Breiðdalssetur
Málvísindi – Jarðfræði – Sagan
GAMLA KAUPFÉLAGIÐ BREIÐDALSVÍK

Málþing um jarðfræði Austurlands

Biosignatures in secondary minerals in tertiary basalts, Breiðdalur, Eastern Iceland

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Beda A. Hofmann (University of Berne Switzerland)

Dr. Beda A. Hofmann, Háskóli í Bern

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- 2. Geology of Breiðdalur, Eastern Iceland
- 3. Secondary minerals
- 4. Evidence for fossil subsurface organisms
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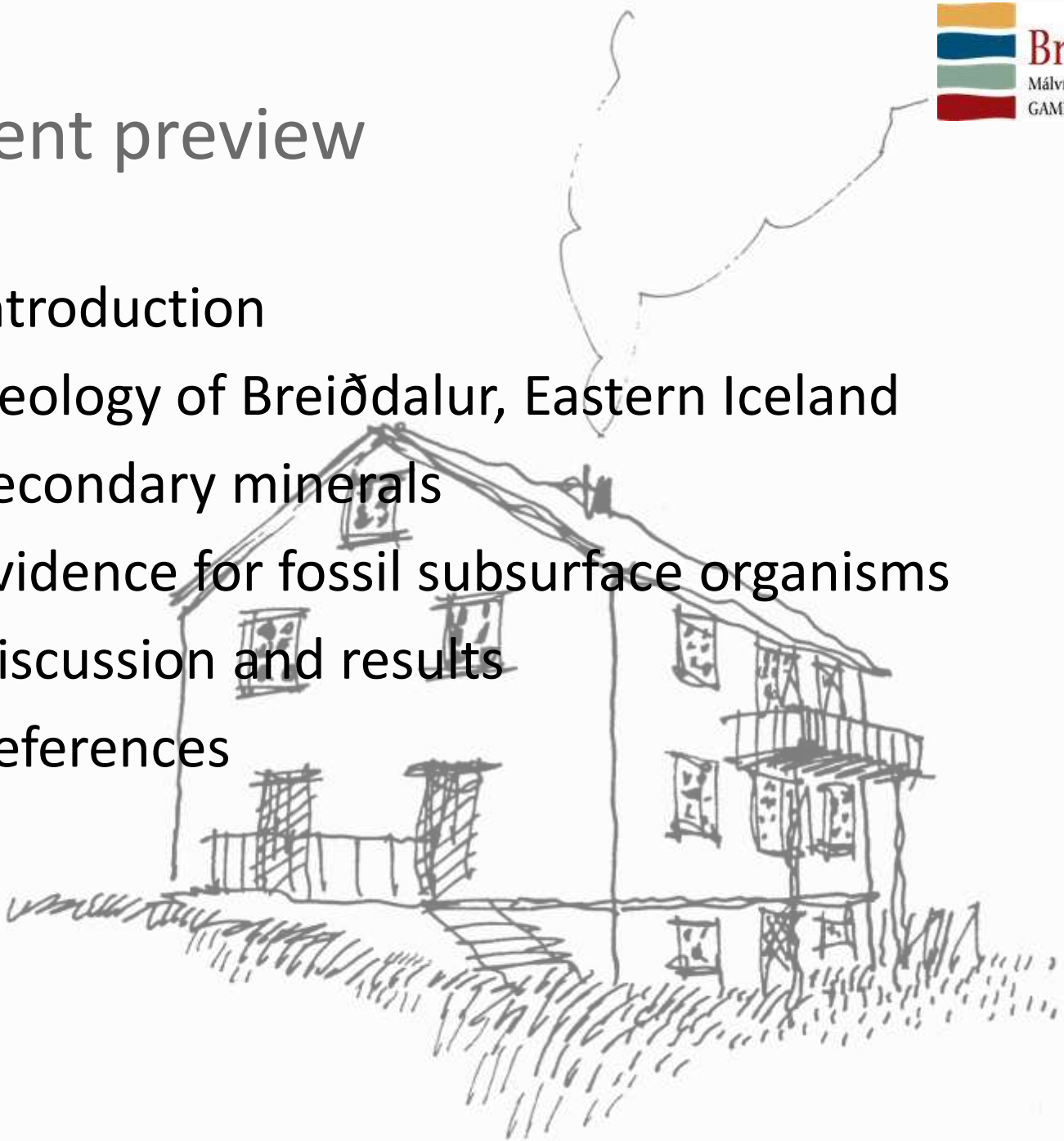

1. Introduction

Breiðdalssetur
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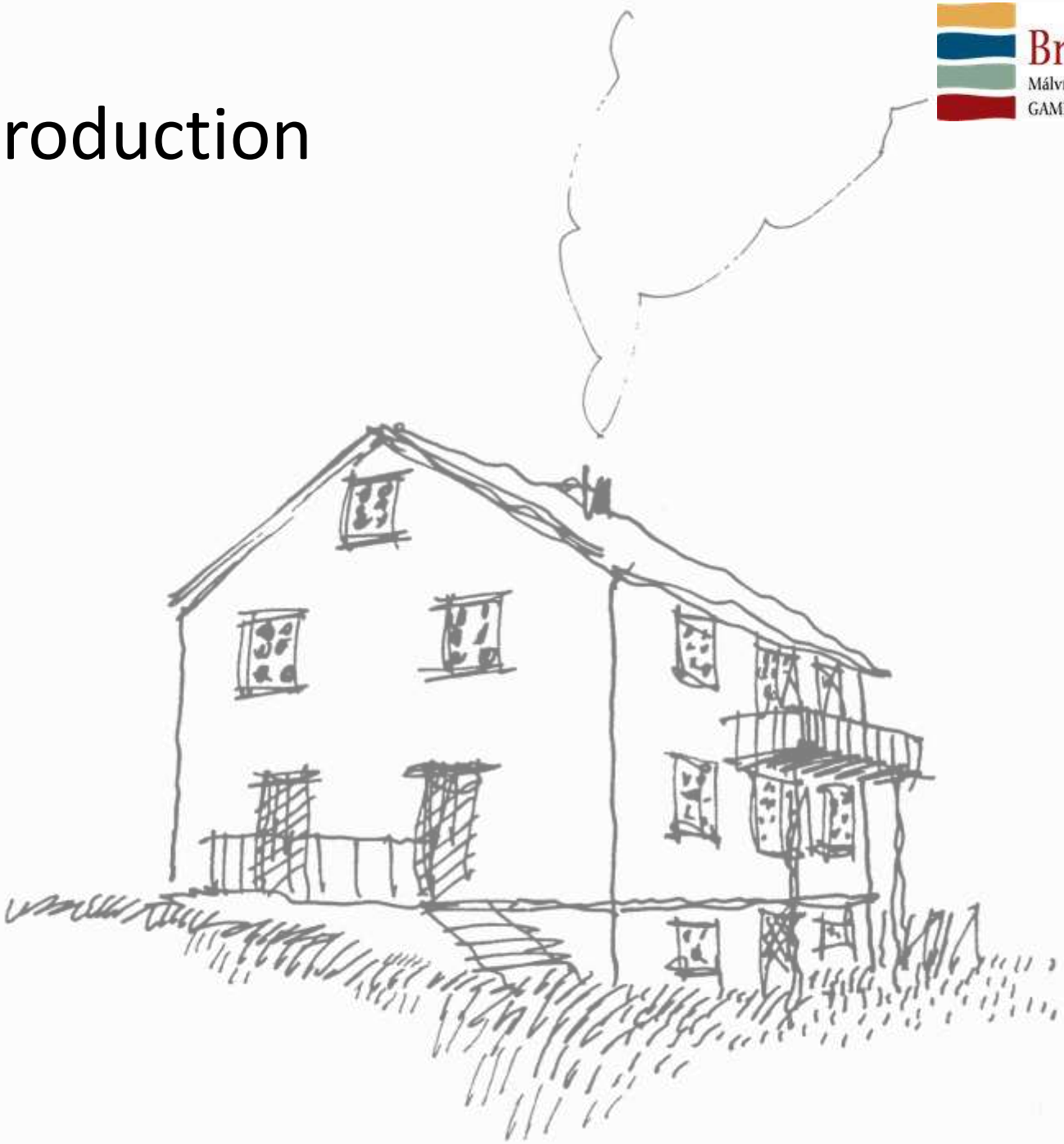
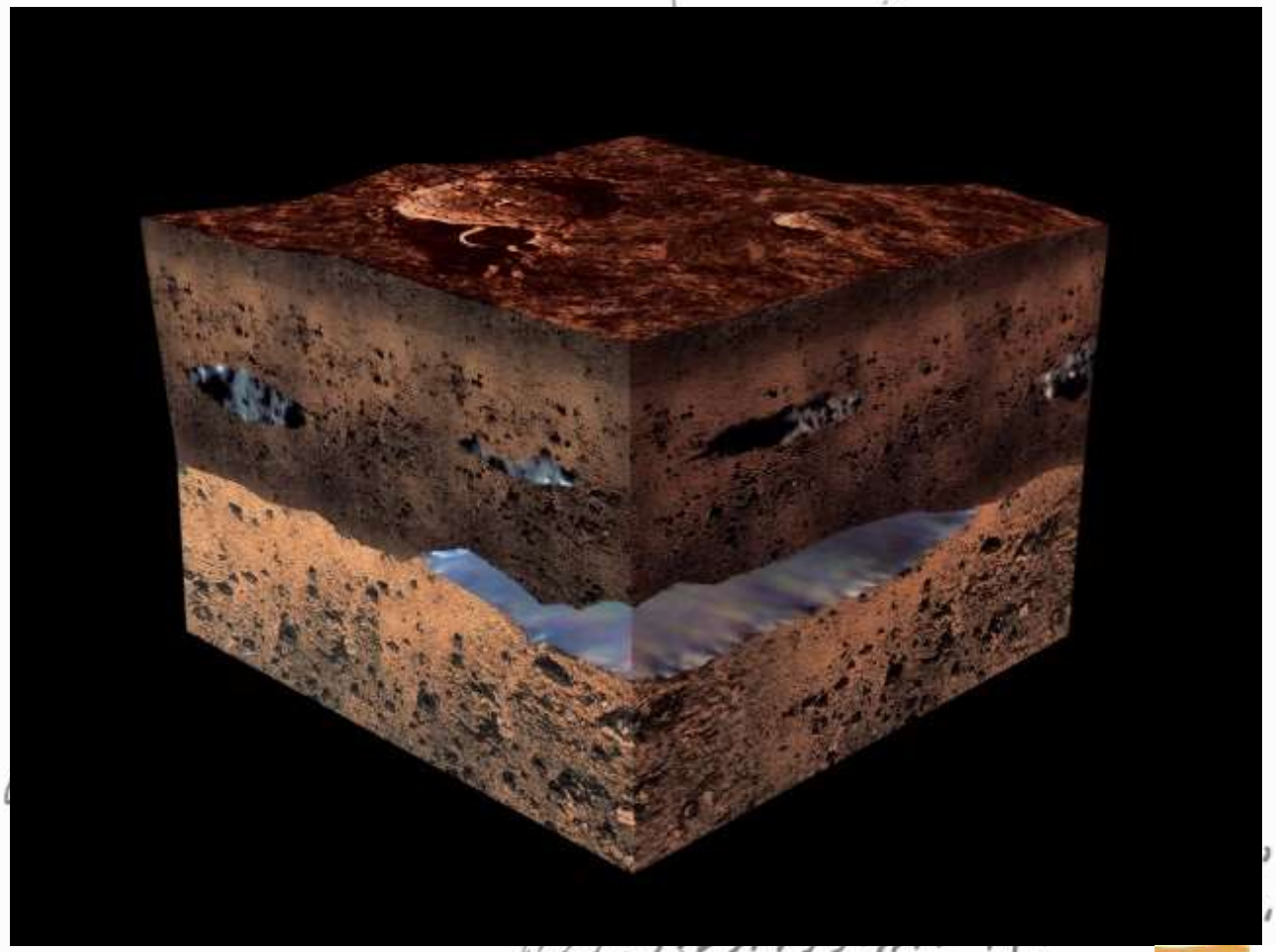


Filamentous fabrics likely represent a fossil record of the subsurface biosphere



Tertiary basalts of Eastern Iceland frequently host fracture- and cavity-infills:
chert like silica with additional
Fe-hydroxides, hematite and Fe-rich clays.

