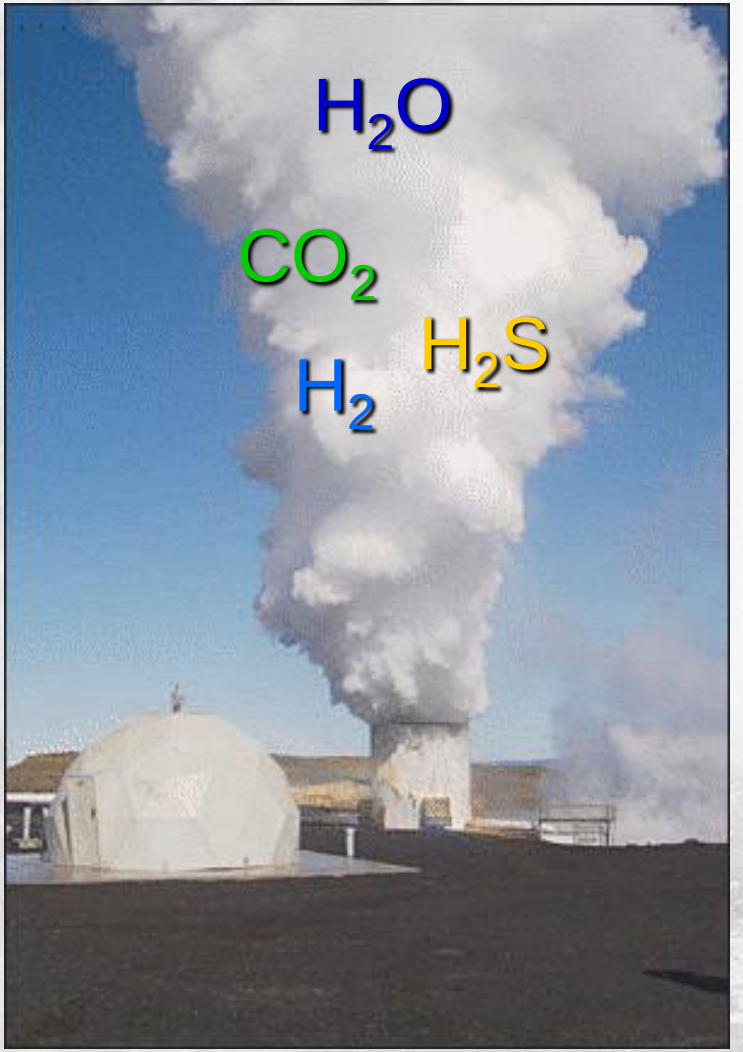
21. maí 2010

Biological Utilization of Geothermal Gas.

