Mapping Hrad Vallis, Mars.  P. J. Mouginis-Mark\textsuperscript{1} and C. W. Hamilton\textsuperscript{2}; 1. Hawaii Institute Geophysics Planetology, University of Hawaii, Honolulu, HI 96822 (pmm@higp.hawaii.edu); 2. Lunar Planetary Lab., Univ. Arizona, Tucson, AZ, 85721.

Introduction:  Hrad Vallis is a geologically young (Amazonian-age) outflow channel located within the Elysium volcanic province on Mars. The determination of its emplacement history provides fundamental information about the planet’s hydrologic and thermal evolution. For the past three years, we have been mapping this area at a scale of 1:175K, as well as using numerical simulations to assess whether Hrad Vallis formed through catastrophic aqueous flooding, effusive volcanism, or a combination of both processes. Our current map is shown in Fig. 1.

![Mapping Hrad Vallis, Mars](7080.png)

Fig. 1:  Current version of our geologic map of the Hrad Vallis region, Mars. Hrad Fossae, the source region for Hrad Vallis, forms NW-SE trending structures in the southern portion of the map that is surrounded by the ridge and trough material (\text{Aelt}) which feeds into flood plain materials (\text{Achp}). Unit \text{Apf} is the unit interpreted to be an inflated lava flow. Galaxias Mons is unit \text{Aelr}. Insert at top right shows the location of our study area. Elysium Mons volcano is at lower right.
Key conclusions from our mapping

Our geologic mapping reveals that the oldest exposed units near Hrad Vallis include assemblages of eroded knolls, plateaus, and flows, which form the high-standing rugged material (Aelc), and a series of lava flows comprising plains-forming materials (Ael). Amazonian-age flow units near Hrad Vallis are attributed to a multi-stage emplacement history, including: (1) an intial aqueous flood deposit (Aps) triggered by the intrusion of a large sill beneath Hrad Fossae [1]; (2) an episode of effusive volcanism that produced a lava-rise (Apf) with lava-rise pits distributed throughout its interior; and (3) a series of flow units (Aelt, Achp, and Ach) that were associated with the formation of Hrad Vallis itself. These flow units are interpreted to be the product of another episode of magmatic intrusion and aqueous flooding. This pattern of alternating aqueous flooding and effusive volcanism is consistent with observations of other outflow channel systems on Mars, such as Marte Vallis [2, 3], Athabasca Vallis [4, 5], and Mangala Valles [6]. This suggests that Amazonian-age outflow channels were not formed during a single event, but rather are the products of multiple stages of activity, alternating between aqueous flooding and lava flow emplacement.

We believe that the intrusions and the lava flows near Hrad Vallis may have interacted with surficial ice deposits, resulting in flow confinement and the development of explosive lava-water interactions (e.g., Galaxias Mons, Aelr, [7]). Our preferred origin of unit Apf as a lava flow differs from previous interpretations [1, 8], because it is not now believed to be a mudflow. But, if this interpretation is correct, it may be one of the best examples of an inflated pahoehoe-like flow on Mars. Such an interpretation would also provide an explanation for the origin of the thermally anomalous craters first identified by Morris and Mouginis-Mark [9]; if unit Apf is an inflated lava flow, then these anomalous craters can be interpreted as lava pits, similar to those identified in Hawaii [10].

Next Steps
As Fig. 1 illustrates, we have almost finished the linework for our map. The COMU and the DOMU are also well underway. Our plan therefore is to complete the draft map and submit it for review this summer. We also have a manuscript submitted for peer review [11], and this is focused on the sequence of the aqueous flooding episodes and volcanic activity, and our interpretation of flow as an inflated pahoehoe-like lava flow.

What is clear is that the western segment of unit Apf extends well to the west of our map area. The central segment of Apf also extends far to the north, and approaches some of the fractures associated with Galaxias Fossae (37.5°N, 217.5°E). The small segment of Apf on the eastern edge of our map area is but a small segment of the flows identified by [8] and mapped as part of a fluvial outflow system by [7]. Thus our current map area really should to be extended to fully understand the spatial extent of these inflated flows. Indeed, the entire area between 33.0 – 37.5°N, 139.0 – 145.0°W is a fascinating area with a complex interplay between ice, groundwater, both effusive and explosive volcanism. It therefore warrents additional attention by the planetary geology community.

References