SUSTAINABILITY OF LIQUID WATER LAKES ON PRESENT-DAY MARS. J. M. Goldspiel[1], [1]Planetary Science Institute (1700 East Fort Lowell, Suite 106, Tucson, AZ 85719, goldspiel@psi.edu).

Introduction: Focused exploration the past two decades has opened up for detailed study the geochemical features of past aqueous environments on Mars. An important development in recent years is the identification of phyllosilicates on the surface [1-7]. Close study of the context and distributions of phyllosilicates provides evidence that aqueous environments existed on the surface during the earliest parts of Mars history in the form of groundwater-fed lakes [8, 9]. Based on other geologic features, cases have also been made for liquid water precipitation at some point in Mars' past, with evidence for a precipitation history often accompanied by descriptions of a warmer surface environment and higher atmospheric pressure [10].

Whether liquid water is emplaced on the surface of Mars from groundwater seeps or atmospheric precipitation, this water would have collected on the surface, at least temporarily. Understanding the physical details of such aqueous systems on Mars is important to understanding the details of the fluvial and environmental history of Mars, and is vital to investigations of potential habitable zones that rely on the sustained presence of liquid water on or near the surface.

Surface Water Modeling on Mars: Short of detailed study (and perhaps return) of surface and core samples from each potential site of past surface water, the best way to gain insight into likely aqueous sites on Mars is through detailed modeling of their formation and evolution. Accordingly, we have begun building a detailed numerical model of small bodies of water on the surface of Mars that are supplied with liquid water at different rates and by different mechanisms.

The intent is to apply the model to lakes or pools on Mars formed under current and plausible past environmental conditions. The objectives are to assess the sustainability of lakes, ponds and pools on the surface of Mars for a range hydrogeologic settings under the cold and dry conditions that exist today, and under warmer conditions that might have existed in the past.

Central to this activity is the determination of the time-variable temperatures of the liquid (or frozen) water at the surface and the regolith beneath as surface conditions vary diurnally and subsurface conditions evolve more slowly. We calculate the regolith and surface water/ice temperatures using a conduction-advection model similar that used in previous studies of groundwater discharge on Mars [11, 12]. Currently the calculations are performed on interpolated 1-dimensional grids.

Beyond just the water itself, a lake on Mars, whether it be groundwater-fed or a result of precipitation and runoff, would be a complex system of different geologic and physical regimes interacting with potentially complex feedbacks. The full representation of such a system therefore requires detailed treatments of the different regimes and the interactions between these regimes. We simulate this complexity by incorporating model components to represent the different physical components of the near-surface environment, and tie these components together through well-defined interactions at common boundaries.

Early Results: Using an early version of our model we have simulated the case of surface water collected in a small flat-floored depression (200 m wide, 20 m deep) on the floor of a larger impact crater. The water in this example is pure and has an initial temperature of 275 K. The input water volume, 6×10^5 m^3, is that which could be discharged from a 150-m thick, 275 K permeable aquifer with a 20-m wide seepage face located at 37°S [12]. This water volume is sufficient to fill the pool area but not produce any significant water depth in the rest of the crater basin. As the surface water is added to the pool it is subject to freezing and evaporation or sublimation at rates appropriate for the given atmospheric conditions.

For present-day Mars conditions, we find that evaporative losses are small compared to the pool depth, and that warming of the atmosphere during spring and summer has only a minor effect on the temperature of the ice cover. More importantly, the early results show that the interior of the pool stays liquid over a full year as an ice cover slowly thickens. These are early results and it is important to remember that the results come from a model with limitations and restrictions that will be eliminated as work progresses.

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