Guðmundur Óli Hreggviðsson



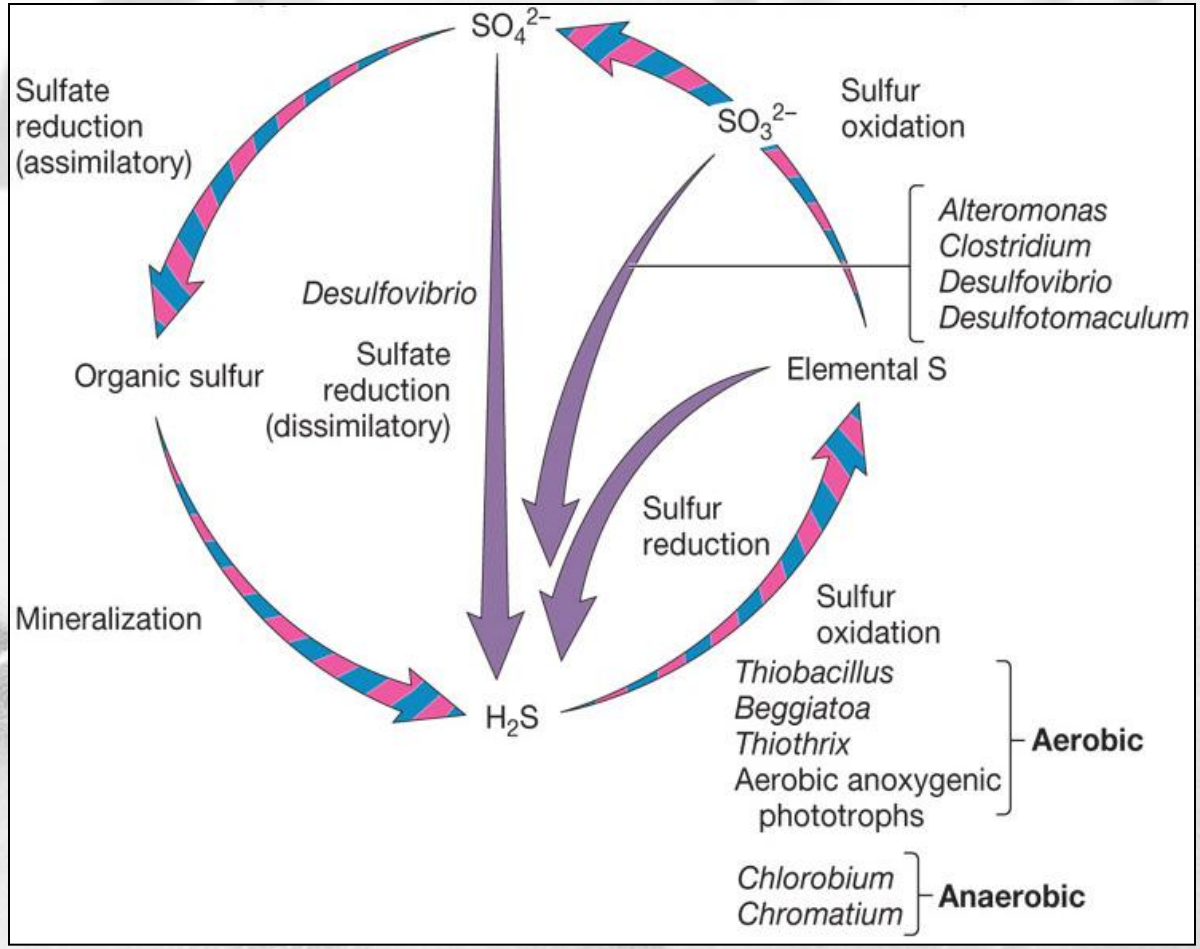
Background

- **2004**: Project starts at Prokaria ehf.:
- Cultivation of bacteria on H_2 & H_2S on geothermal gas for the production of industrial enzymes.

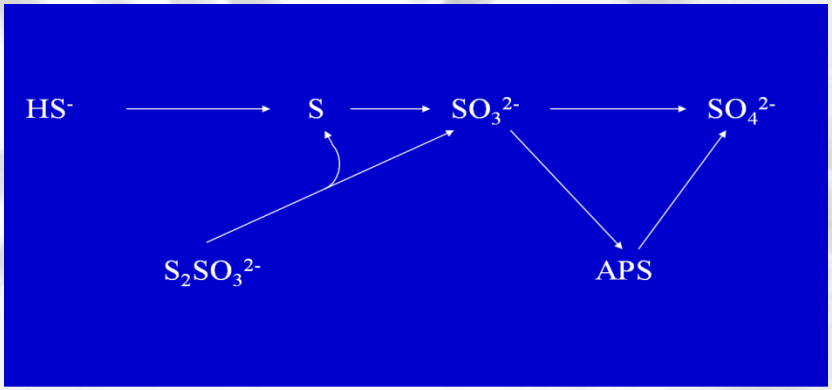
Energy and carbon from the gas utilized for growth

