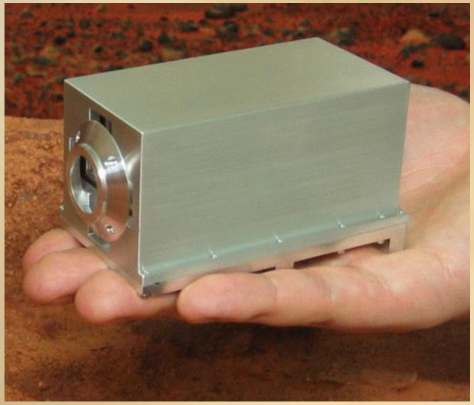
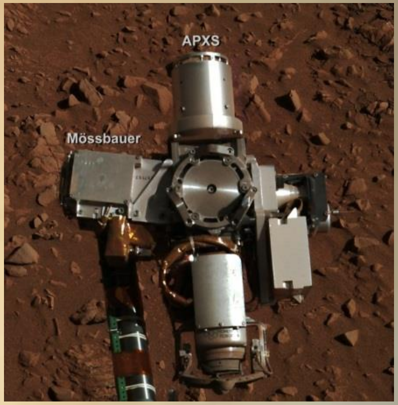
The miniaturized Mössbauer spectrometer MIMOS II for the investigation of Venus' surface





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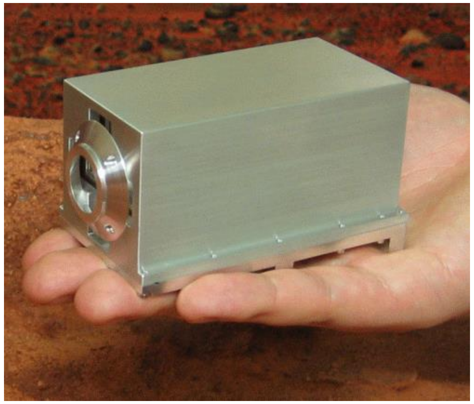
MIMOS II

The miniaturized Mössbauer spectrometer consists of

- Sensor head
  - ^{57}Co gamma-radiation source (halflife 272 days)
  - detector system
  - volume of 50×50×90 mm³.
- Electronics board
  - data acquisition and instrument control units (CPU + FPGA)
  - voltage converters
  - electrical and data interfaces to the spacecraft
  - Volume 100×160×25 mm³.
- Weight <500 g
- Power consumption 4 W
- Data product size 512 kBytes (4 Mbit)



MIMOS II Contribution to Science Goals

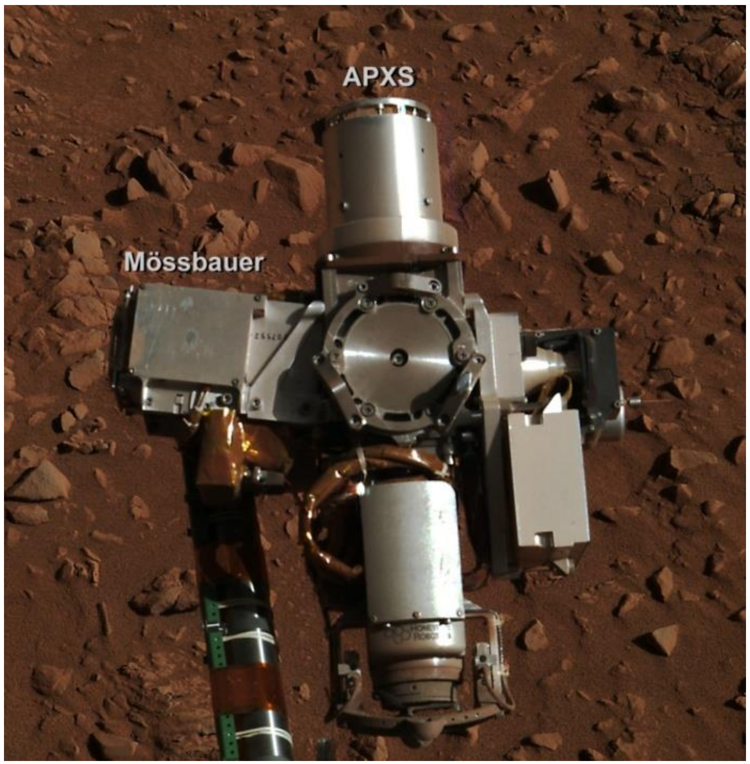
- ❑ Fe-bearing mineral phases
- ❑ Fe oxidations states
- ❑ Quantitative distribution between mineral phases and oxidation states
- ❑ Potential for XRF

