**CONCENTRIC CRATER FILL: RATES OF GLACIAL ACCUMULATION, INFILLING AND DEGLACIATION IN THE AMAZONIAN AND NOACHIAN OF MARS.** James L. Fastook¹ and James W. Head², University of Maine, Orono, ME 04469, fastook@maine.edu, ²Brown University, Providence, RI 02912.

**Introduction:** Concentric Crater Fill (CCF) [1-6] is one of many features on Mars that are thought to either contain ice, or to have been formed by a glaciological process that involved the deformation and movement of a significant thickness of ice, emplaced during a climatic period when the obliquity and other spin-orbital parameters favored deposition in areas where ice is not currently stable [7-10]. Such features include Tropical Mountain Glaciers [11-15], Lobate Debris Aprons, and Lineated Valley Fill [12, 16-28]. Others, such as Pedestal, Perched, and Excess Ejecta Craters [29-32], record the presence of widespread mantling. Features that preserve ice presumably do so by covering the ice surface with a thin (< 15 m) layer of debris [33-37]. In all cases, understanding the mechanism that leads to the formation of these features provides insights into the state of the current climate and how it must have changed in the past.

Although there are many hypotheses of how CCF might have formed (see [1,3] for a comprehensive discussion), in this we assume that CCF is composed largely of debris-covered ice that at some point flowed and then sublimated, producing the observed flow-like debris cover (Fig. 1, [3]), and that the age is Amazonian [2,3,5,6]. Pedestal Craters record a repeating, transient, widespread ice mantling, and even provide estimates of the thickness of this layer [30-32]. The question then is how does a thin mantling layer flow in such a way as to fill CCF craters with ice to a depth of more than a km? Could it have happened during a single, presumably most recent, episode of mantling? Or, is it a cumulative gathering of material into the crater during frequent repeated episodes of mantling?

**Results:** We use a 1D flowband model based on the University of Maine Ice Sheet Model [38-40], coupled with an advection-based model of surface debris transport. We assume that whenever the ice surface drops below the crater rim crest, debris is deposited locally on the ice surface in the crater interior, and then transported with the movement of the downward and inward-flowing ice. To characterize the two cases we perform experiments to see how long it takes for a modeled crater to fill to a level that matches the Fig. 1 observed CCF crater [3]. Fig. 2 shows the two cases.

![Figure 1: P14_006570_2241 HRSC CCF Crater used as a target.](image1)

![Figure 2: a) A single episode of mantling 200 m thick that flows into the crater. b) Multiple episodes of mantling 50 m thick driven by an obliquity scenario.](image2)
continuous sublimation that occurs after 3 Myr when there are no obliquity episodes that exceed the threshold (Fig. 3). The start-and-stop nature of the forward motion of the ice dictates that the transported debris layer will not be uniform in thickness and this is apparent in the modeled green line surface of Fig. 2h. The final state of this 50 Myr simulation driven by an obliquity signal results in ~800 m of fill in less than one-twentieth the time it takes for an infinite persistent layer to flow into the crater to a comparable depth.

Application to the Noachian: Wordsworth et al. [42] recently proposed that the Late Noachian climate resulted in an “icy highlands” environment in which snow and ice blanketed much of the southern uplands of Mars [42]. This same mechanism that operated in the Amazonian would also operate on craters in the Late Noachian icy highlands [43]; these craters would be subjected to similar repetitive mantling events that would carry debris into the craters, shallowing them and degrading the crater rim crests [44].