Exploring the Role of Perchlorates in Supporting Liquid Water at the Mars Surface Today and Implications for Life

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Mars VS Earth

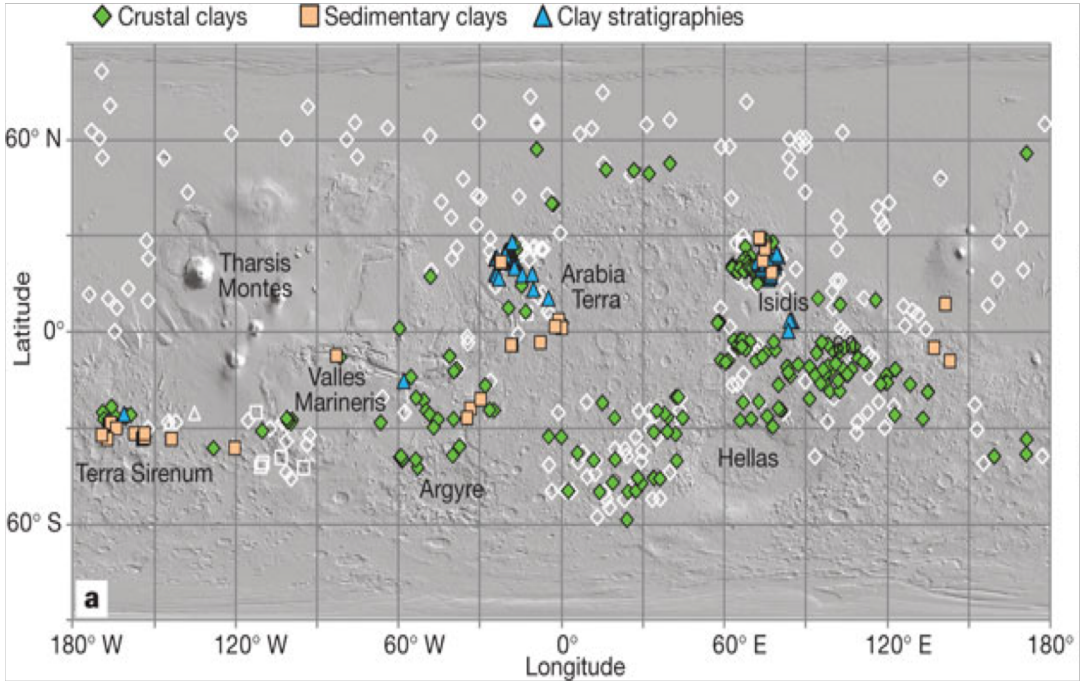
	Mars	Earth
Diameter:	4,222 miles	7,926 miles
Surface:	Rock and dust	70% of liquid water