Breiðdalssetur
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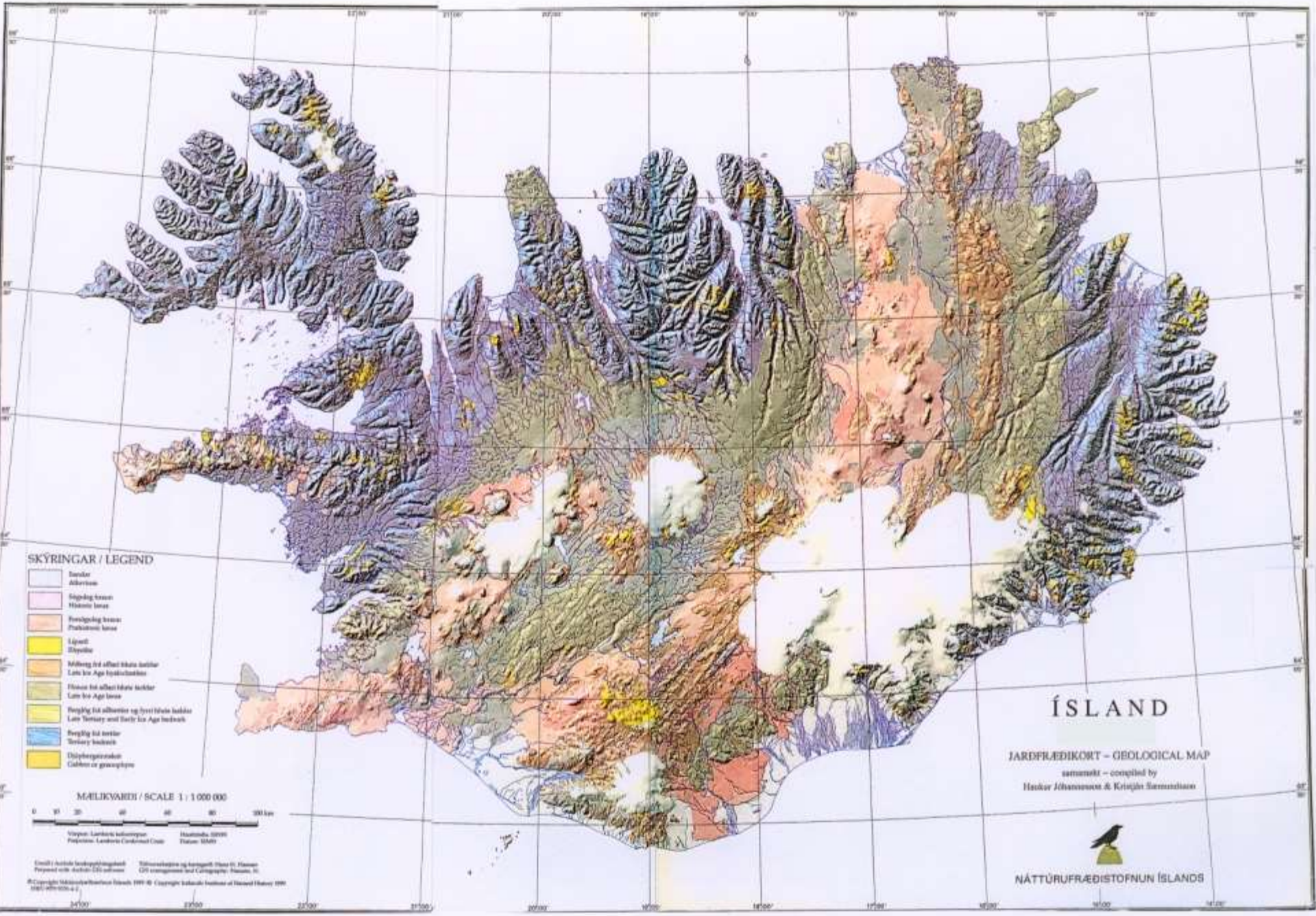
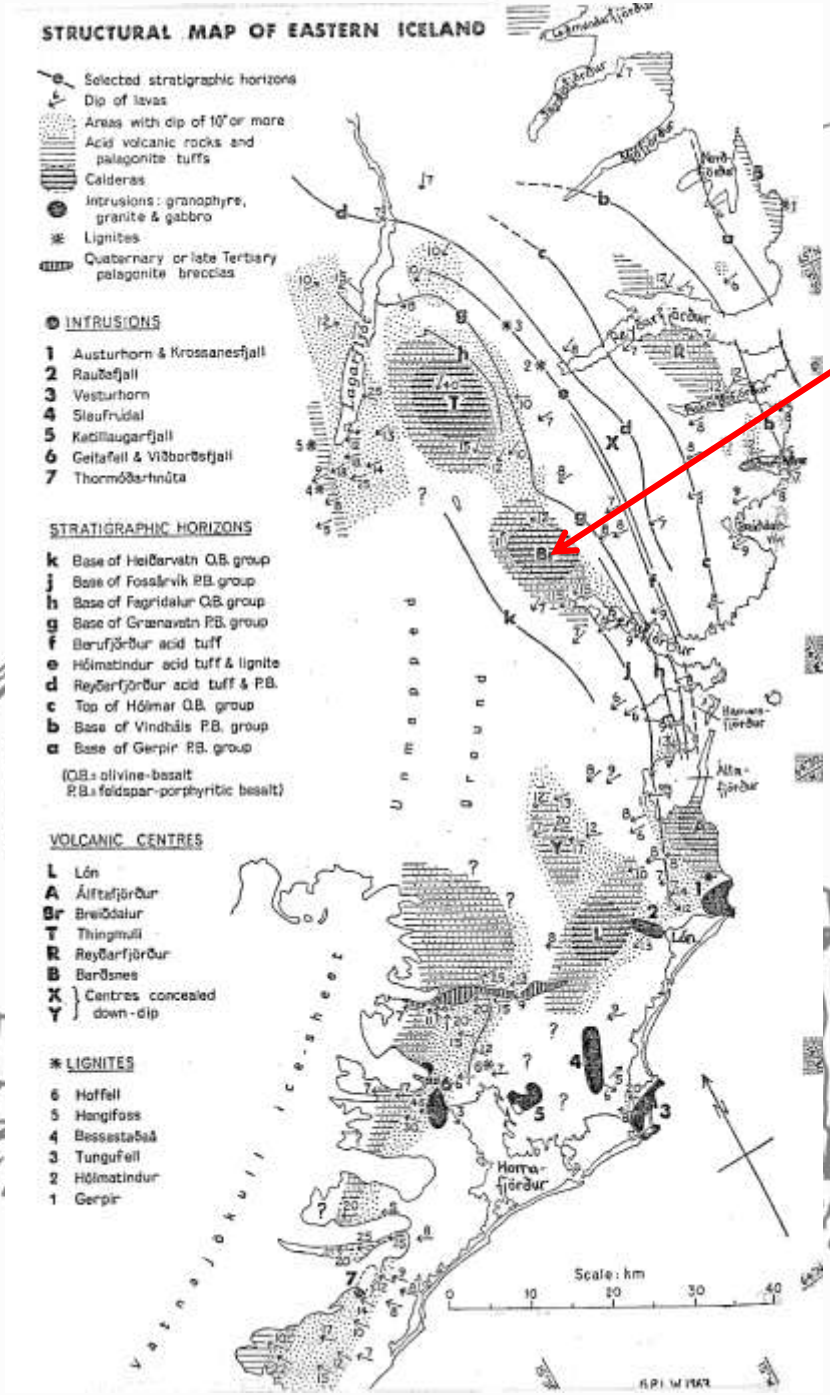
GAMLA KAUPFÉLAGIÐ BREIÐDALSVÍK

2. Geology of Breiðdalur, Eastern Iceland


SKÝRINGAR / LEGEND
MÆLIKVARÐI / SCALE 1 : 1 000 000
ÍSLAND
JARÐFRÆÐIKORT – GEOLOGICAL MAP
NÁTTÚRUFRÆÐISTOFNUN ÍSLANDS

Tertiary central volcanoes and flood basalts



Walker G.P.L.1964

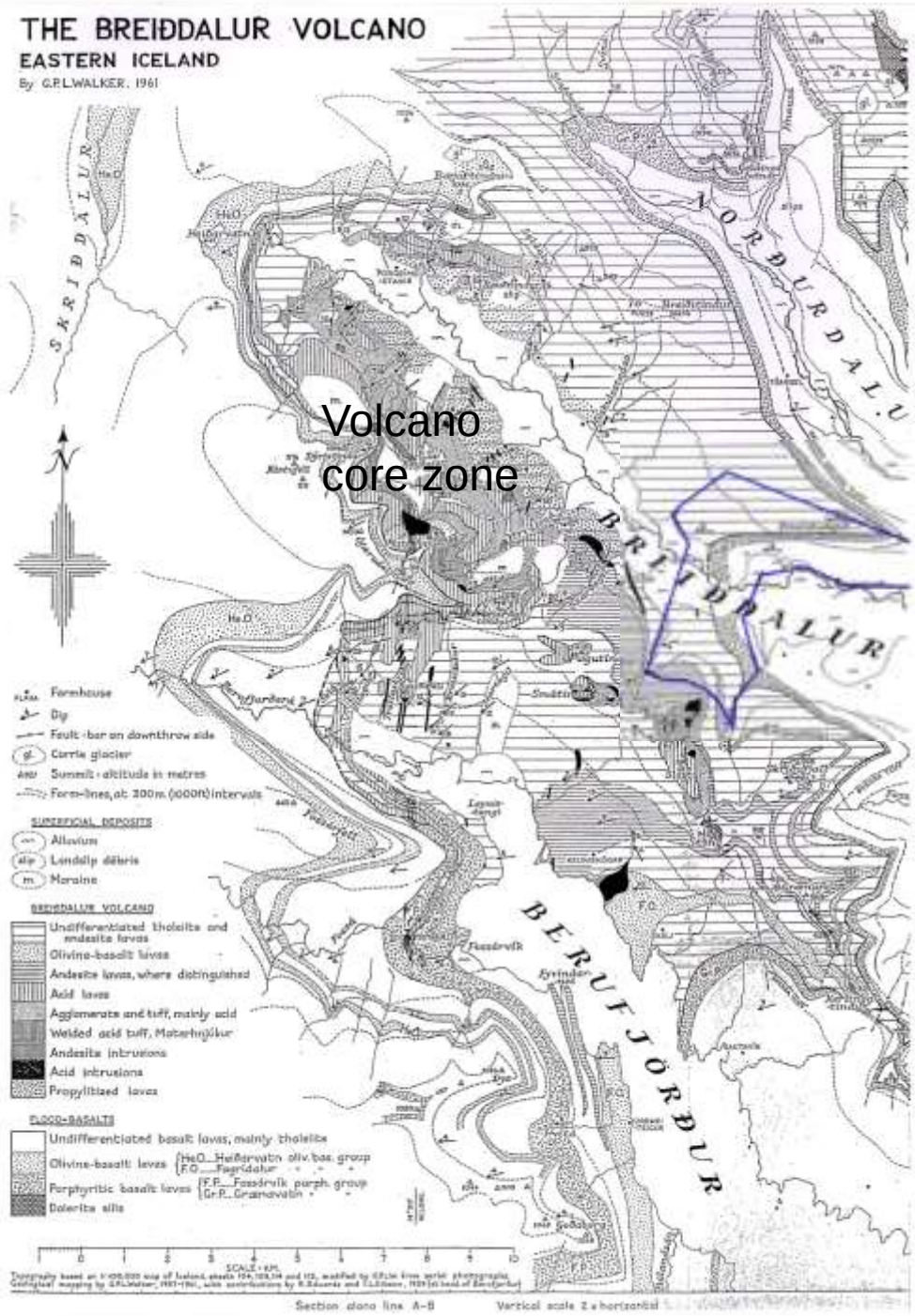
Flood basalts

Laki 1783

Central volcano

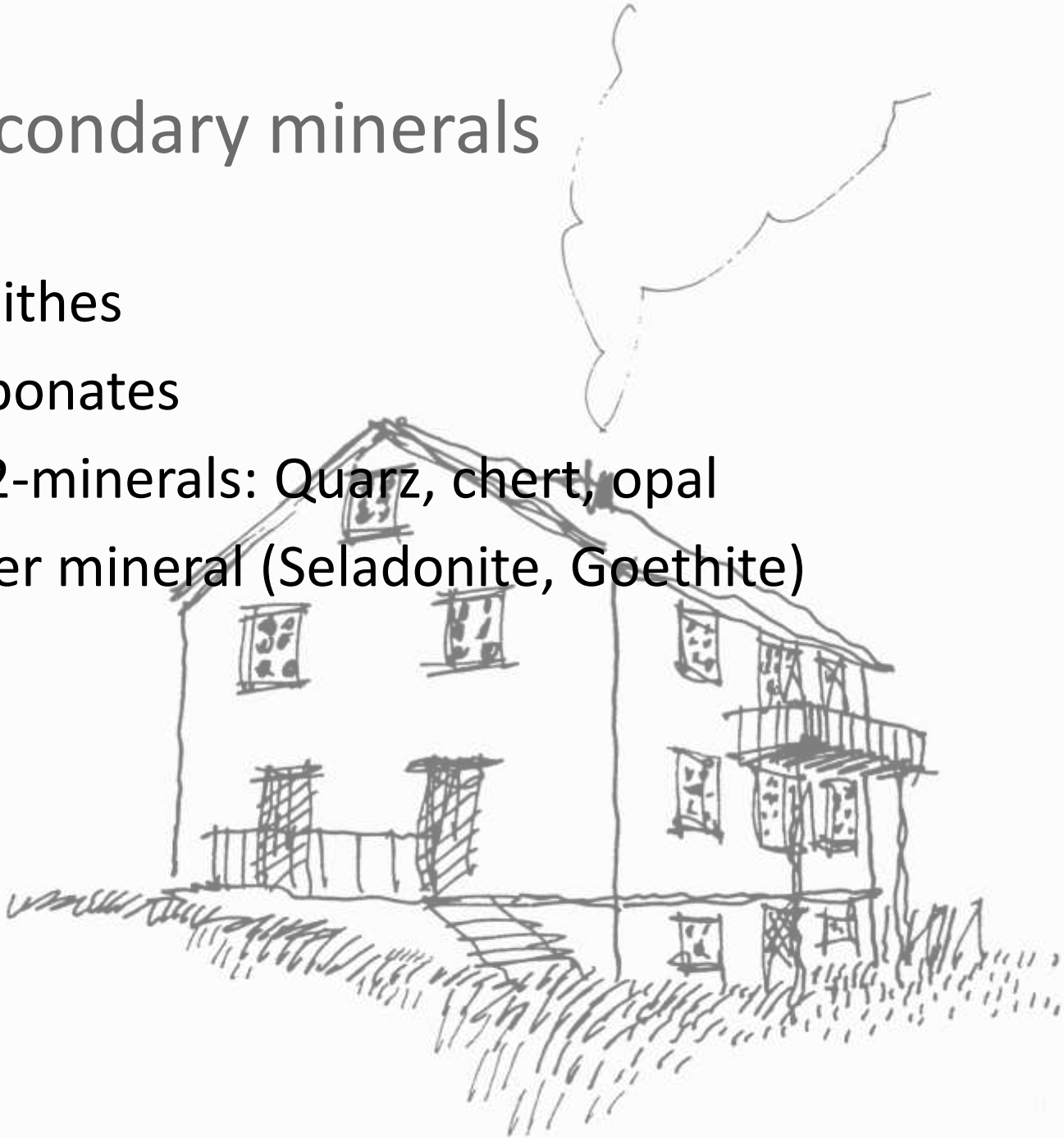
Eyjafjallajökull aprile 2010

Walker G.P.L. 1963



3. Secondary minerals

- Zeolithes
- Carbonates
- SiO2-minerals: Quarz, chert, opal
- Other mineral (Seladonite, Goethite)