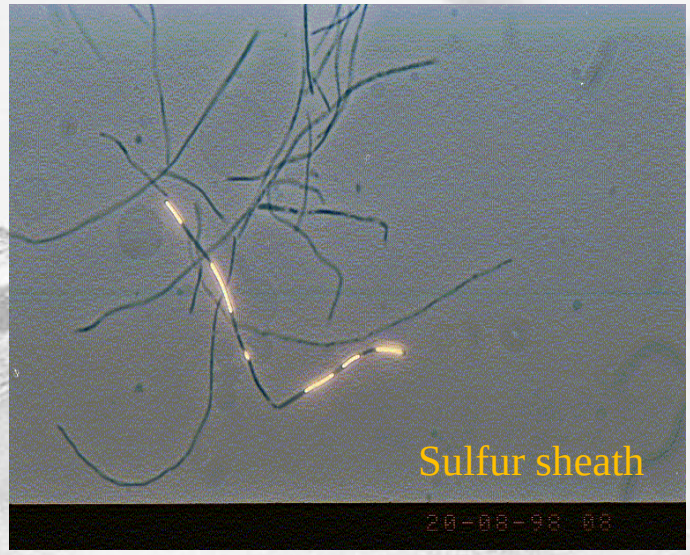
$H_2 + O_2 \rightarrow H_2O$
$H_2S + O_2 \rightarrow S_0 \rightarrow SO_4$
$CO_2 + H_2O \rightarrow (CHO)_n$
biomass

The sulfur cycle



H_2S oxidation





Sulfur deposits
in a microbial mat

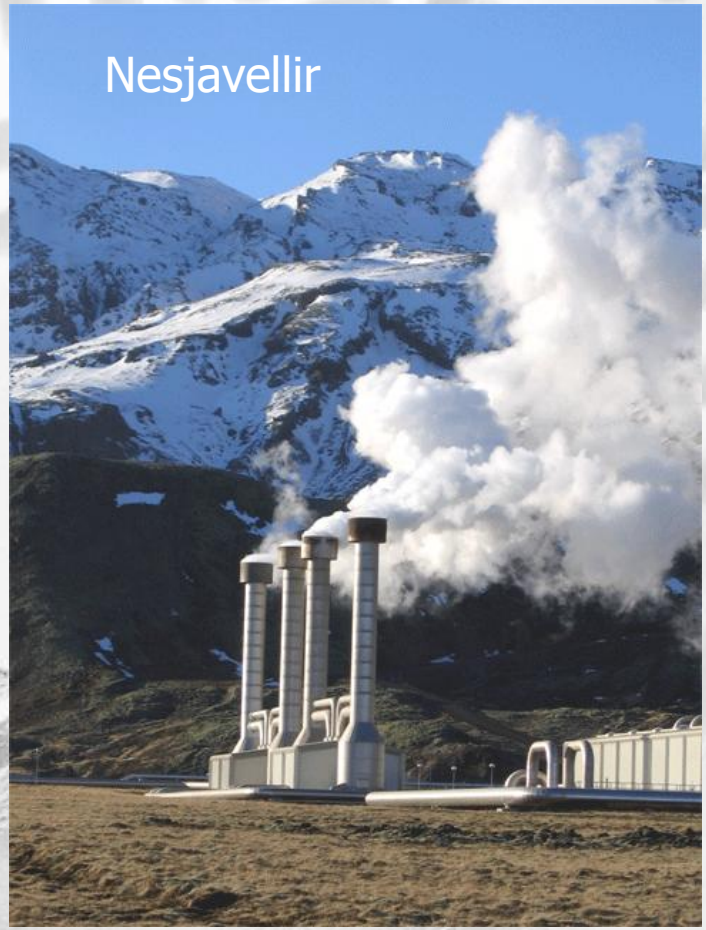
Laboratory studies

- **2005**: Prokatin ehf – spin-off.
  Energy biotechnology: Single-cell-protein (protein meal) from H_2 & H_2S and CO_2 for animal feed

