THERMAL STABILITY & MIGRATION OF WATER AND HYRDROXYL ON THE SURFACE OF THE MOON

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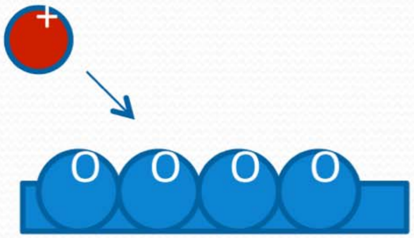
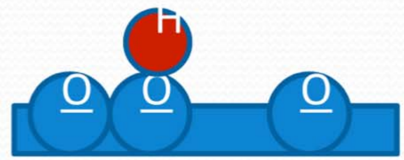
Origin and evolution of water on silicates

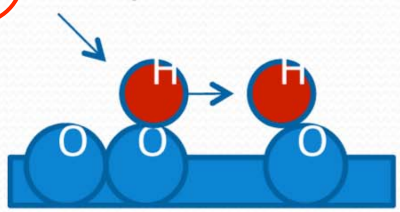


1. solar wind proton strikes surface (possibly neutralizes)

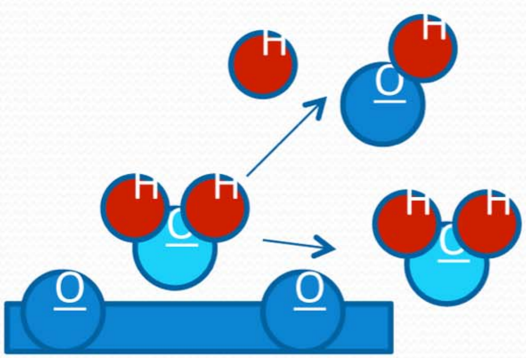


2. forms hydroxyl (preferably near defect like O vacancy)

ΔH or e^-, p^+, hν



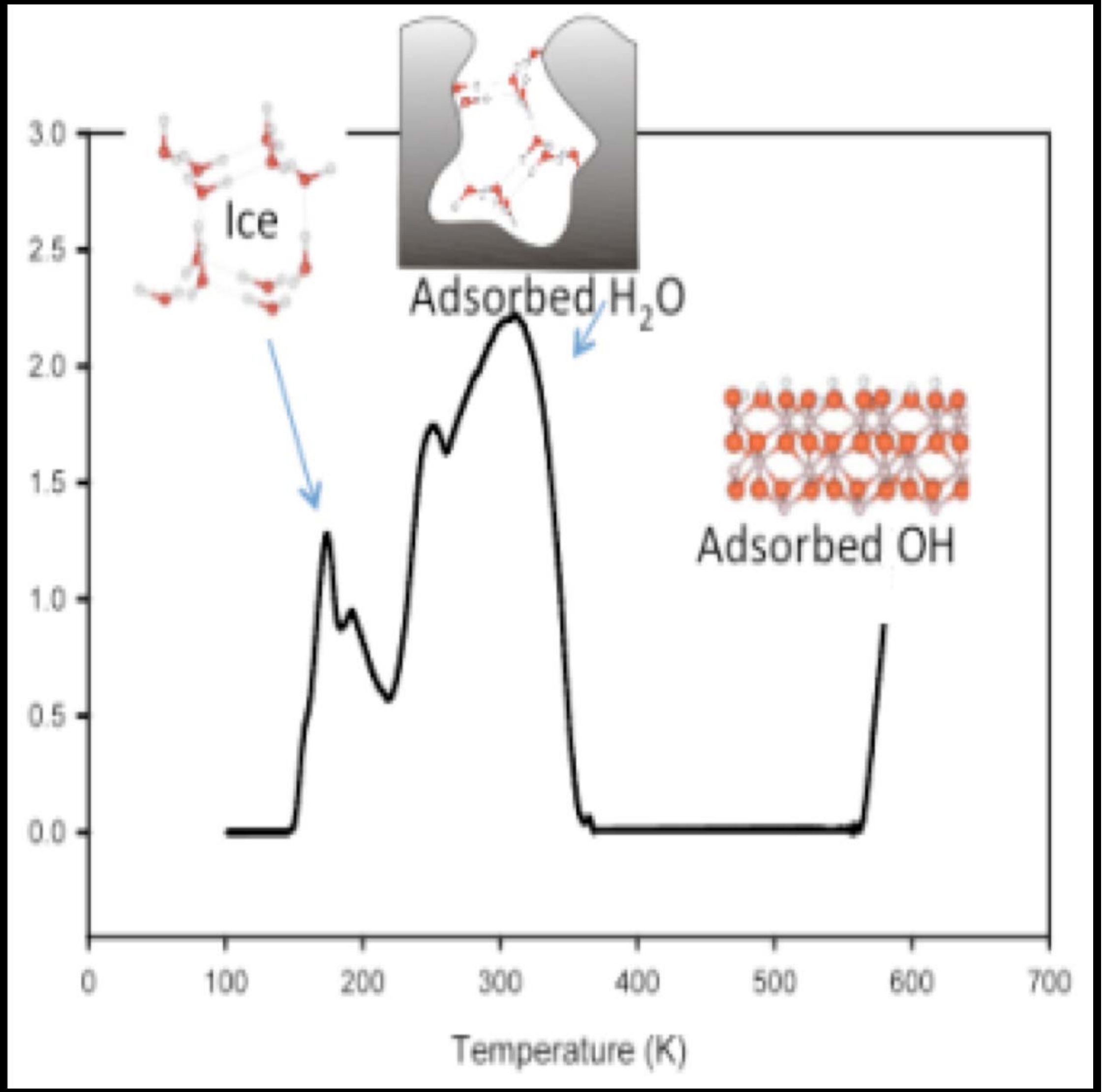
3. when hydroxyl density is high enough, recombination occurs either thermally or radiation initiated (photon, electron or proton)