Wet to Dry environment

more than 4.5 billion years

Why we suspect water was abundant on Mars

- The presence of Minerals that require liquid water to form



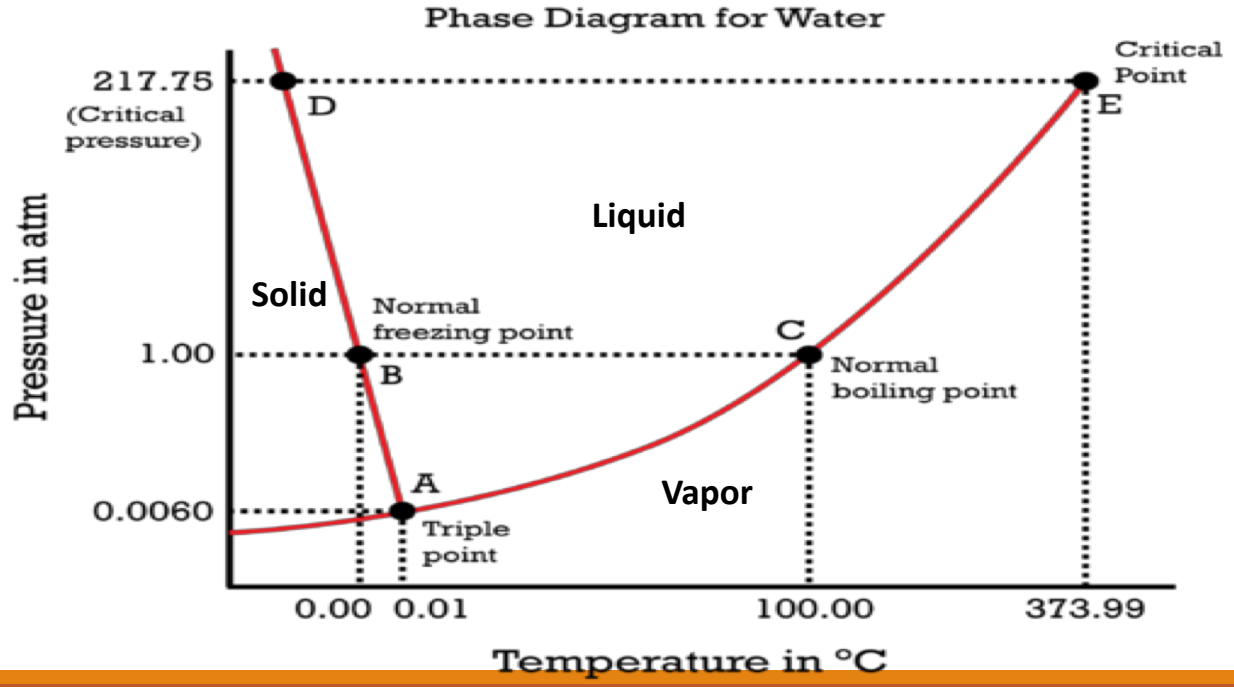
- Features on the surface including valleys carved by the flow of liquid water

Martian current atmospheric conditions

- Mars has a very **thin atmosphere** that consists mostly of carbon dioxide.

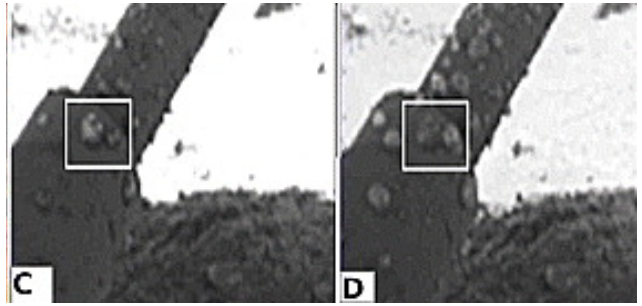
- The average atmospheric pressure on the Martian surface is around **0.006atm**

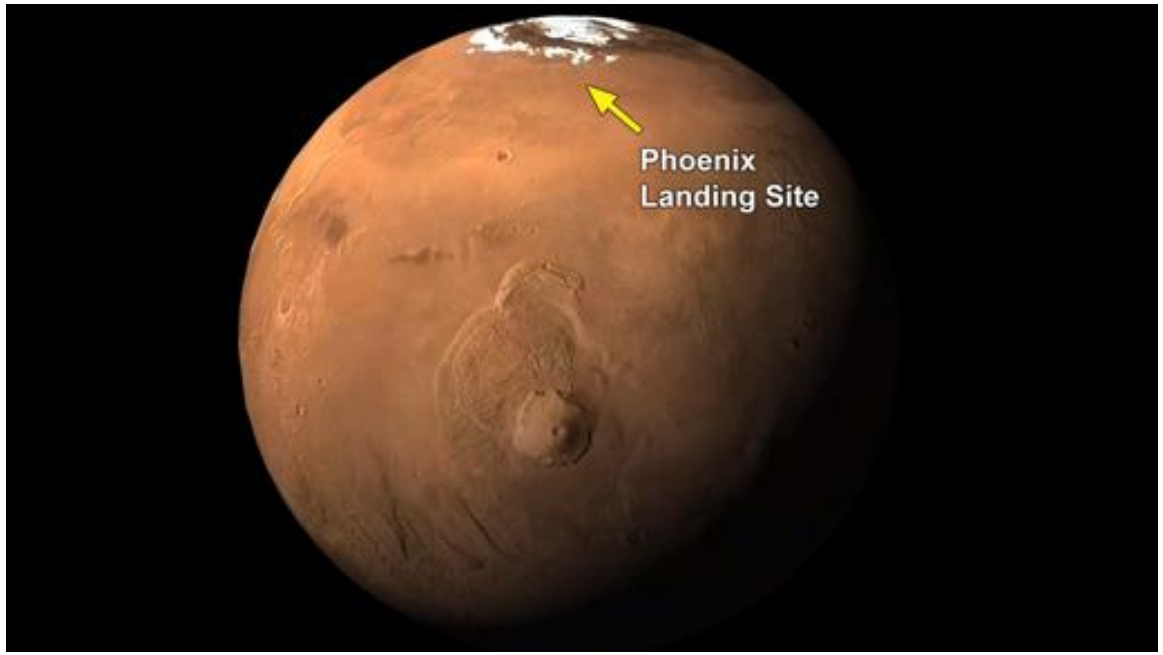
- Minimum Temperature: **-140°C** Maximum Temperature: **20°C** Average temperature: **-60°C**



