

Creation of a Cryogenic, Inert Atmosphere Sample Curation Facility: Establishing Baselines for Sample Return Missions

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The Tagish Lake Meteorite

- Pristine samples have been kept cold (below 0°C) since collection on frozen lake
- A low T, inert atmosphere facility was developed to protect integrity of the samples



Tagish Lake, sample 1

Subzero Facility for Curation and Handling of Astromaterials

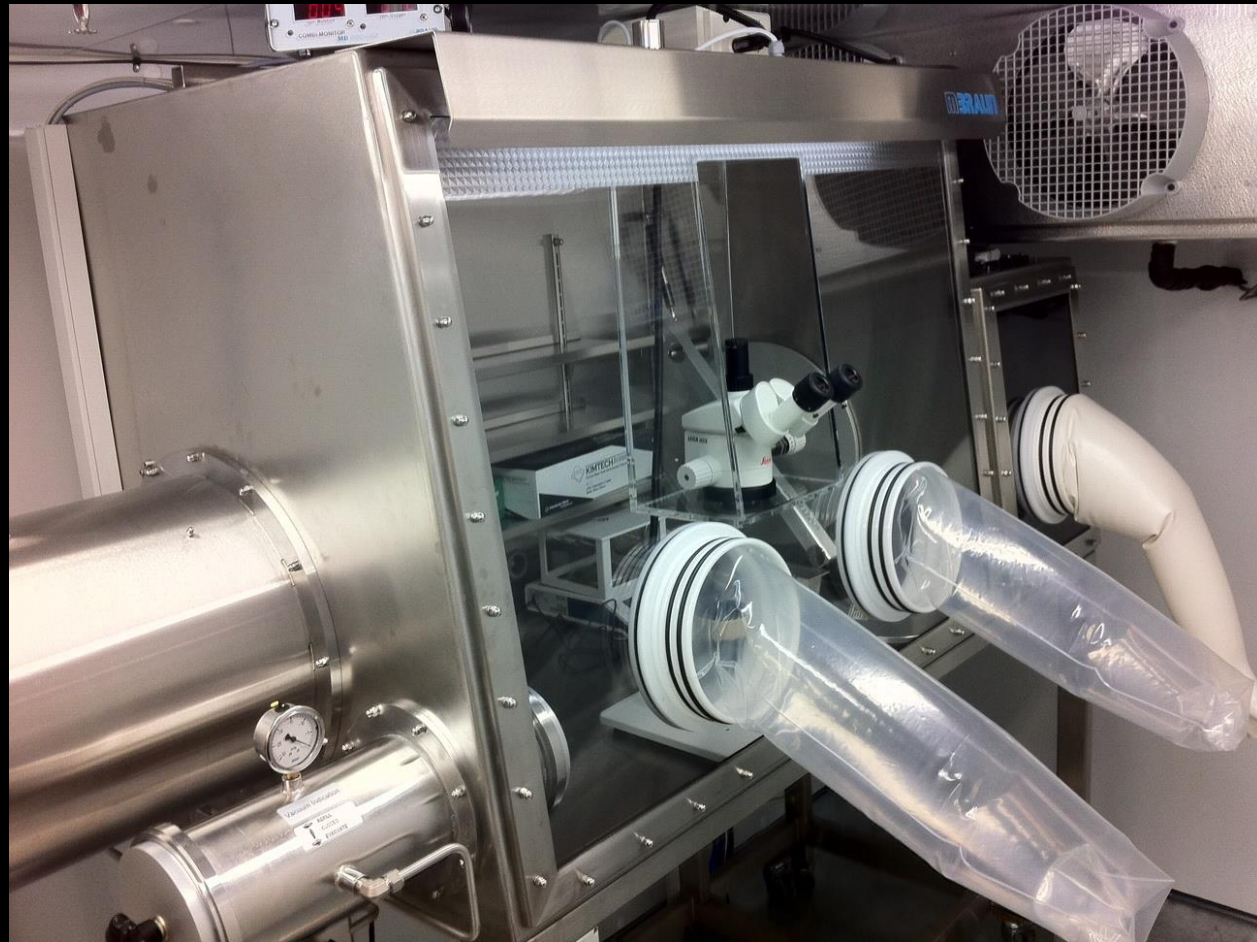
- Clean room, walk-in freezer (-20 °C), argon glove box
- Enables curation and handling under cold, clean and inert conditions



