Search for important minor gases in Martian atmosphere

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Search for ethane (C_2H_6)

Olivine hydration in the Martian regolith and crust may be a source of methane. Methane production is kinetically and thermodynamically favored during low-T aqueous alteration of olivine-rich rocks (C. Oze and M. Sharma, 2005). The H_2(aq) produced in serpentinization process is key to the formation of methane by the hydrogeochemical process. H_2(aq) reacts with carbon grains or CO_2 of the crustal rocks/pores to produce methane and higher order hydrocarbons in decreasing abundances (S. Atreya et al., PSS 55, 2007):

$$CO_{2(aq)} + [2 + (m/2n)]H_{2(aq)} \rightarrow (1/n)\, C_n\, H_m + 2H_2O$$

Therefore, ethane (C_2H_6) could be one of the product of serpentinization other than methane. This gas has a band around a wave-number of 2977 cm^{-1}, as shown in Figure 1. The line intensities are taken from Hitran (2004).

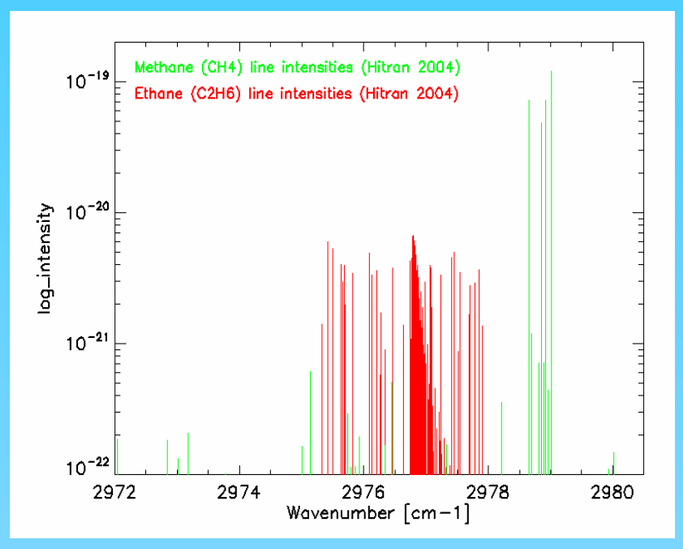


Fig. 1. Hitran (2004) line intensities for methane (in green) and for ethane (in red).

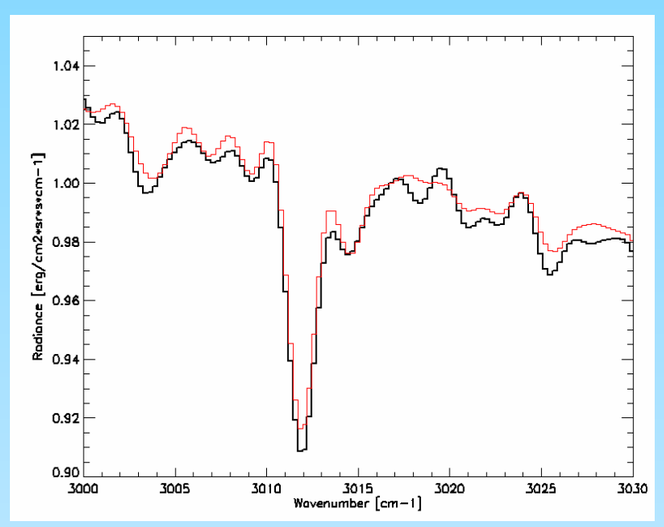


Fig. 2. Two observed spectra in the spectral range where methane has a strong absorption band at 3018 cm^{-1}.

We compare two spectra, shown in Figure 2, obtained using the spectrometer PFS on board MeX.
The black curve is obtained as average of 2181 spectra taken during winter at latitude range [10,50] and longitude range [80,120]. The methane column density is (8.97±0.39)e15/cm^2 as measured using the line depth at 3018 cm^{-1}.
The red curve is an average of 2886 spectra taken during winter at latitude range [-30,30] and longitude range [0,20]. The methane column density is (0.30±0.22)e15/cm^2.
The serpentinization could produce also ethane (C_2H_6).
Therefore, we compare the observed spectra with synthetic spectra. The green curve in Figure 3 is a synthetic spectrum which contains CO_2, water vapour, CO, and CH_4. The violet curve includes also ethane (C_2H_6). The absorption due to ethane is evident in the violet synthetic spectrum, but it is absent in the observed spectrum.

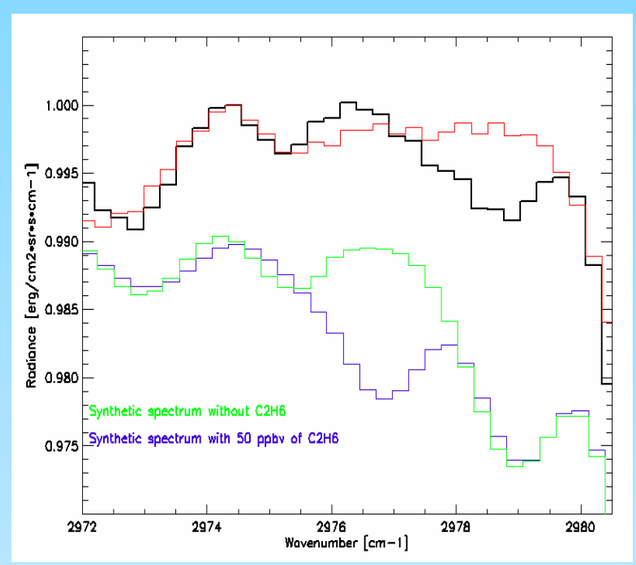


Fig. 3. The observed and computed spectra are shown in a spectral range where ethane has a strong absorption.