Sulfur

Single-cell-protein

Laboratory at Nesjavellir



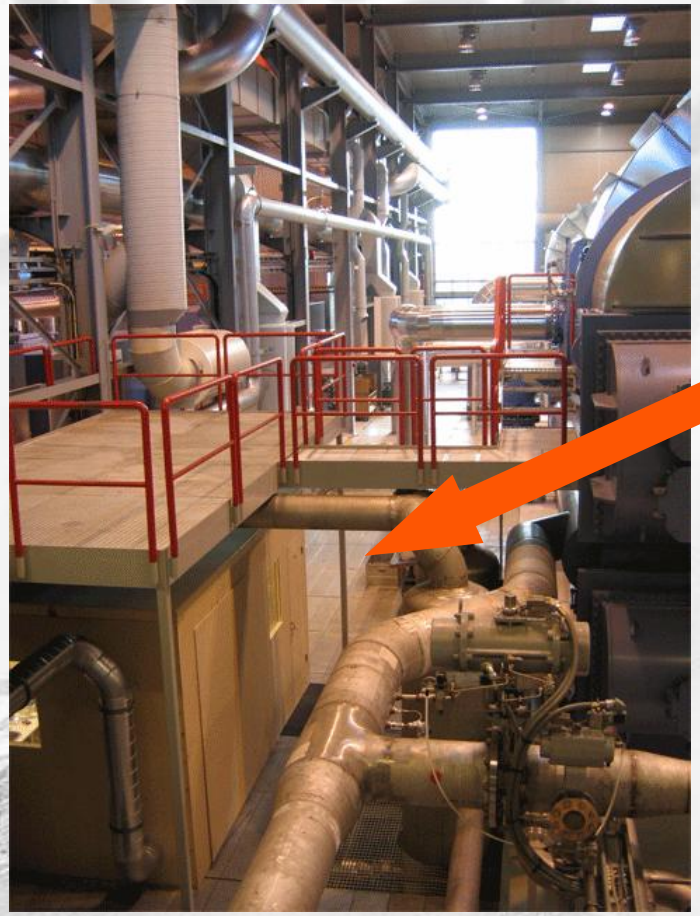
- **2007**: Cooperation with OR
- Laboratory established at Nesjavellir.
- Microbes cultivated on geothermal gasses directly from the power plant
- Aim: remove H_2S, and produce protein & sulfur