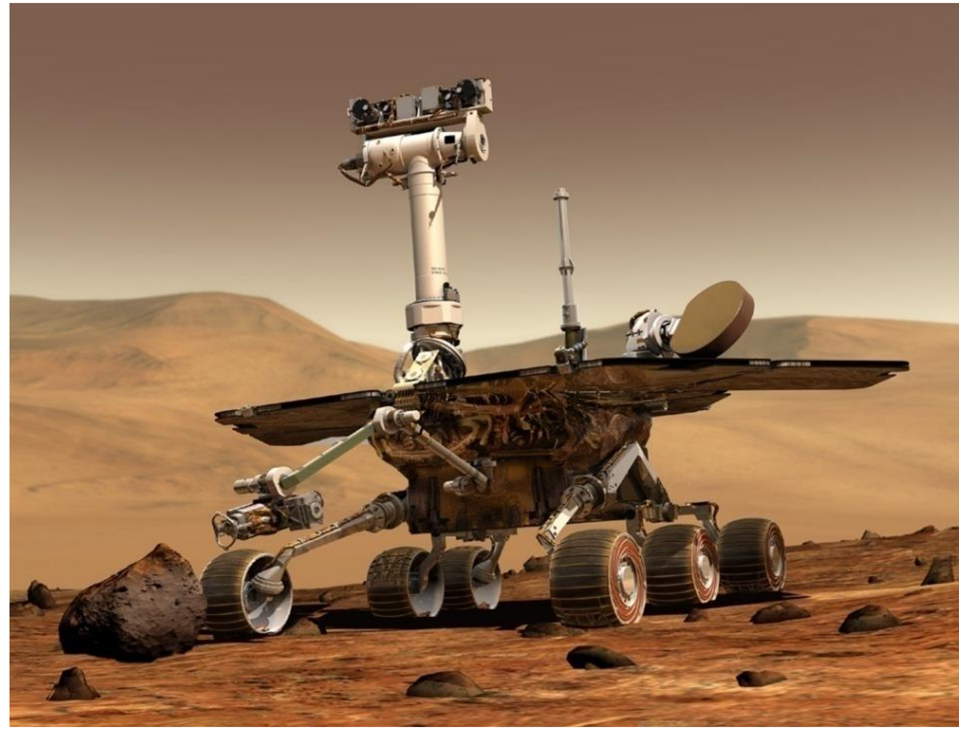
- ✓ Elemental and mineralogical composition of surface, including radiogenic elements.
- ✓ Interaction between surface and the atmosphere.
- ✓ Structure and chemical composition of atmosphere to surface, including abundances of trace and noble gases and isotopic ratios of elements

NASA Mars Exploration Rover

Two robotic field geologists to

1. Explore two sites on Mars where water may once have been present
2. Assess past environmental conditions
3. Assess suitability for life