Class 1000 clean anteroom,
with door to freezer (at left)

Inert Atmosphere Glove Box Inside Cold Room (-20 °C)

- Prevents against:
 - Loss of volatile compounds
 - Reaction with Earth's atmosphere
 - Microbial activity



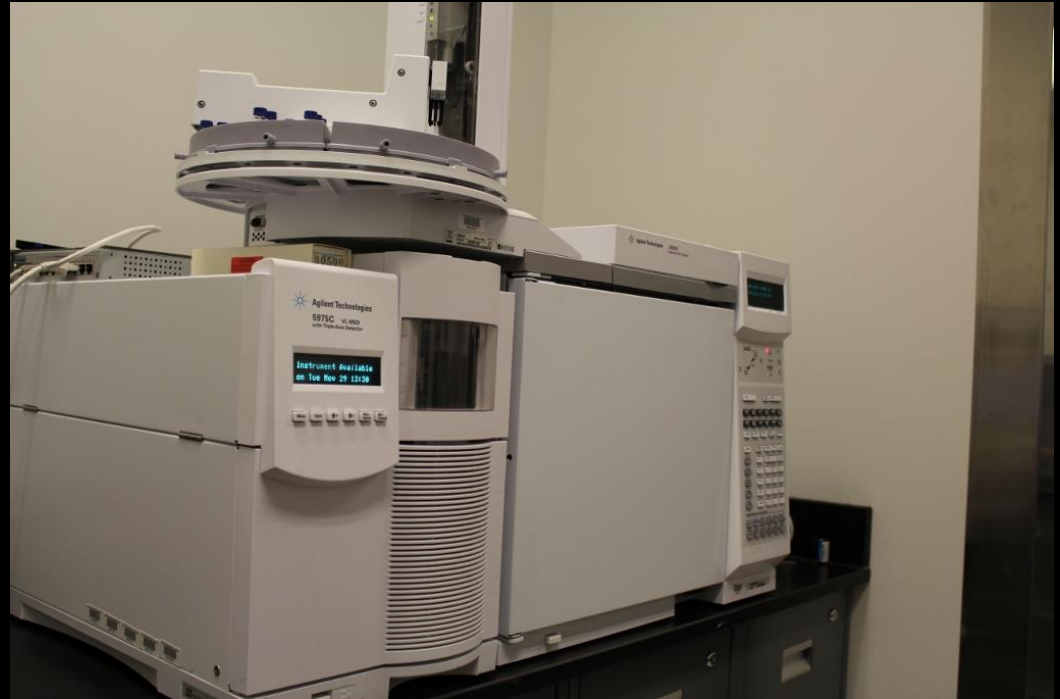
Argon glove box inside walk in freezer

Implications for Mars Sample Return

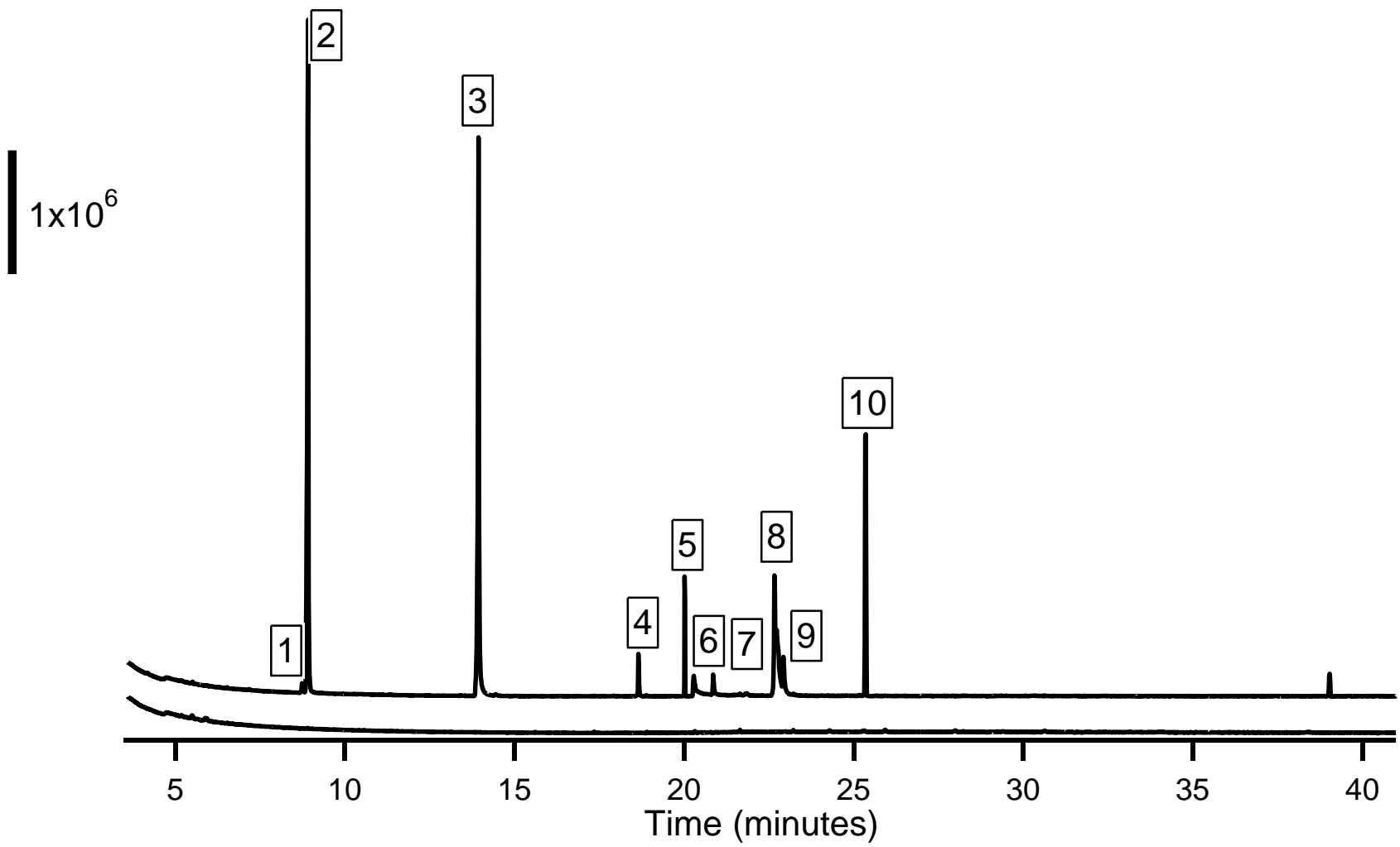
- The unique circumstances of collection, and the pristine nature of the Tagish Lake meteorite demand stringent curation and handling, similar to what is required for sample return missions.
