

CONCEPT EVALUATION OF MARS DRILLING AND SAMPLING INSTRUMENT




Lectio Praecursoria

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Objectives of the thesis

- Analysis of the problem of sampling celestial bodies
- To present past missions and concepts
- Analysis of the scientific and technical requirements for a Mars driller and sampler
- To perform and analyse system and drilling tests
- To present a drill instrument concept, which would fit to ESA's Mars mission



Planet Mars



Columbia Hills, Gusev region, Mars. 13. April 2005. NASA.



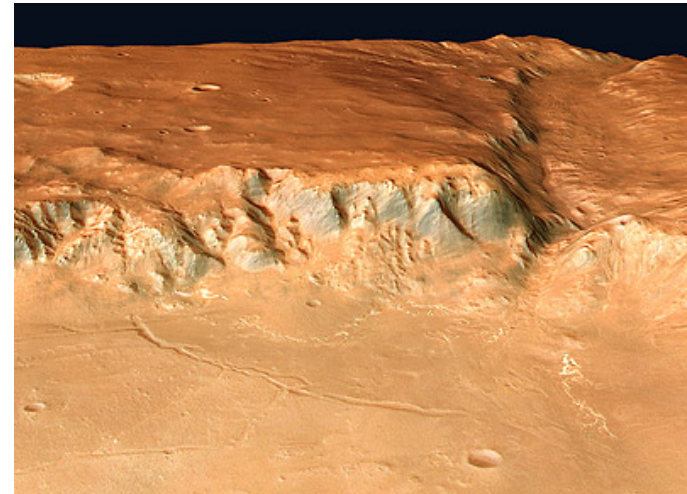
Why Mars is interesting

- Mars is quite Earth-like
- Today Mars is hostile to life
- Possibly in its past, Mars has been more hospitable
- Solar System exploration helps also to understand Earth's past

