AGU P027-01
Rosetta 2014
https://agu.confex.com/agu/fm14/webprogrampreliminary/Session1556.html

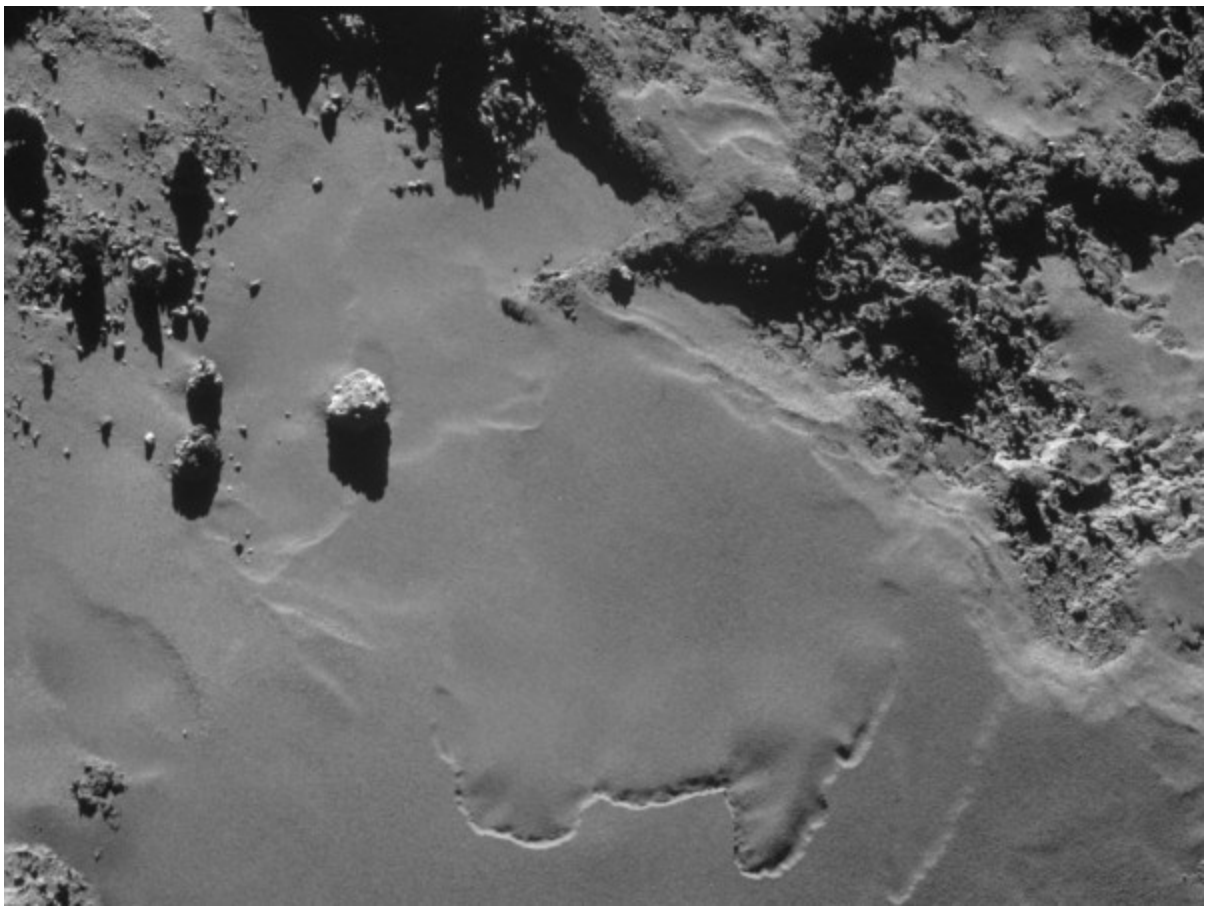
P32B - Rosetta 2014 I
Wednesday, December 17, 2014
10:20 AM - 12:20 PM PST
https://agu.confex.com/agu/fm14/meetingapp.cgi#Session/1556

P33F - Rosetta 2014 II
Wednesday, December 17, 2014
01:40 PM - 03:40 PM
https://agu.confex.com/agu/fm14/meetingapp.cgi#Session/4552

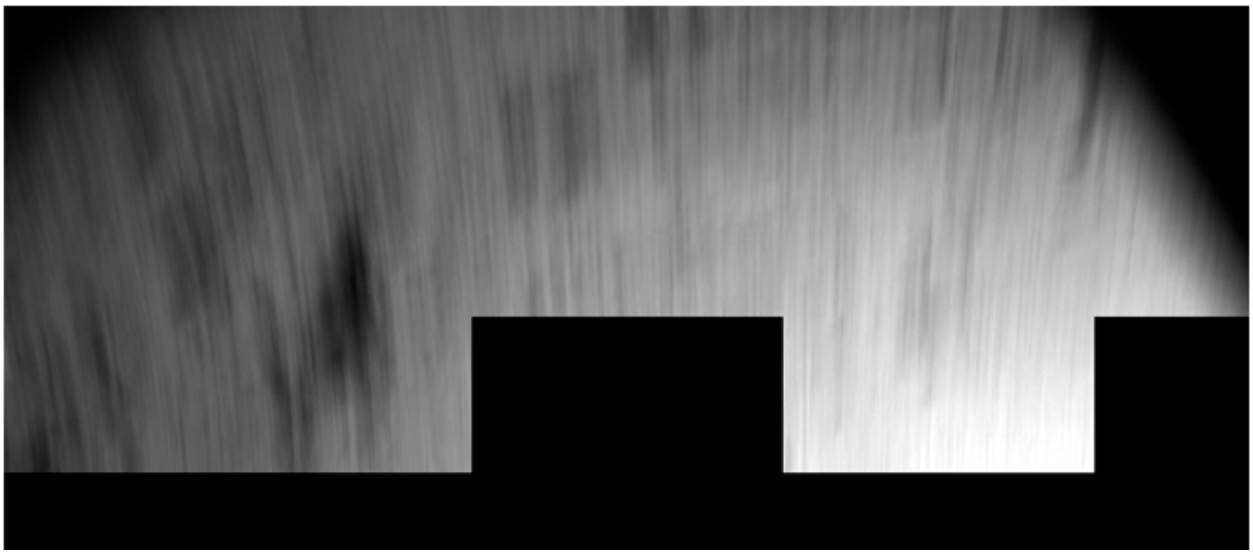
P34B - Rosetta 2014 III
Wednesday, December 17, 2014
04:00 PM - 06:00 PM
https://agu.confex.com/agu/fm14/meetingapp.cgi#Session/4553