Zeolithes

Fibrous zeolithes

Scolesite

Platy zeolithes

Stilbite

Carbonates

Calcite

Aragonite

SiO2-minerals

Quarz

Opal

SiO2-minerals

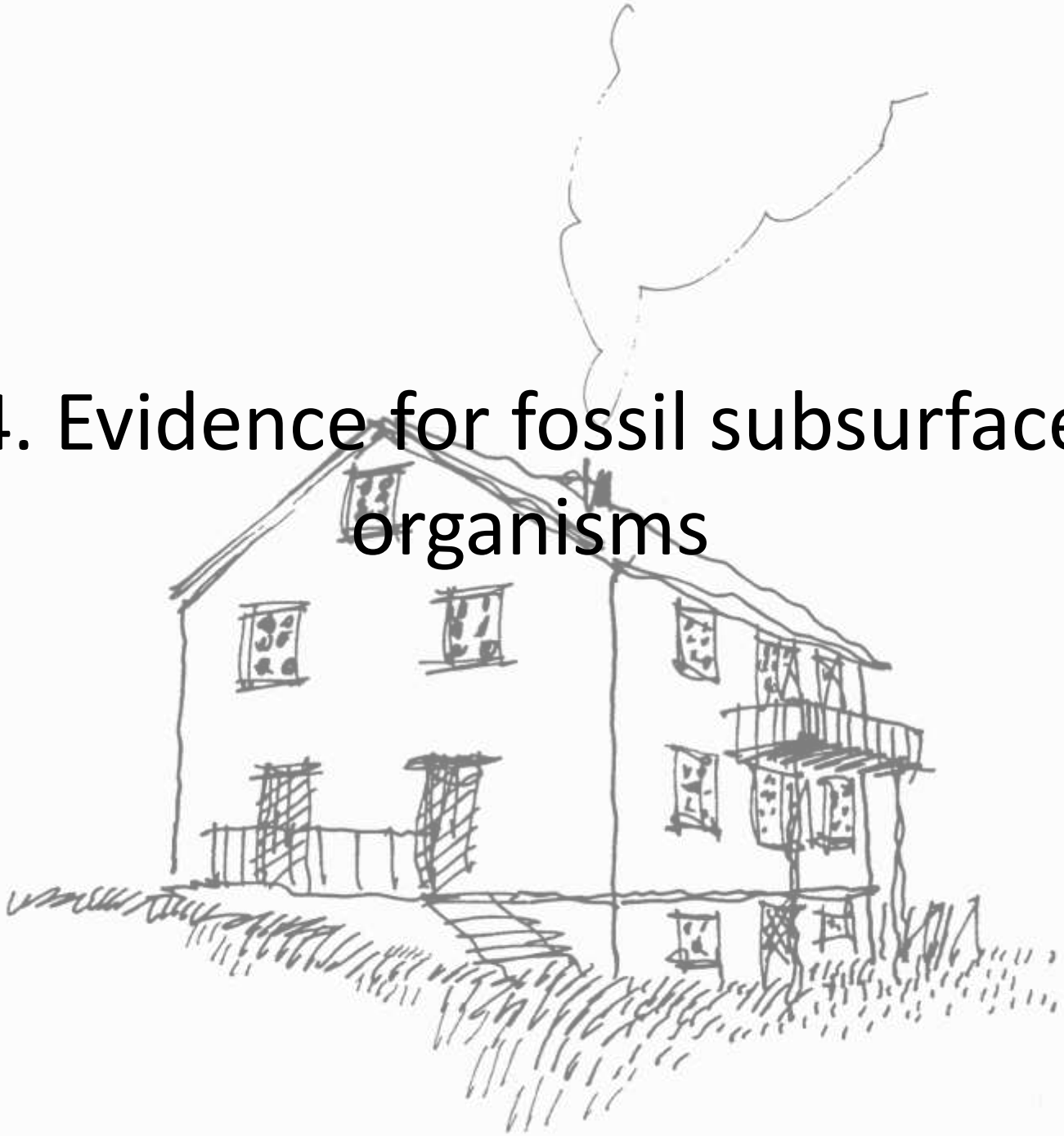
Chalcedony

Other minerals

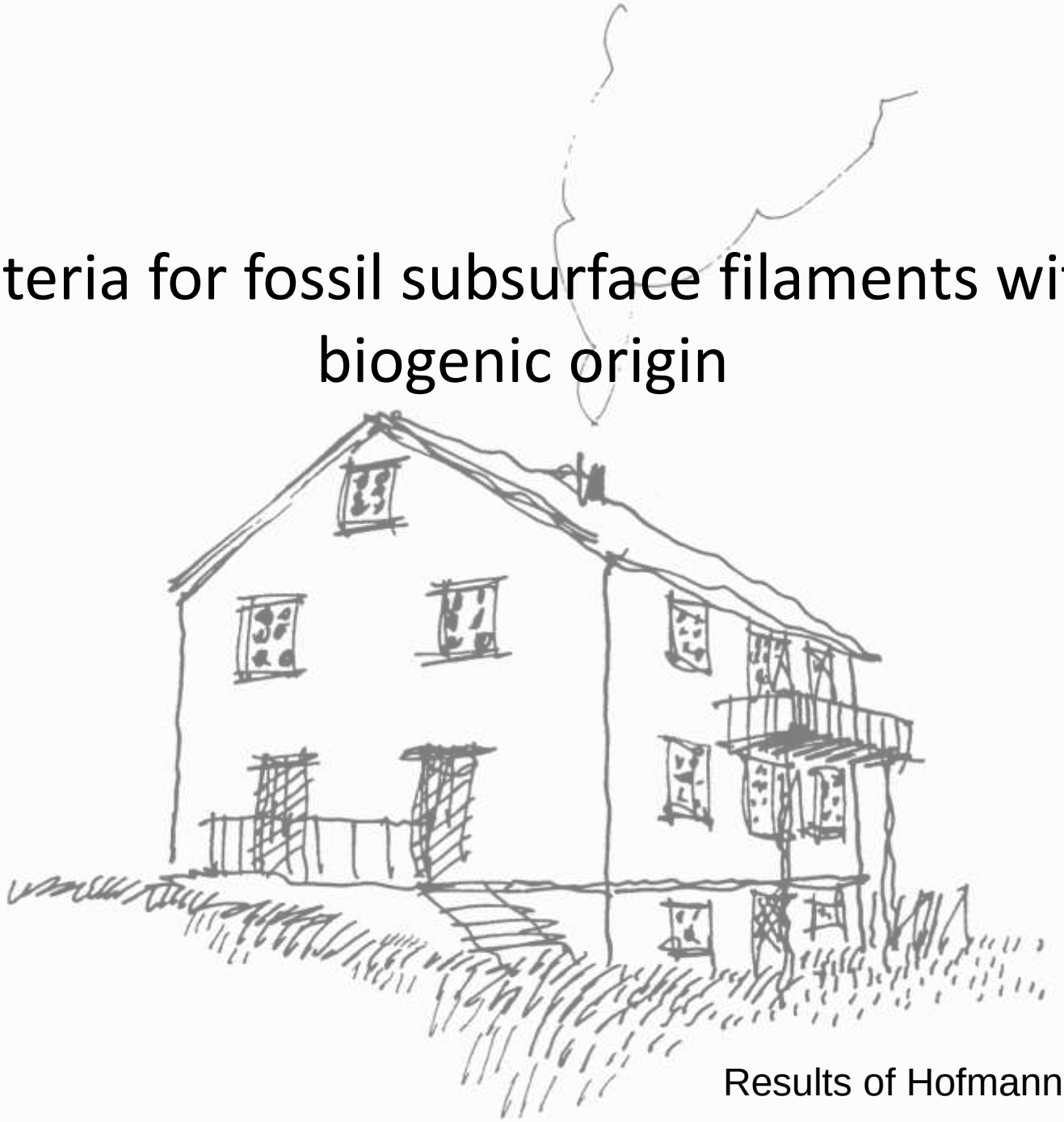
Celadonite

Goethite

4. Evidence for fossil subsurface organisms

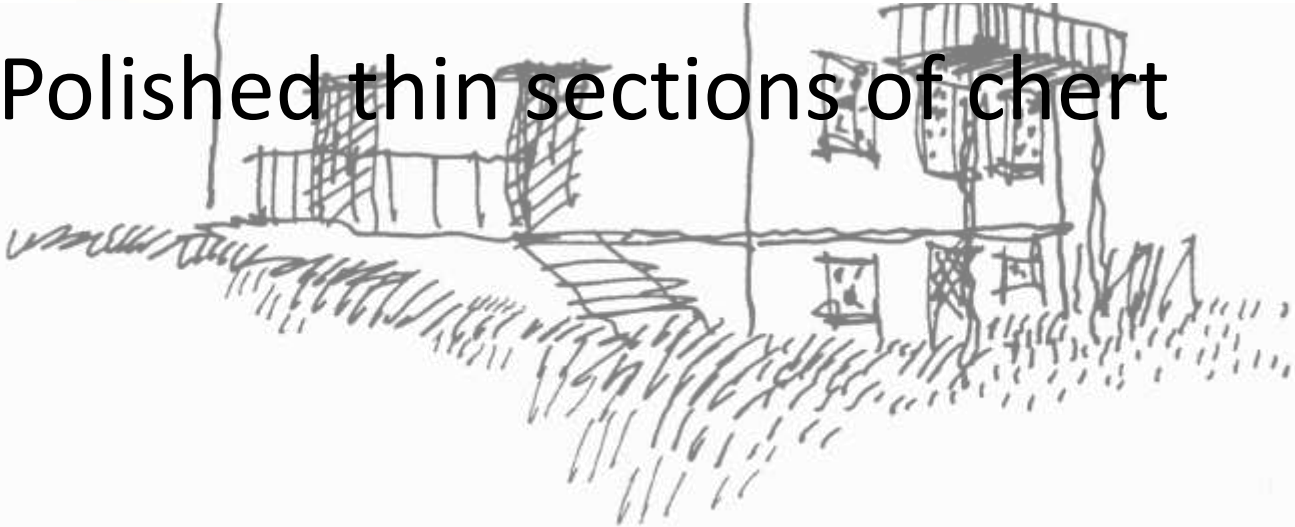


Criteria for fossil subsurface filaments with biogenic origin



Results of Hofmann et al., 2008

Polished thin sections of chert

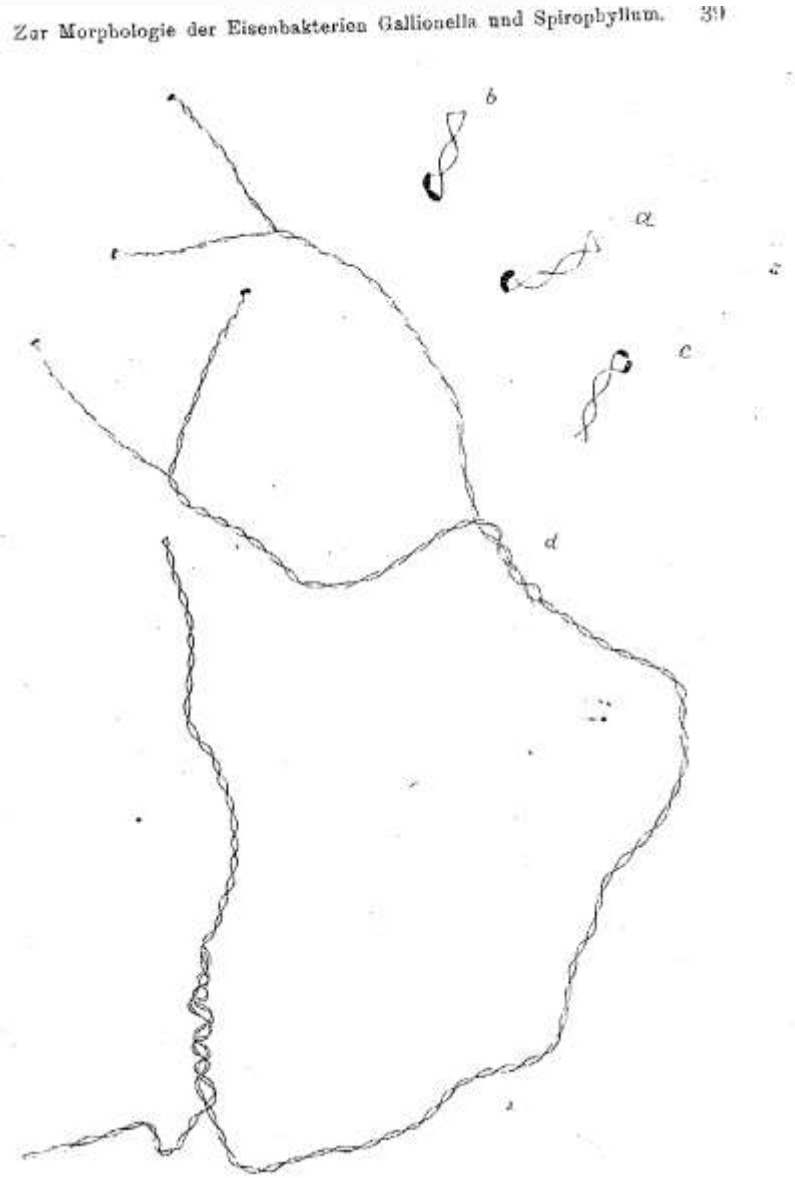


Fe-oxidizing organisms in swamps

Example of possible subsurface microbe:

