Some important things we can learn about Mars by visiting a big basin with MSL

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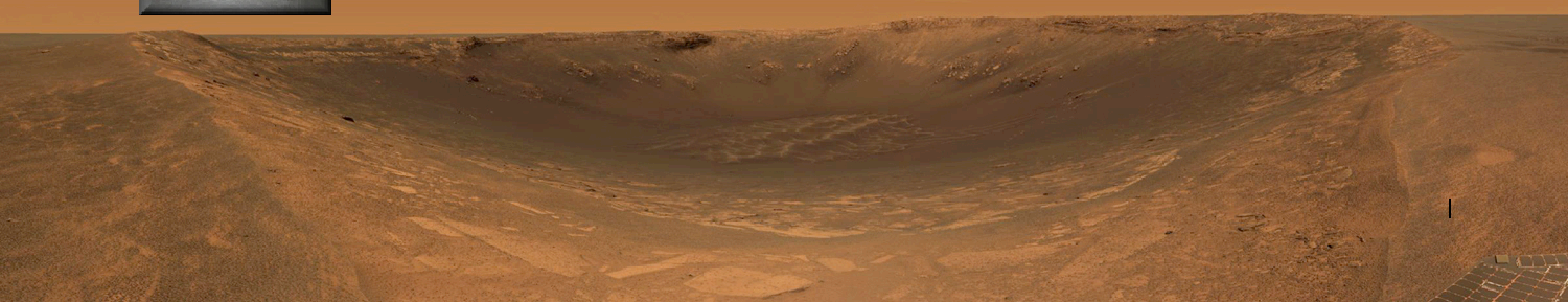
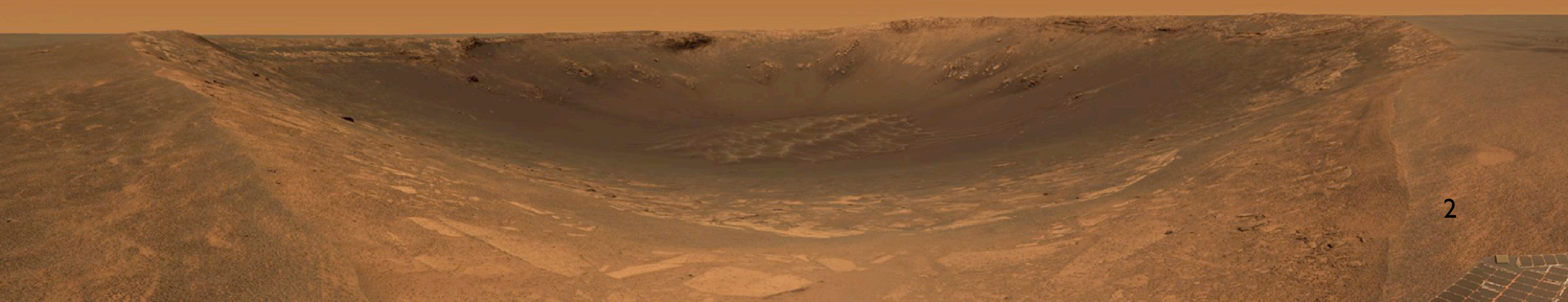
1st MSL Landing Site Workshop, May 31, 2006

