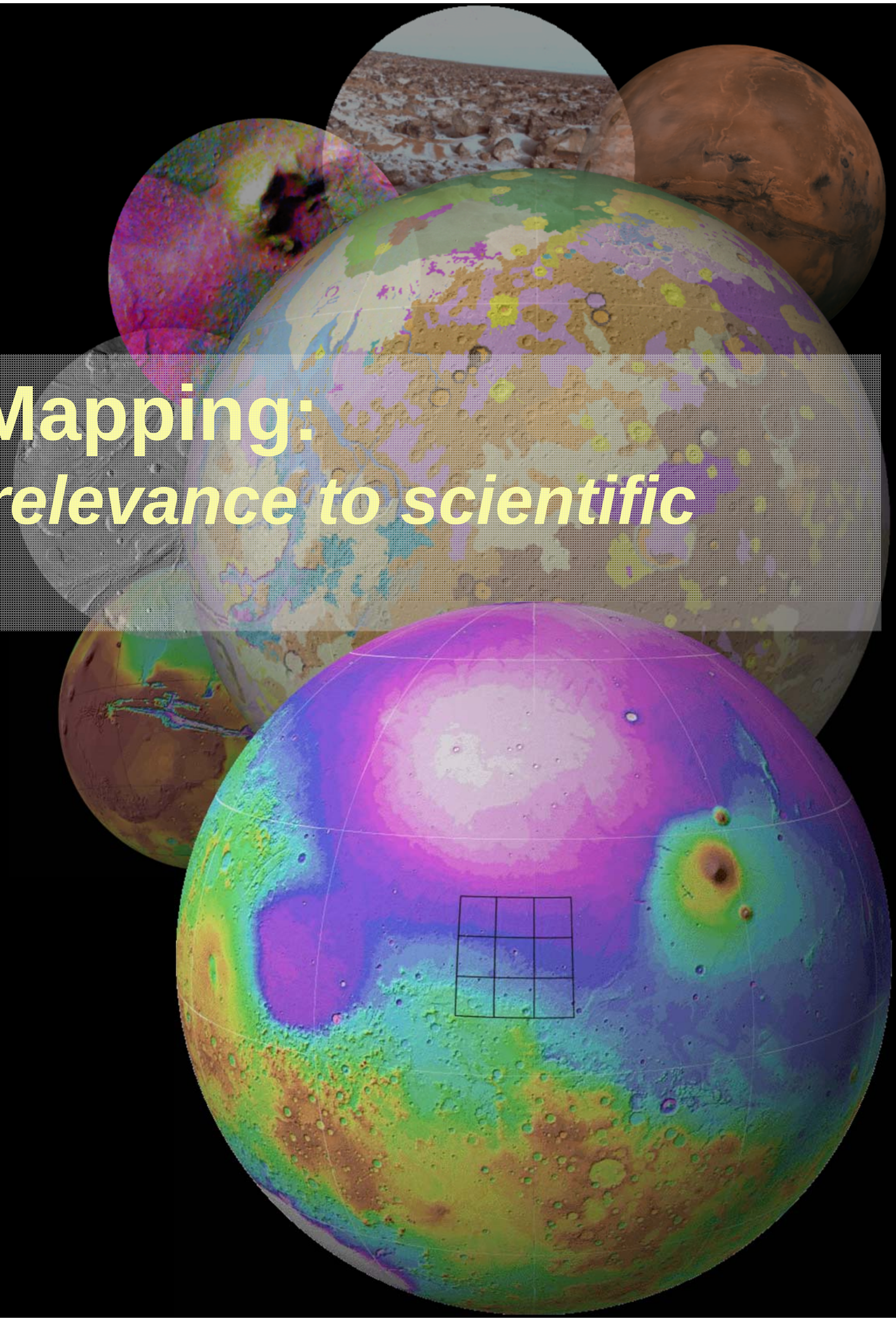
USGS

science for a changing world

Planetary Geologic Mapping:
Process, product, and relevance to scientific research



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Outline

Planetary cartography (+geology)

