



Mars Exploration Rover Heatshield Observation Campaign

Christine Szalai, Benjamin Thoma, Justin Maki, Wayne Lee
Jet Propulsion Laboratory

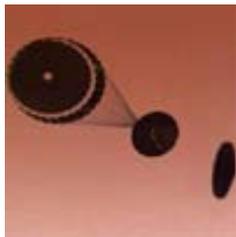
William Willcockson
Lockheed Martin Astronautics

Ethiraj Venkatapathy
NASA Ames Research Center



First Ever Look at Heatshield on Another Planet! **JPL**

Mars Exploration Rover



*Opportunity lands on Mars
January 24, 2004*

- Excellent opportunity for TPS community to evaluate TPS performance and possible anomalies
 - No TPS instrumentation on board so we have NO other information other than “it worked”
- What can we learn from visual observation?
 - Surface color variability and surface feature observations (e.g. roughness) will allow us to compare with ground test results, assess potential impact of turbulent transition, and edge heating effects
 - Observation of main seal integrity
 - Observation of color variability of internal structure that may indicate thermal gradients
- Why is this important?
 - We’ve never had the opportunity to evaluate TPS performance after a Mars entry
 - Data obtained may help us improve future TPS designs



Heatshield Observation Plan



Mars Exploration Rover

- Obtain data to measure char depth
 - Utilize rover's microscopic imager
 - Gives us information on TPS performance vs. predictions
- Obtain images to discern external char pattern
 - Gives us information on heating gradients and transition to turbulence at shoulder region
- Obtain detailed images of Main Seal
 - Gives us information on overall performance of the main seal
- Obtain images of internal structure
 - Looking for any signs of overheating



Heatshield "Before"



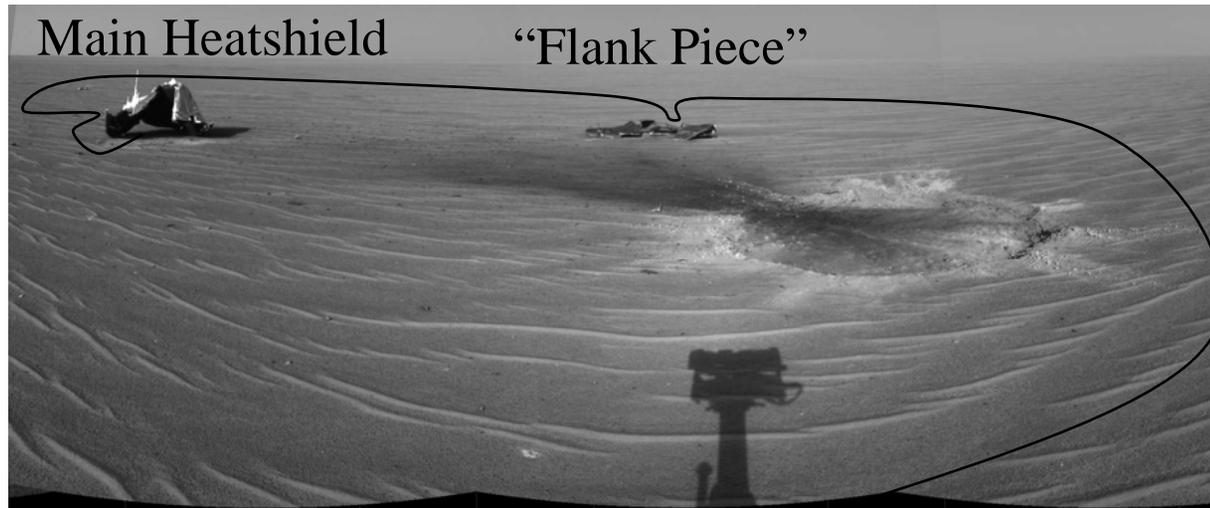
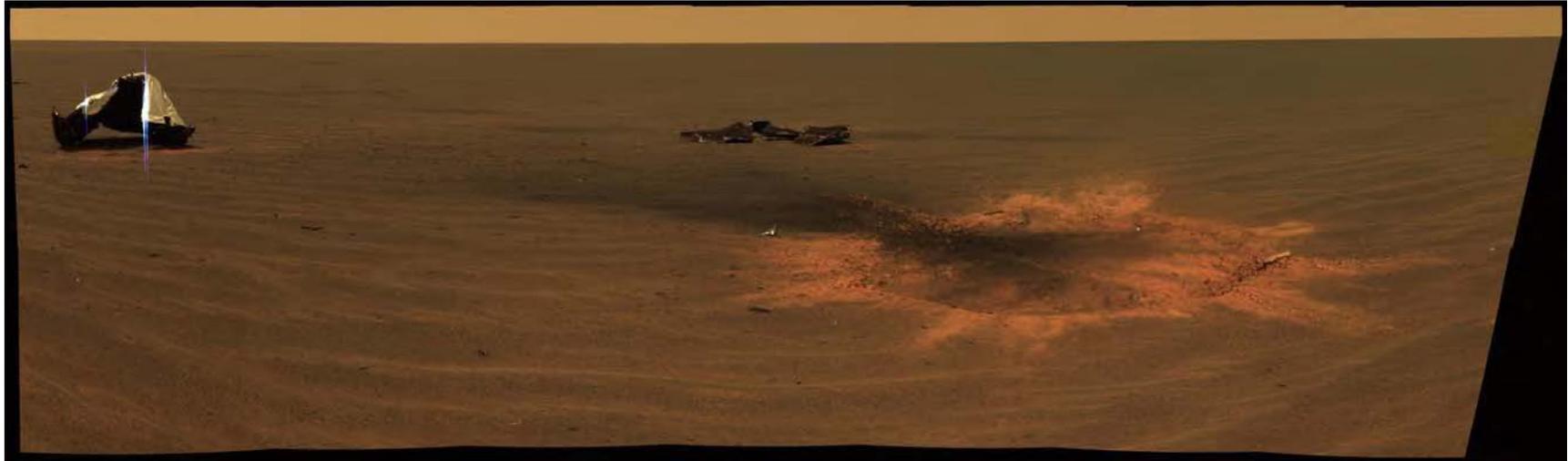
Heatshield After Impact



