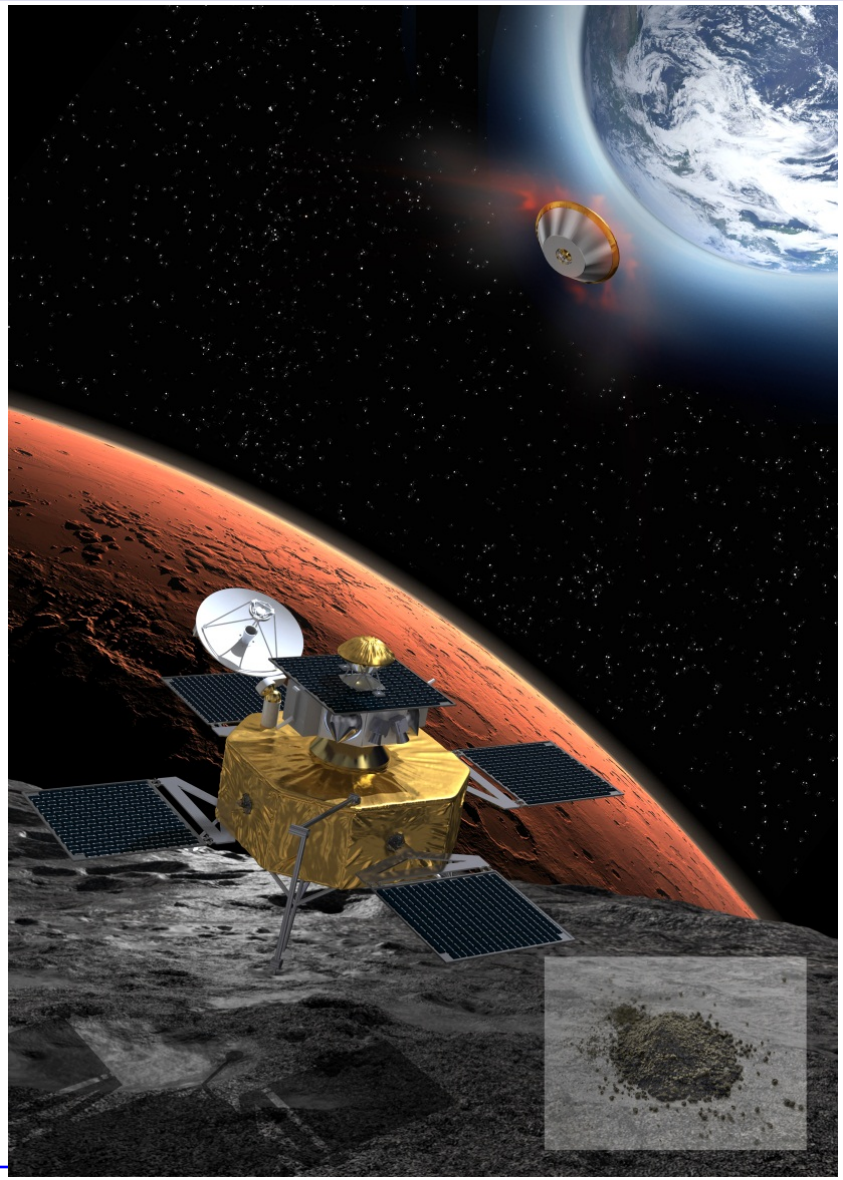
PHOOTPRINT

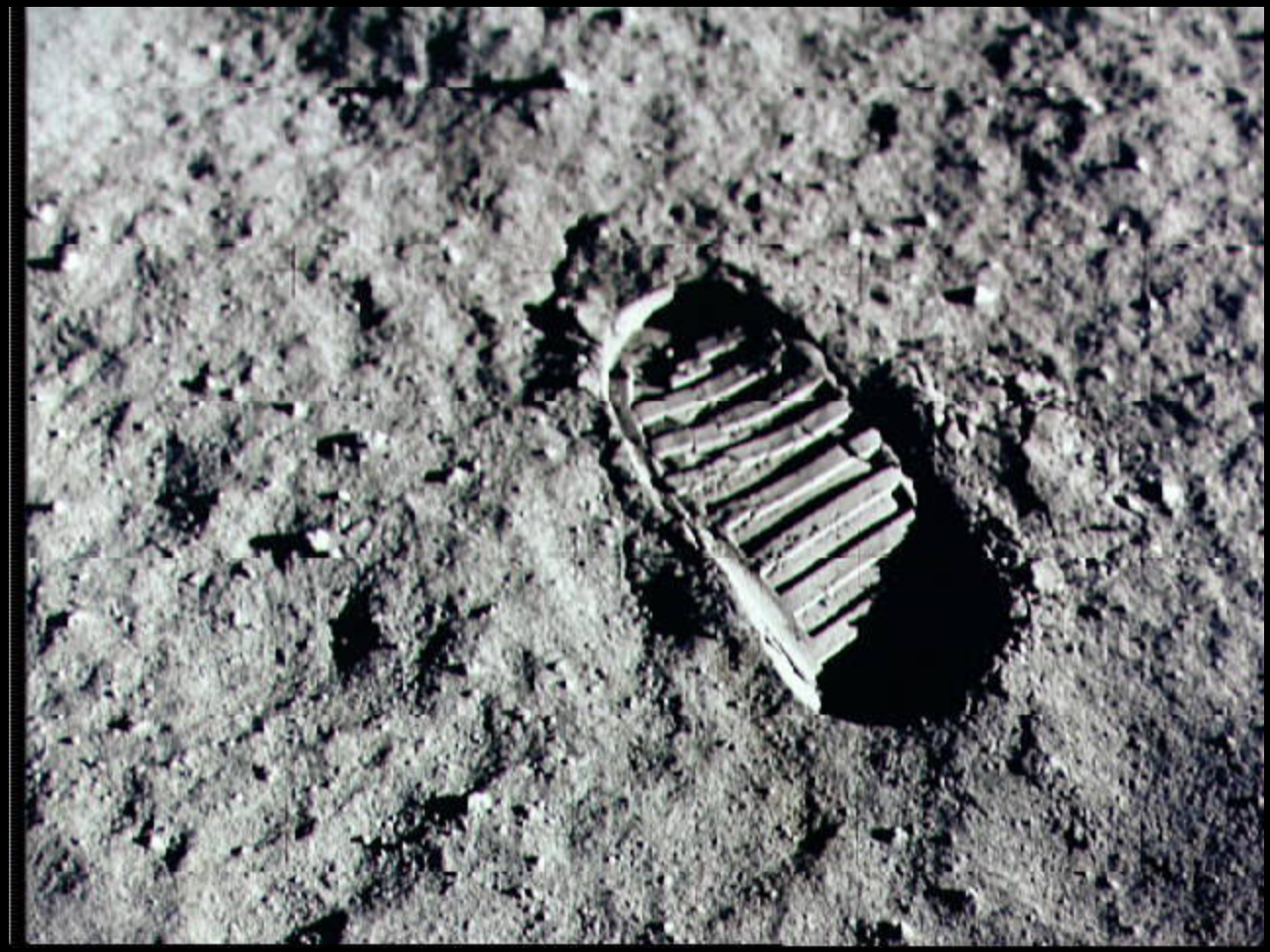
An ESA mission study

previously: ***MMSR*** (Martian Moon Sample Return)

D. Koschny (Study Scientist, ESA/ESTEC)

And the MMSR Science Definition Team





MMSR Study Team

Science Experts:

- P. Michel (Obs. Cote d'Azur, Nice, France) -> asteroids
- J. Brucato (INAF Italy) -> ground-based analysis
- B. Gondet (IAS, France) -> Phobos, remote sensing
- O. Korablev (IKI, Russia) -> Phobos-Grunt
- N. Schmitz (DLR, Germany) -> in-situ instrumentation
- K. Willner (TU Berlin) -> Phobos, 3-D reconstruction
- A. Zacharov (IKI, Russia) -> Phobos-Grunt

ESA

- D. Koschny (ESA Study Scientist)
- D. Agnolon (ESA Study Manager)
- J. Romstedt (ESA Payload Manager)

Science goals - 1

Top-level science goal:

Understand the formation of the Martian moons Phobos and Deimos and put constraints on the evolution of the solar system.