Basic concepts and history

Topical vs. Contextual

Work flow

Funding

Management

Concerns

Conclusion

PLANETARY CARTOGRAPHY: MAPPING SOLID OBJECTS BEYOND EARTH

- High quality, reliable processes and products
  - Geodesy and control
  - Image processing
  - Precision co-registration and geo-registration
  - Tool development
  - Visual representation
  - Community standards
- Critical infrastructure for dissemination, scientific analysis, and public consumption of mission data
- Planetary cartography ≠ geologic mapping

PLANETARY GEOLOGIC MAPPING: A COMPONENT OF CARTOGRAPHY

- Multiple planetary bodies
  - Mars, Moon, Venus, Mercury
  - Io, Ganymede, Enceladus
  - Small bodies
- Geodetic control at various scales
- Wide range of data sets
- Processing, mosaicking, and co-registration
- Standardized process and product
- Driven by community need
  - Guided by NASA, PSS, and AGs

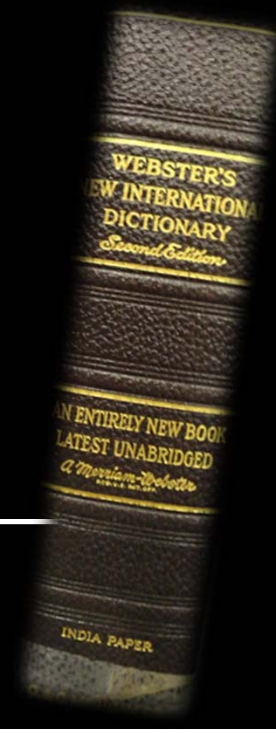
CONCEPTS OF GEOLOGIC MAPPING

geo•log•ic map ***noun*** (\ jē-ə-lä-jik \ map \)

: a chart showing the distribution of discrete geologic bodies in a particular area, emphasizing spatial and temporal associations, in order to inform about evolution

: a contextual framework for displaying bulk observations

: minimally consists of map, symbol key, and description of map units



GEOLOGIC MAPPING ON EXTRA-TERRESTRIAL BODIES?

- Remote observations sufficient?
- Limited datasets (topography)
- What to describe? In what detail?
- How infer 3-D architecture?
  - Terrestrial outcrop formed by tectonism and erosion
- How similar are the geological processes to Earth?
- Addressed by Shoemaker et al. in 1960s
  - Approach works because it is based on standard observation

HISTORY OF PLANETARY GEOLOGIC MAPPING

- Relationship with NASA and USGS
  - Planetary cartography
  - Geologic mapping (coordinated campaigns)
  - Technology development
  - Mission support (astronaut training, landing sites)
- On behalf of NASA, USGS has published:
  - >150 of planetary geologic maps
  - Multiple bodies, scales, bases
- Standardized process and products
- Exciting time for planetary studies

