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Was the formation of a 20km diameter lunar crater observed in June, 1178 AD?

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Acknowledgements

Everyone I’ve bugged about this, including...

Bill Bottke, Alan Bernstein, Brad Schaefer

Lon Hood, Tim Swindle, John Lewis, Jay Melosh

Laz, Jen, Betty, Maria

There are bound to be a few people I’ve forgotten...

...On the Sunday before the Feast of St. John the Baptist...was witnessed by some five or more men...Now there was a bright new Moon...and suddenly the upper horn split in two. From the midpoint of this division a flaming torch sprang up, spewing out...fire, hot coals, and sparks...The body of the Moon which was below writhed...throbbed like a wounded snake. Afterwards it resumed its proper state. The phenomenon was repeated a dozen times or more. [Finally] the Moon...along its whole length took on a blackish appearance. [The witnesses] are prepared to stake their honour on an oath that they have made no addition or falsification in the above narrative.

Talk Structure

- Why is this important?
- A look at Giordano Bruno
- Testing the hypothesis using samples, crater counting, crater appearance, laser ranging, and historical sources
- Conclusions

Why is this important?

- If true...
  - Dangers from NEAs
  - Very young large crater to study
  - Can be used to constrain ages of other craters
- If false...
  - Perhaps we'll learn something along the way

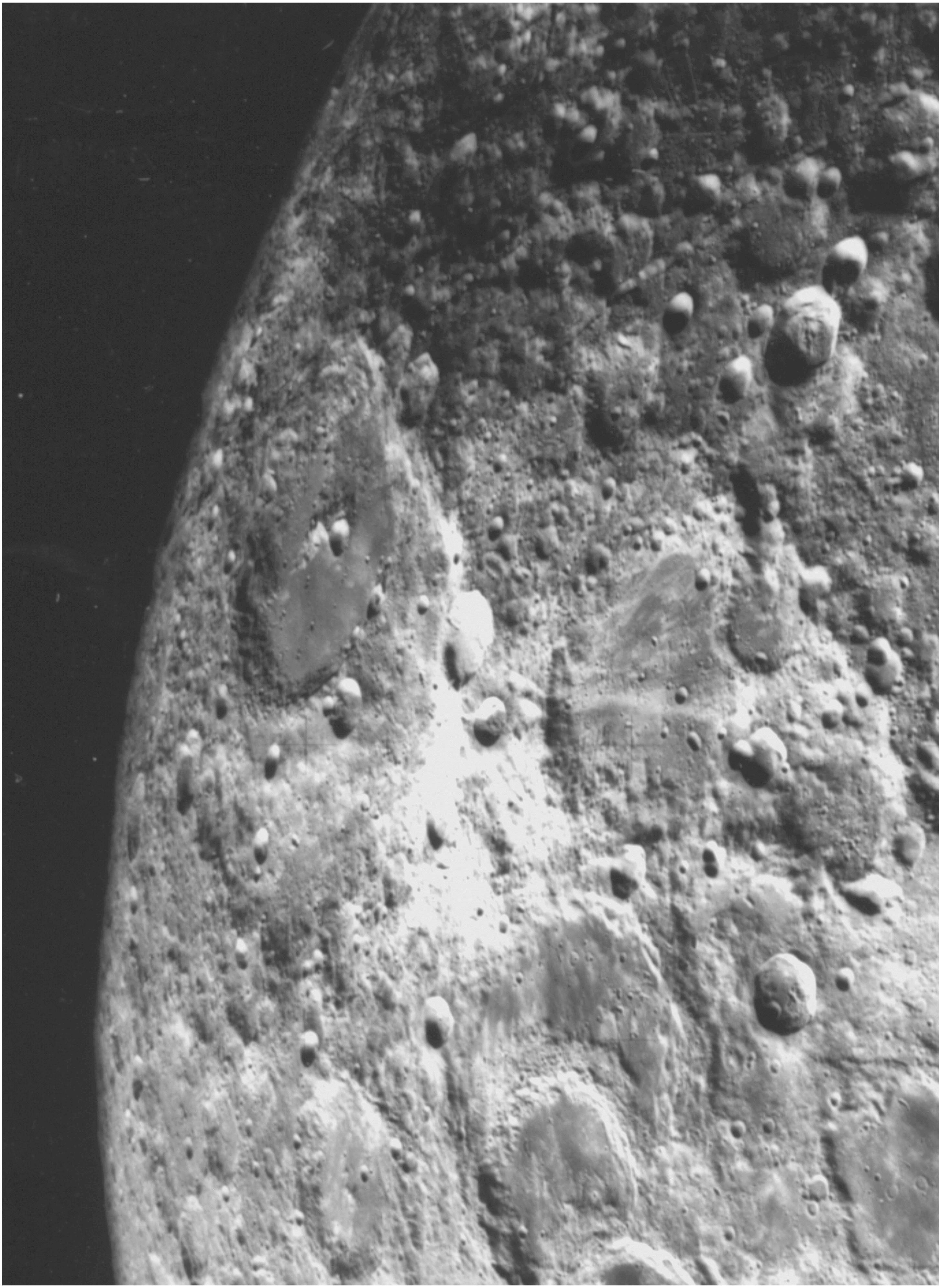
A look at Giordano Bruno

22km diameter, 36ʼN, 103ʼE, unseen from Earth.

