DWG 8: Science case 1: Compositional gradient in the solar system

DWG 3/5: Science case: Surface characteristics of planetary bodies

What can be done with the icy moons?

Three bodies of interest:

- **Europa**
- **Titan**
- ***Enceladus (maybe too new)?***

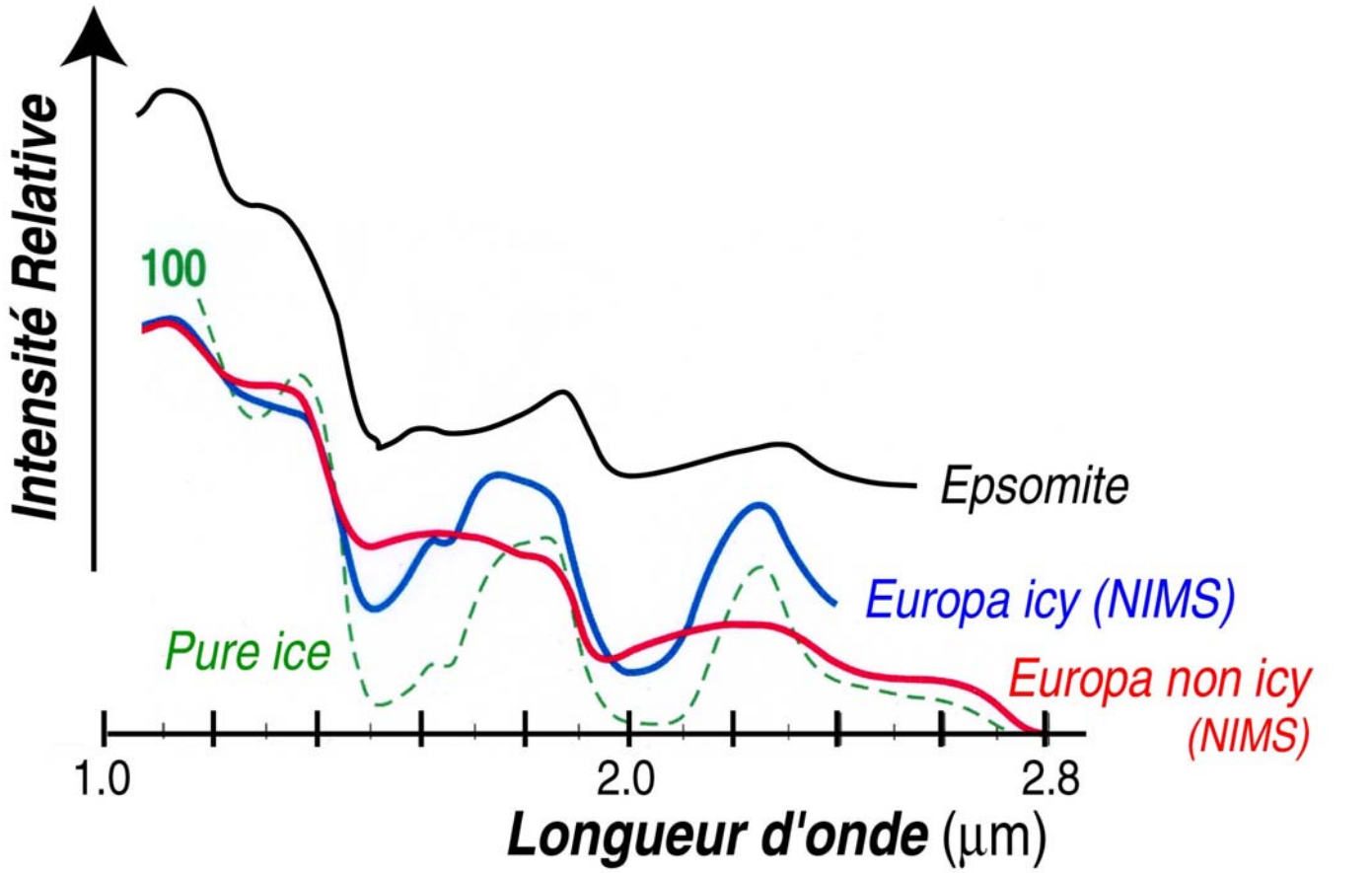
State of the Art-what do we have?