MODERN PLANETARY GEOLOGIC MAPPING

PDS Data Portals

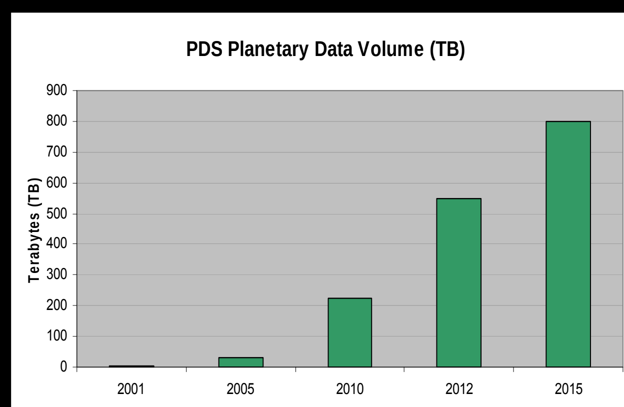
Data volumes

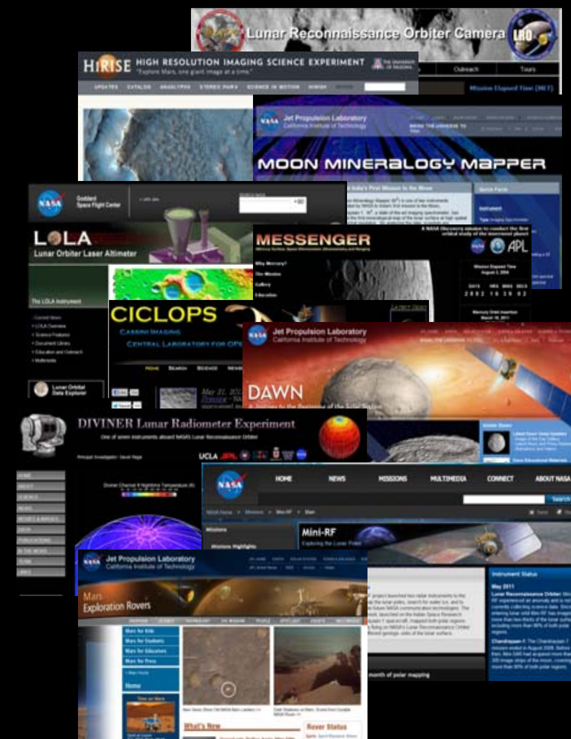
Data types

Spatial scale

Formats

GIS

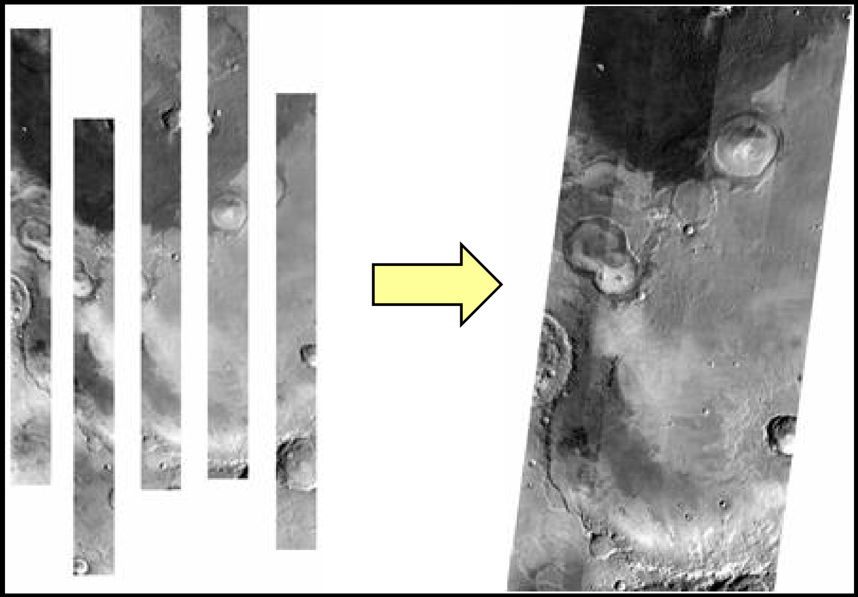


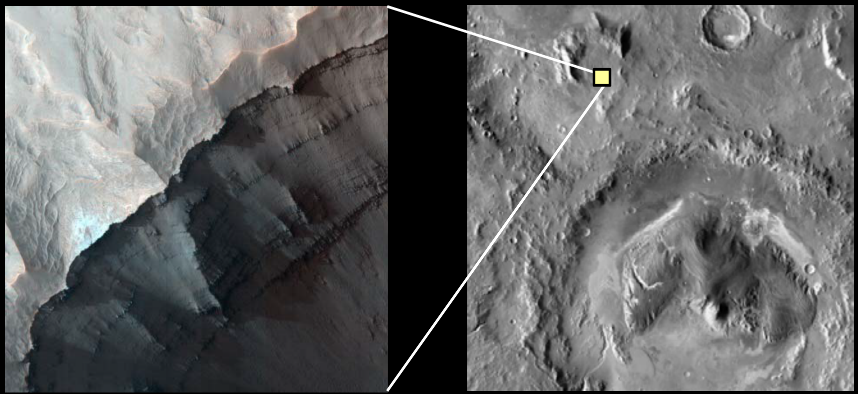


Mission Portals

MODERN PLANETARY GEOLOGIC MAPPING

- Modern process
  - Controlled digital mosaics
  - GIS and tablets
  - Quad or non-quad
  - Mapping ≠ production scale
- Modern product
  - Hard copy and digital maps (GIS)
  - Unlimited and immediate distribution
  - Diverse utility