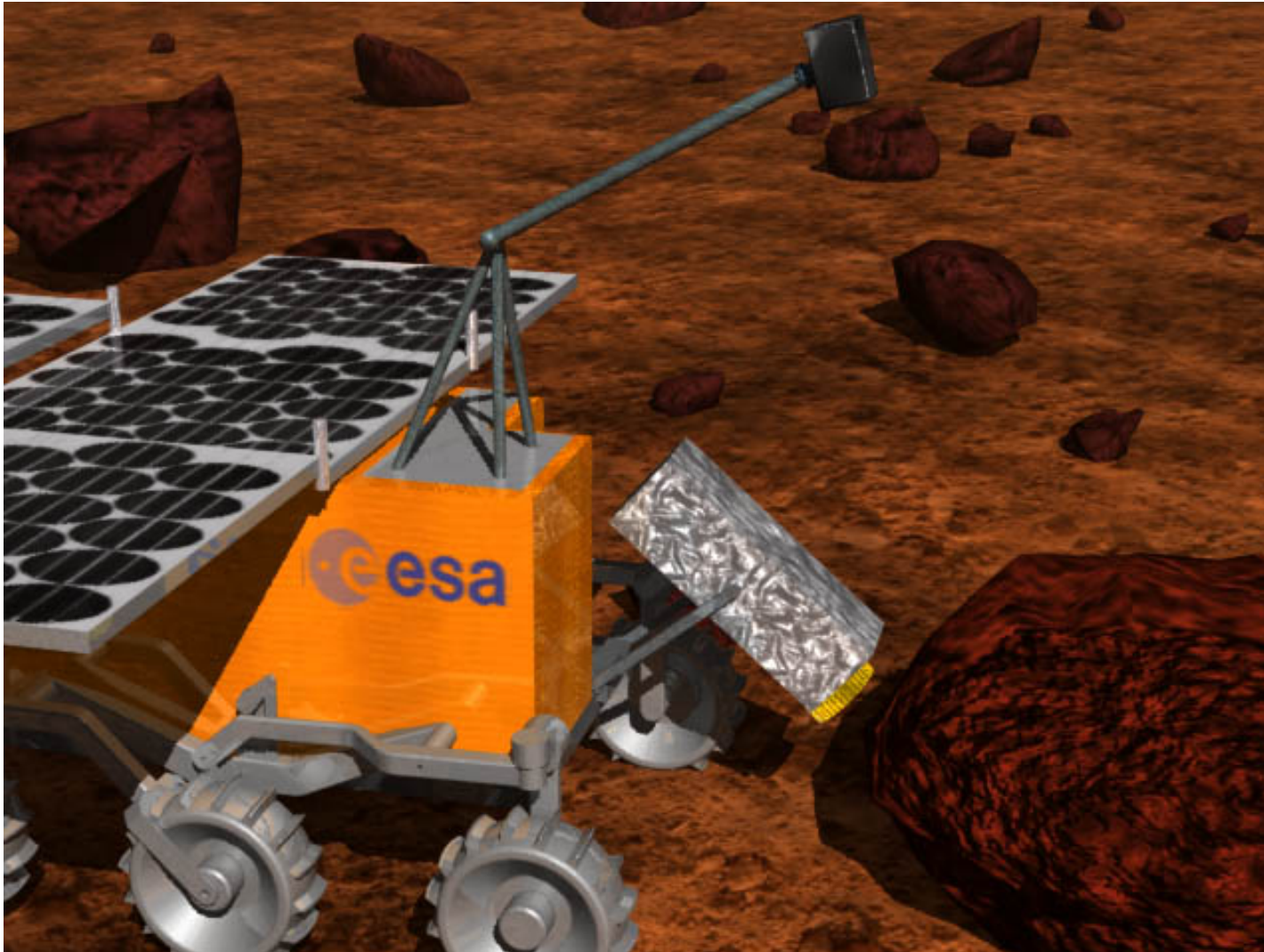
Mars exploration

- Several missions
 - Fly-byes and orbiters
 - Landers
 - Not yet deep subsurface sampling

- ESA's goal: 2011 to send a rover with drill instrument
 - Not yet firm plans nor constructor



