



Mars Exploration Rover

Landing Site Safety Assessment

Mark Adler

Jet Propulsion Laboratory,

California Institute of Technology

March 28, 2002

3rd Mars Exploration Rovers

Landing Site Selection Workshop



Acknowledgement



Mars Exploration Rover

- **This research was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.**



Summary from Tuesday



Mars Exploration Rover

- **Winds are now more of a concern than rocks and slope**
 - But they all conspire together in Monte Carlo failure cases
- **All of the high priority sites have difficulties**
 - Hematite appears ok so far, but may have shorter surface lifetime
- **Other candidate landing sites may need to be identified to reduce the risk of ending up with only one safe site**
 - But do we have enough time to get the requisite MOC coverage?
- **May be able to extend latitude band North and elevation limit up**
 - To open up option space for other candidates
 - Further North results in less integrated mission energy and larger ellipses
 - Higher up may require shallower entry angle and thus larger ellipses
- **Fortunately, other developments are providing us with more time**
 - A rarity on this project
 - More propellant allocated for site targeting can defer any irreversible landing site decisions by six months to a year



Preliminary Landing Safety Assessment



Mars Exploration Rover

	Hematite	Melas	Gusev	Isidis
Baseline	Green	Red	Yellow	Hashed Yellow
Baseline Plus Aggressive Winds	Green	Red	Red	Hashed Red
Baseline Plus Aggressive Rocks	Green	Red	Yellow	Hashed Yellow
Baseline Plus Aggressive Slopes	Green	Red	Yellow	Hashed Yellow

(GREEN) Looks pretty good, so far

(YELLOW) Uncertain outcome—more analysis needed

(RED) Appears unlikely to be deemed safe even with more analysis

(hashed) Wind environment not yet modeled—assessment based on an assumed wind environment

(Also Isidis TES rock abundance/outcrop not taken into account)