P41C - Rosetta 2014 IV (Posters)
Thursday, December 18, 2014
08:00 AM - 12:20 PM
https://agu.confex.com/agu/fm14/meetingapp.cgi#Session/4554

Many of the sessions can now be viewed on demand:
https://virtualoptions.agu.org/search/rosetta



TD1 on 67P/Churyumov-Gerasimenko viewed at a 10-kilometer distance
(*from*: http://news.sciencemag.org/europe/2014/11/tensions-surround-release-new-rosetta-comet-data)



First image taken by Philae lander during bounce
(from: http://www.nasa.gov/sites/default/files/thumbnails/image/pia19094_bounce.jpg)

P32B - Rosetta 2014 I
Wednesday, December 17, 2014
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Altwegg: Even after 10 years in space, Rosetta is still outgassing. ROSINA detects this as water - has determined Rosetta is terrestrial

Altwegg: Rosetta has found 3x terrestrial amount of heavy water. Suggests Kuiper belt comets are diverse, Earth water from asteroids

Altwegg: have detected Na, Mg, Ca, but only over winter "hemi-duck", not summer; probably sputtered by solar wind impacting surface

Altwegg: surprised by variety of species in CG. Didn't expect more than H2O, CO, CO2; has found nearly everything ever seen in comets

https://virtualoptions.agu.org/media/P32B-01.+Rosetta+2014+I%2C+Presented+By+Kathrin+Altwegg/0_342gp17c

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Sierks: Looking at cliffs/scarps, see odd texture, round granular 2-3m in diameter (he called them "dinosaur eggs"), all over comet

[note that Sierks presentation was NOT live streamed and the public was not shown these images]

Emily Lakdawalla tweeted: “Holy cow, the amazing structures in Sierks' presentation of high resolution OSIRIS images. I WANT THOSE IMAGES”

Alexandra Witze tweeted: “Those gorgeous OSIRIS images Sierks showed here? Unavailable to the public”

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Bentley: MIDAS atomic force microscope on Rosetta seems to be imaging fluffy micron-sized aggregates, much bigger than expected

Bentley: MIDAS hasn't seen expected sub-micron-sized grains. Not sure if actually don't exist or if they're not reaching detector

https://virtualoptions.agu.org/media/P32B-03.+Rosetta+2014+I%2C+Presented+By+Mark+Bentley/0_vnhfxqu9

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Rotundi: GIADA has now detected 800 dust grains. About 700 are very slow particles arriving in "dust clouds"

Rotundi shows cool plots of where GIADA comet dust detections were in space around comet -- clearly associated w/active N hemisphere

https://virtualoptions.agu.org/media/P32B-05.+Rosetta+2014+I%2C+Presented+By+Alessandra+Rotundi/0_hu9shcgt

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Choukroun: Hemisperic outgassing from the dayside of the comet with velocity of ~700m/s. Outgassing rate of 1x10^25/s that's ~300mL/s

Choukroun: diurnal variation in water, thermal inertia measurements from MIRO tell us water located within a few cm of comet surface

https://virtualoptions.agu.org/media/P32B-06.+Rosetta+2014+I%2C+Presented+By+Mathieu+Choukroun/0_56amxop2

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Capaccioni: VIRTIS temp maps show high T up to 220 K on some surfaces. Strong shadow effects on neck--maybe related to its activity?

Capaccioni: Very high resolution VIRTIS observations have detected some water ice on comet surface, maybe exposed by landslides

[Capaccioni's demonstration of this was very unconvincing]

https://virtualoptions.agu.org/media/P32B-07.+Rosetta+2014+I%2C+Presented+By+Fabrizio+Capaccioni/0_eb9d69c6

P33F - Rosetta 2014 II
Wednesday, December 17, 2014
01:40 PM - 03:40 PM
https://agu.confex.com/agu/fm14/meetingapp.cgi#Session/4552

Groussin: Examples from all over comet of basins forming by collapse into interior voids. Suspects they are primordial voids

Groussin: Can estimate strength of comet surface material from overhangs. <20Pa. Notes similar strength/gravity ratio to Earth

[Groussin's presentation was not live streamed and the public did not see the images shown. Some apparently were 3D images]

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Emily Lakdawalla tweeted: "'I warned theAGU that Rosetta session would be too popular for its 300-seat room. They made an overflow room to stream live feed but...Many of Rosetta mission scientists have redacted their talks from the live feed, so #AGU14 attendees in overflow room cannot watch it!" . . . .

"Even members of the Rosetta science team are not being permitted to see OSIRIS images they *need* to do their mission research. Ridiculous." . . . .

"I should note that Rosetta is hardly alone among space missions whose imaging teams have restricted other mission teams' access to data." . . . .

"Spacecraft cameras are both science instruments *and* context for other instrument data. These problems need to be fixed in contracts."

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Feaga: Comet is very dark (1-2% reflectivity). slight blue slope. See big differences in spectral slope from head to neck to body

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Andrew Steffl tweeted: "I find it odd that in the #Rosetta session at #AGU14, the vast majority of questions are asked by Rosetta Co-Is."