TOPICAL VS. CONTEXTUAL MAPS

- Data volumes & digital environments ~ cartographic concepts are common
  - Pipeline production (*e.g.*, DTM, batch processing, mosaicking)
  - Geodetic control (mission specific)
  - Nomenclature (your name here!)
  - Journal-based geologic maps
- Maps all fulfill purpose, but are not equivalent
  - Different use of community-adopted criteria
  - Range of accuracy and precision
  - Standards: Easy to say, hard to do

TOPICAL VS. CONTEXTUAL MAPS

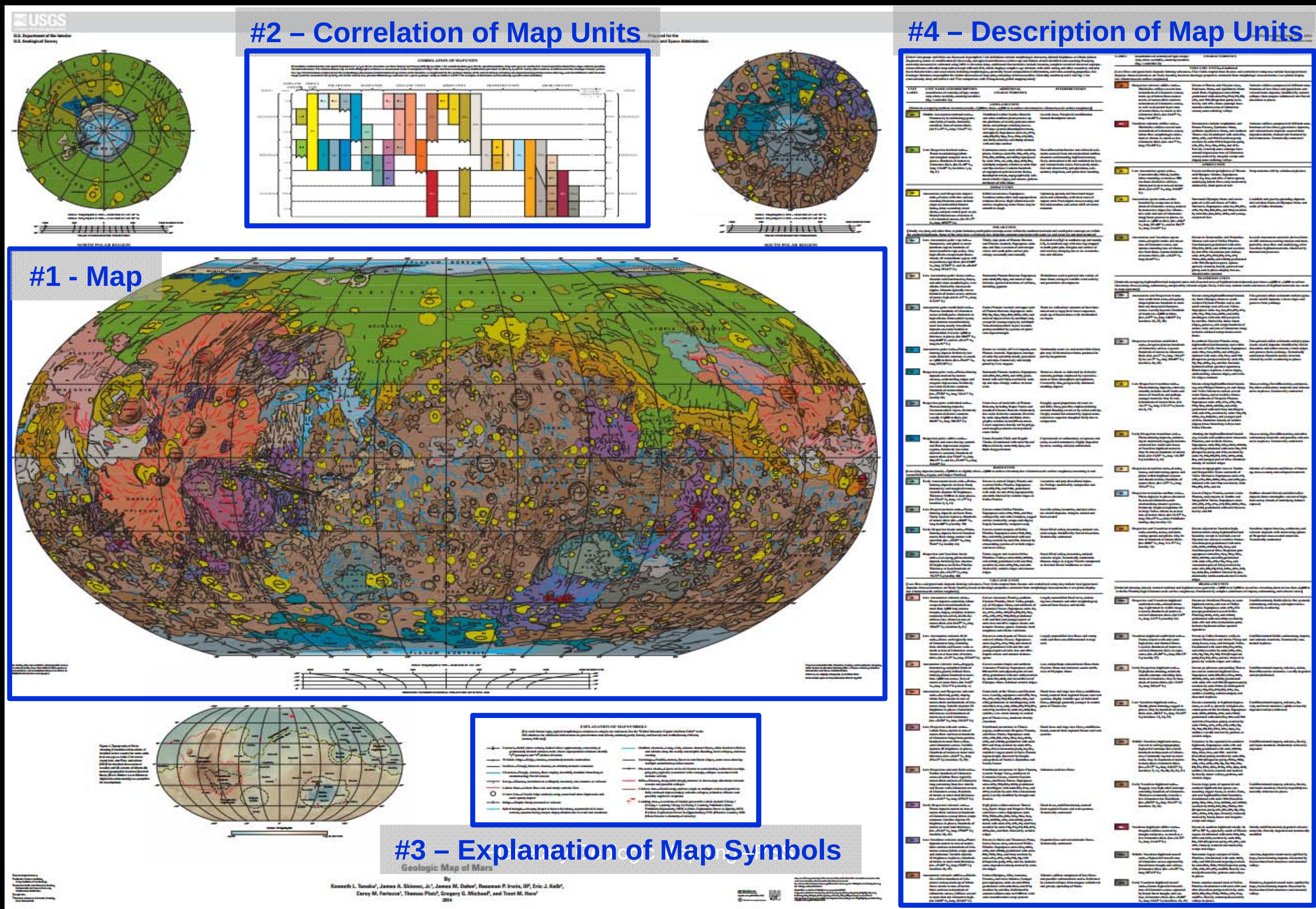
Topical Maps