ESA's ExoMars rover

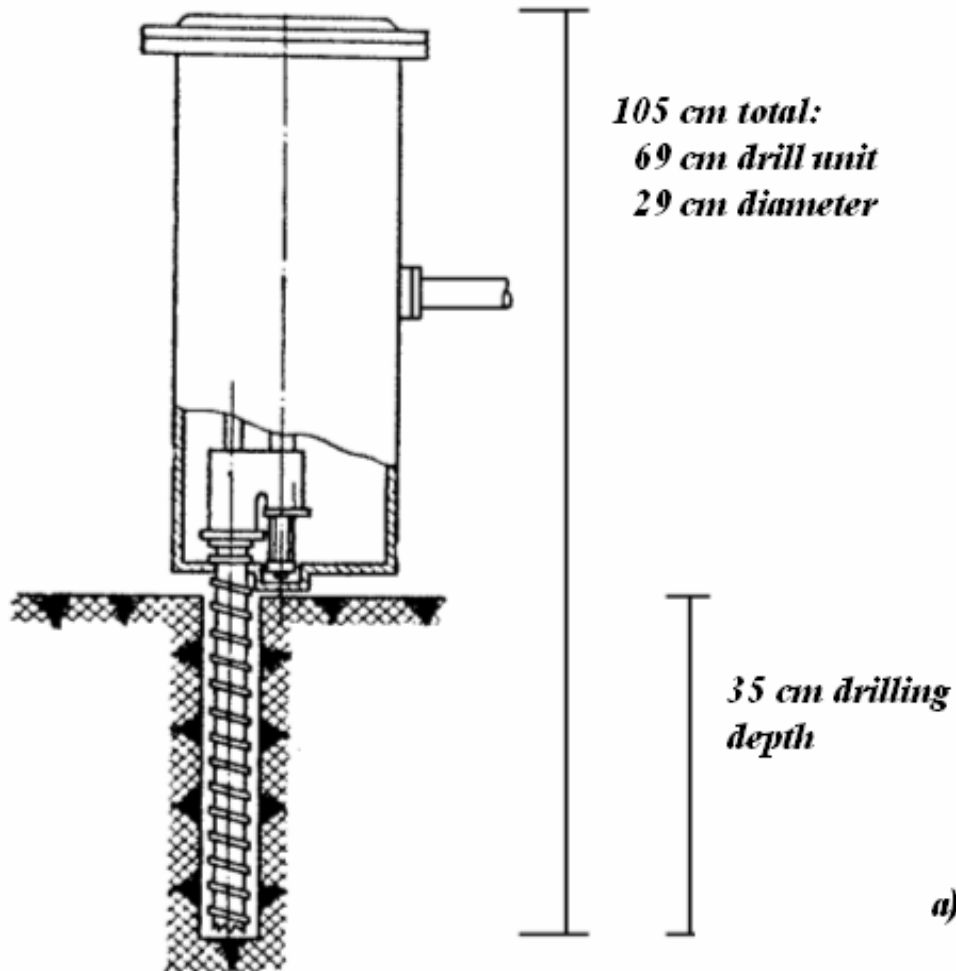




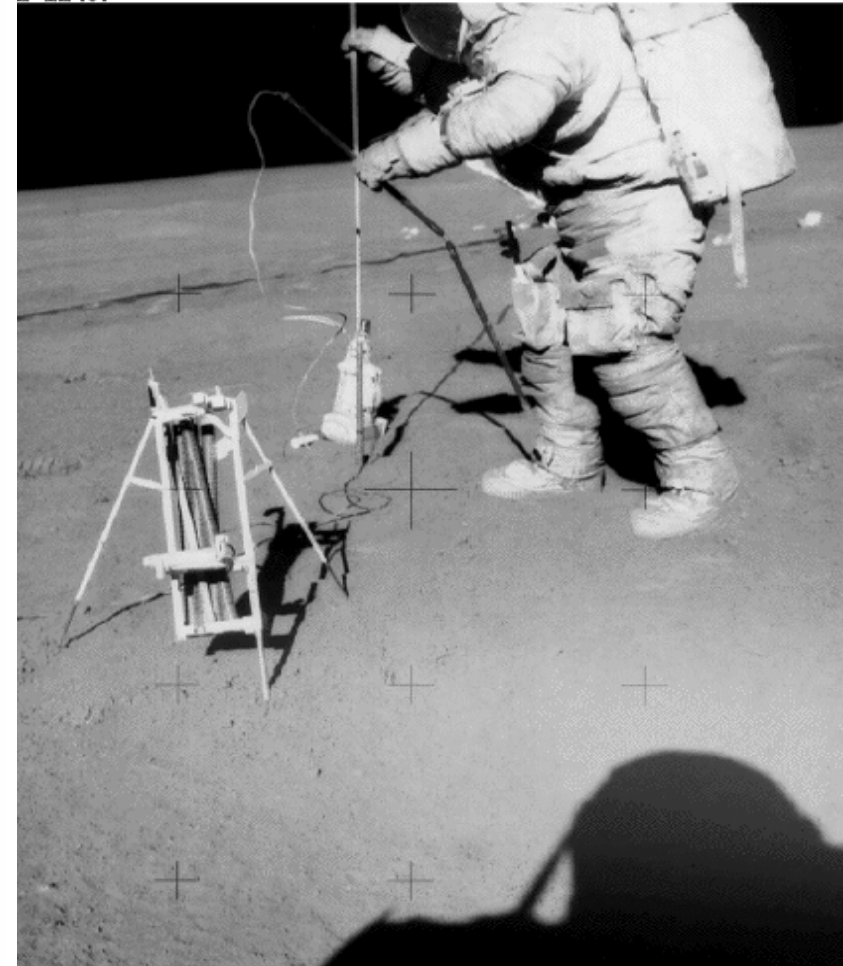
Drill instruments in space

- The Moon, Venus, Mars
 - 12 working drills or abrasion tools
- Would these fit to the ExoMars drill's requirements?
 - Analysis of old missions' instruments

