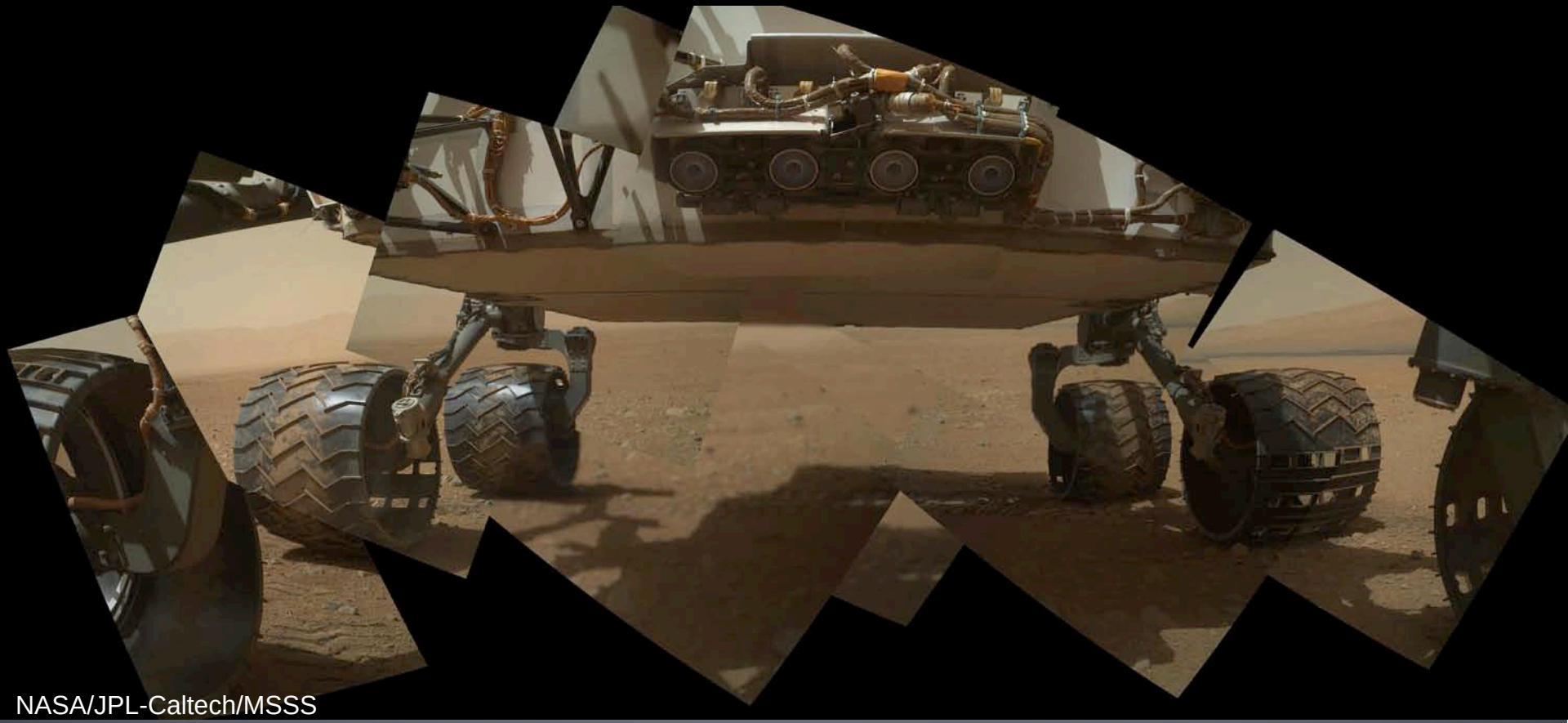
Working on the Curiosity Mars rover



NASA/JPL-Caltech/MSSS

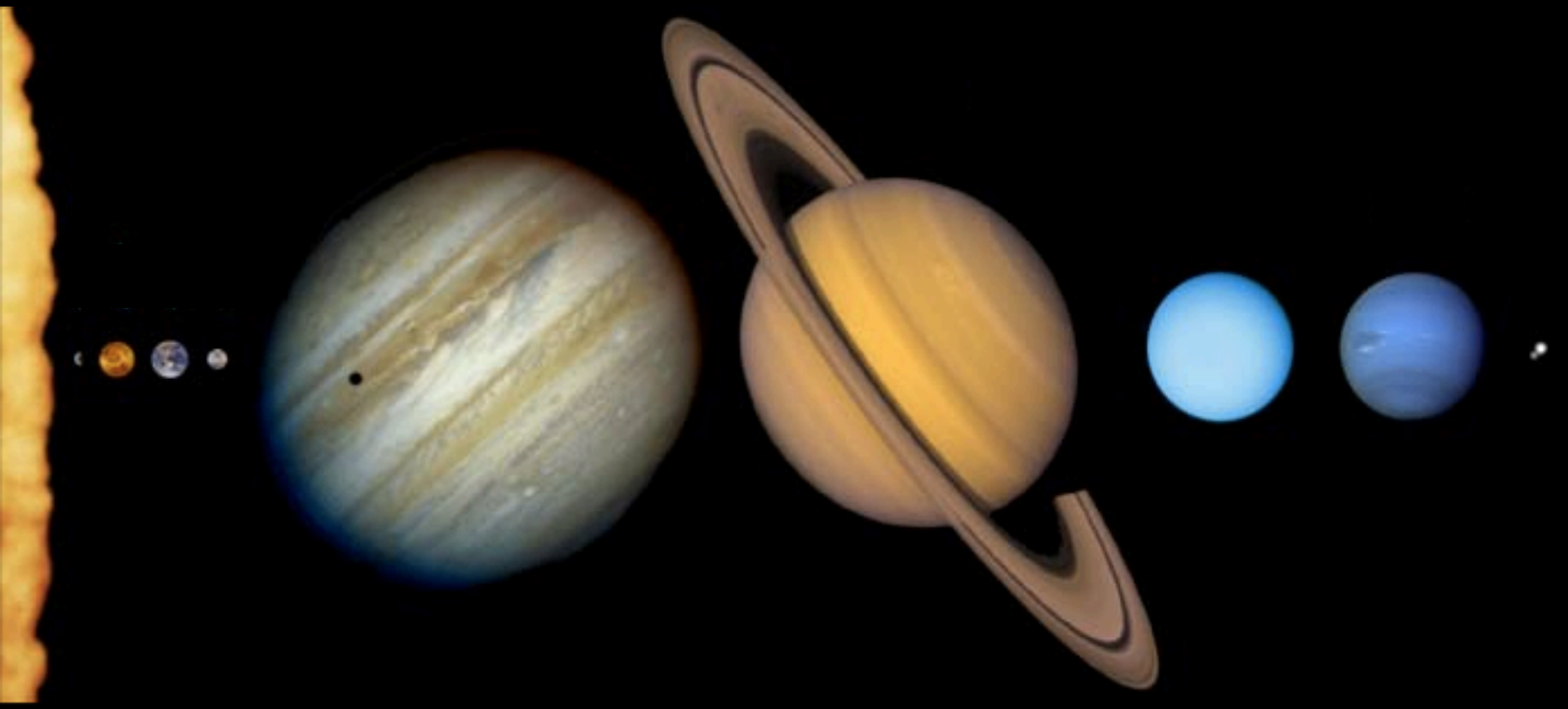
Nina Lanza and Agnes Cousin
Expanding Your Horizons
Santa Fe, NM
2 March 2013

LA-UR-13-21424

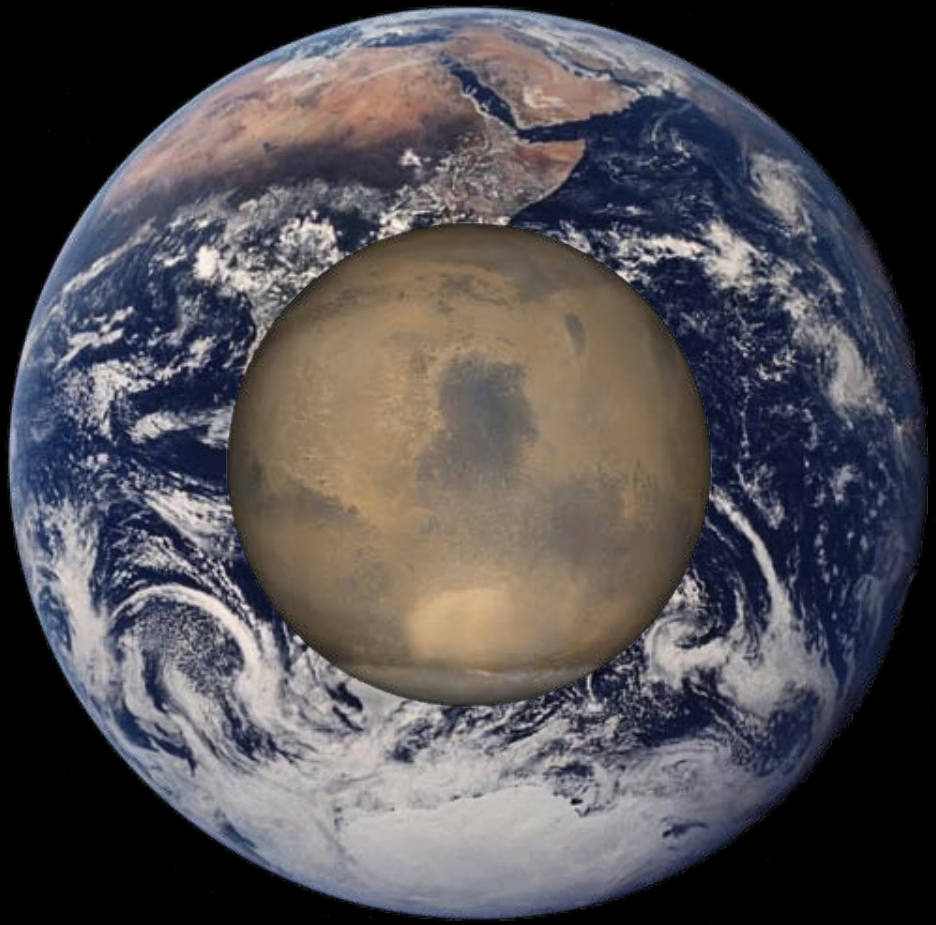
Who are we and what do we do?

