COMPARISON OF THE ICE COVER FISSURE SYSTEMS OF JOVIAN SATELLITE EUROPA AND FROZEN LAKE BALATON, HUNGARY.

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Europa analogs: The Europan cryovolcanic counterparts of the observed ice phenomena are grey bands which are interpreted to be young strike-slip faults [7]. One such example is Astypalaea Linea (Fig. 3), an other is Yelland Linea (Fig. 4). Both Europan and Balatonian bands have curved edges; are cut by other cracks; and have different albedo – and probably younger age – than the surrounding ice.

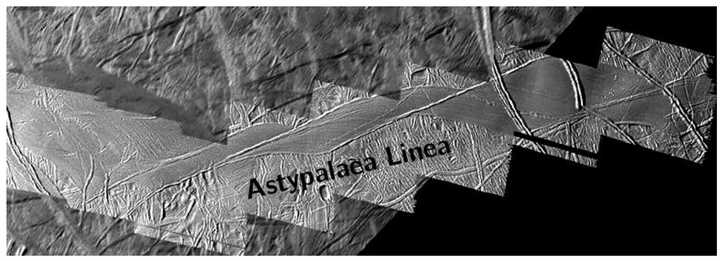

Fig. 3. Astypalaea Linea on Europa (PIA01644)

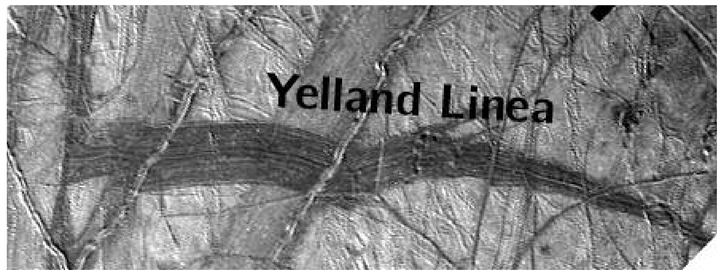

Fig 4. Yelland Linea on Europa (PIA00518)

Wide band on the ice in February, 2006. The two edges were pull apart and the band (ca. 20 meters width) opened almost perpendicular to the direction of two edges.

Crack-in-crack system in the ice of Balaton in January 2008.

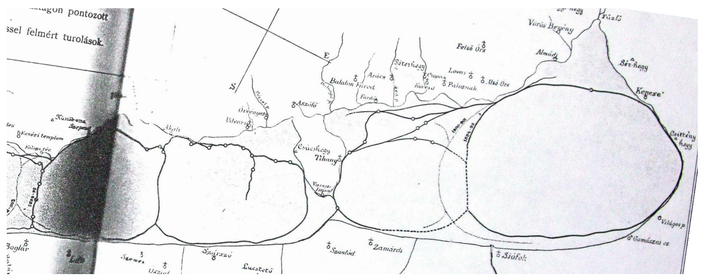

Fig 5. The recurrence of the opening and closing places of the freezing-thawing process in the winter Balaton ice cover. The fissure system returns every frozen year on the same arrangement pattern on the ice cover of the lake. Our image shows the great band departing from the Tihany Peninsula southward to Szántód on the southern shore of the lake (Cholnoky, 1907).

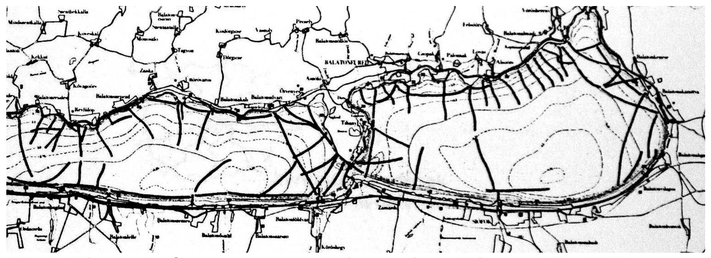

Fig 6. The main fissure system as observed on February 23, 1982.