- Mars, like the Tagish Lake meteorite, is a target in which organics are expected and of interest

Glove Box Preparation

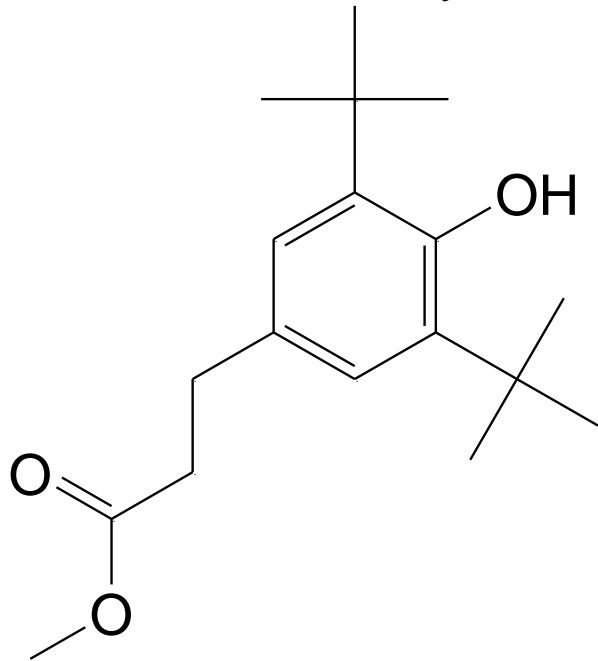
- Distilled water-DCM cleaning procedure
- Effectiveness assessed by sampling/analysis of contaminants:
 - **Surface:** DCM using cotton swabs
 - **Gloves:** DCM rinse
 - **Ar atmosphere:** adsorbed onto an SPME fiber
 - Analyzed by GS-MS



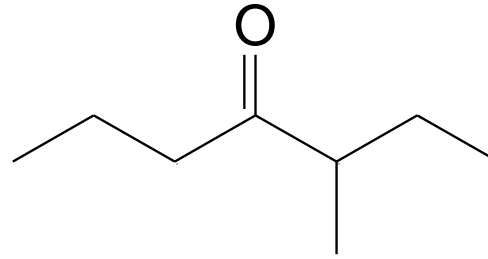
GC Trace for Polyurethane Glove DCM Rinse



