

# Extracting Volatile Water from Lunar Regolith with the Lunar Volatiles Scout



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Investigation of Transient Volatiles Migration in Lunar Regolith for the Lunar Volatile Scout

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## About

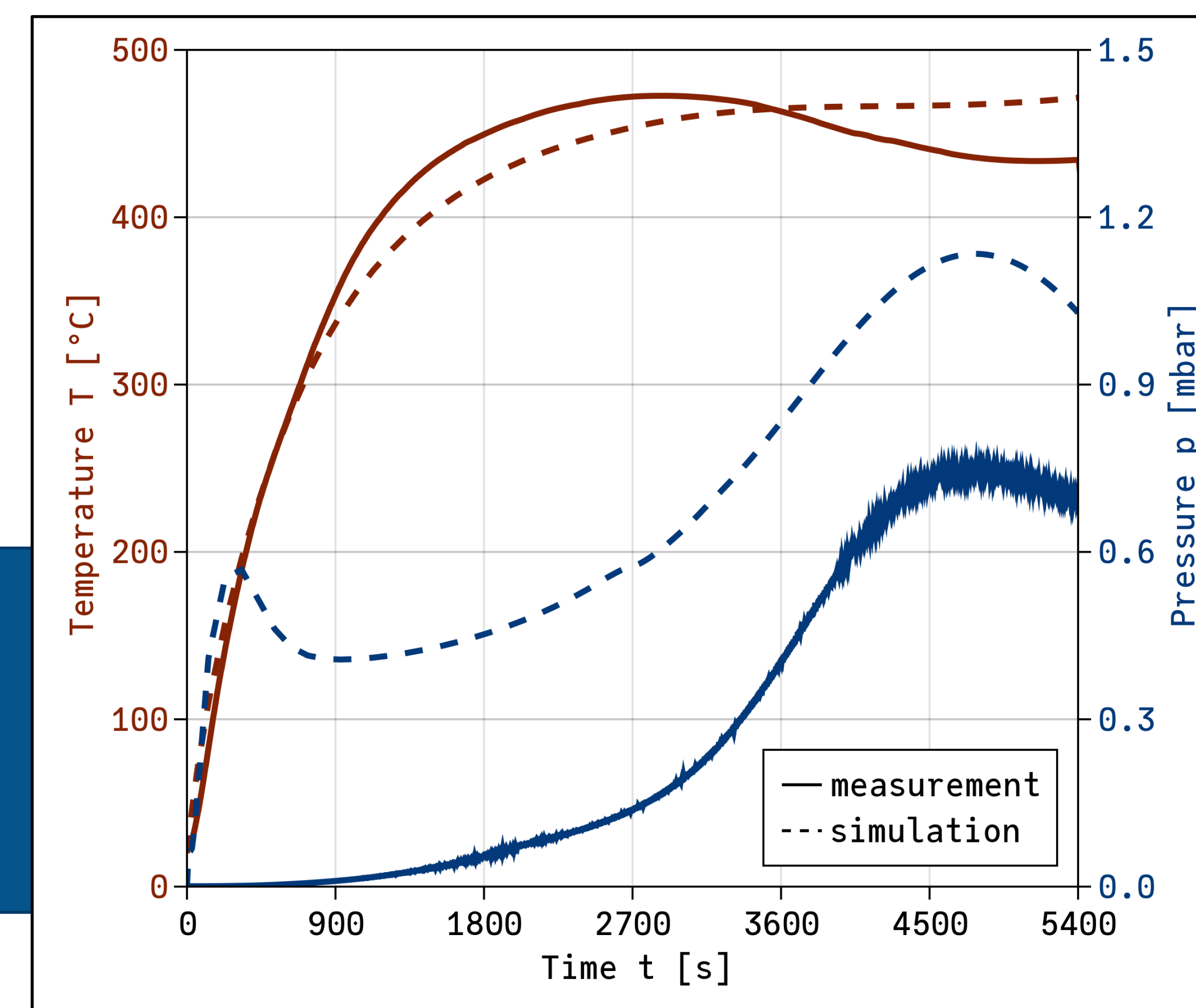
- **Lunar Volatiles Scout** [1], see **Figure 1**, is a novel soil sampling and analysis instrument
- Plan to investigate **volatile water** trapped at the lunar poles
- Utilizes **thermal extraction** by powering the central heating rod once inserted about 100–150mm into the regolith
- **Mass spectrometer** and **pressure sensors** analyzes desorbed volatiles
- Simulation of **numerical model** implemented in COMSOL Multiphysics, based on Reiss, 2018 [2], to verify method