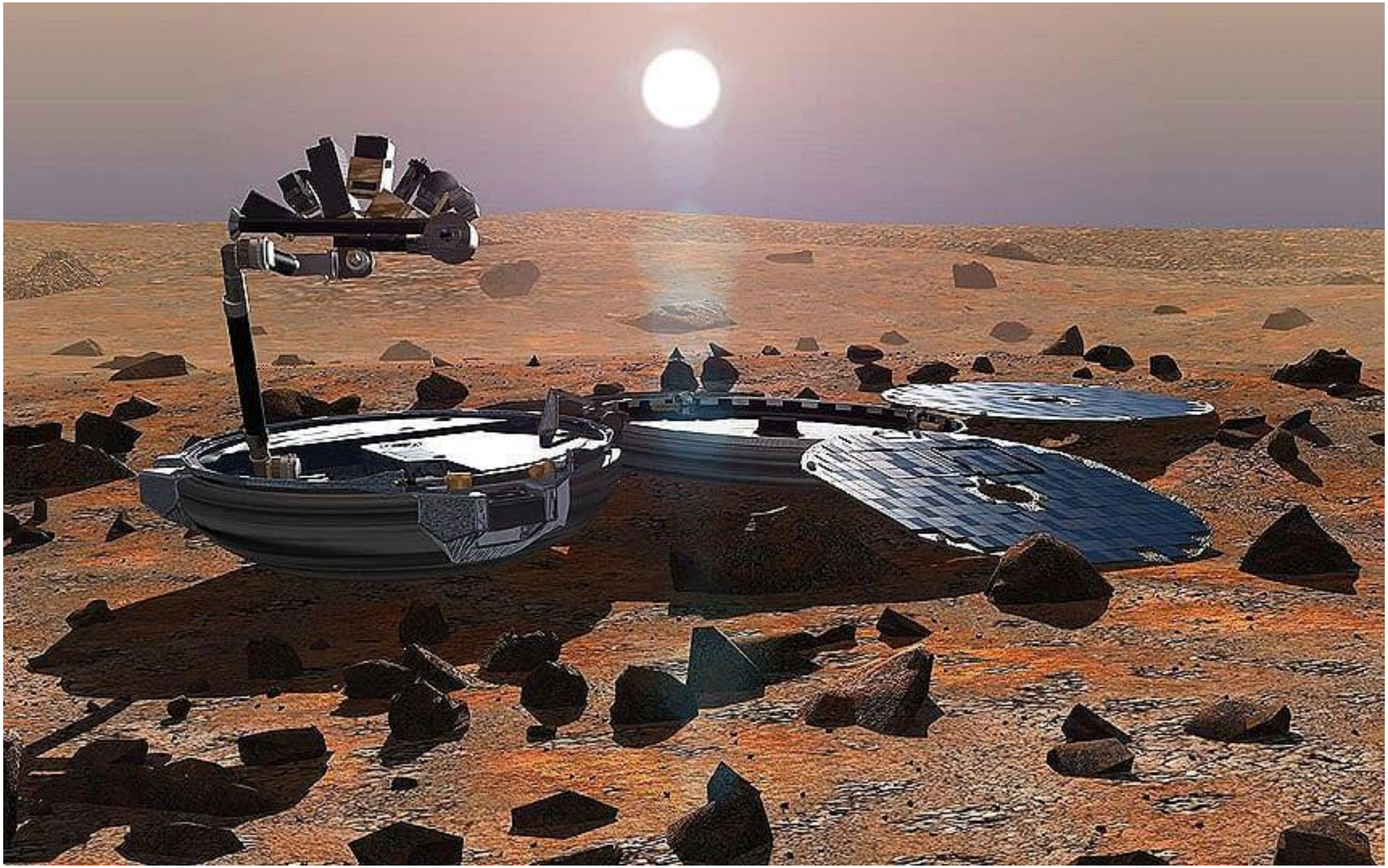


- ➢ Follow-the-Water strategy:

Look for mineralogical and geochemical evidence for aqueous water activity on Mars