Approach Plan



Mars Exploration Rover



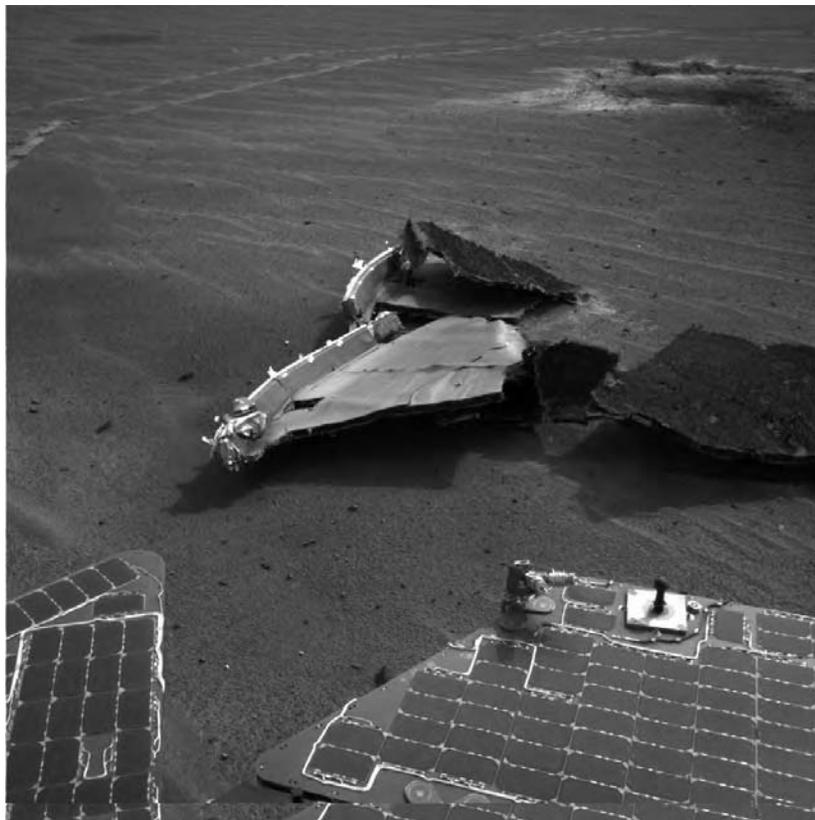
3rd International Planetary Probe Workshop, June 27-July 1, 2005, Greece