- Flexible in approach (variable scale, variable base)
- Tactical timeline (<u>high</u> response to data curve)
- Reviewed primarily for scientific integrity
- Published in scientific journals
- Observations ≤ Interpretations

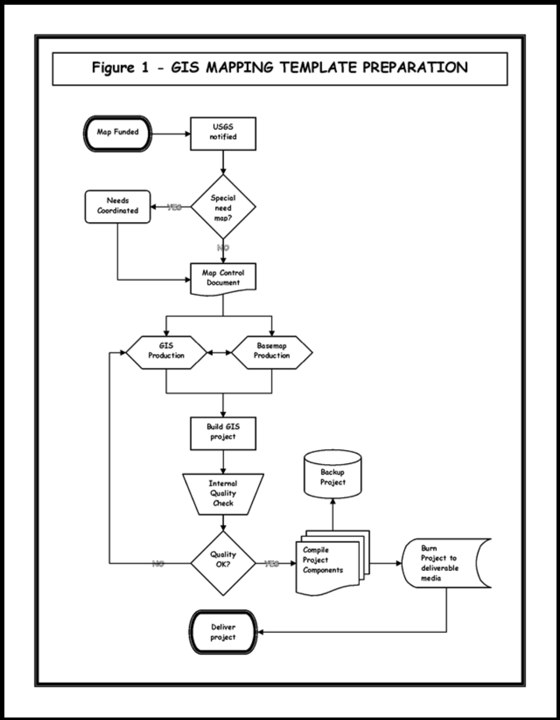
Contextual Maps

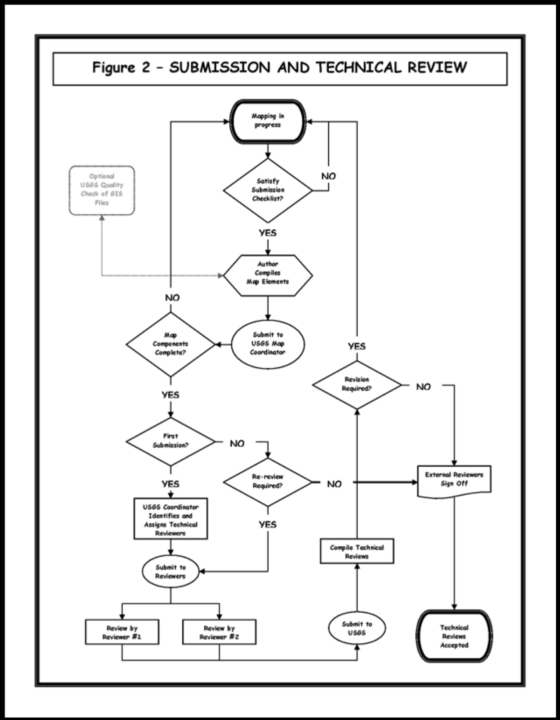
- Rigid in approach (set scale, standard base)
- Strategic timeline (<u>low</u> response to data curve)
- Reviewed for scientific as well as cartographic and technical integrity
- Published by standard survey
- Observations > Interpretations