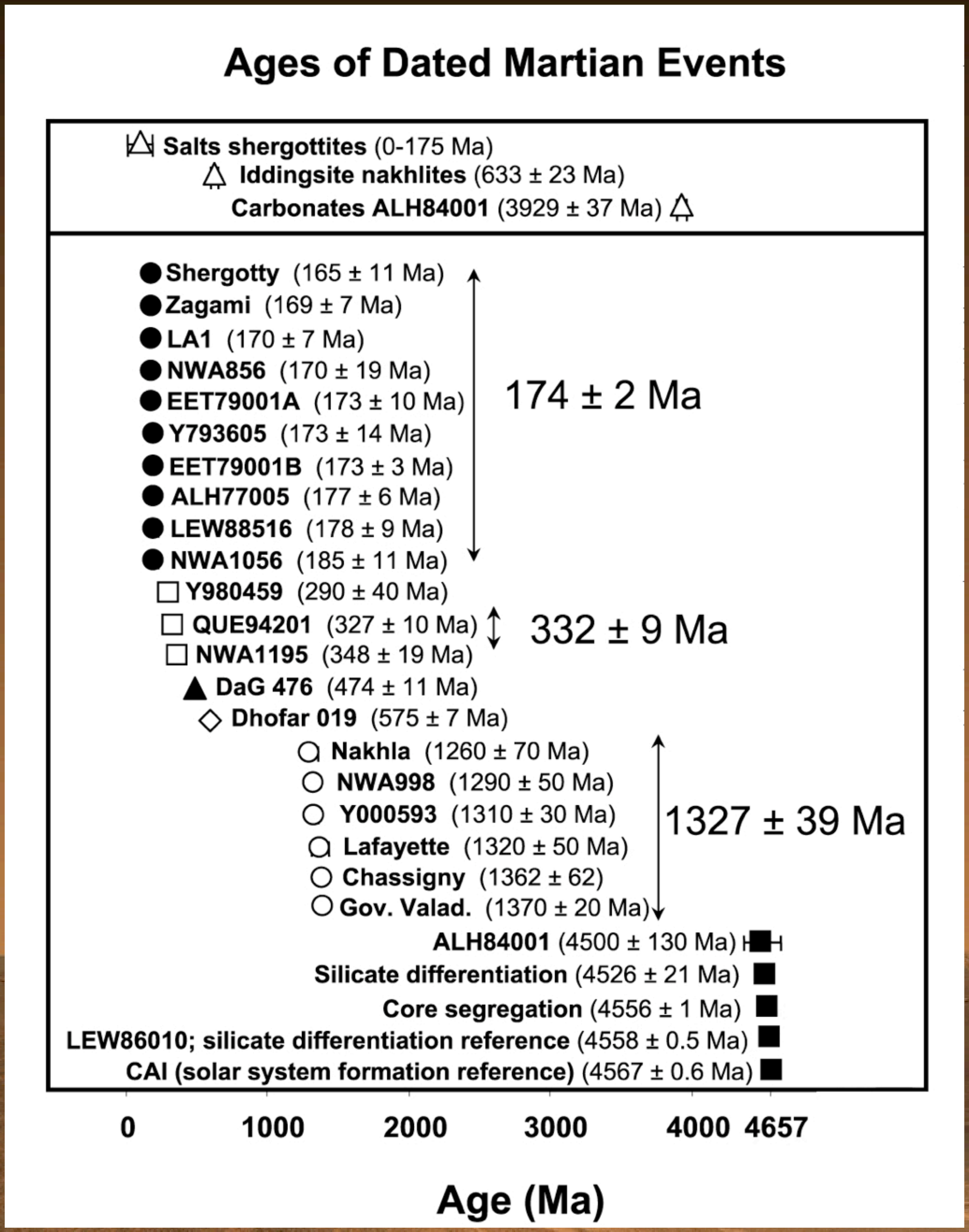


Big Basins

- Formed early in solar system history
- Record of ancient crust and window to the lower crust
- Energetic environments
- Benevolent conditions for life
- Preservable traces of habitable environments
- Key to origin and early evolution of Mars - petrologically, mineralogically, environmentally, biologically



...formed early



- Isidis, Hellas, Argyre, highlands are 3.9-4.0 Ga *(Werner 2005)*
- ALH 84001 is 4.51 Ga; has Ar-Ar shock age of 3.92 Ga, carbonates deposited by water at 3.92 Ga *(Turner et al. 1997, Ash et al. 1998, Borg et al. 1999)*
- Coincident with late heavy bombardment in the inner solar system

