Astrobiology News June 2018:
Learning from Mars: Habitability Over Time

Some of you may have heard that NASA's Opportunity Mars Rover is once again battling a dust storm. Although initially envisioned to be a 90-day mission to investigate signs of a watery past on Mars, Opportunity has already lasted 14 years, so by any measure, it's been incredibly successful! Dust storms on Mars can attain very high wind speeds, but they don't pack much of a wallop, since Mars' atmosphere is so thin.[1] Nevertheless, the current storm is predicted to encircle the entire planet, and the dust has become quite thick over Endeavor Crater, where Opportunity resides. The rover has put itself into a low power mode, but should wake up again once it gets enough sunlight to charge its batteries.[2]

Whether or not Opportunity reassumes its normal operational mode, the Mars rovers have provided a wealth of evidence that water flowed on Mars' surface during the distant past. A recent paper explores how Mars may have evolved from a wet world to an arid one, and discusses how Mars' history might inform searches for habitable exoplanets.[3] Mounting evidence suggests that ancient Mars was not only wet, but may have had global oceans four billion years ago. So what happened to change this?

Although Mars has a very thin atmosphere today, it was once thick. The research team used sophisticated global 3D computer simulations to explore different types of atmospheric loss that would occur over time on a Mars-like world.[4] They found that the rate at which ions (charged particles) would have escaped from Mars' atmosphere was more than a hundred times higher four billion years ago, due to the young Sun's much more intense ultraviolet radiation and stronger solar wind, than today. This led to the loss of Mars' thick atmosphere early in its history, which in turn led to the loss of surface water.

These results have implications for Mars-sized rocky worlds orbiting other stars; in particular, the large number of rocky exoplanets expected to reside in the habitable zones (HZs) of M-dwarf stars. M-dwarfs are cooler and smaller than our Sun, so the HZs of M-dwarfs lie much closer to these stars than HZs around stars like the Sun. Exoplanets in the HZs

of M-dwarfs experience even more intense particle and radiation environments. Mars' history may provide important guidance for choosing exoplanets to study in the future.

Until next month,

Grace

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[1] Although a terrific movie, the scene with the dust storm in *The Martian* took a bit of poetic license…
[2] https://www.space.com/40881-monster-mars-dust-storm-opportunity-rover.html
[3] Dong, C. et al., 2018, *Modeling Martian Atmospheric Losses over Time: Implications for Exoplanetary Climate Evolution and Habitability*, The Astrophysical Journal Letters, 859, L14.
[4] See also https://aasnova.org/2018/05/30/marss-leaky-atmosphere-and-habitability/