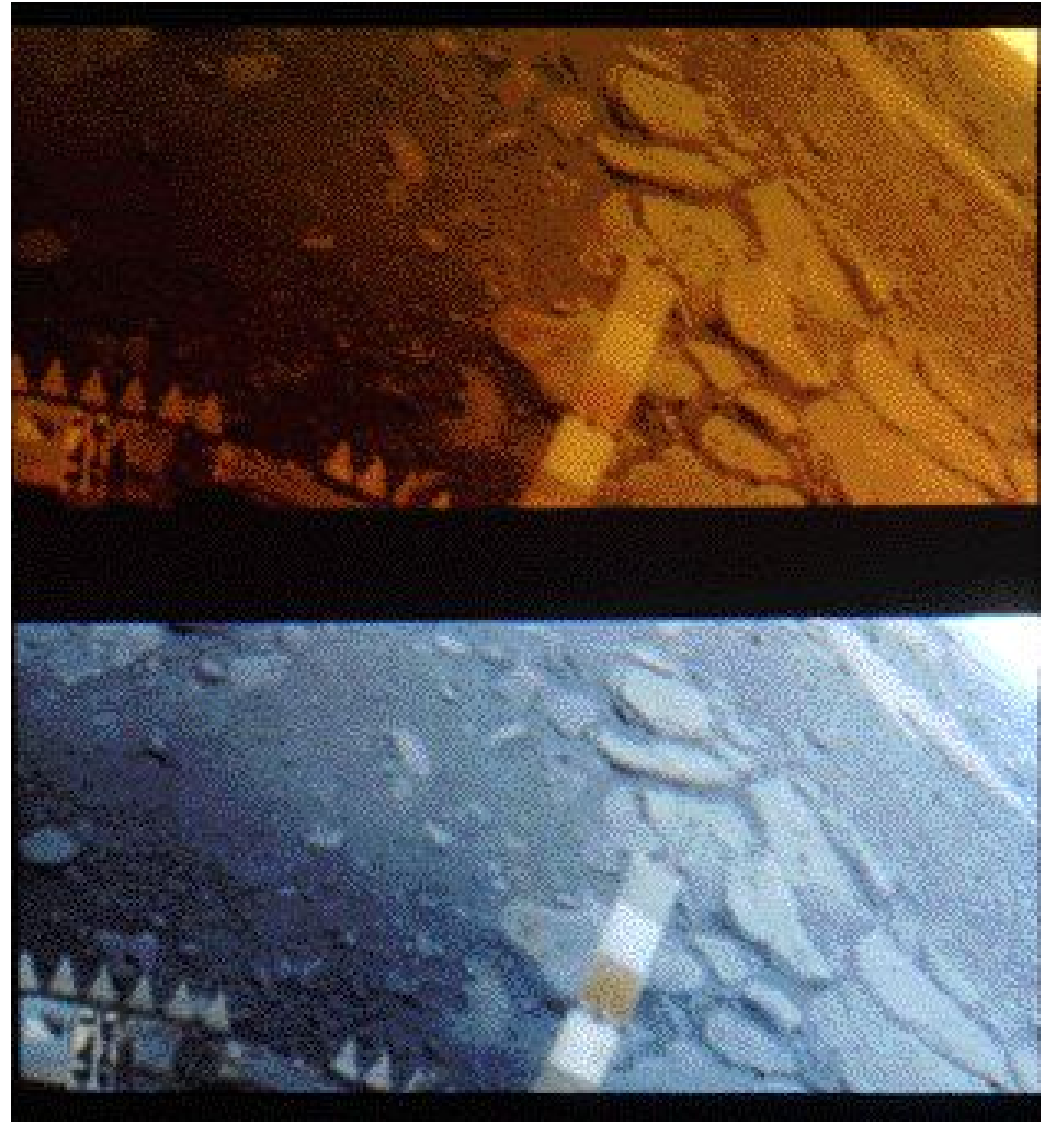
Moon drilling 1970-1976



2-12407



Venus drilling 1982



Mars, rock abrasion tool 2004-2005





Summary of old drill instruments

None of them are suitable for ExoMars needs.

