FORMATION OF PATERAE ON IO: GEOLOGIC MAPPING AND EXPERIMENTAL MODELS. M. C. Decker[1], A. A. Ahern[1], J. Radebaugh[1], E. H. Christiansen[1], and D. A. Williams[2], [1]Department of Geological Sciences, Brigham Young University, Provo UT 84602; meganccdecker@gmail.com. [2]School of Earth and Space Exploration, Arizona State University, Tempe, AZ 85287.

Introduction: Jupiter's moon, Io, is the most volcanically active object in the Solar System, and it has a unique class of volcanic-tectonic depressions called paterae. More than 400 paterae have been identified, covering approximately 2% of the surface [1-4]. Although several models have been suggested to explain the formation and evolution of these features [3,5,6], no experimental models have been constructed specifically for paterae on Io. We are attempting to understand the formation of paterae using experimental models and comparing the results to the geomorphology of Tupan Patera.

Geomorphological Map: We have constructed a geomorphological map of Tupan Patera (Figure 1). The mapping approach is similar to that employed by Williams et al. [7,8,9]. Tupan was selected because it is well-imaged, large, recently active, and represents the range of patera morphologies including arcuate and straight wall segments and a central "island". Tupan Patera also has unique features, including a complex mottled area on the patera floor. Red diffuse deposits (d_f) are interpreted to have formed by condensation of vapors released from the evolving patera. Red patera floor materials (pf_r) may be lobes of sulfurous materials melted in the walls that flowed onto silicate lava flows (pf_d). Overall,the features are consistent with the development of the patera by collapse associated with the rise of hot mafic magma in a volatile-rich crust with attendant loss of volatiles [10,5]. No eruptive emptying of a large magma chamber is necessary; only small volumes of flow material (unit f_b) are found on the rims of Tupan.

Experimental Model: We have constructed an experimental apparatus to examine the unique circumstances related to Io paterae including: a crust composed of dense, high melting-temperature silicates interlayered with less-dense, pyroclastic layers and accumulations of volatile frosts [10], an association with hot mafic or ultramafic magma, the absence of obvious outflow deposits that would have accompanied eruptive emptying of a magma chamber and collapse, the appearance of volatile frosts on the rim and floor, and a