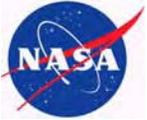


“Flank Piece”



Mars Exploration Rover

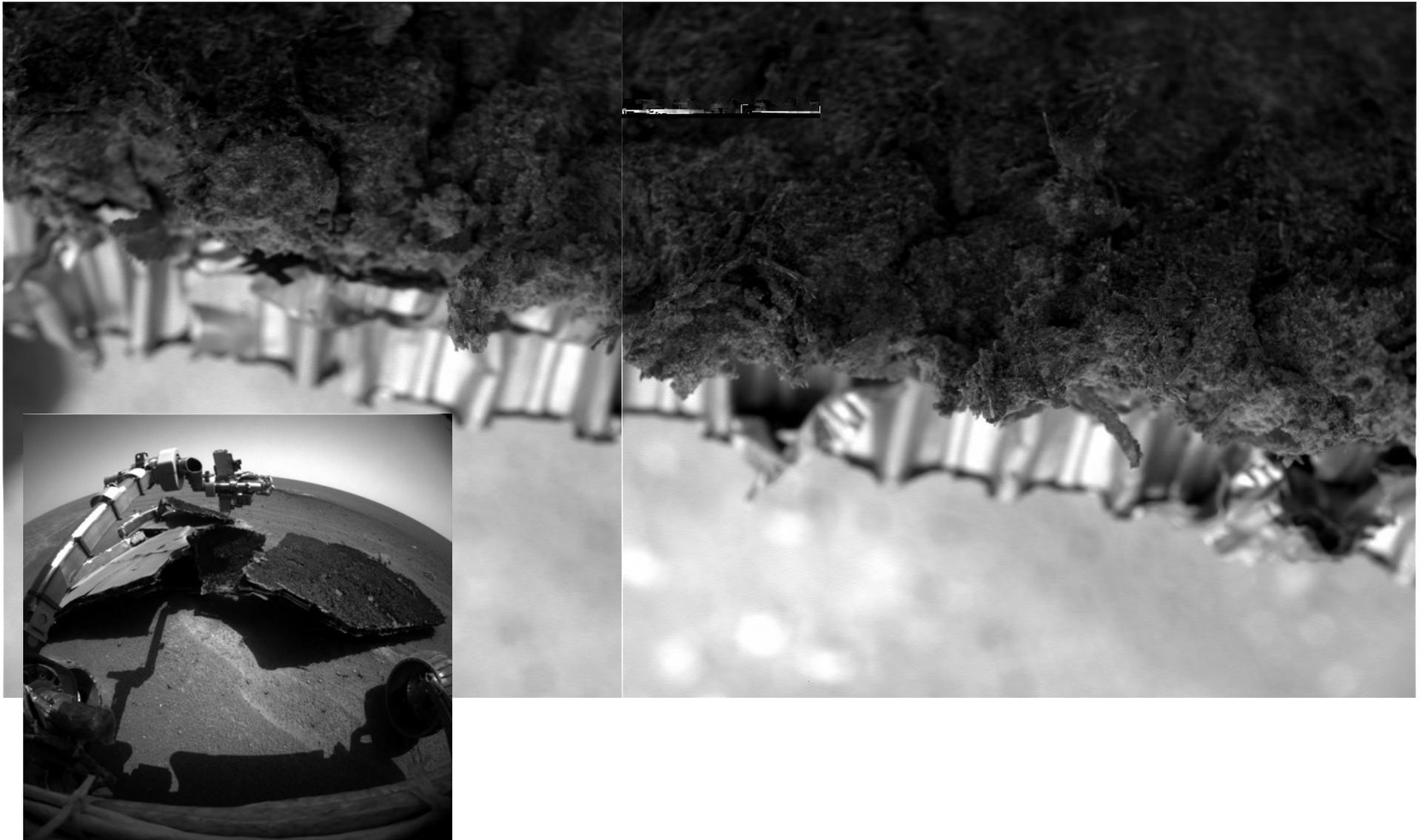




Microscopic Image Data on “Flank Piece”



