STYLE OF EXTENSIONAL FAULTING ON GANYMEDE: NEW INSIGHTS FROM GROOVED TERRAIN ANALYSIS AND COMPARISON WITH TERRESTRIAL ANALOGUES. A. Pizzi[1], A. Di Domenica[1], G. Komatsu[1,2], A. Cofano[1,2], G. Mitri[3], [1]Department of Engineering and Geology, University "G. d'Annunzio" of Chieti-Pescara, Via dei Vestini, 31, 66100 Chieti Scalo (CH), Italy (pizzi@unich.it), [2]International Research School of Planetary Sciences, Università d'Annunzio, Viale Pindaro 42, 65127 Pescara, Italy, [3]Laboratoire de Planétologie et Géodynamique, Université de Nantes, 2 Rue de la Houssinière, 44322 Nantes, France.

Introduction: Ganymede's surface is composed of dark terrain blocks separated by wide corridors of light terrain (sulci) which are often affected by hundreds kilometers-long parallel, periodically-spaced ridges and troughs termed "grooves". Grooved terrains have been often considered as tectonic-related structures within an extensional-dominating regime [1, 2, 3, 4, 5, 6]. Even if these ridges and troughs can be considered as faults, they do not show patterns and scale relationships comparable to those evaluated for typical tectonic terrestrial normal faults.

Structural Analysis: A structural analysis has been conducted in some key areas of the Ganymede's surface characterized by the presence of well exposed grooved sulci.

A spectacular example of grooved sulcus is represented by the Tiamat Sulcus that shows closely-spaced, tens to hundreds kilometers-long rectilinear grooves (Fig. 1a). In this area, crosscutting and structural relationships among grooves and craters, such as evidence of displaced remnants of pre-existing impact craters and interference patterns among distinct sets of grooves, clearly indicates that grooves may correspond to a fault system. Hundreds of kilometers-long rectilinear grooves, similar to Tiamat, can be found also in the Bubastis Sulcus region. Using DEM and topographic profiles available in the literature and provided by Paul Schenk, we performed some quantitative analyses on fault parameters for Tiamat and Bubastis Sulci. Assuming mechanical behaviors of the Ganymede's crust to be comparable to those of the Earth's crust, classical topographic throw *vs.* length diagrams on some faults affecting grooved terrain have been produced and the results have been compared with data from the Earth. Clearly, further investigations are needed to verify the influence of Ganymede's various other physical properties, such as gravity, on the mechanics of its crust.

The analysis highlights that faults in both the sulci show lengths of hundreds of kilometers (100 to 400 km) and are associated with throws of few hundreds of meters (ca. 400 m on average). The obtained maximum throw *vs.* length ratios for Ganymede faults show values between 0.01 and 0.001, approaching to values of 0.0001 in Tiamat area, while classical rules known for terrestrial tectonic faults [*e.g.*, 7] normally show D_{max}/L values around 1 and 0.01, hence at least one order of magnitude higher than Ganymede faults (Fig. 2).