Evidence for present-day liquid water

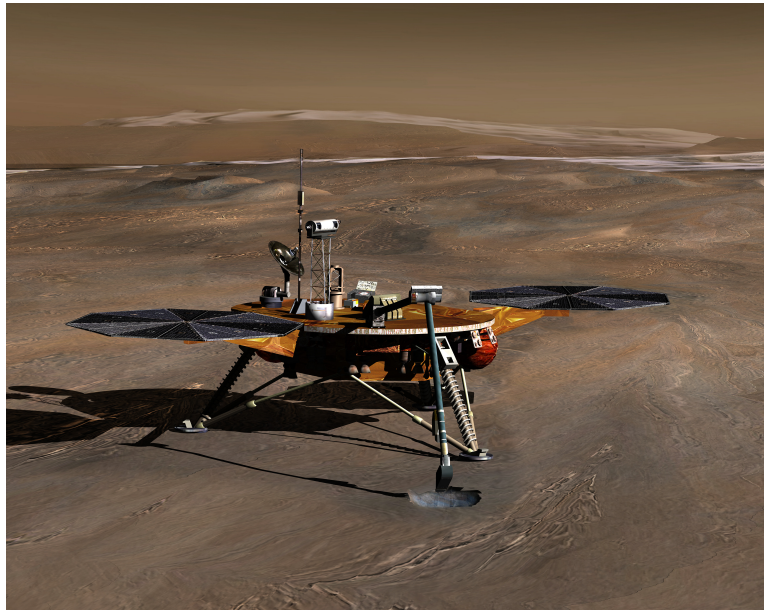
- Liquid water has been recently detected by the Phoenix lander at the Phoenix landing site near the northern polar cap.





Perchlorate salt

- Perchlorate salt consists of perchlorate ion (ClO_4^-) that is chemically bonded to cations including Na^+, Ca^{2+}, Mg^{2+}.
- The Wet Chemistry Laboratory onboard the phoenix lander detected 0.5wt% of perchlorate salt
- Perchlorate salt is found globally on mars since chlorine is abundant everywhere on Mars