Klingelhöfer et al. (2003) *J. Geophys. Res.* 108(E12), 8067

ESA/UK Beagle 2

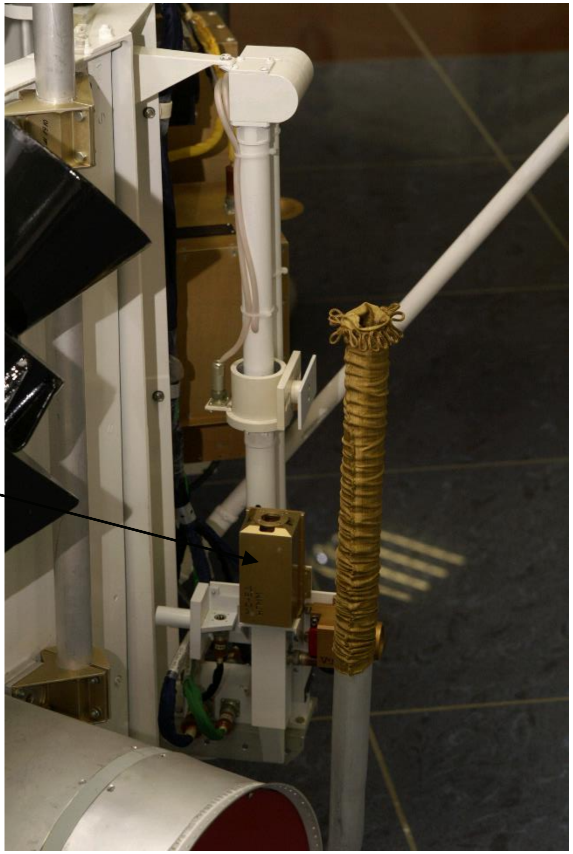


Pullan et al. (2003) ESA SP-1240

Roskosmos Phobos-Grunt

Sensor head

Electronics board



Rodionov et al. (2010) *Solar System Research* 44, 362-370

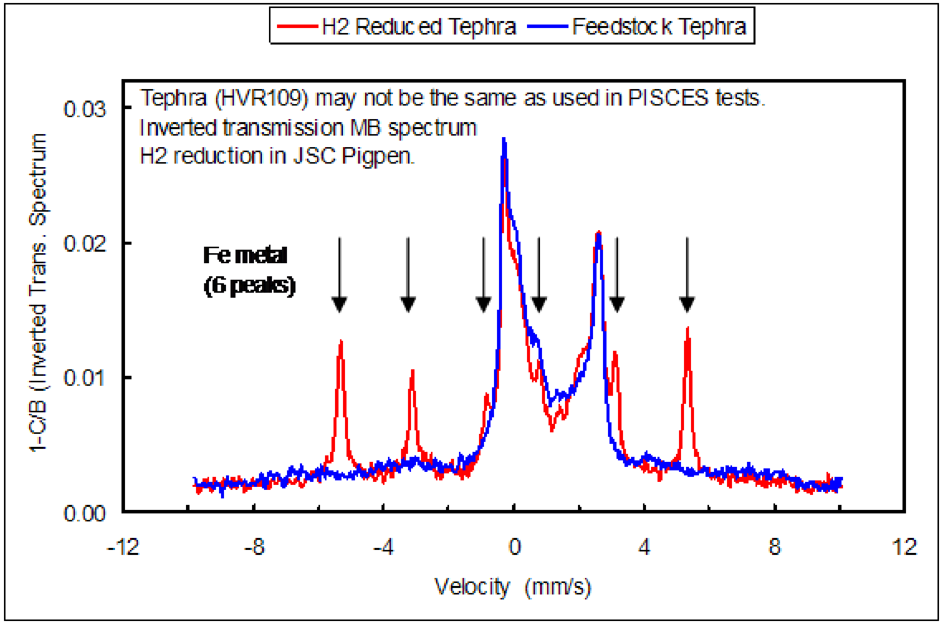
Lunar ISRU

$$Fe^{2+}O + H_2 \rightarrow Fe^0 + H_2O \qquad H_2O \rightarrow H_2 + ½\ O_2$$

Consumption (breathing, fuel, etc.)

Oxygen yield:

- 2 - 5 wt.%
  (1 t of oxygen per 20 t of regolith)
- Proportional to FeO content
- Temperature-dependent
  - 900°C ilmenite and glass
  - >1000°C olivine and pyroxene



Determine yield in g O_2/100 g sample:

100g*(FeO content)*(% O in FeO)*(Fe^0/Fe_T)

