PRELIMINARY REPORT OF SZILVÁGY-PATKÓ (HORSESHOE): A NEW (POSSIBLE) IMPACT CRATER REMNANT IN HUNGARY.

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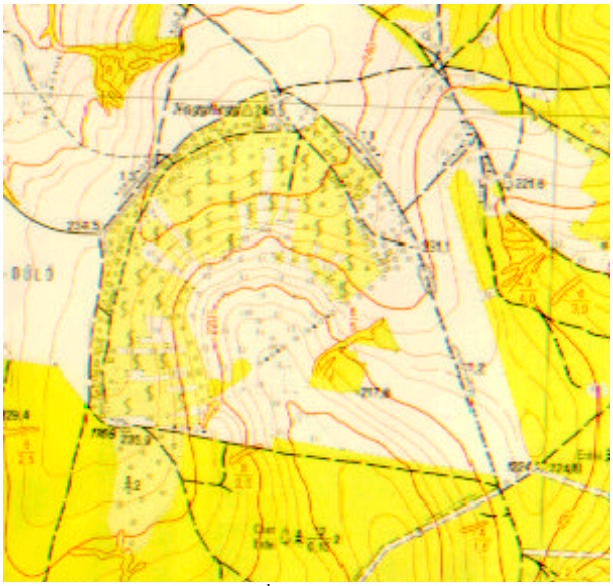
ABSTRACT Photographing from his airplane, A(n). Arday recognized a very expressive central symmetric form in Zala County, West Hungary. It can be found in the vicinity (3 kms from) Szilvágy, in SE direction from the village. Its diameter is 500 meter, depth from the top of the rim is cca. 25 m. Earlier drilling research data has shown that limonitic grains form a layer at shallow depths (between 0-5 meters) and shows a peak population at about 2 meters deep. 10,000:1 mapping expressively shows the horseshoe like crater rim. The horseshoe like crater-remnant is opened toward the SSE direction from which we imply that the impacting body may arrive from this direction. Because of the Pannonian layers on the surface, the age of the possible crater remnant may be a few 10,000 years.

INTRODUCTION In autumn of 1998 A(n). Arday, pilot at aerial photography survey in Hungary, during his work recognized a well developed and exclusive circular form in Zala County, West Hungary. This region is about 250 kilometers WSW from Budapest, in Transdanubia province, near to the Hungarian-Slovenian boundary. The place is in agricultural use, wine-yards are in the upper inner slopes of Szilvágy-Patkó (Horseshoe was its popular name). The geographical coordinates are as follows: 46°43'18.5" N, 16°38'17" E.



FIELD WORKS On 18th November we visited the site. It was a nice early winter day with sunshine therefore we could take good morphological observations. We could imagine, standing on the bottom of the crater, as if we were on the Moon, so expressive was the central symmetry, looking northern direction. All this northern part of the depression (the slopes facing southward) have been used for grape agriculture since the known times. From the aerial view it could be recognized that boundaries of the small-holder's wine-yards were arranged along the radials of the circle, the fences also emphasized the central symmetric arrangement. We could see the same from the center of the horseshoe crater. The wine-yards from the upper small rim plato came down toward the central depression till the inflexion point (which is the place where the upper rim region's curvature radius - focus in deep - changes to the depression's curvature radius up above the crater). Therefore the last individual grape blocks downslope in all yards showed a circular edge (we called it inflexion circle), looking from the center of the depression. With a hand driller we took soil samples till 1.5 meter deep. On the site we could observe that some red clay grains can be found at about 1 meter depth.

DATA FROM EARLIER DRILLING One of us (Gy.D.) worked earlier on the fields and could remember that in 1986 they took drilling samples from the section NW rim of the Szilvágy structure. Looking for these data we could identify important layers as follows:

Between 0.0 - 4.8 m : after the 20 cm thick upper soil a yellow-yellow-brown silt, its has micro-layered structure, and contains limonithic spherules in great quantity (the largest is max. 1 cm, ferrous concretions). Their amount has maximum between 2.0-2.1 meter. Its color, from 2.5 meter is more intensive yellow, but does not contain the spherules. Between 4.8-4.9 meters brick-red microlayered clay can be found. Between 4.9-9.8 meters the brown-yellowish-brown silt with fine grained sand continues downward. Between 9.8-10.0 meters (the bottom) : Greenish-blue-gray microlayered clay. On the whole region the layers are from the Upper Pannonian age, and these layers are covered by thin Quaternary sediments, which is missing in some patches. On the geophysical maps no anomaly can be seen in the deep on this region.

