

Long term ice survival in Kasei Valles, Mars

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1 Summary

- Located amongst the lava deposits of Kasei Valles ($\sim 27^\circ\text{N}$ $\sim 73^\circ\text{W}$) are a series of enigmatic depressions that surround isolated mesas and are found parallel to scarps (Figure 1). These depressions demarcate the past interaction between flowing lava and former lobate debris aprons (LDAs), which have long since disappeared (Hauber et al., 2008). We term these features, ghost LDA depressions. Here we derive model ages for depressions, mesas and the lava flow from crater counts. We approximate the surface and volume of former glacial ice deposits using a 2D model of glacial ice constrained by the topography of ghost LDA depressions and a range of values for yield stress, τ_y , derived from contemporary LDAs (Karlsson et al., 2015).
- Our modelling indicates **between 2277–5227 km³ of ice existed in Kasei Valles at the time of lava formation (~ 1.31 Ga)** with a mean thickness of 100 m–240 m (where $\tau_y=16\text{--}80$ kPa). CSFD dating of the ghost LDA depressions, and of the mesas contained therein show that the **former LDAs survived for a minimum additional time ranging from 0.2 to 1.1 Gyr** (Figure 3).
- Former LDAs reconstructed represent some of the oldest glacial ice masses on Mars. Dating and modelling of ghost LDA depressions yield a unique insight into low latitude ice in the early Amazonian, beyond the known extent of contemporary ice-rich VFFs and before the oldest estimates of mid-latitude glacial activity



