GLOBAL SPATIAL DISTRIBUTION OF RAISED CURVILINEAR FEATURES ON MARS. R. M. E. Williams[1], [1]Planetary Science Institute, 1700 E. Fort Lowell, Suite 106, Tucson, AZ 85719, williams@psi.edu.

Introduction: Positive-relief landforms, which appear curvilinear in plan view and often form branching networks, covering areas ranging from tens to hundreds of square kilometers have been identified at sites around the globe in MOC (0.5-12 m/pix) and THEMIS IR (100 m/pix) and VIS (18-36 m/pix) images [1,2]. Burr et al. [3] advocate the nongenetic term 'raised curvilinear features' (RCFs) for these ridge landforms on Mars. This stuy documrnts the spatial distribution of RCFs, and examines the implications of these landforms on the history of water on Mars.

Background: This study includes RCFs at a range of scales from large scale sinuous ridges (10-200 km long, 0.3 to 3 km wide) identified in Viking images [4] to fine-scale bifurcating ridges (few hundred meters long, few tens of meters wide) [2]. The RCFs exhibit a variety of planimetric patterns ranging from single, curvilinear ridge forms to branching networks.

All published studies to date have universally interpreted RCFs as fluvial in origin, but authors differ on the nature of the flow and the source of the water. Based on their curvilinear and bifurcating appearance and their similarity to terrestrial fluvial landforms, the Martian RCF's are interpreted to be the remnants of former fluvial channels formed by continually flowing water, now expressed in inverted relief [1,5]. In addition to precipitation-fed surface runoff, other scenarios for generating fluids have been proposed in the formation of these landforms including impact-generated melt from ground-ice, glacial meltwater or subglacial streams (eskers) [3,4,6-8].

Methodology: A catalog of RCF locations has been compiled by the author based primarily on MOC and THEMIS image review. The catalog includes RCF locations from prior works based on lower resolution Viking images [e.g. 4]. At present, 175 individual sites have been identified and the list continues to grow.

Preliminary maximum ages were assigned to each RCF location based on visual inspection of an ARCGIS database on the intersection relations with the published 1:15M geologic maps [9,10]. This approach of relating RCF age to ages as defined by crater statistics has limitations [11]. This approach assumes that the age from extensive geologic deposits, which can be confidently assigned one of three age groups on the basis of crater statistics, can be applied to a small locality (the RCF) within that geologic unit for which crater statistics are less well defined [e.g. 12]. Errors in assigning maximum age also stem from uncertainties in the geologic mapping. Nevertheless, this is a useful exercise as it provides an initial assessment of the maximum age distribution of RCFs as well as a common methodology for comparison with prior studies [e.g. 13].

Observations: The RCFs are observed at locations scattered around the globe (-80° to 50° N latitude and all longitudes, figure 1). They are located on both highland and lowland surfaces (elevation range: -8000 to 4000 m), but are more prevalent on the cratered uplands. RCFs are observed on a range of terrains including plains, crater basins, and volcanoes.

There are regional clusters of these landforms. Kargel and Strom [4] noted the occurrence of large-scale RCFs in northwest Hellas Planitia, northwest Argyre Planitia and Dorsa Argenta in the south polar region (6 locations in this study's catalog). This study has identified several dozen smaller scale RCF locations, including localized concentrations of RCFs on the plains proximal to Valles Marineris and nearby chasmata, along the dichotomy boundary in the eastern hemisphere notably associated with the western Medusae Fossae Formation [3], in northwest Arabia Terra and along the northern rim of the Hellas basin.

Age determination for the 175 RCF locations in the catalog were as follows: 32 were assigned a maximum age of Amazonian, 54 were assigned a maximum age of Hesperian, and the rest were assigned a maximum age of Noachian. Half of the RCF locations were determined to be post-Noachian in age. The majority of the RCFs with a maximum age of Amazonian are located in the Medusae Fossae Formation, although other apparently young RCF sites include volcanoes, the western Hellas floor, and crater floors. Most of the RCFs with a maximum age of Hesperian are located in northwestern Arabia Terra or on the plains near Valles Marineris and nearby chasmata.

