From Vesta to the Kalahari: tracing meteorites from asteroid 2018 LA

Tim Cooper
ASSA Shallow Sky Section

Image credit: NASA/JPL-Caltech/UCAL/MPS/DLR/IDA
Timeline

- ~22.8 Ma fragment ejected in collision that formed Rubria crater.
- 2018 June 2, 08h16 UT, asteroid 2018 LA detected in space.
- 2018 June 2, 16h44 UT, bolide from asteroid 2018 LA.
- 2018 June 7-11, calibration of video images.
- 2018 June 23, first meteorite found, MP-01 weighing 17.92g.
- 2018 July-September, three further expeditions made no more finds.
- 2018 October 8-12 - 5th expedition team finds 22 more fragments.
- 2021 April 21, publication of MAPS paper, 66 authors (2018 LA Consortium).
- 2021 June, publication of ASSA account in MNASSA.
First images of 2018 LA
2018 June 2.3443

Catalina Sky Survey discovery images of 2018 LA
Image credit: Catalina Sky Survey

SkyMapper Southern Survey g,r,i, and z colour bands
(Wolf et al. 2018)

- Absolute magnitude: 31.1
- Albedo: 0.25
- Diameter: 156 cm
- Spin rate: 244 sec
- Geocentric velocity: 17 km/s
Meteoriet

By my pale op plaas kamera naby Ottosdal.

Die meteoriet het naby deelpan geval volgens ooggetuies.

#Meteor #Meteoriet
Frame grabs at 1 second intervals
Gaborone video footage, Botswana
Image credit: Beverly Lombard
Gaborone video footage
Calibration image taken by Tim Cooper
Gaborone video footage
Calibration image taken by Tim Cooper
2018 June 8
Image @ 16:41:00 UT
10 seconds

Ottosdal video footage
Calibration image taken by Tim Cooper
Ghanzi video footage secured by Tim Cooper
2018, July 6 - A fresh-looking 1.8-g meteorite was found in the Central Kalahari Game Reserve during a search effort dedicated to finding debris from asteroid 2018 LA. The search was guided by Peter Jenniskens and conducted by three Botswana institutes, the Botswana International University of Science and Technology (BIUST), the Botswana Geoscience Institute (BGI) and the University of Botswana at Maun Okavango Research Institute (ORI), and supported by Central Kalahari Game Reserve staff. Peter Jenniskens teamed with Oliver Moses of ORI (to the right in image above) and recovered video security camera footage in Maun and Rakops that helped constrain the disruption point and focus the search. Images were calibrated from star background by Jim Albers. Tim Cooper from ASSA calibrated videos to the south. Jelle Assink and Laslo Evers of the KNMI provided atmospheric wind data. The first meteorite was found by team member Lesedi Seitshepo on Saturday June 23 (center front in photo).
Diagram adapted from 'The impact and recovery of asteroid 2018 LA'
Published in Meteoritics and Planetary Science
Jenniskens et al, https://doi.org/10.1111/maps.13653
Members of the expedition which found 22 fragments, October 9-12, 2018

Standing left to right Tim Cooper (ASSA), Oliver Moses (ORI), Mohutsiwe Gabadirwe (BGI), Thebe Kemosedile (ORI), Sarah Tsenene (DWNP), Kabelo Dikole (BGI), Mosarwa Babutsi (Botswana National Museum, Gaborone), kneeling Kagiso Kgetse (DWNP) and Peter Jenniskens (SETI Institute). Photo by team member Odirile Sempfo.
### Fragments of meteorite Motopi Pan

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<tr>
<th>MP-#</th>
<th>Latitude (°S)</th>
<th>Longitude (°E)</th>
<th>Alt. (m)</th>
<th>Date (2018)</th>
<th>Time (UTC)</th>
<th>Finder</th>
<th>Affil. †</th>
<th>Mass (g)</th>
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*Table adapted from that in Meteoritics and Planetary Science