Gallionella ferruginea, recent species:

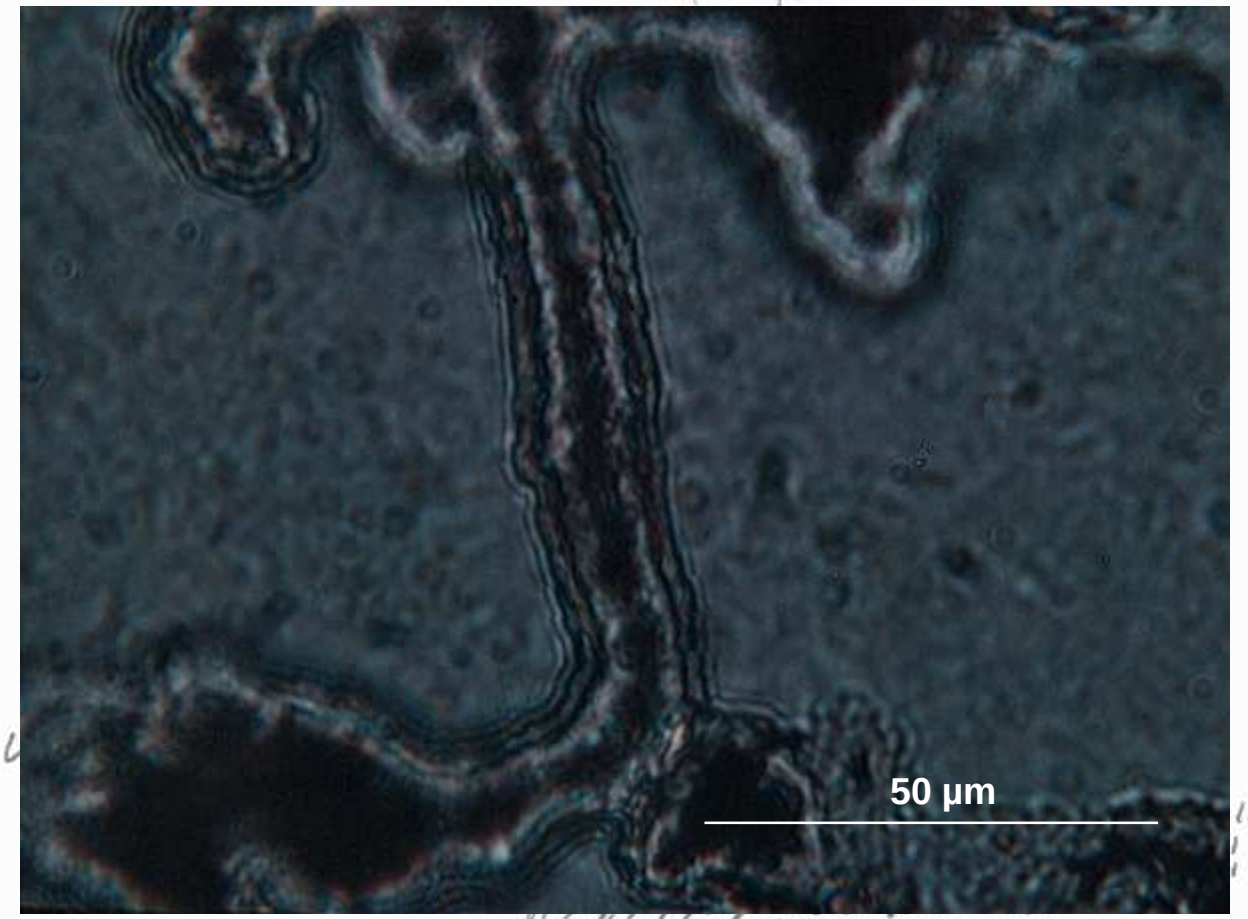
Fe-oxidating chemoautotroph



Track of a Gallionella f. Bacterium, enlargment 1000x
Ref. *Cholodny 1924*

Criteria for fossil subsurface filaments with biogenic origin

- Median width of the filamentous core <5 µm



Results of Hofmann et al., 2008

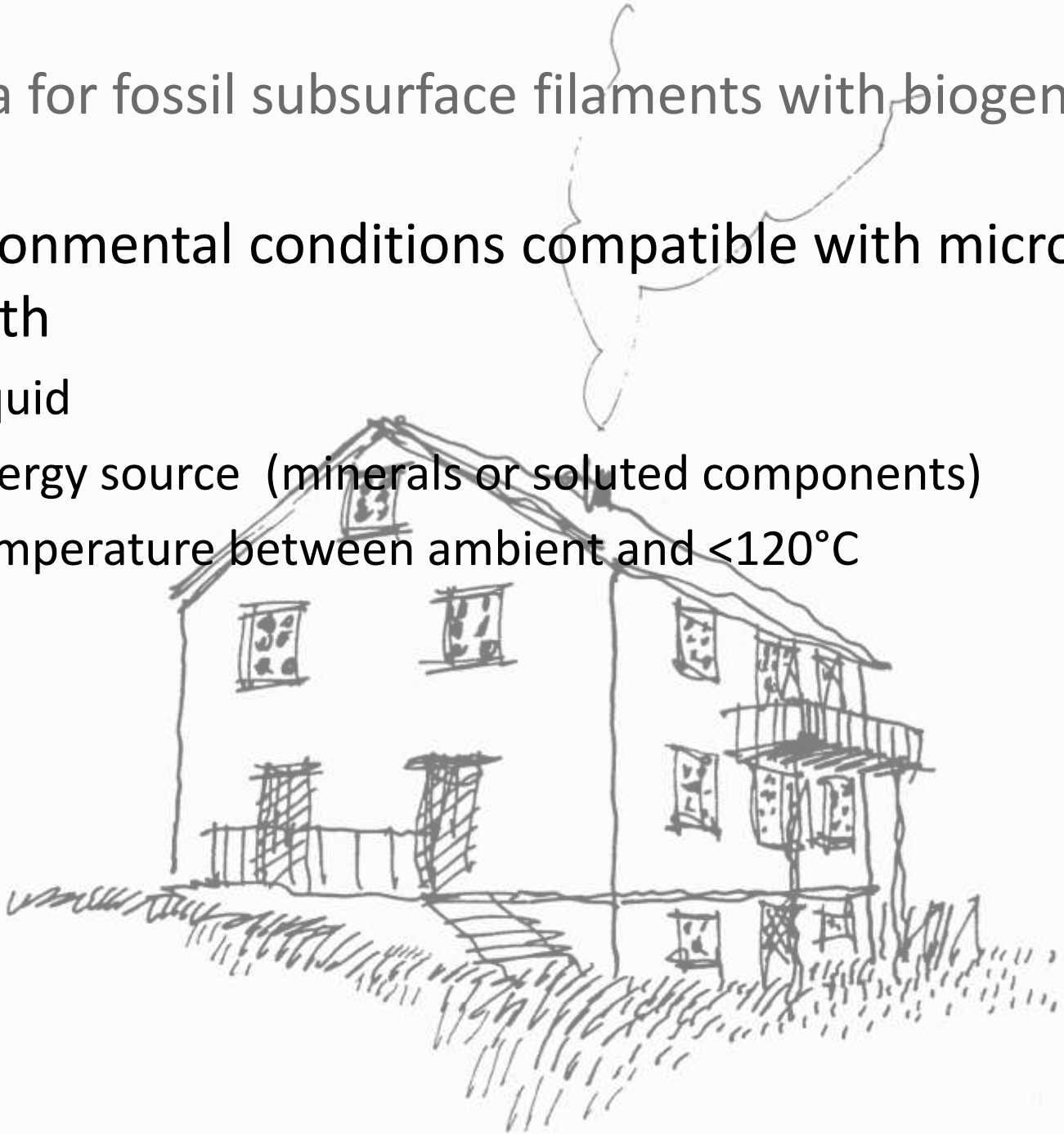
Criteria for fossil subsurface filaments with biogenic origin

- Filamentous core show a high degree of irregular bending (<0,5°/µm) many direction changes >10/mm)

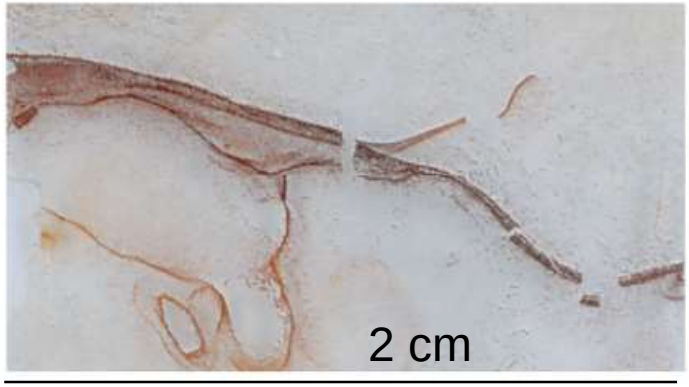
Results of Hofmann et al., 2008

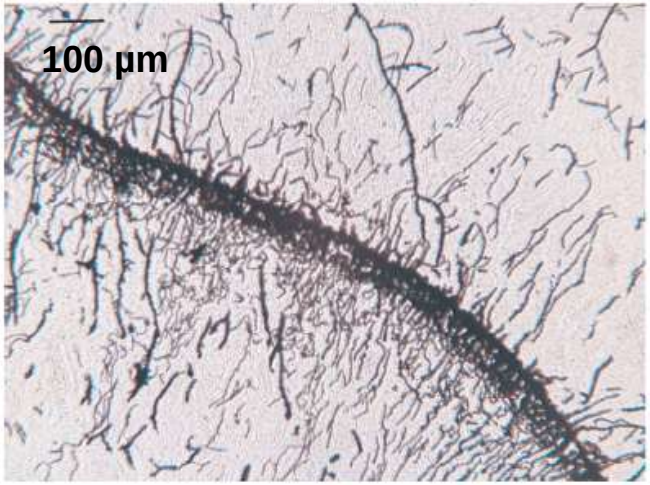
Criteria for fossil subsurface filaments with biogenic origin

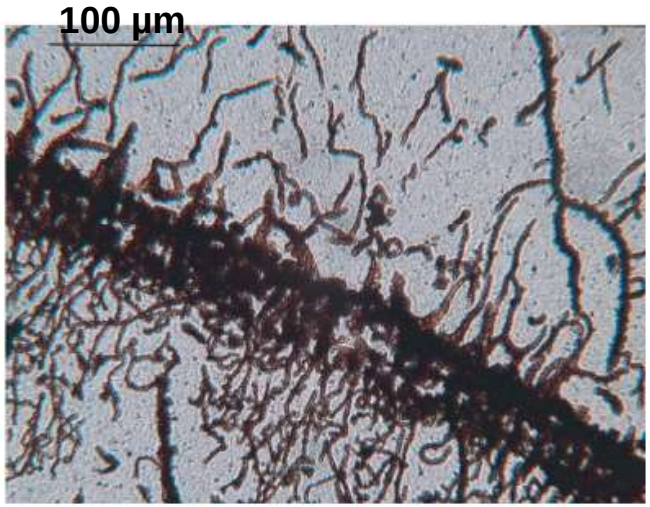
- Environmental conditions compatible with microbial growth
  - Liquid
  - Energy source (minerals or soluted components)
  - Temperature between ambient and <120°C