THE RECONSTRUCTION OF THE PROJECTILE. We know the sizes of the crater: radius 250 m, depth cca. 30 m. To estimate the impactor, there is the thumb rule for terrestrial impacts

when cca. 97 % of the material is ejecta; the case of the Ries crater where the ejected volume is 124-200 km^3 (Pohl & al., 1977) while the impactor is estimated to r=0.5-1 km (Hörz, 1982); and rough energetic considerations. All of them suggest cca. 30-100 times of projectile mass to be ejected. Newton's estimate is that the projectile traverses cca. its own length in a target of similar density. Now we choose the factor 30. Then we get a diameter/depth ratio cca. 6, roughly valid for the Arizona meteor crater and in accordance with the empirical Baldwin rule in the size range considered. Then cca. R=40 m, i.e. for a stony body $M \sim 8*10^5$ t, and the double for iron. This is an order of magnitude higher than the estimate for the Tunguz impact (Menzel, 1975). So the Szilvágy event must have been mechanically at least as devastating as the Tunguz one. The latter uprooted the woods of dense forest at 50 km distance and buildings were told to be damaged at 200 km.

ON THE AGE OF THE IMPACT (HISTORICAL RETROSPECTIVE). The Pannonian layers are not disturbed, the event cannot have happened before Pliocene. The geological details are still being investigated, but standard geologic maps of the Szilvágy area suggest Quaternary.

A very strong constraint is that up to now no conjecture exists for myths, tales, &c. reflecting a Tunguz-type event in the Carpathian Basin W. of the Danube. The general area is populated for at least 350,000 y, but cultural continuity is expected since Homo Sapiens. The area was Neanderthal-roamed until BC 35000. If later geologic surveys permit earlier event, then no problem arises.

In latter ages it would have been difficult not to observe something devastating at 50 km and very troublesome at 200 km. It is worthwhile to note, however, that the general Szilvágy area is devoid of definite sites up to the XIIIth century, AD. There is no specific explanation for this.

From Neolithic we know the connections of the peoples of the area. Changing uncalibrated data of Makkay (1982) into calibrated ones following Suess (1970), (an educated guess before 5300 BC) we get the following story of the Szilvágy area.

Before 6100 BC a Mesolithic hunter-gatherer people. 6100-5900: connection with the Körös-Starcevo culture. Körös-Starcevo had strong connection with the Neolithic population of Balkan, Asia Minor and even of Mesopotamia (Renfrew, 1979), having later the variety of myths recorded. 5900-4800: the Körös-Starcevo culture, Central European Corded Ware. 4800-4400: the Lengyeli culture, with southern connections. 4400 BC: Early Copper Age. In the Copper Age the area belongs to the Baden culture extending to Austria. The 2nd millennium BC is there Bronze Age. First half: People of Pots with Lime Inset. Second half: People of Urnfields, also in Austria. 1st millennium: Hallstadt Iron Age.

In the IIIrd c. BC Celts reach the territory which becomes a part of a linguistic community extending to half of Europe. Henceforth news any strange event can propagate without problems. BC 8: the Roman Empire annexes the area which so becomes part of a worldwide administration. During the whole period it is impossible for such an event remaining unobserved by neighbors.

However there remains an interesting chance whose possibility can be determined by later geologic survey. In 433 AD West Rome ceded Pannonia to the Huns. They evacuated the territory in 454, when Emperor Avitus reoccupied but after some months his troops were utterly defeated by the incoming Eastern Goths (Sági, 1978). In the following turmoil starts a flight of the remainder of literate Roman population of the Western cities nearby Szilvágy. There is no more Imperial administration. Now, on Sep. 7, 456, according to late Roman records and also detected from findings, an earthquake demolishes Savaria, 55 km from Szilvágy, maybe the nearest city still in existence. In the vicinity of the epicenter such an event, of course, could erase the archaeologic sites.

The cause and details of that earthquake are still obscure. The inner Carpathian Basin lack global tectonic events and the few devastating earthquakes always have local mechanisms. The distance is not too large for a Tunguz event. So, while data before 35000 BC would be less problematic, if later investigations suggested more recent times, Sep. 7, 456 AD would still be at hand.

REFERENCES Menzel D.H.: Astronomy. Chanticleer, NY. 1975; Pohl & al., in Impact and Explosion Cratering, ed. Roddy D.J., p. 342 Pergamon, NY 1977; Hörz F.: Geol. Soc. Amer. Sel. Pap. **190**, 39 (1982); Makkay J.: A magyarországi neolítikum kutatásának új eredményai. Akadémiai, Budapest, 1982; Suess H.E. in Radiocarbon Variations and Absolute Chronology, ed. by. I.U. Olsson, Wiley, p. 303 (1970); Renfrew C.: Before Civilization. Penguin, Harmondsworth, 1979; Sági K.: in Régészeti barangolások Magyarországon, p. 101, Panoráma, Budapest, 1978