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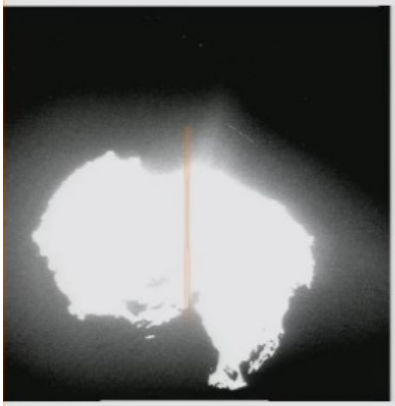
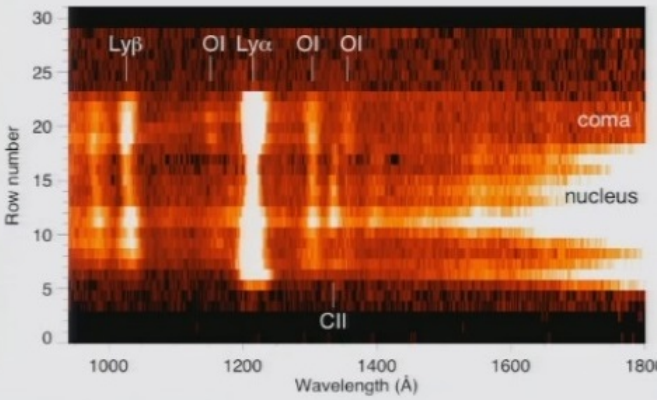
Feldman

https://virtualoptions.agu.org/media/P33F-03.+Rosetta+2014+II%2C+Presented+By+Paul+Feldman/0_m9wuzur3

Alice — September 21 observations



OSIRIS Wide Angle Camera
UT 01:10
OSIRIS images courtesy of H. Sierks and J.-B. Vincent

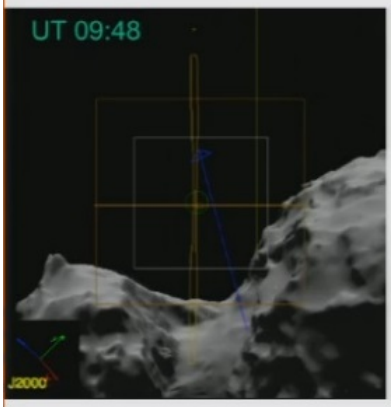


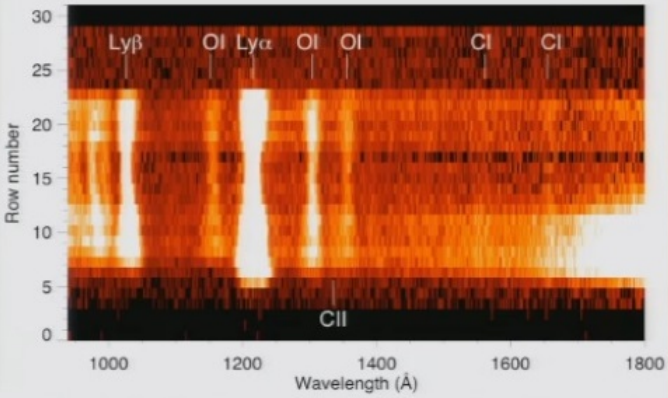
r = 3.33 AU; d = 27.9 km;
1 row = 145 m; phase = 79.2°

12/17/14

Alice — November 29

In this case we see the coma emissions above and against the neck. The C I emissions also appear weakly across the entire length of the Alice slit.





12/17/14

18

Alice

Summary (1)

- The far-ultraviolet spectrum of the coma of 67P/Churyumov-Gerasimenko as observed by *Alice* consists predominantly of H I and O I emissions and has not changed over 4 months of observation.
- The presence of both O I λλ1152 and 1356 suggests that a dissociative process involving H_2O is the source of the observed atomic emissions. The relative intensities are roughly consistent with the laboratory electron impact (200 eV) spectra of Makarov et al. (*JGR* **109**, A09303, 2004). Laboratory cross sections for 20-50 eV electrons do not exist.
- This spectrum is fundamentally different from far-ultraviolet comet spectra observed from Earth orbit, which view the coma on scales of hundreds to thousands of km, in which atomic emissions are due to resonance fluorescence of solar UV radiation.
- The atomic emissions exhibit brightness variations with sub-spacecraft longitude and latitude similar to abundance variations observed by other *Rosetta* orbiter instruments (ROSINA, MIRO).

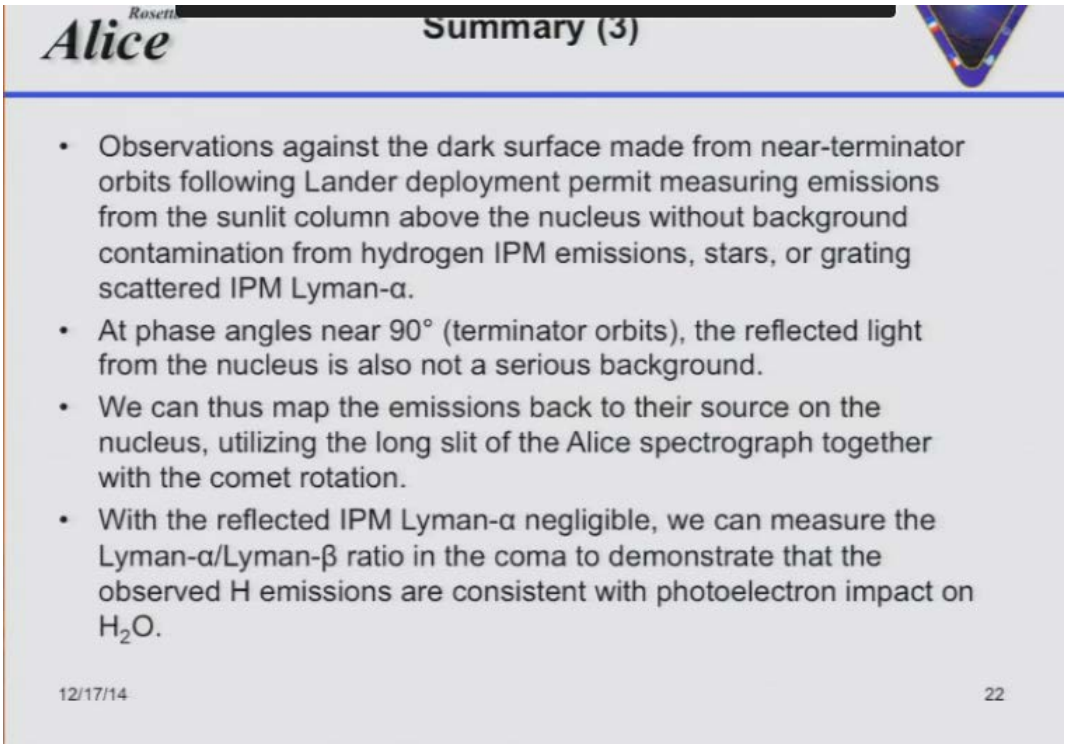
12/17/14

Alice

Summary (2)