Mars Exploration Rover

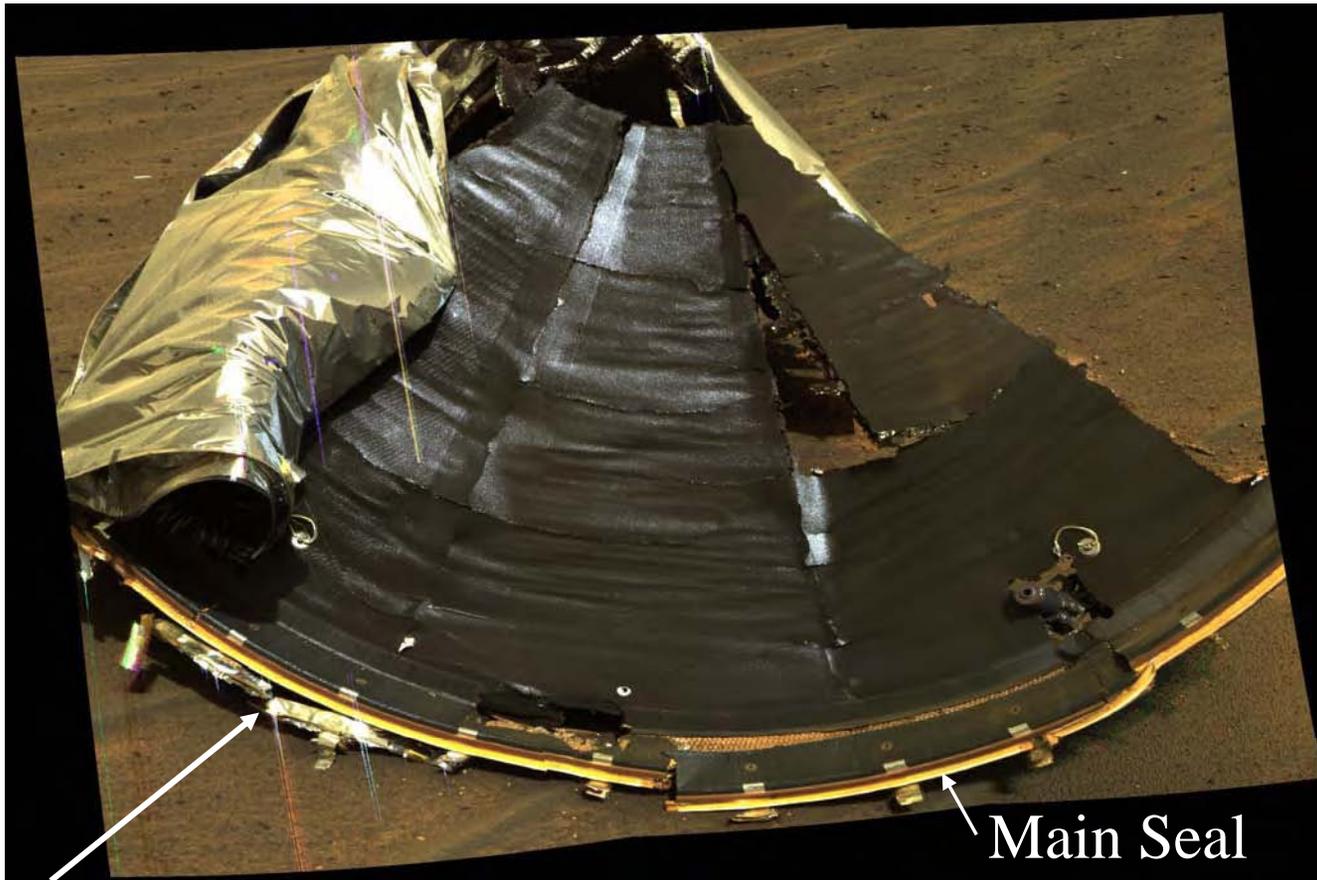




Main Seal and Structure Observations



Mars Exploration Rover



Thermal Blanket tape strip remnant

