Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.20382

In and Out – Venusian atmospheric chlorine abundance provides evidence of extensive in-gassing.

RICHARD W THOMAS[1], JON WADE[1], BRENDAN DYCK[2] AND BERNARD J WOOD[1]

[1]University of Oxford

[2]University of British Columbia Okanagan

Presenting Author: Richard.thomas@earth.ox.ac.uk

Venus is now inhospitable, and its geological history remains shrouded by its hot, dense atmosphere. However, this may not have always been the case and Venus may have once been more Earth-like and perhaps even habitable[1]. Although there is little data on the planet's surface and atmospheric compositions, what is available from the pioneering landers of the Venera (1970-81) and Vega (1985-85) missions and subsequent observations of the atmosphere pose many questions. One long-standing enigma is the fate of Venusian chlorine. On Earth, chlorine is concentrated in the Earth's oceans, which contain around 1.9% chlorine by weight. The concentration of terrestrial chlorine in seawater is a consequence of efficient planetary outgassing, a mechanism supported by our atmosphere's nitrogen and noble gas composition. This planetary scale outgassing of the mantle resulted in >90% of Earth's entire chlorine budget being present on the terrestrial surface. The nitrogen composition of the Venusian atmosphere supports the hypothesis that Venus has also witnessed a similar degree of mantle outgassing to the Earth. However, unlike Earth, chlorine now appears to be almost entirely absent from the Venusian atmosphere. If, as the composition of the Venusian atmosphere suggests, chlorine did out-gas from the Venusian mantle, why is it absent from the present-day surface? Recent work has shown that, contrary to long-held beliefs, chlorine is highly soluble in silicate melts, which suggests its loss from the Venusian surface may be a consequence of the extensive volcanism seen on Venus and the production of low-degree, alkali-rich melts. Given the physical conditions of the Venusian atmosphere/surface interface, we show that the sequestration of chlorine into erupted silicate melts would be efficient. On cooling, such melts will crystalise halide-bearing minerals (e.g. sodalite, apatite) with melt compositions consistent with *in-situ* Venera measurements, and suggestions of active rifting and a putative Venusian geotherm.