A TALE OF TWO LOW-STRENGTH (BUT PROBABLY METEORITE-DROPPING) FIREBALLS: BRITISH COLUMBIA, CANADA, DECEMBER 20, 2014 AND UTAH, U.S.A., NOVEMBER 18, 2009.

A. R. Hildebrand[1], L. T. J. Hanton[1] and R. D. Nowell[2], [1]Department of Geoscience, University of Calgary, 2500 University Drive NW, Calgary, AB T2N 1N4 (ahildebr@ucalgary.ca, ltjhanto@ucalgary.ca), [2]College of the Rockies, 2700 College Way, Cranbrook, BC V1C 5L7 (NOWELL@cotr.bc.ca).

Introduction: The fireballs occurring when asteroidal rocks enter Earth's atmosphere have characteristics reflecting the rock's physical properties; strength is perhaps the most easily derived property (correlating with fireball end heights) [e.g. 1]. The weaker lithologies are less likely to survive entry, and have lesser survivorship if they do. In recent decades, an explosive growth in meteorite recovery of finds has been biased towards the strong asteroidal lithologies (which also tend to be more resistant to terrestrial weathering) resulting in the weaker lithologies (typically dark carbonaceous lithologies presumably derived from the dark asteroids) being relatively less well known. Nonetheless two relatively recent fireballs resulting from weak rocks probably dropped meteorites.

British Columbia, December 20, 2014: A bright fireball occurred after local midnight over a relatively remote part of the eastern Rocky Mountains from 07:25:02 to ~07:25:06 UT on December 20, 2014. Although the sky was partly cloudy two serendipitous digital images recorded the fireball clearly, and one dedicated all-sky camera partly recorded the fireball through clouds. One of the still images was from a large format camera resulting in a better than usual record of the fireball's characteristics.

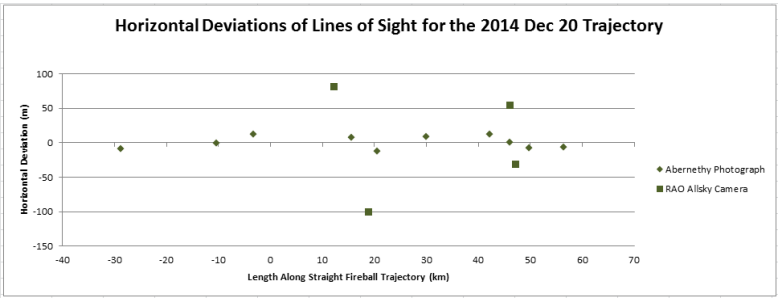

Figure 1: MILIG program output showing low fireball trajectory solution residuals due to a serendipitous high format framing camera image; the two images were calibrated with simultaneously imaged stars.

Unusual characteristics of this fireball are its relatively high end point of 29.9 km, and relatively high recorded start point of 107.9 km; the latter was probably observed because of the high quality of one of the framing cameras. The fireball magnitude was ~-12 corresponding to a mass of order 100 kg. The high end point indicates a weak object, but a meteorite fall was still indicated as the fireball turned red at its end which typically results from surviving material cooling as it decelerates to dark flight. The video allowed deriving a velocity of ~18 km/s for this fireball, and its trajectory resulted from a low inclination (~15°) but unusually eccentric orbit (e ~0.8) with an aphelion beyond Jupiter suggesting an outer solar system origin and consistent with the low strength indicated by the high end point. Unfortunately the projected strewnfield was mostly forested, mountainous terrain (much of which had been burnt a decade earlier) and no known searches recovered material.

Utah, November 18, 2009: A v. bright fireball occurred after local midnight southwest of Salt Lake City, Utah at ~07:07:19 UT of ~4.5 seconds duration on November 18, 2009, over the Great Salt Lake Desert/Dugway Proving Ground; satellite sensors indicate a relatively large energy release of ~1.8 kT; the event was widely observed and recorded by serendipitous video cameras and seismic stations. Video cameras record two major fragmentation events consistent with seismic records containing two distinct large amplitude arrivals. A relatively high end point of ~25 km for this large meteoroid indicates a weak lithology, but video records at least one ~10 kg rock decelerating after the end of fragmentation. Using SUPRACENTER [2] the nearest seismic records were used to locate the last fragmentation event independently of video triangulation. The seismic records did produce a relatively accurate location once the local temperature profile data had been incorporated, but lacking radiosonde data, the solution was >10 km in error; the seismic solution is limited by records from only three stations within ~100 km although booms were recorded at greater distances. The potential meteorite fall remains largely uninvestigated.

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