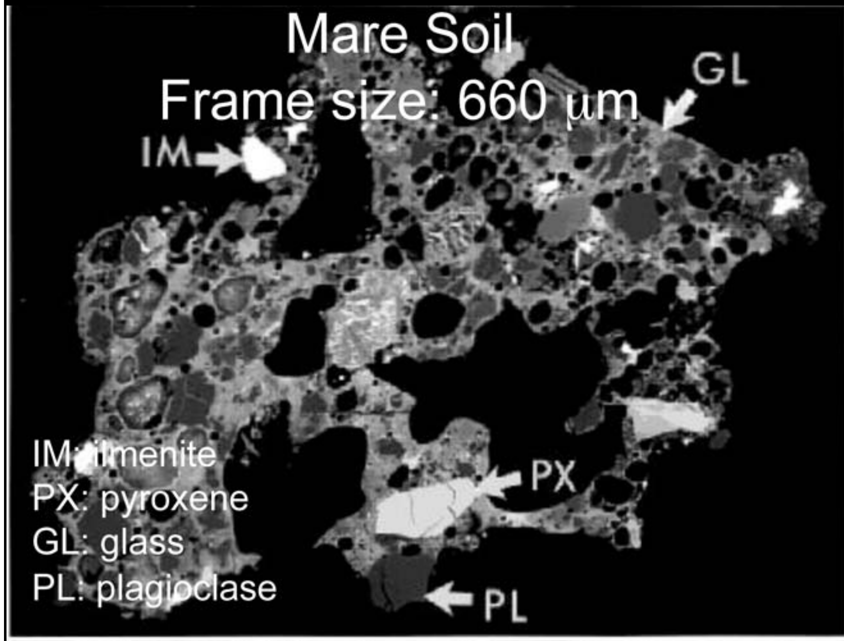
4. H_2O forms, and may now migrate *but* is vulnerable to photo-desorption and photodissociation