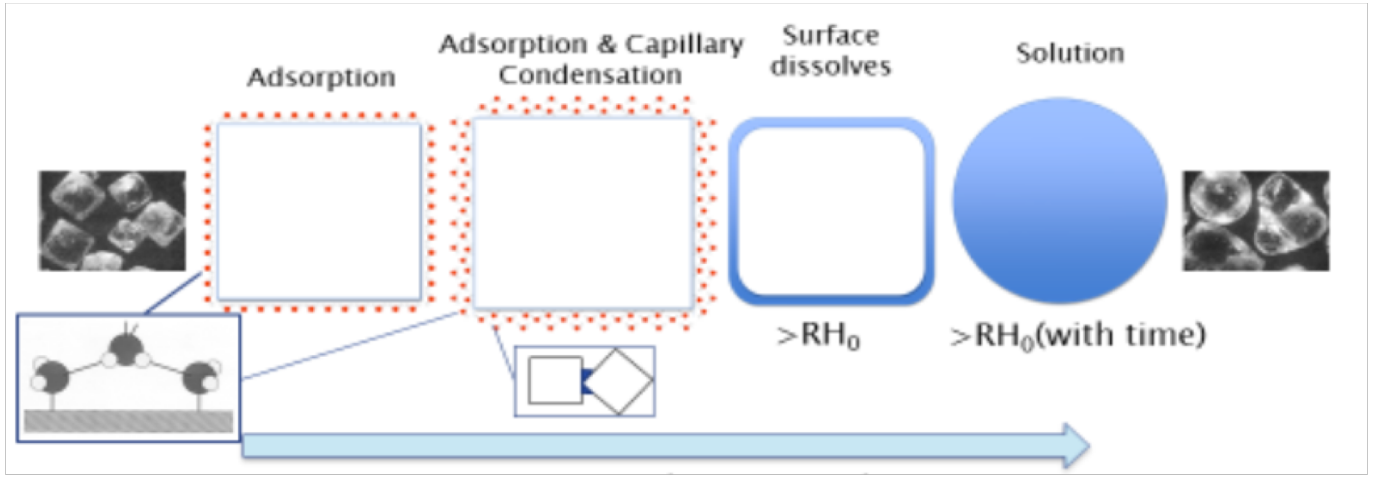


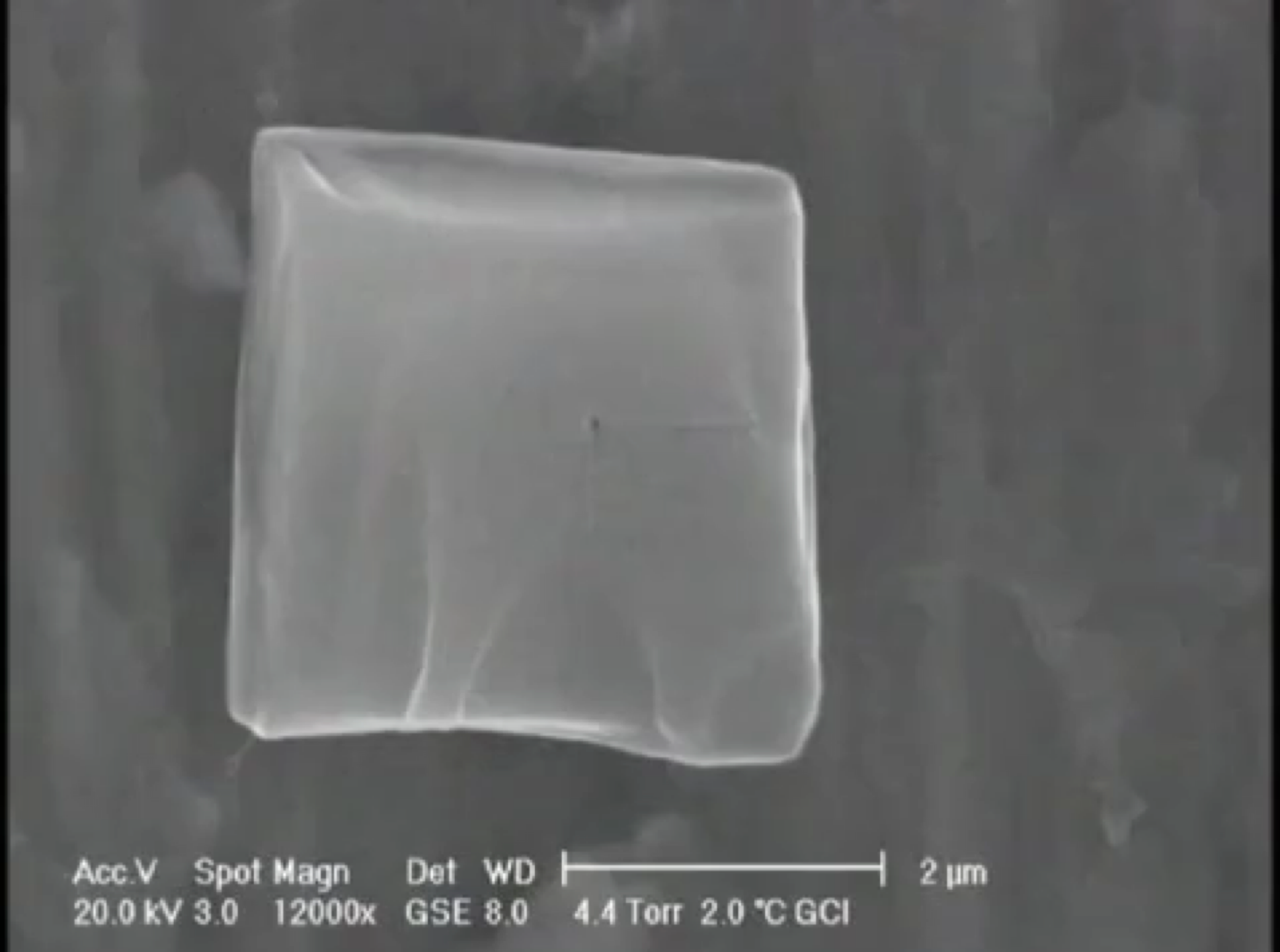
Deliquescence

- Perchlorate salt is highly deliquescent: a process where the salt has the ability of collecting the surrounding water vapor and dissolving into an aqueous solution