Jenniskens et al, [https://doi.org/10.1111/maps.13653](https://doi.org/10.1111/maps.13653)
Fragments of meteorite Motopi Pan

Images credit Peter Jenniskens, adapted from ‘The impact and recovery of asteroid 2018 LA’ Published in Meteoritics and Planetary Science, Jenniskens et al, https://doi.org/10.1111/maps.13653
Examples of finds which were not meteorites;
MP-not 1 is a piece of charcoal from recent bush fire
MP-also not 1 is a Gemsbok dropping.
Meteorite images courtesy Peter Jenniskens
Non-meteorite images by Tim Cooper
Gaborone video, calibration of lamp brightness
Calibration image taken by Tim Cooper
Diagram adapted from 'The impact and recovery of asteroid 2018 LA', Published in Meteoritics and Planetary Science, Jenniskens et al, https://doi.org/10.1111/maps.13653
Team members responsible for securing and calibrating video footage from 2018 LA bolide and shadows: Left to right Tim Cooper (ASSA), Dr Oliver Moses (ORI) and Dr Peter Jenniskens (SETI Institute and NASA Ames)
Scientific results by 66 authors (2018 LA Consortium)
Impact and recovery of asteroid 2018 LA

Peter Jenniskens [1, 2], Mihutulina Gabaldzhieva [3], Qing-dha Yin [4], Alexandre Preyler [5], Oliver Roses [6], Tomas Kahout [7, 8], Piotr Franchi [8], Roger L. Gibson [9] and the 2018 LA Consortium


Asteroid 2018 LA


New detection: asteroid 2018 LA in SkyMapper Survey data.

On June 2, 2018, asteroid 2018 LA was detected by the Catalina Sky Survey on an impact trajectory, 6 hours before possible impact. A video security camera in Ototsk, South Africa, recorded a fireball on the night of May 30/31, 2018, over service town of Ottsoko near Croagh. Here, we report on additional detections in the SkyMapper Survey data from their discovery on June 2, 2018, and their orbit and enable an approximate determination of the asteroid’s spin period and shape.

Recovery


Video security camera footage from Ototsk, Khabarovsk, Harbin, Rakeshpur and Ghazi was calibrated to triangulate the fireball disruption. From that position, using wind model data, the fall area was calculated. First meteorite found on June 23, 2018 by László Soltész of BruST.

Video detection of the fireball.

Fall area in Central Khakassian Nature Reserve in central Siberia. Red ellipse is the position of the fireball estimated by video triangulation. Black ellipse is the position of the fireball after taking into account the asteroid’s atmospheric drag. Blue line shows the ground-projected path, with orange circles marking 10-km steps in altitude. Thin black line is the calculated fall line. Orange areas were searched, yellow dots are found.

Planetary Defense


Reflectance spectra: Isotopic & elemental compositions:

Analysis of 7 meteorites showed these were part of a HED polymict breccia derived from howardite, cumulate and basaltic eucrites, and diogenite orthoites. Some similarities and some differences with howardite Sanjakbey were noticed.

Vesta crater age versus size

Age distribution of a known HED:

Orbit of 2018 LA is consistent with origin at Vesta (S - 4 A), hence a pristine type C impactor (age 23 ± 4 Ma, similar to HED Sanjakbey, thought to have originated at the asteroid impact crater). Unlike Sanjakbey, Nukur Pan experienced a heating event 42.4 ± 4 Ma ago, possibly from formation of asteroid impact basin. Later formation of Khashtah spread this material around. On top of Khashtah spectra is 10-km sized crater Rufts, a good candidate for the origin crater.

Acknowledgements & further reading:

Poster paper presented by Dr Peter Jenniskens to the 7th IAA Planetary Defense Conference, Vienna, 26-30 April 2021
In this issue:

Award of Overbeek Medal to Magda Streicher and Clyde Foster

Asteroid 2018 LA
(Observed in space and recovered on the ground)

The Eta Aquariids in 2021

Visit to SARAO Carnarvon