Mass balance evaluation of Tsarev meteorite collection completeness.

L. A. Muravyev[1] and V. I. Grokhovsky[2],
[1]Institute of Geophysics Ural Branch of RAS, 620016, Amundsen st. 100, Ekaterinburg, Russia, mlev@igeoph.net;
[2]Ural Federal University 620002, Myra st.19, Ekaterinburg, Russia, grokh47@mail.ru.

In present the dispersion of meteorite showers fragments on Earth's surface is studied insufficiently. There are general regularity that large fragments are located on average closer to the Earth's point of the bolide trajectory than the smaller ones. There is an empirical Frost rule that relates the position of a fragment on the surface with its mass: $l=a-k\cdot log(M)$ [1]. At the same time, a number of factors distort the atmospheric sorting and lead to deviations from these regularities. A detailed analysis of the patterns of destruction and motion of fragments of meteoritic bodies in the atmosphere will make it possible to estimate the completeness of the collection of meteorite on the ground. Find out where to focus the search for the remaining fragments, if any.

For the analysis, we chose a stone meteorite shower Tsarev L5 [2], presumably fallen in 1922, December on the territory of the present Volgograd region of Russia. The fragments found from 1979 to the present time allowed to determine the orientation, size and shape of the strewn ellipse [2] and the initial mass of the meteoroid, which, according to V. Tsvetkov, could reach 10 tons. But the information about meteorite fragments location is approximate becouse it is given by these finders. Coordinates of many found samples was indicated by local people from their memory, some fragments were moved during plowing.

There is a method for estimating the direction of the meteoroid flight applicable a many meteoric showers, which fall was not observed [3]. The spatial distribution by mass will be the most orderly along the "true" direction of the bolide flight. For the meteorite Tsarev this direction was 315° [4]. A mass balance must be observed relative to this direction by virtue of the conservation of momentum law. For example, a large fragment on the left side from the strewn ellipse main axis should be balanced by a similar fragment on the right side. For Tsarev meteorite strewn field (fig. 1, left) we calculated the sum of the products of the sample's masses at their distances from the main axis: right and left from the meteoroid flight direction, dividing the trajectory into sections of 1 km long (fig. 1, right).

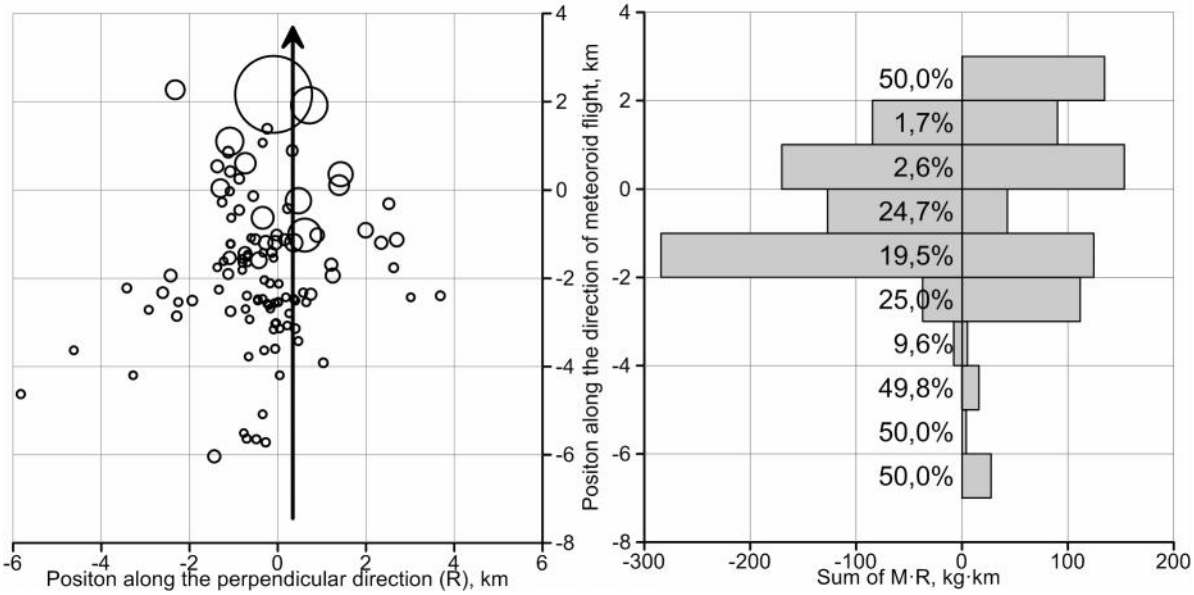

Figure 1. Left: scattering field, rotated to the flight direction (indicated by the arrow), the origin of coordinates is the center of masses. Rigth: mass balance diagram relative to the meteoroid flight direction.

It is clear that some fragments of meteorite shower Tsarev are not completely found. We can expect new findings in all ranges of masses, espetially low-mass samples (up to 500 g). This method of estimation can be applied for similar meteorite showers (e.g., Mbale L5/6, Kunashak L6, Kainsaz CO3, Krymka LL3), with big amount of findings with well known coordinates.

Acknowledgements: This work was supported in part by the Ministry of Education and Science of the Russian Federation (the Project no. 3451, 4825) We thank A. Korochantsev for the granting Tsarev later finds database.

References: [1] Frost M.J. (1969) *Meteoritics* 4: 217–232. [2] Zotkin I. T., Tsvetkov V. I. (1984) *Meteoritika* 43: 3-8 (In Russian).[3] Tsvetkov V. I., Goritskii Iu. A. (1973) *Solar System Research* N3, V7: 139. [4] Muravyev L. A., Grokhovsky V. I. (2016) *Meteoritics & Planetary Science* 51 S1: A477.