- The source of electrons is photoionization of H_2O, giving photoelectrons with energies in the 20 - 50 eV range (as detected by RPC/IES).
- Mechanism is similar to that used to explain the detection of H_2O plumes on Europa (Roth et al., *Science* **343**, 171, 2014), except that H I Lyman-β is observed instead of Lyman-α.
- Photodissociation of H_2O into excited atomic states does not appear to be sufficient based on solar rate (Wu and Chen, *JGR* **98**, 7415, 1993) and by selection rules for H_2O absorption that favor the formation of O in singlet states rather than triplets (1304 Å) or quintets (1356 Å) (Wu and Judge, *J Chem Phys* **89**, 6275, 1988).
- Spectra also show emission of C I λλ1561 and 1657 and C II λ1335, indicative of electron impact excitation of either CO_2 or CO. The relative cross-sections (Ajello, *J Chem Phys* **55**, 3158, 3169, 1971) suggest CO_2, whose derived abundance relative to H_2O is variable.

12/17/14



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Wurz: ROSINA sees major differences in coma composition from nothern to southern comet hemisphere

Wurz: south is "carbon hemisphere," dominated by CO2; water, CO small & similar abundance; move to north and water dominates

Wurz: ROSINA sees heterogeneity in water emission -- most from neck. Also in sulfur -- from neck as well as body

https://virtualoptions.agu.org/media/P33F-04.+Rosetta+2014+II%2C+Presented+By+Peter+Wurz/0_p5hbtqyd

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Langevin -- photos from COSIMA of comet dust collected on plates. First comet dust collected at low velocity

Langevin: COSIMA collecting large (400 microns) dust aggregates, like microscopic rubble piles, disaggregated on impact

Langevin: Some larger grains have moved over time -- by what force?

Scattered clusters

subpixel sampling (7 µm steps, 14 µm pixel)

Kamil (3D0)

Many examples
at all size ranges
since August

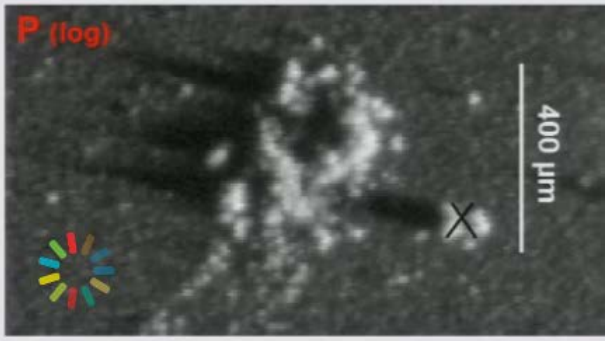
Very complex shadows,
substructure

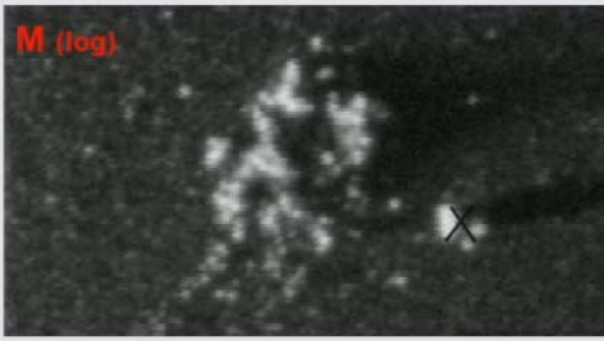
400 x 400 µm (x-y)
20 - 50 µm (z)

Scattered grains from
a single parent particle

Higher velocity ?

still not very high:
rebounds / craters
expected from simulations
at 100 m/s





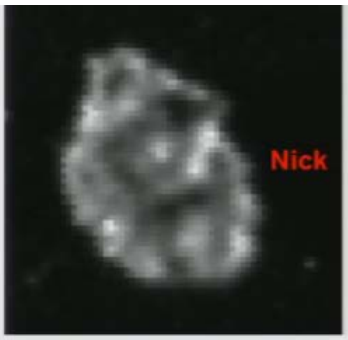
solid grains (2)

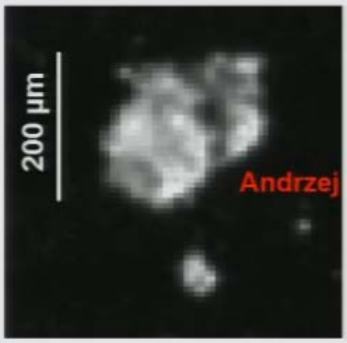
Irregular shapes,
large and small pits

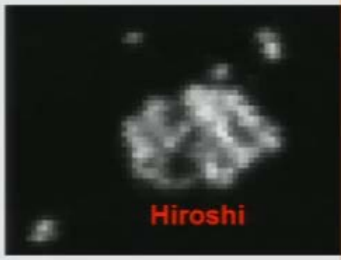
another hint towards
partial sublimation ?

