Large impact basin-related climatic and surface effects on Mars: Argyre basin as a case study

Ashley M. Palumbo and **James W. Head**

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Ashley_Palumbo@Brown.edu

@ashleympalumbo

Brown University
Department of Earth, Environmental, and Planetary Sciences

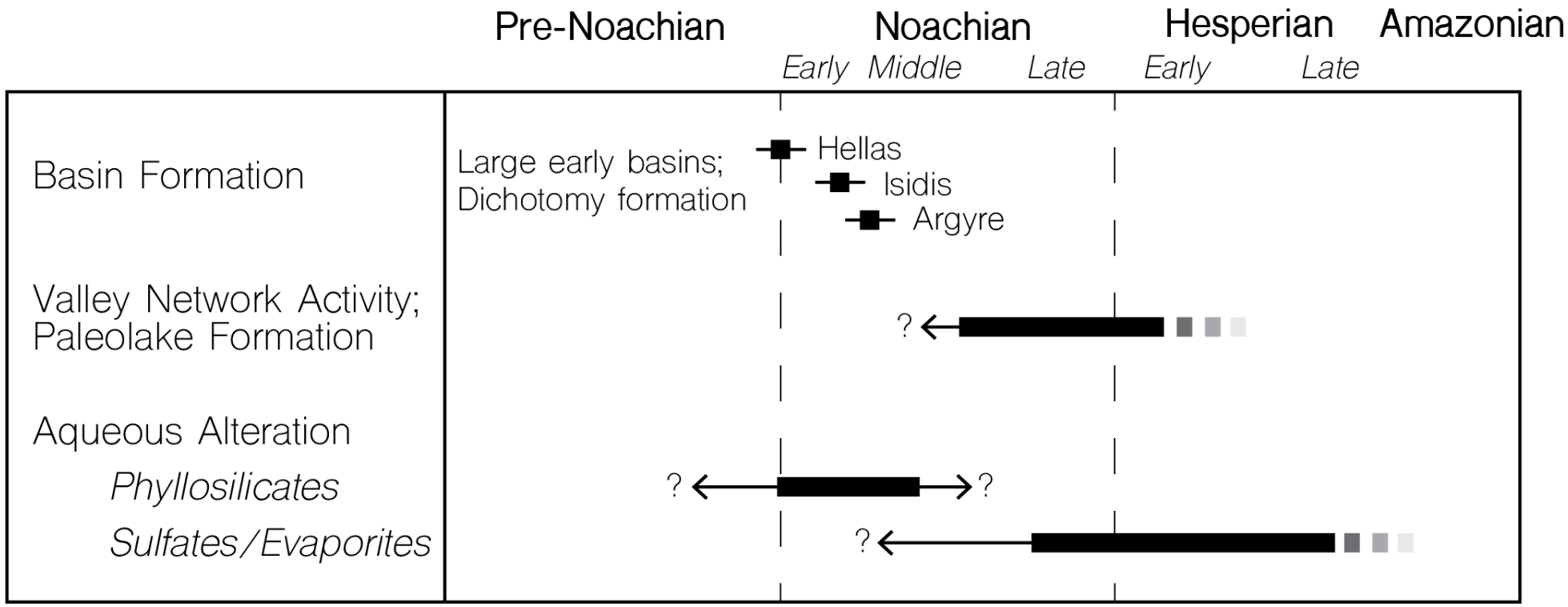
Large basin-forming events cause global effects

Key post-impact effects:

1. Transient high atmospheric and surface temperatures
2. Deposition of hot spherule layer
3. Transient phase of intense, hot rainfall

Palumbo and Head (2018), *MAPS*
Segura et al. (2002; 2008); Toon et al. (2010)