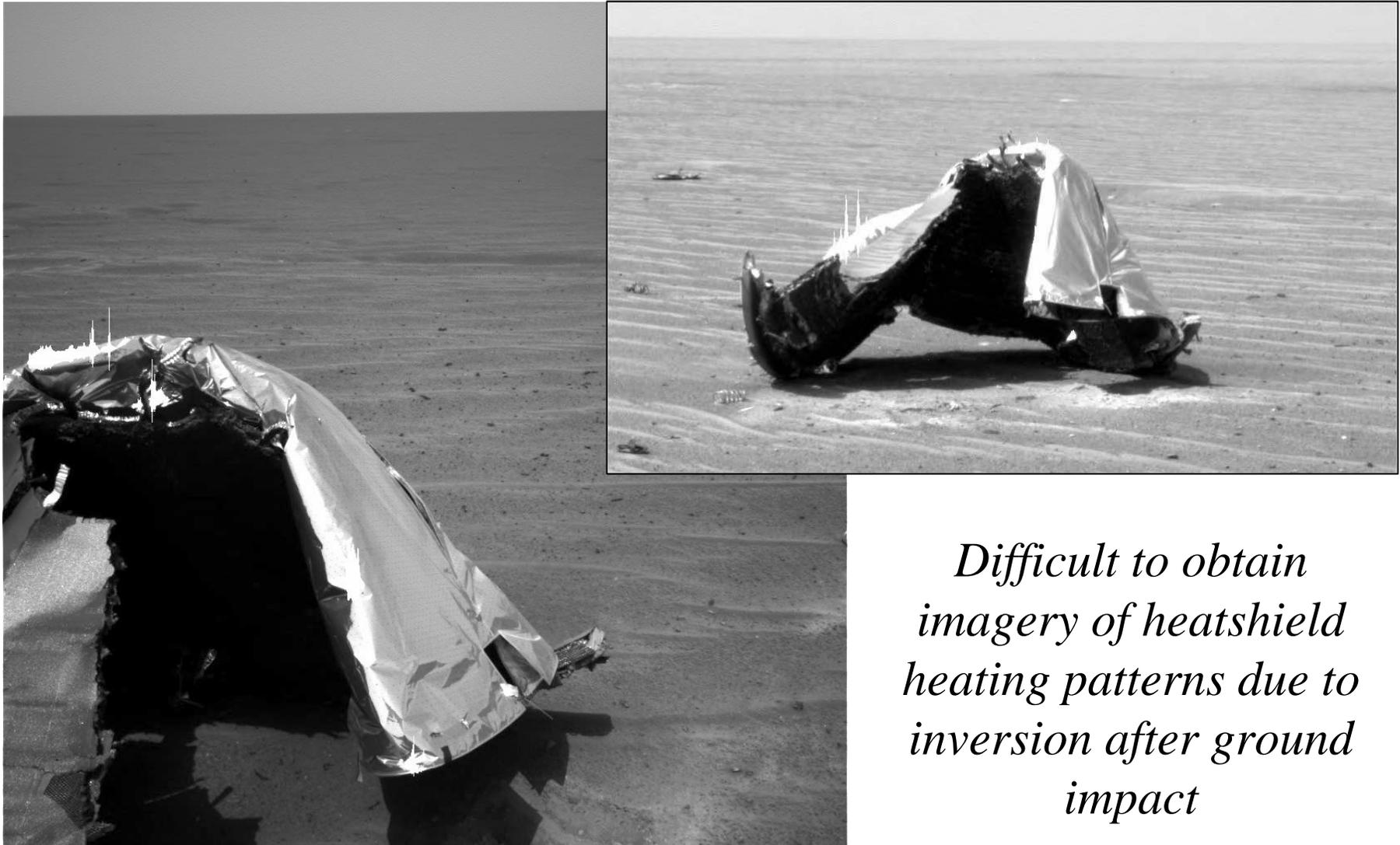
Observation of tape strip remnant is being studied as a possible cause of unexpected angle of attack growth during entry