albedo contrasts

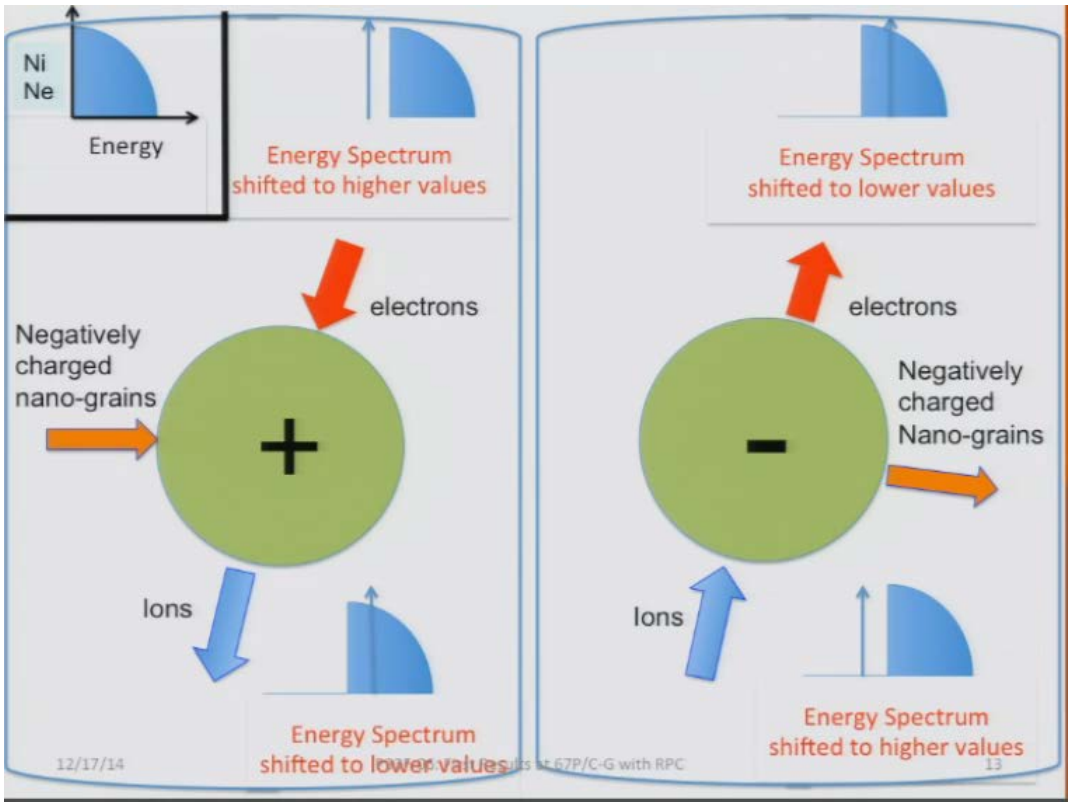
(TBC with different
view angles)







Linear scale, combining both illuminations,
all four images at the same spatial scale



First conclusions after 3 months

- The collection rate (> 2000) much exceeded expectations (factor ~ 100 !) and the collection velocity was also lower than expected (<< 100 m/s)
  Cometary dust models need to be significantly adjusted

- Wide range of sizes, shapes, structures, thickness, scattering efficiency
  - rubble piles (low cohesion, many sub-components)
  - shattered aggregates
  - dark subdued clusters (extremely low cohesive strength)
  - grains holding together after collection
- Most large features during the first two months are aggregates, rubble piles, shattered or subdued clusters: « old » grains in orbit ? Dust mantle material ? link with IDP's ?
- During the last weeks, COSIMA encountered two dust storms, with large, cohesive, mobile grains (> 200 µm in size);

  - mobility, pitted structure: hints towards partial sublimation ?

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Emily Lakdawalla tweeted: “I see a different space mission PI doing A Bad Thing in the front row of the Rosetta session, taking pictures of Biele's slides”

[Biele’s talk was not streamed live to the public and the public did not see these images]

