Large Impact Basin-related Climatic and Surface Effects on Mars: Argyre Basin as a Case Study

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The collision of large bolides with planets with substantial atmospheres, such as Earth and early Mars, results in climatic and surface effects. For very large impacts, forming basins >~500 km in diameter, these impact effects would be global and include [1]: (1) transient high temperatures, (2) deposition of material that was vaporized by the impact and subsequently condensed (e.g. terrestrial spherule layers), and (3) a transient phase of hot rainfall with rates sufficient to produce flooding. On Mars, the formation of such large basins, including Hellas, Isidis, and Argyre, occurred in the early- to mid-Noachian [2]. Previous work has qualitatively [1] and quantitatively [in 3D; 3,4] constrained the effects from large basin-scale impacts on Mars, but lacks detailed application to any specific impact.

The fact that these drastic, global effects would occur following each large basin-scale impact [1,3,4] implies that the effects from formation of the youngest large basin would be best preserved closest to the surface. Here, we qualitatively and quantitatively explore the climatic and surface effects from the formation of the youngest large basin, Argyre. We find that: (1) a tens of meters thick, globally-distributed, spherule layer should be preserved on or near the surface, (2) induced rainfall would have been characterized by rates higher than Earth rainforests and lasted for decades, (3) hot rainfall would have caused flooding, erosion, smoothing of landforms, and surface aqueous alteration.

Implications include: (1) distinguishing the role of impact-induced aqueous alteration from that of normal climatic conditions, (2) predictions of areas where the spherule layer and alteration products may be observed, (3) the transition from a basin-scale impact-dominated regime to a basin-free regime in climate evolution, and (4) guidelines for exploration and recognition of these impact-related units at rover and sample return scale.

References: [1] Palumbo, Head (2017), *MAPS* 53, p687. [2] Fassett, Head (2011), *Icarus* 211, p1204. [3] Turbet et al. (2019), *Icarus* 335, p113419. [4] Steakley et al. (2019), *Icarus* 330, p169.