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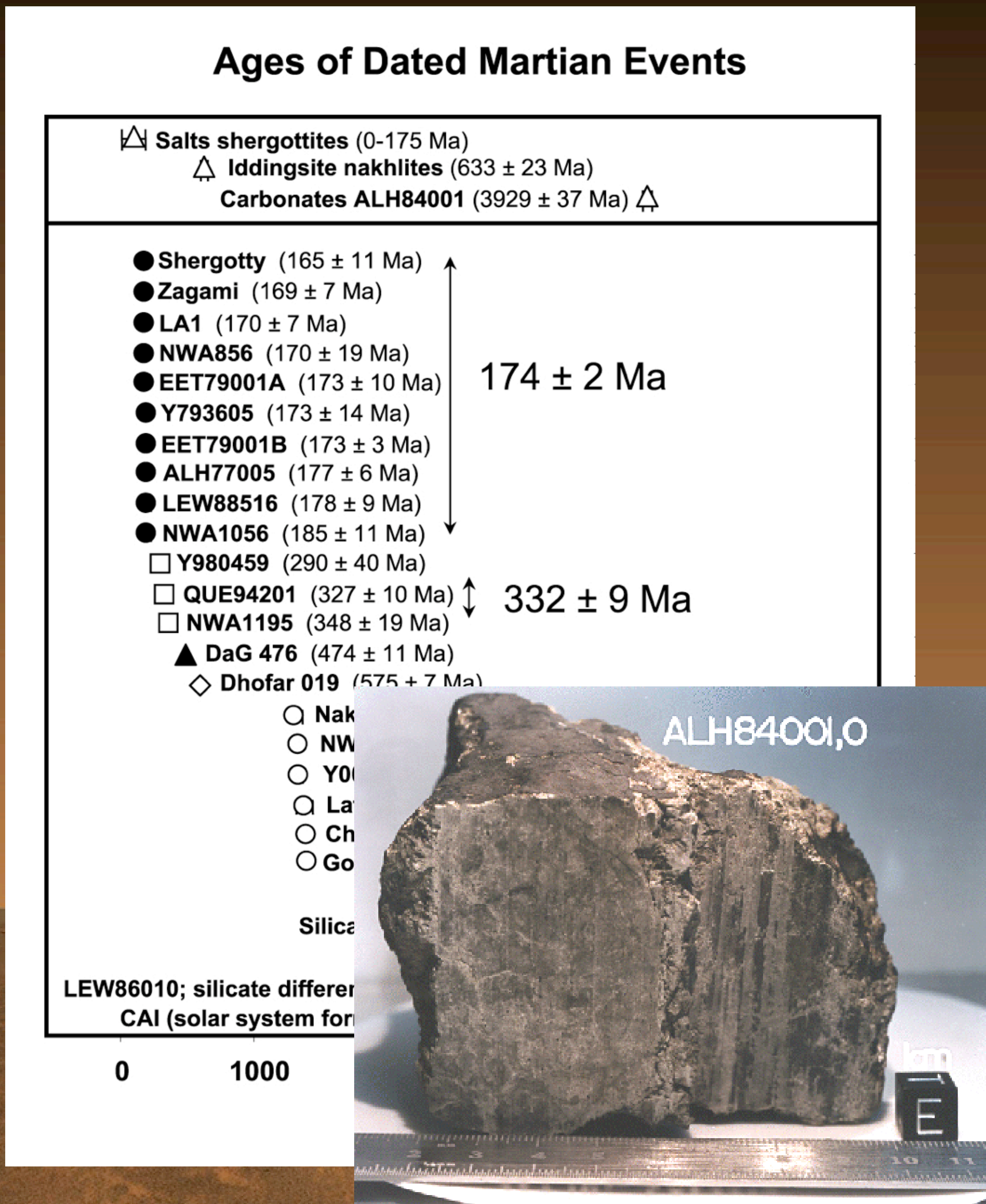