- Nina Lanza & Agnes Cousin
- Geologists and postdocs
  - Recently finished PhD, still in training
- Los Alamos National Laboratory (LANL) in NM
- On MSL ‘Curiosity’ rover science team
  - ChemCam instrument

Where's Mars?



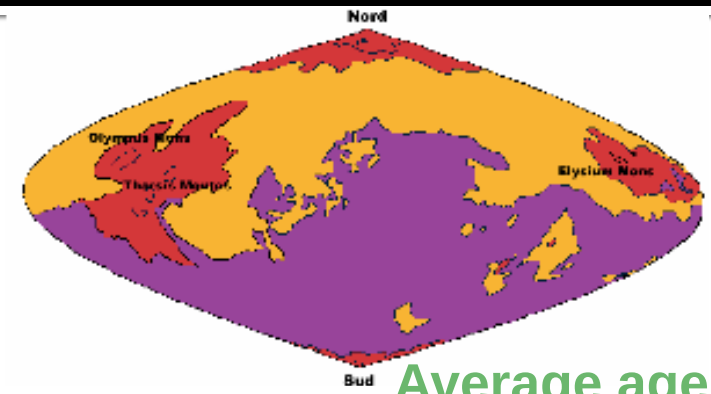
(Not to scale!)



Planet	Equatorial Diameter	Mass	Rotation
Earth	12,756	1	23h 56 min
Mars	6,792	0.107	24h 37 min

What do we know?
Differences between Earth and Mars

Mars: An ancient surface



Water on Earth

Life on Earth

Average age of Mars' surface

Average age of Earth's surface

Clays

Sulfates

Anhydrous ferric oxydes

Noachian

Hesperian

Amazonian

4.5

3.5

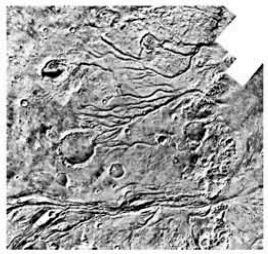
2.5

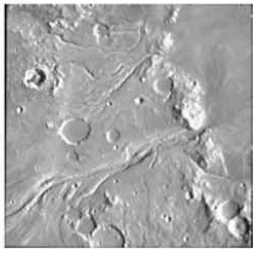
1.5

0.5

0

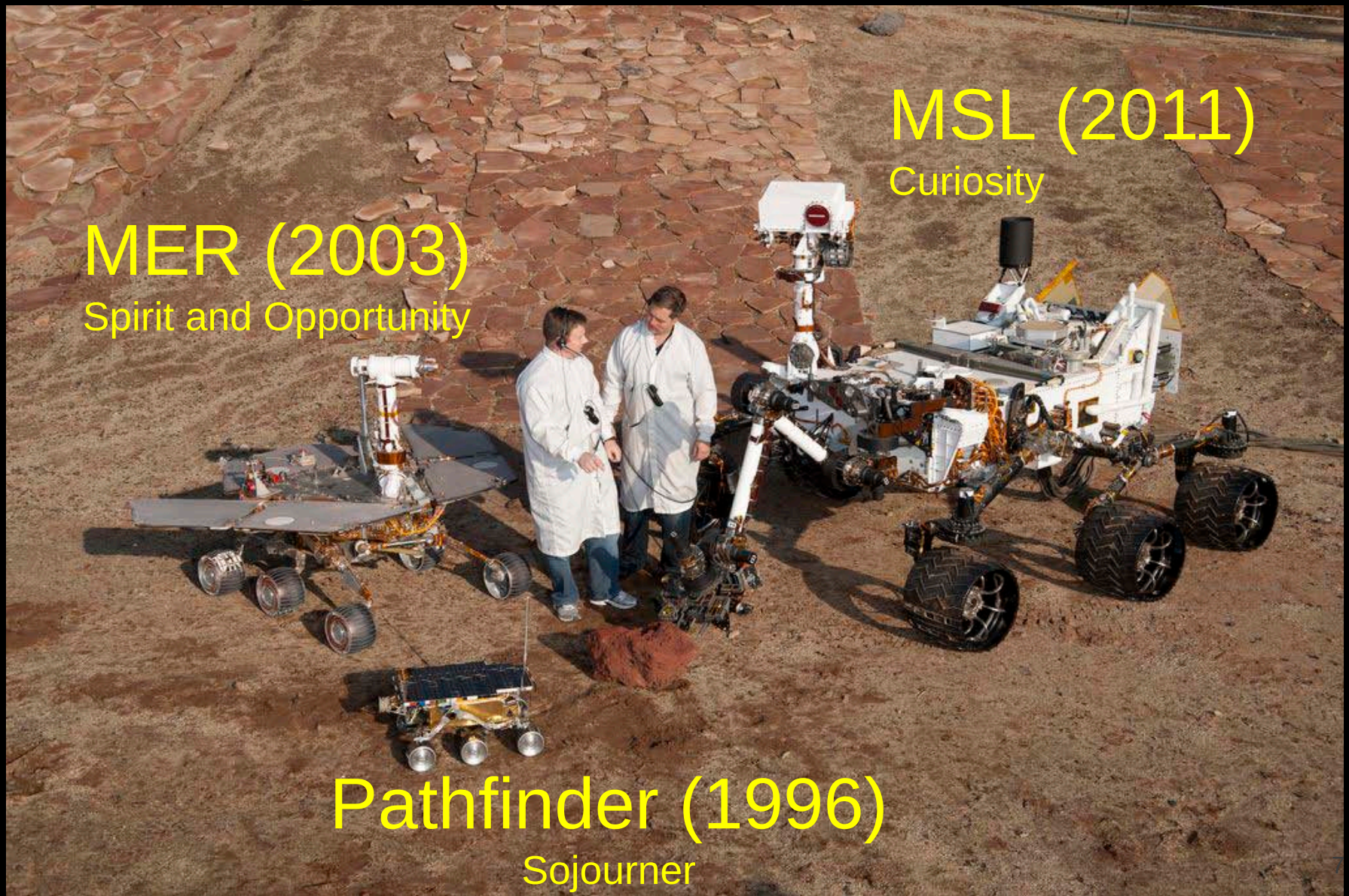
Billions of Years





Wet ---------- Dry

Mars Science Laboratory (MSL)
'Curiosity'



Goals of MSL

To assess the past and present habitability of the martian environment

- Not a search for life per se
- Environments in which life could exist
  - H_2O (key criterion for life)
  - Hydrated and water-formed minerals
  - Organic materials
  - Other bio signatures (chemical or morphological)

