

THE EVOLUTION OF VENUS AND THE VENUSIAN ATMOSPHERE

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BACKGROUND

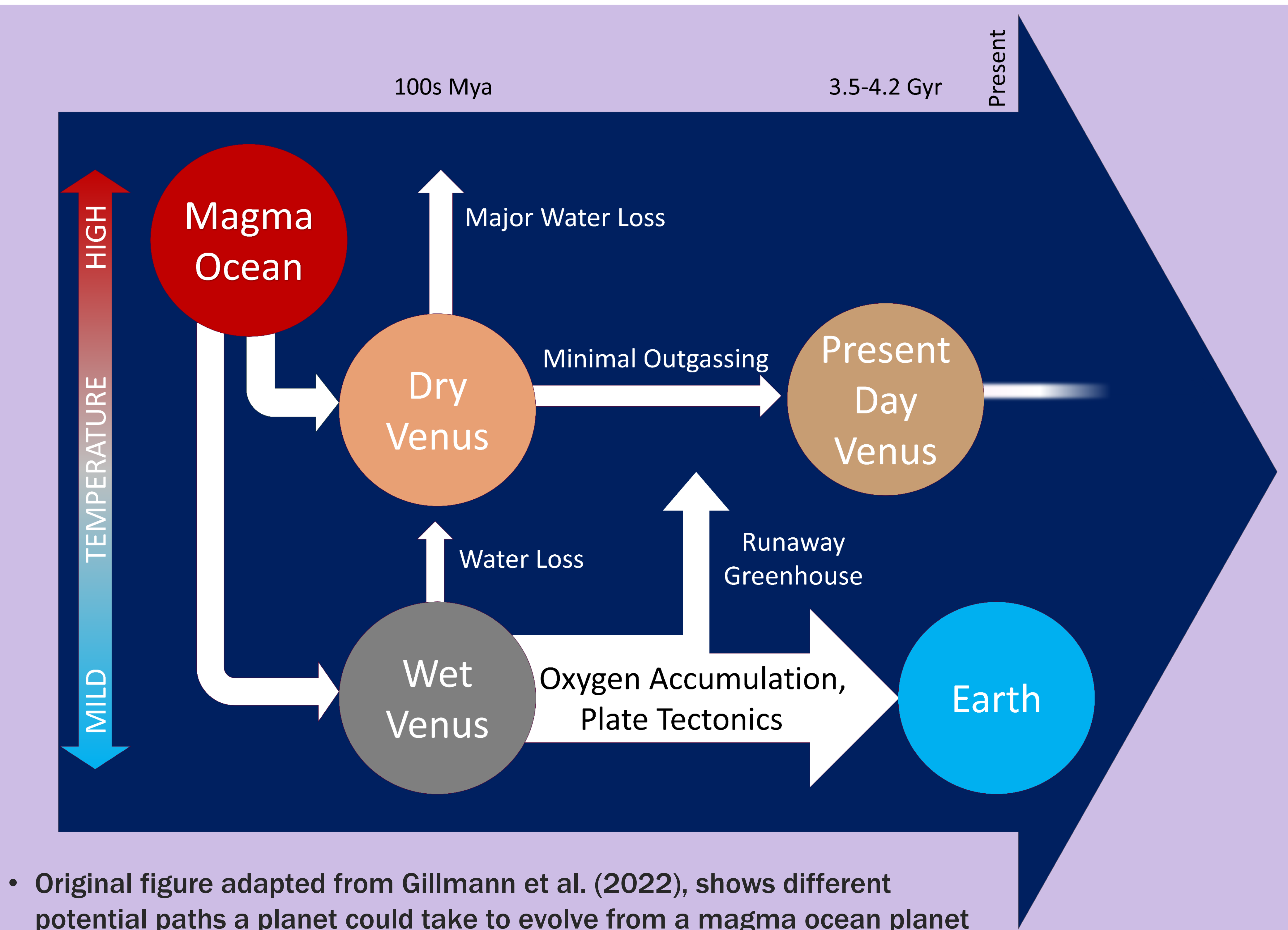
- Venus is the second closest planet to the Sun, often referred to as ‘Earth’s sister planet’ due to the similarities between the planets.
- Radius is 0.95 times the Earth radius
- Mass is 0.814 times the mass of Earth
- Density is 0.95 times the density of Earth

MISSIONS

- The first successful mission to another planet was the Mariner 2 mission to Venus, which observed an optically thick atmosphere with uniform temperatures across the whole planet
- Venera is a set of missions that discovered that carbon dioxide is the most abundant element in the atmosphere
- Magellan found that there is no evidence of tectonic plates on Venus