## Studies

- **Adsorption rate study**  
Investigation of the influence of  $k_a$ , implemented through **Langmuir's Adsorption Theorem** [3], on the extraction, mainly on the **molar flux** over the regolith's surface, see **Figure 2**.
- **Correlation study**  
Based on prior experimental results, fitting the **adsorption rate**  $k_a$  and the **desorption energy**  $E_d$  [4,5], see **Arrhenius Equation**, of the simulation to match the transient temperature and pressure behavior, see **Figure 3**.

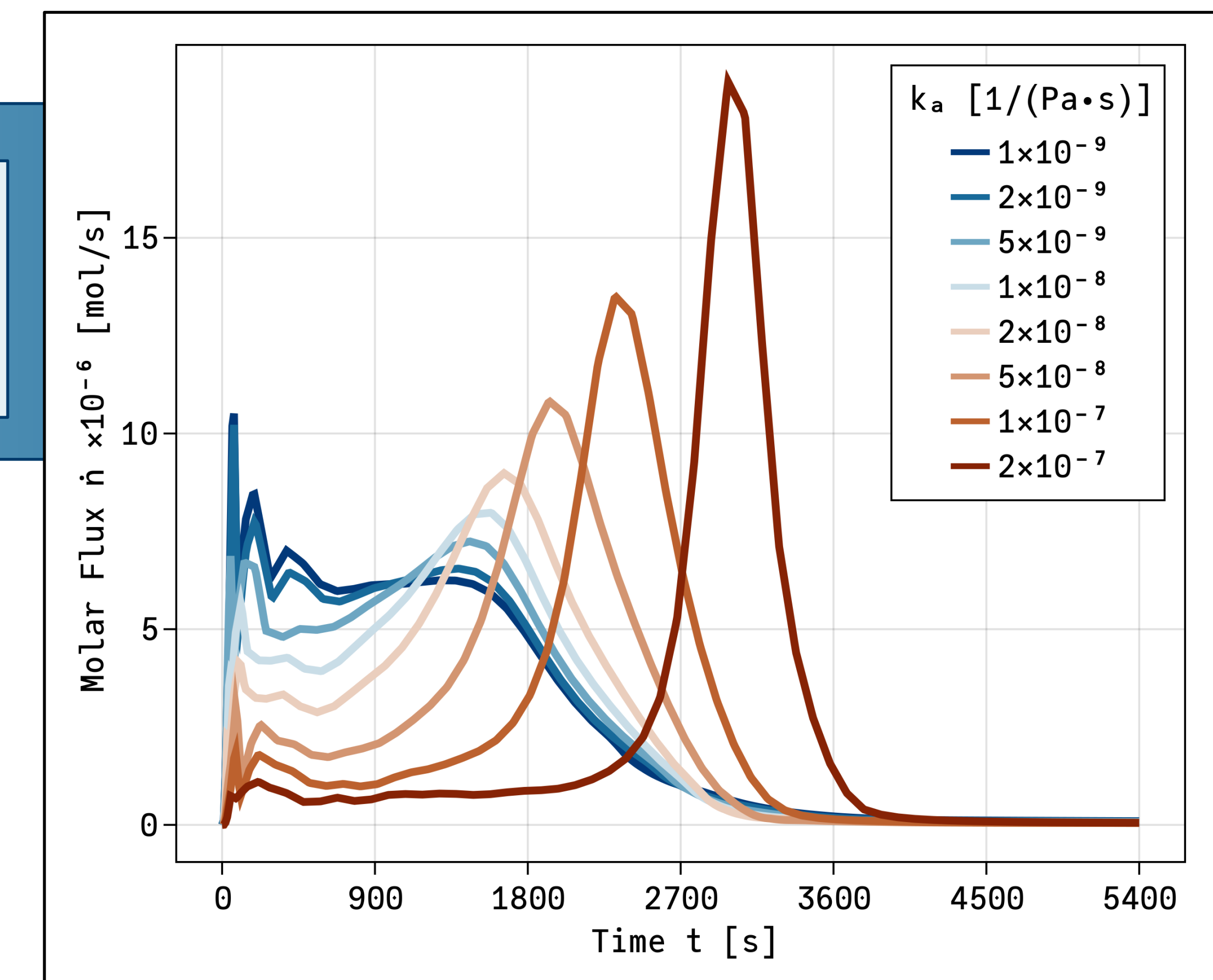
## Conclusion

- Increasing adsorption rate shifts the molar flux peak to **later times and higher maximum values**
- **Significant positive correlation** found with the factors  $k_a = 4.5 \times 10^{-8} \text{ Pa}^{-1} \text{ s}^{-1}$  and  $E_d = 0.99 \text{ eV}$ , shown in **Figure 3**
- Pressure offset and temperature inertia due to data generation

