Shallow Ridges in the Martian Northern Plains

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The northern plains of Mars, as seen by Viking, are essentially flat and featureless. The causes of their youth and smoothness are still debated. The Mars Orbiter Laser Altimeter (MOLA) instrument on the Mars Global Surveyor (MGS) spacecraft has drastically improved our knowledge of the topography of these plains, reducing km-scale vertical uncertainties from the Viking era by several orders of magnitude. MOLA data reveal that the northern plains are the flattest known surface in the solar system and that the plains are not featureless. The plains are criss-crossed by ridges. The ridges have characteristic heights of 100 metres, characteristic lengths of 100s of kilometres, and characteristic slopes of only a couple of degrees. Their incredibly shallow slopes explain why they escaped detection in the Viking era. Ridge locations and strikes are not distributed randomly. Ridges are most common near obvious stress centres such as Alba Patera and the Utopia Basin. In these regions, ridge strikes are preferentially radial to, or circumferential to, the stress centre. In regions of high ridge density, ridge spacing is on the order of 100 kilometres Profiles across the ridges indicate that the ridges are asymmetric. The distribution of the ridges around obvious stress centres suggests that they have a tectonic origin.

Some of the ridges appear related to known wrinkle ridges in the highlands, suggesting a common origin.

Comparison of ridges circumferential to and radial to the Utopia Basin reveals differences in spacing, amplitude, and morphology.

Some of the ridges are candidates for ancient shorelines. These candidates are not obviously different from all the other non-shoreline ridges.
Viking Photograph
MOLA Data
There are well-known wrinkle ridges in the highlands to the east of Tharsis and Alba. There are also ridges in Chryse that may be flow features. However, the Chryse ridges are parallel to the wrinkle ridges and have morphologies that are suggestive of wrinkle ridges.
Ridges in plains parallel Lunae Planum wrinkle ridges. Ridges extend above level of outflow channel. Compare profiles.
Many of the ridges are located near the Utopia Basin. Ridges in this region are either circumferential to, or radial to, the basin. This favours a tectonic origin for these ridges.
Ridges circumferential to and radial to the Utopia Basin.
Compare profiles.
Linear slope changes have been interpreted as shorelines of an ocean. However, these changes are ubiquitous in the northern plains and are primarily seen in association with tectonic structures such as Alba or Utopia. They are not preferentially parallel to topographic contours. Specifically, terrace/ridge pairs have been interpreted as shoreline indicators. However, terraces are sometimes upslope from ridges and sometimes vice versa, which is hard to understand in the context of shorelines.
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Some ridges are very shallow. They are only visible because the background terrain is very flat and the dataset is superb.

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