- The aqueous solution formed is liquid brine, which consist of 50% salt and 50% water by mass

- The salt within the aqueous solution lowers the freezing point of the solution far below the freezing point of pure liquid water



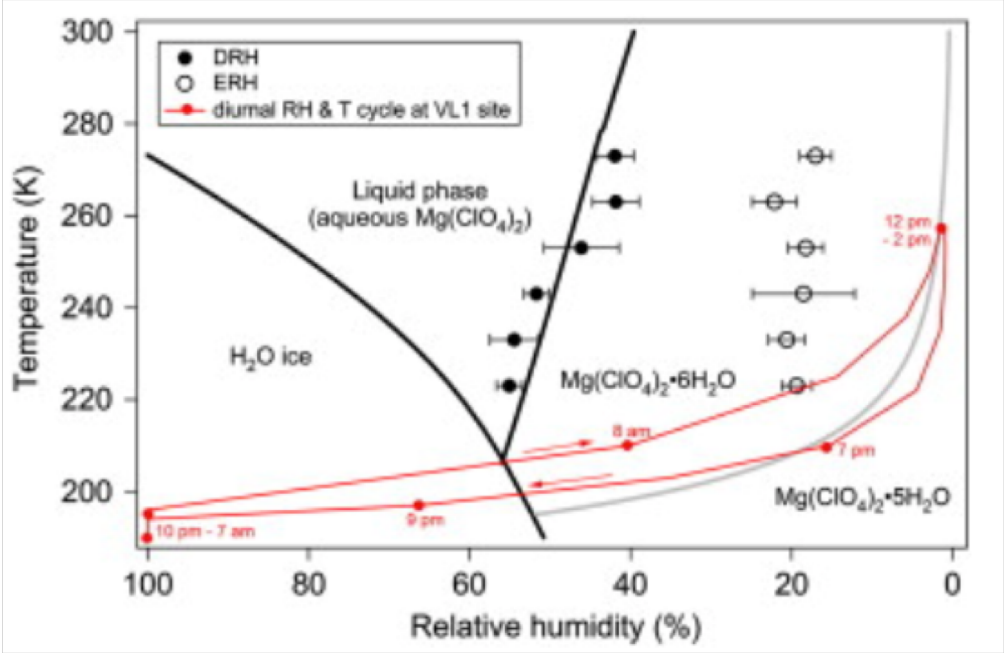

Acc.V Spot Magn Det WD
2 µm
20.0 kV 3.0 12000x GSE 8.0 4.4 Torr 2.0 °C GCI

Conditions required for the perchlorate to deliquesce

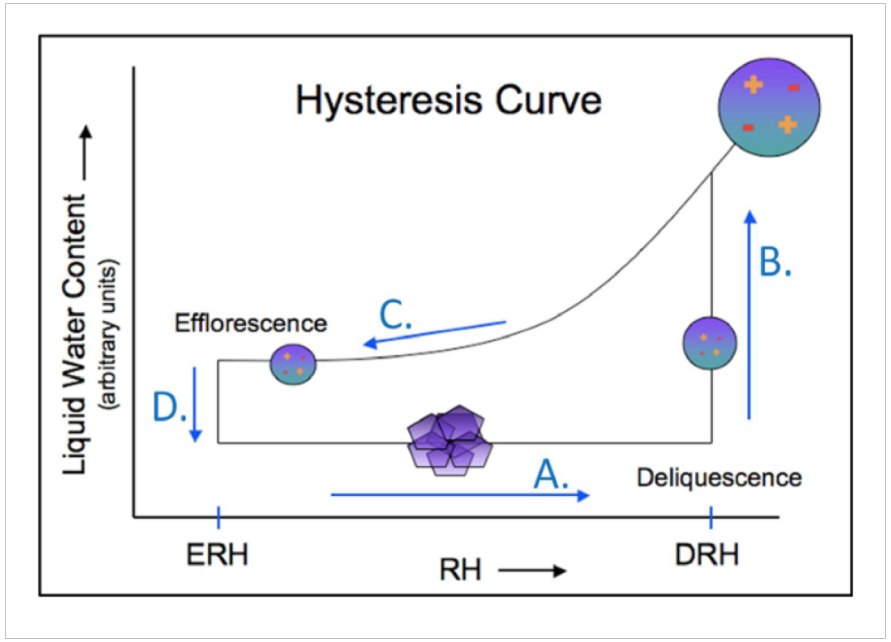
- The phase change between solid to liquid occurs at low temperature at the deliquescence relative humidity (DRH)