- In addition, several concepts were studied
- Total of ~20 drills + ~10 other samplers

ESA needs a drill instrument, which:

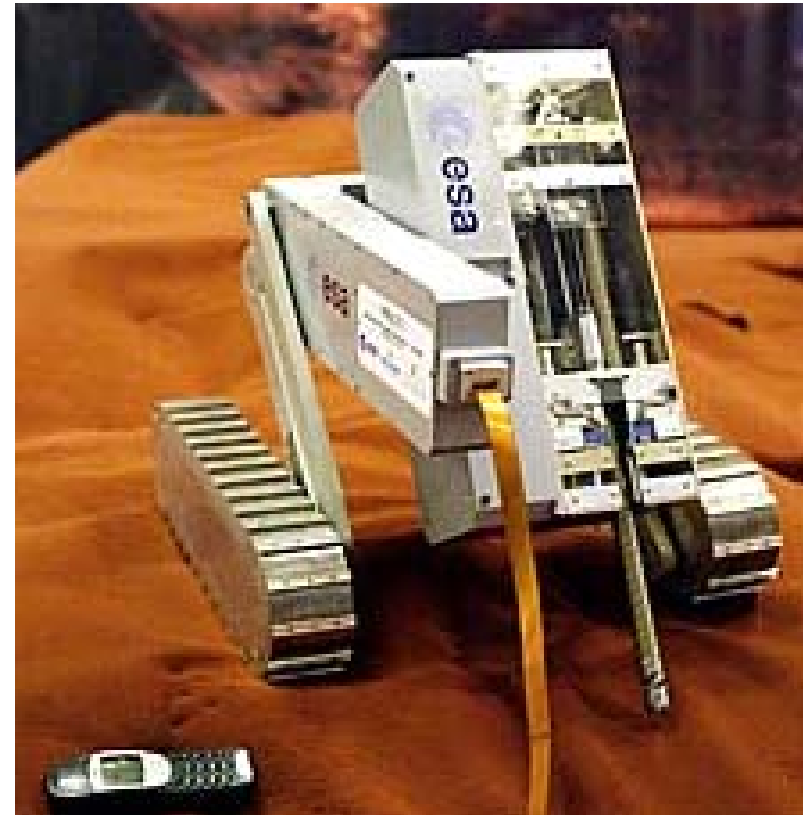
- Takes samples automatically up to 2 m depth
- Max 11 kg with manipulator arm, 16×16×50 cm, power: 10-40-70W

Projects that were used in this thesis

- Miro projects:
 - Extendable drill string
 - Max 2 m depth

- Finnish
 - SSF, TKK, VTT, ESA

- Several tests





[VIDEO PRESENTATION HERE]

- 3-minute video of the MRoSA2 ("Miro") rover's drill module
- Video shows operational phases from initialising to drilling up to second drill pipe.
- Texts in Finnish, Matti explains the video to the audience in Finnish.

