Widespread lava–water interactions in Elysium Plantia, Mars: Implications for paleoenvironments during the Middle to Late Amazonian Epochs

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The Elysium Volcanic Province (EVP) includes the youngest and best preserved eruptive products on Mars. These young (Middle to Late Amazonian) eruptive products are dominated by extensive lava flows that provide insight into the planet's thermal evolution and volcanic history. The Cerberus Fossae 2 and 3 units, located in the southeastern portion of the EVP, include regionally extensive flood lavas that host numerous cratered cone groups. These cratered cone groups are generally interpreted to be the products of explosive lava–water interactions (i.e., volcanic rootless constructs) and provide evidence of near-surface water or ice at the time of lava flow emplacement. This study focuses on the Cerberus Fossae 2 unit and uses imagery from the Mars Reconnaissance Orbiter to demonstrate that the cratered cone groups cover 15,000–20,000 km^2. The Cerberus Fossae 2 unit also includes pitted terrains that are interpreted to be thermokarst, which was generated by lava-induced melting of near-surface ground ice followed by foundering of the overlying lava. If these landforms were associated with lava–ground ice interactions, then their distribution implies an extensive near-surface H_2O reservoir at the time of lava flow emplacement approximately 125 Ma ago (with a factor of ± 2 uncertainty). The region also includes annular depressions around high-standing knolls and mesas of the Noachian-age Nepenthes Mensae unit. These features are interpreted to be the result of another form of lava–ice interaction, with lava flows embaying ice-bearing lobate debris aprons that were subsequently removed by sublimation and deflation to form an annulus around the high-standing topography. When lava flows associated with the Cerberus Fossae 2 unit were emplaced, the inferred paleo-distributions of near-surface ground ice and ice-bearing debris aprons are consistent the ice accumulation zones predicted by Mars climate models with approximately 35° obliquity.