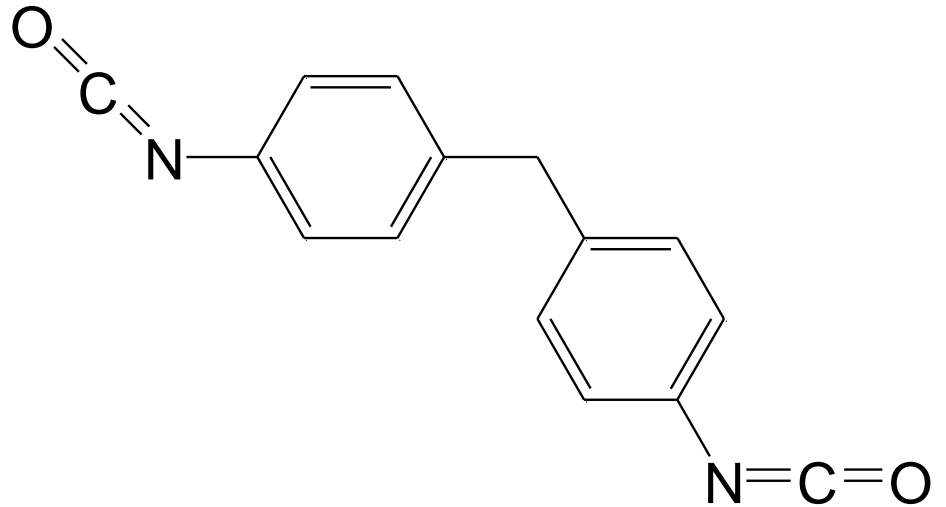
Polyurethane Glove Rinse -Surface contaminants



