EUROPA ANALOG ICE-SPLITTING MEASUREMENTS AND EXPERIMENTS WITH ICE-HUNVEYOR ON THE FROZEN BALATON-LAKE, HUNGARY.

T. Földi[1], H. Hargitai[2], S. Hegyi[3], Gy. Hudoba[4], Zs. Kovács[5], F. Roskó[6], Sz. Tóth[6], A. Pintér[7], Sz. Bérczi[8]. [1]FOELDIX, H-1117 Budapest, Irinyi J. u. 36/b. Hungary, [2]Eötvös University, Dept. Physical Geography, Cosmic Mat. Space Res. Gr., H-1117, Budapest, Pázmány Péter s. 1/c, Hungary, [3]Pécs University, Faculty of Science, Dept. Informatics and G. Technology, H-7624 Pécs, Ifjúság u. 6, Hungary, [4]Budapest Polytechnik Kandó Kálmán Faculty of Electrical Engineering, Inst. of Computer Technology, H-8000 Székesfehérvár, Budai út 45., Hungary, [5]Berzsenyi College, Dept. Technology, H-9700 Szombathely, Károlyi G. tér 4, Hungary, [6]EWorld Hungary Kft., H-1026 Budapest, Garas u. 1, Hungary, [7]High School of Pannonhalma St. Benedict Archabbey, H-9090 Pannonhalma, Vár 1. Hungary, [8]Eötvös Loránd University, Department of General Physics, Cosmic Materials Space Research Group, H-1117, Budapest, Pázmány Péter s. 1/a, Hungary. (bercziszani@ludens.elte.hu)

Introduction: Lake Balaton is a 70 km long and 8 km wide lake in Hungary. Its geological setting is in a tectonic fault. The lake consists of two basins: the NE one and the SW one. The average depth is 4 meters, but this depth does not exceed the 5 meters, except in one place, in the well of Tihany, where it deepens to 16 meters. The movements of the water inside the lake allows no regular modeling, because in case of the classical weave propagation model the amplitude of surface-weaves is comparable with the average depth of the lake.

Fig. 1a and 1b. Lake Balaton in middle winter. The lake is partially frozen; the ice cover is lighter blue. NE of Tihany peninsula is the NE-basin, SW of it is the SW-basin of the lake (LANDSAT image [1]).

It is interesting that the average water level in the two basins may be different. The reason is that frequently, the SW winds push considerable amount of water into the NE basin lifting up that water level. When the wind ceases the response effect is that more water returns to the SW-basin, and then the average amount of water, therefore the local level there will be higher then resting level. This effect is a kind of balancing motion between the two basins which gradually relaxes. This mutually attached twofold alternating water system gives an extraordinary opportunity to study various effects of great water mass deformations. These possibilities are more exciting in wintertime when lake is covered by ice.

For example we may suppose that the motion of the Moon is affecting this amount of water, too. However, this tidal effect has not been yet measured because the average weaving – even during calm - overlaps this small effect. In winter, however, it is possible to measure the thin lifting/sinking effects on the top of the stable icy surface of Balaton Lake (Fig. 1). We plan to connect these measurements with comparative planetary analogous effects, for example with those possible on Europa of Jupiter. The measurements are planned with Hunveyor university lander model. We call this experiment-assembly: Ice-Hunveyor.

