CO_2 Storage in Novel CO_2-H_2O Phases at High Pressure

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Importance

- Atmospheric CO_2
- Climate change
- Mitigate further damage to environment
- Proposed alternative methods
  - Oceanic
  - Underground
  - Geologic

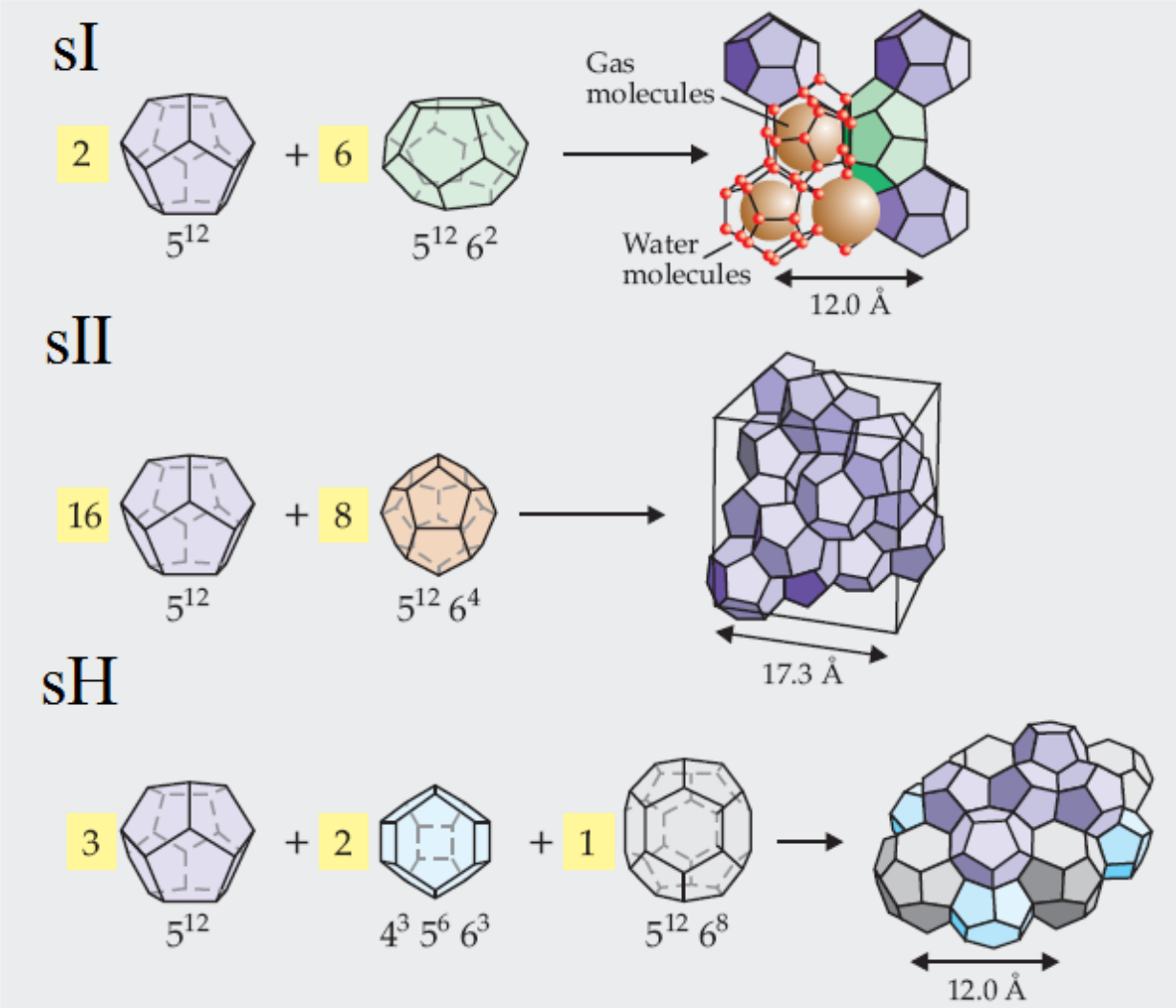
Outline

- Clathrate
- High pressure formation
- Raman Spectroscopy
- Likely that many forms exist
- Potential storage for atmospheric CO_2