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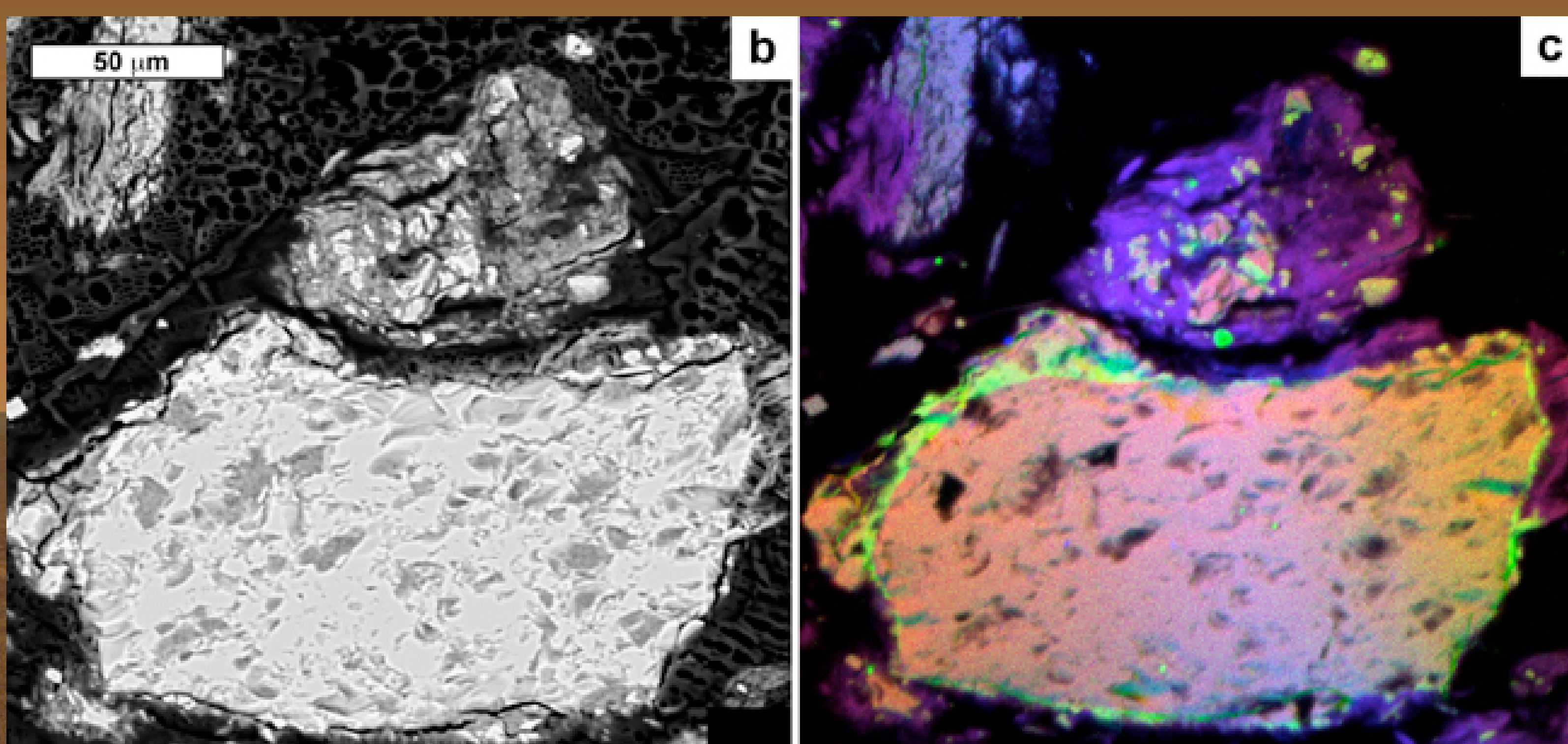
...excavated deeply

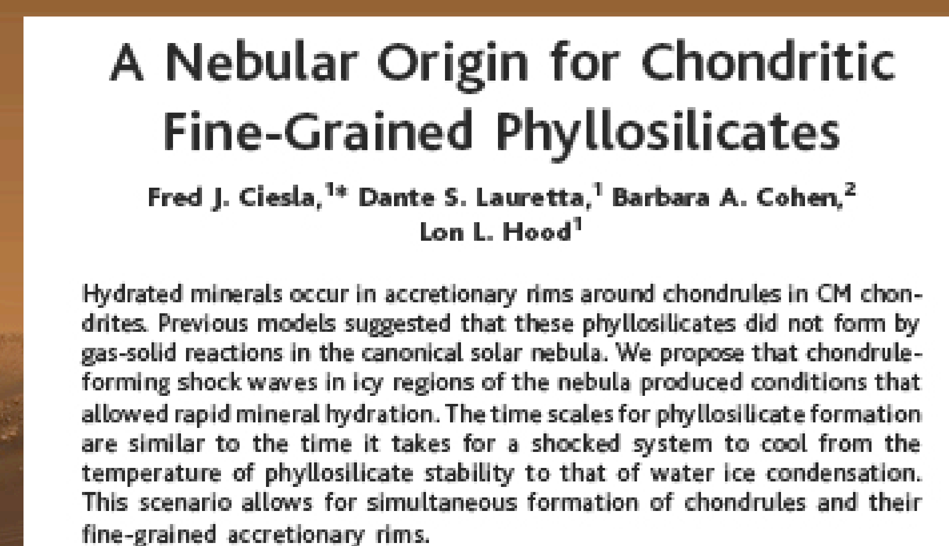
- Argyre basin example: ~1100 km final diameter (100 km rocky impactor at 20 km/s or 100 km icy impactor at 50 km/s)
- Final crater depth 4.8 km; transient crater diameter ~500 km; excavation depth tens of km
- Excavated middle crustal materials - best chance for “genesis” rocks
- Original crustal composition gives us 50% more data describing planetary differentiation and the key to bulk Mars *(e.g. Dreibus and Wanke 1994)*