Main Heatshield Observations



Mars Exploration Rover

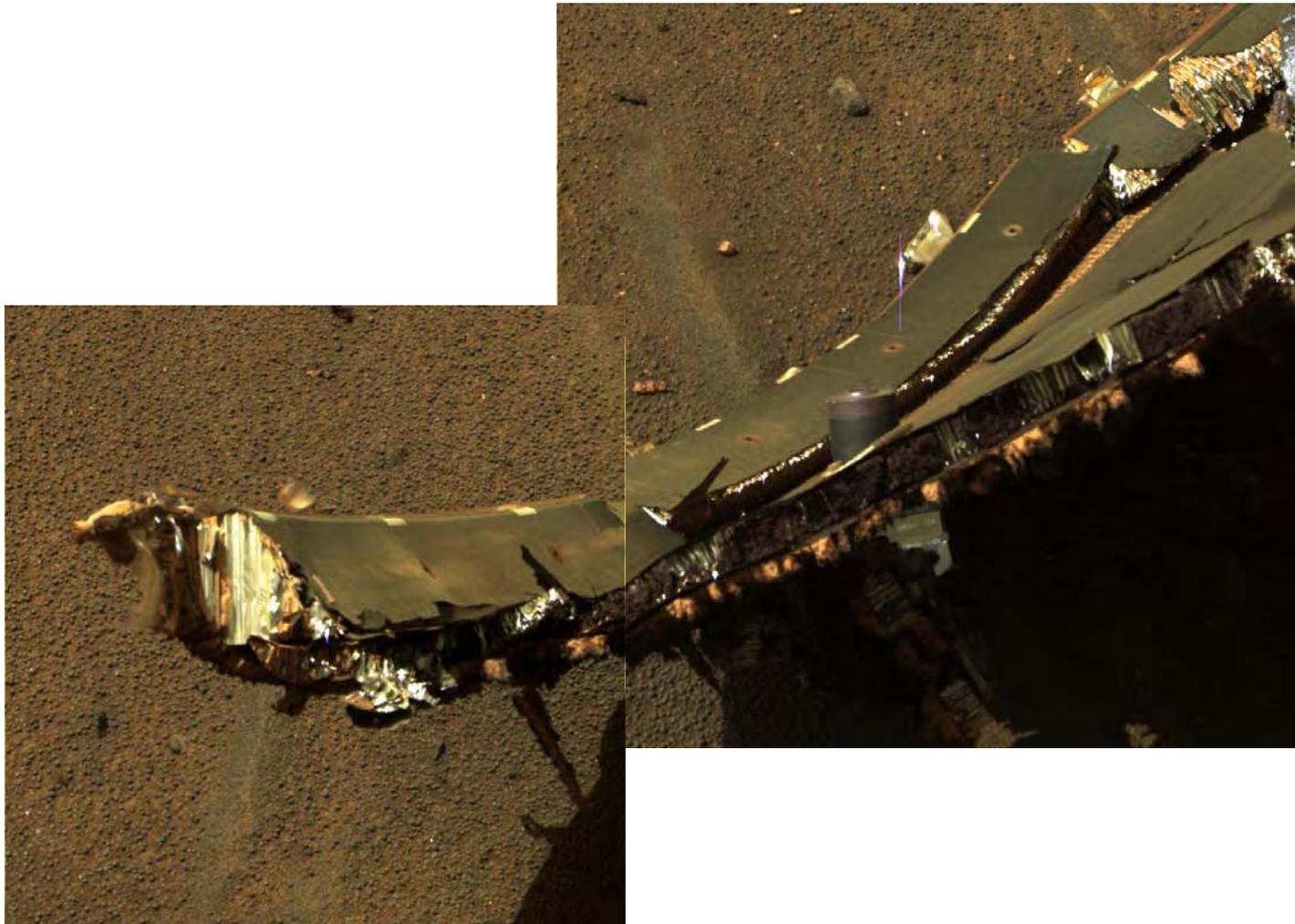


*Difficult to obtain
imagery of heatshield
heating patterns due to