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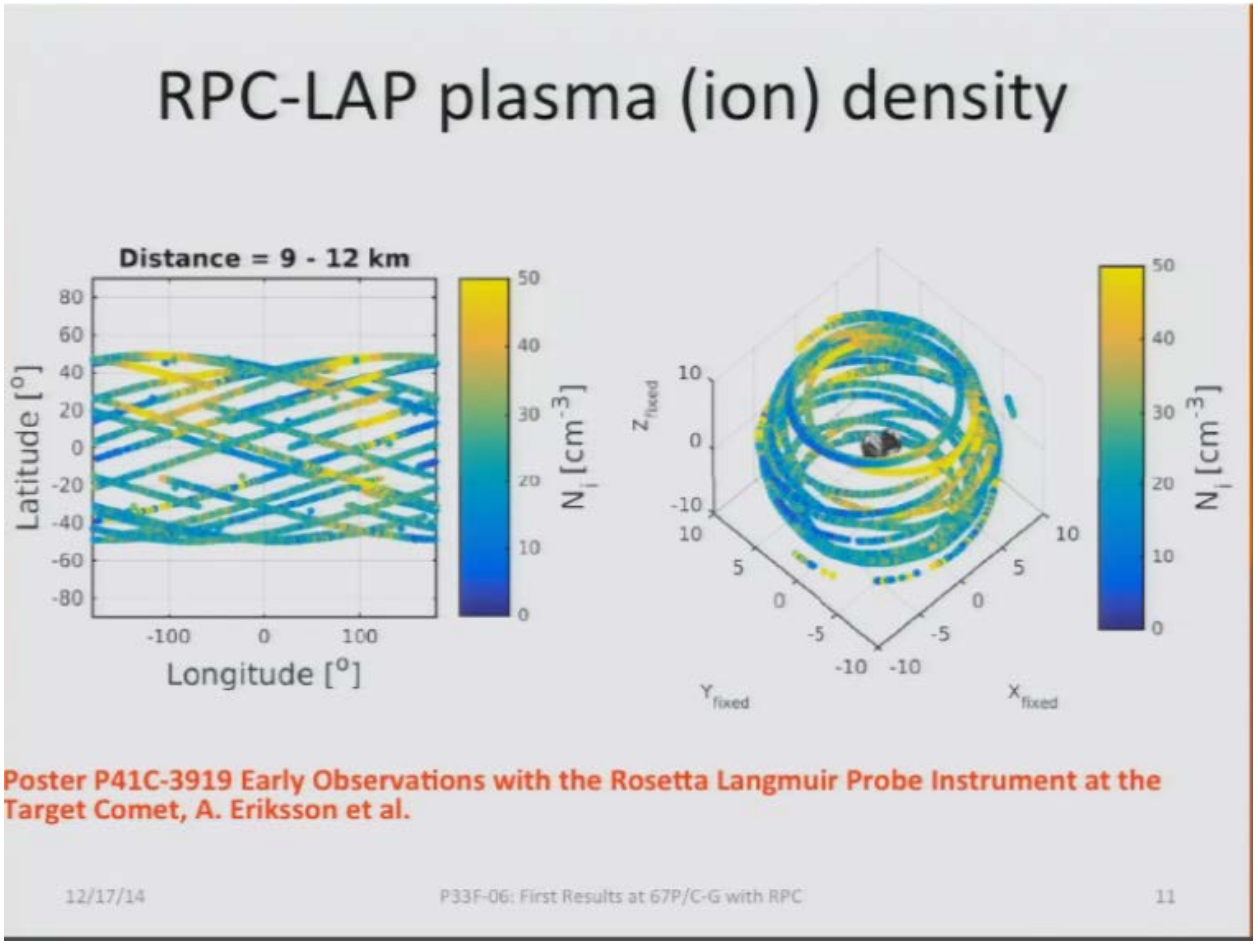
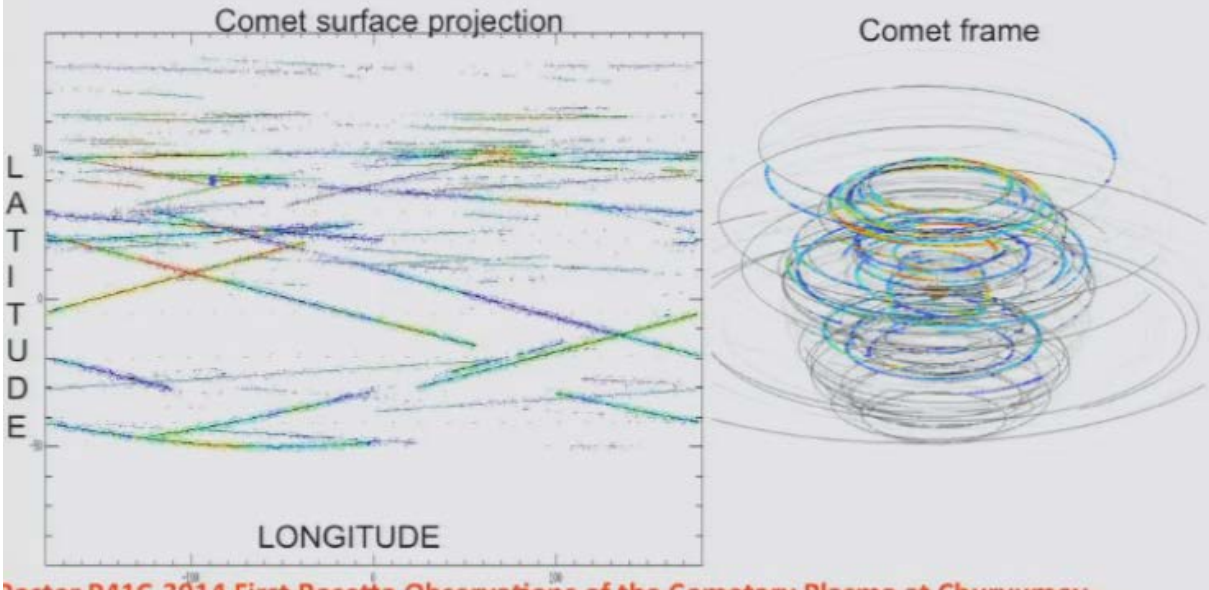
Lebreton

https://virtualoptions.agu.org/media/P33F-06.+Rosetta+2014+II%2C+Presented+By+Jean-Pierre+Lebreton/0_gv1i3y6u



RPC-MIP plasma (electron) density



Poster P41C-3914 First Rosetta Observations of the Cometary Plasma at Churyumov–Gerasimenko with the Mutual Impedance Probe (RPC-MIP), P. Henri et al.

P34B - Rosetta 2014 III
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https://agu.confex.com/agu/fm14/meetingapp.cgi#Session/4553

Kofman: At 14:50 CONSERT started detecting reflections from the surface of the comet during its descent

Kofman: Early CONSERT results: get good signal where radio was only going through comet "head," poor when also going through body

Kofman: no evidence for volume scattering in comet interior

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Auster: Because of bounces, ROMAP got 4 measurements of comet mag field in 4 different places. Saw no magnetic field at all at any

Auster: Comet magnetization is lower than anything measured on Earth, Moon, meteorites. Only other place measured so low was asteroid Eros

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Spohn: Philae MUPUS finds a lower limit on compressive strength of ~1 MPa from lack of hammer penetration, possibly like firn

Spohn: Most important Philae MUPUS finding; Very hard comet surface, covered with dust mantle of at most 15cm thickness

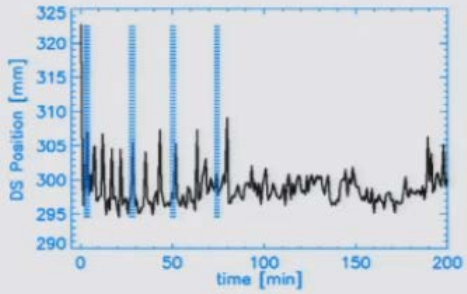
--**MarsRovers PI Steve Squyres** asks: MUPUS sees 10-15cm dust layer, but CIVA images don't show that; can you reconcile that conflict?
--**Spohn**: No.

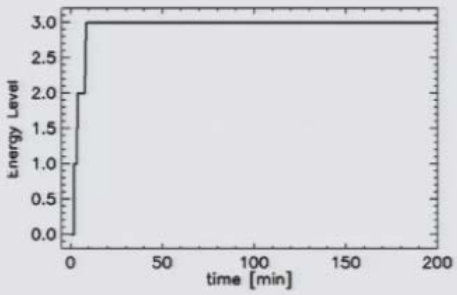
https://virtualoptions.agu.org/media/P34B-03.+Rosetta+2014+III%2C+Presented+By+Tilman+Spohn/0_pkszxshj

What MUPUS (probably) did not do and what it did do:

- **Did not do**:
  - Since we did not penetrate into the ground, there was no measurement of the near surface temperature and thermal conductivity profiles!
  - Since the anchors were not fired, temperature measurement at ca 1-2m depth and accelerometry was not performed!
- **Did do:**
  - Measurement of the strength of the ground upon penetration attempt!
  - Thermal mapping on approach and during hopping across the surface!
  - Measurement of the thermal diurnal cycle with both TM and PEN from which the thermal inertia can be derived!

