



# Mars Landing + 50 Years:

## *Lessons from Social Decisions and Selection of the First Viking Landing, Considerations for Mars 2020 Re- Visit*

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# How could social processes have driven Landing Site selection for Viking 1?

- Viking 1 Site Certification and Selection based on:
  - “combined efforts of nearly the entire Viking flight team”
  - “daily activities of the Landing Site staff”,
  - preparation of recommendations, votes and decisions.
- Methodology of Study: Review original documents for text and social networks, treat Viking as a Complex Adaptive System (CAS)
- “Observations of the Viking 1 prime landing area in the Chryse region of Mars is geologically varied and possibly more hazardous than expected, and **was not certifiable** *as a site for the Viking landing...the selected site considered at 47.5W, 22.4N represented a compromise* between desirable characteristics observed with visual images and those inferred from earth-based radar.”

*Masursky, H. and Crabill, N., (1976), The Viking Landing Sites: Selection and Certification, Science, Vol. 193, pp. 809-812.*

# Analytical Techniques Employed in Landing Site Selection for VL-1

- Ellipses fitted to maps with:
  - Radar interpretations
  - Hazard probabilities from image observations
  - Geologic terrain maps
  - Crater counts
- Comparisons with Surveyor Lunar landing sites
- Photogrammetry of terrain statistics
- Photometric roughness maps

# Social Construction of VL-1 Mission Science

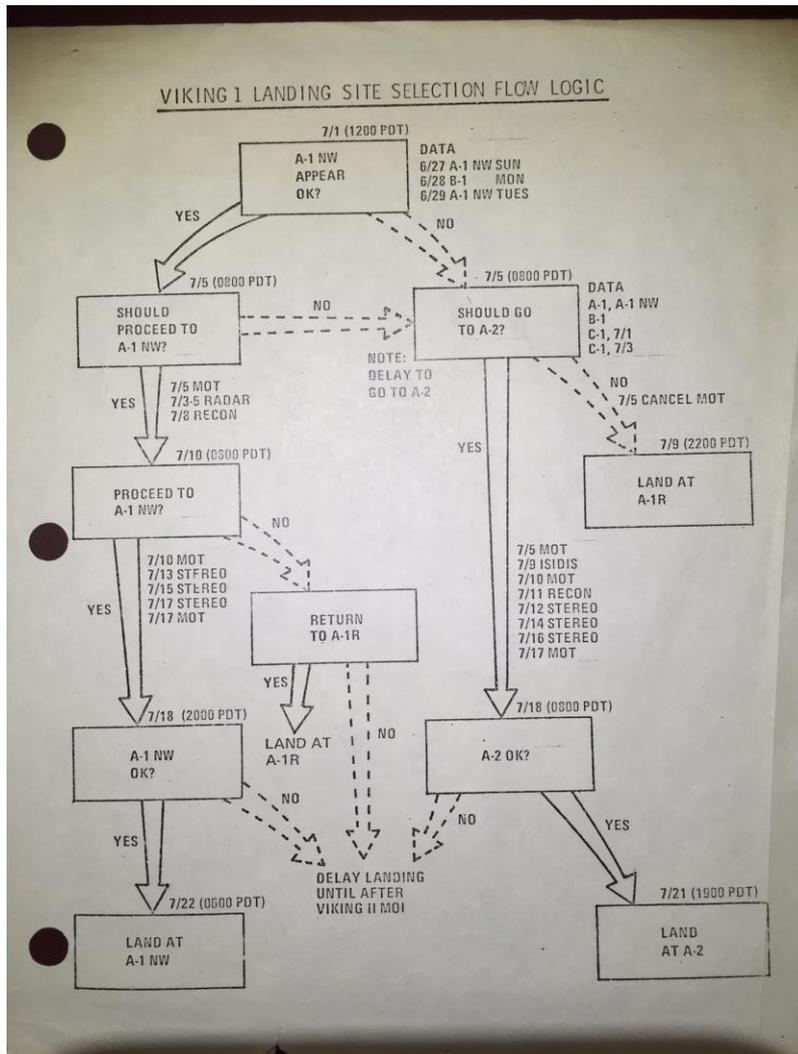
## OBJECTIVES

- The original VL-1 landing site (A1) was “considered to be the **best** area to observe where *water* and possibly *near-surface ice* had occurred in large quantities in the past – the **optimum** place to look for *complex organic molecules*”

## SOCIAL DECISION

- “The original A1 area was **rejected** on June 26 (1976) **primarily on the basis of the orbital imaging data**, which indicated that the terrain was **unexpectedly complex.**” – Masursky and Crabill, p. 810.