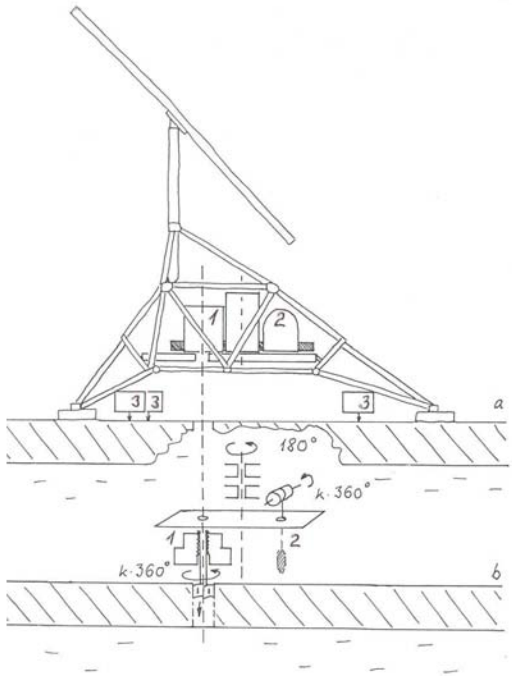

Fig. 2a and 2b. Ice-Hunveyor on the ice cover of Lake Balaton. On the instrumental platform the following elements can be found: 1: driller, 2: hydrophone with its rolling cylinder and 3: pick-up of sensors measuring ice-popping and fracturing in the sound frequency range (20 Hz - 20 kHz). Both 1 and 2 are placed on a rotating table which emplaces the hydrophone into the hole after a half turn rotation.

Special measurements on Ice-Hunveyor:

The following four measurements are prepared on Ice-Hunveyor. **1)** Measuring the self-noise of the ice in the sound frequency range (20 Hz - 20 kHz). **2)** Determination of the direction of the source of the self-noise of the ice in the sound frequency range (20 Hz - 20 kHz) by using two sensors of similar types placed in 1 meter distance from each other. **3)** Measuring the noise of living beings (fishes) under the ice cover by a hydrophone sensor hanged from Ice-Hunveyor through a drilled hole. **4)** Measuring the meteorological parameters of the winter environment (temperature of air and water, wind direction and strength).

1. measurement: The main instrument consists of a pick-up (piezzo-electric or magnetic type) sensor. From this sensor through a FET, filter and amplifiers the signal is analyzed. In order to distinguish the ice-motion signals 3-6 amplitude levels were defined (one the 3 sensor of Fig. 2a.).

2. measurement: In 1 meter distance from the earlier sensor two other such sensors are settled for ice-motion picking-up. The 3 sensors form a triangle. Previously to ice-splitting noises were measured. From the comparison of the 3 signals the direction of the noise source are determined. (all 3 sensor of Fig. 2a. and Fig. 2c.). The 3 signals will have a phase-delay depending on their direction from source. We determine the distance of the source by a fouth, a microphone detector which is hanged on the frame of Ice-Hunveyor in the air. (The arrival sequence of the noises is the following: 1. is coming through ice, 2. is coming through water, 3. is coming from air. Earleir no such measurements of the propagation of cracking noises in all 3 physical phases – ice, water, air – were made.)

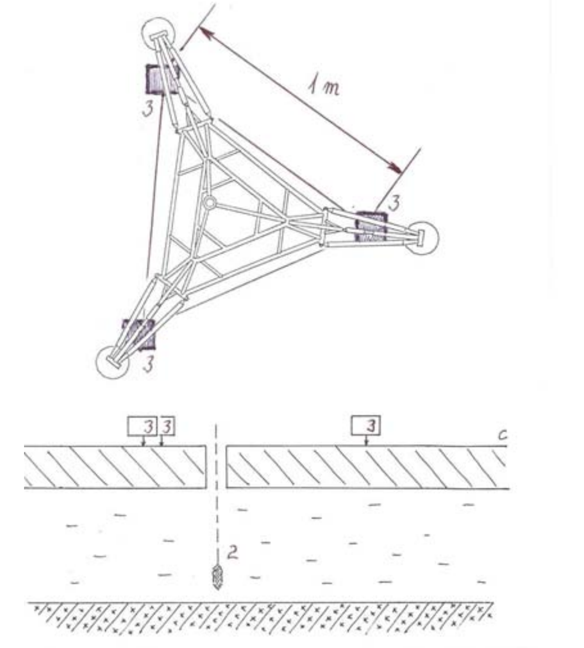

Fig. 2c. The measuring arrangement of the three sound frequency range sensors and the hydrophone hanged on. The triangular arrangement makes possible to determine the noise direction of popping and fracturing of ice from the phase differences of the arriving signals. Hydrophone measures the noise sources in water, mainly from biological motions (of fishes for example).