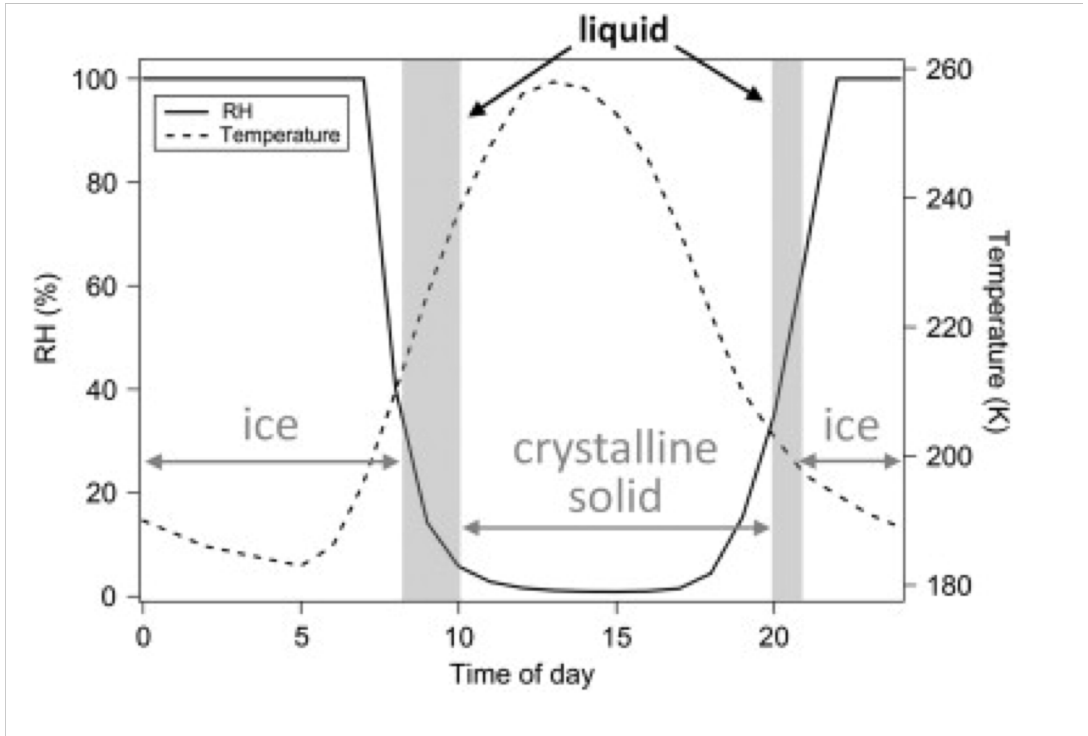
- The Efflorescence relative humidity (ERH) is the reverse of DRH, it is the process of crystallization of a salt.

- ERH is lower than the DRH



Metastable phase





Effects of liquid water on Mars

The presence of liquid water on the Martian surface has important implications for geochemistry, climate

It is also important for habitability because liquid water is a requirement for life

My focus

To determine whether the liquid water formed by perchlorate salt would be able to support support life on mars

