CHAPTER 8

ENIGMATIC NORTHERN PLAINS OF MARS

Although the northern plains of Mars form the flattest known surface in the Solar System, they are crisscrossed by ridge features (Smith et al., 1999). Here I test the idea that they might once have been covered by an ocean by examining the topographic profiles of possible shorelines (Head et al., 1999). I conclude that these candidate shorelines were more likely to have been formed by tectonic rather than oceanic processes.

Linear slope changes in the northern plains have been identified as possible shorelines of an ocean formed during the middle part of martian history (Head et al., 1999). Figure 8.1 shows topographic profiles, generated from Mars Orbiter Laser Altimeter (MOLA) data, across two such groups of shorelines (Smith et al., 1999). Candidate shorelines near the Utopia impact basin are flat terraces with a ridge of higher elevation bounding their landward, or upslope, side (Figure 8.1a). Possible shorelines on the other side of the proposed ocean, near the Alba Patera volcano, are also flat terraces with a ridge of higher elevation bounding their oceanward, or downslope, side (Figure 8.1b).

I believe that this morphology is hard to explain in terms of a shoreline formation process, as is the reversal of shoreline morphology from one side of the ocean to the other. I favour the idea that these candidate shorelines were created by tectonic activity, on the basis of recent MOLA digital terrain models of kilometre-scale horizontal resolution of the northern plains of Mars.

As seen from early images recorded by Viking (Figure 8.1c), these plains

are essentially flat and featureless, but MOLA data (Figure 8.1d) reveal a network of ridges spanning the northern plains, some of which are the candidate shorelines of the proposed ancient ocean (Head et al., 1999). Most ridges appear related to obvious stress centres, such as the volcanic Tharsis Rise, the Utopia impact basin, and the Alba Patera volcano. These ridges are generally perpendicular to predicted directions of maximum compressive stress, which suggests that the ridges have a tectonic origin (Banerdt et al., 1992). They also have the characteristic profile of wrinkle ridges formed by compressive tectonism (Schultz, 2000). Some ridges are close to known wrinkle ridge provinces, such as Lunae Planum, and have similar strikes; clearly, these formed with the known wrinkle ridges. Both groups of candidate shorelines have orientations consistent with their formation by compressive tectonism.

The causes of the youth and smoothness of the northern plains are still debated. This network of ridges is the only tectonic feature in this enigmatic region and their discovery opens a new tectonic window into Mars.

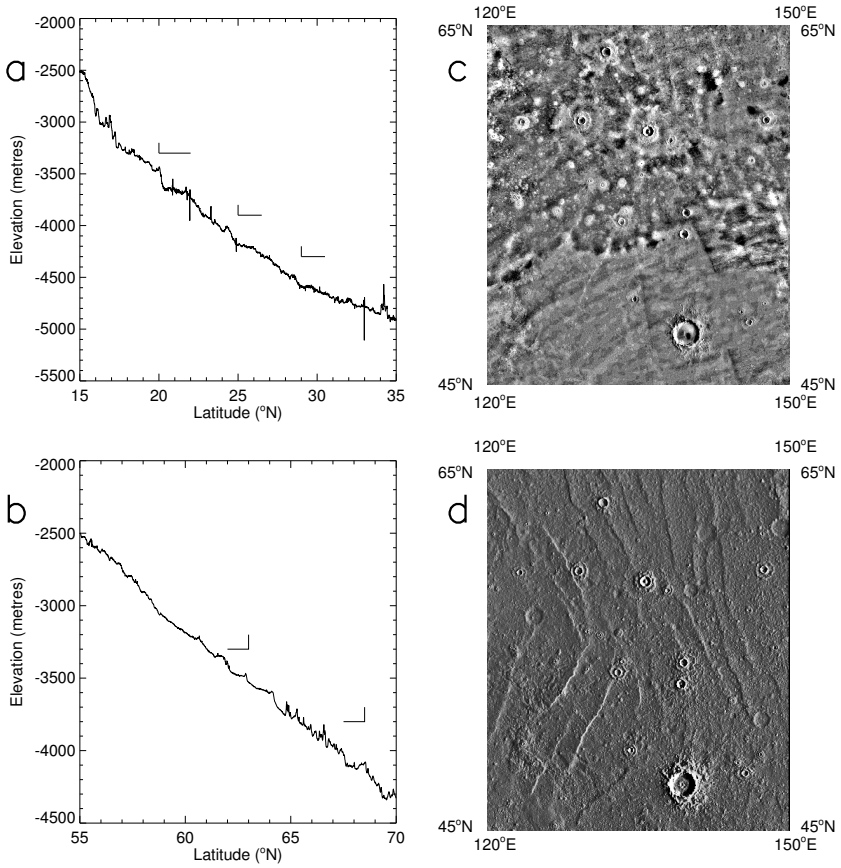

Figure 8.1: Martian topography. a, MOLA profile 10190 near the Utopia impact basin. Terraces and ridges are marked by horizontal and vertical lines, respectively. Vertical exaggeration $\sim$ 400. b, MOLA profile 10929 near the Alba Patera volcano. Terraces and ridges are marked by horizontal and vertical lines, respectively. Vertical exaggeration $\sim$ 400. c, Viking photomosaic near the Utopia impact basin, Mercator projection. d, Shaded relief map generated from MOLA digital terrain model of the same region with the same projection. Many ridges are visible in the MOLA image, but not in the Viking image.