- **Visible images (low/high resolution)**
- **Hyperspectral analysis of the surfaces (low resolution)**
- **Geophysical data (poor but it exists)**
- **Laboratory experiments on ices (rheology, spectroscopy, chemistry of ices, …)**

Where are we now?

- **Surface Composition are still unknown (even for Europa)**
- **Interior-surface exchanges not really understood**

1) Constraining the composition of Europa's ices

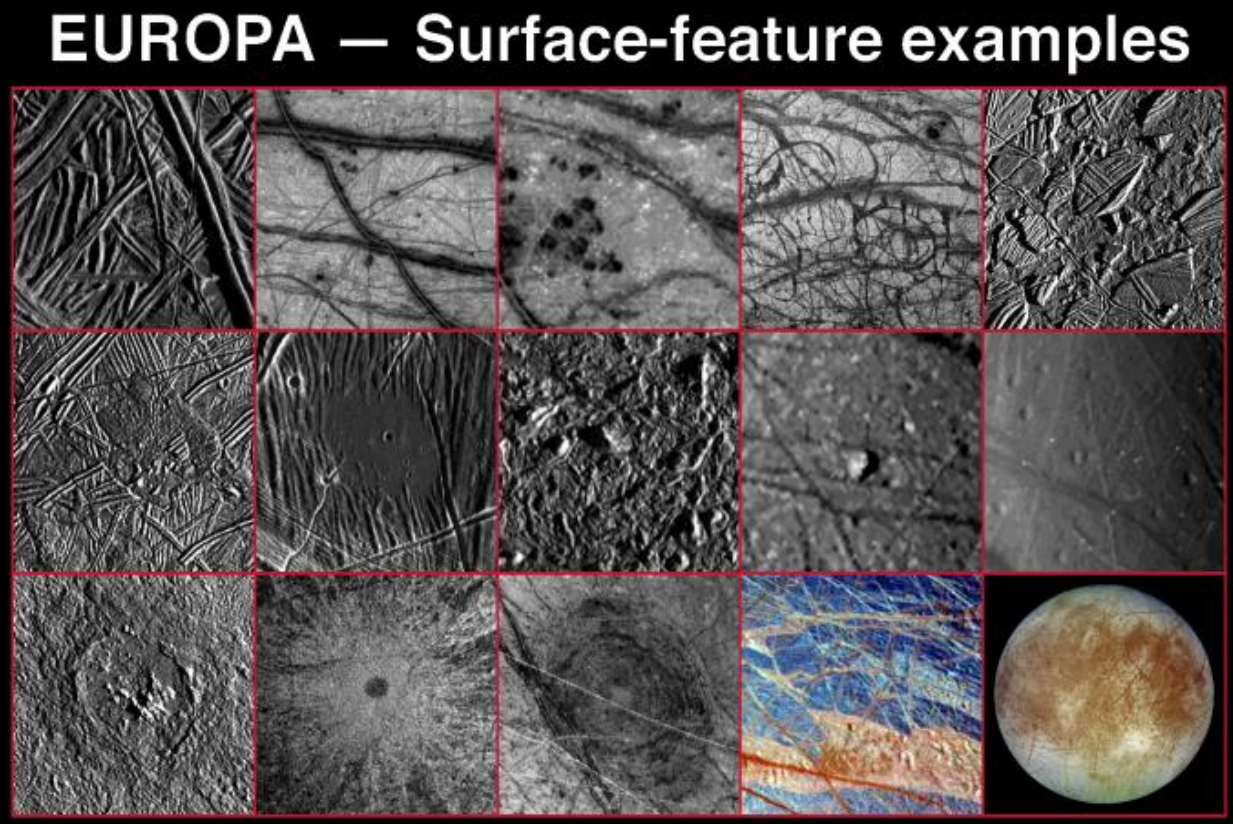


from McCord et al. (1999)

Blue surface: pure ice

Red lines and spots: material from the deep interior

2) The tectonics of Europa (exchange between the surface and the interior…)