inversion after ground
impact*



Color Image of Heatshield Shoulder **JPL**

Mars Exploration Rover

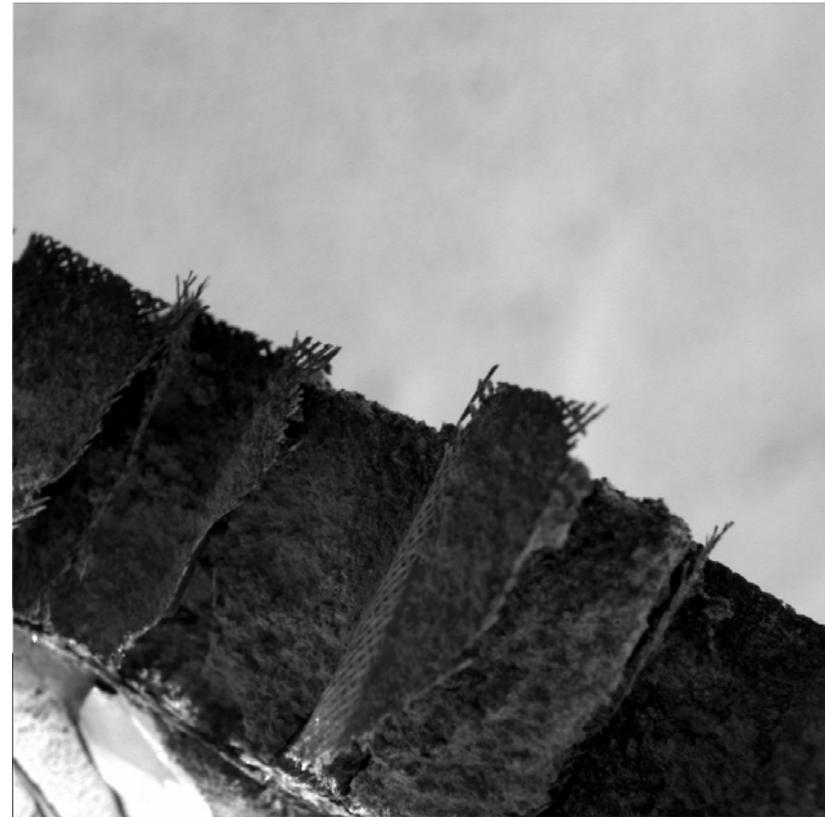
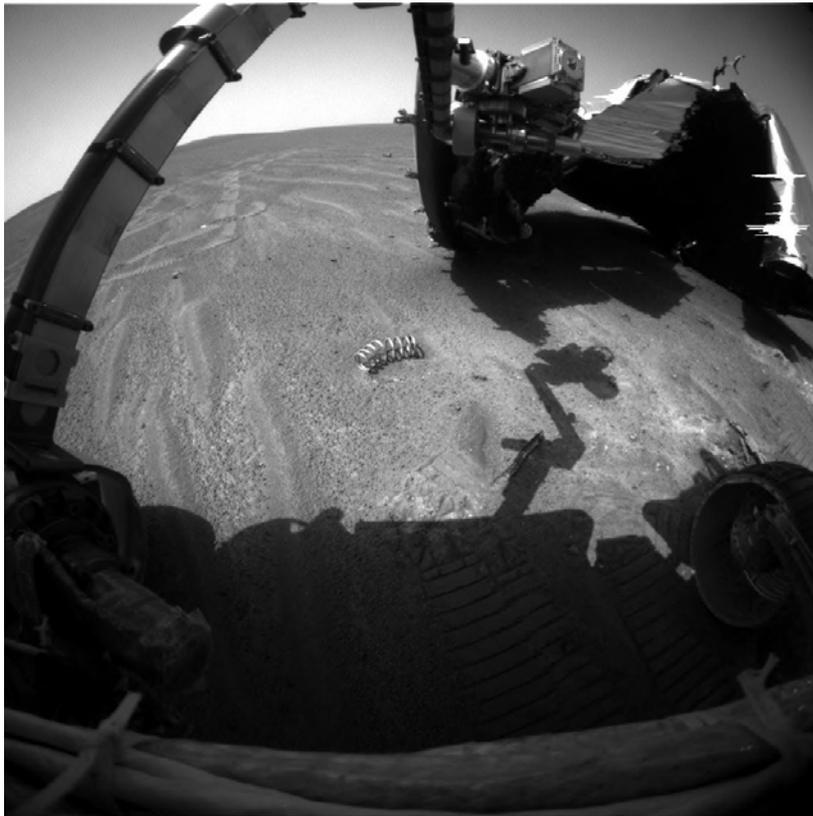