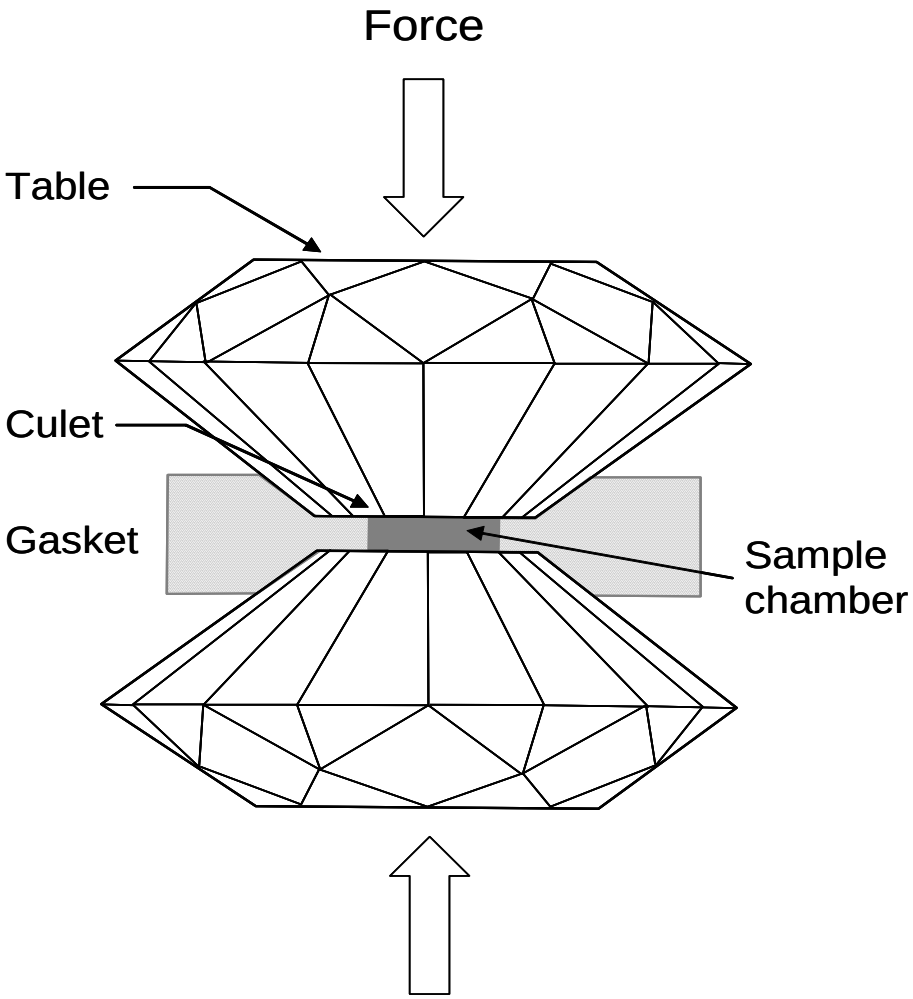
Objectives

- Interaction of CO_2 and H_2O up to ~50 GPa
- Compositional dependency
- Guidance for future storage methods

Clathrates


sI
2
+ 6
5^{12}
$5^{12}\,6^2$
Gas molecules
Water molecules
12.0 Å
sII
16
+ 8
5^{12}
$5^{12}\,6^4$
17.3 Å
sH
3
+ 2
+ 1
5^{12}
$4^3\,5^6\,6^3$
$5^{12}\,6^8$
12.0 Å