3. measurement: The drilling is carried out in the symmetry axis of Hunveyor. The hydrophone gives the signal of noises from the water, which is compared with the signals from the surface sensors (Fig. 2b.) This noise of living beings should be extracted from the measured signals of surface sensors. Here we show some earlier results from meteorology.

Sonogram: The ice has a special sound that is being made in temperature change. This is the sound when cracks are being made, somewhat similar to earthquakes when stresses are released. The crack formation is most frequent in the moments of sunset and sunrise, i.e. in the terminator line.

Preliminary studies show that cracks has a sound sonogram similar to whistles made by the electromagnetic waves of lightning carried in the magnetosphere. Here the sound of cracks is carried in the ice. The sound is only whiste-like when listened from a far (Fig. 4.), while it is different from near (Fig. 5.), like in the case of lightning. In addition to the ascending tone, there is a constant ca. 200 Hz tone that is produced by the microscopic crack formation in the sunset moments [3]. The question is: how the sound characteristic depends on the characteristic of ice and the water below it?

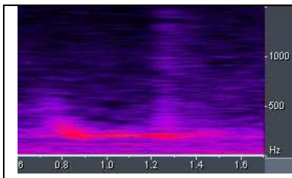

Fig 4. Sonogram from far (Hargitai, 2003).

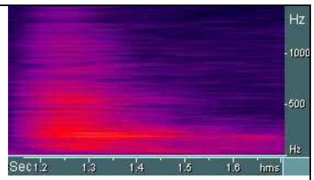

Fig 5. Sonogram from near (Hargitai, 2003).

For microscopic observations, the evolution of ice can be observed throughout a seasonal period: formation and reddening of ice. For the Hunveyor probe it is very useful to have a Husar rover for which it is easy to move and search for special features otherwise inaccessible by humans (because of their weight). Features like Aeolian barcan dunes made of snow or special cryotectonic features like faults can be observed this way (Fig. 6.)

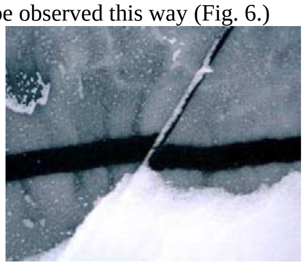

Fig. 6. Microsplitting before the large scale formation in ice. Length of the image is 20 centimeters (strike slip fault, photo by Hargitai, Dec., 2001).

The splitting cracks on Balaton Lake were earlier observed [3] and documented (Fig. 7.) by surface geodesic observations and aerial photography, respectively [4]. Since that no such survey was made, however it would be useful to find high resolution satellite images [1] for this task (although total freezing of the lake surface is a nonfrequent event).

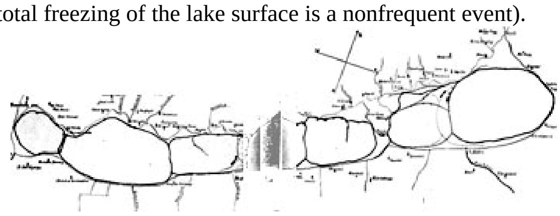

Fig. 7. Historical sketch about thelarge scale main splitting cracks on Balaton (Cholnoky, 1907) [3].

For planetary comparisons all the above mentioned can be used for the ice of Europa. We will investigate these in the next winter season, using the Hunveyor probe and its Husar rover.

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References: [1] LANDSAT (1999): images of 188/27 and 188/28 taken on 1999-12-31. [2] Hargitai, H. (2003): Sonograms of ice-splitting at Lake Balaton, in winter of 2003/2004. [3] Cholnoky, J. (1907): *A Balaton jege.* (The Ice of the Balaton). [4] Budapest; Starosolszky Ö. (1984): A balatoni jég mértékadó terhelésének becslése. Budapest