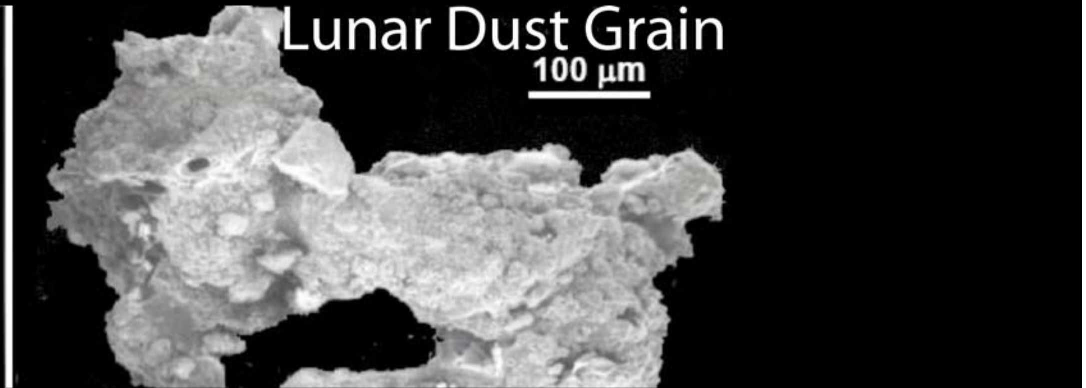
Types of Adsorption

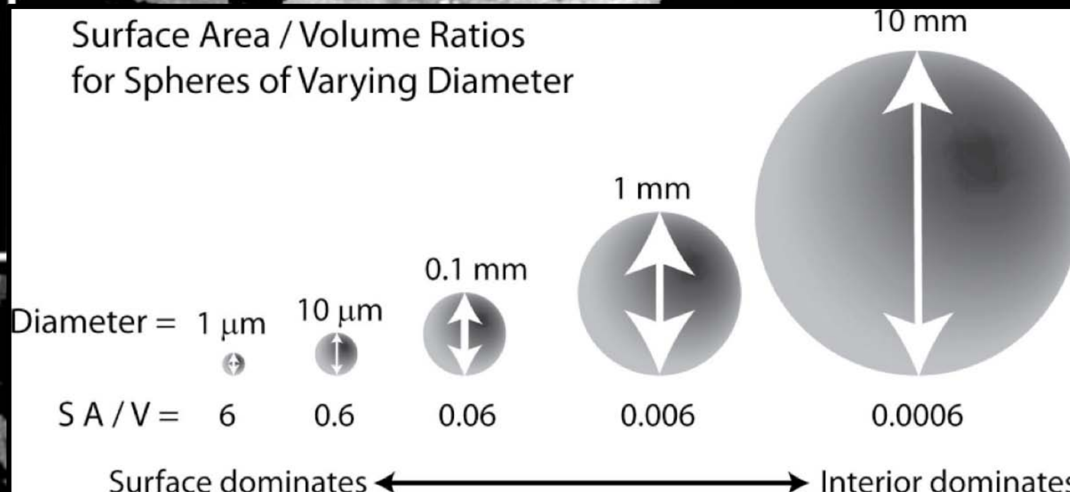
- Ice phases (~150K).
- Low energy molecular chemisorption (~150 to 250K).
- High energy molecular chemisorption (~250K to 350K).
- Dissociative chemisorption of -OH groups (usually >500K).

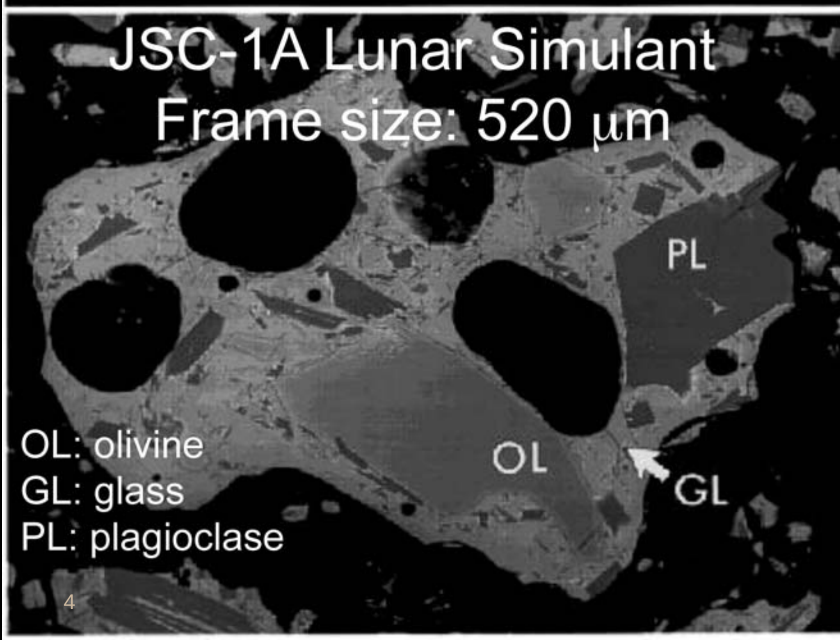


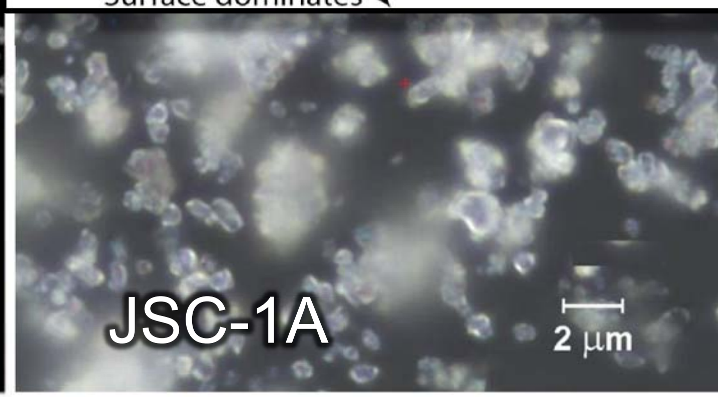
Importance of SURFACE AREA.