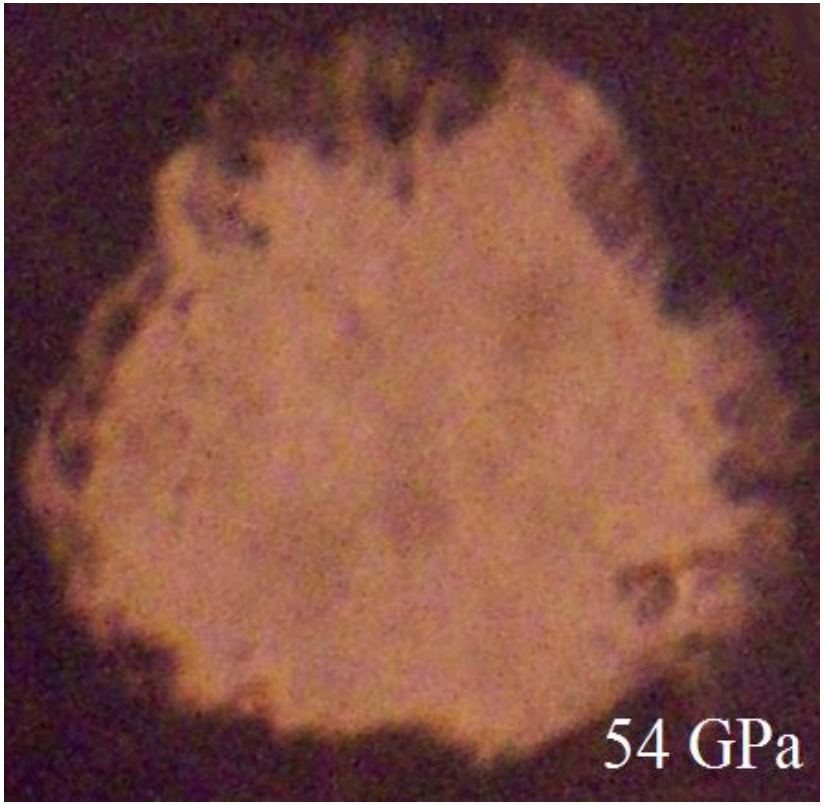
Design

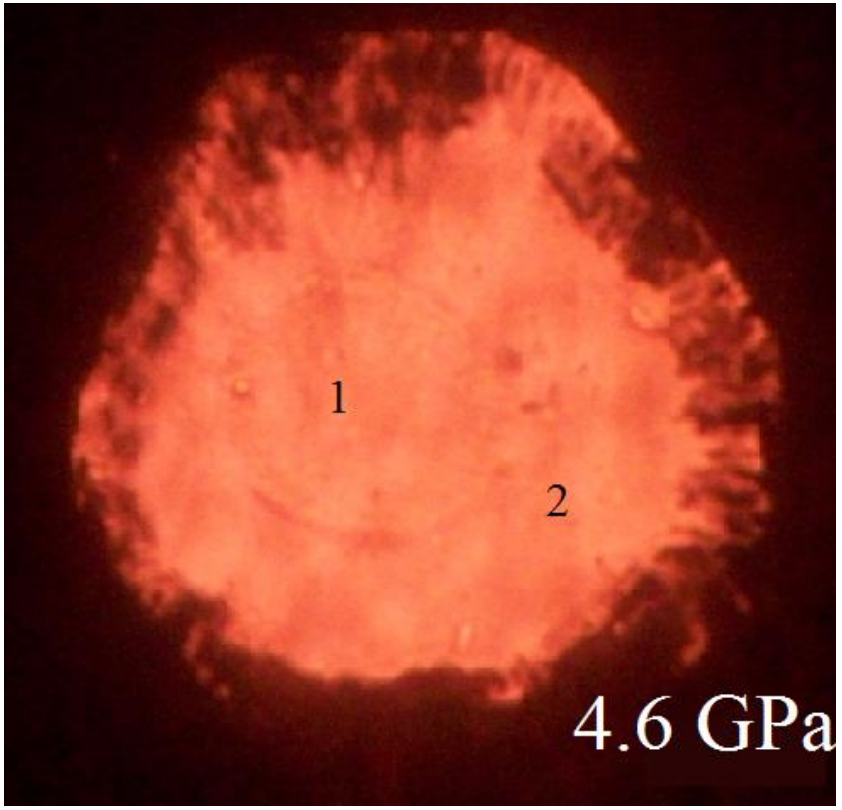


Design

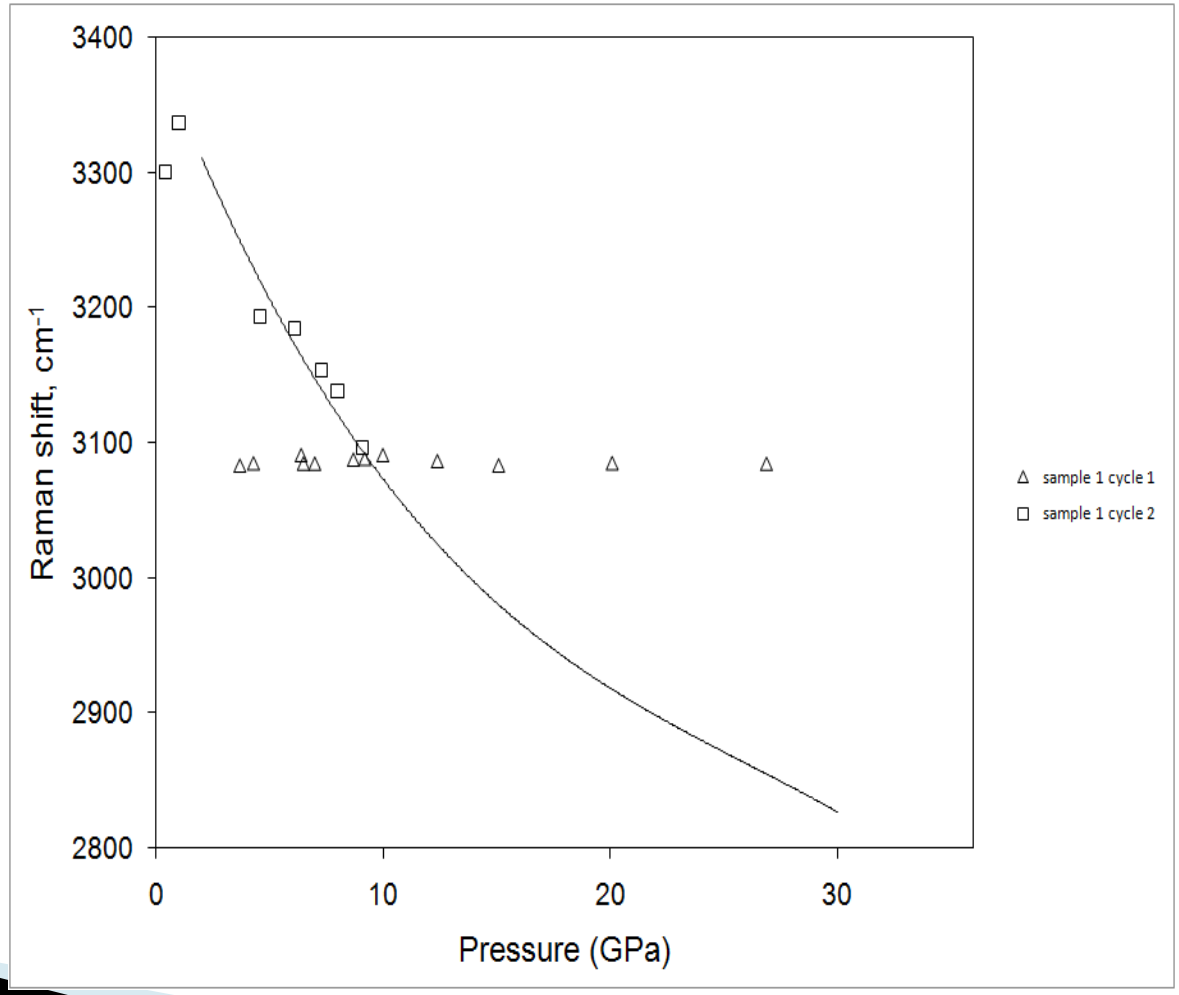
- Sample 1
  - Mixture of CO_2 and H_2O
  - 54 GPa to 1 Gpa
  - Lowered to 1 GPa, then re-compressed to 10 GPa
- Sample 2
  - 5 GPa to 35 GPa.
  - Decrease in pressure.
  - Much more CO_2 than H_2O
- Raman Spectroscopy
  - In situ probe for vibrational peaks
  - Various locations