Mineralized filaments with biogenic origin

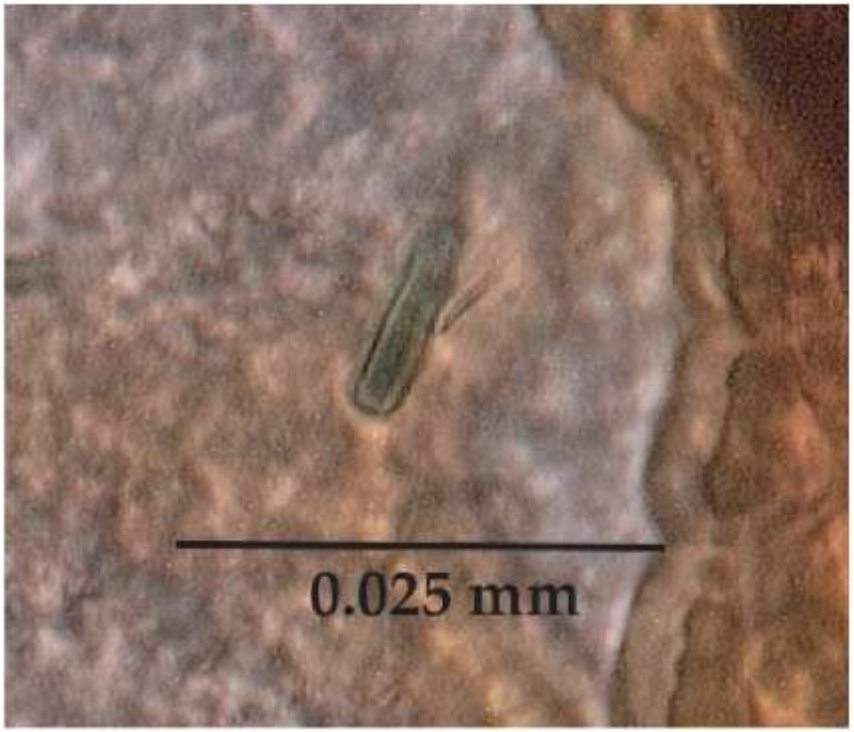






Picture <----> ca 300 µm, polarised

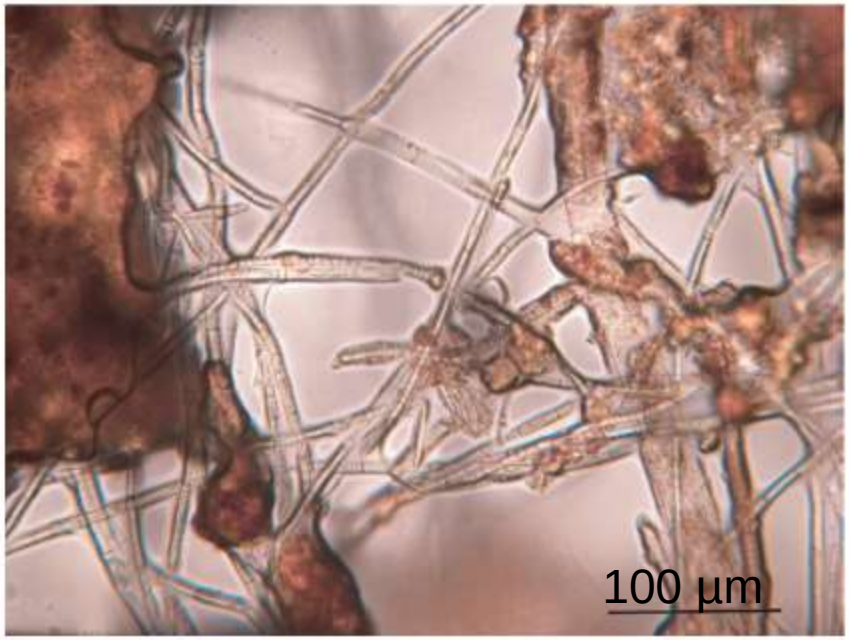
Leptothrix

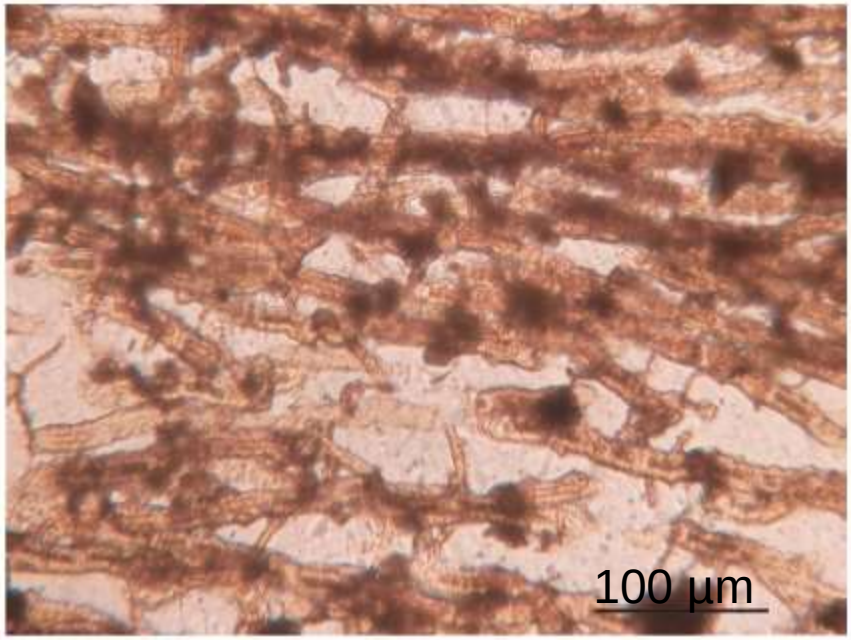


Recent

Fossil

Fungi

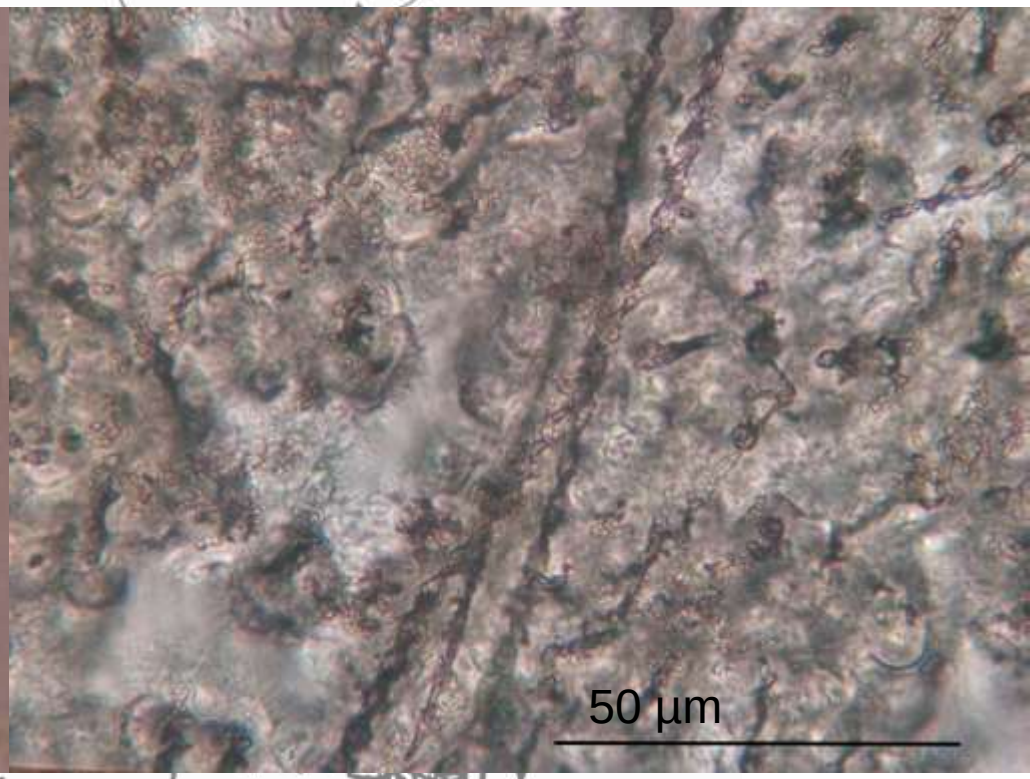




Recent

Fossil

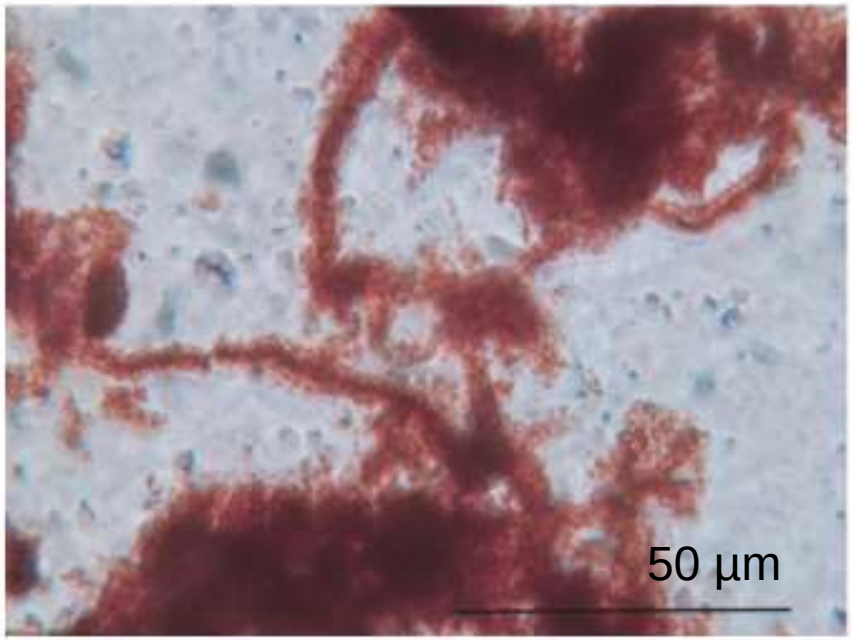
Gallionella ferruginea, twisted stalks

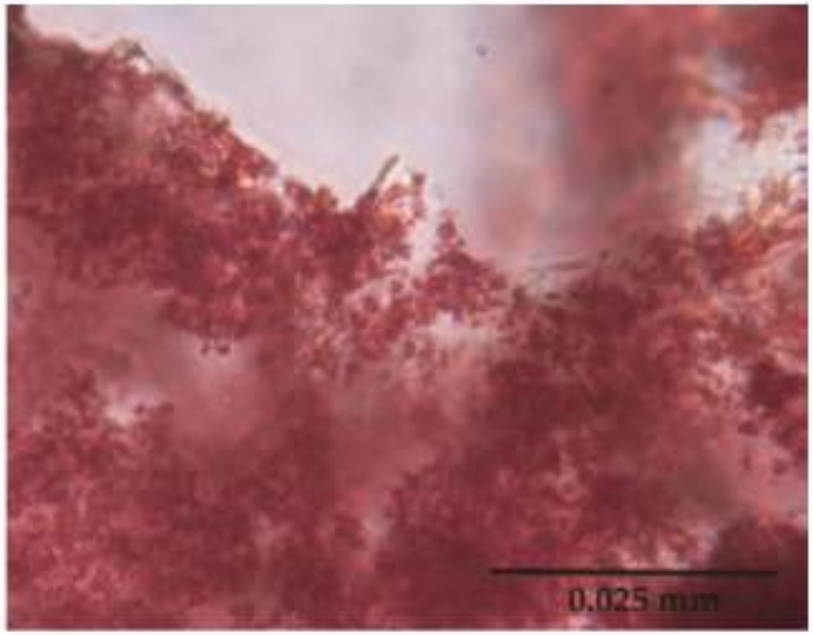


Recent

Fossil

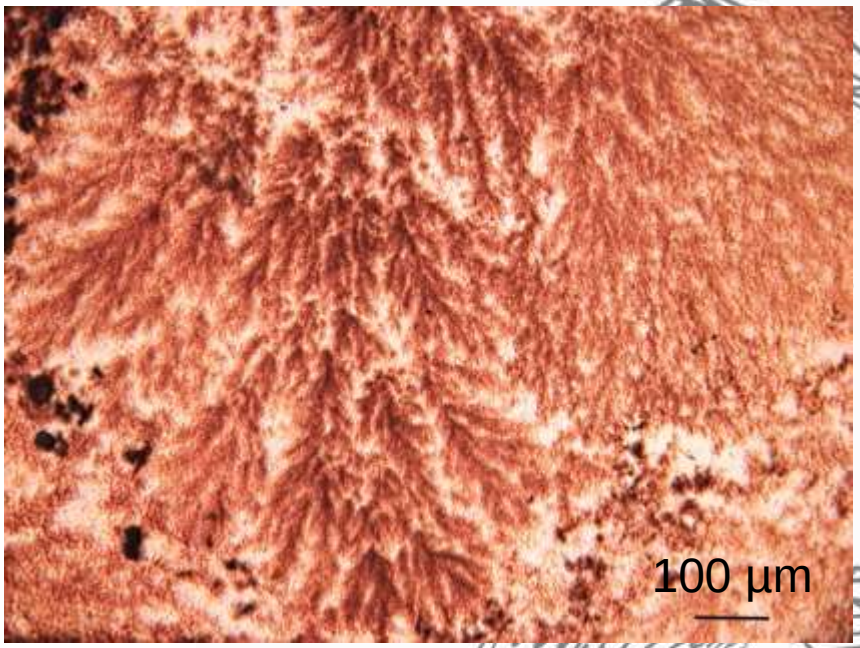
Biogenic?