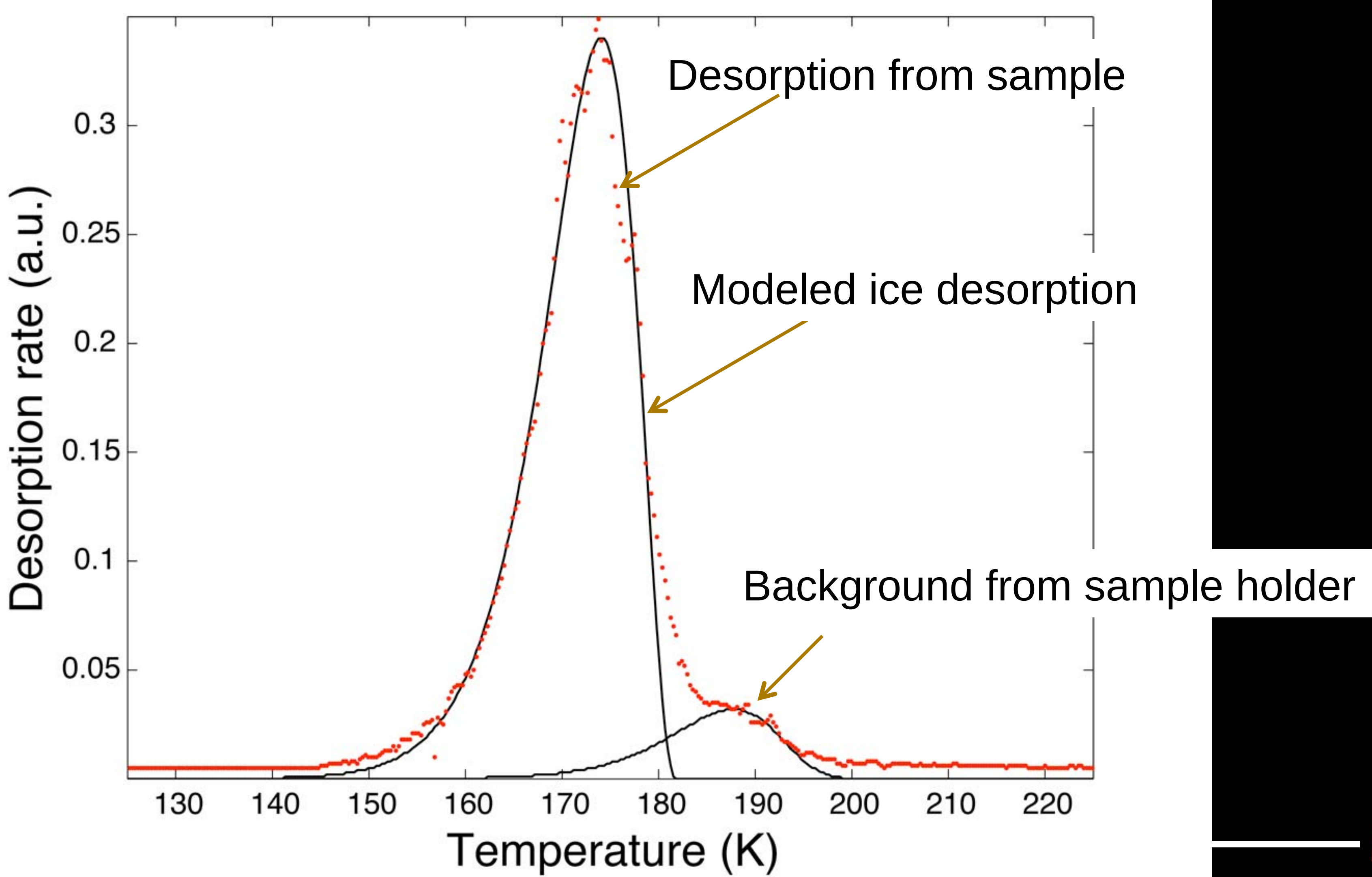






Surface Defects are important to adsorption