Large basins formed in the Early to Middle Noachian

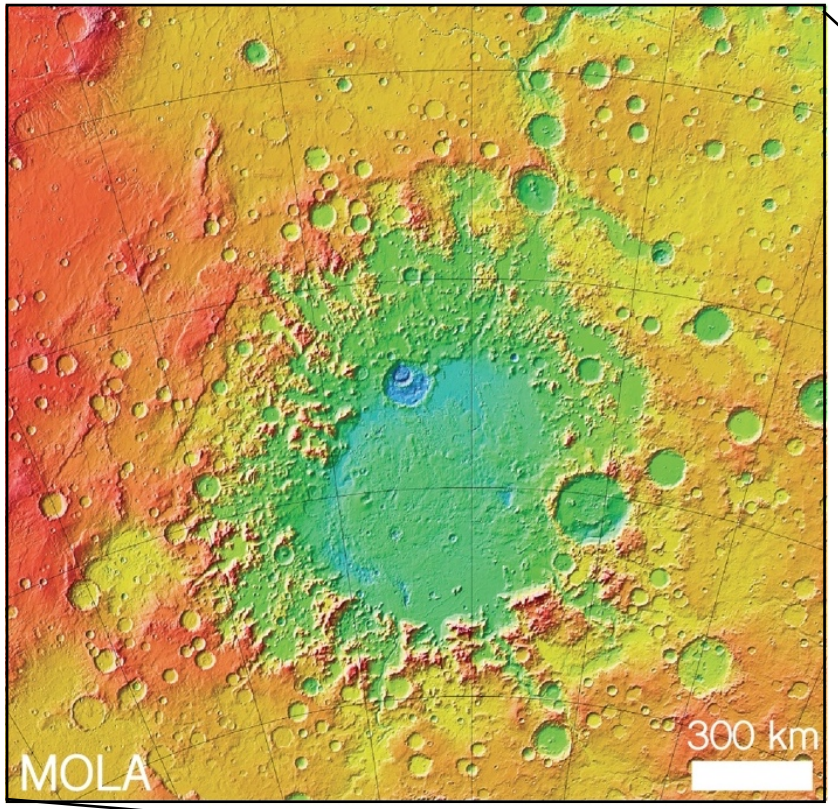


The formation of the largest basins was contemporaneous with surface aqueous alteration and crater degradation, but not with valley network and lake activity. Smaller, younger impacts would not have caused intense, global effects.

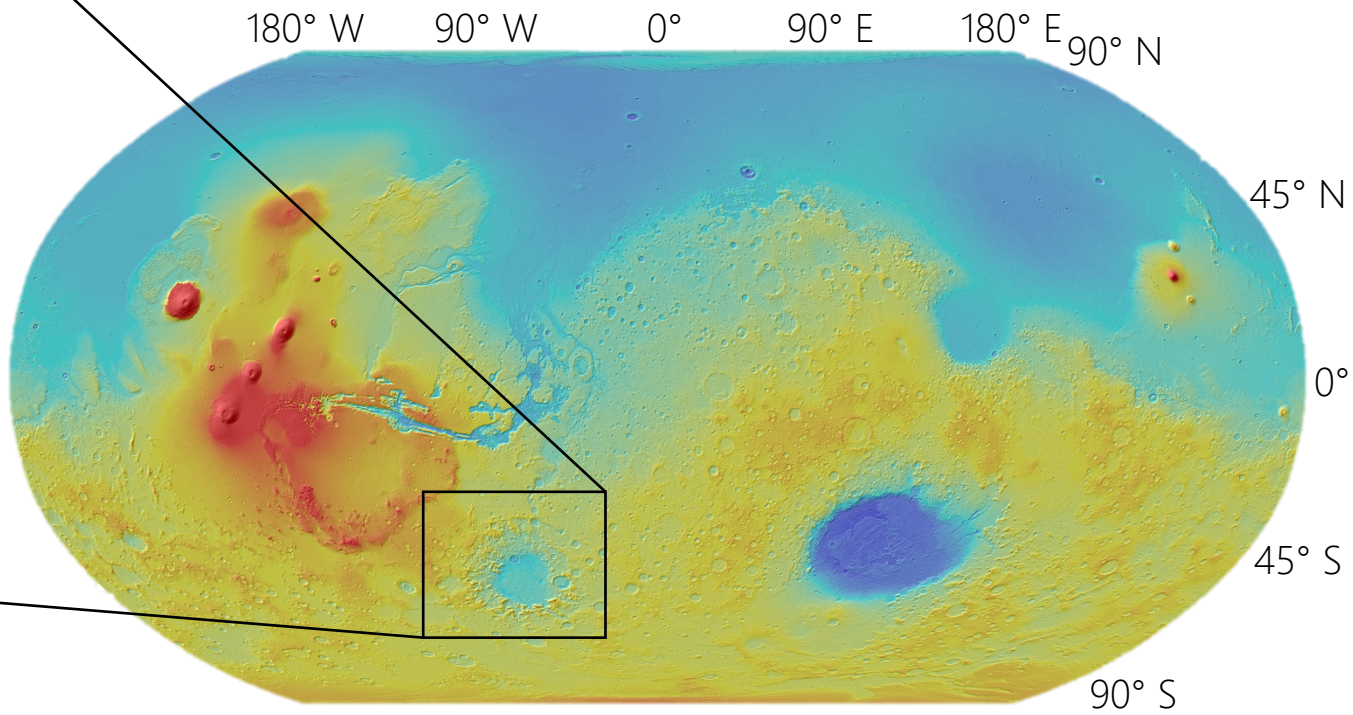
Figure adapted from Fassett and Head (2011)