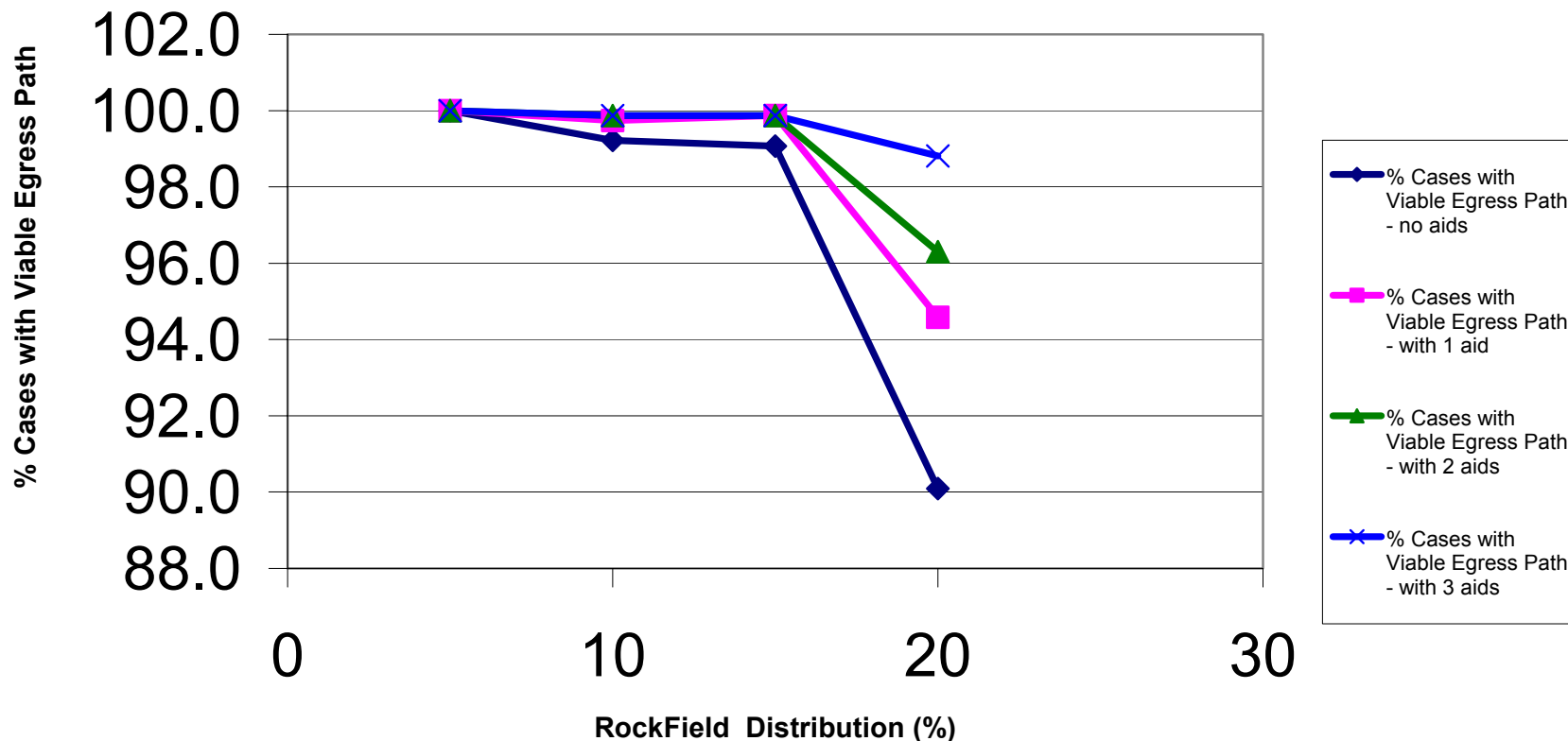
Egress Performance Assessment



Mars Exploration Rover

Egress Rover Performance

Allow Rocker Scrape; 30cm Airbag knots (58% compressible);
20cm max rock capability



Footnote: Testing has determined that the carbide grit/urethane coating is not needed—the baseline is bare aluminum (that's a good thing)



- **Hematite may have a lifetime shortfall in parts of the ellipse**
 - Down to 80 sols on MER-B in “bad” pixels, may need to be on MER-B
 - Further analysis to assess conservatism and probability of less than 90 sols
 - Environmental testing on flight article in August will provide more accurate system performance for lifetime assessments
 - Even if 90 sols not met, if science benefit deemed worth giving up a little lifetime, then it is likely that the level 1 requirement could be renegotiated
 - Also could potentially move ellipse out of colder area
- **Eos and Athabasca appear to have significant trafficability problems**
 - Eos rock abundance may be too high for mobility using hazard avoidance
 - Athabasca radar return indicates possibly impassable terrain
 - Isidis TES rock abundance indicates trafficability problem there?
- **Otherwise, surface missions will meet requirements at all sites**
 - So long as we don’t send both to the same site or within 37° central angle
 - Melas shy of 90 sols at MER-B, but could send MER-A there
 - Have not evaluated thermal effect of high winds at Melas



- **The MER Project, MER Project Science Group, and Mars Program are meeting tomorrow morning to decide on the direction of work on landing site selection**
- **We need to focus our observational and analysis resources on the most likely sites to be selected**
- **Here's where we may be headed from a purely mission success point of view, intended to seed the discussion this afternoon:**
 - **Hematite, Gusev, and Isidis maintained as our high priority sites**
 - **Our analysis would be focused on these sites to show if they are safe or not**
 - **Melas and Eos dropped from the list completely**
 - **No further analysis would be done by the project, and no new observations requested by the project**
 - **Athabasca retained as a backup site**
 - **Focus on observations and analyses to correlate morphology to radar return**
 - **Add two new sites to backup list with potential for Hematite-like safety**
 - **Identify *soon* to begin observations and safety assessment**



Thank You!



Mars Exploration Rover

- **The proper selection of the MER landing sites has a profound bearing on the quality of this mission**
- **The science community has really stepped forward with a great deal of observation, analysis, and thought that has been and will continue to be key to selecting the best two landing sites on Mars for the MER science objectives and MER mission success**
- **The project greatly appreciates your work and engagement in this process**
- **We're not done yet! There's a lot to do over the next year (including this afternoon) and the project will continue to interact closely with this community to do this right.**



Review of How You Can Help



Mars Exploration Rover

- **We are asking the science community to comment on:**
 - The science merits of the proposed landing sites
 - The veracity of the environmental models that have been developed
 - The application of the environmental models in the engineering analyses
- **We'd like to come out of this workshop with:**
 - An annotated prioritization of the sites taking into account our knowledge to date of the science and safety of the sites in order to best focus our limited observational and analysis resources over the next year
 - Recommendations on how to improve existing environmental analyses or perform new environmental analyses to best determine the safety of the sites
 - Recommendations on new observations to improve our safety and science assessments of the sites
- **After the workshop we'd like:**
 - A search for other candidate landing sites in possibly expanded latitude and altitude ranges that have potentially good safety and science properties