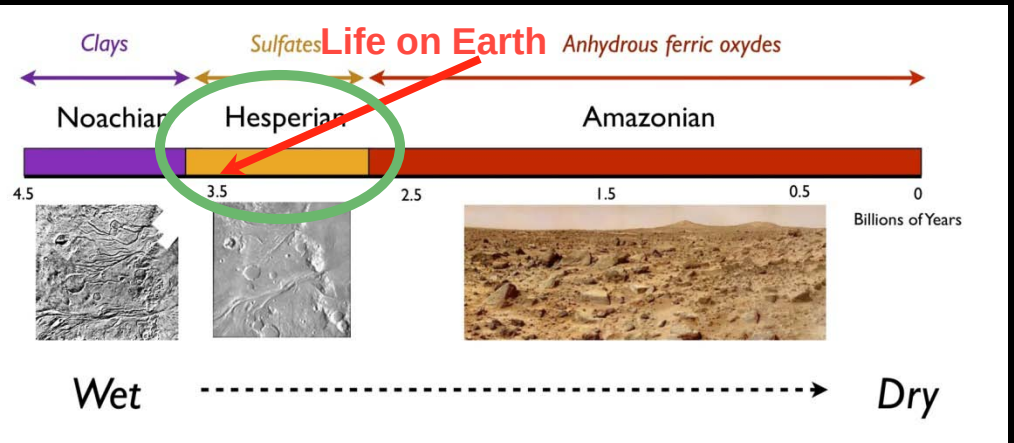
Landing site: Gale crater

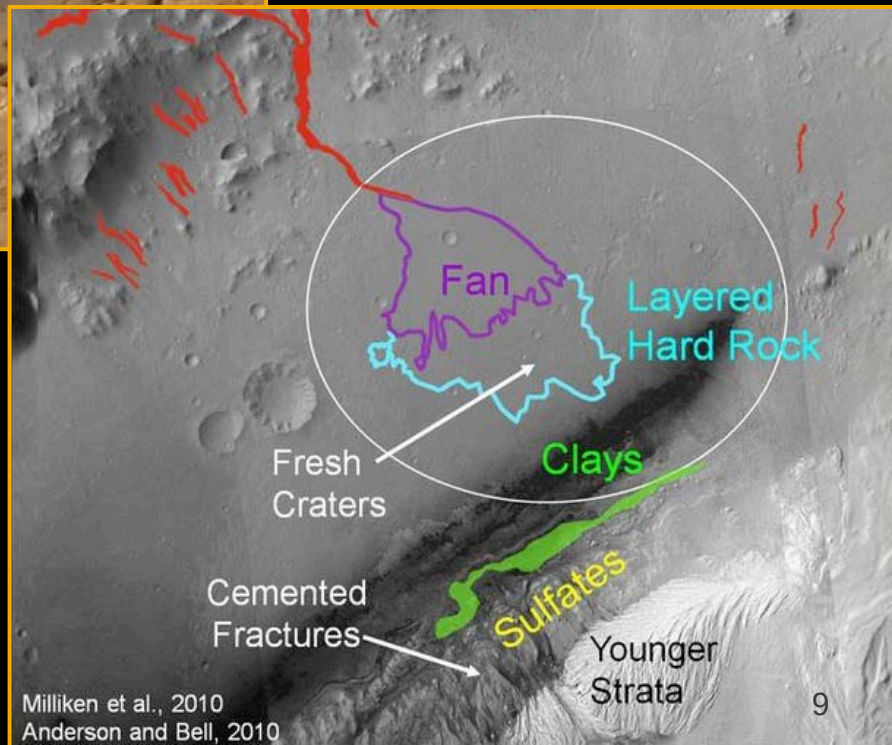
Aeolis Mons (‘Mt. Sharp’) ~5.5 km tall
Crater diameter ~150 km

