



Transient crater lakes at the margins of martian outflow channels: evidence for localised precipitation related to outflow channel activity?

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The circum-Chryse outflow channels were carved in Late Hesperian to Early Amazonian times when martian surface conditions are considered to have been too cold and dry for water at the surface to have been stable for significant lengths of time. Most examples of crater lakes on Mars for example are considered to have formed in the Late Noachian when Mars is considered to have been warmer and wetter at least for short periods. Here we identify and describe evidence for the occurrence of numerous craters adjacent to the proximal reaches of Ares Vallis outflow channel, which show prominent outlet channels breaching the rim of the crater. These craters do not show evidence for any inflow channel. The outlet channels exit the crater and subsequently flow down the flood-eroded sides of Ares Vallis. The channels show linear to slightly sinuous planforms, and have steep linear to convex-up profiles. The channels debouch to the floor of Ares Vallis revealing flow down the valley flanks and indicating that they post-date final valley incision.

We interpret these outlet channels as spillover drainages from transient crater lakes. The craters formed closed basins that held temporary lakes. On overfilling, crater rims became breached with consequent formation of the spillover channel. The absence of multiple spillover channels emerging from these craters suggests that filling-and-spilling may have been individual events. The height of the breach in the crater rim together with topographic data over the craters enables us to estimate the minimum volume of water that was held in these transient lakes.

Given the problem of the long-term stability of liquid water on the martian surface during the Hesperian, it remains difficult to explain both filling of the crater lakes and subsequent erosion of the outlet drainages. We speculate that given the large outbursts of water required to form the outflow channel, it is plausible that this flood water may have evaporated leading to localised transient precipitation in the vicinity of the outflow channels, leading to water filling craters adjacent to the margins of the outflow channel. Visual inspection indicates that crater-lake spillover channels are not generally observed away from the Ares Vallis channel, suggesting a causal relationship between the outflow channel and these crater-breaching drainages.