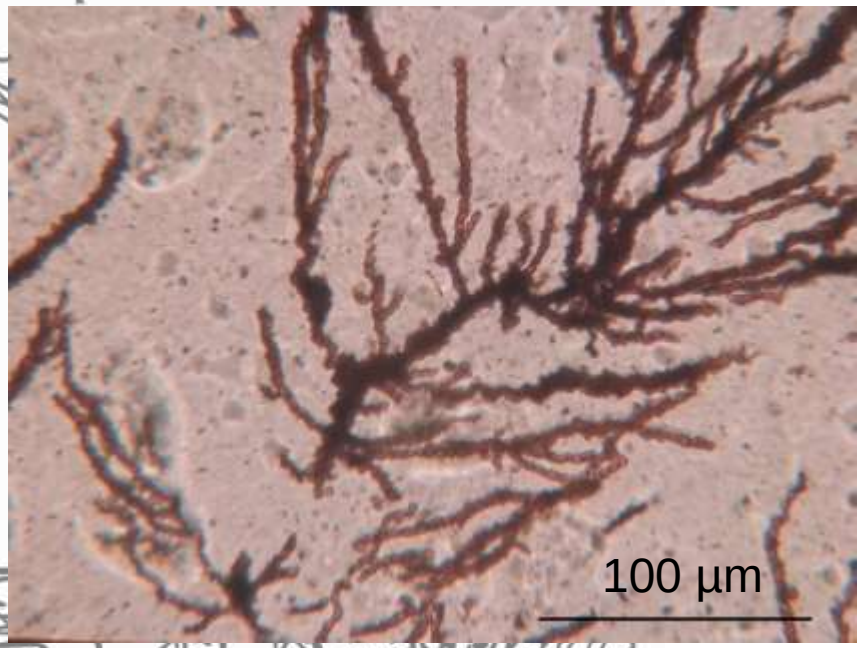


Dendrites

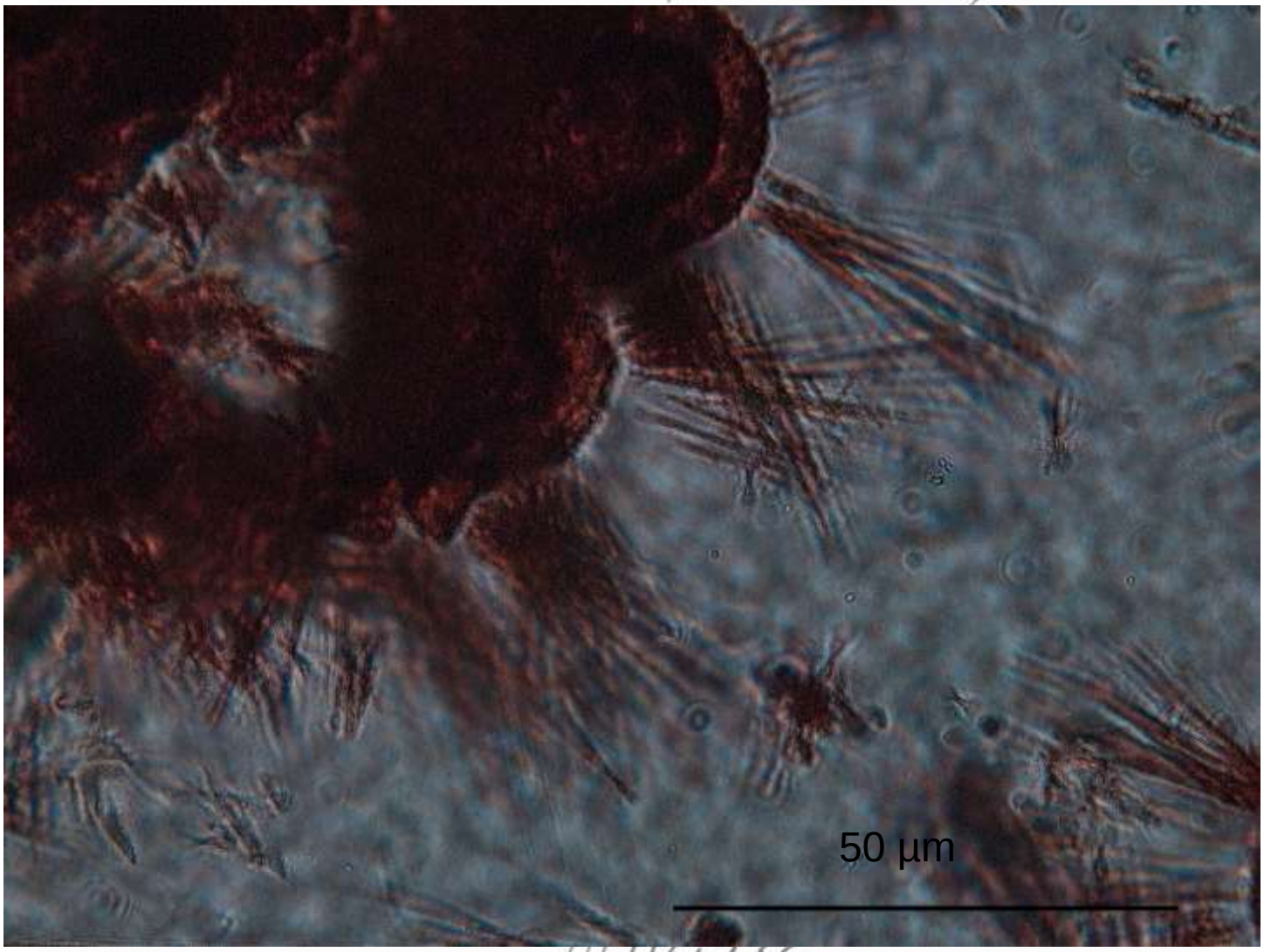
Probably abiogenic



Probably biogenic



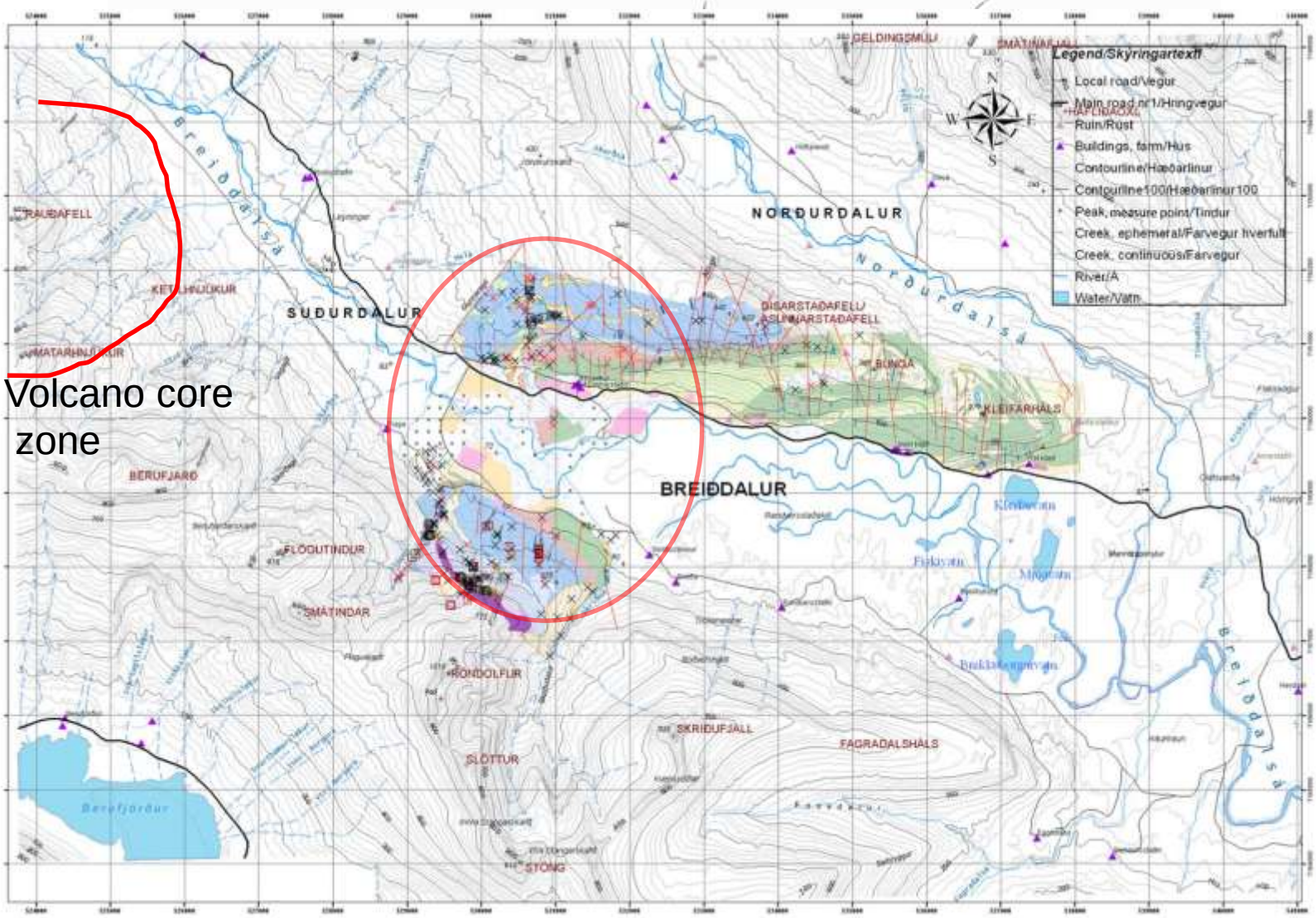
Abiogenic: Fibres



Goethite

5. Discussion/results

Associated with central volcano contact aureole ~5 km from volcano core, where chert is most abundant



