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The Trans-Alabama Superbolide of 5 December 1999

PAGES 253, 257

Several dozen very bright superbolides enter Earth's atmosphere each year, usually terminating with an explosion of the incoming meteoritic body. Coordinated camera set-ups have captured images of a very few meteorites, which led to their recovery. But most bright meteoritic events are seen by eyewitnesses who are in the right place at the right time, or by security cameras, which are typically not pointed at the sky. The superbolide that is reported on here was seen by many and recorded on such security cameras. Careful collection and analysis of eyewitness data allowed a trajectory to be estimated, which is at odds with data of the U.S. Department of Defense (DoD) on this event. A few meteoritic events result in an "impossible" effect; that is, they apparently start ground fires. The superbolide that is the subject of this article was one of them.

At approximately 04:18 AM CST (10:18 UT) on 5 December 1999, light from an exceptionally bright bolide (i.e., a superbolide) was seen across part of the southeastern United States. This superbolide was witnessed, heard, and (or) felt by hundreds of individuals who called local and state police, fire departments, and the state emergency management agency. According to newspaper and television accounts, the superbolide's light was seen within a 300-km radius of its flight path. This area included most of the state of Alabama, and parts of adjacent Tennessee, Georgia, and Florida. This incident was widely reported in regional and local newspapers and on local television news programs. Surveillance camera videos made in two Alabama towns, Weogufka (33.02°N, 86.31°W) and Pell City (33.16°N, 86.28°W), recorded direct light, reflected light, and shadows from this superbolide event.

In published abstracts [*King et al.*, 2001; *King and Petruny*, 2002], this event has been referred to as the Goodwater (Alabama) superbolide, because the DoD initially indicated the location of its flight path as being nearly over Goodwater, Alabama (Figure 1, site G). Perhaps a better name for the event is the Trans-Alabama superbolide, as the flight path suggested here is more extensive than the DoD's (see Figure 1). This meteoritic event is referred to as a superbolide (versus a bolide or bright fireball), because it was detected by satellite, and because it shows brightness on video recordings that could be magnitude -17 or brighter [*Ceplecha et al.*, 1999]. At the same time as the superbolide event, simultaneous fires started within the town of Harpersville, Alabama, which is located about 53 km northwest of Goodwater (Figure 1), as discussed here.

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Flight Path

DoD press release 202 (dated 16 March 2000), stated that this superbolide was first detected at approximately 33.1°N, 85.9°W (altitude = 74 km) and last detected at approximately 33.0°N, 86.1°W (altitude = 23 km). These points are, respectively, approximately 15 km east-northeast and approximately 9.2 km south-southwest of the town of Goodwater, Alabama (Figure 1, site G). The azimuth defined by the points above (stars on Figure 1) is approximately 237°.

Eyewitness accounts of a perceived flight path are limited to three reliable sources and they contradict the DoD press release. A former land surveyor in Auburn, Alabama, reported that he saw the superbolide and estimated the flight path to have been "east by southeast." A geologist driving his automobile a few kilometers south of Athens, Alabama, saw the superbolide and estimated its flight path to have been "east, southeast." Lastly, the general store owner in Weogufka, Alabama, reported that residents who saw the superbolide light in his town told him the object moved "northwest to southeast" (for locations of these towns, see Figure 1).

Shadow movement in the Weogufka surveillance video confirms the storeowner's account. From shadows on this video, an estimated easterly flight path was obtained, which had an azimuth of 097°. The eyewitness near Athens stated that the superbolide was moving "right at the crescent moon." According to the U.S. Naval Observatory's data services Web page, a waning crescent moon was visible that day from Athens, just above the horizon on an east-southeasterly azimuth of 104°. The observer in Auburn (AU in Figure 1) noted the orientation of a shadow cast by a vertical rod in making his assessment of bearing.