prokatín

Orkuveita Reykjavíkur

The laboratory at Nesjavellir

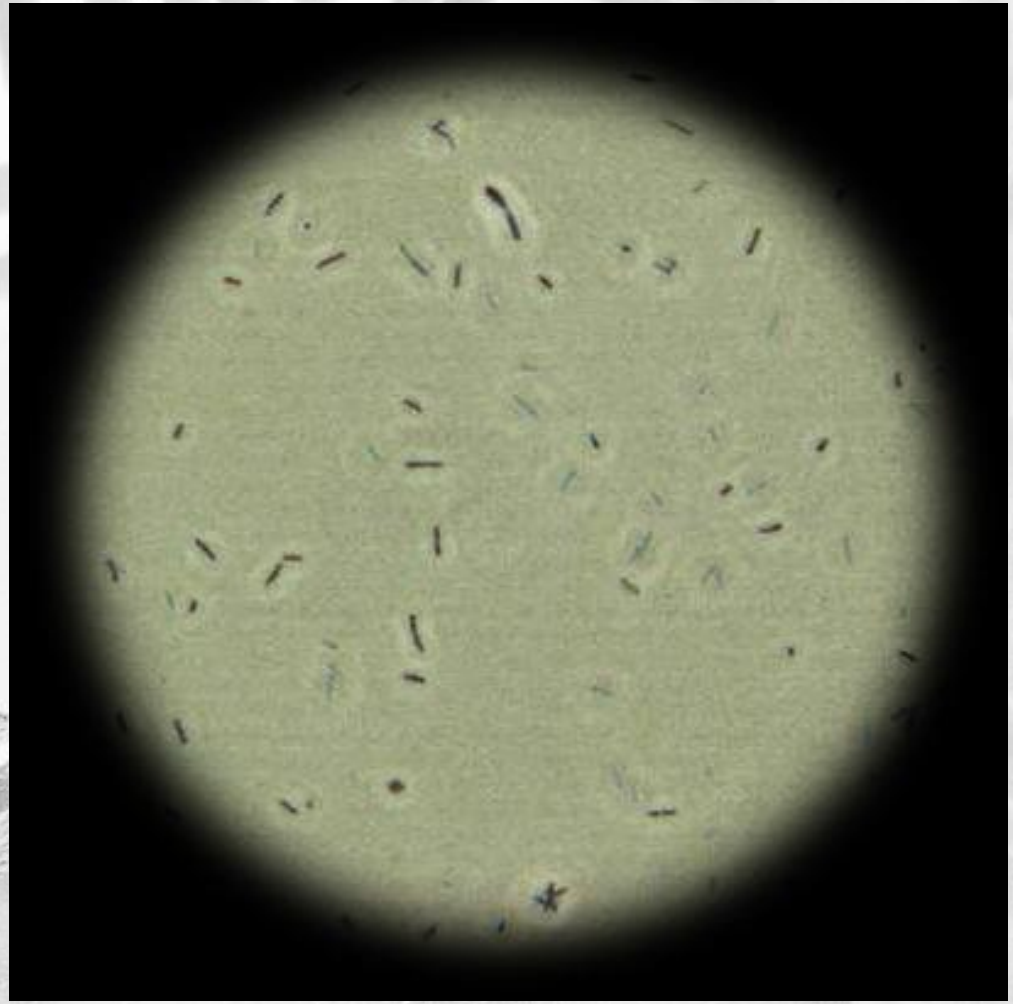
The engine room at Nesjavellir



The Laboratory

Cultivation of microbes on gasses directly from a geothermal powerplant

Isolation of microbial strains



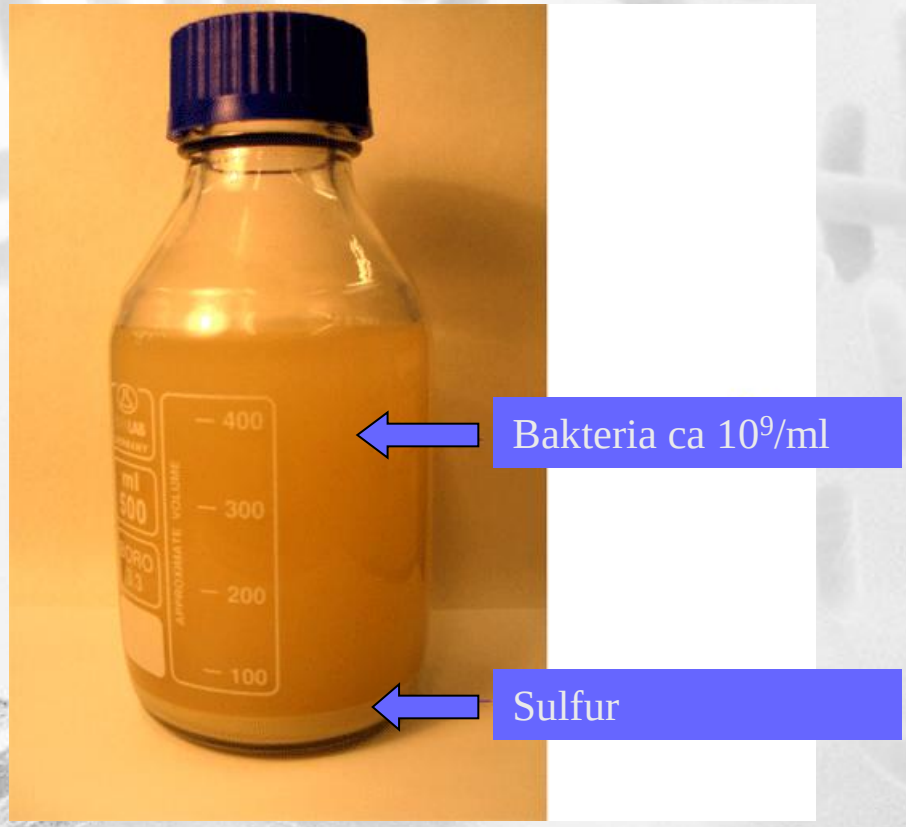
Enrichment experiments

16S rRNA analysis:

Thiobacillus sp.

Thiomonas sp.

The biology works



Suklfur as product metabolism

Reactions:

Step 1: $H_2S + O_2 \rightarrow S^0$

(Step 2: $S^0 + O_2 \rightarrow SO_4$)

“Proof-of-principle”

2008-2009: 10 L scale cultivations –”proof-of-principle” New contract with OR.

Next step:2000 L pilot plant.

Main results from Nesjavellir:

Good microbial growth on geothermal gasses

The microbes utilize all the H_2S from the gas as an energy source

Approx. 99% pure elemental sulfur precipitates from the cultures

The biomass formed contains >80% protein

Main problems: Sensors and control equipment

Pilot scale

- **2009**: Design and construction of a pilot plant.

If all the gas is utilized:

450 tons of H_2

2.500 tons of protein

Binds 4.500 tons of CO_2 (of a total of 25.000 tons)

Removes ca 7.000 tons of H_2S

Pilot factory at the Power plant in Hellisheiði

- **2010**: 2000 L pilot plant will be ready in the end of June 2010 at Hellisheiði.
- The plant will be run for 12 months
- Will “clean”1% of the gas and produce protein and sulfur in tons scale
- Experiments started:
  - Protein: fish feed
  - Sulfur: fertilizer (“organic” sulfur)

Example: Bio-protein protein-meal has been produced from microbes