...created environments

- Ejected materials are pulverized, shocked, and/or melted; ejecta blankets are environments vulnerable to alteration
- Alteration of glass and/or ultramafics to phyllosilicates is geologically rapid even in cool, low-pressure environments *(Ciesla et al. 2004, Cohen et al. 2004)*
- Alteration products (carbonates, phyllosilicates) are contained inside the rocks - not in layers



En + Fo, 400C, 3 months



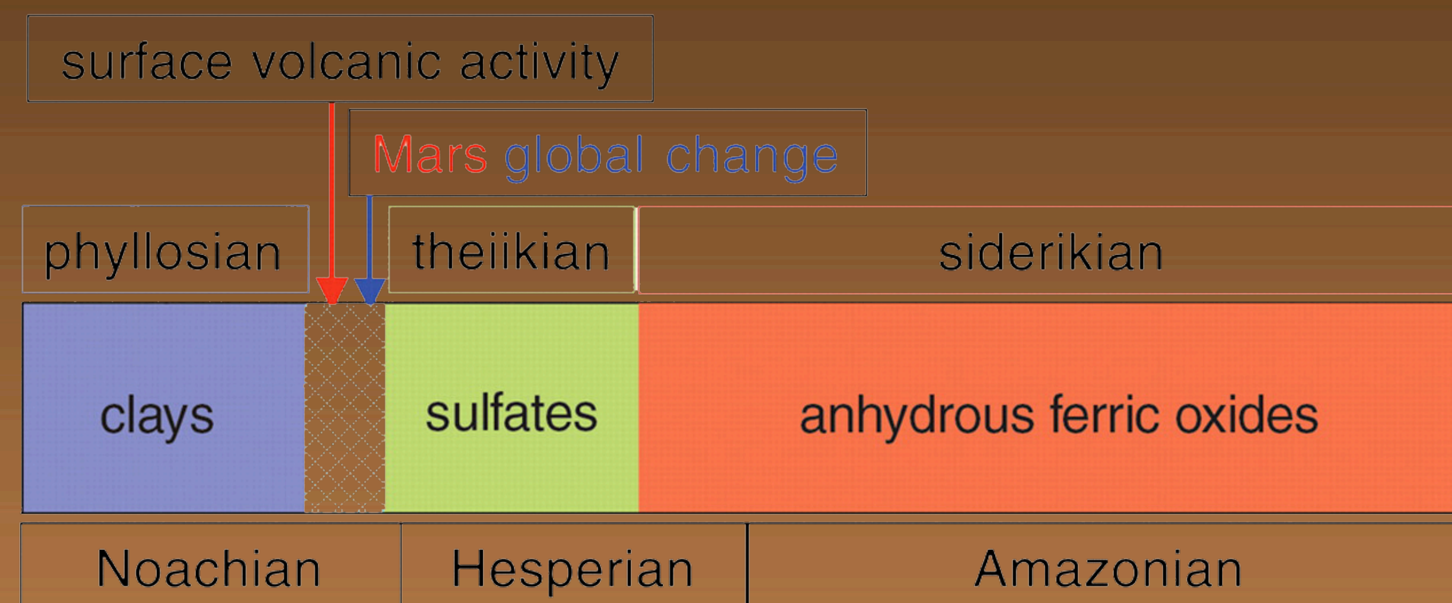
A Nebular Origin for Chondritic Fine-Grained Phyllosilicates

Fred J. Ciesla,[1*] Dante S. Lauretta,[1] Barbara A. Cohen,[2] Lon L. Hood[1]