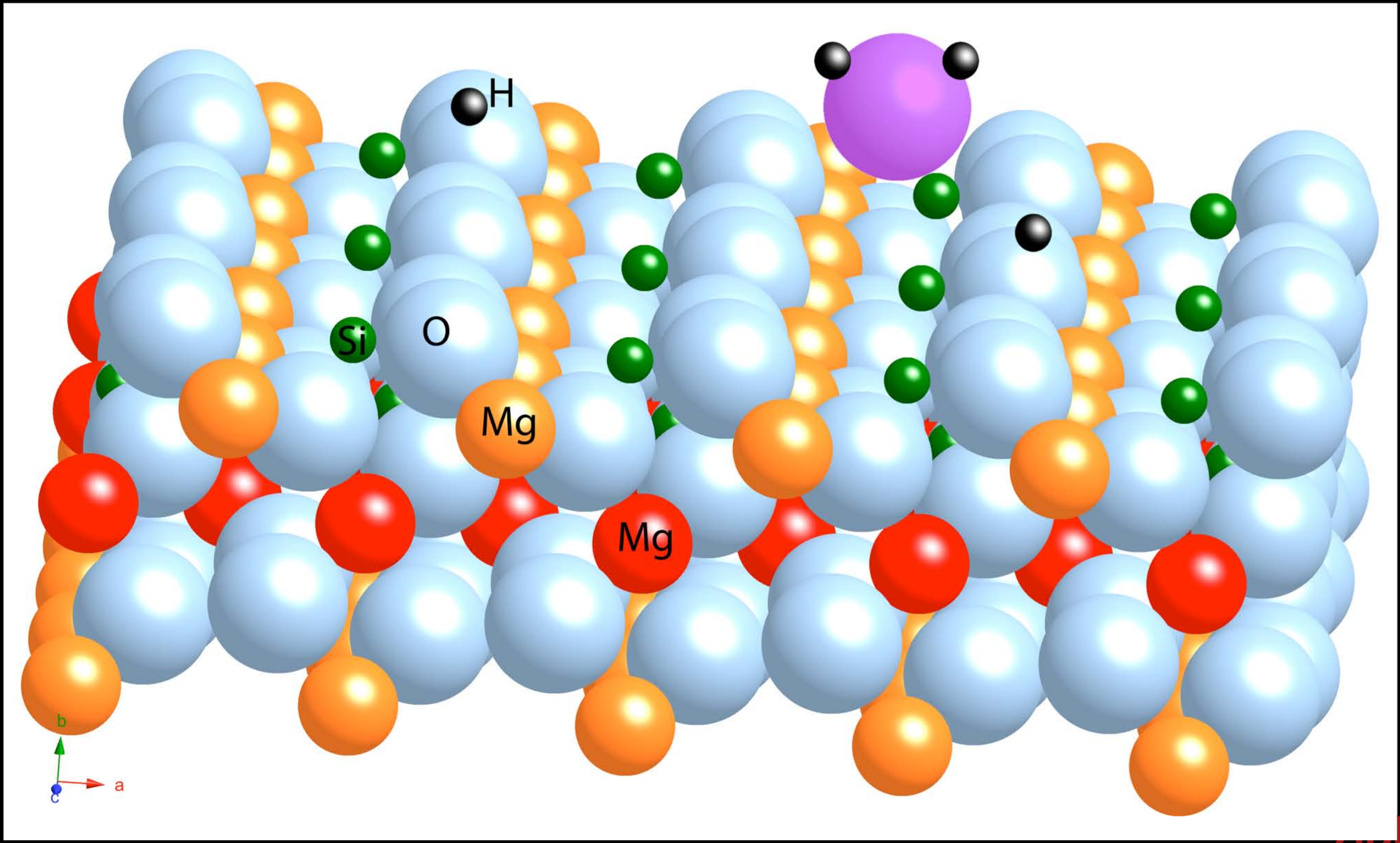
Fe-rich Anorthitic Lunar *GLASS analog* – *not adsorptive*