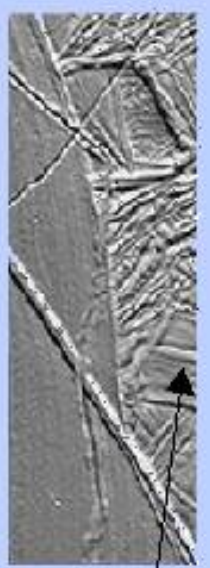
Description of data is easy BUT
INTERPRETATION of data is very difficult

Comparison with planetary analogs is difficult:

- **« New » features (triples bands, chaos,…)**
- **Known features (craters, faults)**
- **Need for analogic models …**

3) The use of Earth analogs – example of compressional features

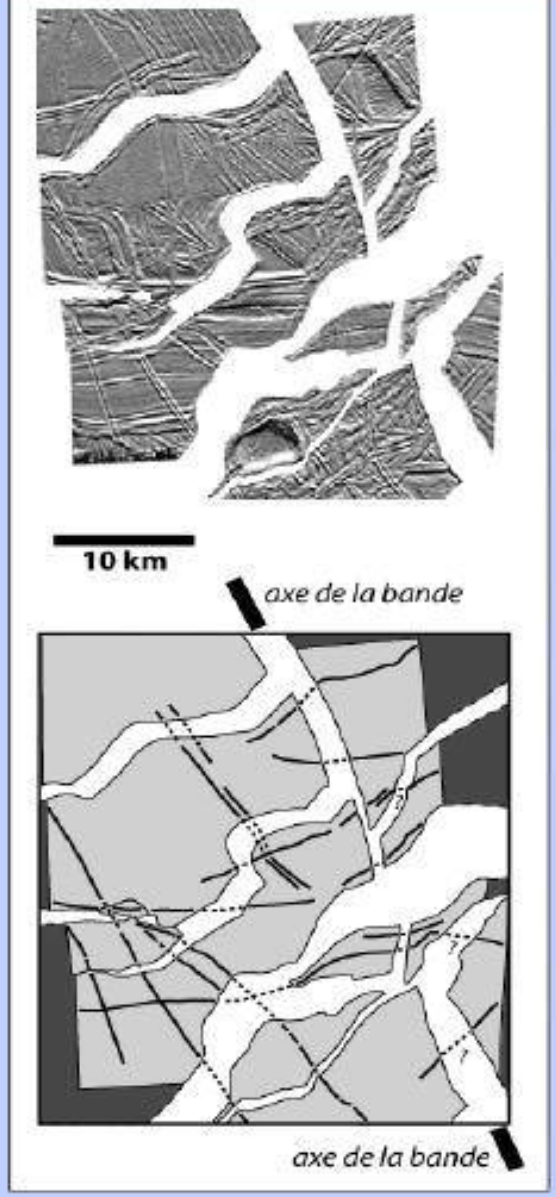
Crust extension



Nord

10 km

Crust compression?

