SHEAR DEFORMATION IN THE GRABEN SYSTEMS OF SIRENUM FOSSAE, MARS: PRELIMINARY RESULTS. F. Martín-González, M. A. de Pablo and A. Márquez. Área de Geología. Dpto. de Matemática y Física Aplicadas y Ciencias de la Naturaleza. Escuela Superior de Ciencias Experimentales y Tecnología. Universidad Rey Juan Carlos. 28933 Móstoles, Madrid. Spain (fmgonzalez@escet.urjc.es).

Introduction: This abstract approaches the results of a preliminary study of a detailed mapping of the structures that form the Sirenum Fossae graben systems. The study has been focused on the segment crossing Gorgonum Chaos (centered at 37.5ºS, 170.9ºW) (Fig.1A). In this area, some of the grabens features and geometries have raised the importance of a detailed study of their shear deformation in order to measure the total extension, the strain ellipsoid, etc.

The graben systems placed in the Martian Highlands (Memnonian, Sirenum, Icaria, Thaumasia and Claritas Fossae), due to the radial distribution around the Tharsis region, have been explained in a variety of ways: a) faulting due to regional strain associated with isostatic, dynamic, or thermal Tharsis uplift [1] [2] [3] [4] [5], b) near surface faulting due to radial dyke emplacement [6], o c) or the combination of these factors [7] [8].

The extensional structures, studied in this work, have been interpreted as simple grabens [6] [11] [12], which are bounded by two inward dipping normal faults which have typically undergone displacements from ten to hundreds of meters. The floors are flat and bound by equal scarps [6] [11]. They have typical widths of about 1-2 km and depth of 100-300m. The structures of Sirenium Fossae cut Noachian and Early Hesperian aged units, and none intersects the younger flanking Arsia flows of Daedalia Planum [6]. Measurements of fault scarp widths have been used to estimate a total extension for Sirenum Fossae of 2.5 ±1.7 km [12] or 1 km [13].

The graben systems studied are located in Sirenum Terrae and belong to the Sirenum Fossae place in Gorgonum Chaos; coordinates are 30º-40ºS and 165º-175ºW, Phaetonthis quadrant. This basin has been interpreted as part of a Late Noachian great lake (Eridania Lake) of about ~3,000,000 km^2 [14]. The structures cut volcanic materials (lava flows and pyroclastic deposits) Middle Noachian aged. In some places they also cut Early Hesperian aged ridges [15] [16].

In order to carry out this study, a wide range of images (*Viking*, *Mars Global Surveyor*, *Mars Odyssey*) with different resolution have been used, as well as a DEM built from the MOLA data.

Structures: In the study area, grabens are bounded by two antithetic normal faults. They have widths from 0.5 to 2km and depth from 50 to 150m. Grabens relay from one up to three, with a 13 km separation. It should be noticed that the floors are flat and they display structures and markers that have been cut by the faults. Craters have been used as markers in order to establish strike-slip displacements; however, no relevant or conclusive one has been found. The most relevant feature in this study is the sigmoidal-shaped geometry and the *en echelon* arrangement (Fig. 1B).

In the studied area, these structures have common elements with *en echelon* tension fractures and sigmoidal-shaped gash fractures generated in a brittle ductile shear zone, as well as structures formed in a strike-fault systems [9] [17] [18]. Structures as tension fractures and tension cracks has been studied in other Martian regions [20] [21] [11], but they are morphologically distinct from simple grabens (located in this area); they are narrower, deeper and v-shaped, and they do not have a flat floor [20] [6] [11]. However, some studies have suggested that they underlie grabens. Another feature, the segment linkage and faults distribution in Mars has been analysed as well [22]. The present work raises the need of paying more attention to these features and structures, because to produce them, a simple shear component is required. In these shears, the gash fractures are generated normal to σ_3, the axis of minimum compressive stress, or normal to ξ_1, the orientation of maximum extension axis of the incremental strain ellipsoid [17] [19]. So, for the graben system, the maximum extension axis, the strain orientation and the total extension calculated may meaningfully vary, compared to the measurements obtained if we assume that they are perpendicular to the graben trend and have been produced only by a pure shear. In addition and supporting that, contractional features has been found in the same area (Fig. 1C) and they are similar to structures generated in a restraining zone of strike-slip faults [17] [19]. This restraining structure appears in a segment with unfavourable orientation to σ_1, that has been changed locally.

