The relationship between mantle petrology and the geochemistry of planetary atmospheric nitrogen

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Understanding the chemical evolution of Earth's atmosphere and hydrosphere is important, especially with regard to the history of the buzzword-elements (e.g. COHNS). A major process in forming planetary atmospheres is mantle degassing via volcanism and the primary control on what elements are degassed by this process is their compatibility in mantle minerals relative to melts and fluids. However, because subduction happens on Earth, it is also necessary to trace the partitioning of volatiles through subduction systems over geological time to understand the long-term evolution of the Earth's atmosphere. We present theoretical predictions constraining the aqueous speciation of nitrogen, a governing factor for partitioning, to explain how subduction zones have pumped nitrogen out of Earth's mantle through the oxidation of ammonium[1]. Overall, these results suggest that the development of the unique nature of Earth's habitable outer layer has been strongly influenced by subduction-zone plate tectonics. In contrast, the atmospheres, and potentially the habitabilities, of Venus and Mars have evolved along different paths through geologic time because they lack plate tectonics.

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