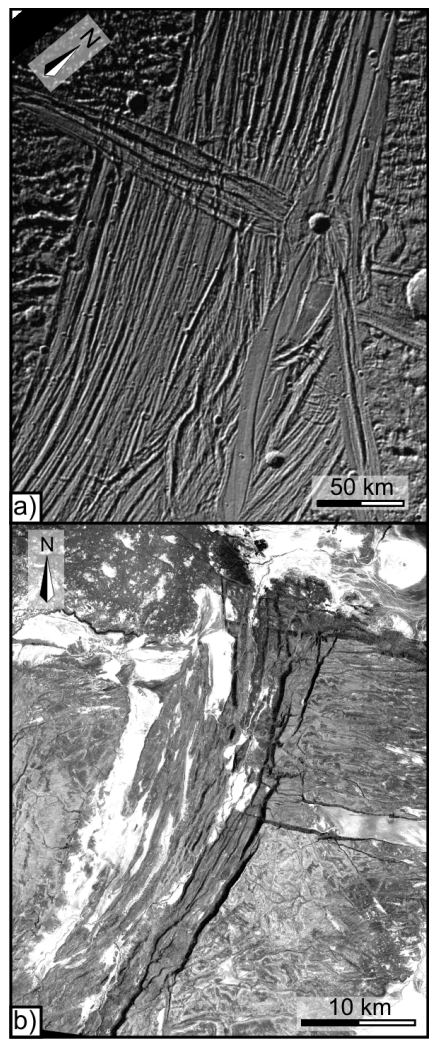

Figure 1: Extensional faults system pattern comparison between the Tiamat Sulcus area on Ganymede (a) and a terrestrial analog in the northern sector of the magmatic-tectonic MER (within the Afar region), Ethiopia (b). Both areas are characterized by a closely-spaced faults pattern (average fault spacing <0.5–1.0 km) and anomalous D_{max}/L ratio values of about 0.001.

Actually, analyzing different fault systems on the Earth we observed that faults similar to Ganymede – showing densely distributed patterns and anomalous throw *vs.* length ratios – are represented by dike-induced faults developing within volcano-tectonic environments, as evidenced in Figure 1 where the comparison with the northern sector of the Main Ethiopian Rift (within the Afar region), is shown. Also in the Main Ethiopian Rift (MER), in fact, throw *vs.* length ratios show values of 0.004 on average (Fig. 2). These values on Earth are peculiarity of faults activated along magmatic segments in transitional rifts showing similarities to slow-spreading mid-oceanic rifts [8].

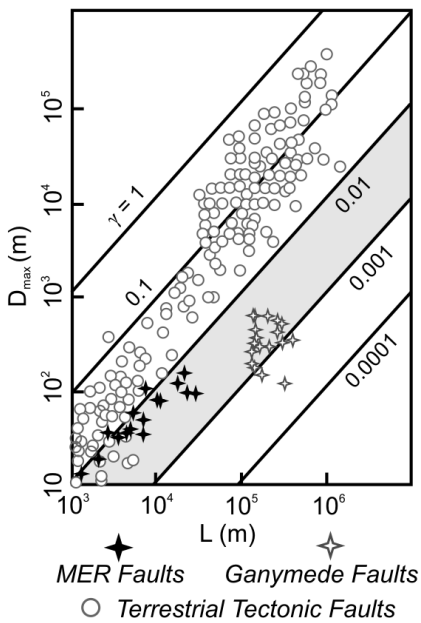

Figure 2: Maximum Displacement (D_{max}) *vs.* Length (L) diagram (modified from [9]) for terrestrial tectonic faults over which Ganymede faults and Main Ethiopian Rift (MER) volcano-tectonic faults are plotted. Both MER and Ganymede faults show γ ratios (D_{max}/L) between 10^{-2}–10^{-3} on average (grey area), at least one order of magnitude lower than D_{max}/L ratios recognized for classical terrestrial tectonic faults.

Conclusions: The throw *vs.* length values obtained for the Ganymede faults are anomalous with respect to those characterizing classical terrestrial tectonic normal fault systems. On the other hand, they can be compared to dike-induced faults that develop within volcano-tectonic rifts contexts on Earth. Throw *vs.* length ratios obtained from the analysis of both MER and Ganymede fault systems fall in the range of 0.01 and 0.001 that typical characterizes volcano-tectonic regimes. Based on these similarities, we suggest that the origin of Ganymede fault systems might be related to diking processes of over-pressured water in the rifted crust.

The analysis presented here is part of effort to support activities of the Radar for Icy Moon Exploration (RIME) scheduled to be flown on the the JUpiter ICy moons Explorer (JUICE) mission [10]. The RIME instrument will investigate near subsurface strcutures of Ganymede with its ice penetrating capacity.

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