Based on uneroded shape, extensive rays, and optical maturity of ejecta, this is the youngest crater of its size or larger on the Moon.

Not well constrained by data...

Suggested as impact site based on position, size, and immaturity - Hartung.



Testing the hypothesis - Samples

Samples can be radiometrically dated.

Apollo - nowhere near.

Luna 24 - just missed a ray close to limb - Maxwell and El Baz.

Lunar meteorites - unknown source craters, all ages greater than 800 years old - Warren.

Has been suggested that ALHA81005 came from Giordano Bruno – Ryder and Ostertag.

Results - inconclusive.

Testing the hypothesis - Crater counting

Expect 20 km diameter craters every 15 Myr or so - Bottke.

No 1 km diameter craters inside crater or on ejecta blanket out to 20 km away - Grier.

Lack of 1 km craters restricts age to less than 1 Byr. Very helpful.

Need to resolve 30 m size craters in this region to get 1 Myr age resolution.

Results - probabilities oppose hypothesis.

Testing the hypothesis - Weathering

Grier's OMAT data compared to both larger and smaller craters suggest age less than 100 Myr.

Uneroded appearance and extensive bright rays suggest "young" age.

Pieters et al preliminary analysis of Clementine data suggests either older than 800 years or lunar weathering much faster than expected.

Results - younger than 100 Myr, probably older than 800 years.

Testing the hypothesis - Laser ranging

Moon is "ringing like a bell" and is do so more violently than expected.

Front cover of Science, February, 1978 - data support 800 year old Giordano Bruno – Calame and Mulholland.

Closer look at data doesn't support or refute hypothesis. 1981, not on front cover of Science - Yoder.

Only other current explanation for "ringing" requires at least partially liquid lunar core.

Results - Moon has liquid in its core.

Testing the hypothesis - Meteors

The formation of Giordano Bruno deposited 10 billion tonnes of ejecta on Earth. In one week – Gault and Schultz.

Mostly recondensed cm size particles, say 5 gram - Betty.

150,000 magnitude 1-2 meteors per hour. Number is comparable with the peak of the 1966 Leonids. For a week.

Not reported in medieval chronicles - Newton.

Results - strongly oppose hypothesis.

Testing the hypothesis - Other chronicles

- Event should have been visible over much of England and northern France.
- Six chronicles in this region record a solar eclipse 3 months later, so are interested in astronomical events - Newton.
- No other records found to date.
- Bad weather that night?
- Results - oppose hypothesis, with caveat.

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Testing the hypothesis - Gervase's report

- Moon not visible on date in question - and date is accurate for solar eclipse 3 months later – Meuss, Schaefer, Newton.
- Only five witnesses, all seated together.
- Distinguish "fire, hot coals, and sparks" on Moon.
- "Writhing" of the Moon.
- "A dozen times" used to describe a single impact.
- Consistent with fireball appearing from Moon.
- Results - oppose hypothesis, as pointed out by Nininger and Huss.

Was the formation of Giordano Bruno witnessed 800 years ago?

- Samples, laser ranging are inconclusive.
- Cratering fluxes, weathering, lack of confirmation suggest not.
- Lack of meteor storm and fireball-like nature of Gervase's report strongly suggest not.

How old is Giordano Bruno?

Comparison of weathering with radiometrically dated craters (Copernicus, South Ray) suggest less than 100 Myr old.

Bottke impact fluxes suggest less than 30 Myr old.

Pieters weathering suggest older than 800 years, can probably constrain to an even earlier bound.

What did Gervase's witnesses see?

A meteor with the right position and velocity to appear coincident with the Moon.

Explains nature of report.

1 km2 footprint on ground explains lack of other witnesses around Canterbury.

Probabilities not too unreasonable.

Ignore date problem...

Why has this idea not died away?

Fascinating idea, much more interesting than alternative.

Difficult to test.

Description consistent with impact to non-specialists.

Meteor storm calculations not yet published - though I bet Jay has done them.

How can it be tested further? Answers on the comments sheets please.