Ellipse ~20 x 7 km

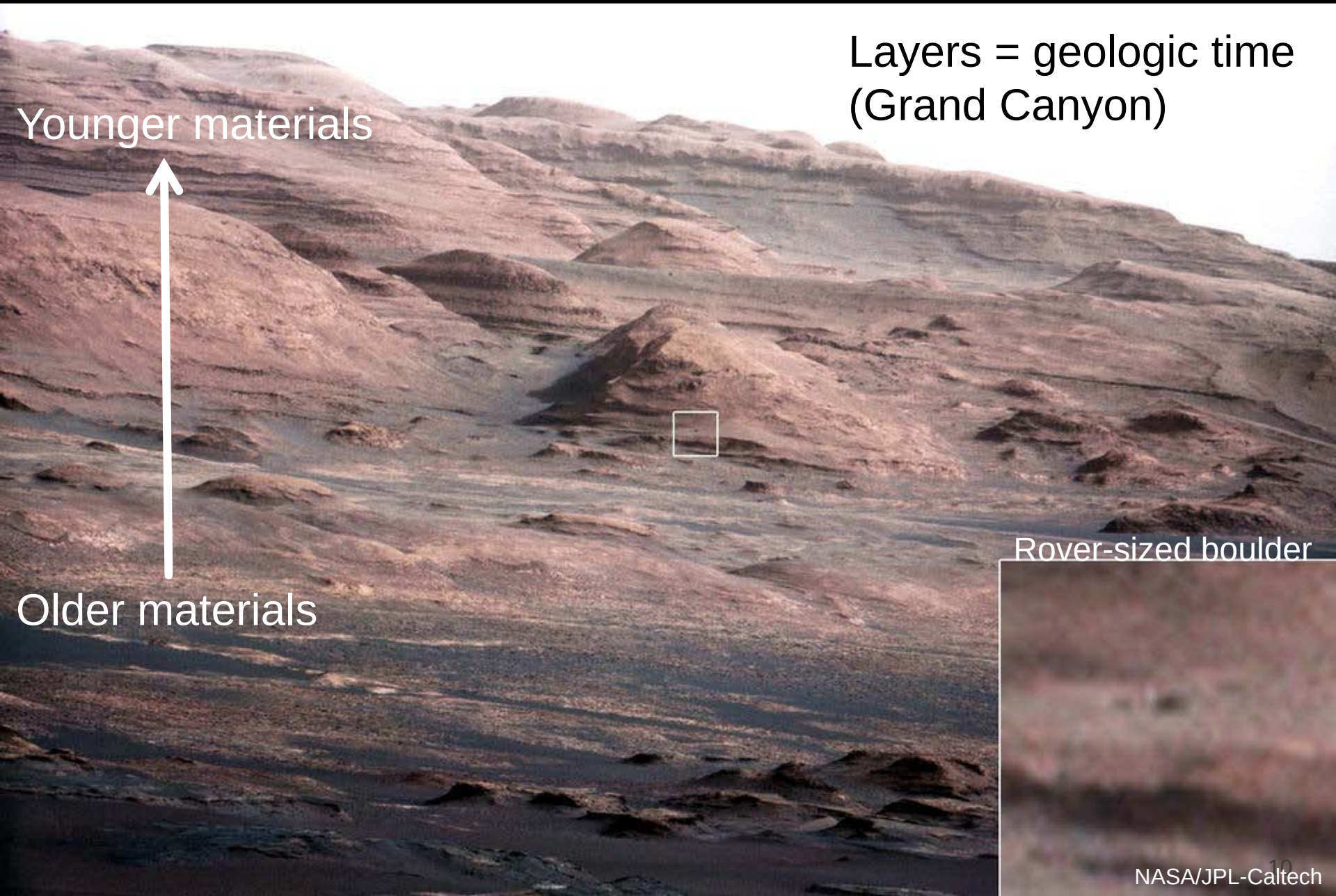
NASA/JPL-Caltech

NASA/JPL-Caltech/ESA/DLR/FU Berlin/MSSS



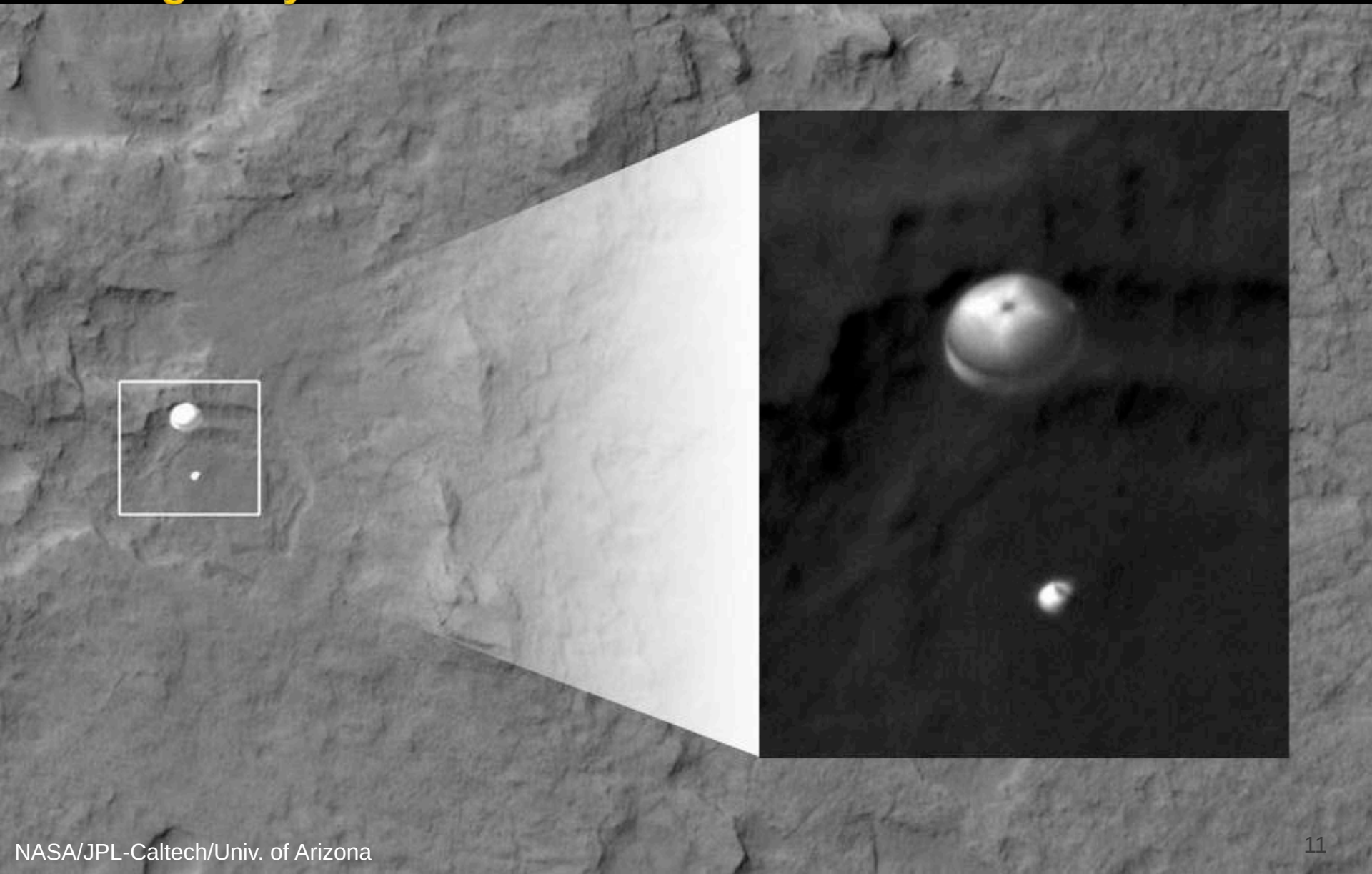


Layers of Mt. Sharp



Curiosity lands on Mars

Imaged by HiRISE on Mars Reconnaissance Orbiter



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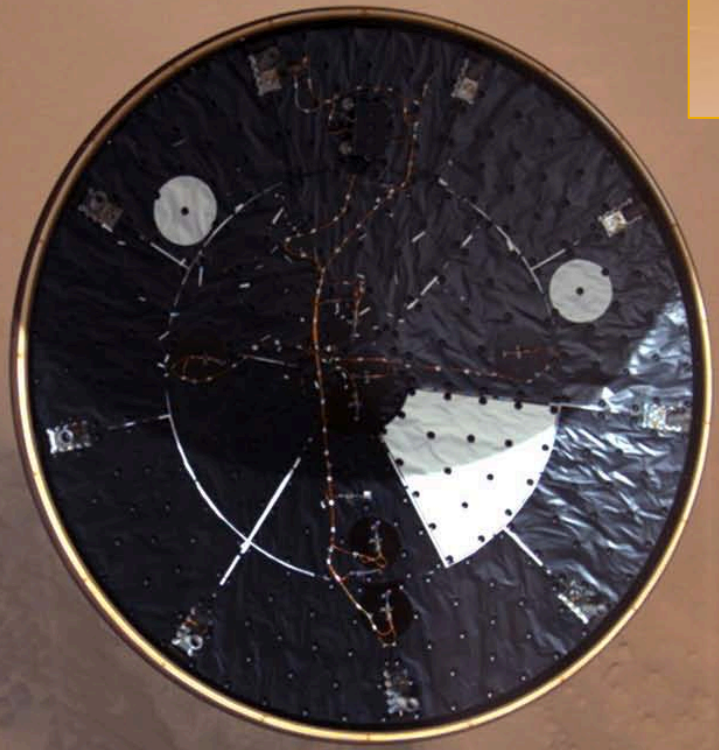
Heat shield separation

Mars Descent Imager (MARDI)



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Just prior to landing

NASA/JPL-Caltech/MSSS

MARDI descent video

View of Mt. Sharp from landing site

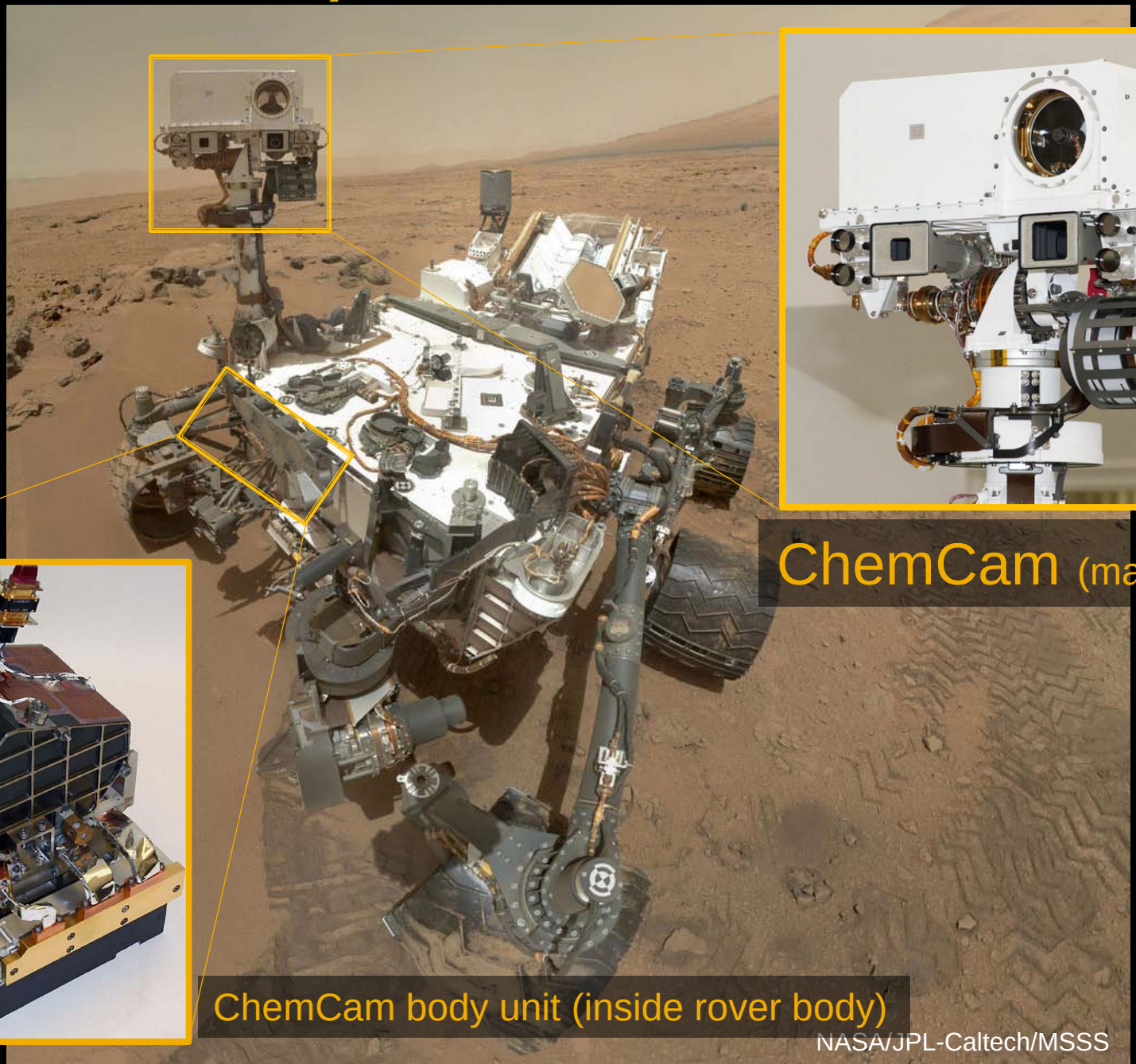
Mastcam image

NASA/JPL-Caltech/MSSS

Self-portrait with MAHLI

NASA/JPL-Caltech/MSSS

Self-portrait with MAHLI



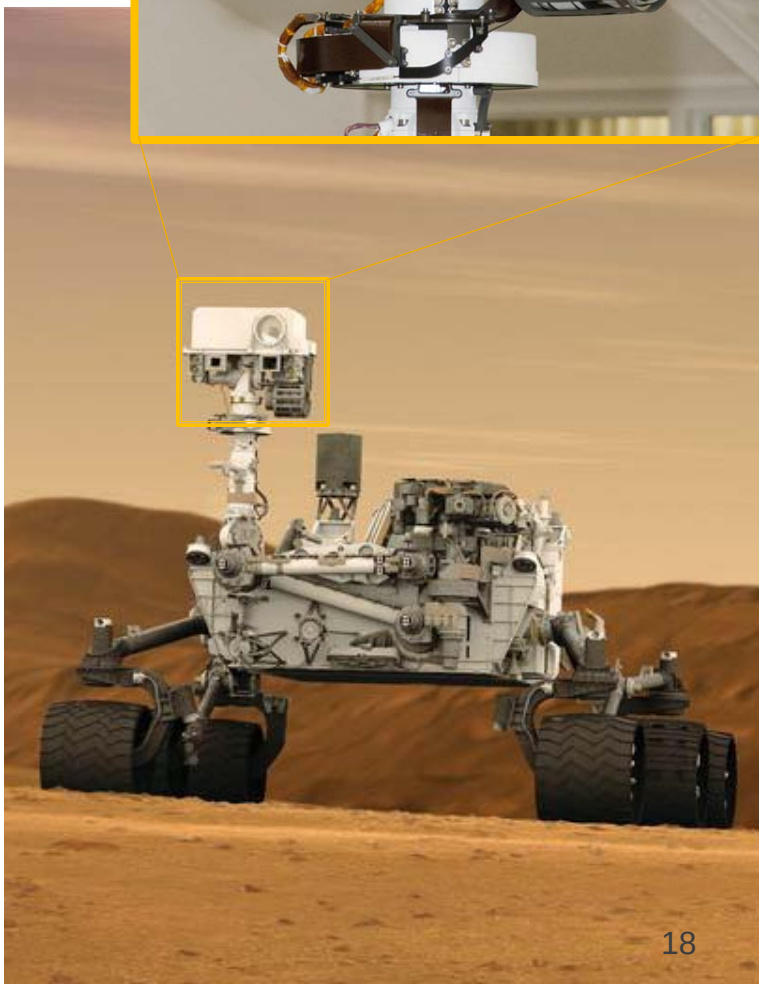
ChemCam (mast unit)