Benzenepropanoic acid, 3,5-bis(1,1-dimethylethyl)-4-hydroxy-, methyl ester

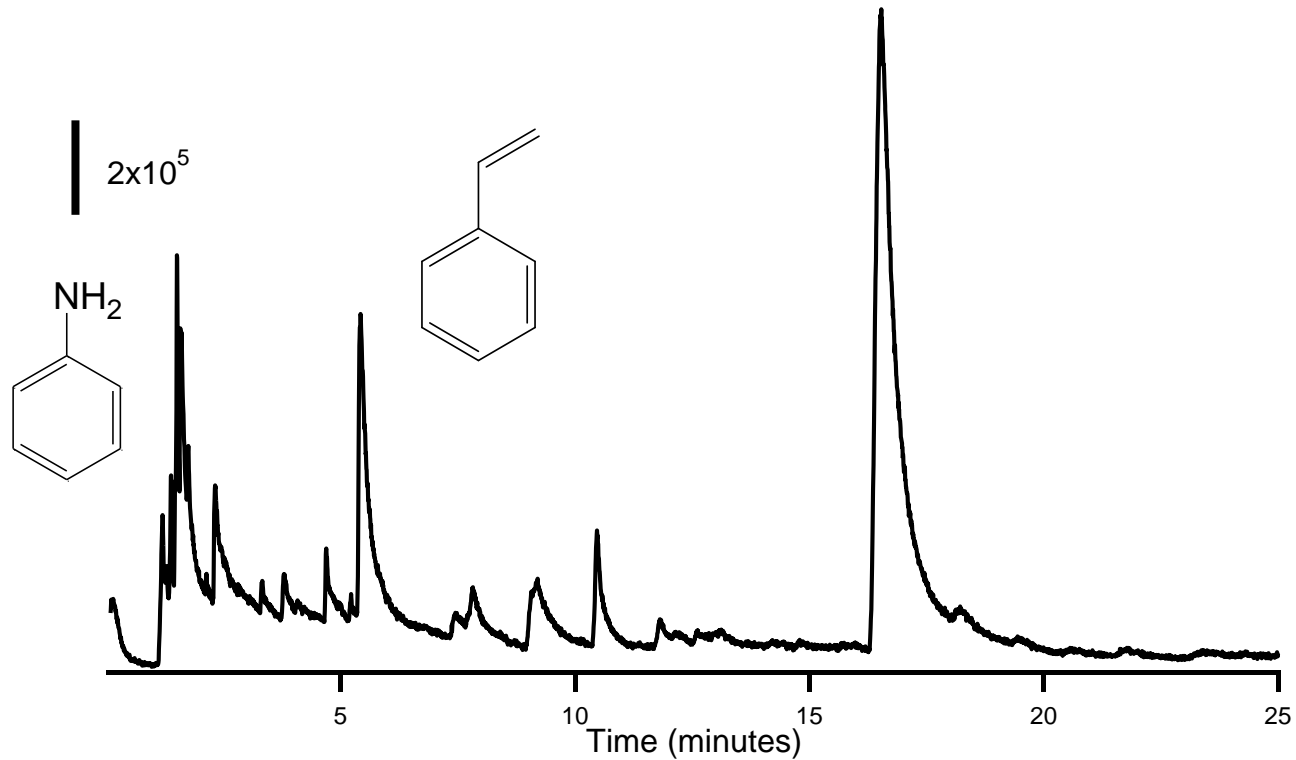


4-Heptanone, 3-methyl-



p,p'-Diphenylmethane diisocyanate

Analysis of the Ar Atmosphere: SPME-GC-MS Results



Ongoing Work

- Low T (- 20 °C) analyses of Ar atmosphere and the inner surfaces will be compared to room temperature studies
- The level of contamination of the atmosphere by outgassed organics will be studied as function of time

Conclusions

- Tagish Lake has been collected and stored as a thermally-sensitive, organic-rich meteorite
- Before samples are introduced, all surface and gaseous contaminants must be identified and documented
- Advantages of low T
 - 1) Keeps volatiles trapped within the sample
 - 2) Suspends microbial activity
 - 3) Outgassing of organic vapours from box components is minimized
- Similar protocols could be used for MSR...

MSR Curation and Handling Protocols (C.C. Allen)

1. All contaminants that come in contact with the samples must be documented
2. Low T storage and handling is required as samples from Mars may contain temperature- sensitive minerals that could be destroyed above zero
3. Heating above zero degrees centigrade may drive off adsorbed gases and any volatile organics
4. Exposure to the Earth's atmosphere may hydrolyze and /or oxidize minerals or organics within the sample
5. Any adventitious terrestrial microbes will be kept inactive at low T
6. Each sample must be kept in a separate container to stop cross contamination
7. Contamination witness plates should be used to assess the levels of organic contaminants in the atmosphere in the box
8. The box and its contents must be scrupulously clean. Operating procedures must minimize introduction of contaminants on to the sample.