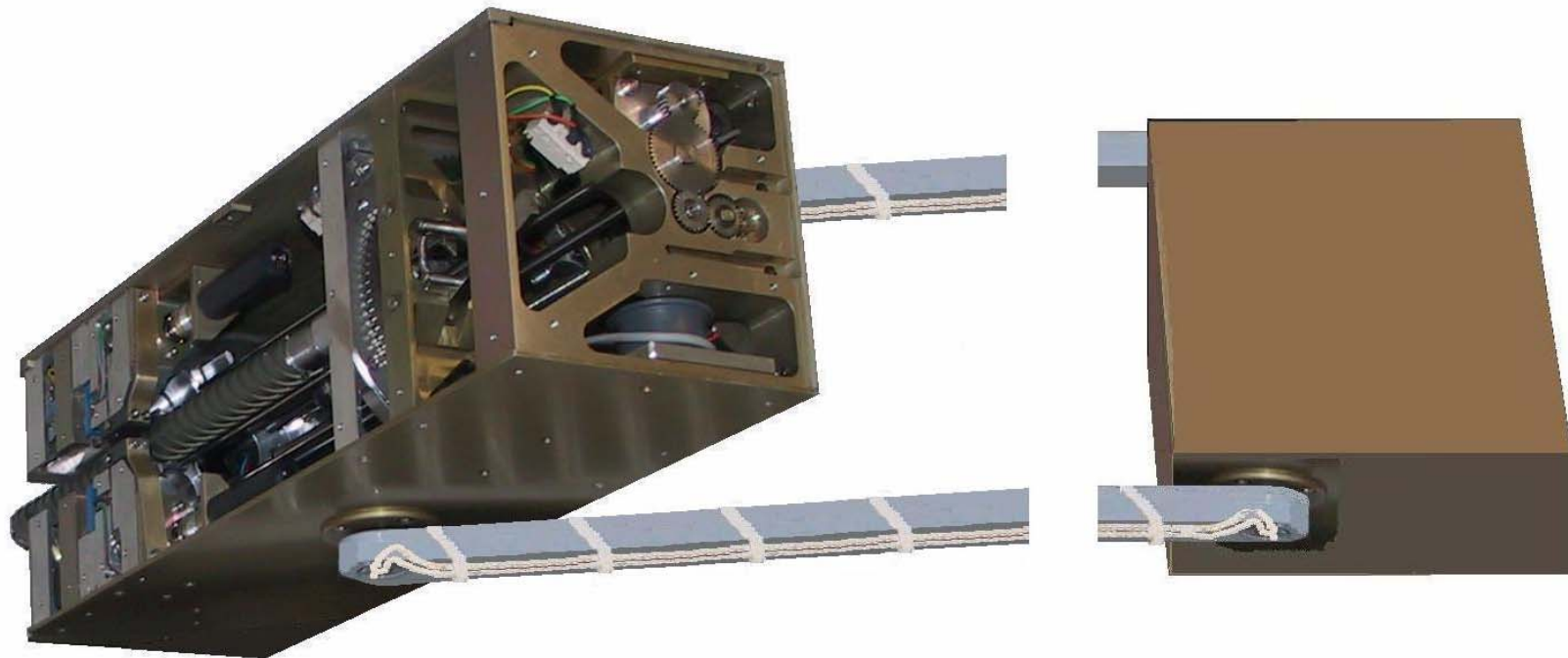
Drilling tests

- MIRANDA 1 and 2
- Test goals:
 - Power/energy
 - Temperature
 - Sampling capabilities of rocks and sand



New concept: MASA drill

MASA = MArs Sample Acquisitor





Aspects of the functionality of the MASA drill

- Based on the Miro (MRoSA2) drill
- ExoMars requirements analysis
- MIRANDA drilling tests analysis
- Structural strength analysis
- Power-, energy- and temperature aspects
- Mass and size analysis
- Operational plans, automation and failure analysis
- Component specification
- Sampling problem solution
- Instrumentation option



MASA drill: Summary

- Depth: 2.5 m, sample size 4 cm × 1 cm
- Max. 10 samples before cleaning
- Automatical
- Data acquisition during drilling + Instrumentation option
- Mass 9.2 kg, size 14 × 14 × 44 cm
- Power 10-40-70 W (similar to the ExoMars drill)
- Improved mechanics of the Miro drill