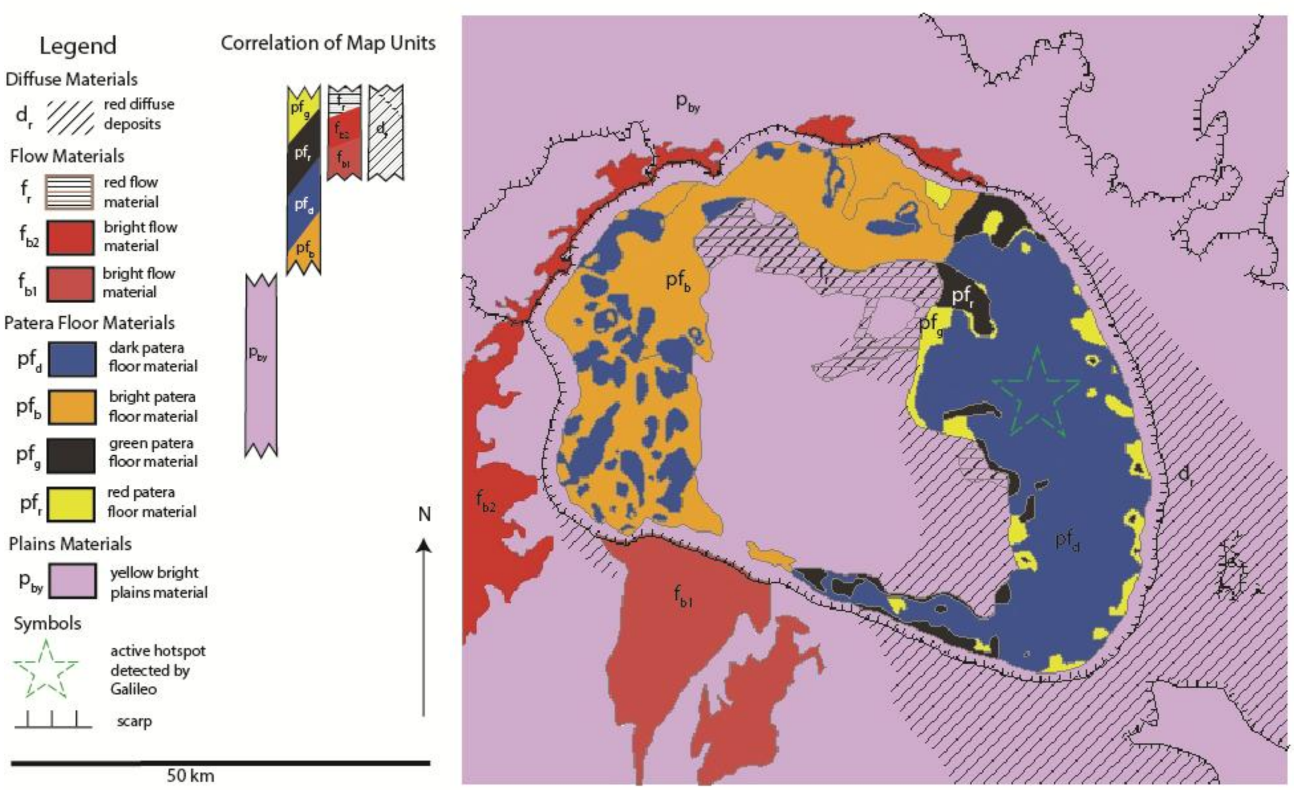

Figure 1 – *Geomorphic map of Tupan Patera. This map includes nine different units as well as scarps.*

role for tectonism in patera formation [2].

Our apparatus is a metal box approximately 0.5 meters on its edge placed on an electric hot plate. One side of the box is movable. Our experiments utilize methods similar to [11,12] in terms of monitoring and attempting to create a scaled analog. We acquire images at specific stages in the experiment with a digital camera.

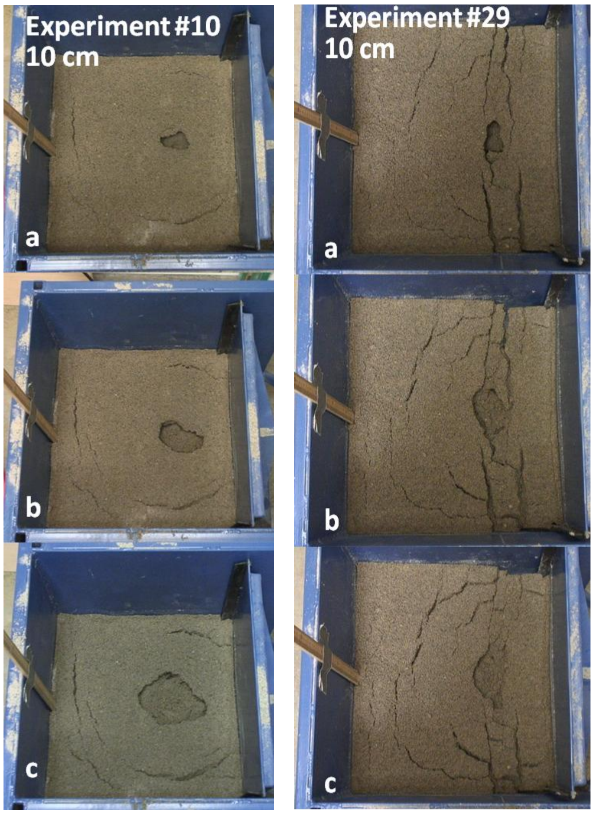

Figure 2 – *Two photo sequences show surface deformation during progressive heating. These experiments used a 10 cm thick layer of ice. The left column is from a 'static" experiment. Note the minimal, concentric fractures. The right column shows an experiment where the right wall of the box was moved to simulate tectonism. Note the linear fractures, which often form during extensional phases of the experiments. Also note that collapse crater was shaped by the fractures, creating a straight crater margin.*

Our experiments are intended to examine the features produced by the "melt through" model of Keszthelyi et al. [10]. Therefore, we constructed a stratified "crust" analog with a 10 cm layer of wet sand on the bottom; followed by either 5, 7.5, or 10 cm of water ice; and capped by a 5 cm layer of wet sand. This simlulates the layers of dense, strong, silicates (sand) and weak, less dense, volatile ices (water ice) thought to form Io's crust. The different thicknesses of water ice are used to test the effects of varying amounts of volatiles. The hot plate simulates a hot subsurface magma chamber. We used the moveable wall to simulate extension and compression in some of our experiments--we create 3 cm of extension (6%) followed by 3 cm of compression spread out evenly over the course of the experiment.

Experimental Results. During the runs, the first thing to appear are multiple fractures releasing steam as the subterranean volatiles vaporize during heating. In "tectonic" experiments the fractures are linear and are perpendicular to the direction of wall movement. In static experiments, the initial fractures are concentric. Eventually, the water ice that lies above the hot plate either melts or boils away which creates instability for the upper layer of sand. This results in a collapse and crater formation. In "tectonic" experiments collapse often occurs along the linear fractures resulting in straight wall segments (Figure 3). Partial collapse often resulted in the formation of an "island" of less collapsed material in the center of the crater. Some craters collapsed in a trapdoor style with one side of the crater floor subsiding more than the rest. After the initial collapse, further volatilization of the water ice layer results in landslides along the rim of the crater until they slow and come to a stop.

Conclusions: Both geologic mapping of Tupan Patera and simple analog experiments are consistent with the development of paterae by collapse, accompanying the removal of volatiles from the crust overlying a hot magma chamber. Future experiments will explore patera formation with the use of dry ice, varying amounts of volatiles, and the use of a 3D laser scanner to map the topography of each experiment.

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