Discussion and conclusions: The presence of *en echelon* sigmoidal-shaped structures and restraining zones, characterises brittle-ductile shear zones and strike-slip faults on Earth. To form them, it is necessary a simple shear component, and they can not be explained by pure shear normal to the graben main

trend, as it happens in others Martian grabens. Moreover, restraining structures found in the area imply a major relevance of σ_1 in the grabens formation. Therefore, all this observations should be incorporated to estimate the total extensions, the strain and the strain ellipsoid orientation related to the graben system formation around Tharsis. The variation in the sigmoidal grabens orientation and their relation with σ_3, are being studied in order to calculate the strain. These variations in the ellipsoid orientation can be connected to: a) variations of local stress field due to topographical changes, local loads, etc, b) different stages in the formation of structures with different stress fields, c) the variety of mechanical properties of the materials affected, or d) lateral movements of the graben sides during the general processes of Tharsis extension.

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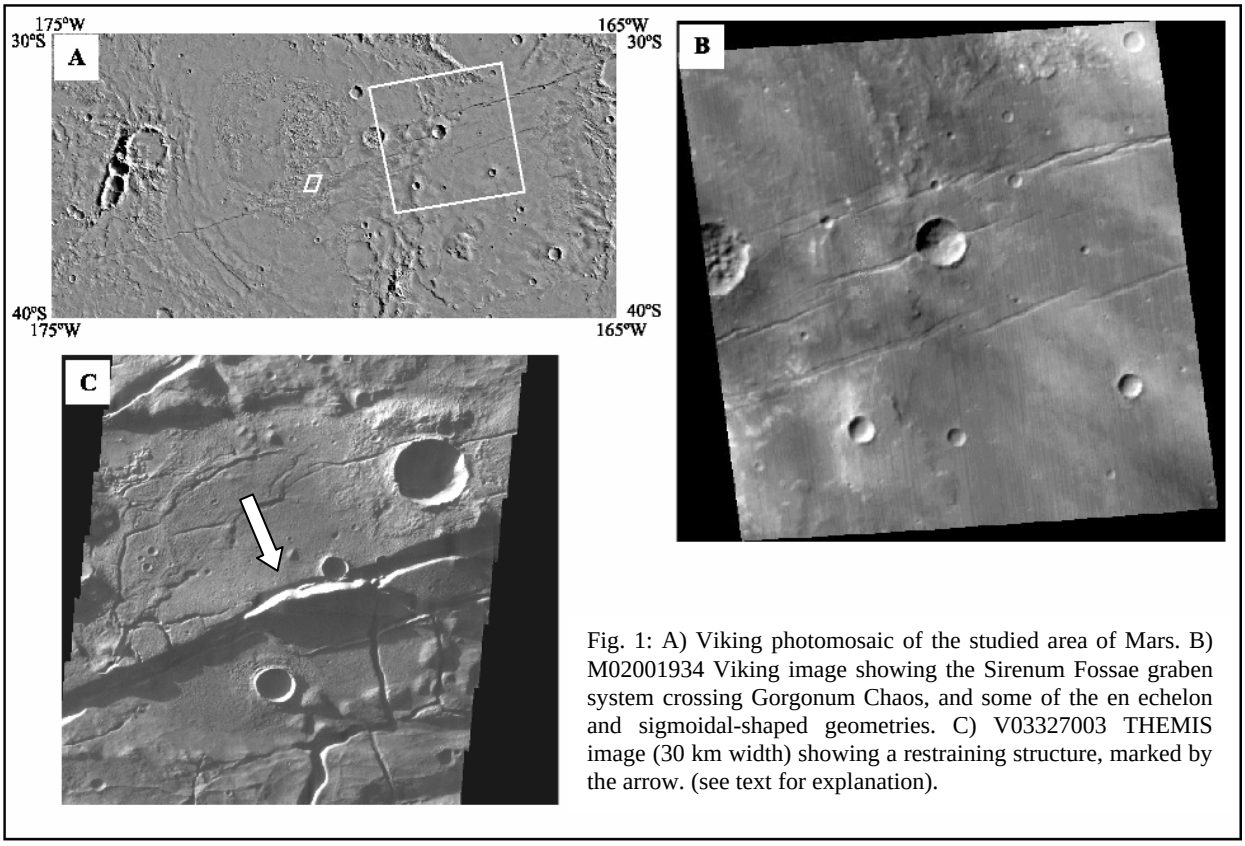

Fig. 1: A) Viking photomosaic of the studied area of Mars. B) M02001934 Viking image showing the Sirenum Fossae graben system crossing Gorgonum Chaos, and some of the en echelon and sigmoidal-shaped geometries. C) V03327003 THEMIS image (30 km width) showing a restraining structure, marked by the arrow. (see text for explanation).