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Sinuous Ridges and the History of Fluvial and Glaciofluvial Activity in Chukhung Crater, Tempe Terra, Mars.

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We explore the origins of a complex assemblage of sinuous ridges in Chukhung crater (38.47°N, 72.42°W), Tempe Terra, Mars, and discuss the implications of the landsystem for post-Noachian fluvial and glaciofluvial activity in this location [1].

We produced a geomorphic map of Chukhung crater using a basemap of 6 m/pixel Context Camera (CTX) images and a 75 m/pixel High Resolution Stereo Camera digital elevation model (DEM). We used 25 cm/pixel High Resolution Imaging Science Experiment images, and a 24 cm/pixel DEM generated from CTX stereopair images [2] to aid classifications of sinuous ridges into four morpho-stratigraphic subtypes. We constrained an age envelope of ~2.1–3.6 Ga for Chukhung crater using modelled ages (from crater size-frequency analyses) of units above and below it in the regional stratigraphy. We derived a minimum model age of ~330 Ma for viscous flow features (putative debris-covered glaciers) in southern Chukhung crater.

Sinuous ridges in southern Chukhung crater emerge from moraine-like deposits associated with the debris-covered glaciers. Sinuous ridges in northern Chukhung crater extend from dendritic fluvial valley networks on the crater wall. The northern sinuous ridges are most likely to be inverted palaeochannels, which comprise subaerial river sediments exhumed as ridges by erosion of surrounding materials.

Both sinuous ridge subtypes in southern Chukhung crater have numerous esker-like properties. Eskers are ridges of glaciofluvial sediment deposited in meltwater tunnels within or beneath glacial ice. One of the ridge subtypes in southern Chukhung crater is best explained as eskers because these ridges ascend the sides of their host valleys and, in places, escape over them onto adjacent plains. Post-depositional processes can cause inverted paleochannels to cross local undulations in the contemporary topography [3] but the ascent and escape over larger, pre-existing topographic divides is (as yet) not adequately explained by these mechanisms. Eskers, in contrast, form under hydraulic pressure in ice-confined tunnels, and commonly ascend valley walls and cross topographic divides. The esker-like properties of the second sinuous ridge subtype in southern Chukhung crater can also be explained under the inverted palaeochannel hypothesis so the origins of these ridges remain more ambiguous.

Chukhung crater has undergone protracted and/or episodic modification by liquid water since its formation between the early Hesperian and early Amazonian. This falls after the Noachian period (>3.7 Ga), when most major fluvial activity on Mars occurred. Esker-forming wet-based glaciation in Chukhung crater might have occurred as recently as the mid Amazonian (>330 Ma), when climate conditions are thought to have been cold and hyper-arid. Rare occurrences of eskers associated with Amazonian-aged glaciers in Mars' mid-latitudes are attributed to transient, localised geothermal heating within tectonic rift/graben settings [4]. The location of Chukhung crater between major branches of the large Tempe Fossae volcano-tectonic rift system is consistent with this hypothesis.

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