



HCl in the atmosphere of Mars: chlorine isotopic ratio

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The ExoMars Trace Gas Orbiter (TGO) mission had started regular measurements in 2018. Primary goal of the mission is to quantify trace gases that could indicate geologic or biogenic activity on Mars (Vago et al., 2015). Atmospheric Chemistry Suite mid-infrared channel (ACS MIR) is a high resolution cross-dispersion spectrometer operating in solar occultation mode (Korablev et al., 2018). It was designed to make the most sensitive measurements of the atmosphere to date. During each occultation up to 20 diffraction orders are simultaneously recorded at different tangent altitudes. In 2020 ACS MIR reports the discovery of the gaseous hydrogen chloride (HCl). Absorption features are present in several consecutive diffraction orders, with both isotopes H^{37}Cl and H^{35}Cl are clearly observed. HCl was observed by ACS simultaneously in both hemispheres after the main phase of the global dust storm. Though the formation mechanism is not fully clear, we believe that the presence of HCl is associated with the lifted dust and chlorine component in it.

On Earth, in general, the chlorine isotope variations in nature are relatively small, ranging from ~ -2 to $+2$ ‰. However, large variations are observed, e.g. in extraterrestrial materials and volcanic gases, due to kinetic fractionation. On Mars Farley et al. (2016) reported a range from -1 ‰ to -51 ‰ (5% reduction) for the $\delta^{37}\text{Cl}$ in the samples drilled in the Gale Crater. ACS observations demonstrate enrichment of the ^{37}Cl up to $+250$ ‰ on average in the atmospheric gaseous. In principle, most atmospheric elements on Mars have heavy isotope enrichments due to preferential loss of the light isotope to space (e.g. Vandaele et al., 2019). Early hydrodynamic escape during intense extreme ultraviolet radiation followed by prolonged atmospheric 'erosion' explains the heavy isotope enrichment. Chlorine loss, as HCl, would raise the $\delta^{37}\text{Cl}$ value of the residual materials, involved in the dust-atmospheric exchange cycle.

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