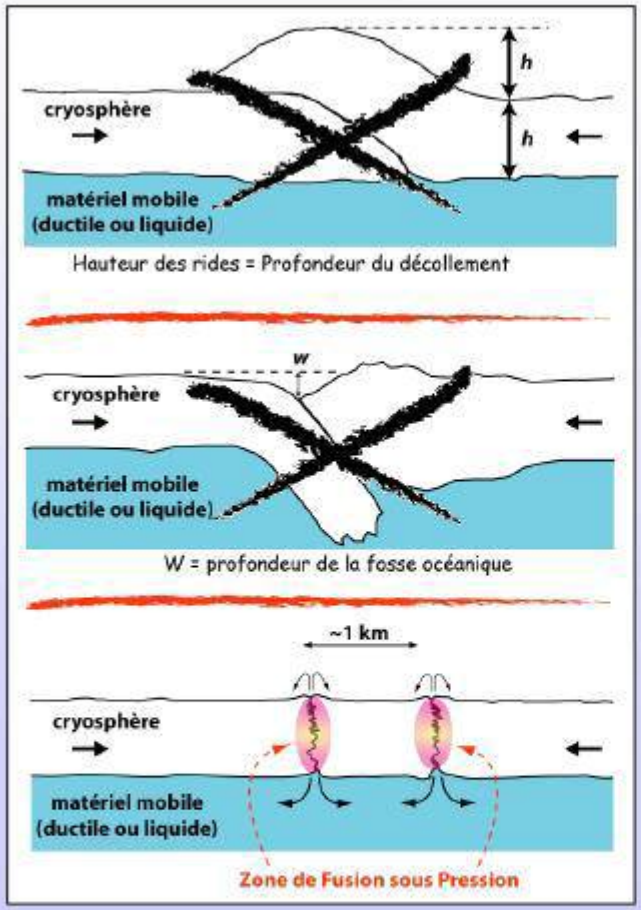


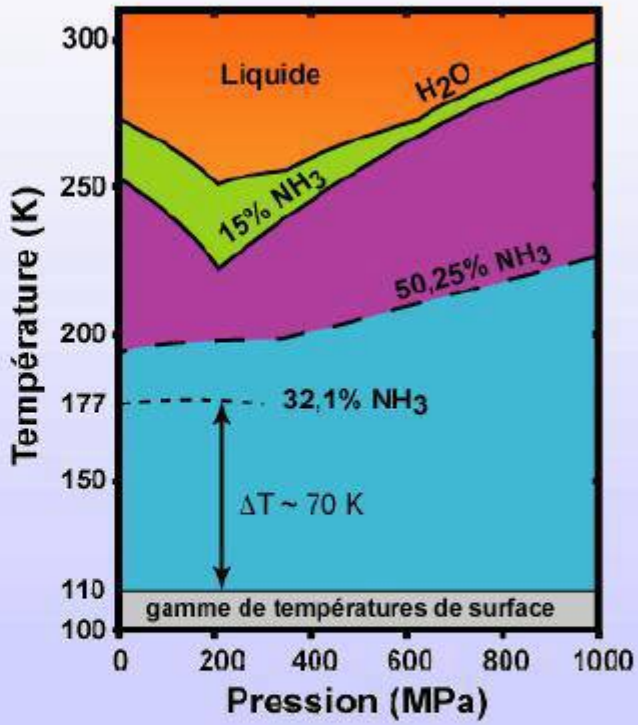
3) The use of Earth analogs – example of compressional features