TECTONIC PLATES

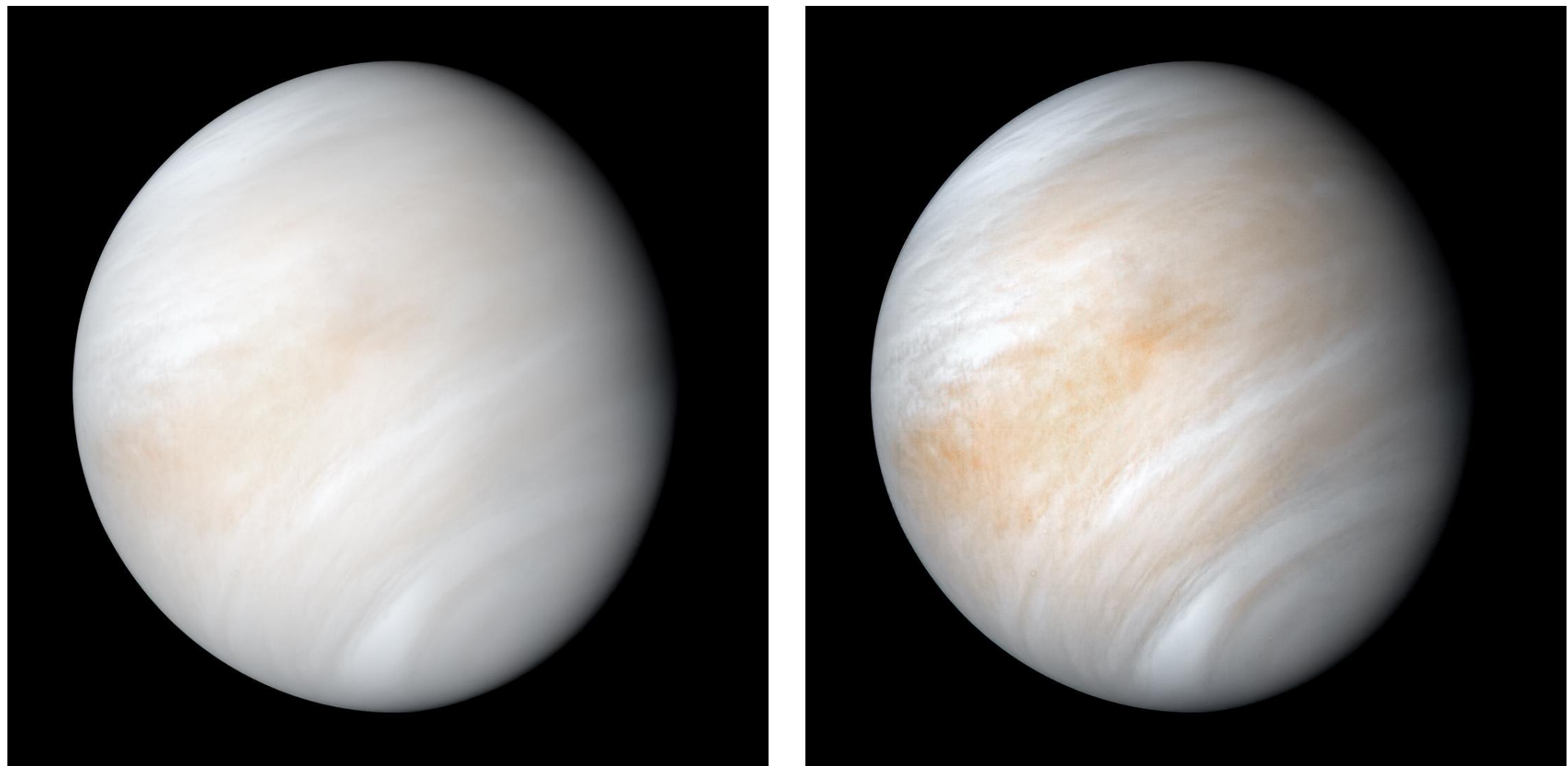
- Collisions on the surface of Venus may have broken the stagnant lid into plate tectonics, which could be an explanation for the fast rate of outgassing
- Outgassing can also occur without plate tectonics occurring where hot spots form and melt the crust of the stagnant lid



- Original figure adapted from Gillmann et al. (2022), shows different potential paths a planet could take to evolve from a magma ocean planet into either a Venus-like planet or into an Earth-like planet.