Requirements for life on Mars

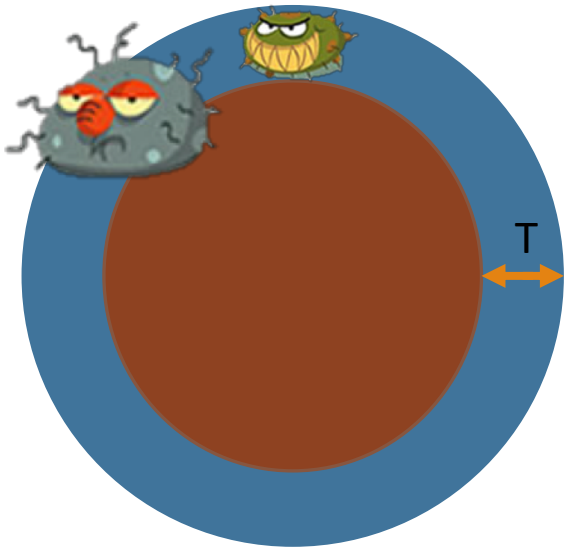
-Essential elements including oxygen, hydrogen, carbon

-Energy for metabolism for organisms to maintain life

-Liquid water

Is there enough water to support organism?

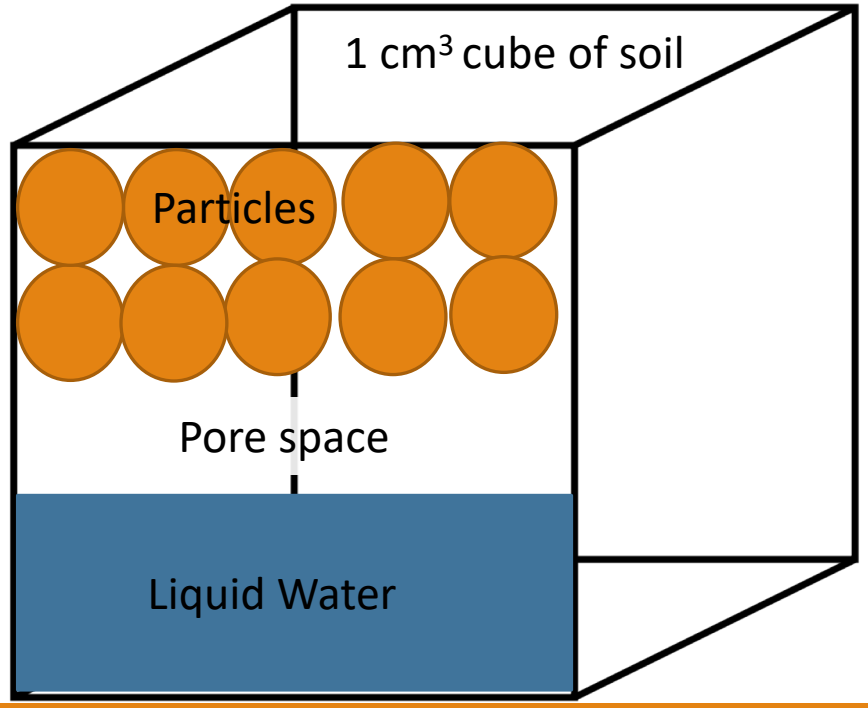
Determine the thickness of liquid water surrounding particle within the Martian soil and find out whether the smallest form of life will be able to reside within liquid water.



Known:

