Solubility of Lava Planets in Steam Atmospheres

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All major rock-forming cations (e.g., Si, Mg, Fe, Ca, Al, Na, K) form volatile hydroxide gases. At high temperatures expected for steam atmospheres on the early Earth and hot rocky exoplanets, chemical equilibrium models predict rocky elements partition into atmospheres as hydroxide gases in larger amounts than expected from their volatility over molten lavas [1,2]. Silicon and $Si(OH)_4$ gas exemplify this behavior. Using data from [3,4] models of the reaction SiO_2 (melt) + $2H_2O$ (gas) = $Si(OH)_4$ (gas) predict $Si(OH)_4$ partial P ~ 0.034 bar at 1873 K in 100 bar H_2O – CO_2 as expected for Earth-like exoplanets [2]. This is ~ 10,000 times larger than expected from vaporization of Si from lavas. I discuss results of atmospheric chemistry models for lava planets with steam atmospheres. The results predict spectroscopically obervable gases on these planets and are also useful for modeling steam atmosphere chemistry on the early Earth.

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