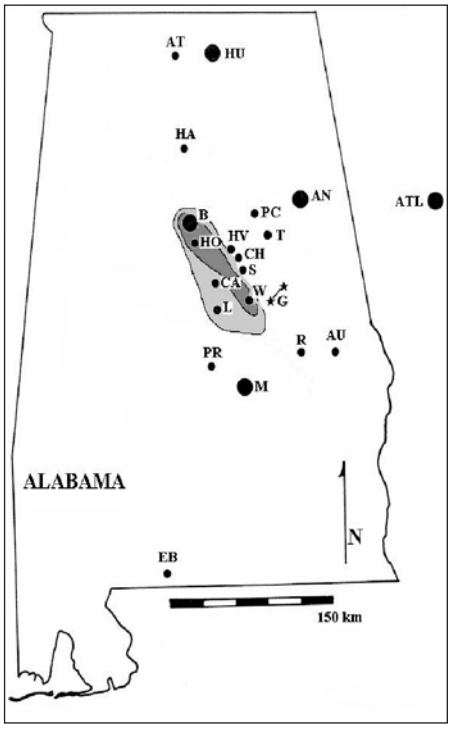

Fig. 1. Eyewitness sites (large dots = numerous witnesses; small dots = mainly one witness). AN = Anniston; AT = Athens; ATL = Atlanta; AU = Auburn; B = Birmingham; CA = Calera; CH = Childersburg; EB = East Brewton; HA = Hanceville; HO = Hoover; HU = Huntsville; HV = Harpersville; L = Lay Dam; M = Montgomery; PC = Pell City; PR = Prattville; R = Reeltown; S = Sylacauga; T = Talladega; W = Weogufka; connected stars = DoD-described flight path; G = Goodwater (located under the DoD flight path); light shading = sounds heard in this area; heavy shading = sounds heard and shaking felt in this area. Inferred flight path is over shaded areas from B toward W.

It is not clear why there is such a large discrepancy between the DoD-reported flight path and the observer's accounts. It is concluded herewith that the DoD information is in fact wrong, and that a northwest-to-southeast trajectory (following the trend of the shaded areas on Figure 1) is correct.

Brightness and Color

Eyewitnesses described the superbolide brightness as being briefly like mid-day sunshine. Newspaper accounts said that several people were awakened inside their homes by the bright light. In Atlanta, Georgia (170 km

northeast of Goodwater), the superbolide's light caused a resident to report an 'aircraft crashing.' Near Athens (210 km north-northwest of Goodwater), the eyewitness noted above was 'completely blinded' while driving. Surveillance video from Weogufka includes a brief segment in which superbolide illumination temporarily overwhelmed the camera's capabilities. Eyewitness reports describe mainly a blue coma, and a surveillance video from Pell City shows the concrete floor of a self-service gasoline station reflecting bright, iridescent blue light during superbolide passage. Eyewitnesses also reported orange and white coma colors, but these reports are associated only with the terminal phase of illumination.

Sound and Shaking

Alabama eyewitnesses in an area 100 km to the north and west of Goodwater (encompassing sites B, CA, L, and W on Figure 1) reported associated sounds, mainly 'rumbling sounds' or 'two explosions' occurring 'a few minutes' after the superbolide passage. An audio recording accompanying the Weogufka surveillance video sounds initially like a 'distant rifle shot' that occurs 83 seconds after the end of the superbolide illumination. Then, superbolide-produced sound continues for an additional 91 seconds, as an unbroken 'thunder-like noise or rumble,' which varies in intensity while fading away gradually.

Ground shaking associated with superbolide passage was reported in an area more restricted than the one where sounds were noted (sound area is indicated by lighter shading in Figure 1). The shaken area formed a narrow corridor that extended from Weogfka toward the northwest (dark shading on Figure 1); covering a distance of approximately 90 km (encompassing sites B, HO, and W on Figure 1).

Angle and Velocity

The DoD press release cited earlier says that the superbolide entered the atmosphere at an angle of 55° with respect to horizontal. However, DoD illuminated flight-path data, provided in the same press release, plot as a steeper angle of approximately 66°. An eyewitness in Atlanta reported the estimated angle of descent was 45°.

Using duration of the Weogufka video illumination (~3.4 seconds) and illuminated flight-path length (~55.6 km), an average superbolide velocity of ~16.4 km/sec is obtained. A second estimate using speed of shadow movement in the Weogufka surveillance video indicated a velocity of ~18.3 km/sec.

Fragmentation and Potential Impact Area(s)

Eyewitnesses from several viewpoints reported sudden superbolide light extinction, without any illuminated fragmentation. It is remarkable that no one reported any visible fragmentation, which may mean the meteoritic mass fell more or less intact, or that fragmentation occurred during dark flight. A distant eyewitness in East Brewton, Alabama (240 km south of Goodwater) reported seeing a 'trail of smoke' behind the superbolide.

