Endogenic Thermal Activity at Cerberus Fossae, Mars? M. P. Milazzo[1] and A. S. McEwen[1], [1]Lunar and Planetary Laboratory, University of Arizona, 1629 E. University Blvd. Tucson, AZ 85721. (mmilazzo@pirlmail.lpl.arizona.edu).

Introduction: There is great interest in discovery of Martian "oases", where liquid water may be present near the surface today, as part of the search for extant life. The recent detections of trace methane in the atmosphere [1,2,3] has led to renewed discussion of possible hydrothermal and biotic activity in communication with the atmosphere. Based on geologic evidence, the Cerberus plains (SE Elysium Planitia) is one of the best candidate regions on Mars for such activity.

The Cerberus Fossae, in particular, exhibit evidence for very recent activity. The Cerberus Plains are covered by some of the most recent Martian flood lavas [4], and the "Cerberus Fossae" were identified as likely vents for some or all of the lava flows by [5,6]. Small lava flows are clearly seen in MOC images as having erupted from a portion of the Cerberus fractures [7]. The Cerberus Fossae were also identified as probable sources for recent floodwaters [8,5]. Secondary craters from the recent (probably less than a few Ma) 10 km impact crater, Zunil [9] pepper these lavas, yet there is a lack of craters within the fissures and at least one high resolution visible image shows one of Zunil's likely secondaries as having been cut by the wall of a fissure, although this could be explained by the widening of the fissure by collapse of the walls. Thus there has likely been very recent or ongoing activity, perhaps tectonic and probably by mass-wasting of the walls. Many of the fissures have walls with slopes near 90°, as shown by MOC images where the geometry enables shadow measurements. Estimated rates of mass wasting may enable better age constraints on the tectonic activity.

Recent THEMIS nighttime IR images show high brightness temperatures (204 K, in Figure 1.) within the east-west trending fractures. While it has been assumed that the preferred orientation of the insolation, high thermal inertia and low albedo are the main causes of elevated temperatures (relative to nearby regions) during the night, endogenic heating has not yet been ruled out. In this work we investigate whether we can account for these elevated temperatures without invoking endogenic heating.

Theory: The Cerberus Fossae are located at latitudes 5-15 N, so sunshine during the late northern spring and early fall illuminates much of the walls and floor of the canyon. The low albedo of the canyon walls causes a large fraction of the sunlight to be absorbed, and the high thermal inertia of the bedrock allows the walls to retain a large portion of their heat throughout the night. Also, although incoming solar energy strikes much of a fissure's interior, during the night as it tries to re-radiate energy it only "sees" a small portion of the sky—the interior walls and floor radiate to a hemisphere, a large part of which is filled with other rock surfaces. This causes the canyon to retain more of its energy relative to a flat, open surface with the same thermophysical properties.

If the only source of energy is the sun, any change in insolation will cause a corresponding change in radiation from the canyon wall. A decrease of solar energy, say during a northern winter, causes a decrease in canyon temperature that is greater than the decrease of surrounding flat regions. If there is a second source of energy, the decrease in radiative energy must be smaller than expected.

Brightness temperature in different THEMIS IR bandpasses enables modeling of sub-resolution temperature variations [10]. Although we don't expect to see evidence for extremely high temperatures, as on Io, there could be temperatures that are difficult to explain with passive models alone.

Observations: We have identified several areas of overlap between THEMIS night time IR images taken at different times of the Martian year. Figure 1 shows a section of an image covering small portions of two of the fissures.

Figure 2 shows a ratio between such images taken in mid spring and late fall of the same Martian year. Although not the ideal seasons as sun azimuths are similar, there have nevertheless been significant changes. There was a decrease in radiance from the canyon walls and floor by as much as 10-30% in the fall relative to the spring, especially on the southern (north-facing) wall. This ratio is complicated by the fact that during the winter, part of the southern wall is in shadow during at least part of the day. Such regions in shadow throughout a season provide strong constraints on potential endogenic heat in these regions, as passive heating is confined to re-radiation from the opposite illuminated wall. More detailed analysis will be reported at the conference.

Preliminary Conclusions: Currently there is no strong evidence for a significant endogenic source of thermal energy at the Cerberus Fossae. A weak source of endogenic heating may not be powerful enough to be detected through the changes in insolation due to seasons without exceptionally accurate and precise thermal measurement and modeling of the surface layer, the underlying bedrock, the insolation, and perhaps the atmospheric thermal behavior, and

Figure 1: THEMIS night time IR (band 9) image (image number I06717009RDR) of a portion of the Cerberus Fossae. Bright areas are high radiance due to some combination of low albedo, high thermal intertia, topography, and perhaps endogenic heat flow. The nearly linear bright features are the radiating fissures that make up part of Cerberus Fossae. The bright areas surrounding the lower fissure are young lava flows.

without higher spatial resolution coverage over longer time periods. However, this study should help define the types of future measurements needed to search for thermal anomalies.

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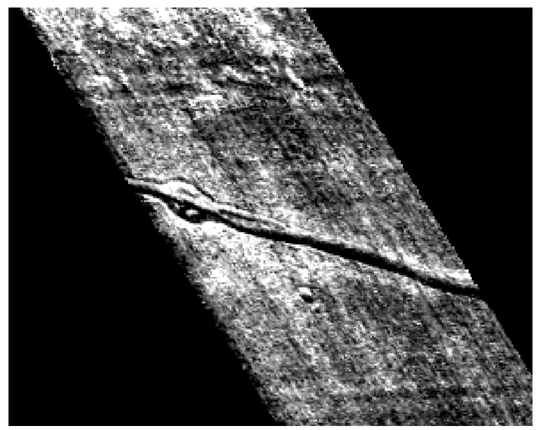

Figure 2: Ratio between night time IR images from late spring to mid fall of the same Martian year. The linear feature with the dark band is the same as the lower fissure seen in figure 1. Dark is where the radiance was lower in the image taken during the fall.