earthquake will fall short on the predictions of Parker and colleagues. The legacy of this event would then be one of reduced relief and lower mean elevations, but not necessarily one of negative mass balance.

Whether the earthquake added or removed mass therefore depends on the time needed for the rivers to remove the excess sediment and the recurrence interval of similar earthquake and landslide events. Both are superimposed on natural variations in the climate of the region — wetter, cooler climates could lead a different magnitude of landslide material displaced during earthquakes, as well as more efficient evacuation of landslide sediment. Understanding these timescales is the key to understanding the long-term evolution of topography in the Longmen Shan mountain range, already an enigmatic margin of the Tibetan Plateau[7]. There is a spatial correlation between the presence of steep river channels and higher rates of rock uplift in the earthquake region. This suggests that the local landscape is adjusted to reflect a balance between erosion and tectonics[8]. The spatial pattern of coseismic rock uplift and landslide erosion observed for the earthquake is consistent with this correlation, but the large volume of mass wasting documented by Parker and colleagues indicates a short-term imbalance between the magnitudes of erosion and uplift. For the long-term balance to exist, it would seem additional rock uplift from fault movement is needed, but not at the cost of more mass wasting and erosion.

Parker and colleagues[1] have emphasized the role of landslides in dictating landscape evolution in steep, actively deforming mountains, particularly those in which active faulting plays an important role in mountain building processes. There is growing evidence[9] that large earthquakes with the potential for massive coseismic landslides deserve to join the ranks of catastrophic floods and climate cycles as events that regularly punctuate landscape evolution and make the erosion of mountains discontinuous over millennial to ten-thousand-year timescales. ❐

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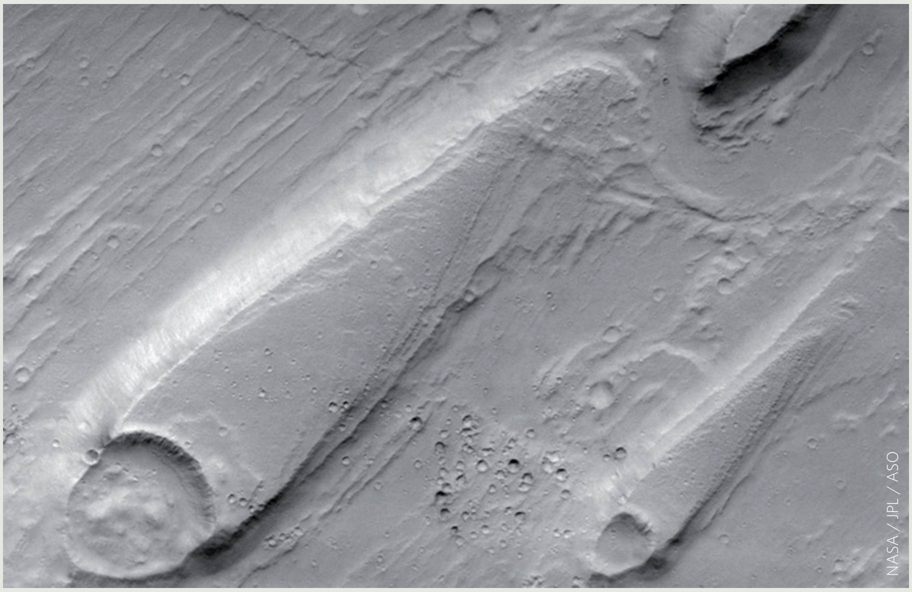
PLANETARY SCIENCE

From shore to shelf

Identifying past oceans and lakes on Earth is — relatively — easy. Cliffs and road cuts reveal rocks rife with fossils and minerals formed in water. Seismic data reveal buried shorelines and channels. And radioactive elements allow us to assess when these markers were deposited. Finding former bodies of water on other planets is markedly more challenging. Spectral data can hint at the presence of aqueous minerals, but most evidence comes from satellite images of planetary landforms that resemble fluvial or marine features found on Earth.


NASA / JPL / ASO

The presence of such analogous surface morphology has led to the suggestion that the northern plains of Mars were once covered by vast oceans. Deep chasms in the Chryse Planitia and Valles Marineris regions have been interpreted as outburst channels that fed ground water or molten ice into the ocean basin. But these features may not be signs of a shoreline at all: Lorena Moscardelli and Lesli Wood of the University of Texas, Austin, suggest that elongated mounds near the chasms are more consistent with channel formation in a continental slope setting (*Geology* **39,** 699–702; 2011).

The martian channels look like flood remnants, but also bear a striking resemblance to submarine channels found on Earth. Dotted among these channels are triangular elevated features termed teardrop-shaped islands. Moscardelli and Wood show that these martian landforms are geometrically similar to erosional shadow remnants found on the continental shelf near Trinidad. The Caribbean erosional remnants formed during a mass wasting event in the distal reaches of the Orinoco Delta, and similar processes could have been at work in the martian plains.

Traces of mass wasting events are present elsewhere in the northern martian plains, namely in the form of chaotic terrains in the upper limbs of the outflow channels near Chryse Planitia. This surface morphology is consistent with channel collapse and underwater transport of sediments.

If the channels were indeed carved under water, we may need to redraw the outlines of the hypothesized ancient martian ocean, and raise estimates of the volume of water that once occupied it.

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