Compressional features on Earth require topography

Melting under pressure
a new process which does not imply topography

Fusion sous pression





dans des zones d'anomalies thermiques

4) A review of the data requirements

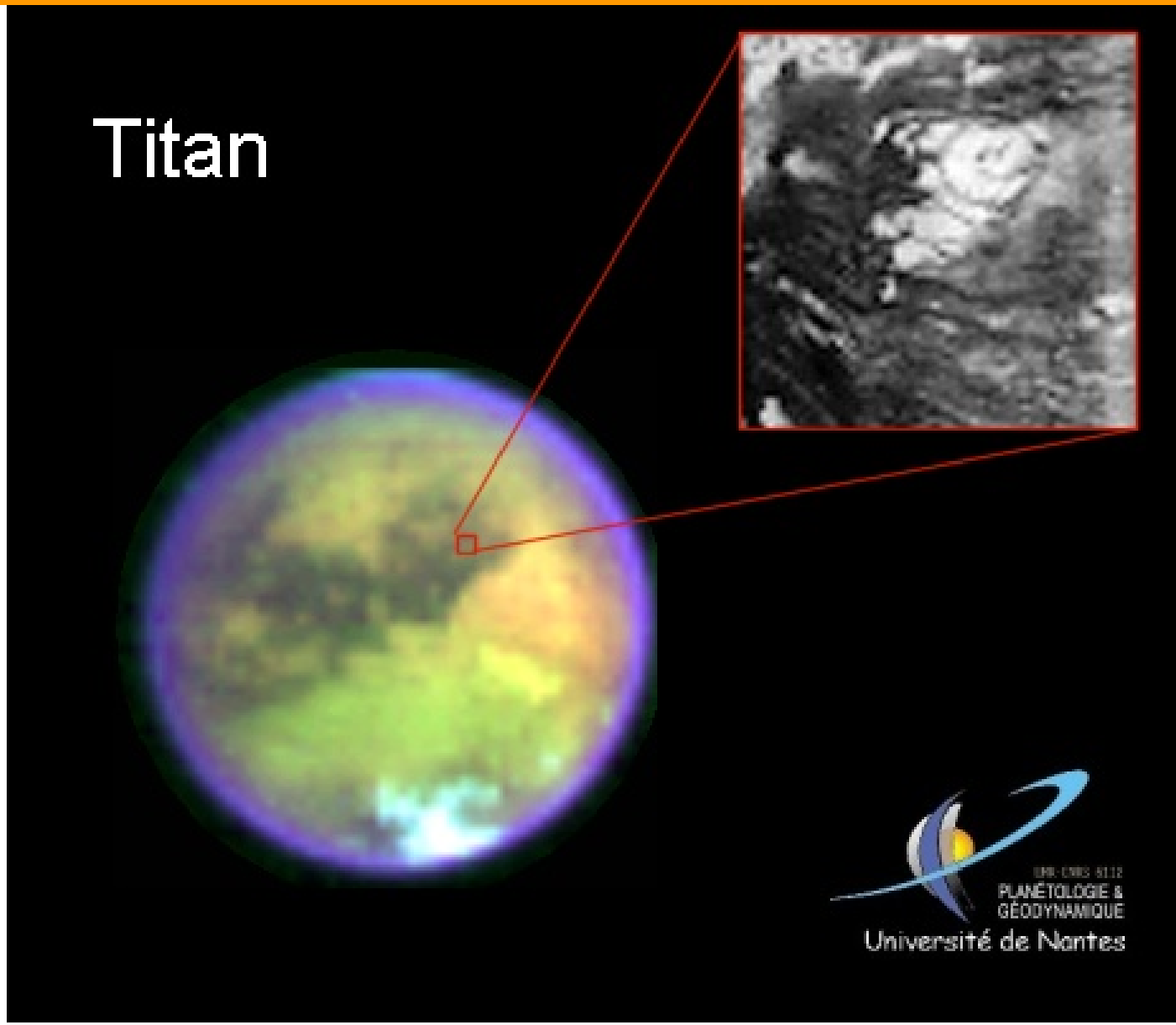
Implications:

- **Morphology description**
- **Description of tectonic activity**
- **Surface datation (craters)**
- **…**

