

**BUILD OLYMPUS MONS!** Edward F. Albin (ed.albin@fernbank.edu), Department of Space Sciences, Fernbank Science Center, 156 Heaton Park Drive (NE), Atlanta, Georgia 30307.

### Introduction

Armadas of space probes are either on their way or being readied for the next phase in the exploration of Mars. Their cameras will obtain the sharpest images ever taken of the Red Planet. High-resolution imagery will show in great detail the giants of Mars -- its volcanoes. There are a dozen of these mountains larger than any found on the Earth. Of these, one represents the ultimate in volcanic accumulation; a volcano named Olympus Mons. To learn more about this Martian "mega-volcano," I've detailed plans for the construction of a miniature model of Olympus Mons. Only simple and inexpensive materials are required to complete this project.

If a volcano is built primarily from successive lava flows, it's called a shield volcano [e.g., 1, 2]. This name is taken from the fact that this type of feature looks like an inverted warrior's shield -- a broad convex dome. Olympus Mons is a shield volcano, and it was constructed from a predictable sequence of events. The growth process started as molten plumes of rock migrated upward through the crust toward the surface. Then lava spilled out through fissure vents. Initially, lavas simply erupted to form expansive flow plains. When the magma supply continued over a prolonged period of time, a convex pancake-like feature was created. This feature soon evolved into a classic shield volcano. A central summit depression resulted when lava drained back into the edifice through an internal conduit, thus causing the overlying mound of rock to collapse forming a caldera.

### Materials

The growth of a shield volcano can be modeled in the classroom. Basically, we'll build a miniature version of Olympus Mons by pouring molten wax onto a flat surface -- simulating the eruption process. Before we proceed, several materials should first be acquired. Most of these items are simple household products or, if purchased, they are inexpensive (Figure 1).

- (1) Cookie Sheet. Any flat surface onto which molten wax can be poured will do. The sheet should be at least 15 inches square or larger.
- (2) Hot Plate. One with thermostat control is needed or you can simply use your kitchen's stovetop.
- (3) Cooking Pan. A glass beaker could be substituted or any container that can take heat and hold molten wax.
- (4) Small Ladle. A small soup ladle works fine. Since wax melts at a low temperature, a plastic ladle works well.
- (5) Candle Wax. Wax can be purchased from most arts and crafts stores. Depending on how many eruptions you have and how large you wish to make your volcano anywhere from two to five

pounds should work.

- (6) Wax Coloring Dye. Also purchased from arts and crafts store. Use red or orange to match the color of Mars.



Figure 1. A miniature wax model of Olympus Mons can be constructed out of melted wax.

### Building Olympus Mons

Now that we've discussed how a shield volcano is produced and what materials are necessary to build one, we are ready to model the Solar System's largest volcano. Olympus Mons can be duplicated in miniature in your kitchen. Begin by placing one or two pounds of wax into a small cooking pan, and then set the container onto a hot plate or stove burner. Keep the temperature low since wax has a low melting point. In approximately 15 minutes, the block(s) of wax should thoroughly liquefy. Colored dye chips (orange ones give the volcano a Martian tint) can now be added if so desired. They are inexpensive and provide the planet's characteristic ruddy salmon color.

Next, use a ladle to dip a cupful of molten wax (although wax melts at a fairly low temperature, it's still hot to the touch -- so be very careful) and slowly pour it onto a 15 x 15 inch or larger flat cookie sheet or substitute surface. If the wax cools too rapidly and begins to clot on the ladle, the temperature may need to be turned up slightly. Should the reverse be true; that is, the wax pours nicely but takes too long to solidify, simply turn the temperature control down. Ideally, a flow should crust over in about 30 seconds. You'll need to experiment a bit to see what works best.