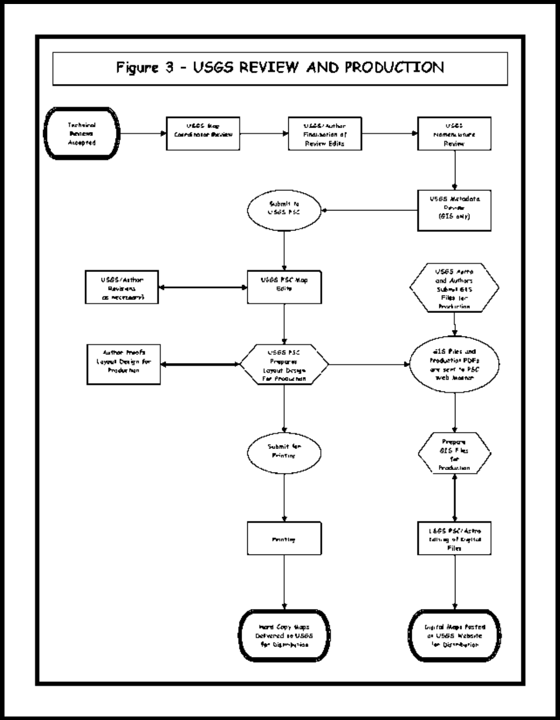
TOPICAL VS. CONTEXTUAL MAPS



WORK FLOW: FROM (NASA) PROPOSAL TO (USGS) PAMPHLET







WORK FLOW

1. Pre-proposal
2. Review and selection
3. NASA notifies USGS of “new starts”
4. Base map and GIS created
5. Mapping by author
6. Submission for review
7. Technical reviews (two, sometimes three)

WORK FLOW

8. Map Coordinator review
9. Nomenclature review
10. Map accepted for publication
11. GIS and map files formatted
12. Submission to USGS PSC - Menlo Park
13. Map editing and cartography
14. Galley proof and final edits
15. Print, post, distribution

WORK FLOW

Tractable (idealized) timeframe

• Base map/GIS	3 months
• Mapping	24 months
• Submission prep	3 months
• Review and re-submit	6 months
• Editing and cartography	6 months
• Production	6 months
	48 months

COMMON DEVIATIONS FROM THE WORK FLOW

- Multiple programs funding maps
  - Multiple notices of "new starts"
  - Potentially over-commits USGS
  - NASA and USGS coordinate "new starts"
- Map not possible as proposed
  - Base, scale, projection not possible, not considered
  - Encourage pre-proposal contact
  - Proposer, reviewer, and program officer awareness

COMMON DEVIATIONS FROM THE WORK FLOW

- Scales and bases necessitate adapted approach
  - Solicit community input – PCGMWG/GEMS
  - Encourage USGS contact
- Map submitted after project funds over
  - Attendance at annual PGM meeting for status report
  - Encourage USGS contact
  - Establish a cut-off term for delinquent maps
  - Propose for 4 years

FUNDING: THE WALTZ

- NASA ROSES (to individuals)
  - SSW (Venus, comparative planetology)
  - MDAP
  - LDAP
  - PDART (w/o research emphasis)
  - Others?
- "Cartography" funds (to USGS)
  - Infrastructure and support
  - Historically from PG&G

FUNDING: USGS GEOLOGIC MAPPING PROGRAM SUPPORT

- Geologic Map Coordination
  - Image and/or topographic bases
  - Coordination of technical reviews
  - Editing/print production of USGS map
  - Cartographic standards and "best practices"
  - PGM Website maintenance
- MRCTR GIS Lab (PIGWAD)
  - Tools, tutorials, workshops, guest facility
  - Data formatting and packaging
  - GIS web interfaces

FUNDING: COST BREAKDOWN PER MAP

- Preparation – 54 hours
- Support – 74 hours
- Pre-Production – 72 hours
- Production – 278 hours
  - USGS Editing and Cartography – 250 hours
  - Printing and distribution- $8,000
- TOTAL COSTS (unburdened) – $37,000 / map
  - $22,000 in technical cartography and printing

MANAGEMENT: WORKING GROUPS

- Planetary Cartography and Geologic Mapping Working Group (PCGMWG)
  - Define and prioritize cartographic needs
  - Represent entire science community
  - Review USGS Cartography proposal
- Geologic Mapping Subcommittee (GEMS)
  - Adopt new approaches
  - Represent geologic mapping community
  - Chair sits on and communicates with PCGMWG