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Known source

Known production method

Lab products hve been tested

Content known

Similar factory (Norway)

Methane utilizing

Large scale production

Permitted in EU

Markets in place & growing

Experiments using the sulfur in fertilizer

- Experiments using sulfur in fertilizer started in the greenhouse of Landgræðslan í Gunnarsholti started this spring
- Experiments outside will start with increasing production (when the pilot plant is up and running)

Feed experiments

- Microbial protein in feed, experiments will also start when larger quantities can be produced.
- Tilapia
- Cooperation with Matís and the company Arctic Tilapia, in Keldnaholt & in cooperation with the Norwegian feed company Mowi (Salmon)

Tilraunastöðin á Hellisheiði

Cooperation

- **Prokatín**: Dr. Arnþór Ævarsson, Dr Jakob K. Kristjánsson, Guðný Inga Ófeigsdóttir, MS nemi við HÍ
- **Háskóli Íslands**: **& Matís**: Dr. Guðmundur Óli Hreggviðsson
- **Matís &Arctic Tilapia ehf :** Dr. Ragnar Jóhannsson (líka)
- **Mannvit**: Ásgeir Ívarsson efnaverkfræðingur ofl.
- **Háskólinn á Akureyri:** Dr. Jóhann Örlygsson og stúdentar
- **Háskóli Íslands**: Dr. Andri Stefánsson jarðefnafræðingur
- **Nýsköpunarmiðstöð Íslands**: Hermann Þórðarson, efnafræðingur
- **Landgræðslan**: Dr. Guðmundur Halldórsson, rannsóknastjóri

Gott samstarf og mikil tækifæri

prokatín

MANNVIT
ENGINEERING

Orkuveita
Reykjavíkur

HÁSKÓLI ÍSLANDS

Háskólinn
á Akureyri
University
of Akureyri

matís

PROKARIA