ON THE ORIGIN OF A DAYLIGHT BOLIDE OVER CANARY ISLANDS ON NOVEMBER 30, 2022: A METEORIC EVENT OVER GRAN CANARIA DETECTED BY SEISMIC DETECTORS. J.M. Trigo-Rodríguez[1,2], I.F. Domínguez-Cerdeña[3], E.A. Díaz-Suárez[3], M. Tapia[4] and E.A. Silber[5]. [1]Institute of Space Sciences (CSIC), Campus UAB, Carrer de Can Magrans s/n, 08193 Cerdanyola del Vallés, Barcelona, Catalonia, Spain, trigo@ice.csic.es, [2]Institut d'Estudis Espacials de Catalunya (IEEC), Ed. Nexus, Barcelona, Catalonia, Spain, [3]Sismología, Unidad de Volcanología, Instituto Geográfico Nacional, C/La Marina, 20, 2º. 38001, Santa Cruz de Tenerife, Spain. [4]IEGEF-IEC, Barcelona, Catalonia, Spain. [5]Dept. of Earth Sciences, Western University, London, ON, Canada.

Introduction: A number of bolides entering mid and lower atmosphere in broad daylight may not always be accompanied by a spectacular visual phenomenon, mainly due to the geometry of their observed trajectories [1-4] as well as local weather conditions. We present data on a meteorite-dropping bolide that produced a large flare at the end of its luminous path. This bolide, catalogued by the Spanish Meteor Network (SPMN-CSIC) as SPMN301122D, occurred on Nov. 30, 2022 at 15h35m00±5s UTC. It was observed by tens of eyewitnesses all over the Canary Islands, and its final fragmentation produced a shock wave that coupled with the ground to produce a noticeable seismic signal recorded by 6 Instituto Geográfico Nacional (IGN) stations. The event was promptly reported by the press, including some casual videos informing about the fireball sound, finally compiled in the framework of the SPMN. Fortunately, the Instituto Geográfico Nacional (IGN) seismic stations detected the event. We compiled the most relevant information, mostly inferred from seismic data.

Technical procedure and observational data: We have used data collected by the IGN permanent seismic stations listed in Table 1. All of them use broad band seismometers (100 s period).

Station	Longitude (W)	Latitude (N)	Alt (m)
CLUM	15° 39' 1"	27° 49' 5."	435
EOSO	15° 33' 9"	28° 4' 18"	760
GGC	15° 38' 14"	28° 7' 18"	548
MACI	16° 30' 30"	28° 15' 1"	1674
CGUI	16° 30' 0"	28° 22' 6"	871
CPIT	16° 23' 31"	28° 24' 6"	1165

Table 1. SPMN stations recording the 020121 event.

Discussion: The data obtained about the fireball trajectory is scarce because very few eyewitnesses provided detailed reports. César Pardinas (CP) and Sílvia Calle (SC) saw the bolide from Fuerteventura, and María Carballo (MC) from Tenerife. These separated locations provided strategic vantage points which, due to the bolide's apparent proximity to the Sun, allowed for roughly constraining its atmospheric trajectory. From Gran Canaria, the bolide was unnoticed because it was mostly cloudy, but several observers from Tenerife and Lanzarote provided reasonably accurate observing reports. However, the IGN seismic stations obtained valuable information, like the characteristic wave train that allowed us to establish its meteoric nature (Fig. 1)

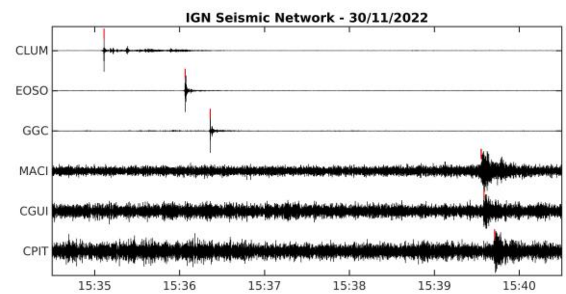

Figure 1. Seismic signals for the six IGN stations. Red lines indicate picking used for the event location.

From those observational reports, a tentative starting altitude of 100±5 km was obtained with the end of the luminous phase at 18±2 km. A rough estimate of the average velocity is 15±5 km/s. From the catastrophic disruption of the meteoroid at a height of 20±1 km and the inferred velocity we estimated its tensile strength, ~5±1 MPa, consistent with that typical for a chondritic projectile [6-7]. The bolide luminous path was quite homogeneous but exhibited a couple of fragmentation episodes (Fig. 2) before the final catastrophic disruption followed by a bright flare. The latter was distinguishable even when the eyewitnesses noticed the fireball evolving closely to the Sun in broad daylight. That catastrophic disruption produced the strong (and audible) shock wave recorded by the seismic stations. The shock wave appeared less attenuated for CLUM (Fig. 3). A tentative fireball luminosity based on the available eyewitness reports was -15±2 absolute magnitude, near the limit of its detection from space. We reflected on previous case studies with similar circumstances [4] to unbiasedly interpret the limited number of eyewitnesses' descriptions. Using the Geostationary Lightning Mapper we did not detect any near Gran Canaria, neither the Center for Near Earth Objects has released any bolide recorded by the US Government sensors.