COMMUNITY CONCERNS: JULY 9, 2014 LETTER TO PSS, AGs, and NASA

- Background
  - Historical funding through PG&G (some DAPs)
  - Reliance on USGS cartographic support (PG&G)
  - One “core” program facilitated communication between NASA program managers and scientists
  - PCGMWG has been intermediary between NASA and science community on technical elements of cartography
  - GEMS intermediary between PCGMWG, NASA, scientists
  - PCGMWG and GEMS ensures standards
  - Standardized cartographic products (incl. geologic maps) are foundation for scientific analyses and protection of robotic and human assets

COMMUNITY CONCERNS: JULY 9, 2014 LETTER TO PSS, AGs, and NASA

- Concerns
  - Re-structured NASA R&A programs separate geologic mapping-related proposals from the program that provides infrastructure and support
  - No single point of contact at NASA
  - Will PCGMWG and GEMS remain in existence as critical intermediary between research community and NASA?
  - Where will PCGMWG be “located”, who from NASA will lead representation, and how will institutional knowledge be transferred?
  - How will NASA continue to be informed about critical cartographic infrastructure related to science and exploration?

COMMUNITY CONCERNS: JULY 9, 2014 LETTER TO PSS, AGs, and NASA

- Recommendations
    - Designate a NASA program manager as the lead representative to the planetary cartography and geologic mapping community
    - Notify USGS of geologic mapping "new starts"
    - Match (and coordinate) level of "new starts" from each of the various NASA R&A programs with USGS
    - Ensure DAPs include sufficient new funds and knowledgeable panel members to accommodate evaluation of geologic mapping-related science proposals
    - Create a Planetary Cartography and Geologic Mapping Analysis Group, or equivalent

CONCLUSION: MAPS ARE CRITICAL INFRASTRUCTURE

- Short- and long-range planning maintains health of infrastructure
  - Technology (hardware and software)
  - Human capital
  - Community resource
- Fundamental reliance on “standardized” mission information
  - Allows community to speak the same language (even if they don’t know it)
- Requires collaboration, cooperation, and community oversight
  - Development (carrot)
  - Adherence (stick)