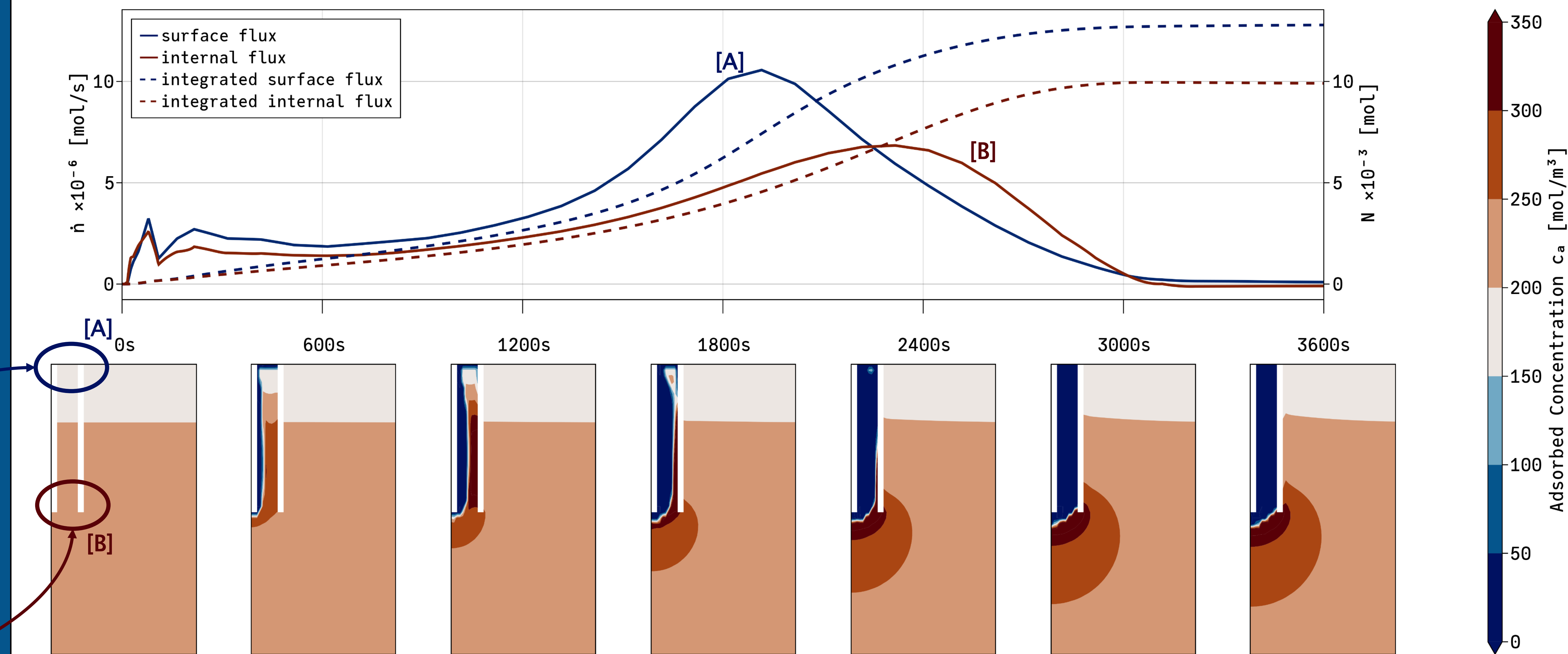


**Figure 2** Molar flux over LVS' enclosure regolith surface, see **Figure 1 [A]**, for varying **adsorption rates**.

**Figure 3** Comparison of simulation results with data from **end-to-end testing** [1] for the correlation study.

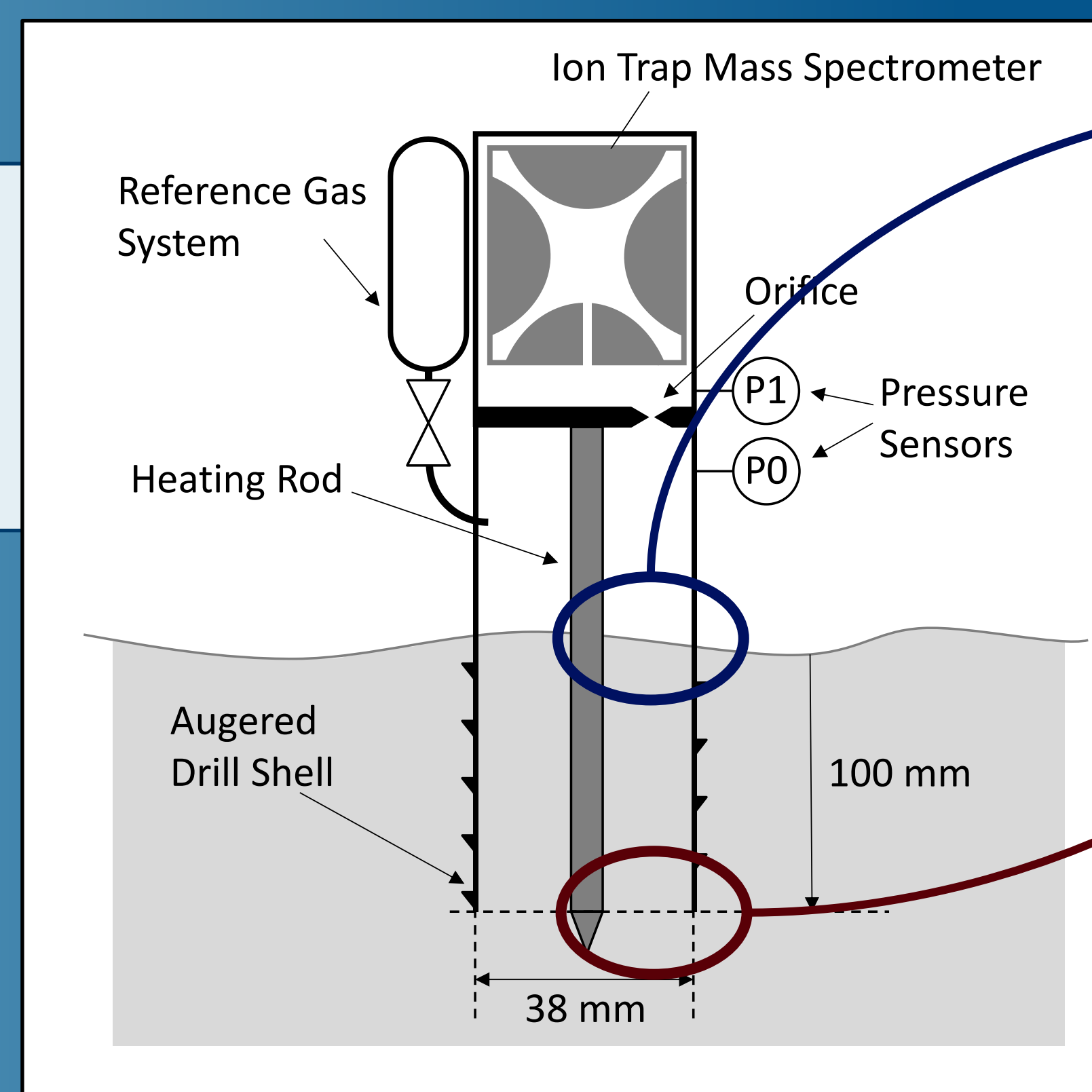


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- [5] C. A. Hibbitts, G. A. Grieves, M. J. Poston, M. D. Dyar, A. B. Aleksandrov, M. A. Johnson, and T. M. Orlando, "Thermal stability of water and hydroxyl on the surface of the moon from temperature-programmed desorption measurements of lunar analog materials," ICARUS, vol. 213, pp. 64–72, 2011.



**Figure 4 (Top)** Molar flux of desorbed volatile water over the regolith's surface [A] over the inside of the LVS' enclosure and over the internal regolith boundary [B] leading into the enclosure. The dashed lines show the **integrated values** for the molar flux. **(Bottom)** Distribution of the **adsorbed water** in and around the LVS' enclosure. The timestamps are matching with the time axis of the above graph.

**Figure 1** Schematic of the Lunar Volatiles Scout.



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