**A GEOLOGIC MODEL FOR LUNAR ICE DEPOSITS AT MINING SCALES: UPDATES AND LESSONS FOR PROSPECTING CAMPAIGNS.** K. M. Cannon[1] and D. T. Britt[1], [1]University of Central Florida, Center for Lunar and Asteroid Surface Science, Orlando FL. Email: cannon@ucf.edu.

**Introduction:** Recently, we published a geologic system model describing how icy regolith deposits form and evolve at the lunar poles, treating them as potential resources rather than scientific curiosities [1]. Here, we present updates focused on site selection and ground-based prospecting.

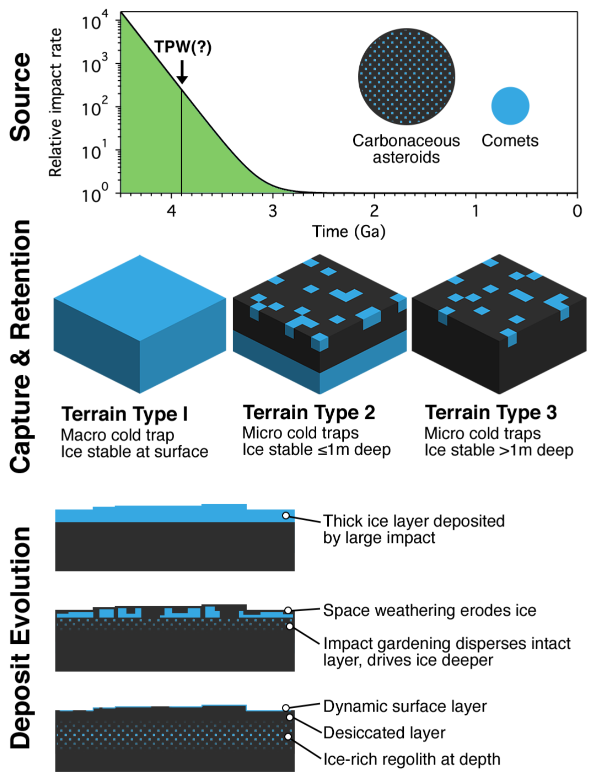


**Fig. 1.** Overview of geologic system model from [1].

**Geologic System Model:** The conceptual system model (Fig. 1) [1] describes the source, capture, and retention of water ice over geologic time to build up potentially economic deposits. Key highlights include:

1. Volatile delivery from carbonaceous asteroids was likely the major driver for depositing thick enough ice layers to survive space weathering and be mixed down into the regolith column. Volcanic outgassing was only a minor source, and solar/Earth wind may have contributed to a thin, potentially unstable dynamic surface layer.

2. True polar wander described by [2] and impact gardening [3-5] were the major processes that affected ice-rich deposits after deposition. Based on the paleo and present-day ice stability [2] we divided the polar terrains into three different terrain types (TT), with 9 permutations for those surfaces that formed before the proposed episode of true polar wander.

3. Using a quantitative model of ice sources, capture, and retention, we developed an Ice Favorability Index (IFI) as a forward predictive model for where the richest ice deposits may have accumulated.

**Updates and New Findings:** Since the original work was submitted, we have carried out new model runs and analysis techniques. New findings include:

1. When ice deposition is tied to the same impact rate used to model gardening, we find the total amount of ice increases rapidly to a plateau, then steadily decreases as the impact rate decreases. A CM-like asteroid (~9% $H_2O$) ~5 km in diameter contains enough water to cover the PSRs and SSRs (maximum extent) with a 10 cm layer of ice, but this is a lower bound due to trapping efficiency and the presence of micro cold traps.

2. Using semi-variograms, we find the ice distribution rapidly evolves to a pure nugget effect as gardening proceeds. In other words, the variance is the same at all distances from a given point, and there are not coherent mineralization zones like in terrestrial ore deposits.

3. Rapid burial by a medium to large nearby impact is the best way to preserve relatively intact layers of ice in the subsurface, but ballistic sedimentation may be destructive for much larger impacts.

**Site Selection Approach:** The IFI and the updated version with 2x resolution (IFI+) can be used to down-select potential sites for ground-based prospecting. A particularly powerful approach is to combine the IFI with filters based on illumination conditions, slope, etc. to quickly select ideal locations. To this end, we are developing a GUI that allows users to easily create maps based on multiple terrain criteria.

**Ground-based Prospecting:** New variography analyses of our sandbox impact gardening models suggest very high nugget effects are likely in polar ice deposits. At face value, this argues against extensive drilling and surface-based remote sensing campaigns to map out ice concentrations at meter to ten-meter scales. Faster and cheaper trenching or drilling in several select locations may be sufficient for verifying the viability of a deposit.

**References:** [1] Cannon K.M. and D.T. Britt (2020) *Icarus*, *in press*. [2] Siegler M. et al. (2016) *Nature 531*, 480. [3] Gault 1974 [4] Costello E.S. et al. (2018) *Icarus 314*, 327. [5] Costello E.S. et al. (2020) *JGR 125*, e2019JE006172.