- **Constrain the moon formation scenario by analysing returned samples**
- **Constrain dynamical models of the early solar system by showing how often a large impact occurs**

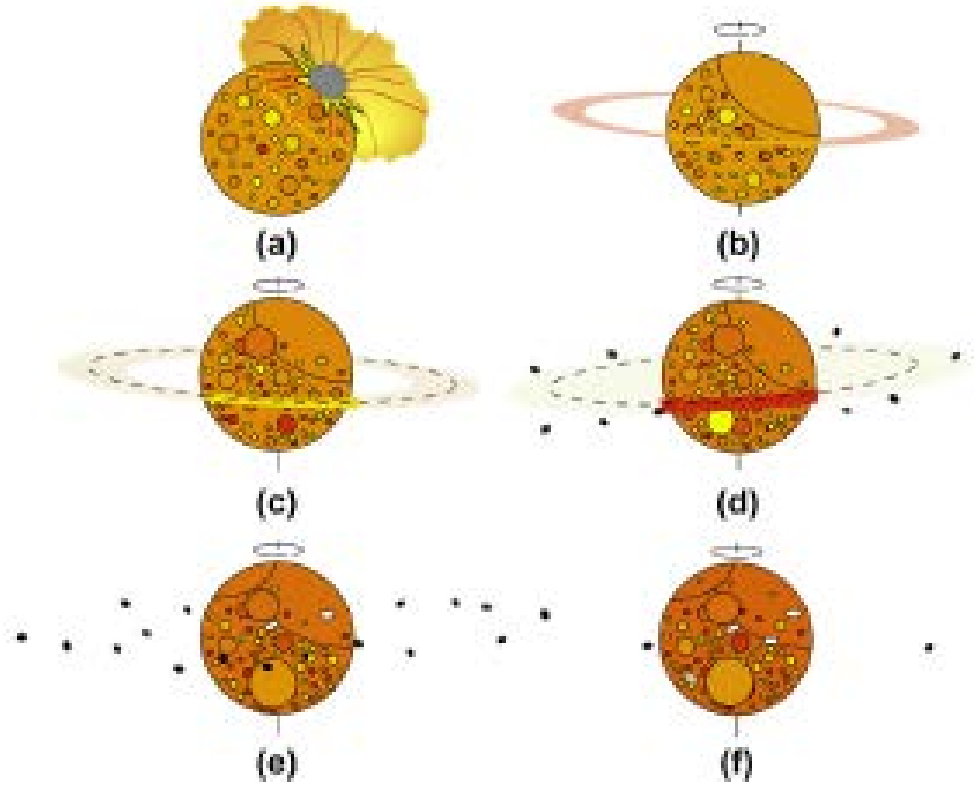
Science goals - 2

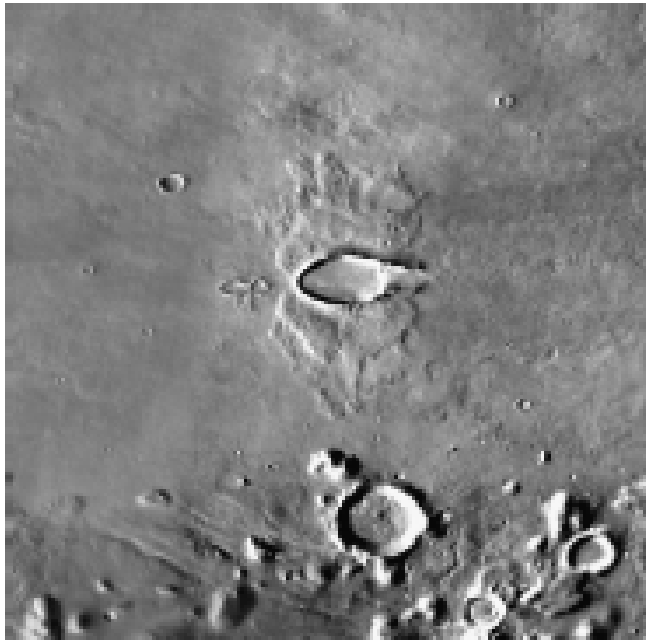
(a) capture of objects coming close to Mars (Bursa et al., 1990);

(b) co-formation with Mars (see *e.g.* Burns 1992 and references therein);

(c) Impact of a large body onto Mars and formation from the impact ejecta (Singer 2007, Craddock 2011, Rosenblatt 2012).