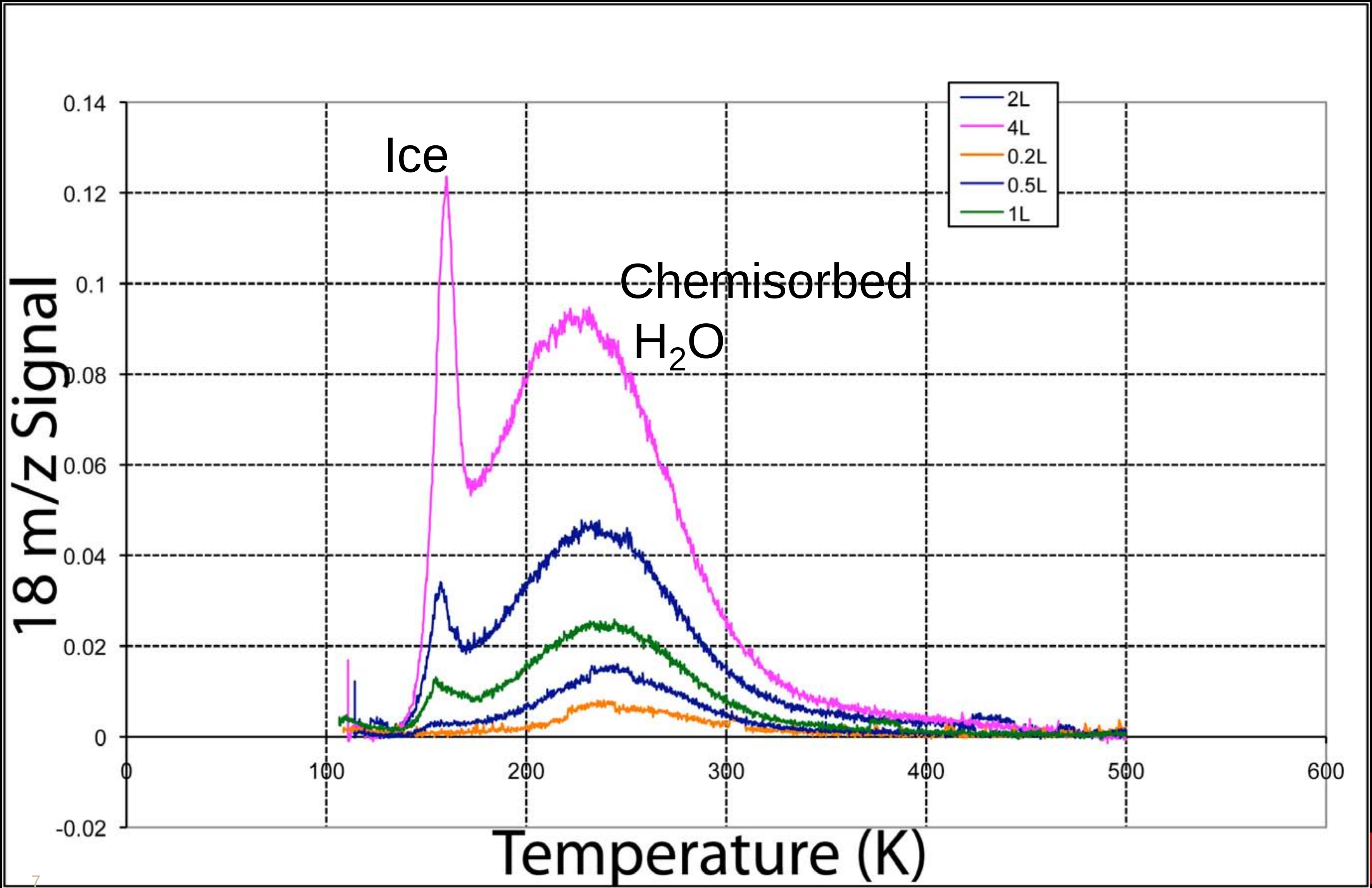
APL

Desorption of Water from Lunar mare analog JSC1A

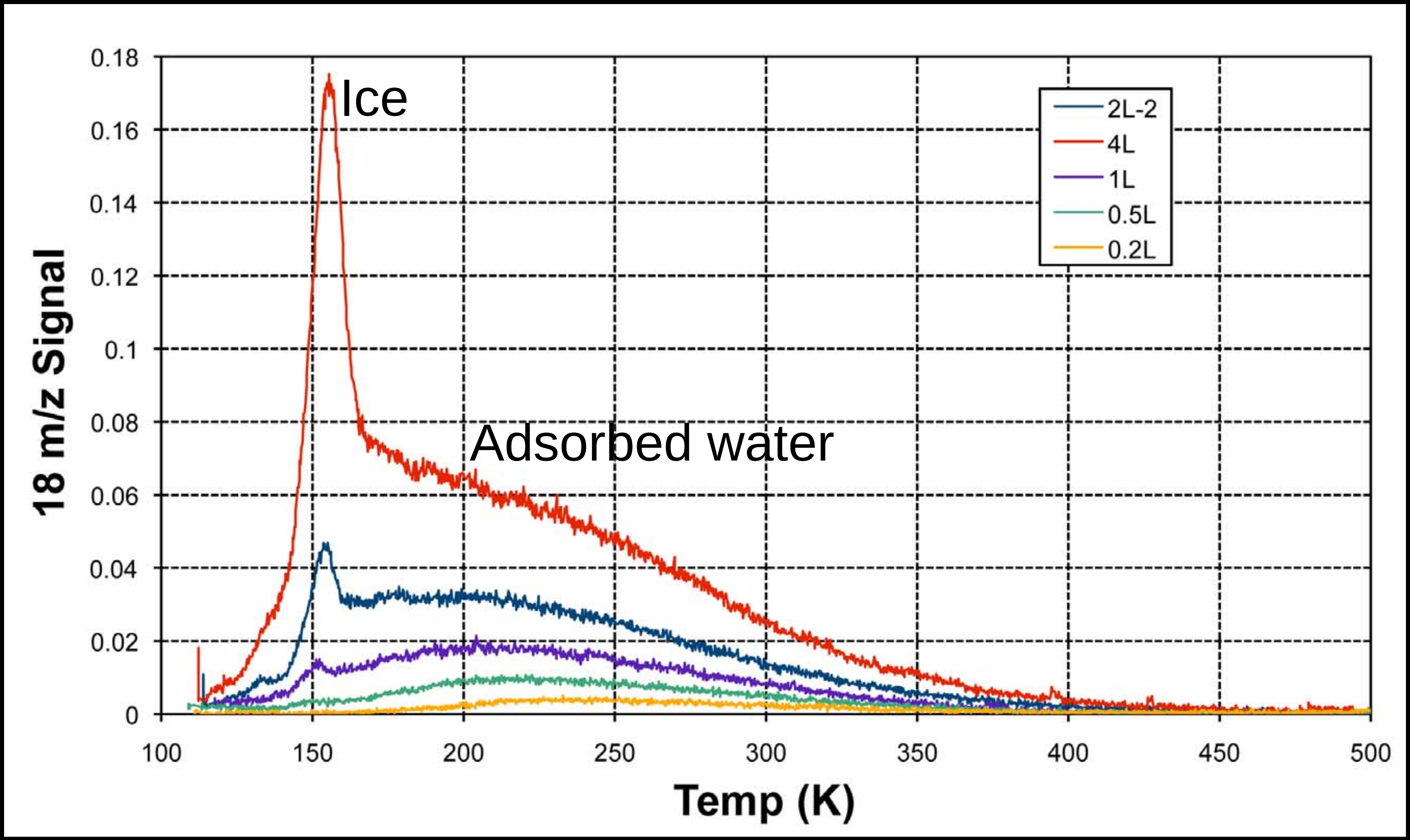
Olivine (010) cleavage showing adsorbed H and H_2O



