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Structural map of the grooves of Ganymede

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Abstract

Intense tectonic activity deforms most of the bodies of the inner and outer Solar System. The crust of the Jovian satellite Ganymede shows a great variety of kilometric-scaled morphotectonic features. These are the grooves and the furrows, developed within the light terrain and the dark, respectively. These structures represent the evidences of the past (and possibly the present) tectonic history of the satellite and their formation is a debated topic. In this contribution we investigate the grooves of Ganymede. Their geometry and crosscutting relationship represent a powerful mean to understand the global tectonic evolution of the satellite. We produced the structural map of Ganymede grooves where more than 6700 grooves were manually recognized and quantitatively analysed according the groove azimuth, length, sinuosity and spacing. Identified grooves were grouped into 5 structural systems and their remote sensing analysis allows to infer the stress field and the relative lithosphere rheology and thickness. The structural map of the grooves aims to identify the regional tectonic regime that affected Ganymede lithosphere. In this way we observed that groove systems are often organised as the terrestrial shear zones. This setting has been identified at local and regional scale. Two regions centered at 130°W-23°S and at 74°W-4°S suggest that strike-slip tectonics played a significant role in the formation of the recognized groove systems. Further investigations will be done to study the global tectonics of Ganymede with the aid of the obtained map.

1. Introduction

The crust of Ganymede is one of the most tectonized in the solar system. The younger light terrain covers the 65% of the surface and it is deformed by morphotectonic structures named grooves [1]. Ganymede grooved terrain is densely populated by subparallel elongated landforms at the global and regional scale and well-defined morphology from straight to curvilinear. Grooves crosscut or intersect with each other with an arrangement not easily detectable. Ganymede groove tectonics was interpreted as mainly extensional [2], although strike-slip has been recently identified within several regions [3] and evidence of contraction has been recognized in transpressional environment [4]. The tectonic origin of these structures remains unclear. A global mapping of the grooves is required to unravel their tangled setting. As the other produced database of grooves [5], our map aims to analyse the different mechanisms for the grooved terrain formation and the construction of a global strain history. We manually mapped and quantitatively analysed grooves of Ganymede to produce a structural map to highlight their tectonic nature. The obtained map is represented by structural groove systems. This result indicates that it is possible to infer the stress field that produced them. By a preliminary structural analysis of several regions of the map we suggest that strike-slip has been the leading component on Ganymede global tectonic history. This map will be object of further investigation within several light terrain regions.

2. Mapping

In a GIS platform a total of 6765 groove structures were manually mapped within light terrain among 178°W-36°E and 60°N-66°S. The detection was performed on the USGS Ganymede Voyager and Galileo global mosaic with a resolution from 2000 m/pixel to approximately 400 m/pixel at the scale of 1:3.000.000. The recognized grooves represent approximately the 26% of the light terrain since about 50% of the light terrain images was not acquired with an acceptable resolution to manually resolve the structures. Identified grooves were quantitatively analysed according to their azimuth, sinuosity, length and spacing among adjacent features.

3. Results

The structural map of the grooves of Ganymede (detail in Fig.1) shows a total of 5 groove systems. These are globally distributed with orientations of N50°-90°W, N10°-50°W, N30°E-N10°W, N30°-60°E, N60°-90°E and their maximum length exceeds 300 km. The longer grooves often describe corridor regions delimited by two parallel boundaries inside which shorter groove systems with opposite azimuths are present. This setting resembles the strike-slip zones of the Earth.

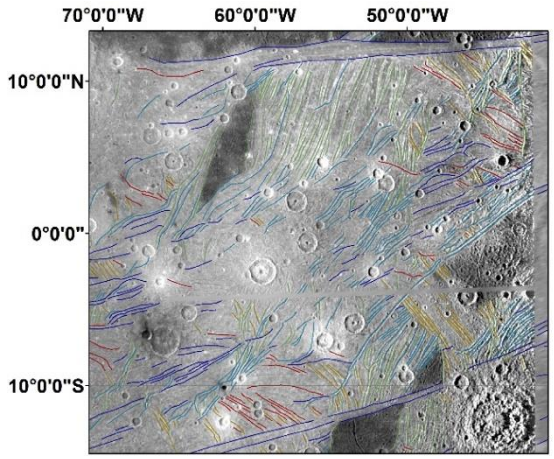

Figure 1: Structural map of the grooves of Ganymede detail. Babylon Sulci 74°W-4°S.

4. Conclusions

We produced a global map of the grooves of Ganymede where grooves are organised in structural systems. Their assemblage is compatible with strike-slip tectonics. We propose that the formation of the groove systems on Ganymede relates to the activity along regional shear corridors. The spatial arrangement of the recognized groove systems within these corridors is similar to the deformation associated to the regional strike-slip environments on the Earth. In this way we suggest a major role of the strike-slip movement in the global tectonics of the satellite. This map is supposed to be an improvement of past studies and a support to understand the tectonic evolution of Ganymede. The structural analysis of the groove system will be further investigated by future studies.

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