Boulder morphology at the DART impact site

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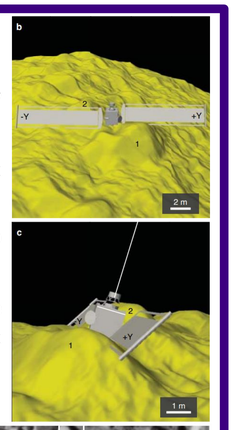
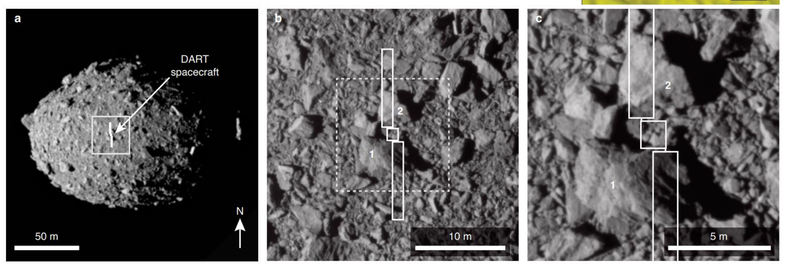
CONTEXT

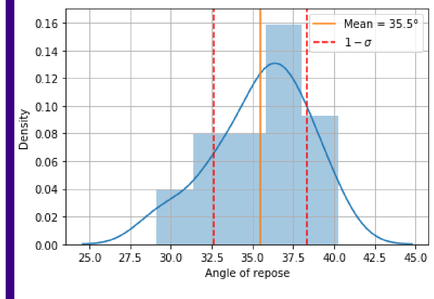
- Last full image of **Dimorphos** captured by **DRACO**
  - Blocky terrain covered with large boulders (Largest boulder is 6.5m long)
- Boulder shapes and sizes are linked to **mechanical properties**
  - Influencing **the ejecta properties** (= **efficiency of the deflection**, see Raducan & al. and Kumamoto & al. talks at this conference)





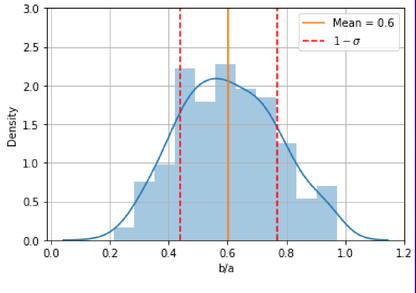
The DART impact site, *Daly, Ernst and Barnouin & al., Nature, 2023*

RESULTS



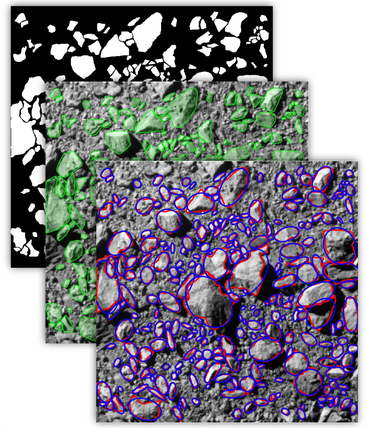
- **Angle of repose** derived from the **roundness** values of the 34 **largest** boulders : $\boldsymbol{\theta = 35.5 \pm 2.9°}$
- Linear relation between φ and R : $\theta = 42 - 17R$ *[Santamarina & Cho, 2004]*
- 35° is also the steepest slope where rocks are observed on top of a boulder on Dimorphos *[Barnouin & al, 2023]*

- **Elongation ratio** of boulders extracted from the last full DRACO image (all ~270 boulders)
- The mean value of 0.6 could be related to a catastrophic disruption formation *[Michikami & al., 2016]*
- Candidate disrupted boulders have been observed on Dimorphos' surface *[Ballouz & al., 2023]*

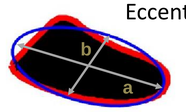


METHODS

- Manual boulder identification
- 2D analysis pipeline of morphological parameters
- ~ 270 boulders selected
  - ~80 around the S/C impact site

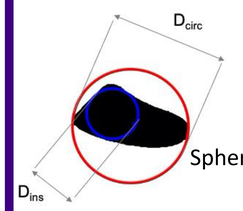


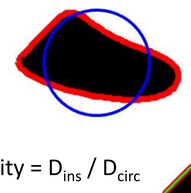
- **Morphological parameters :**



$$\text{Eccentricity} = \sqrt{1 - \frac{b^2}{a^2}}$$

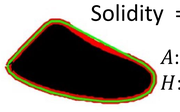
$$\text{Elongation} = \frac{b}{a}$$





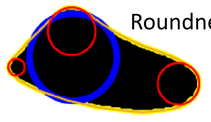
$$\text{Compactness} = \frac{4\pi A}{P^2}$$

$$\text{Sphericity} = D_{ins} / D_{circ}$$



$$\text{Solidity} = \frac{A}{H}$$

A: Area of the particle
H: Area of the convex hull



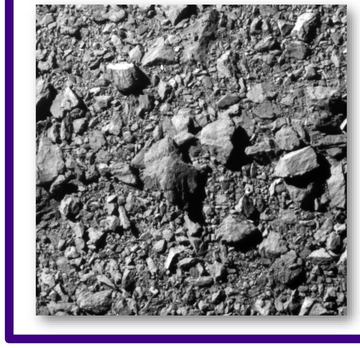
$$\text{Roundness} = \frac{\Sigma_{i=1}^{N} r_i}{N.r_{max}}$$

N : number of corners
r_i: radius of corner circles
r_{max}: radius of the maximum inscribed circle

Methodology from *Zheng & Hryciw, 2015*

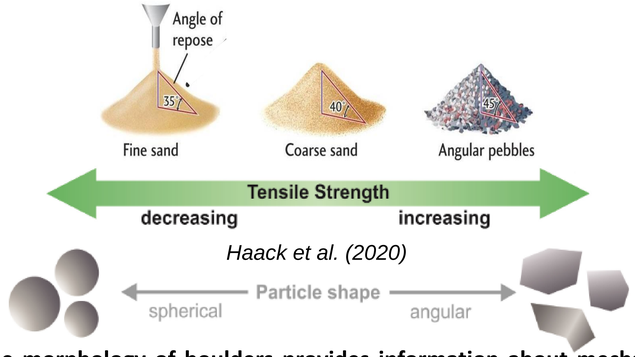
PERSPECTIVES & CONCLUSION

- We made a **morphological analysis pipeline** in order to statistically retrieve **physical properties** from images
- We were able to find, in agreement with other observations :
  - A mean **angle of repose** of **35°**
  - A mean **elongation** of **0.6**
    - Could be related to a **catastrophic disruption** formation of boulders



- Further work will allow to learn more about the **mechanical properties** of boulders regarding their **morphology**
- The pipeline will be used on **other asteroids**, and they will be compared with **Dimorphos**
- The pipeline will also be used with the **Hera mission** which will provide more data and improve our statistics

LINK TO MECHANICAL PROPERTIES



- **The morphology of boulders provides information about mechanical properties**
- Roundness/Angularity and particle size are linked to the angle of friction
  - Lower **roundness**/larger median **particle size** = **larger friction angle** [Bareither & al., 2008] and higher **seismic velocity** *[Liu & Yang, 2018]*
- **Sphericities** reflect **lithology** (mineralogy and structure) *[Sneed and Folk, 1958; Folk, 1980; Briggs, 1977, Yingst & al., 2007]*
- **Sphericity** and **Roundness** enter the calculation of the **cohesive Bond number** *[Grott & al., 2020]*
- **Elongation** ratio of boulders on asteroids has also been linked with the **formation mechanism** *[Michikami & al., 2016]*

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