# Thermal mining of icy regoliths: production decline mitigation

Gordon Wasilewski, PhD
R&D Engineer, Astronika Sp. z o. o., Warsaw, Poland, gwasilewski@astronika.pl

Astronika

## BACKGROUND INFORMATION

Extraction of ice in Permanently Shadowed Regions of the Moon using the thermal mining method may follow distinct production phases closely related to the build-up of a sublimation lag and loss of bulk thermal conductivity [1]. Negative feedbacks in lunar water production, capture and processing need to be closely studied and mitigated using operational and technological methods.

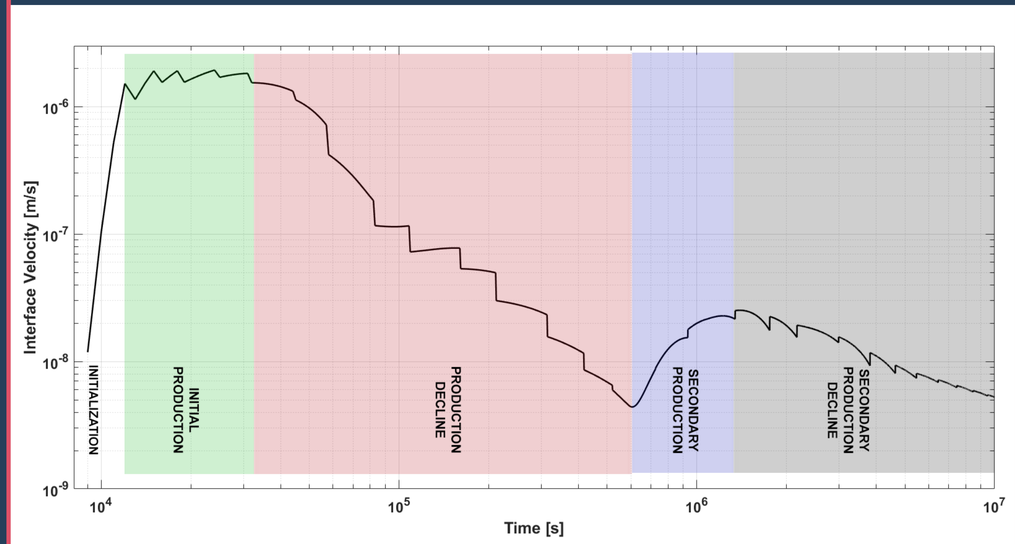


Fig. 1. Sublimation front velocity in simulated PSR conditions undergoing changes due to bulk thermal conductivity loss.

A baseline combined heat and mass transfer model was developed based on experimental tests [2]. Further work focused on heterogenous icy deposits with bulk regolith and ice depth-dependent distributions, lowered ice density, and continuous lag removal.

| A. Baseline model | B. Bulk regolith depth-dependence | C. Ice content depth-dependence | D. Lowered ice density | E. Continuous lag removal | F. Combine all |
|---|---|---|---|---|---|

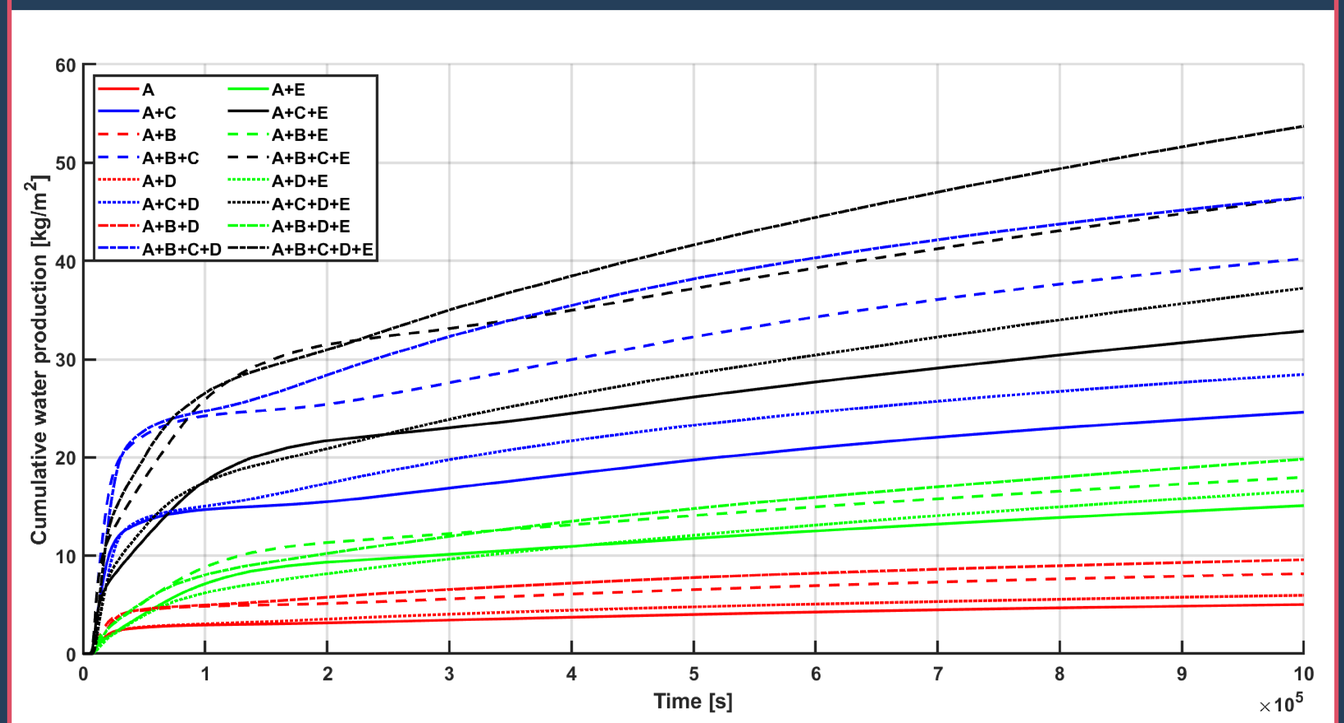


Fig. 2. Cumulative water production in simulated PSR conditions with variable geology and operational scenarios A-E. Higher production is associated with higher ice pore-filling fractions, however the continuous lag removal provides the highest yield.

Two production decline mitigation methods are proposed [3]:

- Continuous thermal mining with immediate lag removal, unearthing fresh and richer ice deposit. This can be done via pneumatic or mechanic excavation;
- Fracking-thermal mining, with injection of high thermal conductivity materials (e.g. aluminium nitride) into pores and fractures of the deposit.

**REFERENCES:** [1] Wasilewski, 2021, Lunar thermal mining: Phase change interface movement, production decline and implications for systems engineering; [2] Wasilewski et al., 2021, Experimental investigations of thermal properties of icy lunar regolith and their influence on phase change interface movement; [3] Wasilewski, 2022, Influence of ice distribution on thermal mining performance and strategies to counter sublimation lag

www.astronika.pl