Microscopic Image Data from Heatshield



Mars Exploration Rover



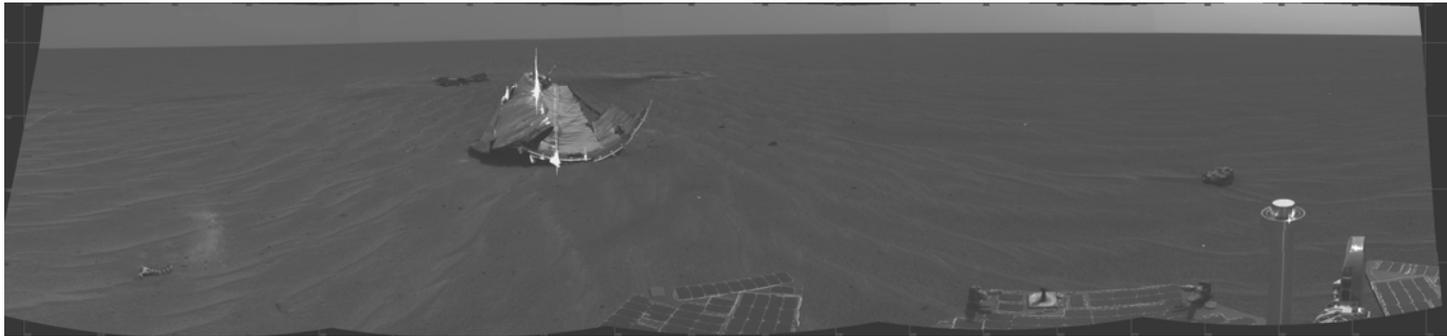
Preliminary char depth measurements show results consistent with pre-flight predictions



Summary



Mars Exploration Rover



- TPS Community got an unprecedented look at the MER heatshield after entry into Mars
- Due to ground impact, it was difficult to obtain good imagery on heatshield heating patterns
- Microscopic images challenging to interpret due to damage from ground impact
 - Preliminary results show measurements consistent with pre-flight predictions
- Excellent imagery of main seal, structure, and internal thermal blankets
 - Shows no visible signs of structure overheating or breach in main seal
- Detailed data reduction still in progress
 - Observation of thermal blanket tape strip remnant is currently being studied as a possible cause of spacecraft angle of attack growth during entry

Bonus for Science Community in finding first meteorite identified on another planet!

