CONSEQUENCES OF EARLY OCEAN & SHORELINE DEFORMATION SCENARIOS FOR JEZERO CRATER, MARS. Mark Baum[1] (*markbaum@g.harvard.edu*), Robin Wordsworth[1,2], Tim Goudge[3]. [1]Harvard University Department of Earth and Planetary Sciences, [2]Harvard School of Engineering and Applied Sciences, [3]University of Texas at Austin Jackson School of Geosciences

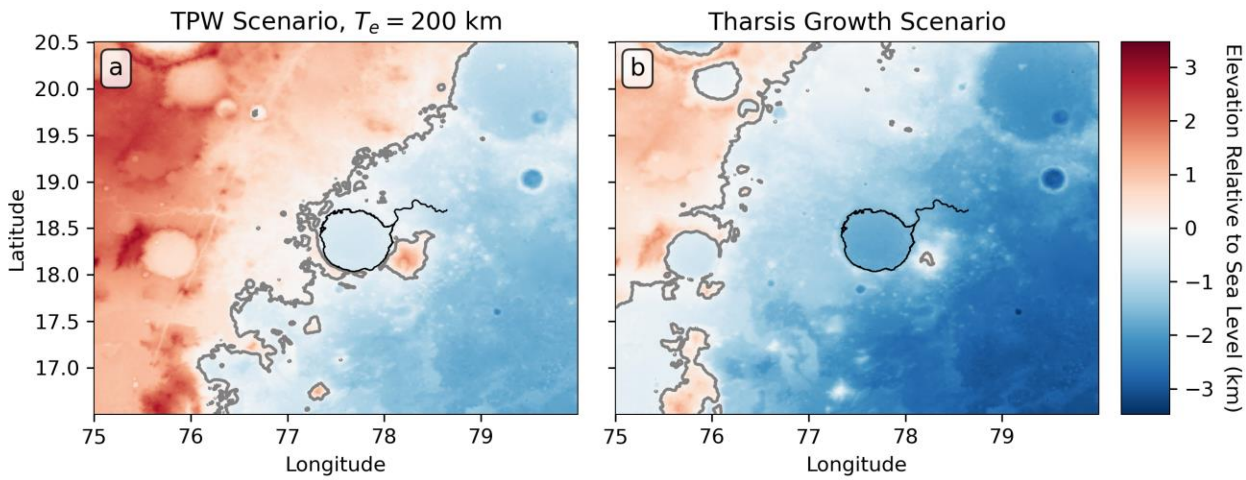

Figure 1: Topography of the region surrounding Jezero crater after applying the global elevation corrections due to (a) TPW [6] and (b) Tharsis growth [7]. The surface elevation is expressed relative to sea level in each scenario and the grey line traces sea level. Sea level is -2.25 km in the TPW scenario and -2.3 km in the Tharsis growth scenario. The black lines show the outlet canyon and the outline of the lake that it drained [8].

Introduction: At the time of writing, the *Perseverance* Rover will soon land in Jezero crater, the site of an ancient fluvio-lacustrine system. The crater was fed by two valley networks, hosted an open basin lake with a clear outlet channel, and contains well-preserved remnants of a delta [1,2,3]. Crater counting of the ancient lake's watershed indicates that fluvial erosion occurred before about 3.83 Ga in the Late Noachian, consistent with many other large valley networks [4]. Understanding the hydrological history of the crater and how it constrains the global climate history of Mars is a major focus of the Mars 2020 mission.

Some of the most interesting and controversial questions about the early Martian climate are whether oceans ever existed on the planet's surface, how large they may have been, and when they might have been present. The primary evidence for ancient oceans is a collection of curvilinear features mapped around the boundary of the northern lowlands, interpreted as evidence of an ancient shoreline. However, they may not be shoreline deposits. There are also many conflicting definitions/mappings of these features and individual definitions often traverse a wide range of surface elevations, unexpected behavior for the boundary of a level body of water [5].

Several studies correct the variation in shoreline elevation with models of global topographic deformation after shoreline formation. Two primary studies with correction models invoke true polar wander [6] and the formation of Tharsis [7] to flatten the Arabia level, thought to represent a relatively large, old ocean. We refer to them as the "TPW scenario" and "Tharsis growth scenario," respectively. Although both studies only reference one of the several definitions of the Arabia level and use only a segment of the definition for their analysis, it is worth examining the consequences of these shoreline correction scenarios for the environmental history of Jezero crater and for the proposed ocean itself.

Jezero Submerged: We apply the topographic deformation scenarios [6,7], which are global, to the region surrounding Jezero crater. Figure 1 shows the crater and the location of the proposed sea level in each scenario. Both of the proposed "Arabia" oceans would submerge the crater. This precludes the simultaneous existence of the proposed oceans and fluvio-deltaic activity at Jezero. It also implies that, if the proposed oceans ever existed, it was not during the main era of global valley network incision in the Noachian/Late Hesperian, because Jezero hydrology was active at this time [4].

If the ocean was present before hydrological activity at Jezero, the *Perseverance* rover may find evidence of it. To our knowledge, the "mottled terrain" is the only unit with a stratigraphic and spatial context that could plausibly be linked to an ocean before deposition of the Jezero deltas [9], but there is currently no evidence supporting such a link.

Finally, it is doubtful that the proposed oceans could have existed after hydrological activity at Jezero. Satellite data show no sign of marine or coastal sediment overlying the deltas in the crater [9], although we will soon learn much more about this stratigraphy. This timeline would also require an improbable transition from a climate sustaining valley network formation but no large ocean to a climate with a large ocean but scant valley network formation.

References: **[1]** Fassett and Head (2005) *GRL, 32*. **[2]** Schon et al. (2012) *Planetary and Space Science*, *67*. **[3]** Goudge et al. (2017) *EPSL, 458*. **[4]** Fassett and Head (2008) *Icarus, 195.* **[5]** Sholes et al. (2020) *ESSOAr*, doi:10.1002/essoar.10502868.1 **[6]** Perron et al. (2007) *Nature*, 447. **[7]** Citron et al. (2018) *Nature*, 555. **[8]** Goudge et al. (2019) *Geology*, 47. **[9]** Goudge et al. (2015) *JGR: Planets*, 120.