2 Key figures

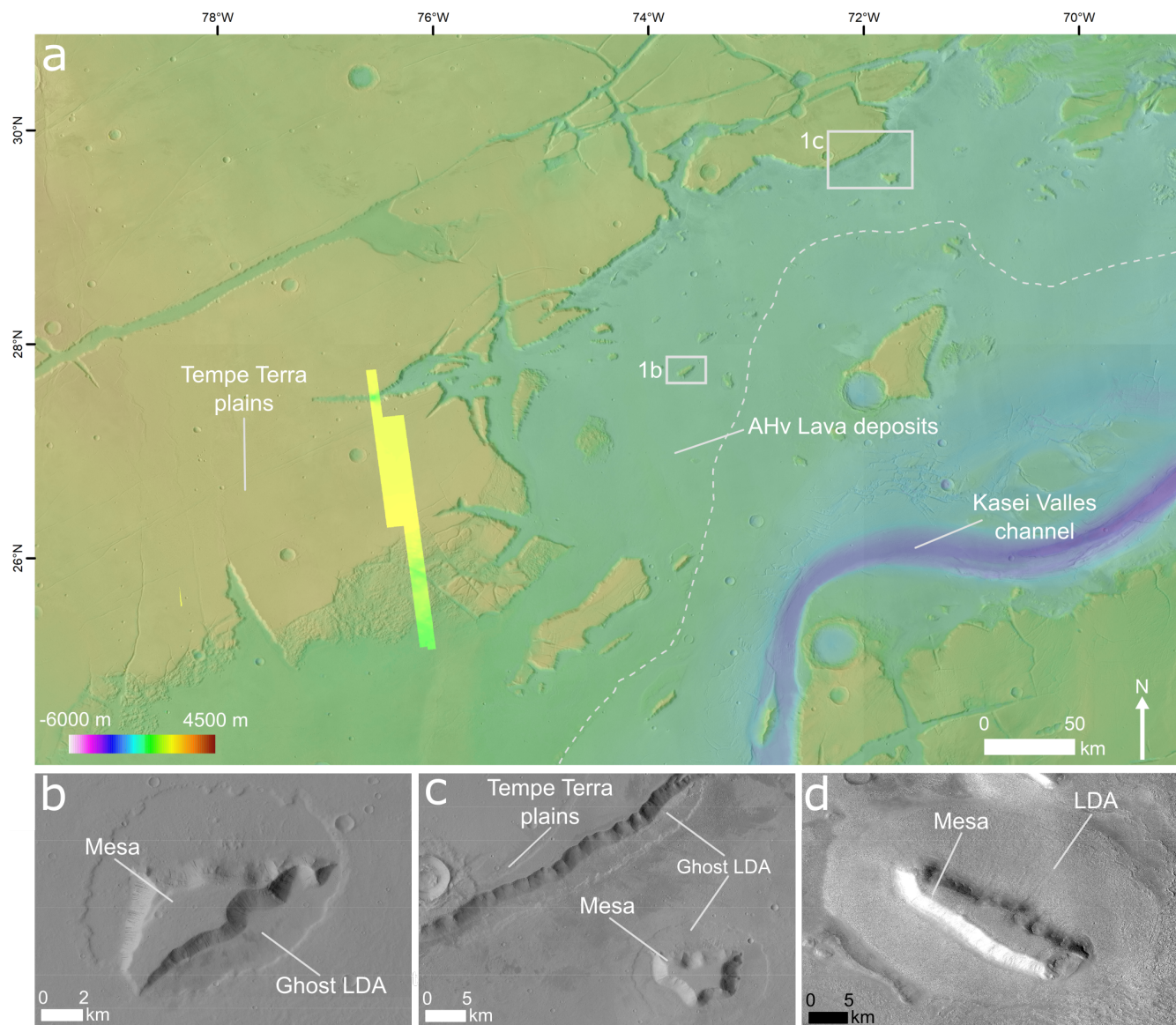


Figure 1: **The Kasei Valles region, ghost lobate debris apron (ghost LDA) depression, and a contemporary LDA.** (a) The Kasei Valles study region. Background colours show MOLA gridded topography (Zuber et al., 1992) in a equirectangular projection, overlain by the Murray Lab Context Camera (CTX: (Malin et al., 2007)) mosaic (Dickson et al., 2018). (b) CTX image of Ghost in a north-up projection. The depression is clearly delineated surrounding the isolated mesa. (c) CTX image of a scarp-parallel ghost LDA and ghost LDA. (d) CTX image of a contemporary LDA in the Protonilus–Deuteronilus Mensae region in a north-up projection. Ice-rich LDA visible as the smooth deposit surrounding the central mesa.

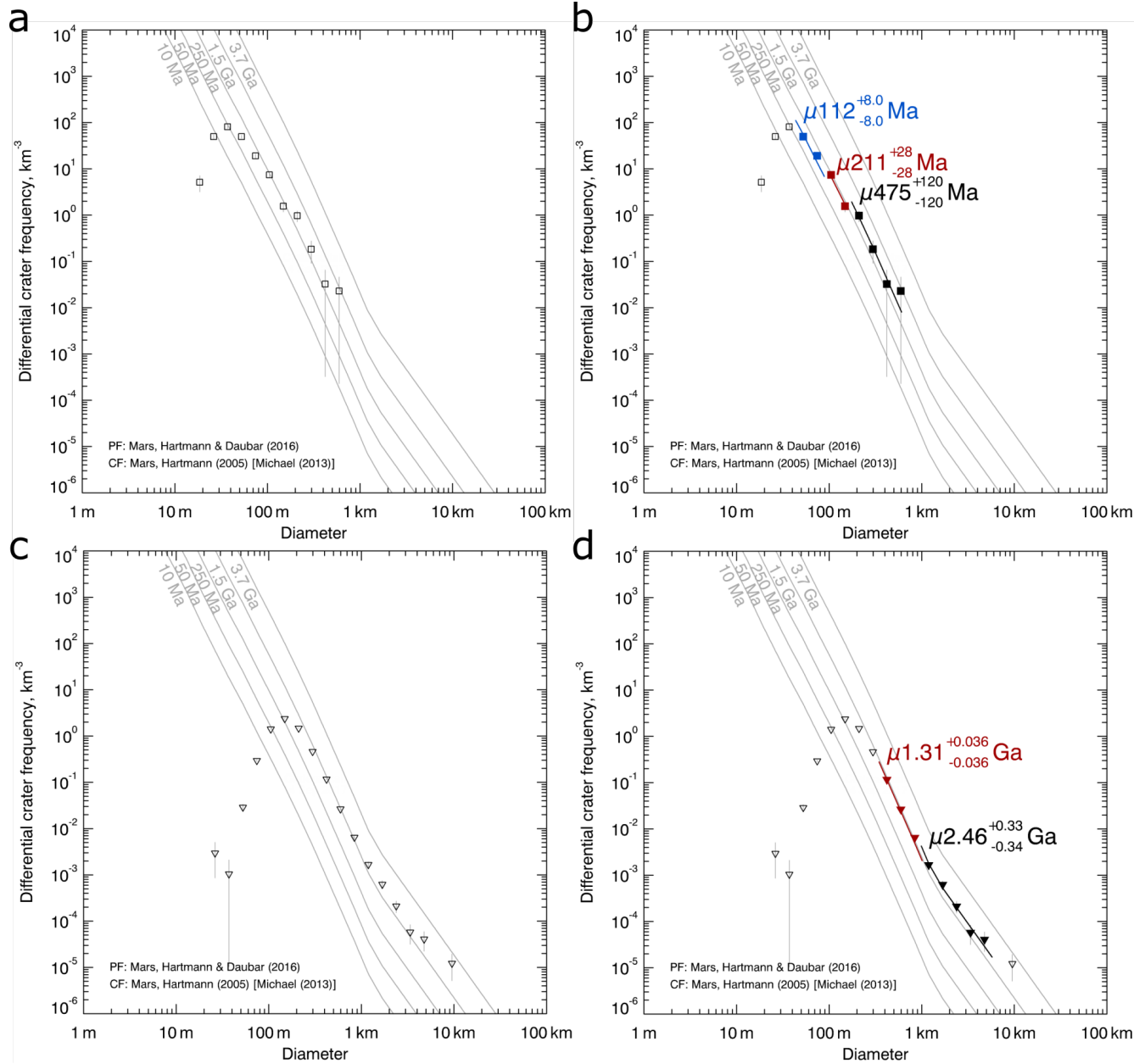


Figure 2: **Impact crater size-frequency distributions of (a–b) a ghost LDA depression and (c–d) the Kasei Valles lava flow.** Data points are derived from crater counts on CTX imagery and grey curves outline the isochron system. Bins align with several isochrons over distinct diameter ranges. The ages reported (b,d) represent the fitted isochrons.