Sample Heterogeneity

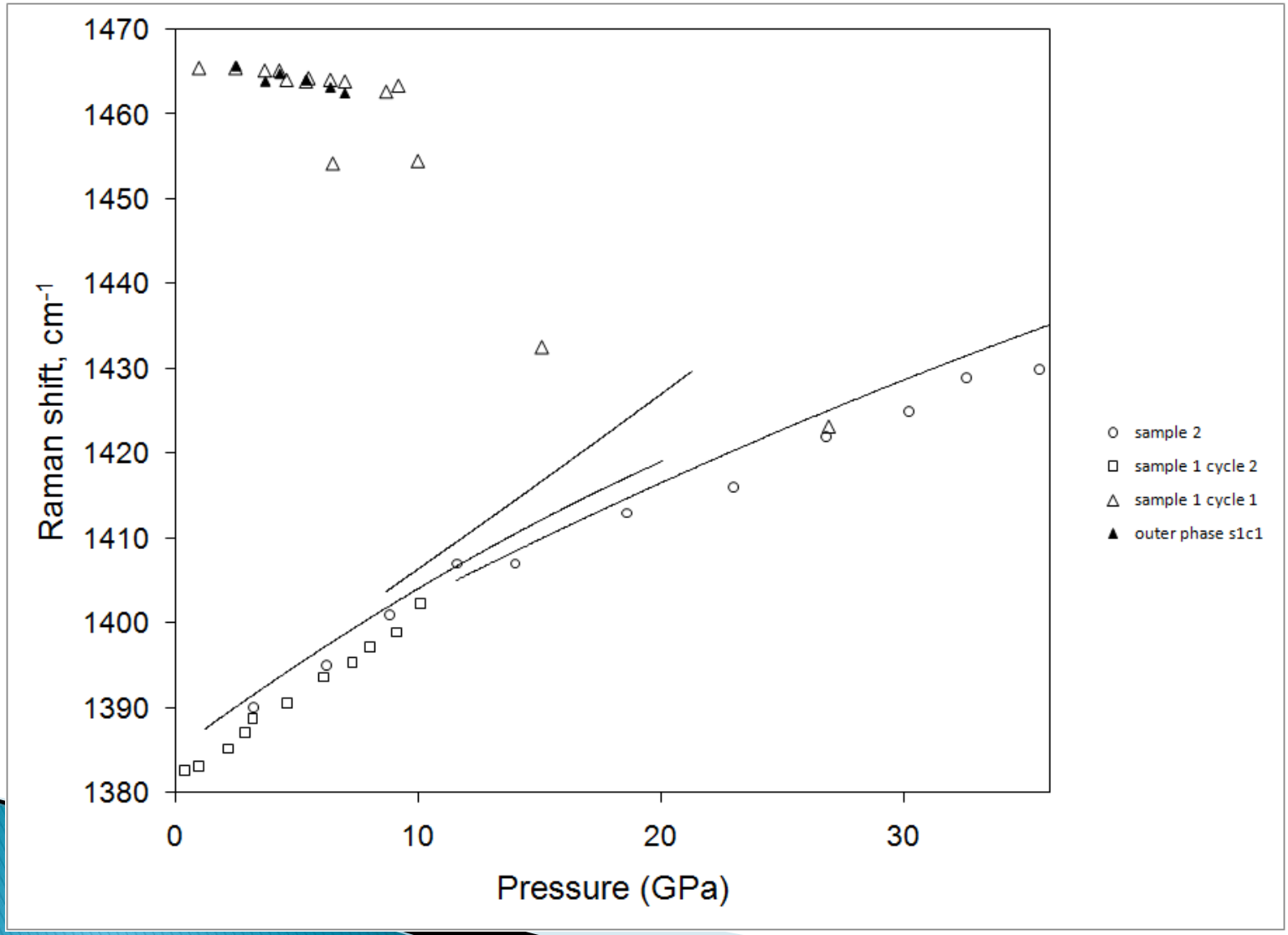




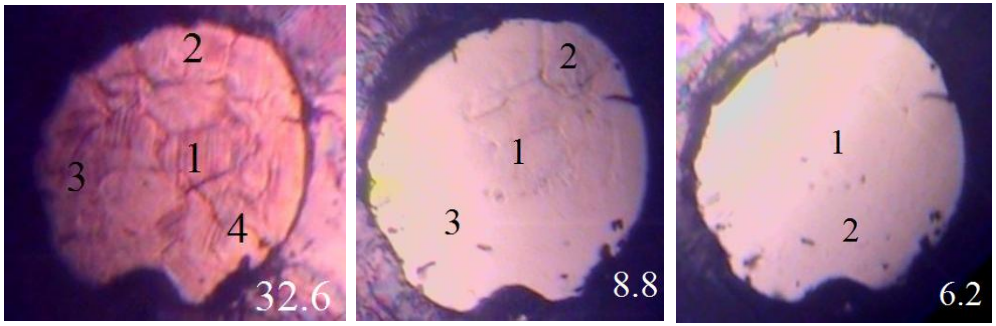
Average Peak Shift as a Function of Pressure for H_2O

