Incorporation of argon, krypton and xenon into clathrates on Mars

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The existence of clathrate hydrates on Mars could be a substantial factor in the distribution and total inventory of that planet's volatiles. However, the thermodynamic stability field of clathrates is such that conditions on Mars are tantalizingly close to the stability boundary (Longhi, 2006), so it is difficult to assess whether clathrates are abundant, nonexistent, or something in between. Hence it is important to determine what their effects on the Martian surface and atmospheric composition might be, in part to find ways to test for their presence.

Thomas et al. (2009) presented calculations characterizing the composition of clathrates potentially formed at the Martian atmosphere-surface interface. We expanded these calculations to include the important trace noble gases krypton and xenon (Swindle et al., 2009). These calculations show that a substantial fraction of the Martian Xe, perhaps even the vast majority, could be in clathrates. In addition, the Xe/Kr ratio in the clathrates would be much higher than in the atmosphere, so the formation or dissociation of a relatively small amount of clathrate could measurably change the atmospheric ratio. Relatively crude (factor of 2) measurements of the seasonal variability in that ratio by in situ spacecraft would be sensitive to ~10% of the seasonal atmospheric CO_2 variability being a result of clathrates, rather than pure CO_2 frost. The Mars Science Laboratory should be capable of analytical precision considerably better than that.

In addition, sequestration of Xe in clathrates remains a viable mechanism for explaining the variable Xe/Kr ratios seen in different suites of Martian meteorites. This could be the result either of long-term climatic changes or something as simple as a seasonal variation coupled with launches of different meteorites at different times of year.

References

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