Desorption of Water from Bancroft albite powder

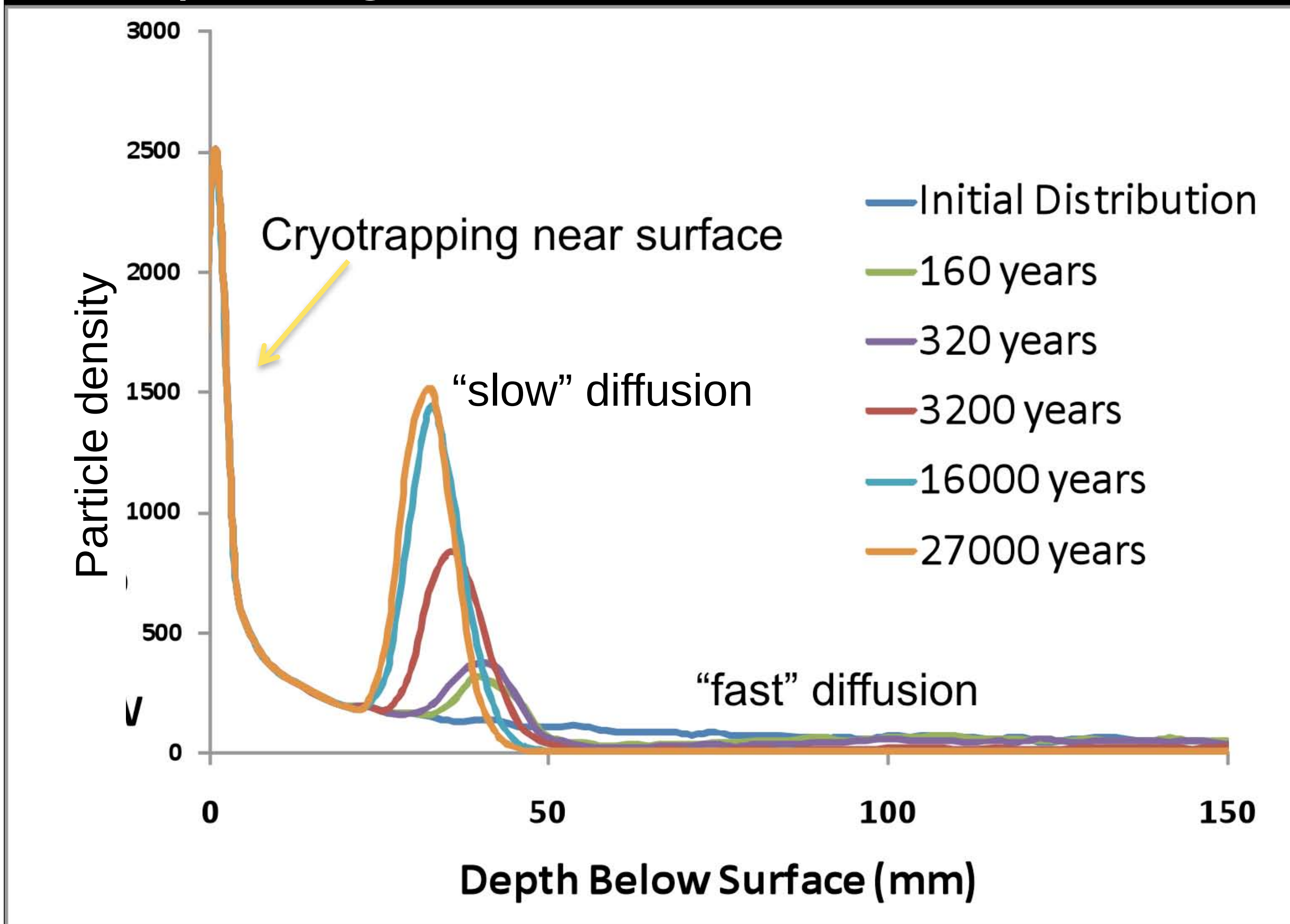


Desorption of Water from Lunar mare analog JSC1A



Mobility and Migration of Lunar Water

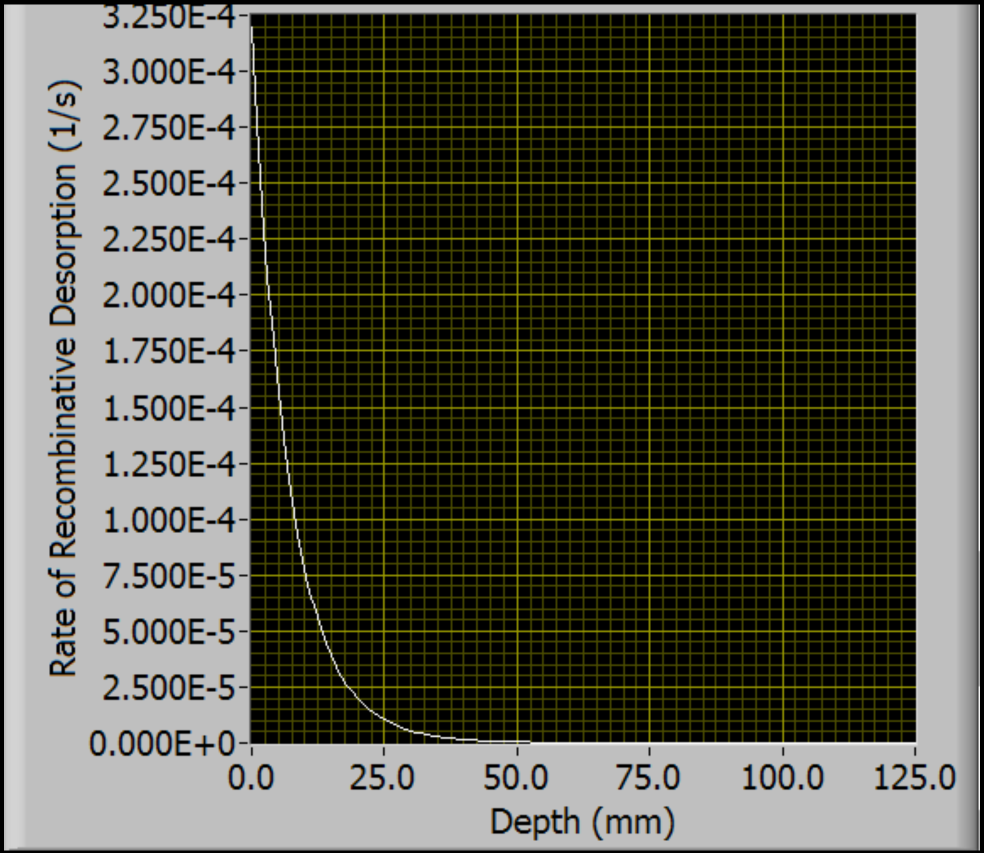
Example: Migration of subsurface water in PSR



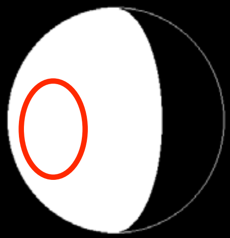
- Thermal migration only.
- Distances and rates qualitative.
- E_a = 60kJ/mole.
- Tsurf = 40K, Tsub=250K, $T=T_o\exp(-z/z_o)$
- Thermal conductivity $10^{-4} – 10^{-8}$

Mobility and Migration of Lunar Water

Example: Recombinative desorption of OH on illuminated Moon



- Activation energy for production of H_2O ~120 kJ/mol
- Surface Temperature 380 K
- Zone around subsolar point where RD occurs at a rate comparable to duration of illumination



New water molecules produced from RD near surface at a rate of 1 per hour to 100s of hours per surface site.

SUMMARY

1. Composition, crystallinity, temperature are important to adsorptivity and stability.
2. Glass (passivated) is hydrophobic. Native metal is expected to be hydroscopic. → agglutinates and mature soils should be less adsorptive than fresh surfaces.
3. JSC-1A is significantly less adsorptive than albite at least in part because of its large glass content.
4. Desorption of water is evident on both analogs up to ~ 400K. This is likely molecular desorption, not recombinative.
5. Migration of molecular water from depth toward surface should occur in subsurface in polar regions.
6. Migration into the surface (and desorpion loss) should occur for surficial water everywhere on illuminated surface. → subsurface cryotrapped layer.