Hammering, Depth Sensor





- Depth sensor indicates that there was an initial displacement (penetration) of about 20mm. Thereafter, the depth sensor amplitude is about 5mm max.
- The power level was increased to the highest level because of the failure to penetrate at lower levels.
- The hammer operated for 3.5h albeit not at the full frequency (H/W issue) and possibly not at the full strength of PS4 (tbc).

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Biele: Lander down 112m from target. Bounced due to harpoons not firing. A number of hops and bounces incl. one grazing collision

Biele: accelerometer data from Philae lander feet: major contact 200ms after first contact: 1m/s descent means soft surface dust 20cm thick

Biele: Assuming elastic collision for 1st Philae impact, get comet surface strength >0.4 MPa

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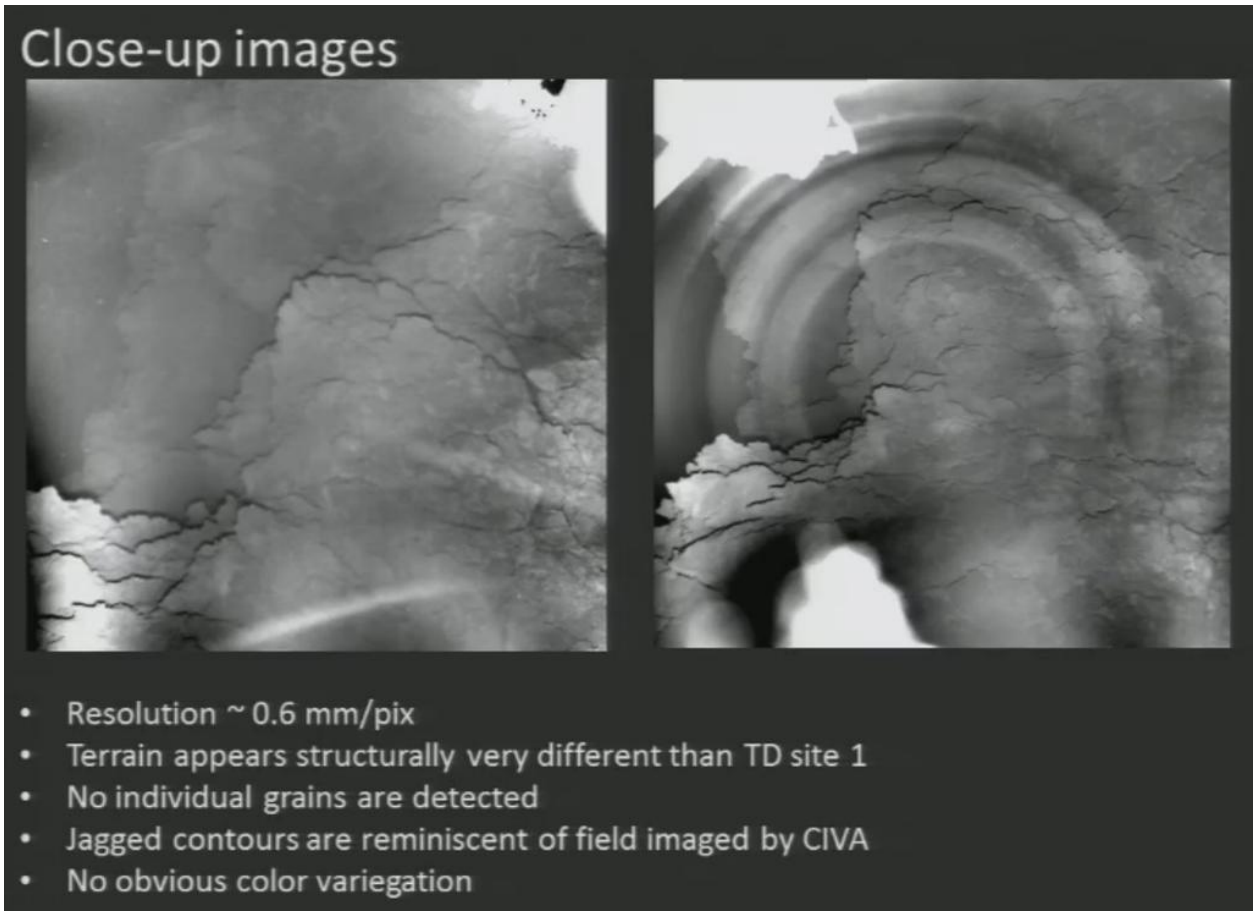
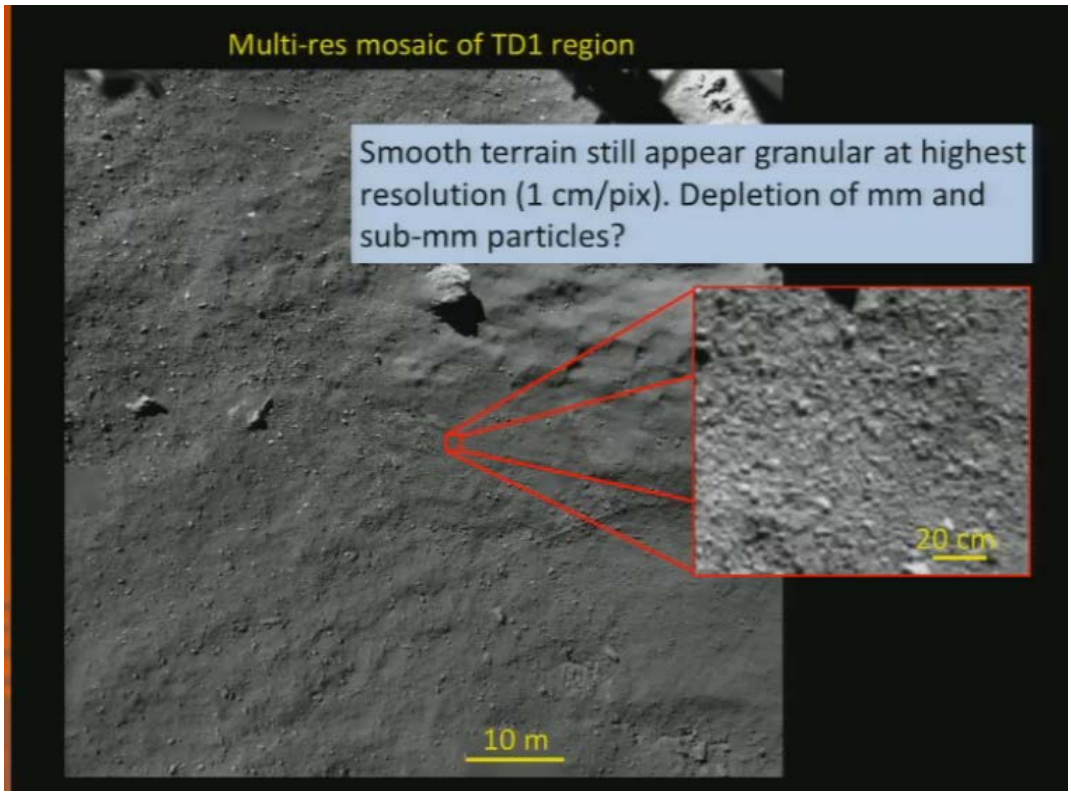
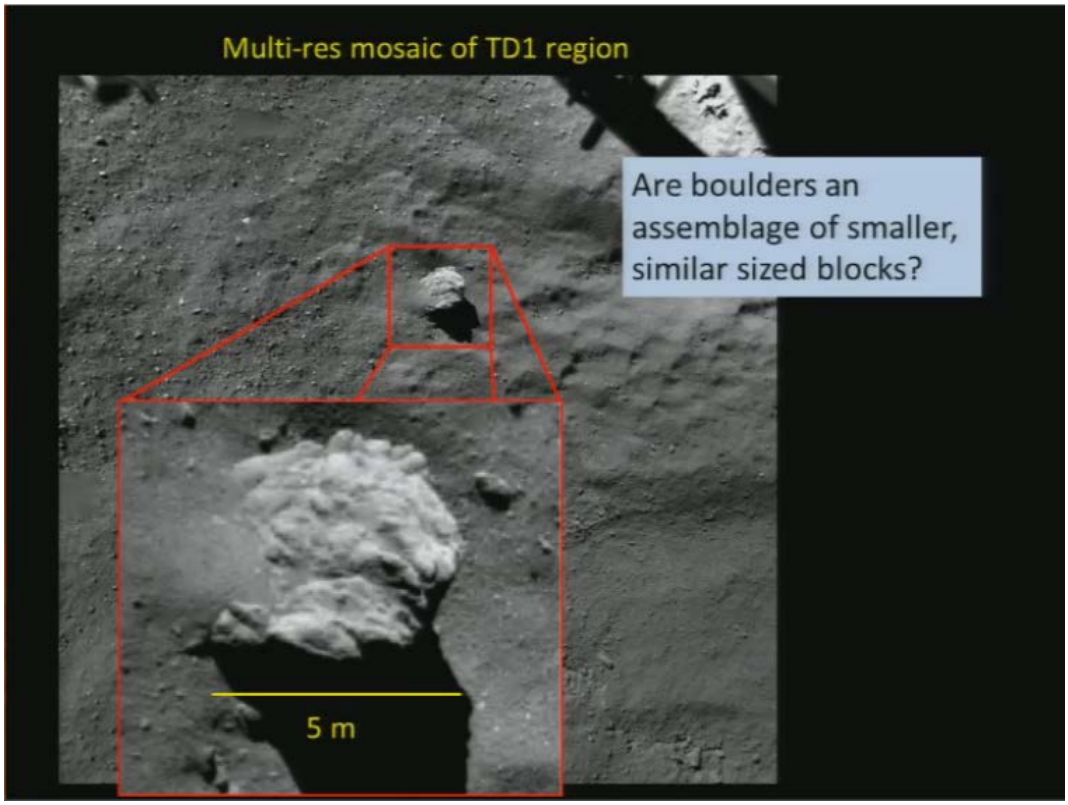
Mottola: ROLIS camera, like CIVA, does not see dust blanketing everything -- but other instruments suggest it's there