Argyre basin as a case study

Argyre Basin, Mars



To determine the morphologic and mineralogic signature of these effects, we quantitatively and qualitatively explore the post-impact effects from the formation of the youngest of the martian basins, Argyre, because the signatures would be preserved closest to the surface.



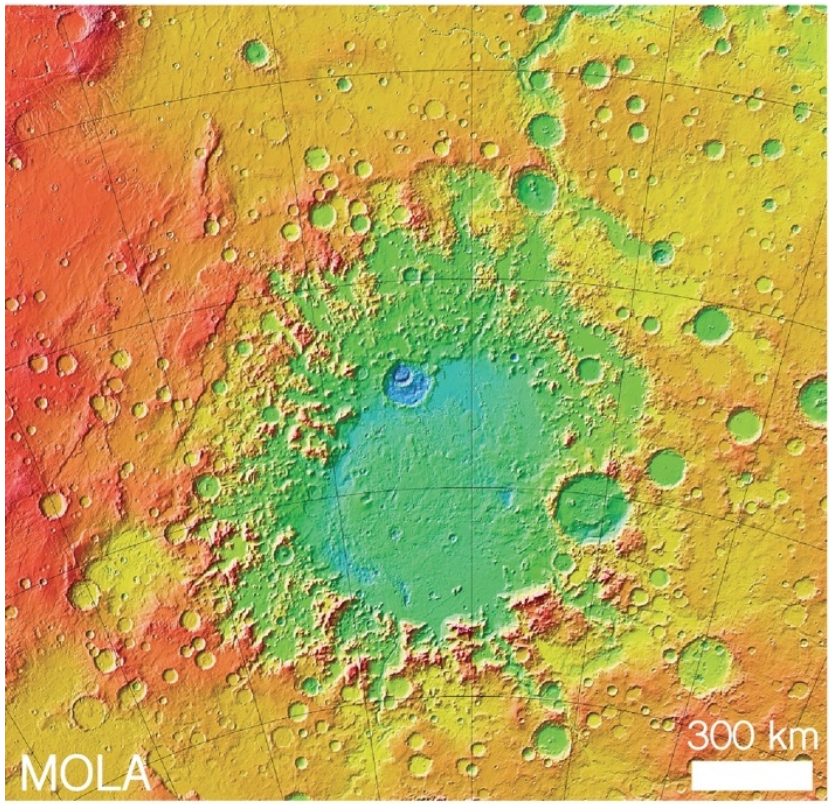