Search for methanol (CH_3OH)

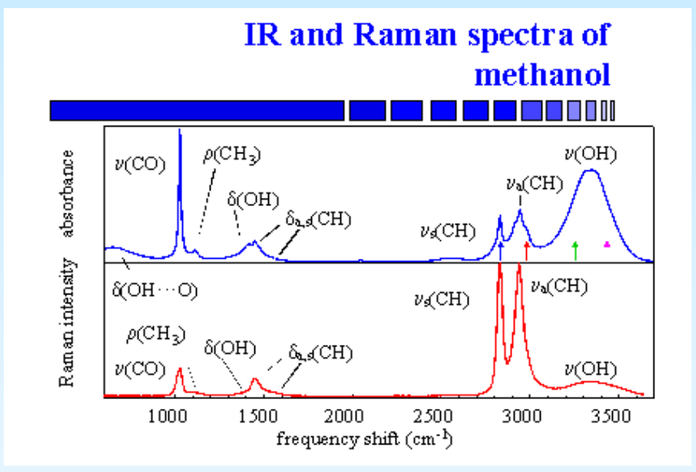


Fig. 4. Methanol spectra.

The Martian atmosphere is highly oxidizer, therefore we search for the gas which are produced from the oxidation of methane. Among them there is the methanol. Its spectrum is shown in Figure 4.
Every PFS spectrum shows the methanol ice features as shown in Figure 5 (the black curve is the observed spectrum and the red one is the synthetic spectrum), but it is due to mirror contamination: methanol was used to clean some parts in the laboratory when assembling the experiment.

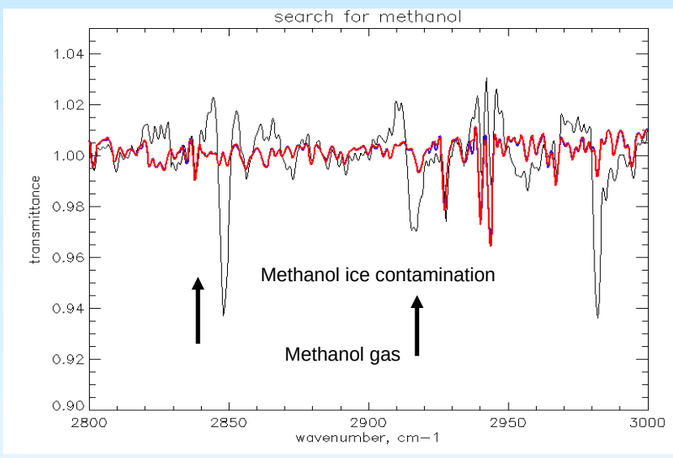
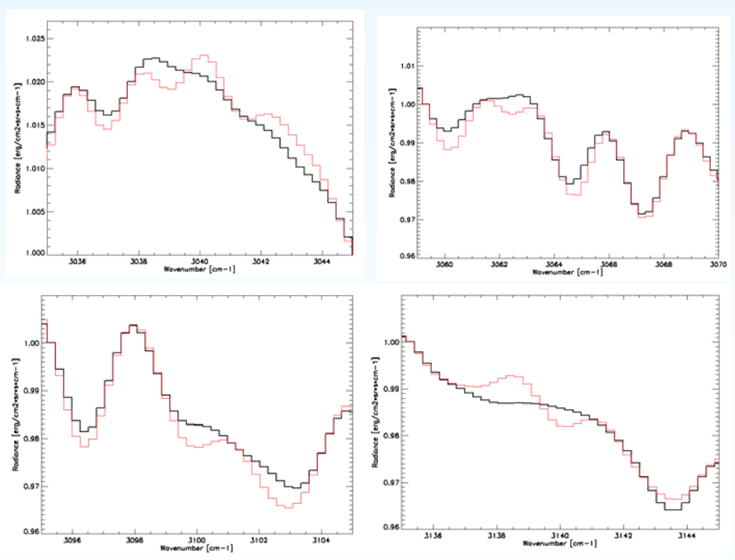


Fig. 5. The observed spectrum (in black) shows the methanol ice features due to mirror contamination. The red spectrum is the synthetic spectrum.

Future work



Differences between spectra with high methane value and the ones with a low value of methane can reveal the presence of other gases produced by methane oxidation or by interaction between methane and other gases present in the atmosphere. For example, it will be very interesting to study the role of perchlorates (found by Phoenix mission recently on Mars) on the minor gases in the Martian atmosphere. Our work will continue in this direction in order to understand not only the production mechanism of methane but also possible chemical interactions of methane with other gases in the atmosphere.

Figure 6. Four spectral range where we see differences between a spectrum with high methane value (in black) and a spectrum with low methane value (in red).

Bibliography
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S. K. Atreya, P. R. Mahaffy and A. Wong, Planetary and Space Science, Volume 55, Issue 3, p. 358-369