GENERATION OF REDOX GRADIENTS IN MODERN MARS ENVIRONMENTS.

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Introduction: A rocky planet, from deep interior to atmosphere has the potential to generate essential nutrients and redox gradients critical for the emergence and the evolution of life. Here, we present preliminary results on two very different large-scale planetary processes that generate nutrients and redox gradients on Earth and Mars.

We specifically focus on the implications for life on modern Mars and potential changes in the last 20 Myr from a 3D time-dependent perspective - by studying the spatial and temporal evolution of oxygen- and hydrogen-rich planetary niches.

Methods: We use time-dependent geodynamic models, capable of computing the 3D temperature profile – self-consistently accounting for serpentinization and radiolysis reactions as a function of subsurface temperature, pressure, and chemistry – throughout the last 4.5 billion years (based on [1]-[4]).

Additionally, we couple a parameterized climate model, which computes the local average annual surface temperature and pressure varying with obliquity and has been gauged with the Mars Weather Research and Forecasting (MarsWRF) GCM. MarsWRF is a global model based on the terrestrial mesoscale WRF model (see [5]-[7]) and is a Mars-specific implementation of the PlanetWRF GCM [8].

Results: Geodynamic and climate models combined allow us to compute for Mars the time-dependent 3D distribution of 1) hydrogen-rich reducing subsurface environments, driven by serpentinization and radiolysis of water, and 2) oxygen-rich regions as a product of atmosphere-brine interactions governed by climate and surface chemistry. We will show spatial maps of such zones and results on their variability in the last 20 Myr and discuss implications for life, planetary protection, and landing site selection on Mars.

Summary: Our framework allows us to study the ability of planets to generate nutrient-rich and redox-rich regions as a function of planet mass, composition, age, and tectonic mode (plate tectonics versus stagnant lid). Here, we show 3D results for hydrogen- and oxygen-rich environemnets throughout the last 20 Myr for Mars and discuss how our model can become a promising tool to help guide future landing site selections and manned missions that are looking for resources on the red planet.

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