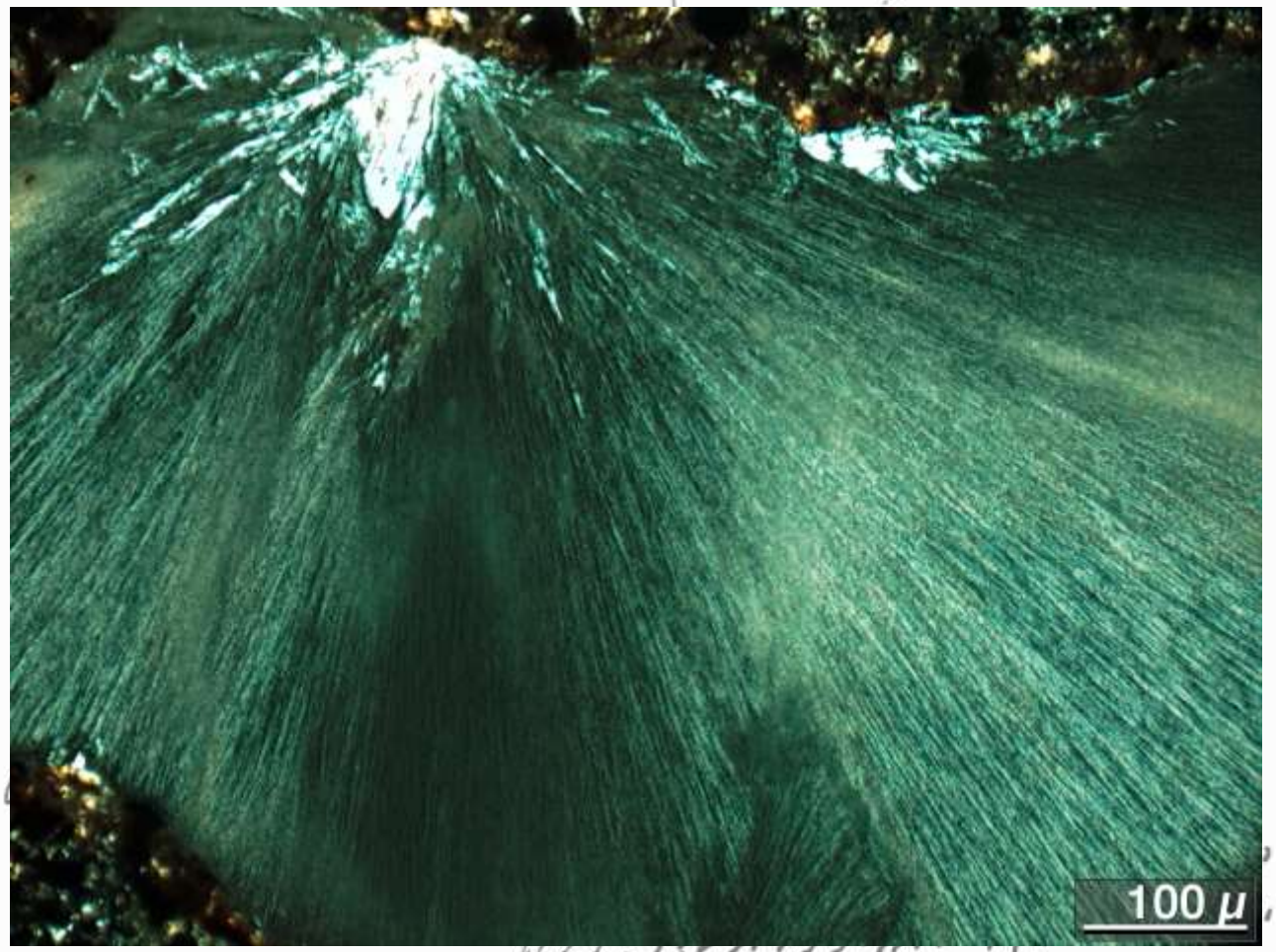
Volcano core zone

In basaltic and andesitic host rocks

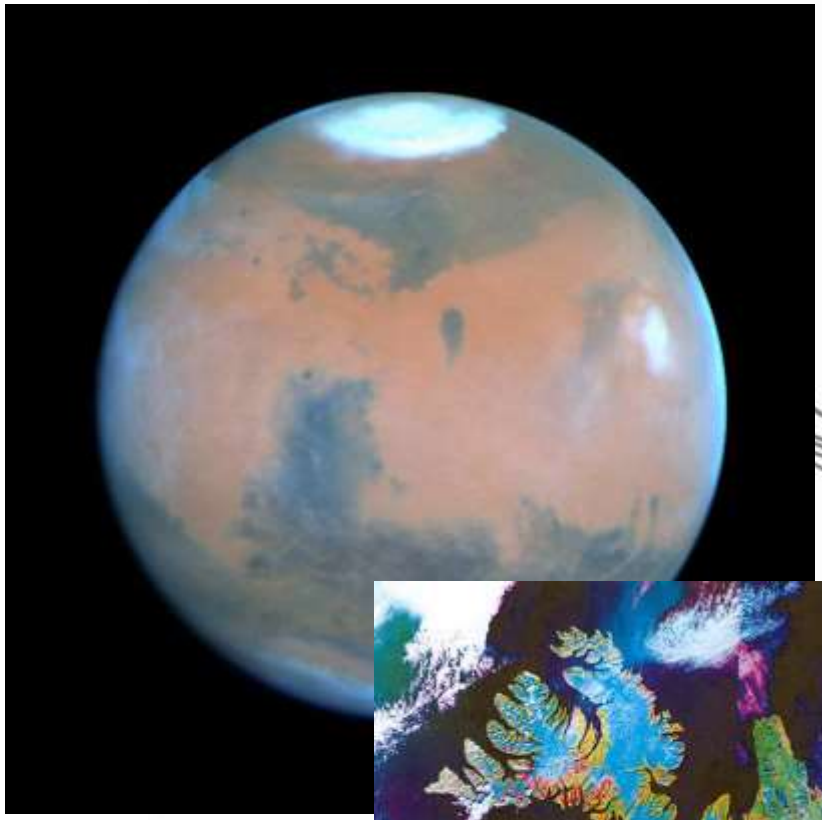
Basalt

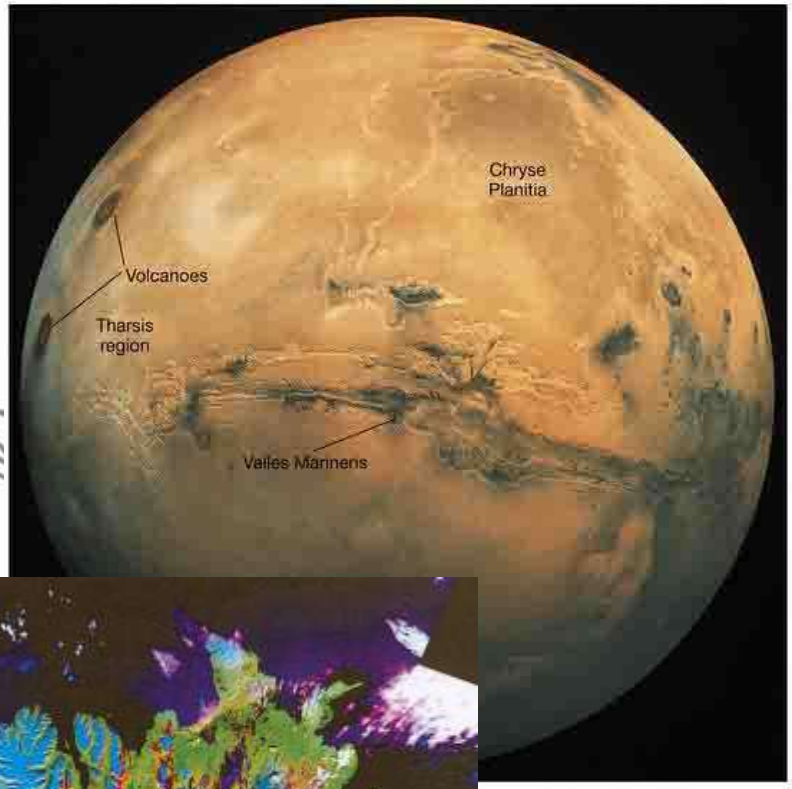
Andesite

No signatures found in zeolithe filled pores

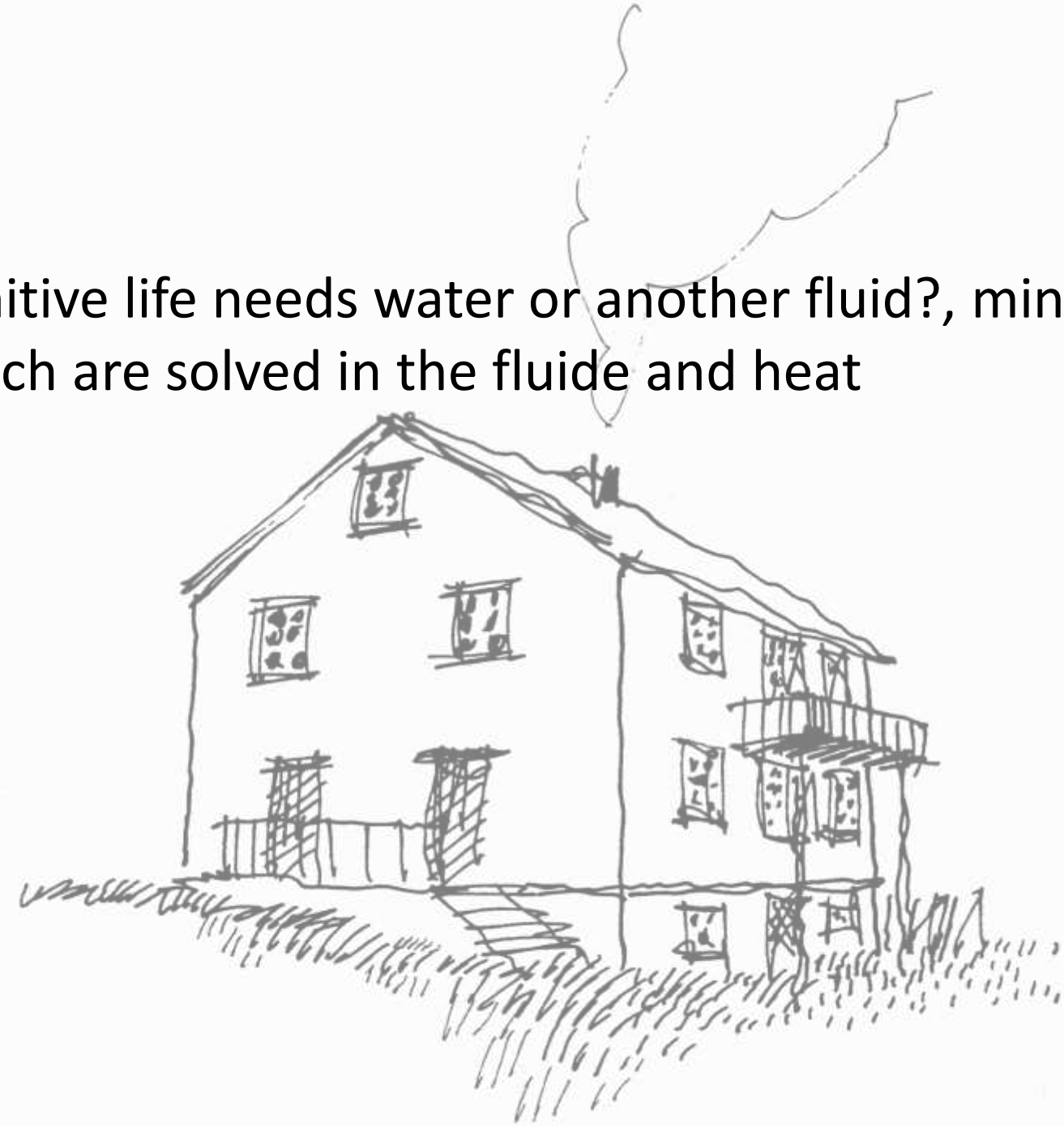


Why researching this???? Link to extraterrestrial



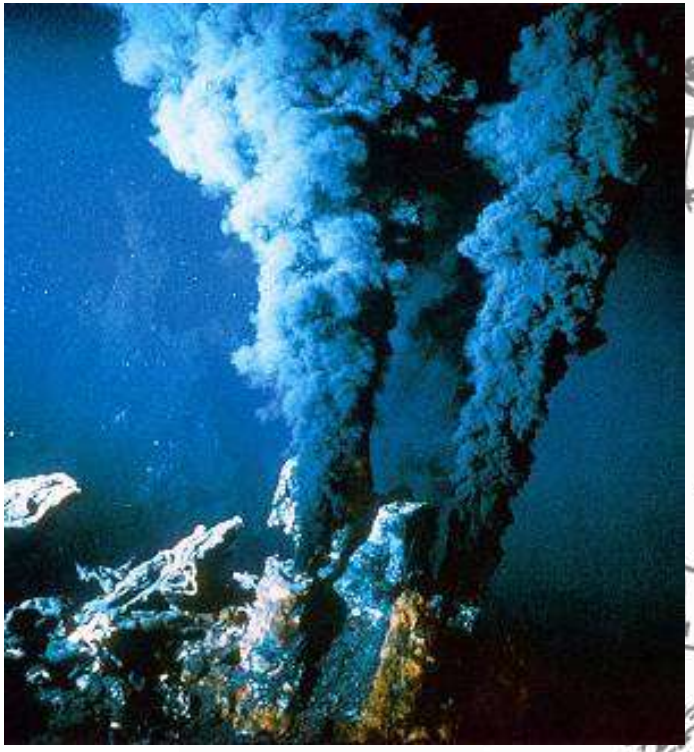


- Pimitive life needs water or another fluid?, minerals which are solved in the fluide and heat



Primitive life on Earth at deep sea hot springs

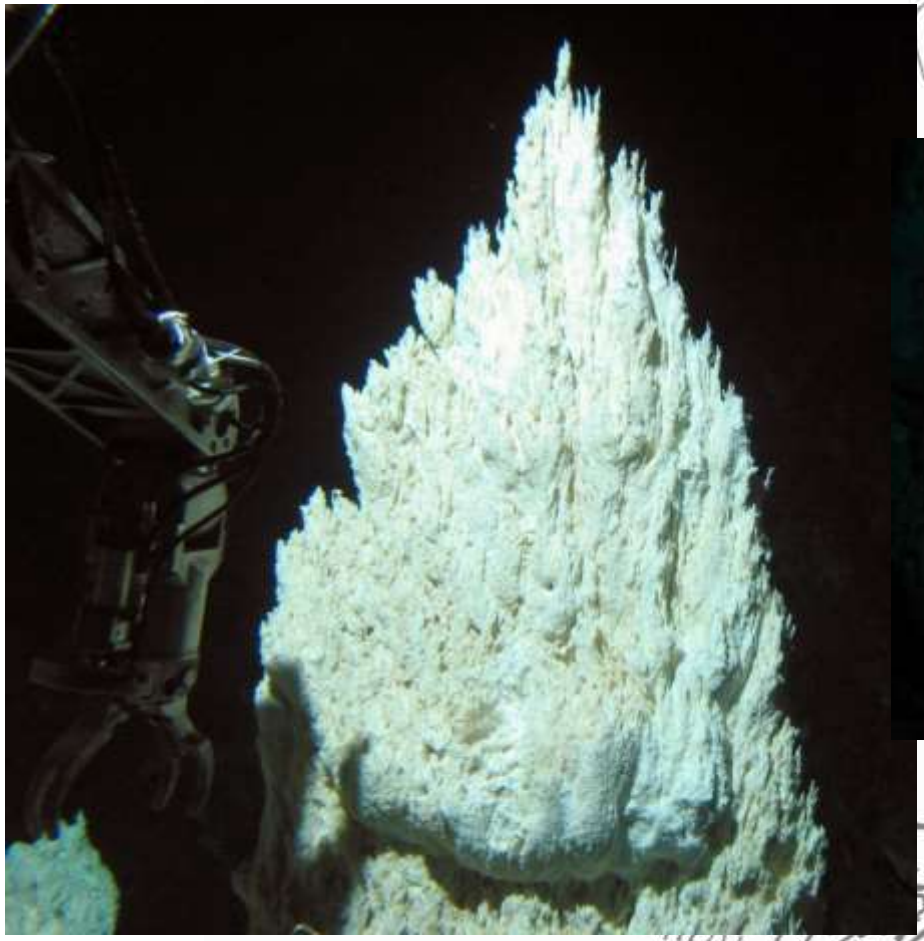
Black smoker



White smoker

Non-smokers, lost City, 2000

Úr karbonöt

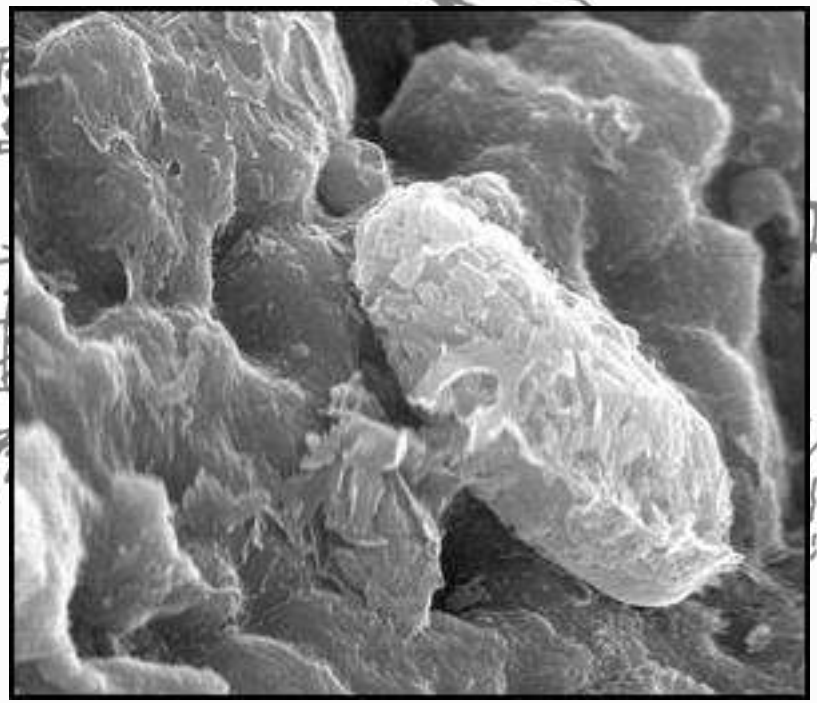


Vatn 40-75°C

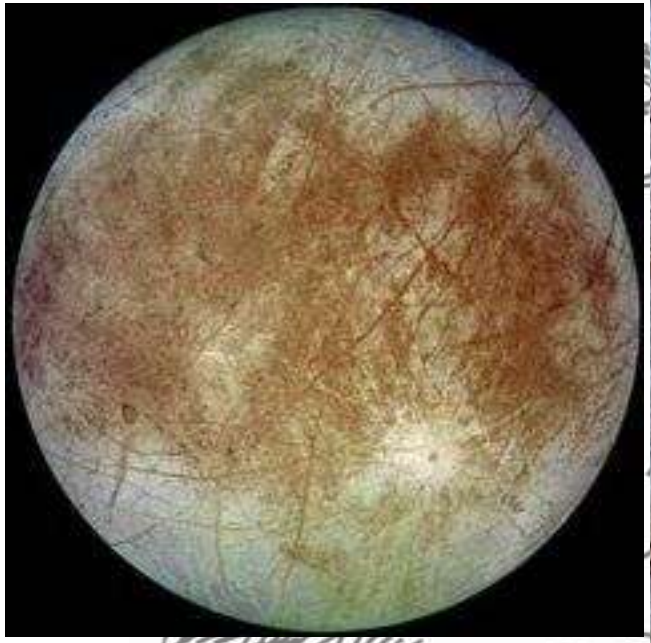
Primitive life on Mars?

Mars Meteorite ALH84001, Antarctica

biogene structures? *Mckay et al. 1996*.