Elevation

low *high*

Palumbo and Head, *In prep*

Argyre vs. Orientale: Comparison of amount of erosion

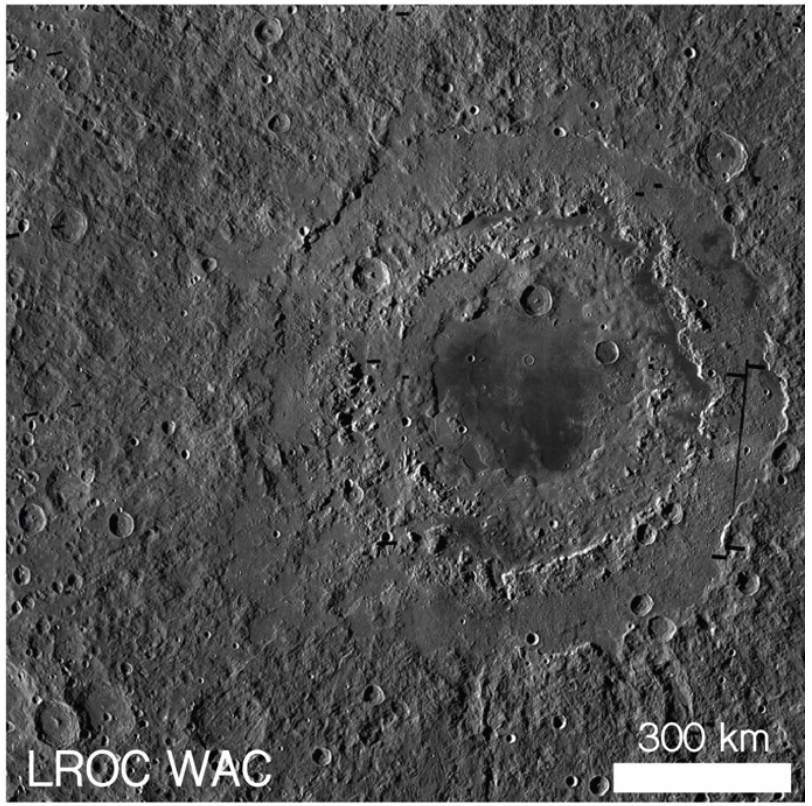
Argyre Basin, Mars



Elevation

low *high*

Orientale Basin, Moon

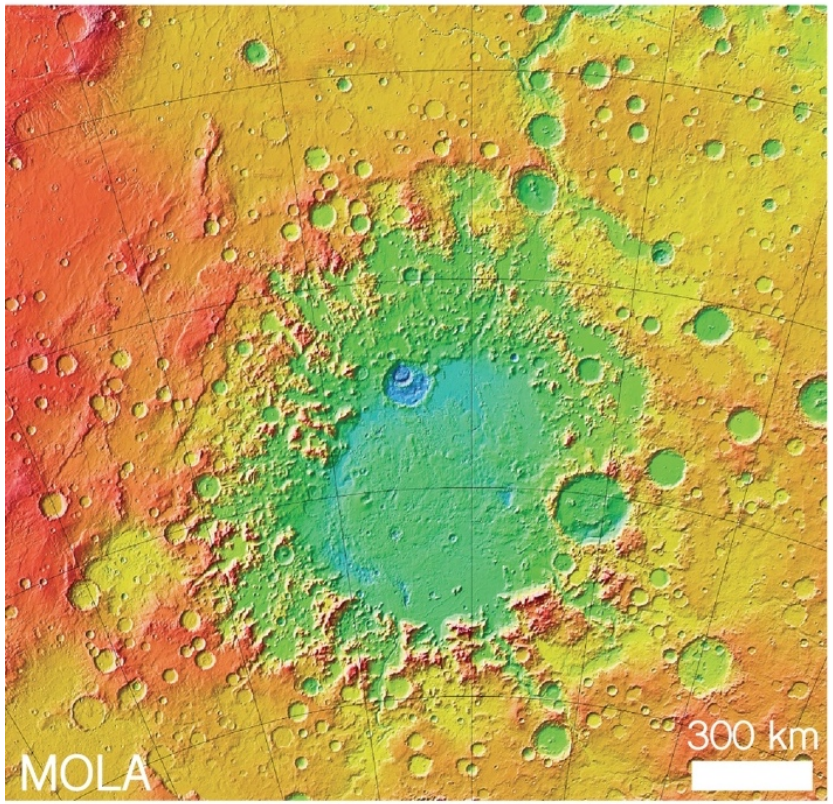


Raised rim topography, radial decrease in topography, textured ejecta, and secondary craters