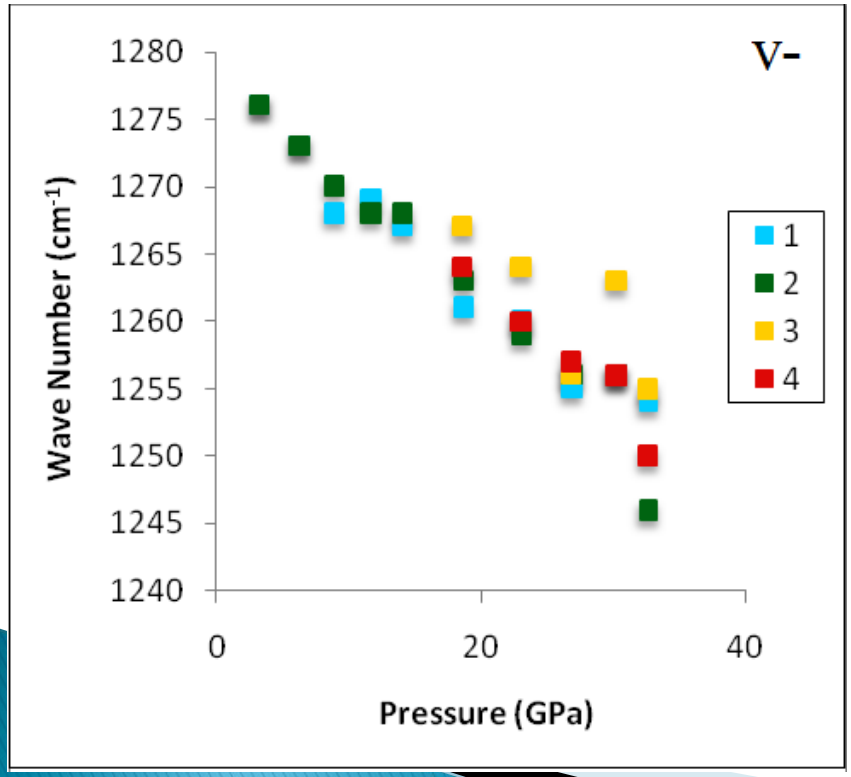


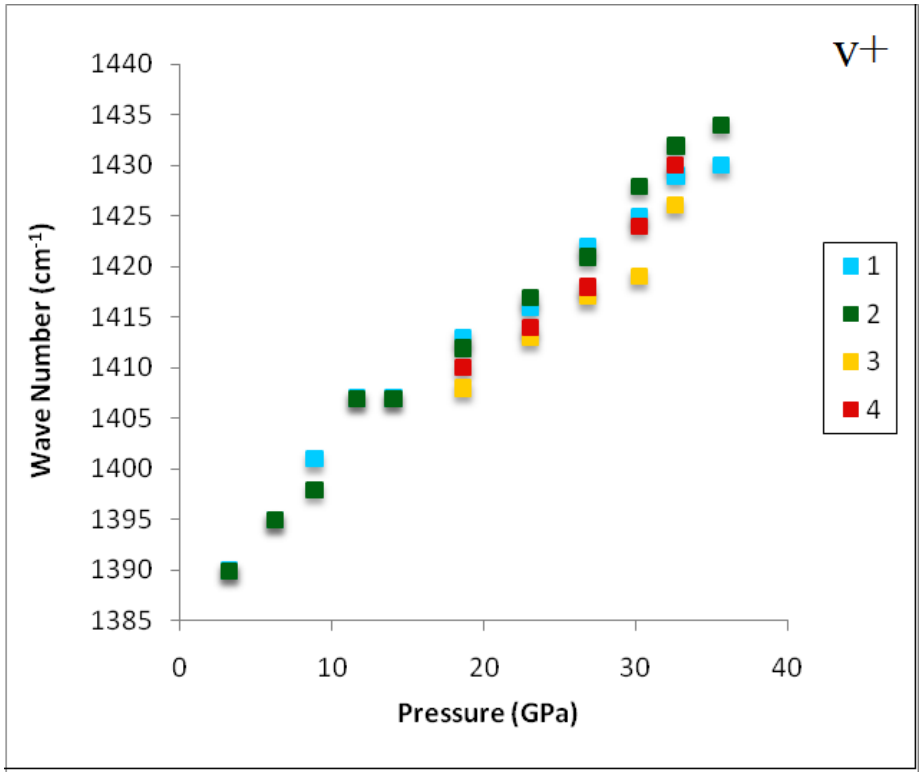
Average Peak Shift as a Function of Pressure for CO_2