HABITABILITY

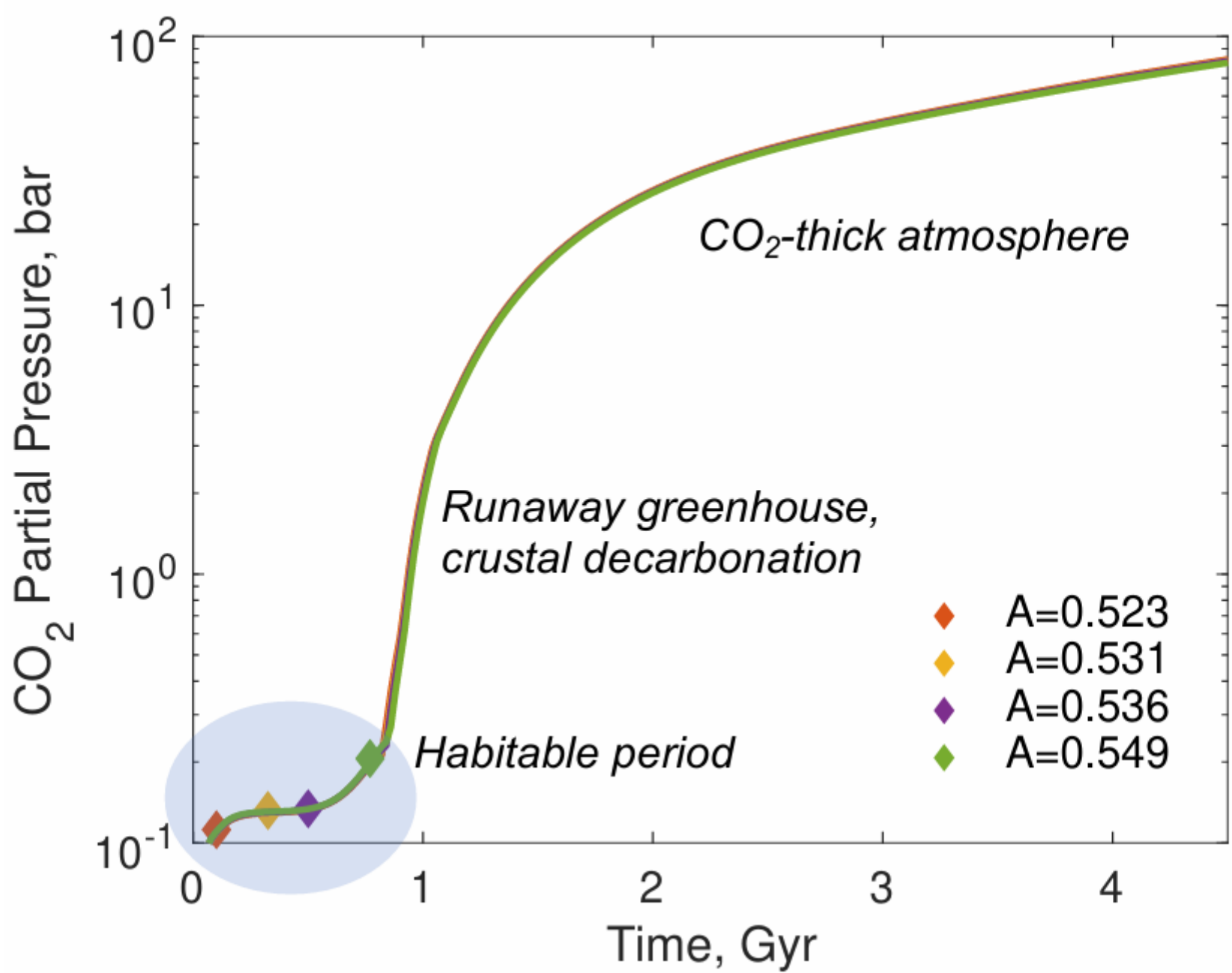
- From the high detected D/H ratio, it can be hypothesized that a large amount of water has evaporated out of the atmosphere, leaving more of the heavier isotopes of hydrogen behind to produce this ratio. The question remains of where this large amount of water came from.
- It has been theorized that the water came from possible oceans, and simulations have been run to determine in what conditions Venus could sustain liquid water, considering the faint young Sun problem.



Images of Venus taken from the NASA Mariner 10 mission, combining orange and UV filter images

GREENHOUSE EFFECT

- A runaway greenhouse effect occurs when water can’t condense to be liquid at the surface, and instead is all vapor in the atmosphere
- The greenhouse effect began due to trying to compensate for the Sun becoming more luminous
- Water vapor evaporates into the atmosphere, then the oxygen bonds with carbon to create a carbon dioxide rich atmosphere



From Gillmann et al. (2022), shows the habitability period and how the runaway greenhouse increased the carbon dioxide pressure in the atmosphere

References

Gillmann, C., Way, M. J., Avicé, G., et al. 2022, SSRv,218, 56, doi: 10.1007/s11214-022-00924-0
NASA/JPL-Caltech



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