ChemCam body unit (inside rover body)

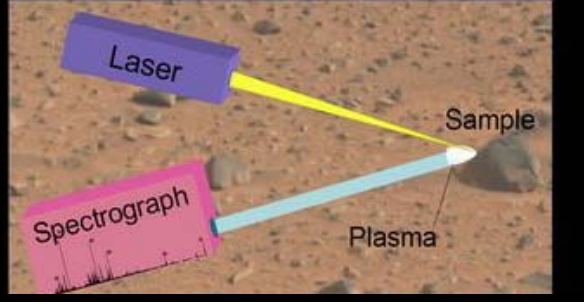
NASA/JPL-Caltech/MSSS

ChemCam
Chemistry and Camera

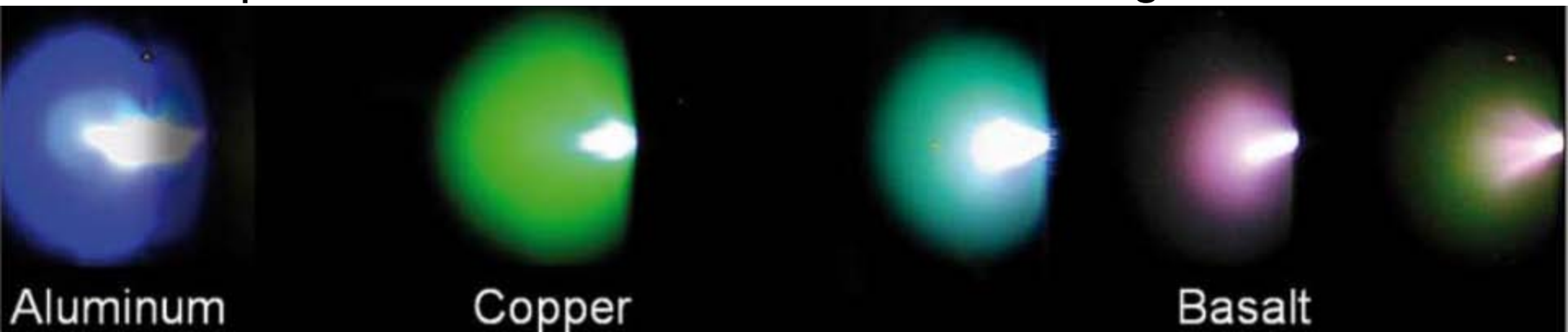
- Composed of two instruments
  - Remote laser-induced breakdown spectroscopy instrument (LIBS)
  - Remote Micro Imager (RMI)
- LIBS determines elemental compositions up to 7 m from rover
- RMI provides telescopic context images
  - Resolution of objects <0.5 mm diameter at 5 m distance
  - Small scale textural information

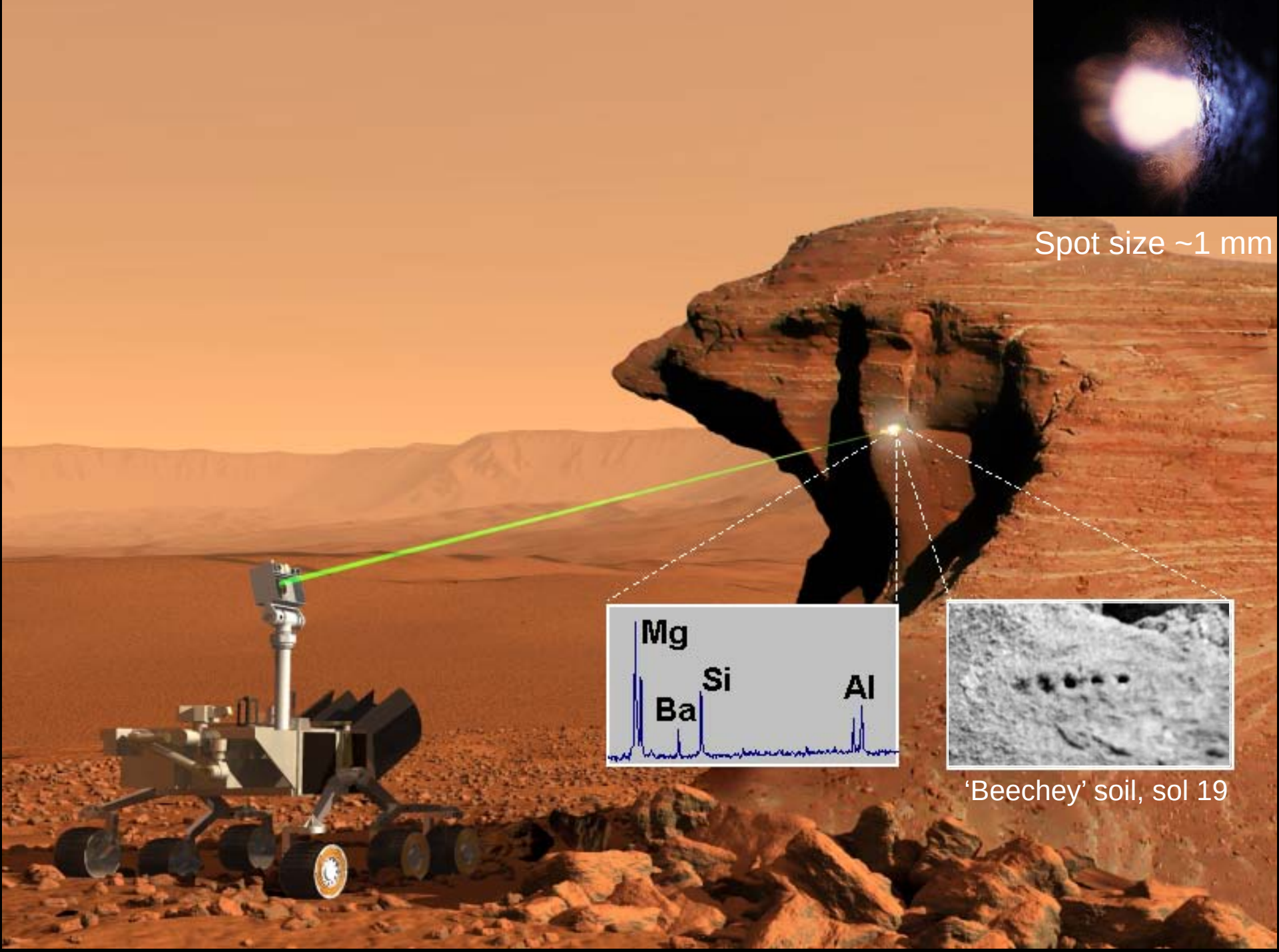


What is LIBS?



- Laser-Induced Breakdown Spectroscopy
- Ablation (emission) spectroscopy technique
- Uses pulsed laser
  - λ = ~1067 nm (NIR)
  - Heats target to ~6000-9000 K and turns surface materials into plasma (ablation)
  - Spectrometer collects light from plasma over ~200-800 nm (UV, VIS, NIR)
  - Returned spectra have peaks that correspond to specific elements → different colors of light



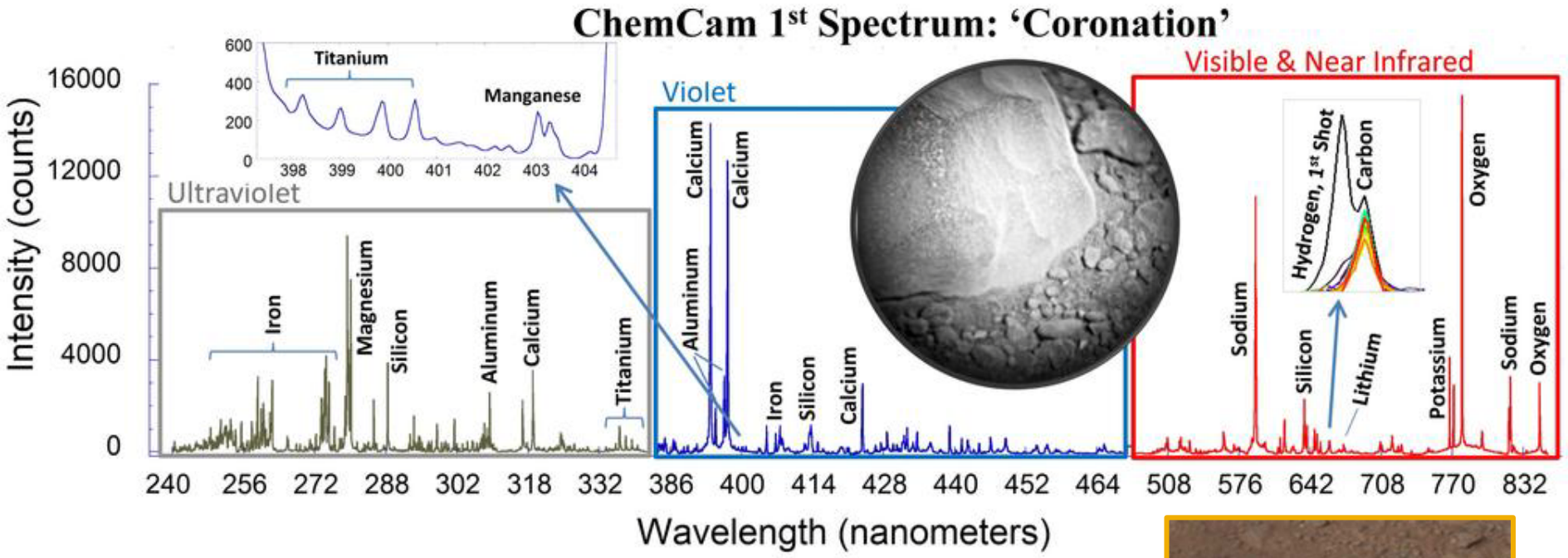

Spot size ~1 mm
Mg
Si
Ba
Al
'Beechey' soil, sol 19

ChemCam in action

(We wish)

