

September 2003

The Gross Symposium 2:
Advances in Palaeoichthyology



Walter Gross 1903 - 1974

FIELD TRIP GUIDEBOOK

Rīga 2003

Stop 15. Kaali meteorite craters

The Kaali meteorite craters, 9 in all, are located within one square kilometre. On the bottom of the main crater there is a natural body of water known as Lake Kaali. The diameter of lake depends on water level and ranges from 30 to 60 m. The depth of lake is 1-6 m, the maximum thickness of lake sediments is 5,8 m. The smaller craters, locally known as dry lakes, are shallow hollows bordered in places with the remains of a low wall. The craters have formed in the clayey basal till and underlying thick microbedded Upper Silurian dolostones. The main crater visited during our field trip measures 105-110 m in diameter at the top of the mound, and is at least 22 m deep (Fig. 13). The upper part of the mound consists of the material ejected from the crater during the explosion and of partly overhanging dolostone layers tilted at an angle of 25-90°. The uplifted bedrock complex with an average thickness of 10 m has been split into nine shifted blocks, each up to 50 m wide.

The diameters of the secondary craters range from 12 to 40 m, and they are 1-4 m deep. On the bottom of craters 4 and 5 meteorite impact traces have been discovered. Based on the calculated main crater's energy of formation and the supposed angle of incidence of 45°, the following ranges of values were obtained: initial mass of meteorite 400-10000 t, mass at impact 20-80 t, initial velocity upon entering the atmosphere 15-45 km/sec, velocity at impact 10-20 km/sec.

Various methods have been used to determine the age of the craters: approximate estimation relative to the history of the Baltic Sea; ¹⁴C dating of the charcoal (which,

however, could be much younger than the craters themselves); palynological analysis of the lake sediments. The results of age-estimations were different – from 5000-8000 years to only 2660-2800 years. Recent investigations have shown that the Kaali area was freed from the waters of the Baltic Sea already some 8000 yr BP. In 1994, a high concentration of microimpactites was detected in the peat of the Piila Bog, about 10 km to the northwest from the Kaali craters. The age of the layer with microimpactites was established by means of palynological and radiocarbon methods. The studies suggest that the Kaali craters were formed probably close to 7500 BP (data of A. Raukas *et al.*).

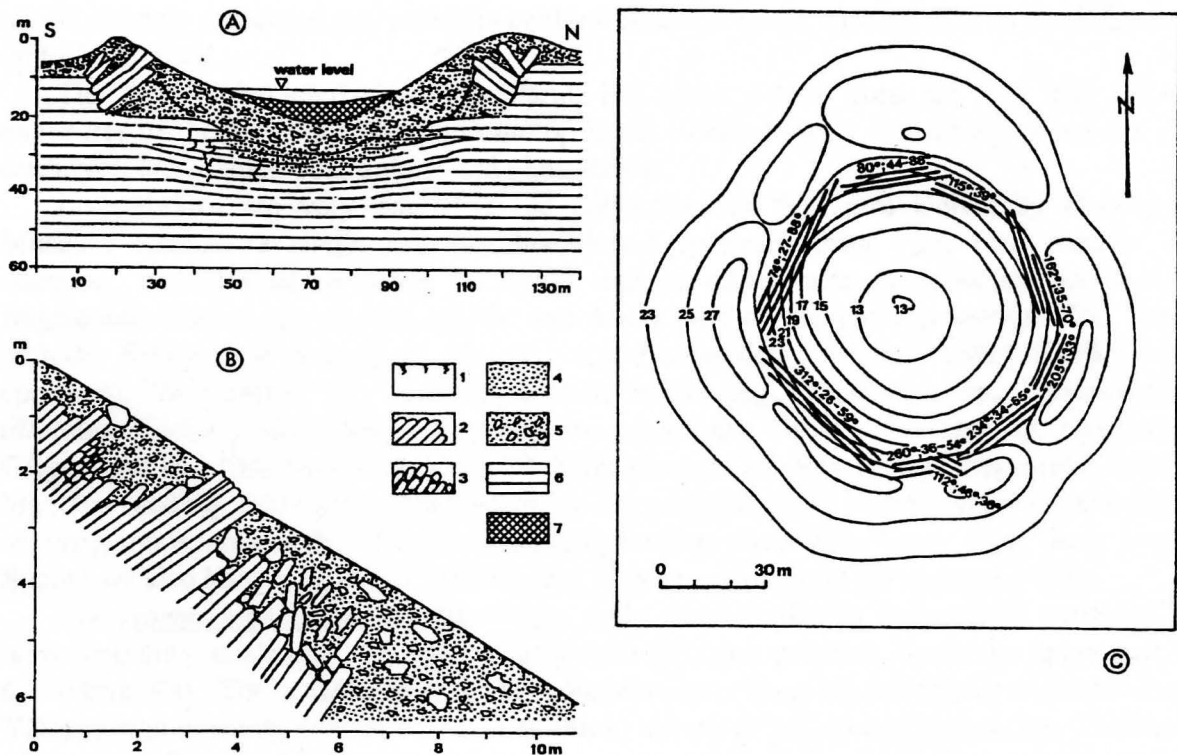


Fig. 13. The geological cross-section of the Kaali main crater (A) and detailed geological cross-section of its south wall (B) after A. Aaloe: 1 – soil; 2 – uplifted dolostone; 3 – shattered dolostone; 4 – dolomitic powder; 5 – filling breccia; 6 – dolostone; 7 – gytja and peat. C: topography of the crater and scheme of dolostone layers crushed by the explosion in the rim of the Kaali main crater.

Up to now, 3,5 kg of meteoritic material has been collected from the craters; the largest piece weighed 28,4 g. The Kaali meteorite is supposed to belong to the class of coarse octahedrite. The chemical analysis showed that the meteorite pieces are made of Fe, 91,5%, and Ni, 8,3% (Tiirmaa, 1997).