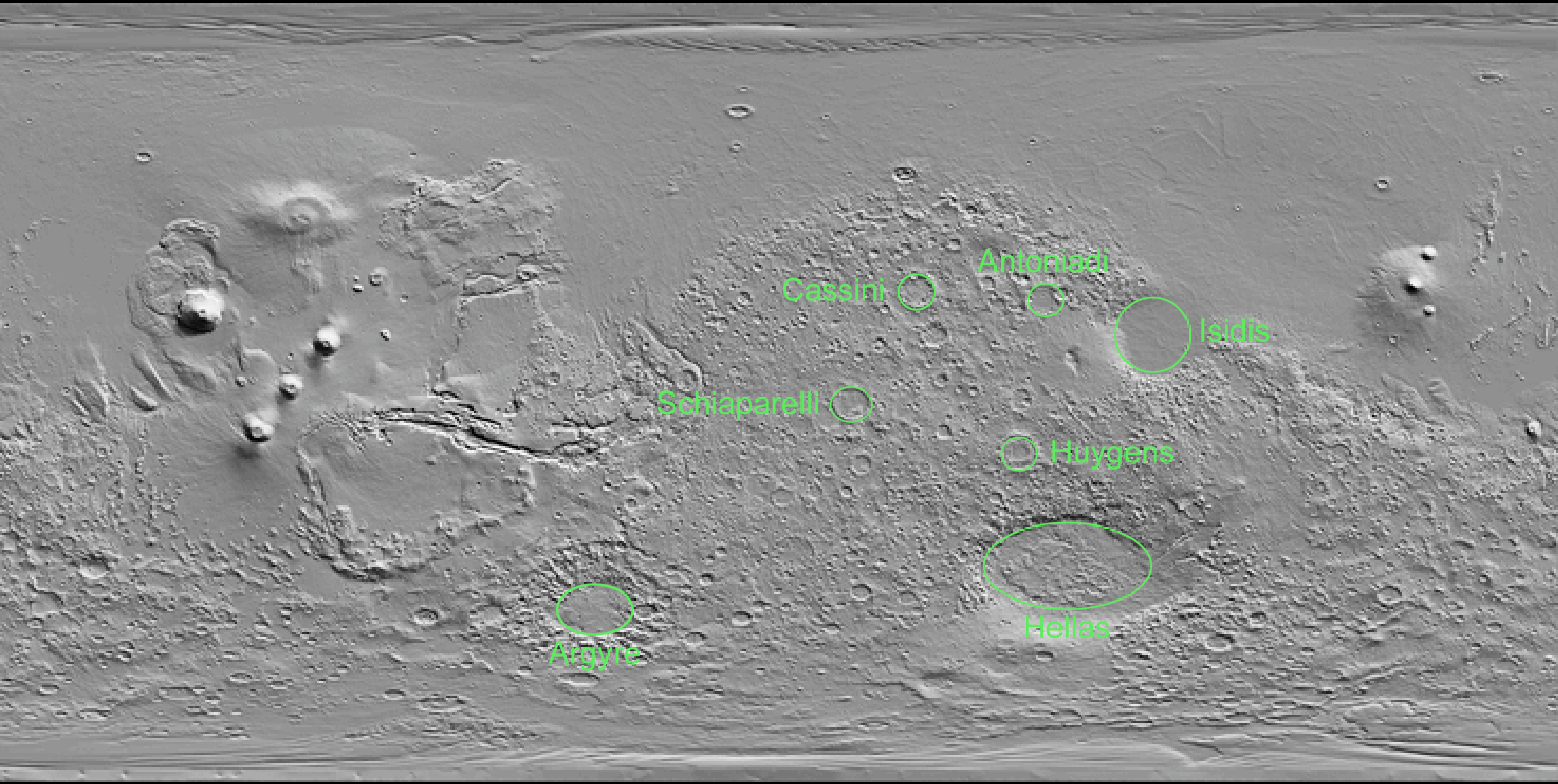
Hydrated minerals occur in accretionary rims around chondrules in CM chondrites. Previous models suggested that these phyllosilicates did not form by gas-solid reactions in the canonical solar nebula. We propose that chondrule-forming shock waves in icy regions of the nebula produced conditions that allowed rapid mineral hydration. The time scales for phyllosilicate formation are similar to the time it takes for a shocked system to cool from the temperature of phyllosilicate stability to that of water ice condensation. This scenario allows for simultaneous formation of chondrules and their fine-grained accretionary rims.