First ChemCam target

Coronation, Sol 13



- A beautiful spectrum!
- Contains H in first shot

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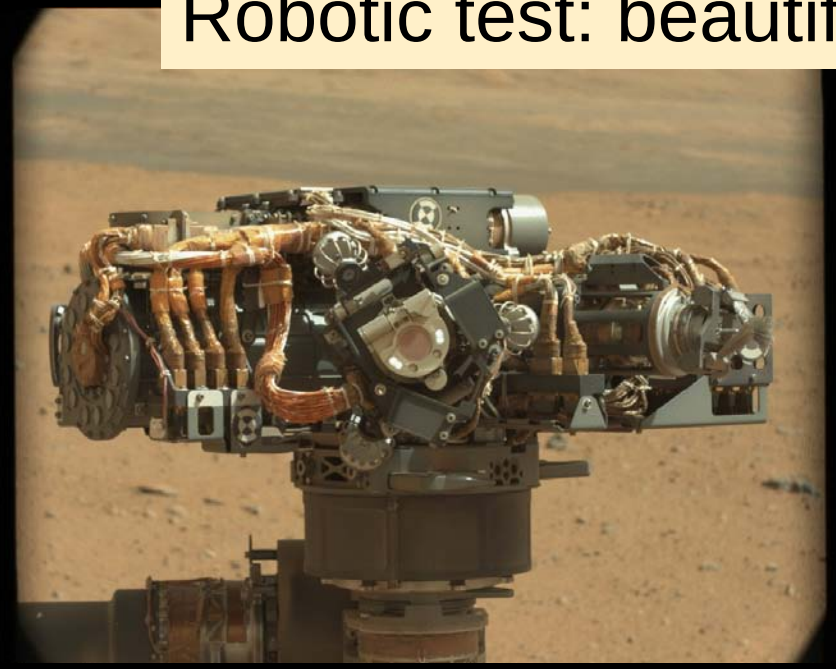
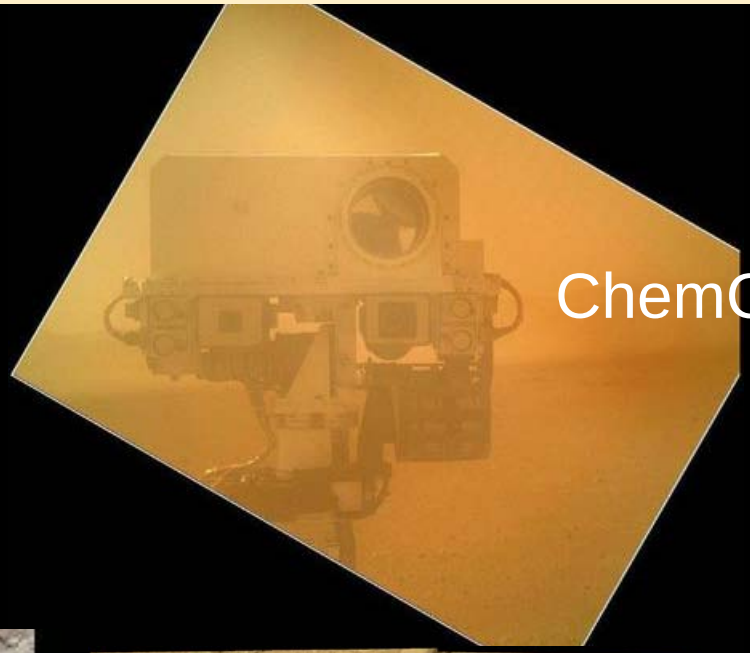
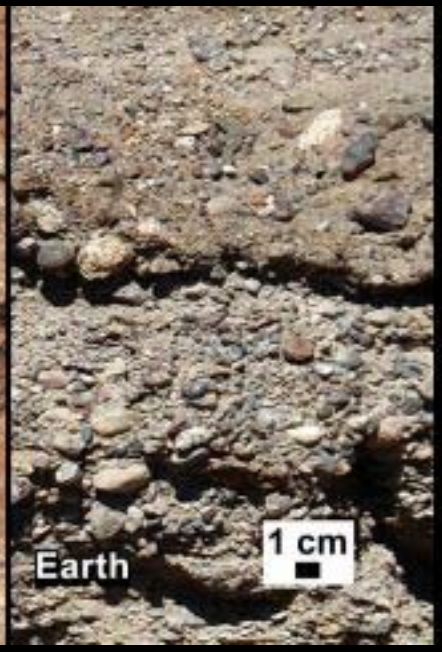
Robotic test: beautiful pictures of the rover!



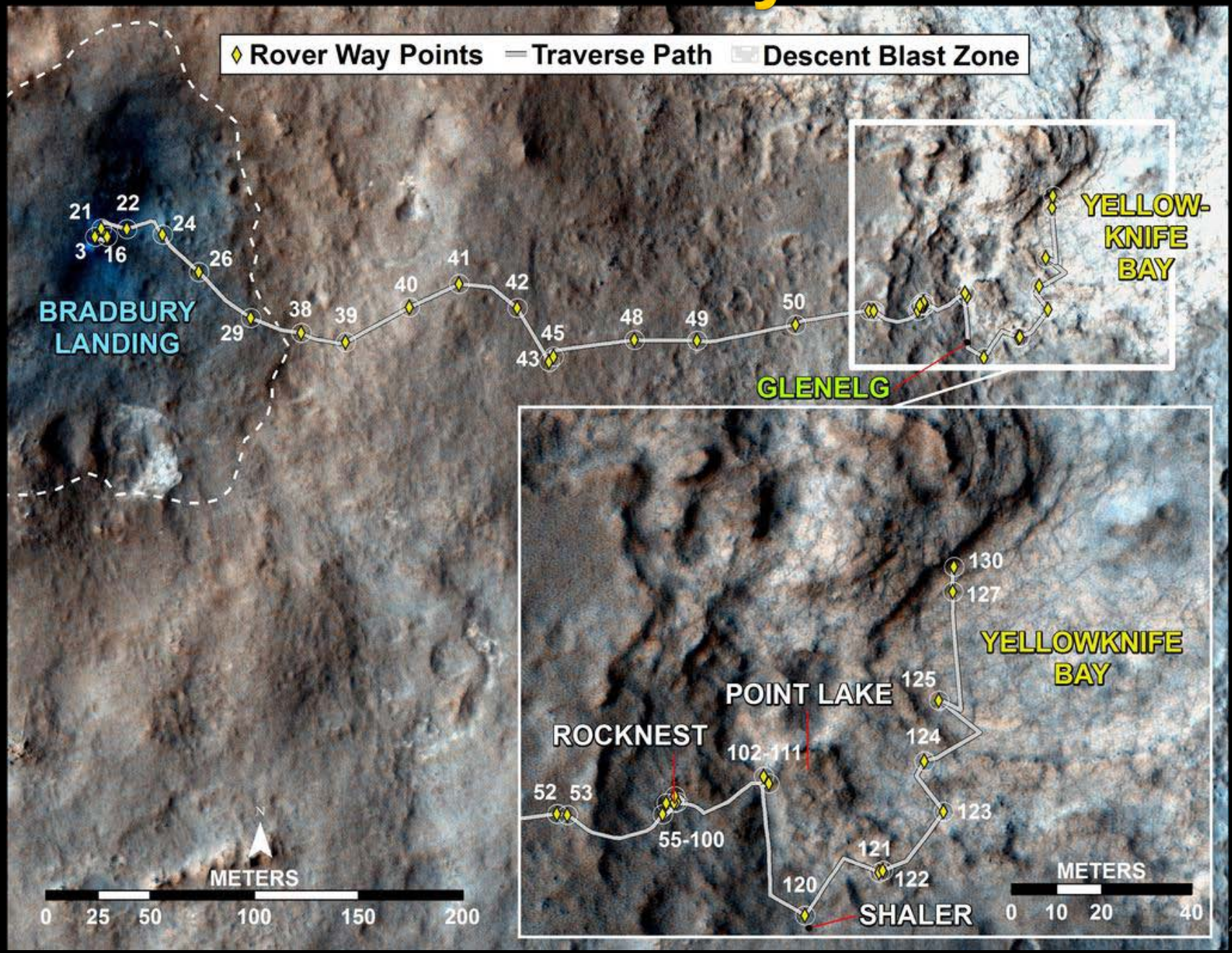


ChemCam!