The New York Times

Brand New Look at the Face of Mars

The Washington Post

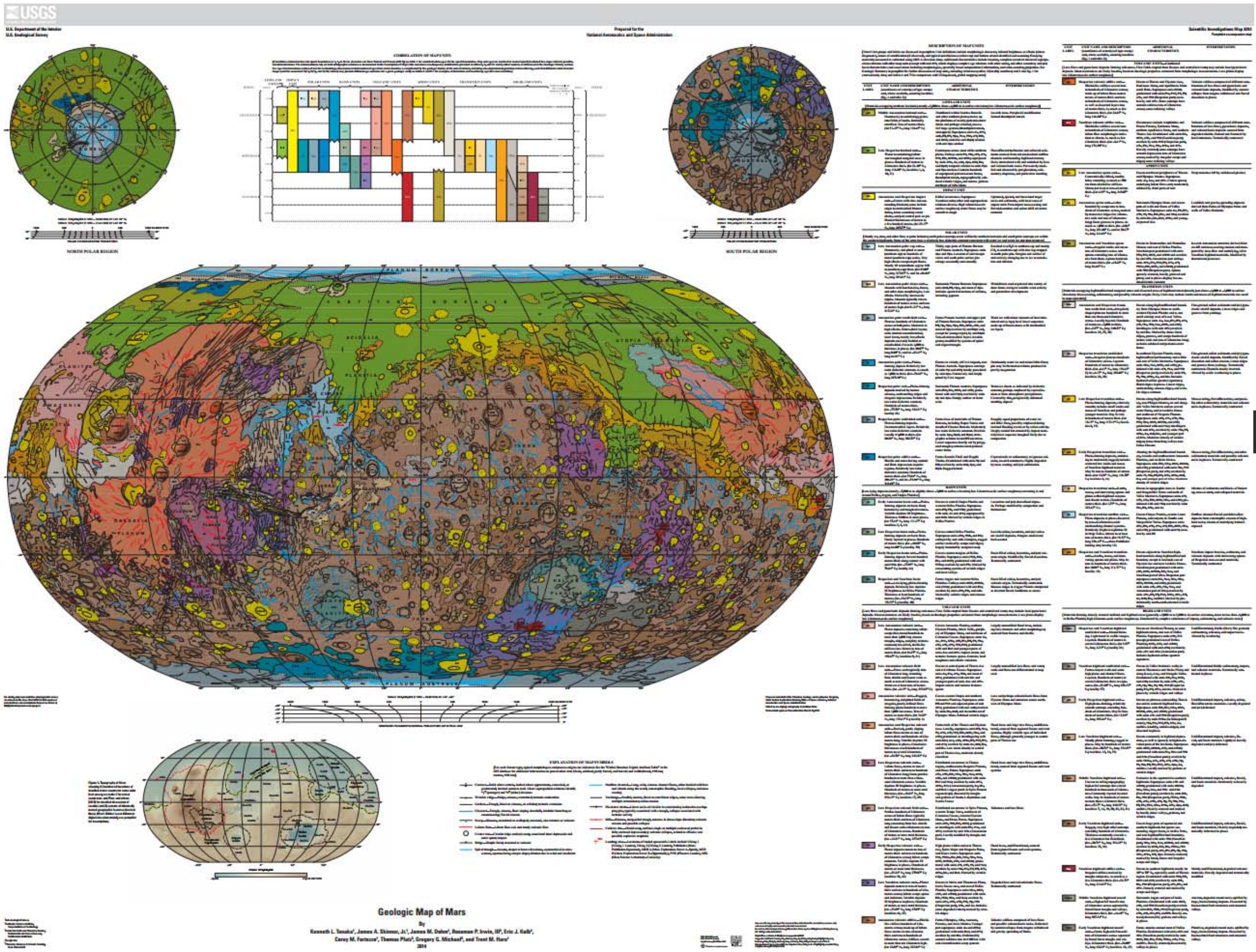
Scientists have compiled the most comprehensive map of Mars we've ever seen

POPULAR SCIENCE

Big Pic: A Planet-Wide Map Of Martian Geology

SCIENCE WORLD REPORT

Most Detailed Map of Mars Reveals the Features of the Red Planet's Surface



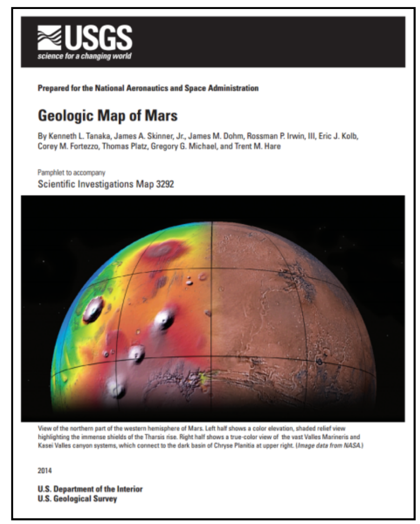
NATIONAL GEOGRAPHIC

NBC NEWS

EarthSky

SCIENCE NEWS • GREAT PHOTOS • SKY ALERTS

AUTO WORLD NEWS



USGS
science for a changing world

Prepared for the National Aeronautics and Space Administration

Geologic Map of Mars

By Kenneth L. Tanaka, James A. Skinner, Jr., James M. Dohm, Rossman P. Irwin, III, Eric J. Kolb, Corey M. Fortezzo, Thomas Platz, Gregory G. Michael, and Trent M. Hare

Pamphlet to accompany
Scientific Investigations Map 3292

View of the northern part of the western hemisphere of Mars. Left half shows a color elevation, shaded relief view highlighting the immense shields of the Tharsis rise. Right half shows a true-color view of the vast Valles Marineris and Kasei Valles canyon systems, which connect to the dark basin of Chryse Planitia at upper right. (*Image data from NASA.*)

2014

U.S. Department of the Interior
U.S. Geological Survey

QUESTIONS? COMMENTS?