A JUMP OF AN IRON METEORITE. J. Moilanen[1,2,3] and M. Gritsevich[1,2,3,4], [1]Finnish Geospatial Research Institute FGI, Geodeetinrinne 2, FI-02430 Masala, (jarmo.moilanen@nls.fi, maria.gritsevich@nls.fi) [2]University of Helsinki, Faculty of Science, Gustaf Hällströmin katu 2, FI-00014 Helsinki, Finland, [3]Finnish Fireball Network, Ursa Astronomical Association, Kopernikuksentie 1, FI-00130 Helsinki, Finland, [4]Institute of Physics and Technology, Ural Federal University, Ekaterinburg, Russia

Introduction: A bright fireball was observed and recorded in Sweden, Norway, Denmark and Finland in 7 November 2020 at 21:17 UTC [1]. A ~14 kg fresh iron meteorite was found a month later within the search area near Ådalen in Enköping, Sweden. The meteorite is an iron meteorite covered by regmaglypts. Unfortunately the meteorite is not yet classified due to legal issues.

Before the meteorite was found some small fragments of iron meteorite crust were found near a large boulder which has an impact scar on top. The meteorite was found 75 ±1 meters from this boulder.

Figure 1. The impact scar (light colored area) on a large granite boulder.

We study is it possible that a 14 kg iron meteorite can jump so far when hitting on a granite boulder. It is also suggested that the meteorite hit the ground next to the boulder and dig a ditch before the jump.

Methods: The fall site was visited in April 2021. Both the bolder (the actual impact site) and the place where the meteorite was found was documented.

The impact velocity of the iron meteorite was modelled using dark flight Monte Carlo (DFMC) simulation code described in [2]. Assuming some loss of velocity after the impact limits for ricochet velocity and angle were determined by using both DFMC simulations and equation for ballistic trajectory.

Results: The impact scar on the boulder is 22 cm long and 9 cm width on SW facing slope of the boulder. The slope is 45 – 50° from the vertical. Hit marks is not flat but it covers two more or less flat surfaces which have ~143° angle between them.

DFMC simulations gives impact velocity to the ground ~110 m s^{-1} for an iron meteorite hitting the boulder in nearly vertical fall trajectory. Both DFMC simulations and ballistic trajectory calculations tells that a 75 meters jump from the boulder is possible. Even if the meteorite hit the ground next to the boulder first.

According to our 3D model of the boulder some part of the hit mark has not so deep slope, which may result higher fly path after deflection. For example, ricochet velocity of 50 m s^{-1} and at 11° angle the meteorite can land at 75 meters distance with 46 m s^{-1} impact velocity. Also ricochet velocity of 36.5 m s^{-1} with ricochet angle 20° works. This seems to be a plausible flight path from the impact scar on the boulder since the slope which is in direction of the resting place of the meteorite is approximately 35° from vertical.

Lowest ricochet velocity needed is 27.6 m s^{-1} when ricochet angle is 45°. This angle is not realistic for this case. Assuming angle to be somewhere between 10° – 20° ricochet velocity has been 35 – 51 m s^{-1}.

If the meteorite dig the ditch before 71 – 72 meter jump ricochet velocities are not too different but ricochet angle must be negative from the boulder. A question remains how the meteorite pass the pine tree root in the ground without breaking it.

The terminal resting place of the meteorite was in SSW direction (azimuth 200°) from the boulder. There is a good number of tall trees between the boulder and the resting place but no hit marks in trees have been found. The meteorite seems to have missed all of them.

The meteorite was found few weeks later than the small fragments. Reason to this delay in spite of search effort probably was the fact that the resting place of the meteorite was on top of an exposed bedrock approximately three meters higher than the boulder. It was resting next a birch tree partly under a root of the tree. It probably was not visible anywhere else put on top of that bedrock. There is nearly no damage in the root of the tree and that is possible only when angle of landing have been shallow.

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References: [1] Moilanen J. and Gritsevich M. (2021) *84th annual Meeting of the Meteoritical Society,* abstract 6252. [2] Moilanen J. et al. (2021) *Monthly Notices of the Royal Astronomical Society*, 503:3, 3337-3350.