...suitable for life

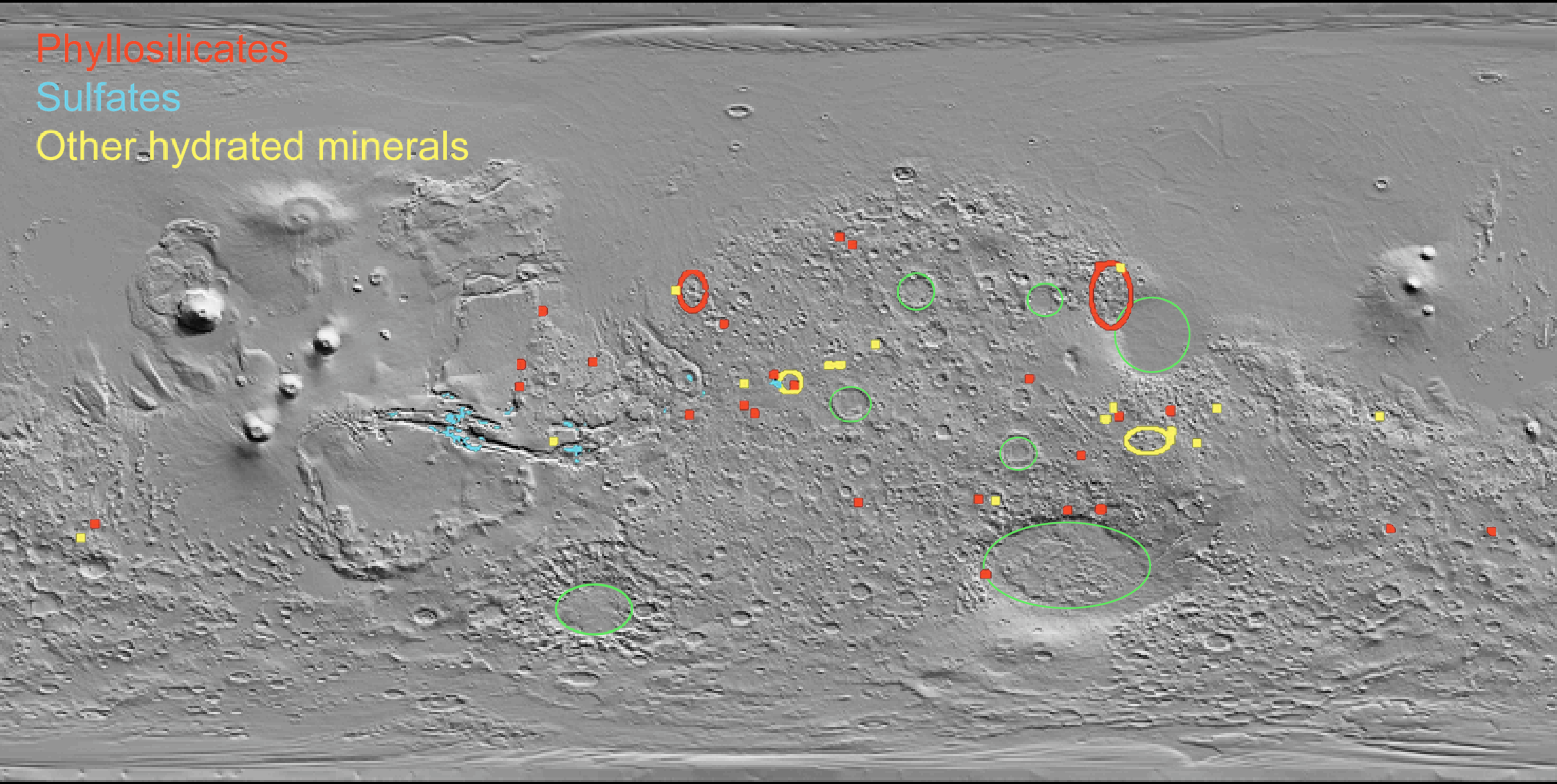
- Hydrothermal circulation is likely around impact craters *(e.g. Newsom et al., Abramov & Kring 2004, 2005)*
- Phyllosilicates form in water-rich, neutral-pH settings
- Serpentinization releases H, a reducer and a biologically critical element
- Chemical and electrical potentials and porous materials provide niches