Fig 7a. Airborn photomosaic of the ice-covered Balaton March 2, 1983

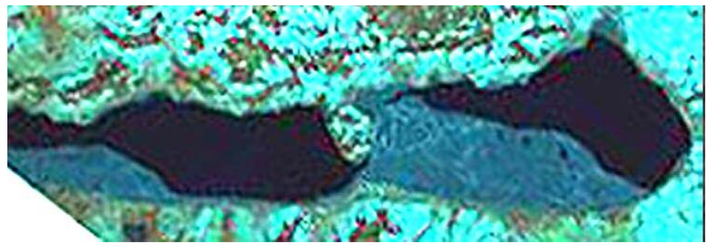

Fig 7b. LANDSAT image of 1999-12-31. No 7188027009936550

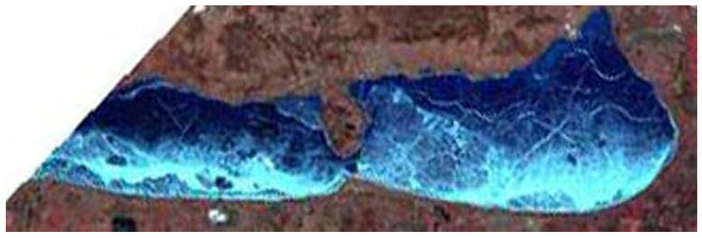

Fig 7c. MODIS Aster VNIR image of 2003-03-03 No 2013224242-20030313

LAKE ICE ON LAKE BALATON, HUNGARY 1907-2003

Introduction: Voyager and Galileo images revealed the fracture system on Europa, showing evidences for strike-slip displacements comparable to the terrestrial plate-tectonics and dilation along cracks comparable to the local freezing-thawing of the ice on lakes [1]. The global character of Europa fracture system was owed the varying tidal stress forces of the Jupiter which results in motions of tables of ice swimming on a water ocean [2]. The terrestrial counterpart to the local band tectonics of Europa [3], [7] is on the frozen lakes connected to the freezing-thawing of the ice and the accompanying dilatation of the ice [4]. Such motions can be observed on Lake Balaton and other terrestrial lakes frozen in winter.

Observations: In winter Balaton freezes gradually and frequently for the middle of winter, the entire surface of the lake freezes. On Balaton's surface the ice is thin: 2-4 decimeters thick in most places as compared to the depth 2-4 meters in average. Local cracks are driven by the freezing-thawing process, resulting in opening and closing [5]. While the freezing ice expands the thawing one contracts and the shrinking and broken plates become separated. First cracks than open water surface appears between this plates. Later the space between the shrinken plates is filled by new surface material with different thickness and color, this way making visible these dilational bands. In February of 2006 a beautiful band was observed on the Balaton ice cover and this observation triggered our study on this comparison. Cholnoky and Eötvös' works on the winter ice cover plane of Balaton: Loránd Eötvös carried out measurements on the Balaton Lake ice cover during the winter of 1901/02 and 1902/03. Cholnoky did worthy observations on the behaviour of the ice on the lake 1894/95 (Fig. 5.) [5]. One of his most important observation is the recurrence of the opening and closing places of the freezing-thawing process in the winter Balaton ice cover.

During the 20th century, more accurate methods have been developed for observing large scale features of the Balaton lake ice. This resulted in a different interpretation of the main fissure system (Fig. 6.). However, even today observation of the actual evolution of fissures, cracks, bands, rafts of the lake ice is difficult because of the short period of snow-free lake ice and the frequent cloudy days that obscure the phenomena from airborn or satellite-based observations. During the last decades only few images have been taken showing snow-free lake ice on Balaton (Fig. 7) [8], [9], [10]

References: [1] D. A. Senske, R. Greeley, J. Head, R. Pappalardo, R. Sullivan, M. Carr, P. Geissler, J. (1998): Geologic mapping of Europa: unit identification and stratigraphy at global and local scales. 29th LPSC, #1743. LPI, Houston; [2] R. T. Pappalardo, J. W. Head, and the Galileo Imaging Team (1999): Europa: role of the ductile layer. 30th LPSC, #1967. LPI, Houston; [3] F. Nimmo, R. T. Pappalardo, B. Giese (2003): On the ori-gins of band topography, Europa. Icarus 166, 21-32; [4] N. L. Dobretsov, S. G. Psakh'e, V. V. Ruzhich, V. L. Popov, E. V. Shil'ko, N. G. Granin, V. Yu. Timofeev, S. V. Astafurov, A. V. Dimaki, Ya. Starchevich, (2007): Ice cover of Lake Baikal as a model for studying tectonic processes in the Earth's crust. Doklady Akademii Nauk, 412, No. 5, pp. 656–660; [5] Cholnoky J.: A Balaton tudományos tanulmányozásának eredményei (Re-sults of the Scientific Observations of Balaton) in Hungarian. Kilián Frigyes M.K .Egyetemi Könyvárus Bizománya, Budapest, (1907). [6] Dr Starosolszky Ö. (1984): A Balatoni jég mértékadó terhelésének bec-slése. (Estimation of the load of the Balaton Ice). In Hungarian. Budapest [7] B.R. Tufts, R. Greenberg, G. Hoppa, and P. Geissler (1999): Strike-slip on Europa: Galileo views of Astypalaea Linea. 30th LPSC, #1902. [8] LANDSAT image of 1999-12-31. No 7188027009936550 [9] MODIS Aster VNIR image of 2003-03-03 No 2013224242-20030313 [10] MODIS Terra images of 2003-03-13, 2005-03-11, 2005-03-16.