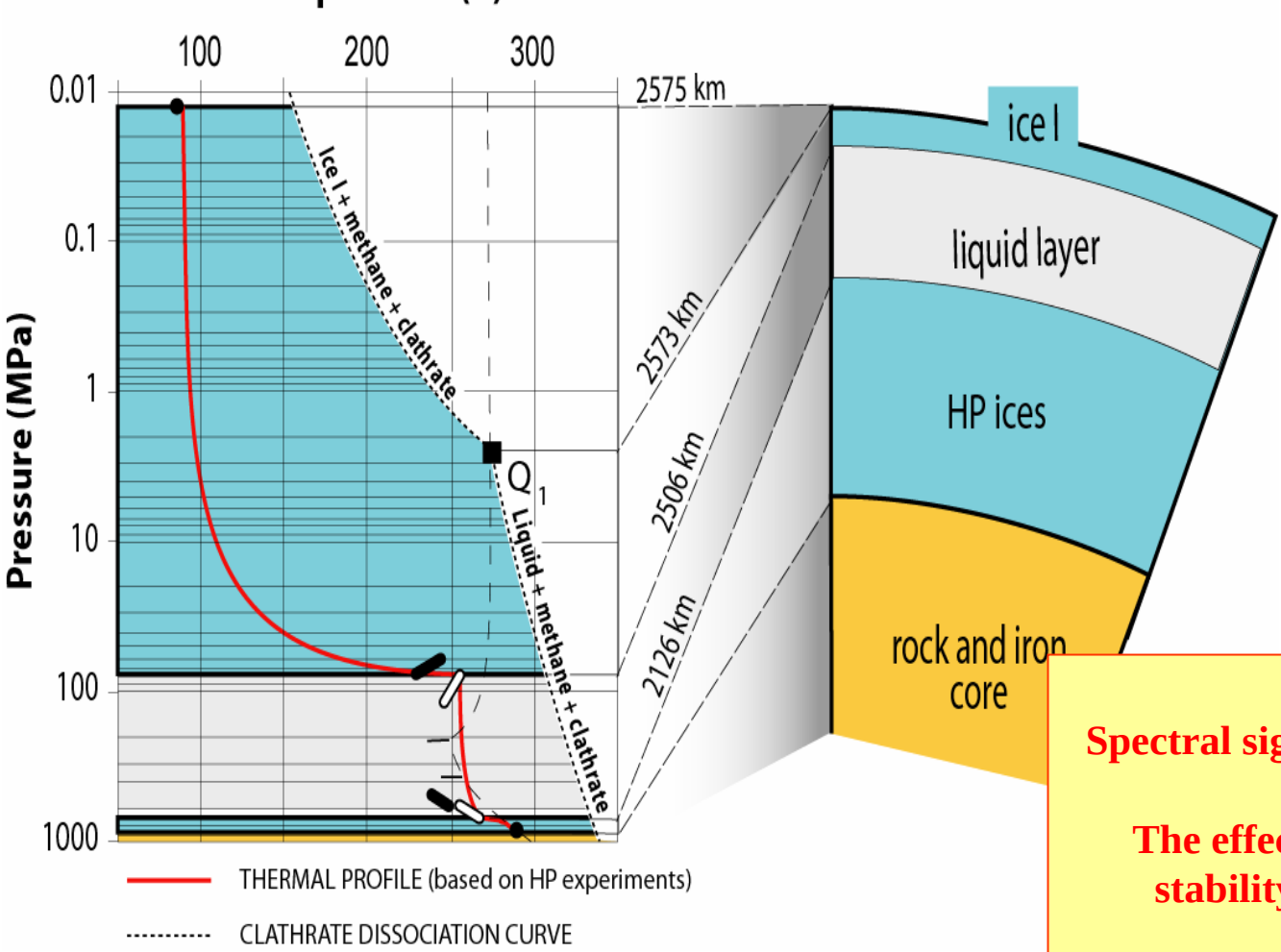
Requirements:

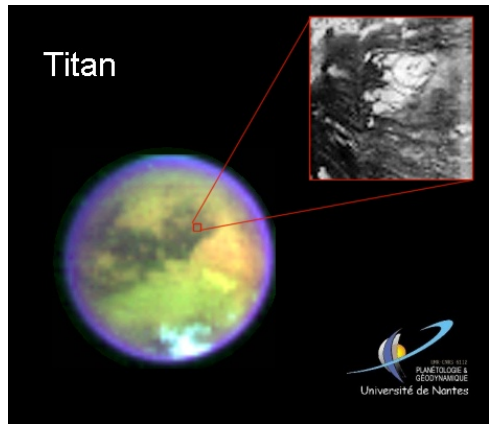
- **Analogic models are missing for icy materials…**
- **Topography measurements**
- **Data system providing detailed mapping of icy surfaces on Earth, Mars, icy moons**
- **Classification of tectonic features in the solar system (maybe it exists???)**

1) VIMS data showing a cryovolcano



2) Constraining the composition of Titan ices - cryolcanism





Requirements:

Spectral signature of clathrates on Titan

AND

The effect of ammonia on clathrate stability has not been considered

Dissociation of methane seems difficult…

Previous works (but difficult to find):

Oil engineers works (60s)

Research studies (chemistry …)

3) A review of the data requirements (experimental)

Pure ices:

- **thermodynamic properties (EOS, thermal conductivity, heat capacity, …)**
- **Rheology**
- **Melting curves at very high pressures (exoplanets)**
- **Spectral signatures (IR + Raman)**

Hydrates and clathrates under pressure

- **Stability phase diagrams**
- **rheology**
- **Densities compared to ices (cryovolcanism)**
- **Spectral signatures (IR + Raman)**

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What is required for going further?

- **New laboratory experiments (no interest here)**
- **Catalog(?) of existing laboratory experiments on ices and silicates (IR-Raman) (DWG 3/5/9/8/ any other?)**
- **Catalog(?) of observed tectonic and volcanic features**