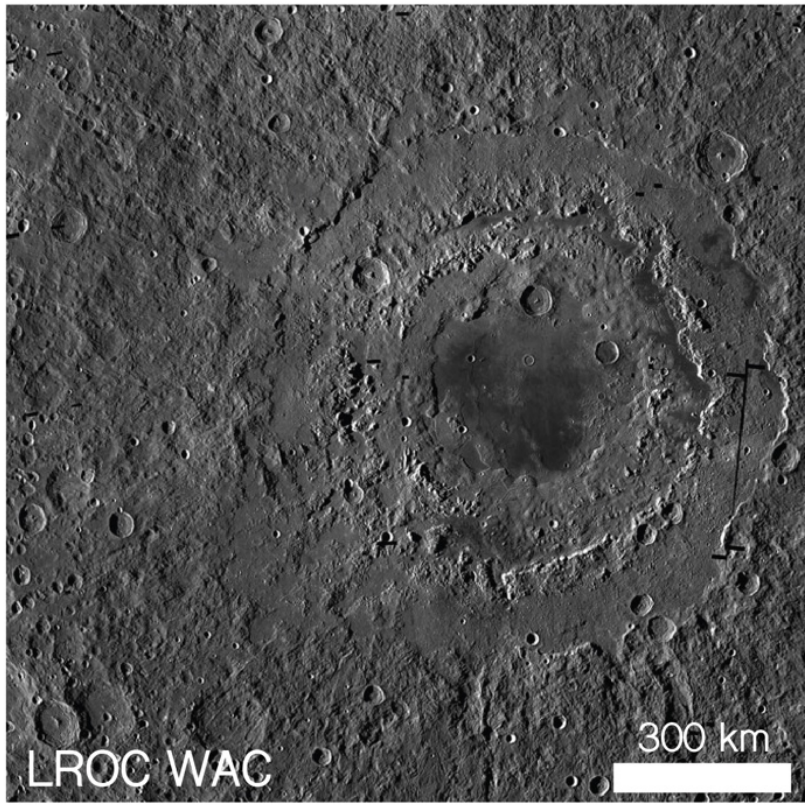
Palumbo and Head, *In prep*

Argyre vs. Orientale: Comparison of amount of erosion

Argyre Basin, Mars



Orientale Basin, Moon



Elevation

low *high*

In comparison to Orientale, Argyre has experienced abundant erosion that cannot be fully attributed to background erosive activity; some must be related to post-impact effects.

Palumbo and Head, *In prep*

Quantitative estimates of Argyre post-impact effects

Key post-impact effects:

Argyre basin:

1. Transient high atmospheric and surface temperatures → 100s of K above ambient for decades
2. Deposition of hot spherule layer → 30 m thick, deposited globally
3. Transient phase of intense, hot rainfall → Rates of ~2.6 m/y for decades

↓

Surface aqueous alteration, smoothing of plains, and degradation of craters.

Based on results from Palumbo and Head (2018) and Turbet et al. (2020)

Palumbo and Head, *In prep*

Key Points:

1) Basin-scale impact effects must be considered in studies of the early martian climate and hydrologic cycle.
2) Post-impact effects are likely to have contributed to smoothing of plains, degradation of crater rims, and aqueous alteration. These observations may not be related to the ambient background climate conditions
3) The Argyre-related units should be preserved at or near the surface. These units should be identifiable at both the orbital and rover scale.