# Process View: Initial VL-1 Site Rejection Initiated Complex Decision Tree

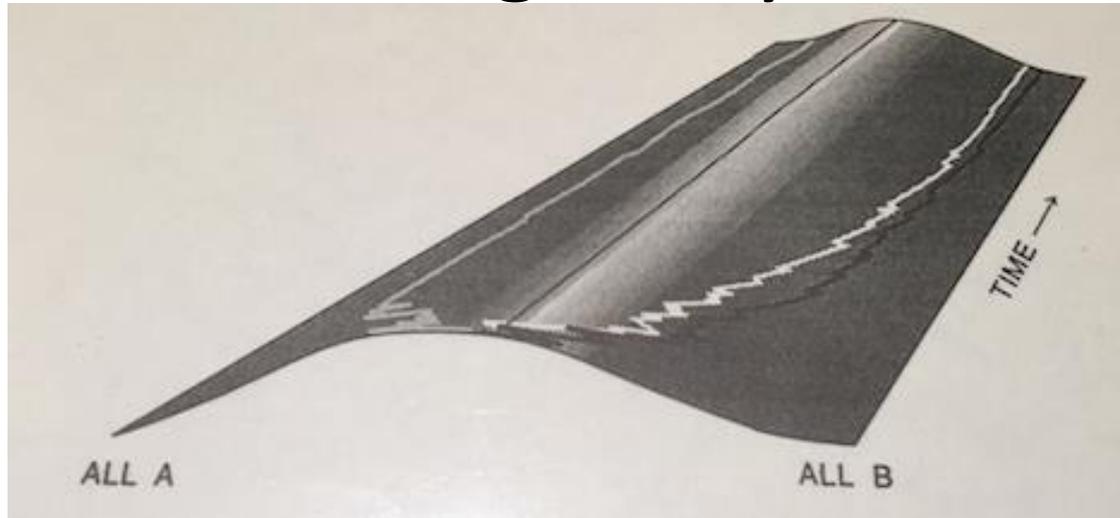


- “ **...flexibility in site adjustment...**”
- *From Paragraph 2.0 SCOPE, in SITE CERTIFICATION PROCESS, June 4, 1976.*
- “**Primary analysis tool...is the visual inspection** of monoscopic mosaics of the ... site area, and visual inspection of stereo pairs.”
- “None of the available techniques can clearly indicate unsafe surface conditions, except possibly radar data... Generally, however, the technique will be one of **comparison with analogues, extrapolation, and inferences.**”
- *From Paragraph 4.2: Analysis, in SITE CERTIFICATION PROCESS, June 4, 1976, pp 3-4.*

# *VL-1 Timeline: Divergence of models to explain A1NW site; fatigued crew.*

- *June 25: “Viking’s “Northwest Territory” offers **visual encouragement to a safe landing** in comparison to the eroded and etched fluvial region (of A-1).”*  
*Viking Mission Status Bulletin No.30.*
- *June 30 LSS Minutes: “The last 24 hours have not been the best”; “if any extra time is available the crew should rest.” “People awful tired this a.m.”*
- *July 7: A1NW Preliminary Radar Assessment: “...it takes a **very tortured explanation to fit the (radar) data.**” “There are an infinity of detailed surface models that could explain the observed data. You can’t do it.”*