Impact, if any, is presumed to have occurred within a few kilometers downrange from either (1) the last DoD-detected location (if one still assumes this information is correct, the site would be a few kilometers south of Goodwater), or (2) a few kilometers downrange from the last station reporting light, sound, and shaking (i.e., Weogufka; W on Figure 1), which probably places it at some point south of Weogufka and west of Reeltown, Alabama (W and R, respectively, on Figure 1). To date, no meteoritic debris or suspect surficial disturbance has been found in either area.

Simultaneous Ground Fires

Eyewitnesses reported three adjacent, simultaneously occurring ground fires inside a forest of young pine trees, located within the city limits of Harpersville, Alabama (33.34°N, 86.43°W; site HV on Figure 1). The Harpersville Fire Department received calls about these fires within a few minutes of the superbolide passage near the area. Residents who live within 50 m of the fires' location stated that the fires began "when we saw the light" (referring to the superbolide). A televised news story of the event showed several Harpersville residents walking around in a still-smoldering area on the morning of 5 December 1999, apparently intent upon finding parts of the fallen object. Subsequent inspection showed three elliptical burned areas, 200 to 450 m^2, where grass, shrubs, lower tree limbs, and the outer tree bark layer (within ~ 0.5 to 2 m of the ground) had been burned. The azimuth of major axes of the burned ellipses varied from 090° to 110°.

In nearly all books and papers on meteoritics, the connection between superbolides and ground fires is uniformly dismissed. At first, a connection in this instance seemed less than likely, because (1) these areas are located several 10s of kilometers from any potential impact area (i.e., not near the end of the flight path), and (2) Harpersville is located a few kilometers east of the flight path's center line, as inferred in Figure 1. However, the accounts of eyewitnesses who lived 50 m from the fires and the timing of calls to the local fire department confirm that the superbolide passage and fire ignition were almost simultaneous. Nothing else can explain these fires. On the Internet, there are numerous, credible reports of simultaneous fires like the ones in Harpersville, which defy easy explanation (e.g., the central Pennsylvania daylight superbolide of 23 July 2001 [http://www.southpole.com/headlines/y2001/ast27jul_1.htm; http://www.cnn.com/2001/TECH/space/07/24/fire.ball/index.html], the Bayt Eides, Jordan, superbolide of 18 April 2001 [http://www.jas. org.jo/mett.html], and the England, Arkansas superbolide of 9 March 2000). In scientific literature, alleged meteorite-related fires have been attributed instead to geoelectrical discharges or ignition of erupting terrestrial gasses [e.g., *Docobo et al.*, 1998].

Possible explanations for simultaneous ground fires and superbolide passage are: (1) an electrical discharge caused by the ionized wake of the incoming object; (2) hot fragments of the object that spalled off and fell near its trajectory; or (3) a plasma discharge from the object's coma. Initially, hypothesis 1 was favored, assuming that the electrical charge made by the ionized wake may have been connected to the ground by atmospheric conditions related to an approaching weather front. At the time of the superbolide passage, a moderately strong weather front was approaching from the west. This front included large clouds that might have acted in some way to help connect the superbolide-generated charge to the ground in the form of lightning. However, a check of commercial lightning-track data for the date of the event showed no detectable discharges in the area. There is no eyewitness data to help confirm or dismiss hypothesis 2 and 3.

Again, it is remarkable that the onset of the fires and the passage of the superbolide were essentially simultaneous. There appears to be a connection between the two events, but the nature of that connection is unknown. It is worthy of note that central Alabama, including Harpersville, was in the midst of a strong drought, which made the woods there particularly susceptible to any ignition source.

Conclusions

Careful analysis of eyewitness testimony can assist in determining meteorite flight path direction and length, but large numbers of witnesses are needed and attention must be paid to witness accounts from people who are keenly aware of compass directions. It is clear from this experience that DoD-reported flight paths can be in error, as shown here. There is no good way to account for the simultaneous Harpersville fires except for the passage of this superbolide, but a mechanism for rapid transfer of energy to the ground remains elusive. In future analysis of such events, perhaps the bolide-ground fire connection should not be dismissed automatically.

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