MYSTERY OF THE BENEŠOV BOLIDE REVEALED AFTER 20 YEARS. P. Spurný[1], J. Haloda[2] and J. Borovička[1], [1]Astronomical Institute, Academy of Sciences, Fričova 298, 251 65 Ondřejov, Czech Republic (spurny@asu.cas.cz), [2]Czech Geological Survey, Geologická 6, 152 00 Prague, Czech Republic.

Introduction: We report results of new analysis of the very bright fireball of –19.5 absolute magnitude which was recorded by 4 all-sky and 2 spectral cameras at 3 Czech stations of the European Fireball Network on May 7, 1991 at 23:03:48 UT. This fireball is well known as the Benešov bolide. Very precise data on atmospheric trajectory, heliocentric orbit, fragmentation history, composition and possible impact location based on detailed analysis of these photographic observations were published in several papers e.g., [1], [2], [3], and [4]. It makes this event one of the best documented and studied bolide in history. Moreover, this bolide belongs to the rarest category of so called superbolides, i.e. events caused by meter sized meteoroids with initial masses exceeding 1000 kg. This meteoroid penetrated very deep in the atmosphere (last photographed point was at 16.7 km) and already from the initial analysis it was evident that not negligible part of its mass fall on the ground. Despite great efforts and many attempts no meteorite was found in the weeks and years after the fall. In time of Benešov there were known only 3 instrumentally observed meteorite falls - Příbram, Lost City and Innisfree.

Results and discussion: In spring 2011, just before 20th anniversary of this extraordinary case, we re-measured all available all-sky records and re-analyzed these data. We used slightly different methods and new approaches which we gradually developed for analysis of several recent instrumentally observed meteorite falls (described for example in [5], [6], [7], [8]). We got new consistent picture of the Benešov event, which resulted in a slightly revised impact location and suggested us new strategy which could lead to recovery of Benešov meteorites after 20 years. We realized that the largest number of meteorites should originate from catastrophic disruption at 24.3 km where the bolide reached maximum brightness in a major flare [2, 3]. Vast majority of these meteorites should survive as really small pieces in the mass range from 1g to 10g. According to our models, such cloud of small fragments could contain several thousands of pieces and thanks to almost vertical trajectory of the Benešov bolide it remained relatively dense during about 7 minutes long dark flight. We found that the predicted impact area for these small fragments covers a cultivated field. If this scenario is correct, after 20 years of intensive agricultural utilization of this field, these fragments should be uniformly spread over about 30 cm thick layer of soil and at least some of them should be close to the surface to be detectable. From very detailed spectral records we knew that the bulk composition of the meteoroid was chondritic [2]. It justified the use of metal detectors for the search because after 20 years meteorites couldn't be distinguishable visually from terrestrial stones and slag.

The reality completely confirmed all our assumptions and highly surpassed our expectations. Three small highly weathered fragments irregular in form and completely without fusion crust with a total mass of 11.3 grams (1.54g (H5), 7.72g and 1.99 g (both LL3.5) – order according to time of find) were recovered exactly in the predicted impact area for corresponding masses, namely within 40 meters from the highest probability line (2 during the first searching day, the third one 10 days later). Although all fragments are very small and their weathering grade is high (W3 for all pieces), their interior was well preserved for reliable analysis. The meteorite is a polymict breccia containing three recognized lithologies with different texture, chemical, and mineralogical composition. The largest portion of found specimens is a LL3.5 chondrite. The smallest fragment was classified as H5 ordinary chondrite. Fragmentary achondritic clast (of 4.8x2.6 mm in size) was found within thick section of the largest sample and is cemented to LL3.5 chondrite lithology by irregular vein of impact melt.

Conclusions: This result is in many aspects pioneering. We proved that in some special cases it is still possible to predict and find meteorites long time after the fall. However the most important result is in heterogeneity of the recovered meteorites. This case clearly shows that larger meteoroids can be compositionally very complicated bodies. We discovered that the Benešov meteoroid consisted of at least three different types of material. Similar heterogeneity was observed also for the Almahata Sitta meteorite [9]. This case also implies that it is very useful to study as many as possible fragments from one fall because there can be significant differences among them.

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