Ten Kate et al. (2013) *Journal of Aerospace Engineering* 26,183-196

UNIVERSITY of STIRLING

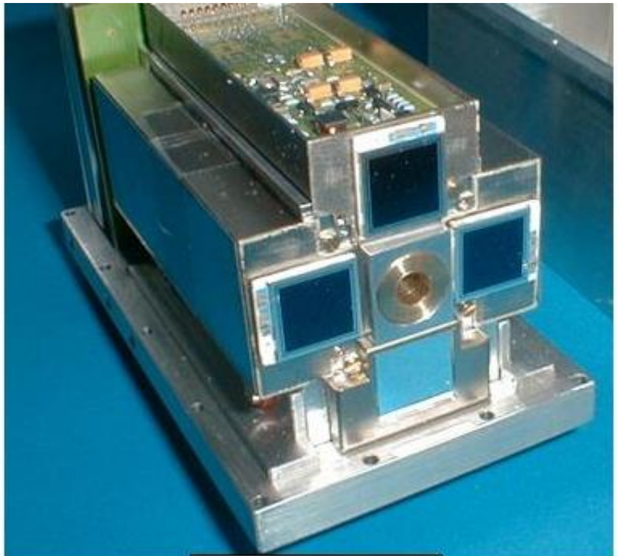
BE THE DIFFERENCE

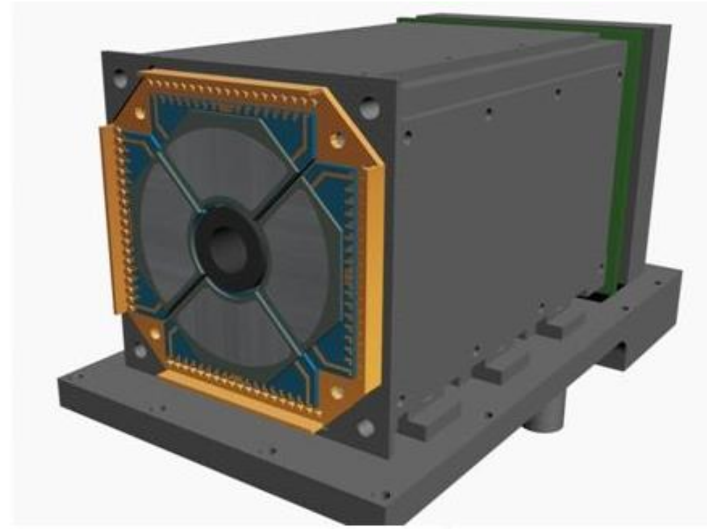
MIMOS IIA

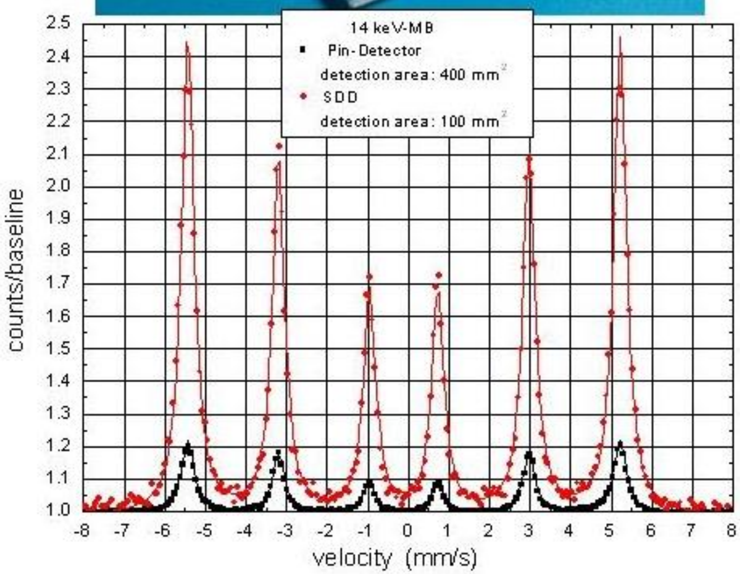
- Silicon Drift Detectors
  - Higher energy resolution
  - Improved signal-to-noise
  - Improved XRF capability
- Energy and Mössbauer spectra acquired simultaneously
- 1024 channels

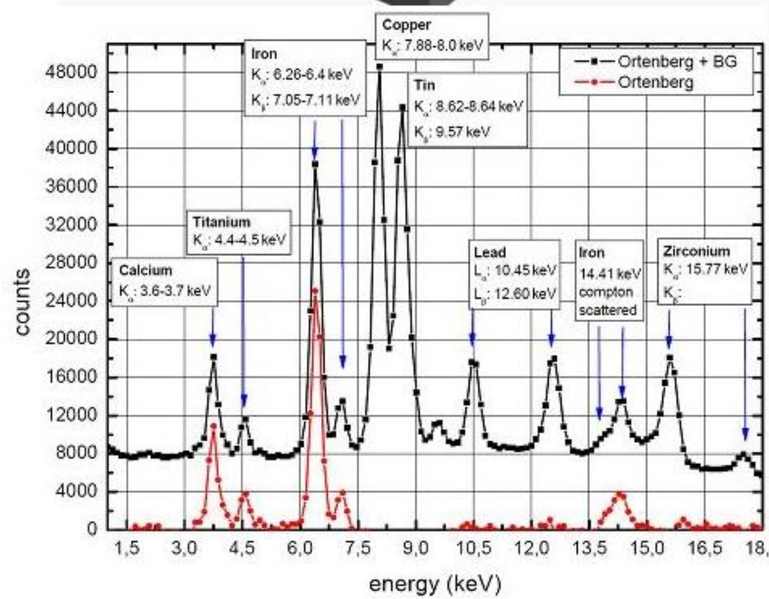
Blumers et al. (2010) *Nuclear Instruments and Methods in Physics Research Section A*, 624, 277-281.