# Model: View VL-1 Landing Site Analysis as competition among analytical workflows



- Random walk on a convex surface – **Positive feedbacks** to workflow utilization (from W.B. Arthur)
- Illustrates **increasing-returns competition** between two analytical methodologies:
  - *Earth-based **radar** observations and interpretations*
  - *In-orbit Viking Orbiter **image** analysis and geomorphologic interpretation*
- Early adoption influenced how **daily reinforcing image analysis** benefited from positive feedback and improved fidelity, and gained more adherents (votes)
- **Further adoption** towards one analytical methodology (image analysis) became increasingly likely as basis for votes and certification

# Perspectives on vote for A1WNW as VL-1

- 12 July: Unanimous vote for A1WNW as landing site.
- Martin (PM): *“remarkable way the (team) worked the problem. There is a **good relationship** among them, asking the right questions, and getting the right answers.”* He believed we had picked the **safest site we can get in a reasonable time.**
- Sagan: *“remarkable willingness of the project to **listen and react** to Viking scientists.”* He found the project **very tolerant of diverse scientific views.**

# The Selected VL-1 Site (A1WNW): An “Interesting” Compromise?

*Matches well*

*Site A1WNW:  
“Compromise”  
& **Interesting?***

*Site A1NW:  
Divergence of Models*

*Site A1:  
“Unexpectedly Complex”*

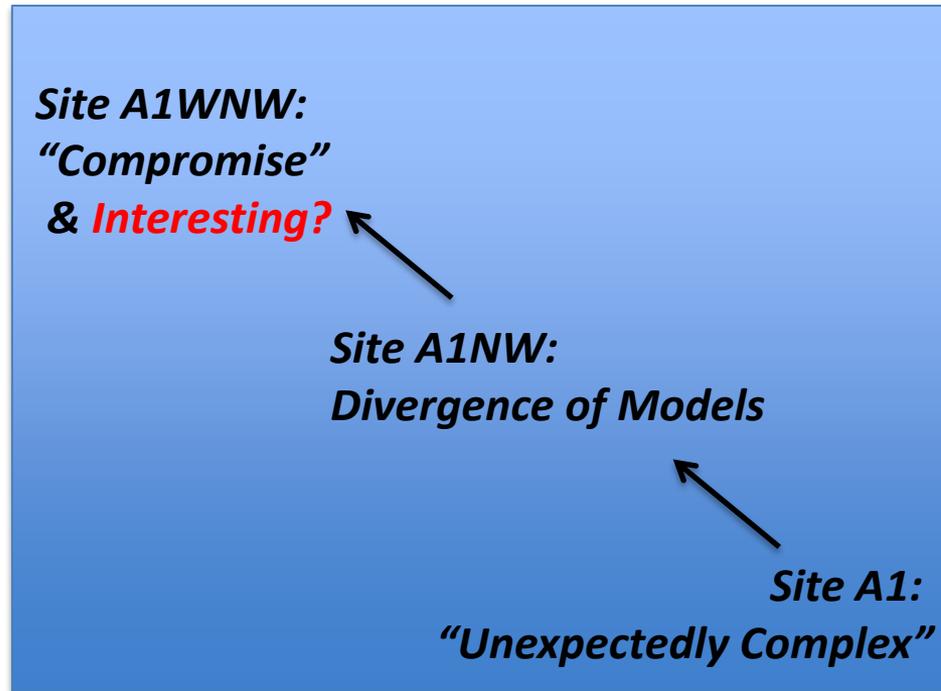
Landing Site  
Observations  
Matches Expectations

*Does not match*

Complexity of Landing Site

*Less Complex*

*More Complex*



# VL-1 Conclusions and Recommendations for Mars 2020 Landing Site selection

- Process: Compromise in landing site selection may emerge from competition among analytic methodologies
  - Early adoption of story from compelling imagery
  - “First-mover” advantage and learning from “workarounds”
  - Reliance on dominant analytic techniques for votes
- Science: Consider transit to VL-1 as ‘downslope’ traverse:
  - A1, A1NW and A1WNW Sites should provide sample diversity
  - Blocky surface not ideally suited for ease of rover navigation
- Adapt Mars 2020 site selection process to consider complex terrains that could offer ‘unexpected’ rewards associated with astrobiologically ‘interesting’ locations