Several kinds of rocks observed

Current status: Today is sol 203



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How do you drive a Mars rover?

Driving the rover

- First 90 sols at Jet Propulsion Lab (JPL) in CA
  - On Mars time!
  - Now at home institutions, CA time (7 days/week)
- Long-term goals are planned in advance
- Daily science experiments decided by science team
  - Look at data returned from yestersol
  - Select new targets for analysis
- Write spacecraft commands in JPL software
- Many, many meetings to check work
  - Could break rover
  - Delay long-term goals
- Science discussion at the end of the sol

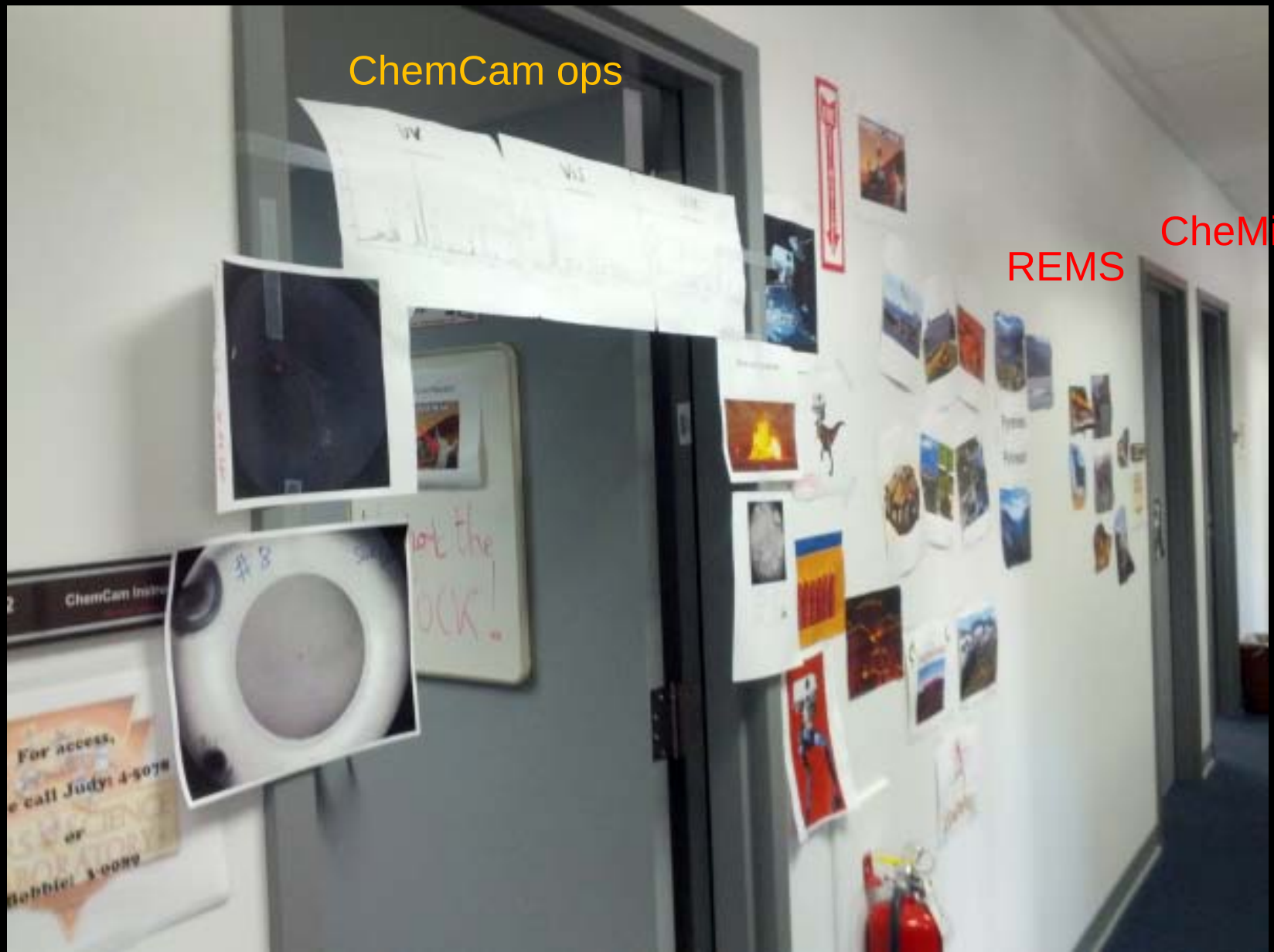
At the science kickoff

~5am, still one meeting to go

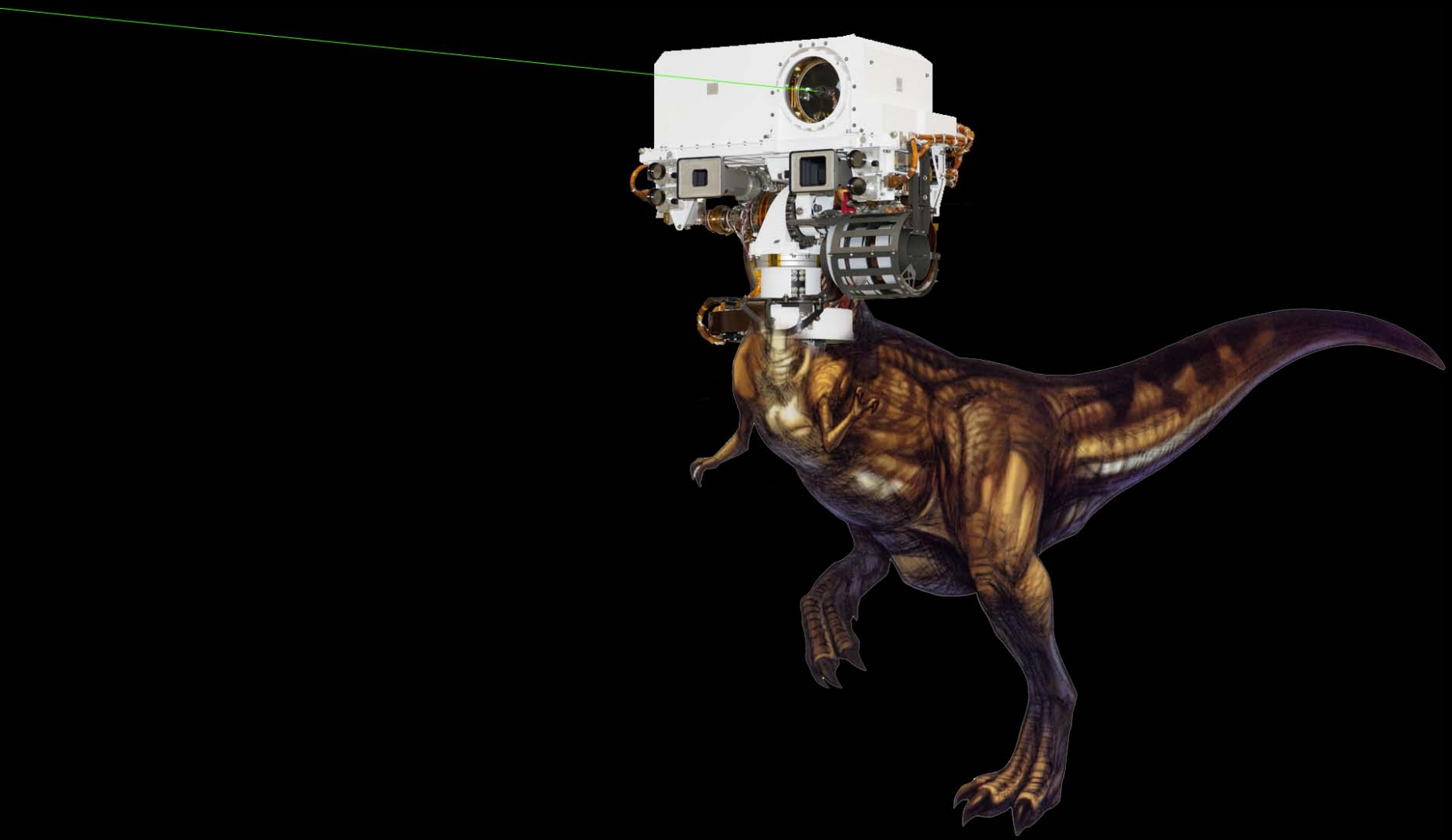
Free ice cream!

Leaving JPL at ~4 am

ChemCam ops exterior



ChemRex



ChemDestroyer

French: “Why do people think that ChemCam will hurt cats?”

Some discussion close to the pool

U.S. – France collaboration

Observatoire de Paris, June 2012

10 women out of 35 team members = 28%
Probably less for entire team

How did I get here?

