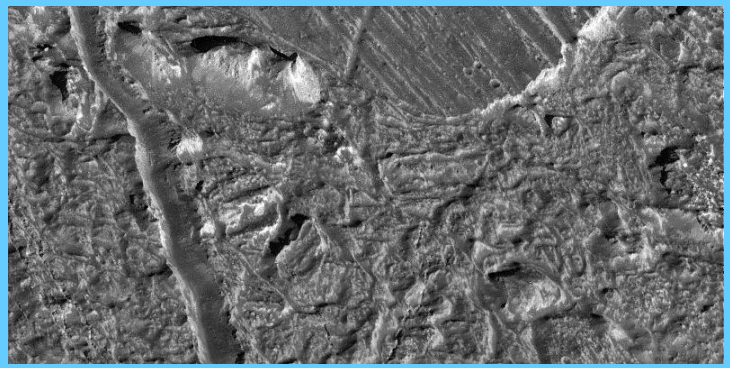
Diking

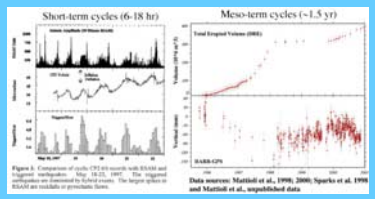
Diking is a process by which magma is transferred through preexisting rock. Dikes appear vertically or nearly vertically oriented, suggesting that they were formed by magma less dense than the surrounding rock, which was trying to reach the surface through the most direct route. Diking is important because it modifies the surfaces of planets throughout the solar system, and diking can give a chronological order to local activity through cross cutting relationships. Dike intrusions are directly related to local velocity fields, a relationship displayed by results from Montserrat. This relationship infers that velocity fields are created by displacement of magma in the magma chamber, which creates dike intrusions. By studying this relationship we will be able to better understand the magmatic system of the Soufriere Hills Volcano on Montserrat, and apply what we learn to other planetary bodies. SHV experiences cyclic patterns of ground deformation, seismicity and explosive eruptions. The cycles provide insights into the eruption dynamics of the volcano, especially for andesitic volcanoes in general. It is important to study SHV on Montserrat because it is currently active, meaning that we can observe the surface deformation caused directly by active volcanism, and not surface modifications related to edifice collapse during inter-volcanic periods.



Above: Map of Montserrat showing location of borehole sites throughout the island.
Left: A photograph of a dike on the island of Dominica.
Below: Schematic for Sacks-Evertson Strainmeter
Below-Right: Cycles of ground deformation, seismicity and explosive eruptions on SHV. The short and mesoterm cycles are displayed.







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