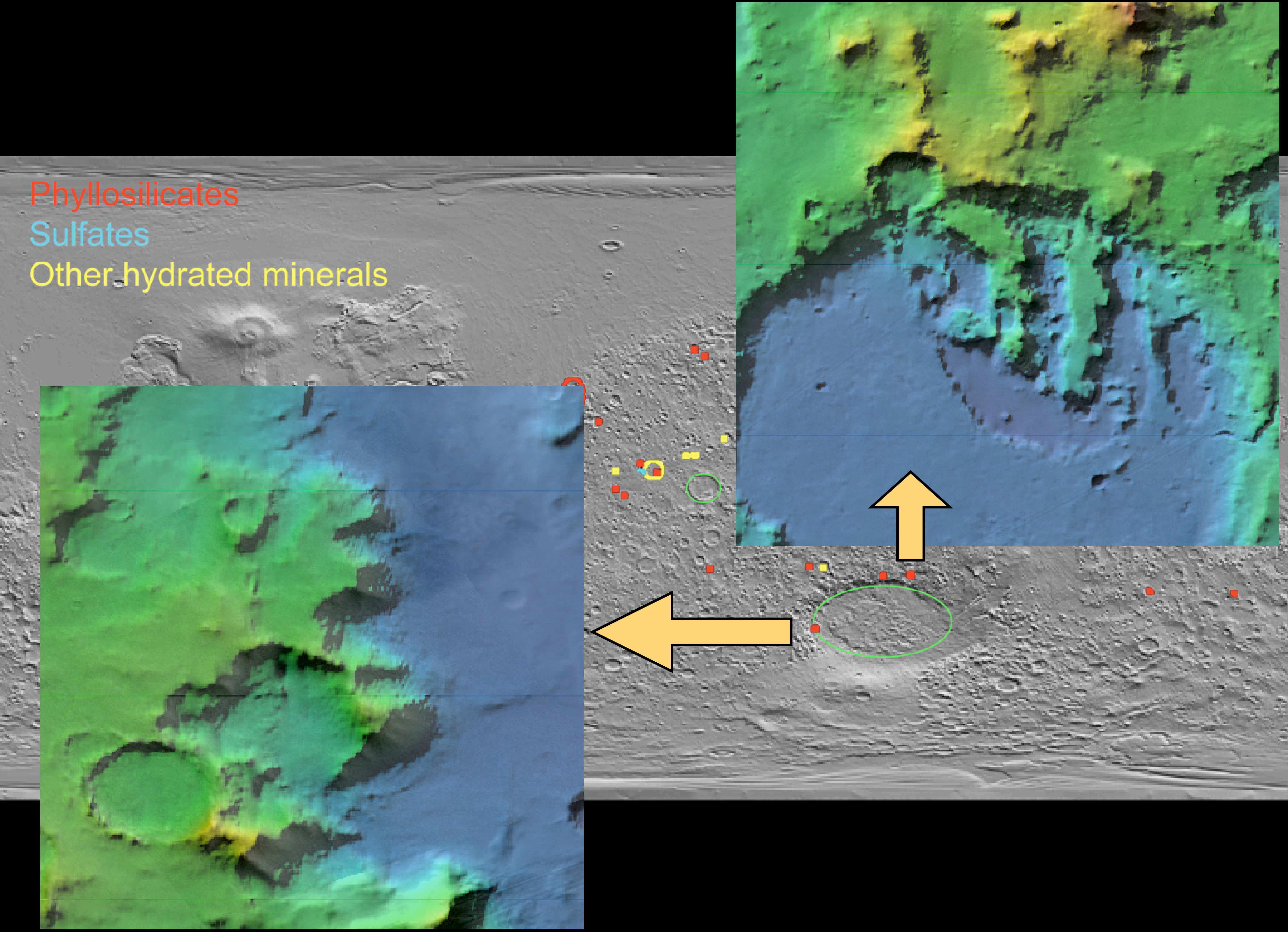


Bibring et al. 2005



Antoniadi
Cassini
Isidis
Schiaparelli
Huygens
Hellas
Argyre


Phyllosilicates
Sulfates
Other hydrated minerals



Phyllosilicates
Sulfates
Other hydrated minerals

Big Basin Characteristics

- Formed early
  Ancient geologic history that has rarely been sampled
- Excavated deeply
  Window into original crust, provides crucial information on bulk planet composition and solar system neighborhood
- Created environments
  Ejecta + hydrothermal systems = alteration minerals in the rocks
- Suitable for life
  Water-rich, reducing, warm, neutral pH, free surfaces
- Processes of relevance to past habitability; investigable by MSL
- Candidate sites exist but ***these characteristics also add value at other proposed sites***