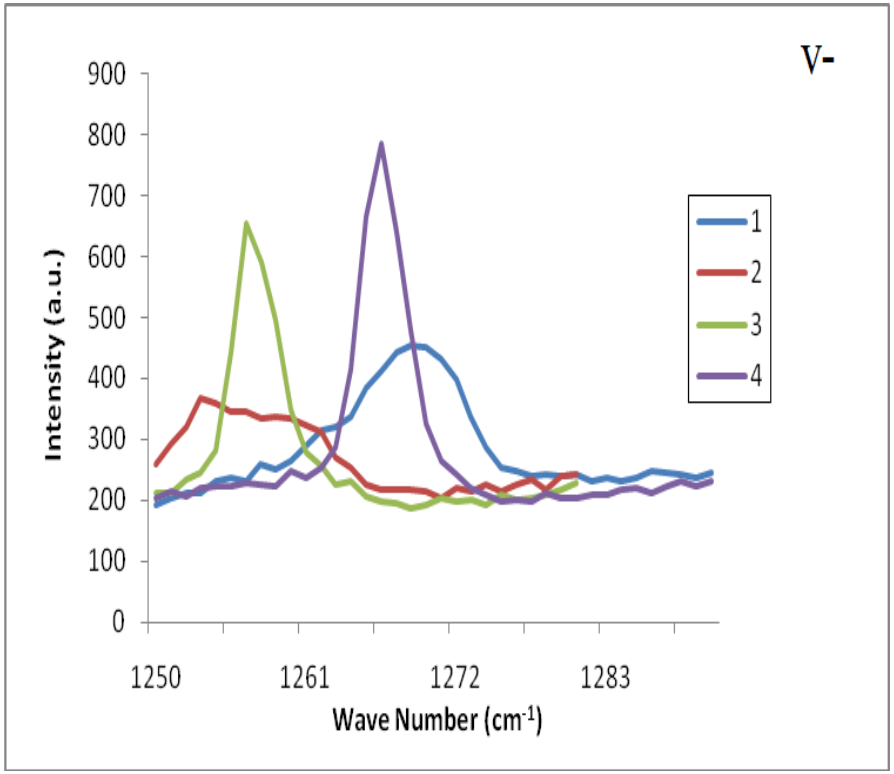
Raman Shift of CO_2 Peaks

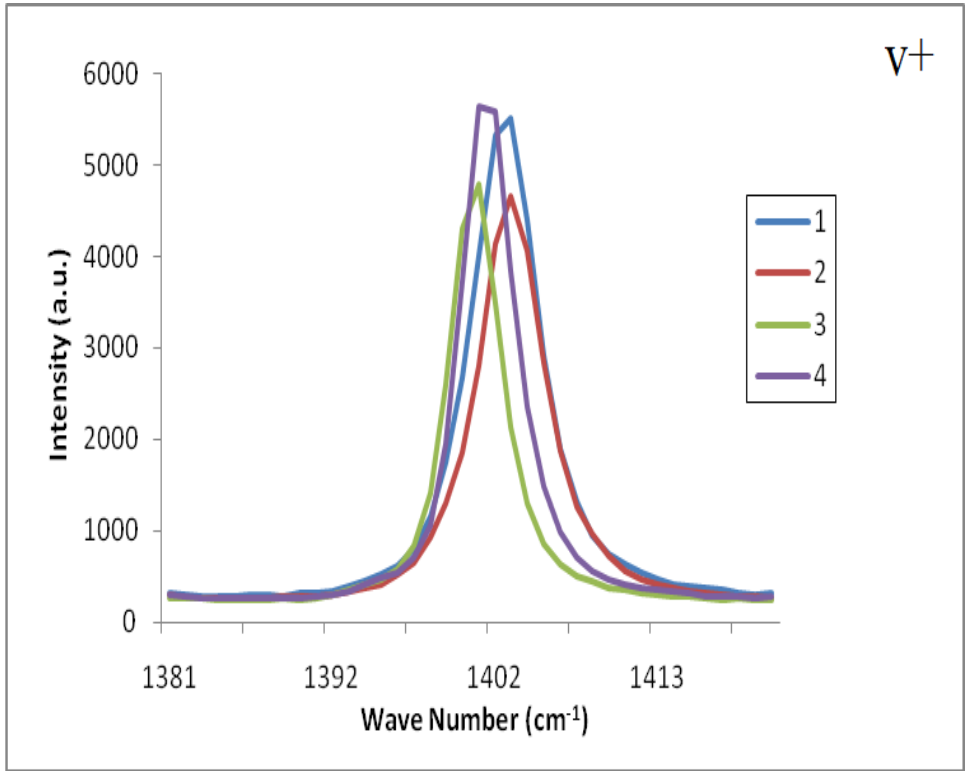






Spectral Variance





Conclusion

- Variations in spectra by:
  - Location
  - Cycle
- Physical differences in sample
- Different phases
  - Dependent on initial composition/conditions

Next Steps

- Temperature
- Initial CO_2:H_2O composition
- Initial Pressure/Temperature conditions
- Structure

Acknowledgements

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- Dr. Chang-Sheng Zha
- Mrs. Ragan