EPSC Abstracts
Vol. 15, EPSC2021-131, 2021
https://doi.org/10.5194/epsc2021-131
Europlanet Science Congress 2021

Redox hysteresis of super-Earth exoplanets from magma ocean circulation

Tim Lichtenberg
Atmospheric, Oceanic and Planetary Physics, University of Oxford, Oxford, United Kingdom (tim.lichtenberg@physics.ox.ac.uk)

Internal redox reactions may irreversibly alter the mantle composition and volatile inventory of terrestrial and super-Earth exoplanets and affect the prospects for atmospheric observations. The global efficacy of these mechanisms, however, hinges on the transfer of reduced iron from the molten silicate mantle to the metal core. Scaling analysis indicates that turbulent diffusion in the internal magma oceans of sub- Neptunes can kinetically entrain liquid iron droplets and quench core formation. This suggests that the chemical equilibration between core, mantle, and atmosphere may be energetically limited by convective overturn in the magma flow. Hence, molten super-Earths possibly retain a compositional memory of their accretion path. Redox control by magma ocean circulation is positively correlated with planetary heat flow, internal gravity, and planet size. The presence and speciation of remanent atmospheres, surface mineralogy, and core mass fraction of atmosphere-stripped exoplanets may thus constrain magma ocean dynamics.