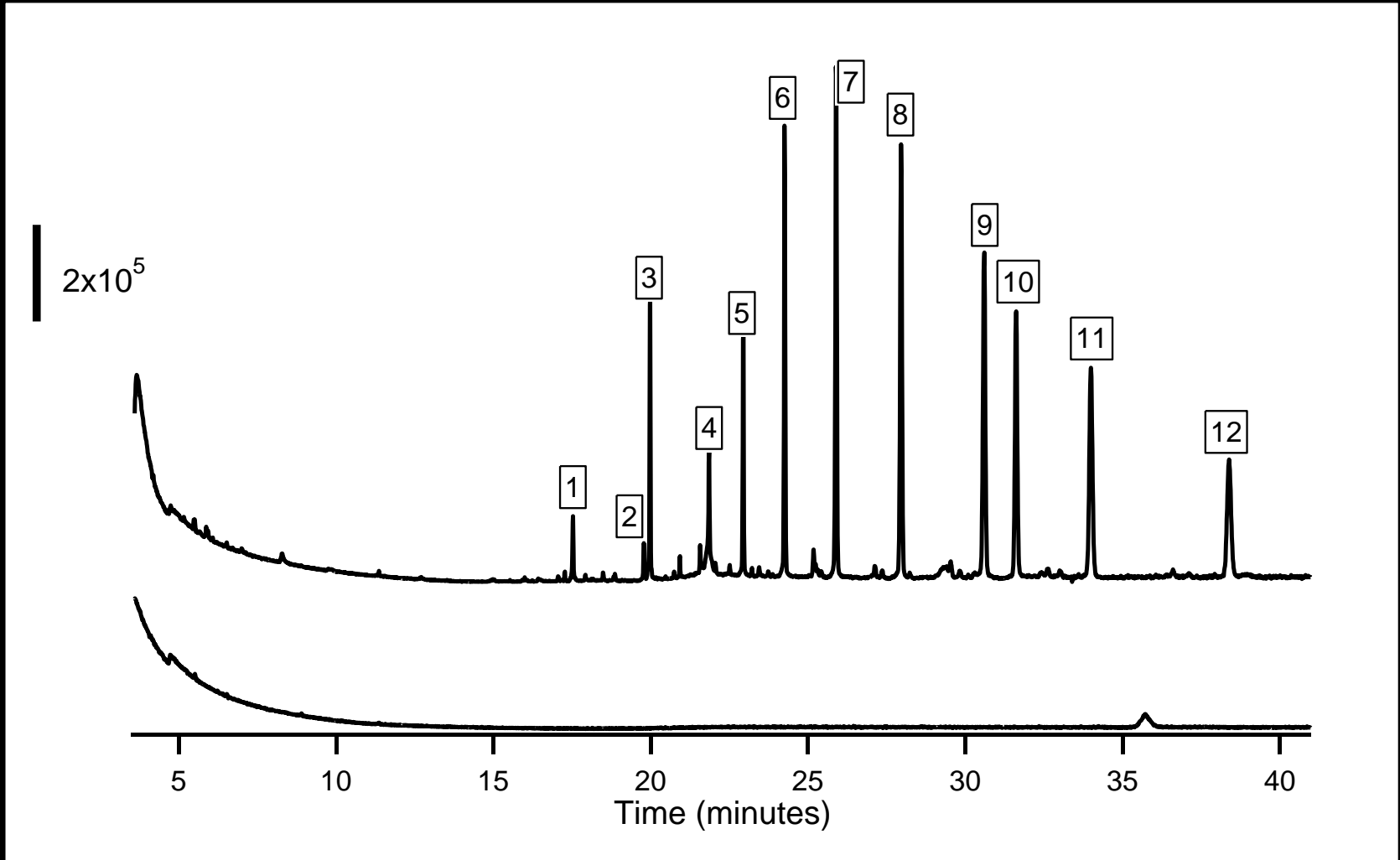
Current and Future Work: Tissint

- Specimen acquired in January 2012
- An opportunity to study a recently fallen Martian rock using sample return protocols



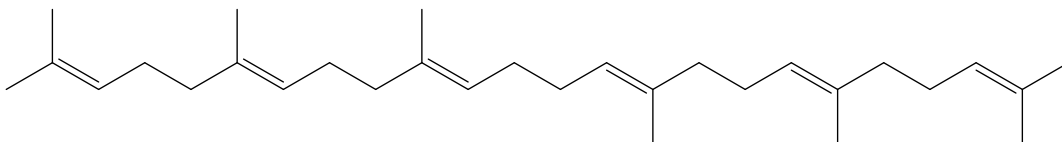
58.25 g specimen of the Tissint martian meteorite (University of Alberta Meteorite Collection)

Current and Future Work: Tissint

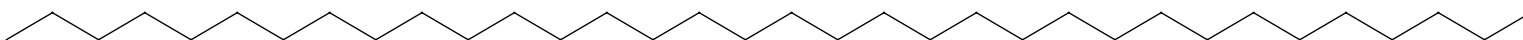


GC trace, DCM rinse of Tissint specimen after handling, before cutting

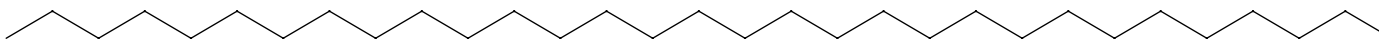
Tissint : Surface contaminants



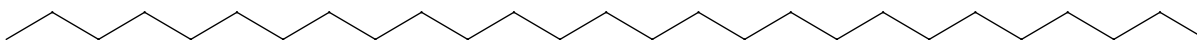
Squalene ($C_{30}H_{50}$)



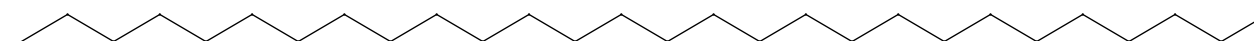
Tetratriacontane ($C_{34}H_{70}$)



Hentriacontane



Heptacosane ($C_{27}H_{56}$)



Octacosane ($C_{28}H_{58}$)

Conclusions

- Inert Ar atmosphere stops oxidation and hydrolysis of minerals and organics in the sample
- Gloves must be well cleaned. Direct contact of sample with the gloves should be avoided
- Astromaterials should never come in contact with bare hands!
- Outgassed organics can be expected in the inert atmosphere

Acknowledgements

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