MIMOS IIA



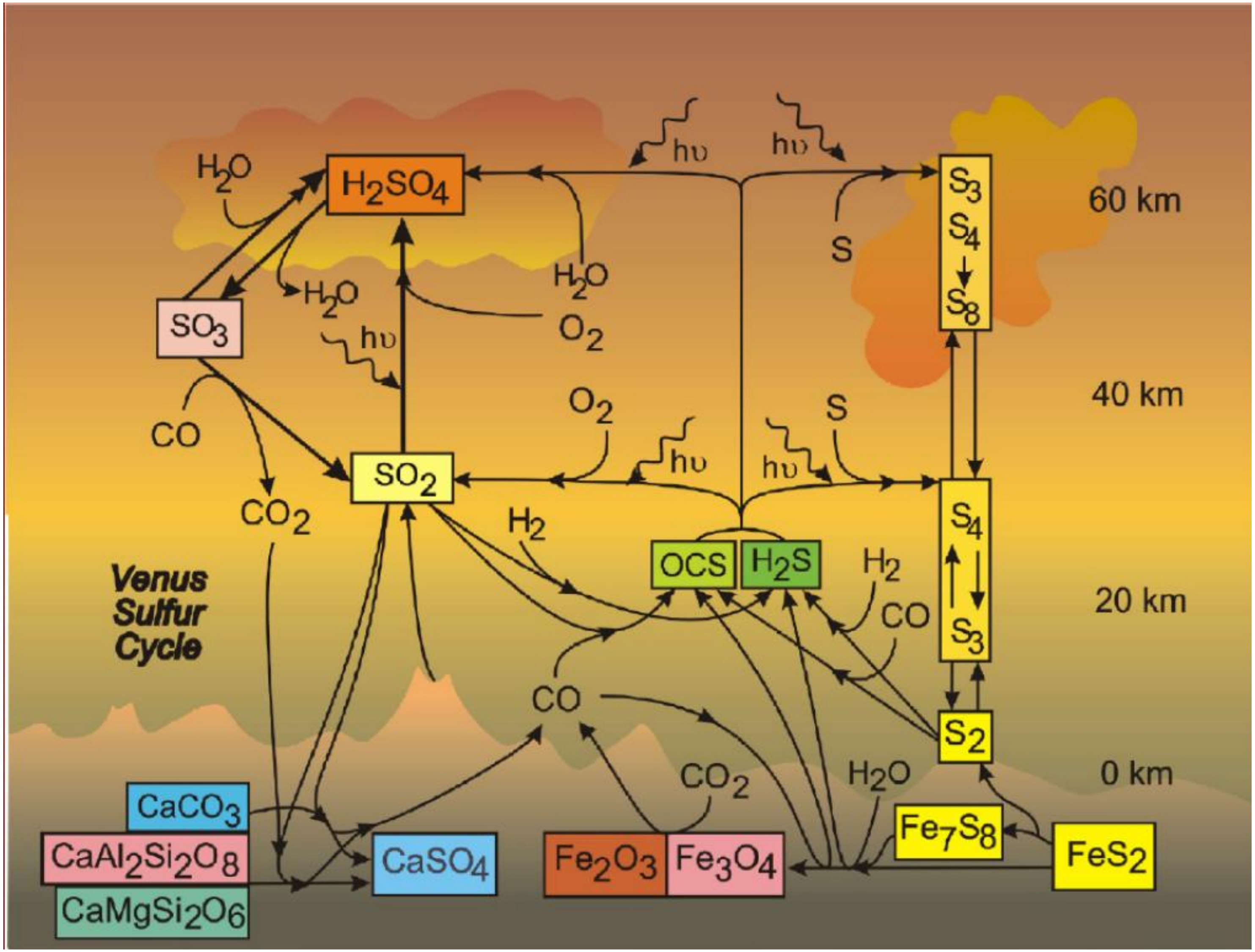






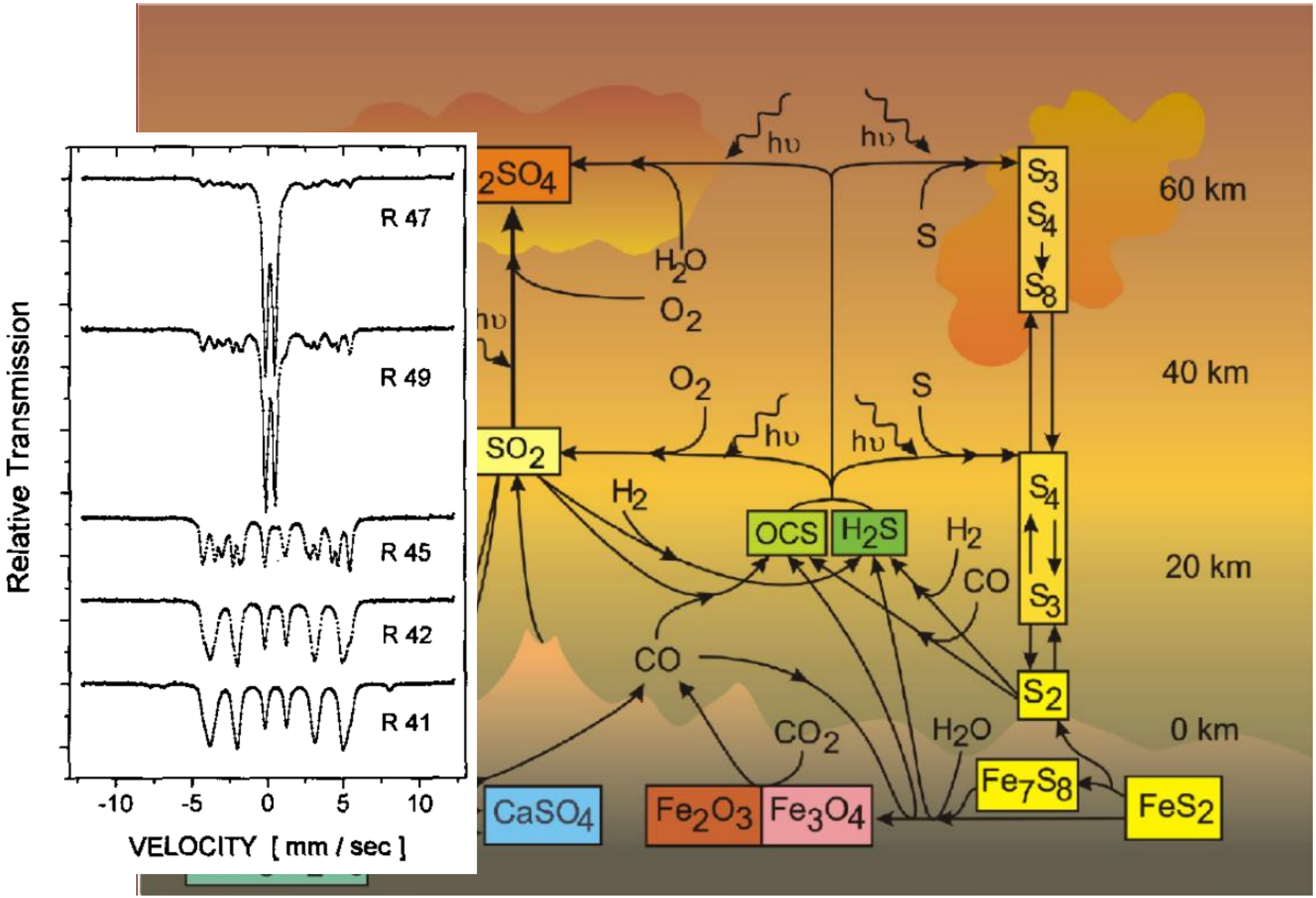
Schröder et al. (2011) *Geochemistry: Exploration, Environment, Analysis* 11, 129-143