1wt% liquid water

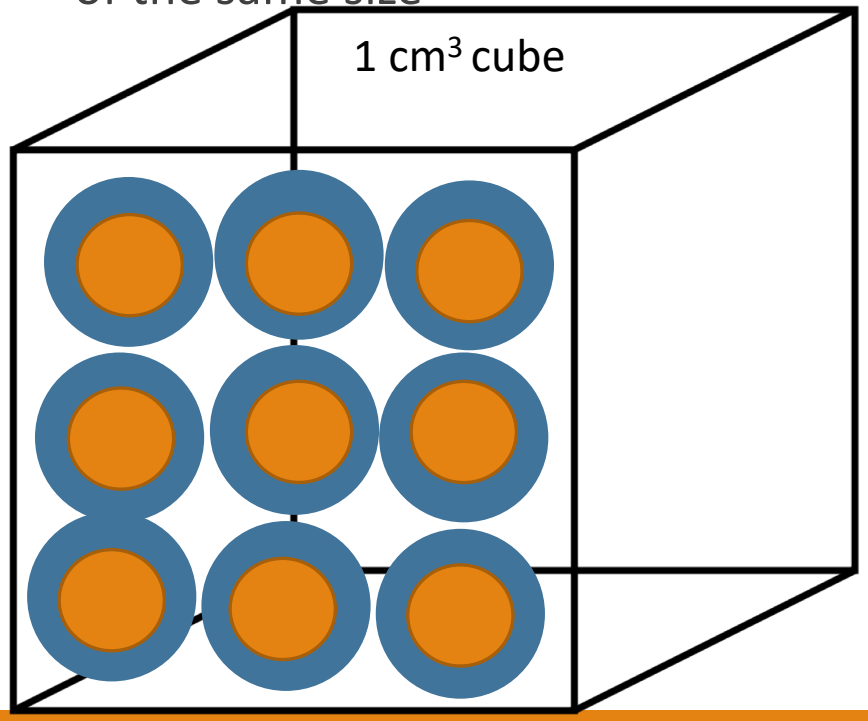
particle size: 10-1000µm



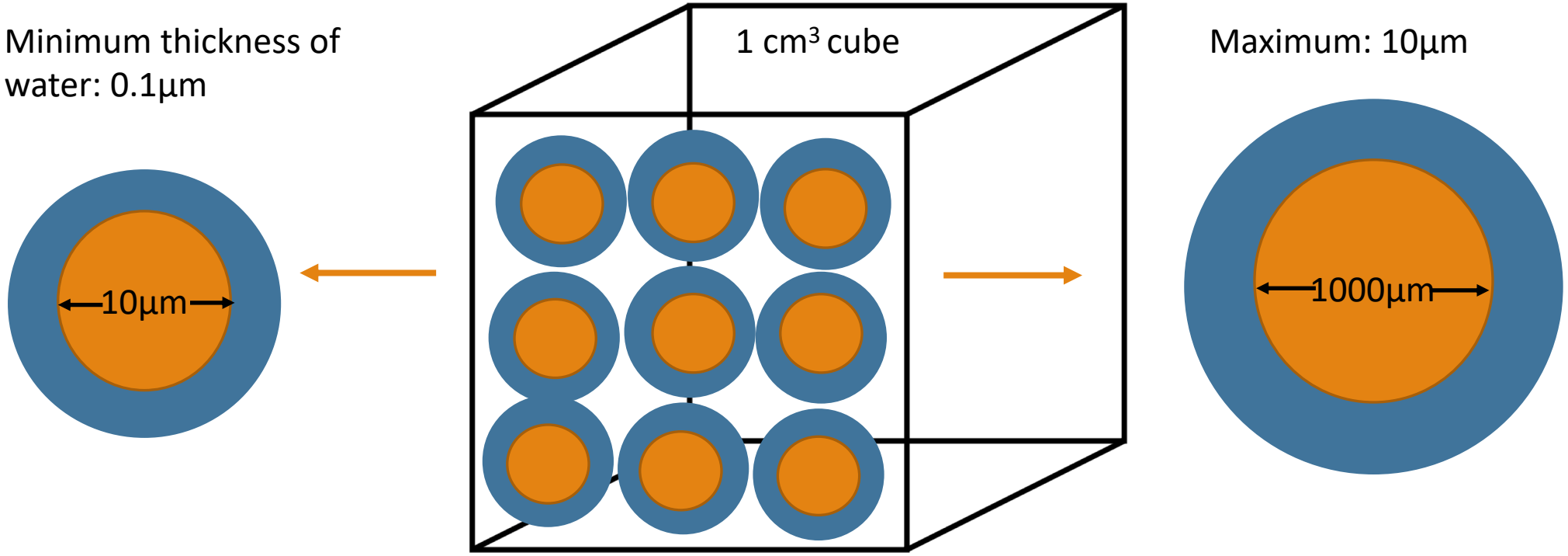
Assumptions:

Liquid water is equally distributed within particles in the soil.

The particles within the soil are all of the same size



Thickness of the water layer



Smallest form of life

Microorganism are living creatures that are unicellular in structure

They are extremely small, microscopic in size

The size of the smallest microorganism is around 0.1-0.6 microns

Conclusion

The water layer formed as perchlorate mineral deliquesce is thick enough that microbes will be able to reside within.

Since the smallest form of life on earth is around 0.1-0.6microns, then it is suspected that if microbes are present on Mars, they would be able to reside in the liquid water formed by perchlorate minerals.

Thank you