Craddock (2011)





Chappelow and Herrick (2008)

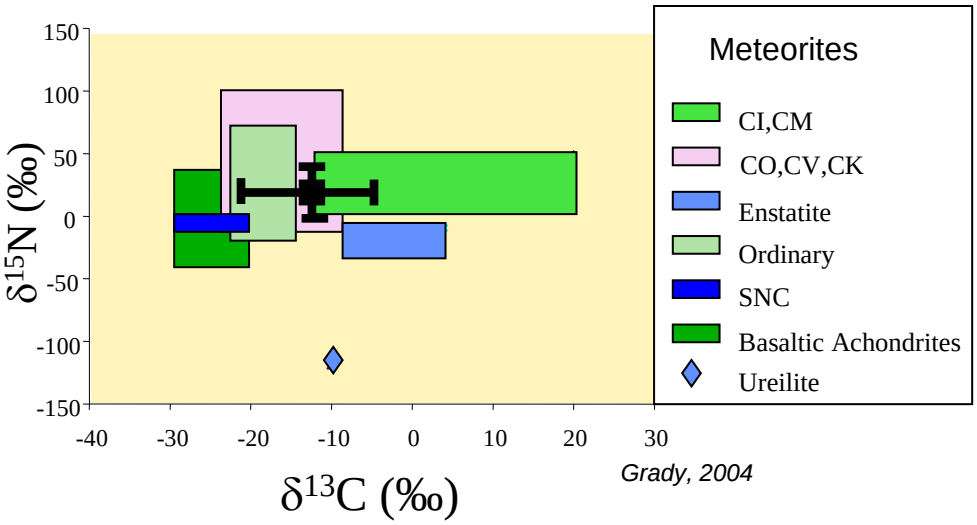
Science goals – 3

Returned sample will allow:

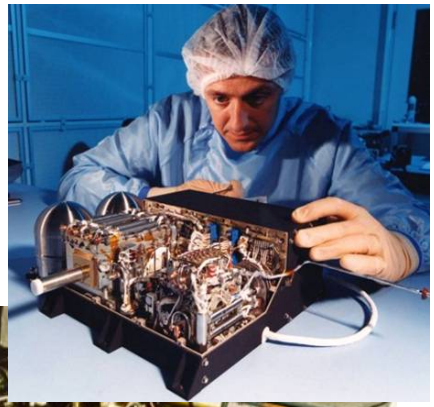
- Detailed chemical analysis (much more than in-situ), mineralogy, texture…
- Dating

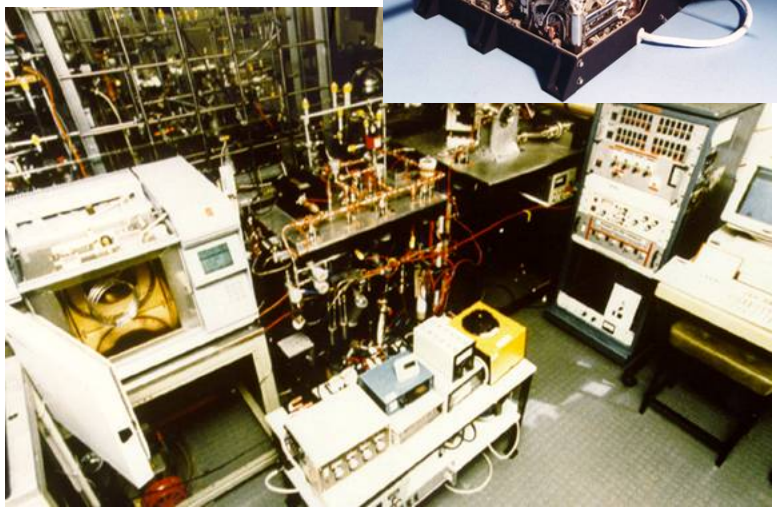
⇒ Better constrain formation mechanism

e.g.: Martian material? Asteroidal material?