Discussion: RCFs as a landform class exhibit tremendous diversity in scale, planimetric form, geologic setting and age. Further study on a case by case basis is needed to determine if different formation scenarios were involved at various locations. At this early stage in the investigation, some general statements can still be made regarding formation of RCFs.

Continunity relations between RCFs and traditional Martian valley networks have been observed in some locations [1]. This observation has led to the recognition that valley networks exhibit various states of preservation including partial or discontinuous exposures and positive relief [1-2, 14-15]. The valley systems, as

observed today, are the products of the combined forces of burial, exhumation and erosion. Thus, RCFs expand the preserved record of fluvial activity on Mars.

The spatial distribution and geologic setting of RCFs differs from that of valley networks. While both landforms are predominatly located on the cratered uplands, valley networks are preferentially located at surface elevations >2 km [13] and RCFs are found at a range of elevations, including many examples that are located on terrain below the 0 m Martian datum. Carr [13] determined that ninety percent of valley networks have a maximum age of Noachian while this study found equal numbers of RCFs in the Noachian and post-Noachian time periods. Assuming the age assessments are valid, the youngest RCFs are generally not associated with high slopes or volcanoes (presumably sites of high geothermal gradients), as was observed for Amazonian-aged valley networks [13].

The RCFs are observed on several terrains that have been mapped as heavily eroded or degraded regions including the Medusae Fossae Formation and northwestern Arabia Terra [16, 17]. These locations are windows into the Martian stratigraphy and provide us with a more complete temporal record of fluvial activity.

Altogether, these observations suggest that fluvial activity was more prevalent in the post-Noachian time period than previously recognized. Small-scale fluvial activity appears to have occurred periodically, at least in locations, throughout Martian history. Further study of these landforms has the unique potential to assess temporal changes in fluvial style on Mars.

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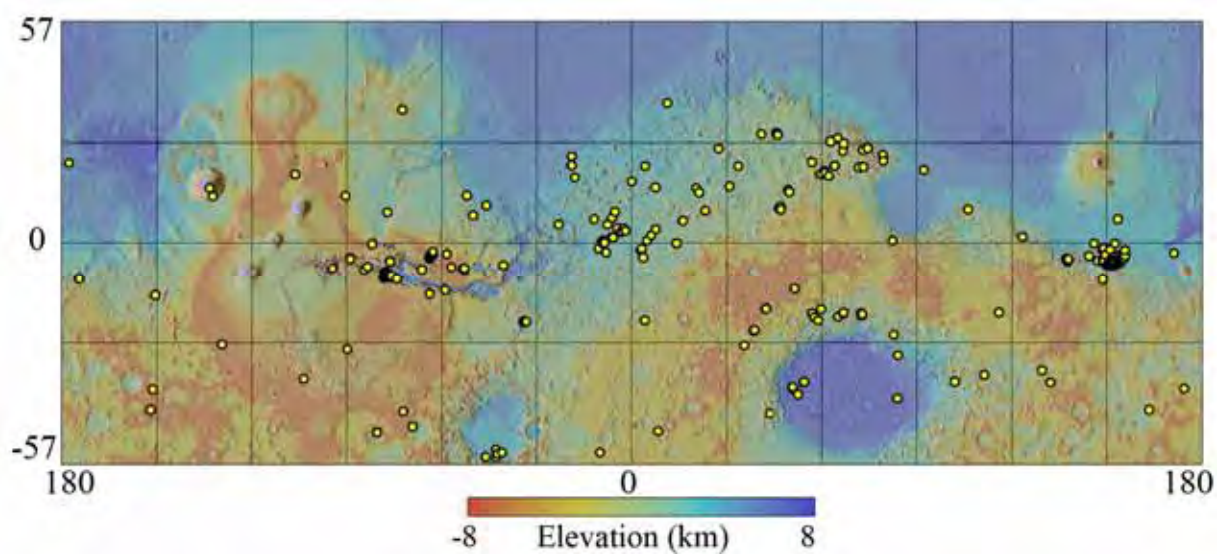

Figure 1: The location of individual raised curvilinear features (RCFs) are marked by yellow dots superimposed on a MOLA-derived digital elevation map.