Sulfur Cycle on Venus



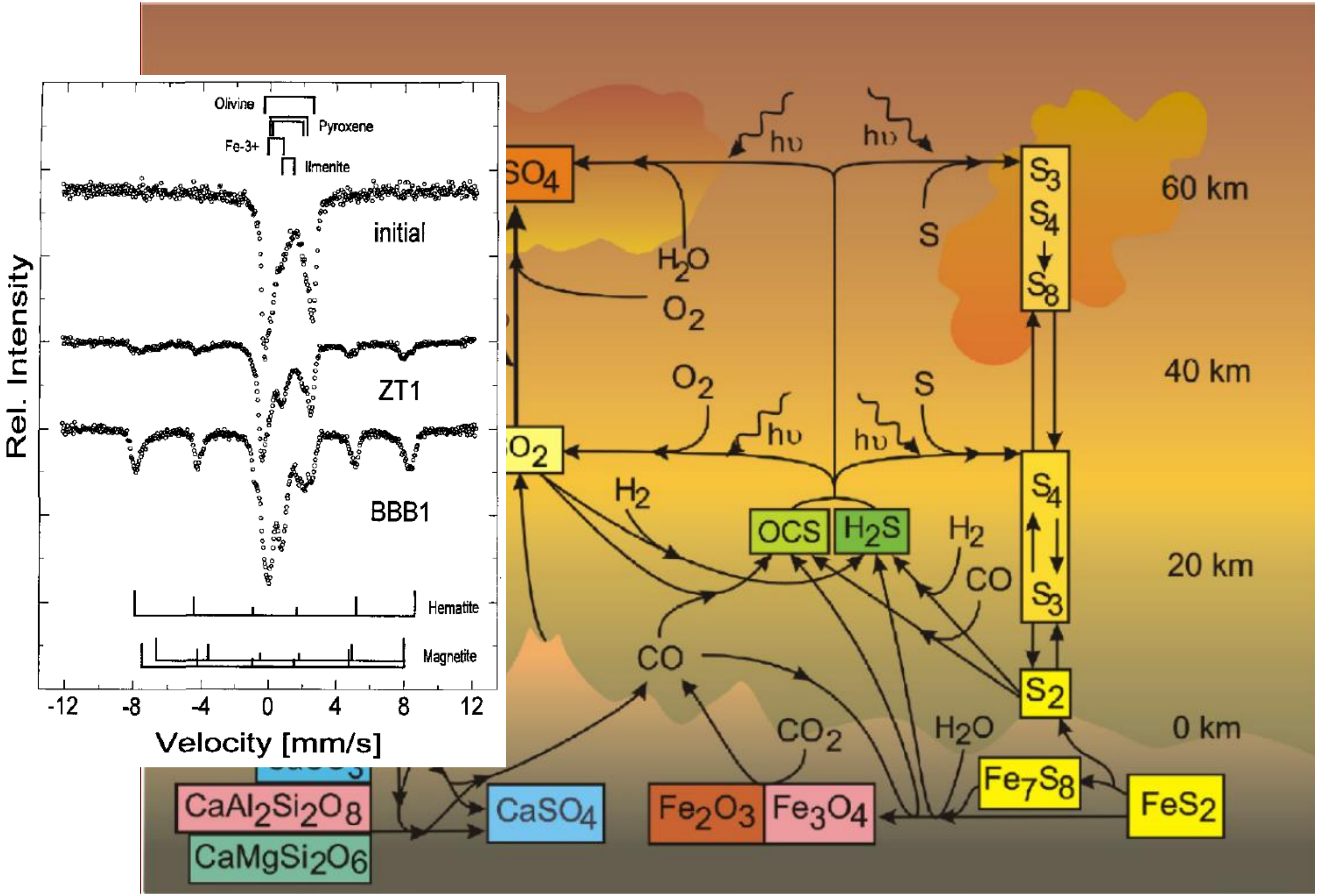
From Visscher, after Fegley et al. (1995)

Pyrite decomposes to pyrrhotite



Fegley et al. (1995) *Icarus* 115, 159-180

Basalt oxidation and formation of hematite



Fegley et al. (1995) *Icarus* 118, 373-383

Considerations for Venus conditions

- 1-3 spectra because of short life time of lander
  - Access to variety of samples?
  - Can sampling system deliver more than one sample?
- Instrument currently operational -120°C to +30°C
  - Detector performance (energy resolution) decreases with increasing temperature
- Mössbauer spectra are temperature-dependent
  - Keep sample temperature stable
- Pressure adjustments necessary?

Conclusions

- Improved MIMOS II for Venus
  - Faster spectral acquisition
  - Higher resolution
  - Simultaneous Mössbauer and XRF
- Elemental and mineralogical composition of surface
  - Fe-bearing mineral phases
  - Some elements via XRF
- Interaction between surface and the atmosphere.
  - Geochemical Fe cycle and atmospheric S cycle are linked
  - Fe oxidation states of surface material

Acknowldegements

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