Mottola showed ROLIS images of surface under Philae lander
(from: https://pbs.twimg.com/media/B5Gdd9gIUAA5u9i.jpg)


Multi-res mosaic of TD1 region
Smooth terrain still appear granular at highest resolution (1 cm/pix). Depletion of mm and sub-mm particles?
20 cm
10 m


Multi-res mosaic of TD1 region
Are boulders an assemblage of smaller, similar sized blocks?
5 m

Conclusions

- The ROLIS instrument acquired the first close-up images of a cometary surface
- Touch-down site 1 (TD1) is covered by regolith and blocks ranging in size from 5m down to the resolution limit (1 cm)
- Hints of processes as regolith mobilization and boulder fragmentation are observed
- Pitted terrain suggests the presence of collapsed pits as a consequence of subsurface ice sublimation or explosive event.
- Preliminary size-frequency distribution of particles on the surface indicate that the material has similar cumulative power-law slope ~ –3, similar to that of ejected particles observed by OSIRIS.
- Close-up images of the landing site reveal characteristics different from those of TD1: no particles or blocks are seen. The jagged terrain observed appears qualitatively different from the blocks in TD1.
- The color variations observed in the close-up field are very small. Some neutral reflectance variations at the ~4% level are detected.

P41C - Rosetta 2014 IV (Posters)
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Jorda: comet volume 21.4±2.0 km^3. Density 470±45 kg/m^3. Grav acceleration 1.3-2.2 cm/s^2, mean 1.6. Surface area 47.4±0.8 km^2

Jorda: comet's gravitational potential at lowest in neck. Slopes locally as steep as 60 degrees (steepest in cliffs at base of head)

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Schroeder: ROLIS images contain out-of-focus comet dust particles moving, seen only in long exposures. Must be quite far from lander

Schroeder: ROLIS post-landing images include one "dark" frame in which scene beyond horizon wasn't dark. Comet jet? Illuminated wall?