TECTONIC AND FRACTAL ANALYSIS OF CONAMARA CHAOS AREA (EUROPA, JUPITER): STRIKE SLIP AND COMPRESSIONAL FEATURES IN AN EXPANSIVE SATELLITE. M.A. Rodríguez Pascua[1], R. Pérez López[1], O. Prieto Ballesteros[2] and J. S. Kargel[3]. [1]Facultad de CC. Experimentales y de la Salúd. Universidad San Pablo CEU, 28668 Boadilla del Monte. Madrid (España) e-mail: marodpas@ceu.es, [2]Centro de Astrobiología, (CSIC/INTA). Torrejón de Ardoz, Madrid (España) e-mail: prietobo@inta.es.[3]Astrogeology Team. USGS. Flagstaff, 86001 Arizona. EEUU. jkargel@usgs.gov

Introduction: Recent geological activity has produced resurfacing on Europa's satellite by tectonism and magmatism. It is representative of Europa the formation of areas with chaotic texture [1], where the crust has been fractured in several blocks which are surrounding by a more fine and lower topographical matrix materials. Clasically, two processes for the chaotic terrain formation based on the interpretation of the Galileo SSI sensor's images have been discussed: a) Solid state convection processes into a thick ice layer [2], b) Melt through processes in a thin layer over a water ocean [3]. Recently, modifications to these processes that take into account the presence of salty materials in the crust of Europa have been proposed [4].

Conamara Chaos is one of the most studied chaotic terrains on Europa. It is located at 8ºN, 274ºW. Blocks on this area have moved and rotated [5] from their original position. The formation of this area has always be related with a thermal anomaly, but the cause of the blocks movement is already uncertain: Turbulences from the inner ocean [5] and Coriolis forces [6] have been proposed to explain it. The tectonic analysis we made shows that the general pattern of the blocks´s motion is consistent with the horizontal displacement of the main surrounding fractures. The main stress tensor obtained from our analysis is in agreement with the observed compressional features in this area. The idea of local compression is not conflicting with the concept of an expansive satellite.

Tectonics of Conamara Chaos: The main tectonic structures of Conamara Chaos area are Agave and Asterius lineae, which are oriented N135ºE and N60ºE. Both have been classified as triple bands [7] and generally have been interpreted as extensional in origin [8], but some observed displaced features show that they also have played horizontally, as some other fractures of the surrounding [7]. Conamara Chaos is located in the sharp angle of the confluence of both lineae.

The relative chronology of several tectonic stages have been obtained from the genetic relationship among the lineaments which are compatible with different orientations of maximum horizontal shortening. Analysis have been made based on the classical Coulom criteria.

Three tectonic stages have been observed (Figure 1):

1- *Relic fault pattern.* It is constituted by faults with several directions which are the relict of tectonic activity. The complexity of this system indicate that resurfacing by tectonics have been very important, as much as in some places the fracturation is as high as the crust could be treated as a cataclasyte there.

2- *Ancient fault system.* It already presents recognizabled structural criteria, which have been used to stablish a tectonic stage preceding the present-day stress field. This faults' system have two main different groups: a) a combined system of dextral strike-slip faults with N-S orientation, and b) sinistral strike-slip faults with NE-SW orientation and subordinated transpressional features. The ancient fault pattern shows σ_1 oriented NNE-SSW and σ_3 ESE-WNW, according to the Coulomb criteria.

3- *Active fault system.* It is formed by structures that configure the actual stress state of the area. Five groups of active faults have been observed. The oldest sets are two combined systems of strike-slip faults: NE-SW sinistral and a dextral NW-SE strike-slips. Some compresional ENE-WSW structures with no ridges cutting the previous group were developed later. The last tectonic stage reactivate the dextral NNO-SSE strike-slip faults and formed a new fault with NW-SE orientation. Active fault system shows σ_1 oriented N-S and σ_3 E-W, according to the Coulomb criteria. Two pull-apart basins from strike-slip en-echelon, with transtensive and transpressive zones have been observed and described in the Galileo SSI images [9]. This whole system is associated with low albedo materials which have been interpreted as hydrated minerals [10, 11, 12], except the compressional ones.

From this analysis it follows that the limits of Conamara Chaos are structurally confined by the tectonic activity and the orientation of the combined strike slip motions. The clockwise direction of the chaotic blocks' movement is compatible with the proposed tectonical kinematics.

Fractal analysis vs. tectonics: The stress field actuating in the surface, generates several fractal fracture patterns in space [13, 14], characterised by the fractal dimension (box-dimension) [15, 16]. This property indicates the degree of geometric complexity. As the fractal dimension has not the additive property, the effect of the overlapping pattern increases the value of the fractal dimension although this value is not the arithmetic sum of the fractal dimensions due to each stress field. Ancient fault sets show $D_0 = 1.41$ while it is 1.77 for the active faults (Fig. 2), both obtained by 2-D box-counting analysis of fault maps (Fig. 1).