Grady, 2004





Gas chromatograph + Rosetta Ptolemy
(isotope ratio accuracy 0.01 % vs. 1 %)

Sample mass

< 50 mg : noble gas measurements, other bulk elemental and isotopic measurements

50 mg : for spectroscopy such as IR, X-ray, Mossbauer (50 mg per technique and therefore per laboratory)

1 g : a polished section (or thin lame) can be done. On one section most of the mineralogy, elemental and isotopic compositions can be determined.

several g : perform age measurements, aqueous alteration

‘Pebbles’ needed (particles with size >0.5 mm) to have material without cosmic ray effects available

Sampling mechanism can sample very fine dust up to larger pebbles

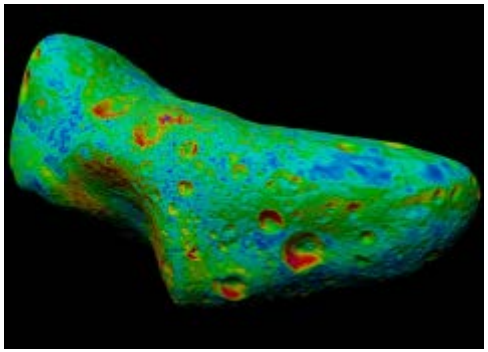
=> Sample about 100 g

Baseline payload

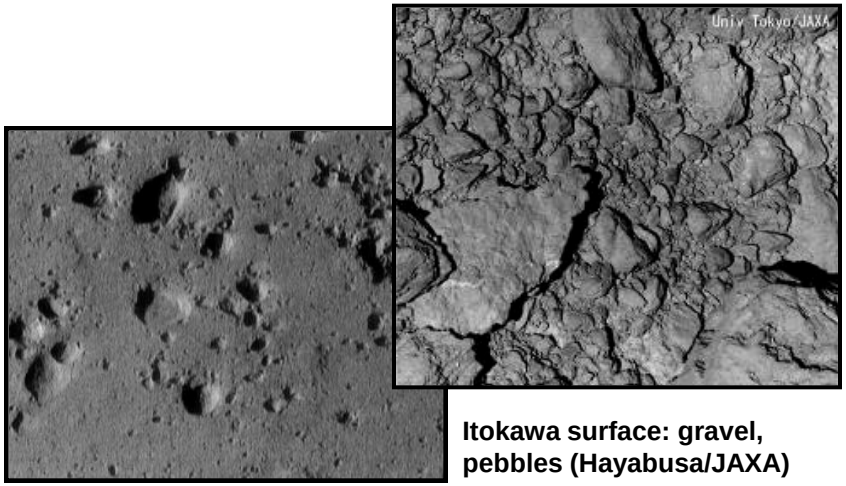
Will put sample in context:

- Wide angle camera
- Narrow angle camera
- Close-up camera
- Vis/NIR imaging spectrometer (0.4–3.3 µm)
- MIR spectrometer (5–25 µm)
- Radio science

More to be discussed, depends on available mass



Coloured image of Eros,
Credit: **NASA**



Itokawa surface: gravel, pebbles (Hayabusa/JAXA)

Eros surface from 250 m distance (NEAR/NASA)

	Total
Mass [kg]	25
Power [W]	50
Data volume [Gbit]	~100

Phobos or Deimos?

Thomas *et al.* (1996): 200 m regolith, "…from the ejecta being accreted … long after the impact…"

Credit: HiRISE, MRO, LPL (U. Arizona), NASA

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Conclusions

- Excellent science case: Moon formation => Solar system formation
- Detailed science require-ments available
- Baseline payload: minimum to give context to sample

HiRISE image PSP_007769_0910, unsharp masked (Thomas 2011)