Jupiter moon Europa



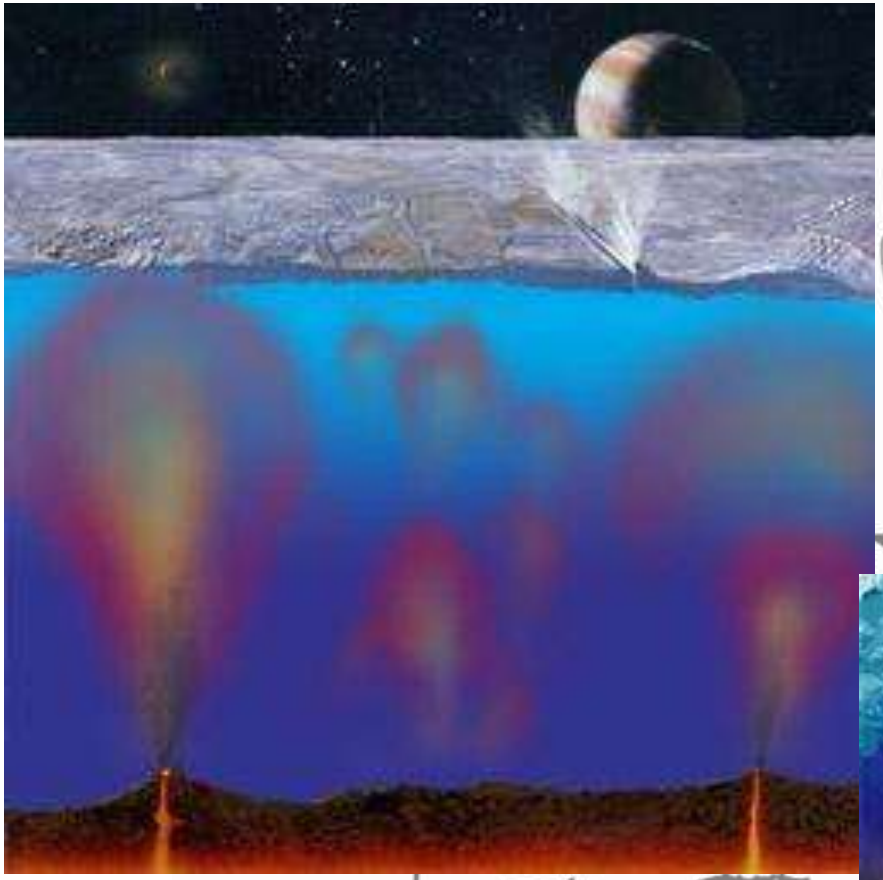
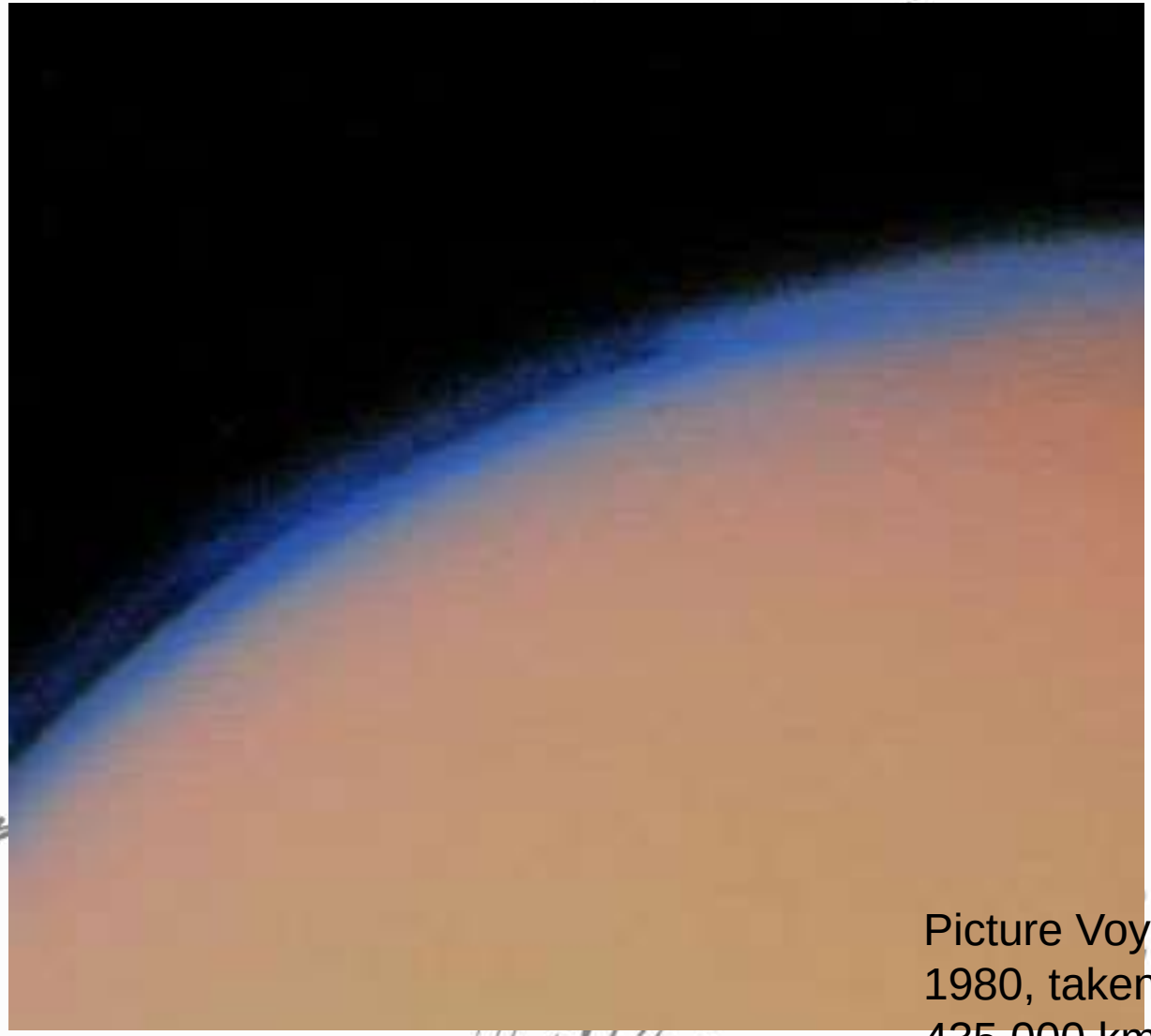
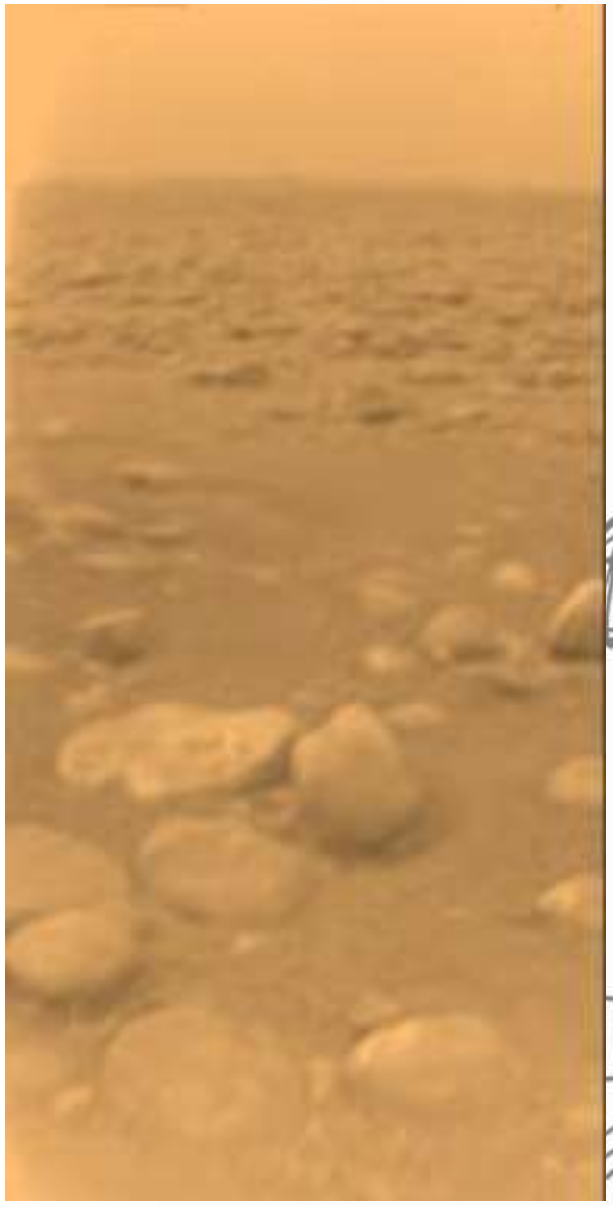


Plate tectonics on ice?

Saturnian moon Titan



Picture Voyager-1 1980, taken from 435,000 km



SA, Space probe Huygens, jan 2005,
nding site

Methan í vökvaformi,
mynd frá 16 km

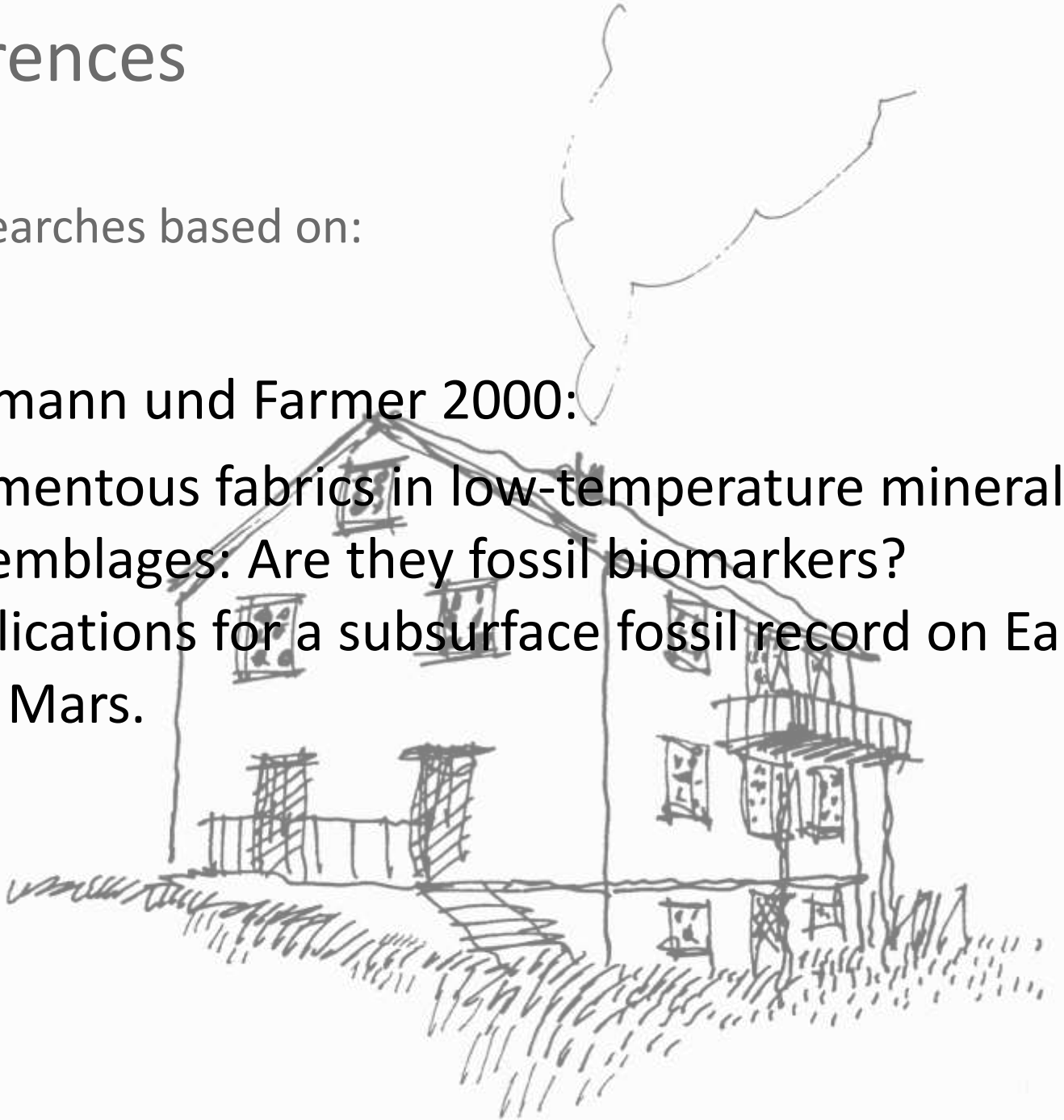
6. References

References

My researches based on:

- Hofmann und Farmer 2000:

  Filamentous fabrics in low-temperature mineral Assemblages: Are they fossil biomarkers? Implications for a subsurface fossil record on Earth and Mars.



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- Hofmann B. A., 2007. Morphological biosignatures from subsurface environments: recognition on planetary missions. *Space Science Reviews*. DOI 10.1007/S11214-007-9147-9.
- Hofmann et al. 2008: Subsurface Filamentous Fabrics: An Evaluation of Origins Based on Morphological and Geochemical Criteria, with Implications for Exopaleontology. *Astrobiology,* Volume 8, Number 1, 2008
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Reference for extreme life

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- MARTEINSSON, V.P., KRSTJANSSON, J.K., KRISTMANNSDÓTTIR, H., DAHLKVIST, M., SÆMUNDSSON, K., HANNINGTON, M., PÉTURSDÓTTIR, S.K., GEPTNER, A. & STOFFERS, P. 2001: Discovery and description of giant submarine smectite cones on the seafloor in Eyafjörður, Northern Iceland, and a novel thermal microbial habitat. Applied and Environmental Microbiology 67, 827-833

Takk fyrir

Thank you