Conclusions: Two different tectonic episodes over a relic background have been recognised and described in Europa, both strike-slip regimes: ancient faults affected by active faults according to a present-day stress tensor. The strike-slip regime implicates compressive structures (reverse faults) due to horizontal movements in the Europa surface. Active fault family has a greater fractal dimension (1.77) than ancient faults (1.41). Therefore, active faults are formed by re-activated and new-formed faults. Fracturation density and geostatiscs analysis are robust with this explanation and complete the structural and tectonic knowledge of Conamara Chaos.

References:[1] Carr, M. H. et al. (1998) *Nature, 391,* 363-365. [2] Pappalardo R. T. et al. (1998) *Nature, 391,* 365-368. [3] Greenberg, R. et al. (1999) *Icarus, 141,* 263-286. [4] Prieto Ballesteros, O. and Kargel J, S. (in review). [5] Thomson, R. E. and Delaney, J. R. (2001) *JGR, E106*, 12355-12365. [6] Spaun, N. A. et al. (1998) *GRL, 25*, 4277-4280. [7] Geissler P. E., et al. (1998) *Icarus, 135*, 107-126. [8] Helfestein, P. and Parmentier, E. M. (1983) *Icarus, 53*, 415-430. [9] Ramsay, J.G. and Huber, M.I. (1987) *Modern Structural Geology*. London. [10] Kargel, J. S. (1991) *Icarus*, 94, 368-390. [11] Kargel et al. (2000) *Icarus, 148*, 226-265. [12] McCord et al. (1999*) JGR, E104*, 11827-11851. [13] Mandelbrot, B.B (1982) *The Fractal Geometry of the Nature.* San Francisco. [14] Turcotte, D.L. (1996) *Fractal and Chaos in Geology and Geophysics 2nd ed.* Cambridge. [15] Gillespie, P.A. et al., (1993) *Tectonophysics,* 226, 113-141. [16] Walsh, J.J. and Watterson, J. (1993) *JSG* 15, 1509-1512.

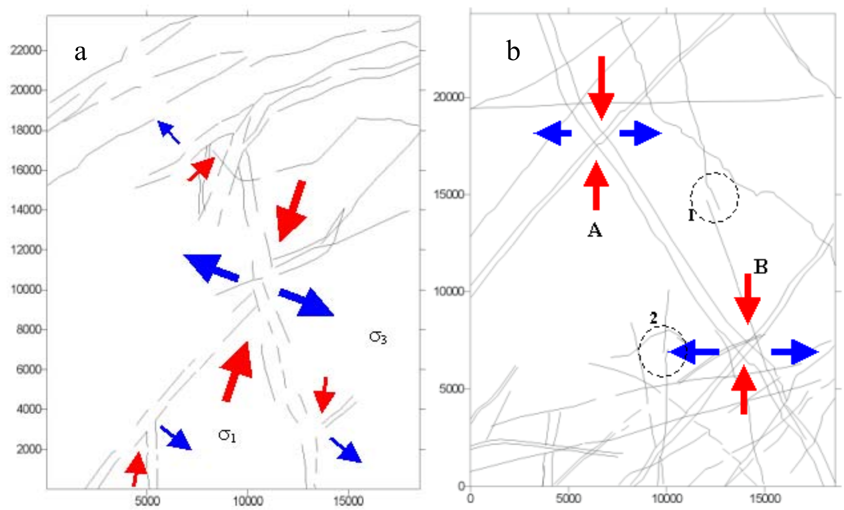

Figure 1. Tectonic sketches of the a) ancient and b) active fault system. Pull-apart basins are marked with circles (1) and (2).

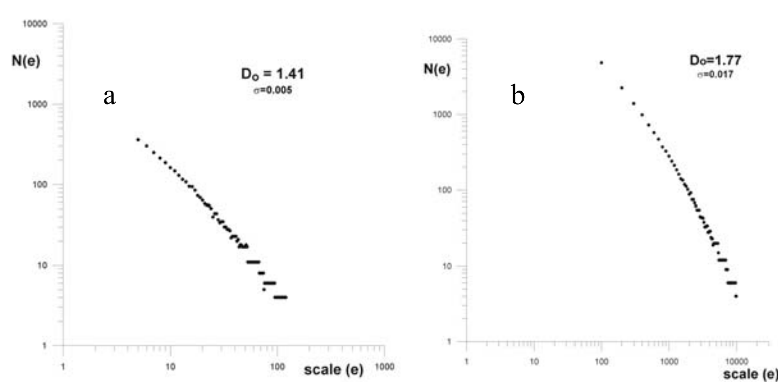

Figure 2. 2-D Box counting for a) ancient faults and b) active faults systems