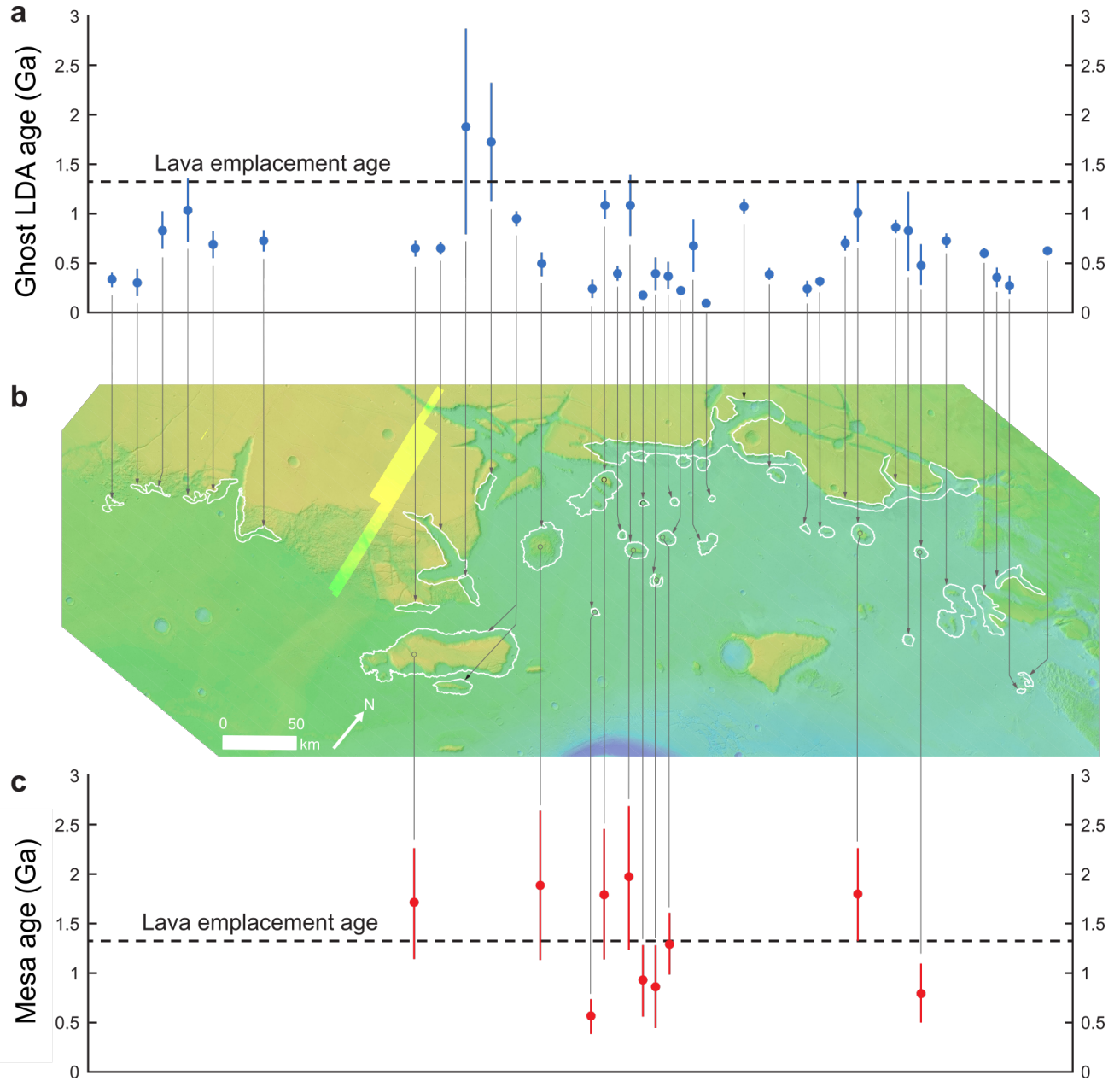


Figure 3: **Ghost LDA and Mesa model ages in Kasei Valles** (a) Ghost LDA model ages, in a roughly west–east progression across the region of study. Vertical error bars indicate statistical age uncertainty. (b) The Kasei Valles study region. Background colours show MOLA gridded topography in a equirectangular projection, overlain by the CTX mosaic. Ghost LDA depressions are outlined by white polygons. (c) Mesa model ages, approximately from west–east across the study region. Vertical error bars indicate statistical age uncertainty. Dashed line in panels a and c indicates the model age of the lava flow (1.31 Ga).

References

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