New MCS and bathymetric data reveal the large-scale structures of five serpentinite seamounts on the outer Mariana forearc, as well as the pre-seamount basement geometry and sediment stratigraphy. These data support the interpretation that serpentinite seamounts are formed by the episodic eruption of mudflows from a central conduit. The presence of thrust faulting at the base of two of the seamounts, along with the low surface slopes (5-18°) of all the seamounts studied, led us to infer that these edifices spread laterally and are subject to gravitational deformation as they grow. Discrete element method (DEM) simulations employing very low basal and internal friction coefficients (~0.1 and ~0.4, respectively) provide the best match to the overall morphology and structures of the serpentinite seamounts. The interface between serpentinite seamounts and the underlying forearc sediments is represented by a reverse polarity reflection beneath some of the seamounts, suggesting that the substrate is under-compacted/over-pressured and may be a zone of fluid migration. DEM simulations imply that this boundary represents a distinct décollement along which the seamounts slide laterally. In contrast, Turquoise Seamount, which is likely inactive, grows laterally, not by stable sliding along the top of forearc sediments, but by incorporating them into large basal thrusts.

Figure: A. Interpreted bathymetry over Turquoise and Celestial seamounts. B. MCS Line 42-44 over Celestial Seamount. Celestial is built in a sedimented forearc basin. The reverse polarity reflection at the top of the forearc sediments is the surface along which the seamount slips. C. The growth and deformation of serpentinite mud volcanoes. 1. The seamount is built by a series of individual flows fed through a central conduit. A depression at the summit is partially infilled by recent mud flows and there are active chimneys and fluid seeps venting slab-derived fluids. 2. An inactive mud volcano in which all fluid upwelling has ceased. A large basal thrust displaces the forearc sediment package and accommodates seamount spreading.