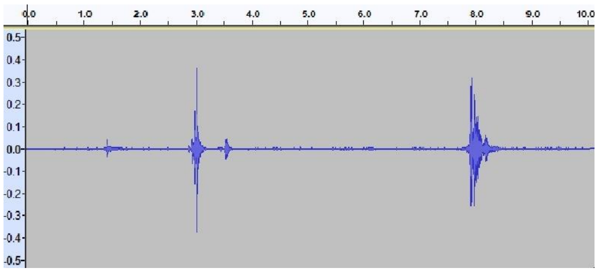

Figure 2. Amplitude vs. time in seconds for the SPMN301122D sound wave recorded from Cambalud SPMN station in Gran Canaria by Francisco Grande.

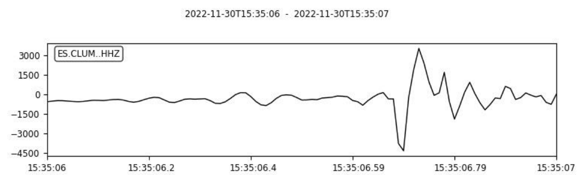

Figure 3. SPMN301122D sound wave recorded from the closest IGN station (CLUM).

Conclusions: The SPMN301122 daylight bolide occurred southeast of Gran Canaria, and our analysis suggests that it was likely produced by a sub-meter sized sporadic suffering a catastrophic disruption at 27.7054º N and 15.5333º W (red star in Fig. 4), and at a height of 20 km. Due to its close proximity to the Sun (and the local dense cloud cover) we were unable to obtain video recordings, except a few detailed eyewitnesses reports. The seismic data was robust enough to constrain the location, and the height of the final disruption of the meteoroid, whose visual magnitude was close to that expected for a superbolide. This bolide was not detected by satellite detectors, nor infrasound as per initial analysis. In the likely case of a meteorite survival, the inferred bolide trajectory points to its fall over the sea.

Acknowledgements: JMT-R acknowledges financial support from the Spanish Ministry (PID2021-128062NB-I00). We also thank the visual reports collected by the SPMN network, in particular those received from Silvia Calle, María Carballo Ceballos, César Paradinas Blázquez, Elena Pérez, J.L. Rodríguez, and J. Santana.

References: [1] Jenniskens, P. (2006) Meteor Showers and Their Parent, CUP, Press, UK, [2] Tapia M. and Trigo-Rodríguez J.M. (2017) In Assessment and mitigation of asteroid impact hazards, Springer, Astrophysics and Space Science, Vol. 46, pp. 199-218. [3] Blanch E. et al. (2017) In Assessment and mitigation of asteroid impact hazards, Springer, Astrophysics and Space Science, Vol. 46, pp. 185-197. [4] Trigo-Rodríguez J.M. (2019) In Hypersonic Meteoroid Entry Physics, Colonna G. et al. (eds.), Institute of Physics Publishing, IOP Series in Plasma Physics, pp. 4-1/4-23. Online ISBN: 978-0-7503-1668-2. [6] Trigo-Rodríguez J.M. et al. (2006) Meteorit & Planet. Sci. 41, 505-517. [7] Popova O. et al. (2011) Meteorit & Planet. Sci 46:10, 1525-1550.

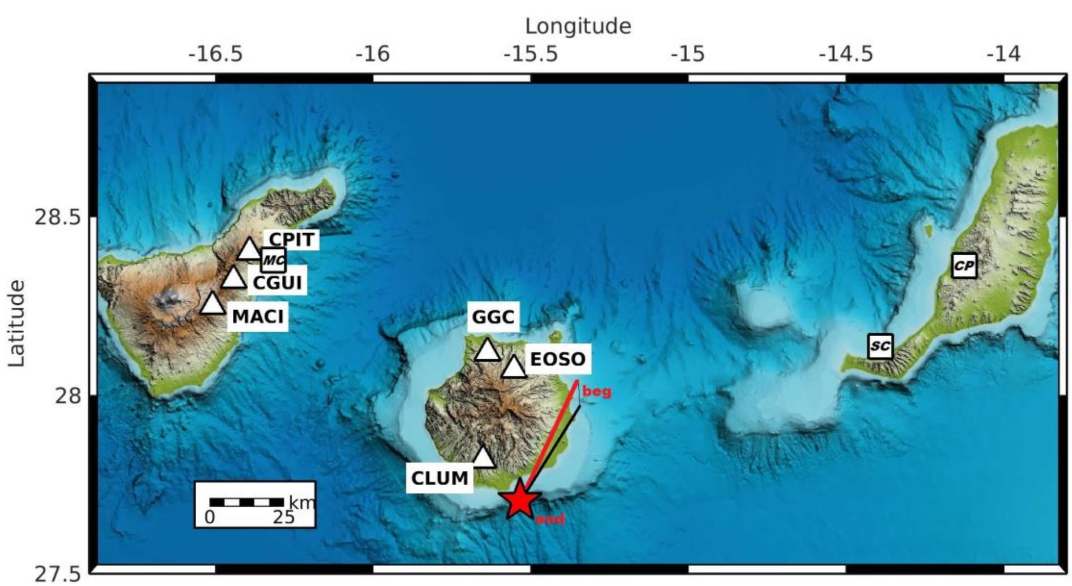

Figure 4. Bolide trajectory and location of the blast (in red). The 6 IGN stations, and eyewitnesses are shown.