Immediately you'll see how the hot liquid spreads over the surface as might a lava flow (Figure 2). The wax is very fluid and this observation can be related to the Martian lavas that produced Olympus Mons. The lava flows of Mars, as well as those on the Moon, had the viscosity (resistance to flow) of motor oil. This is why volcanic plains on these objects can be so extensive. At first, while pouring the wax, one might question whether such a fluid medium could build

## BUILD OLYMPUS MONS: E. F. Albin

a volcano? You'll soon conclude that limited eruptions of liquefied material cannot build a volcanic construct -- only thin lava sheets. To make a volcano dozens of individual flows are necessary.



Figure 2. A shield volcano constructed one flow at a time.

If we continue to simulate eruptions at the same sight for a prolonged period, we'll see that successive eruptions eventually begin to pile up. Make sure that each coat of wax solidifies before pouring another. For at least a period of 30 minutes to a hour, pour a cupful of wax onto the sheet every 30 seconds (or whenever the previous flow solidifies). Again, it's important to allow each flow to thoroughly "freeze" before continuing with the next. Be sure to dump the wax onto the same spot each time (preferably at the center of the pan). Also, vary the size of each eruption -- make some small and others massive. In reality the volumes of lava that erupted varies considerably.

After approximately 100 or so "eruptions," a distinct mound begins to rise above the surface. The classic shield shape replaces amorphous flows as the young volcano takes shape. At first, you'll notice that the growing structure wasn't circular in planar view, but with time you will see it circularize quite naturally. This happens because each flow takes the easiest route down the volcano's flanks. Although this doesn't occur in the beginning, the evolving mound can't help but to become round at the base since flows eventually spill consecutively down all sides. Even more, as the volcano grows, a fascinating feature appears -- a caldera filled with a lava lake. The continued pouring of hot wax at the dome's center has the effect of producing a summit crater. This central depression is maintained as the hot wax cuts down into the top of the structure. Here, the molten wax ponds into a lake, and when it overflows (upon adding more liquid wax), a new stream of molten material rushes down the flanks. With each eruption of "lava," the volcano continues to grow.

To be sure, nature requires great periods of time to make a volcano like Olympus Mons. In our model the time span as well as the volume of lava involved have, obviously, been scaled down. But you'll quickly see that prolonged fluid

eruptions at the same local will lead to an impressive volcano (Figure 3).



Figure 3. The simulated wax shield volcano can be built over a period of hours or even days.

### Mount Olympus -- Super Volcano

Now that we've built a model of the most impressive geologic feature in the Solar System, it's time to reflect a bit on some of its many wonders. Olympus Mons sits on a large volcano-tectonic rise called the Tharsis bulge. The bulge is really a large pile of volcanic materials approximately the size of Africa south of the Congo River (about 2000 miles across). This continental-sized mass rises, with gentle slopes of less than a degree, to an elevation of six miles above the datum. The Tharsis rise, and its associated shield volcanoes, may be related to the action of a number of long-lived hot spots deep below the Martian crust.

One of the most fascinating aspects of Olympus Mons is its astonishing size. It has a volume greater than fifty times that of any Earthly volcano. Remarkably, the feature is approximately 300 miles across at its base, and it towers 14 miles above the Martian datum. At the base of this magnificent edifice, there is found an anomalous cliff or scarp with more than three miles of relief in places.

You'll enjoy seeing Martian volcanoes evolve before your eyes. Even more, much can be learned along the way about how eruption viscosity controls volcanic morphology. Basically, we've seen that fluid lavas give rise to lava flows and then a shield volcano. Perhaps humans will one day see Olympus Mons first-hand. From the base of Olympus Mons, the volcano will be seen to reach endlessly toward the heavens. But from the summit, the starry night sky will shine more brilliantly than anywhere on Mars or Earth for that matter. Even more, these high altitude outposts will offer breath-taking views of the Martian panorama below. Modeling Olympus Mons gives an early appreciation of vistas accessible only to future explorers.

*References:* Williams, H. and McBirney, A.R. (1979) *Volcanology* (Freeman, Cooper, and Company - San Francisco, CA), 397p. [2] Decker, R.W. and Decker, B.B. (1991) *Mountains of Fire* (Cambridge Univ. Press -- New York, NY), 198p.