Nina's story

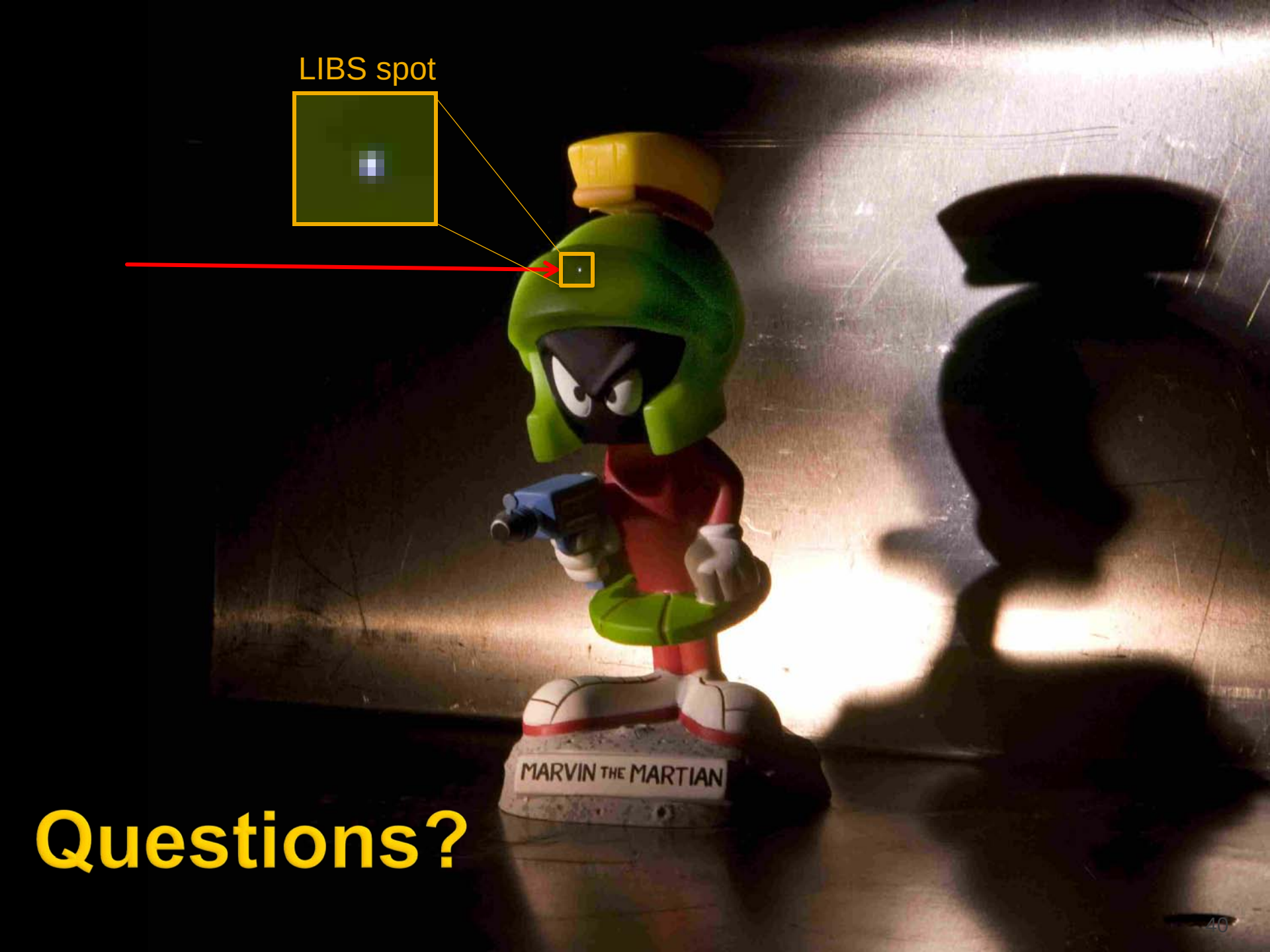
- Saw Halley's comet in 1986 and was hooked
- Took astronomy at Winsor and loved it
- Majored in astronomy in college (Smith College)
- Wasn't sure about grad school
  - Didn't think I was good enough (!!!)
- Question: What do I really like learning about?
  - Science fiction
  - Spaceships
  - Aliens
  - Conclusion: I should study Mars
- Then, I called up a planetary researcher at LANL and asked for a job
  - Worked at LANL as a post-bac student
- Went to grad school in geology
  - Wesleyan University, University of New Mexico

How did I get here, in France?
Agnes' story

- Always have been passionate about space in general and spaceships
- I participated several times in astronomy summer camps, as a kid and then as teacher
- College: Engineering for spaceships or science ??
  - I tried Engineering first ! But changed my mind…
- Majored in geology in college
- Master's degree in planetary science

How can *you* get here?
Or wherever you want to be

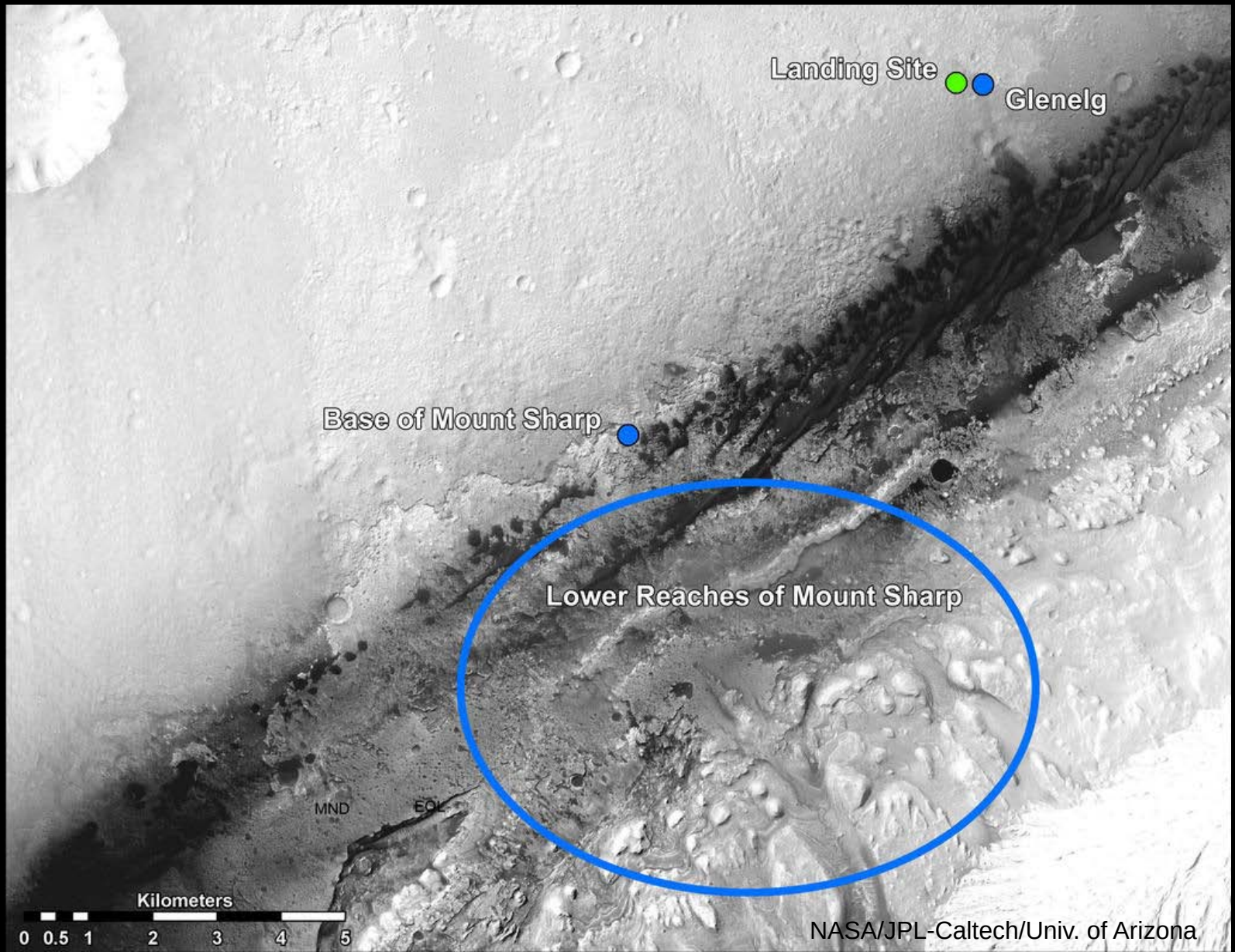
- You don't have to be "good," you just have to love it
  - Experts = ~10,000 h of practice (5 years)
  - You can learn anything if you put in the time
  - Research is about answering questions that no one knows the answer to
    - You aren't dumb if you don't know the answer!
    - Can be good at research and not school
- Don't limit yourself to things that are easy
  - You will have to work hard
  - But the rewards are worth it
- Be persistent



Questions?

Backup slides

Where are we headed?



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Landing night

ChemCam on Discovery (2:28)

http://science.discovery.com/videos/mars-landing-2012-chem-cam.html

Curiosity rover report

http://www.youtube.com/watch?v=iDgv14Qtl1c&list=UUryGec9PdUCLjpJW2mgCuLw&index=21