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An overview of the geology on the C-type Main Belt asteroid (52246) Donaldjohanson from NASA's Lucy flyby

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NASA's Lucy mission [1] will explore the Trojan asteroids, a population of small bodies in the Sun-Jupiter L4 and L5 Lagrange points. En route to the Trojans, Lucy encountered the main belt C-type asteroid (52246) Donaldjohanson on April 20, 2025 [2]. The flyby was an opportunity to assess the performance of the science instruments when observing a small body, as well as test the spacecraft functions needed for the Trojan encounters.

Data types from the Donaldjohanson encounter include visible images from the L'LORRI [3] and TTCam [4] instruments. The images span a range of phase angles, resolutions, and viewing geometries. These data enable measurements of body dimensions and shape [5], albedo [6], and surface features.

The overall shape of Donaldjohanson suggests a contact binary, a situation in which two objects merged to become a single object, with the shape of the merged object expressing a bi-lobed geometry; the connection between the two lobes is narrower and informally called the "neck". One lobe apparently is larger than the other [5]. Craters and boulders, which are common surface features on other asteroids, are present across both lobes and the neck [7, 8]. The surfaces of the lobes express similar regional surface morphologies, apparently dominated by impact cratering. The large lobe has pit-chain like features [9]. The neck's surface is generally smoother than the lobes, and the craters on the neck often appear to be shallower, and some have relatively flat floors. The neck has two prominent ridge-like features that are approximately at either end of its hourglass shape; i.e., the ridges are approximately at the interfaces between the neck and the two lobes. The neck's geometry relative to the lobes results in a distinct region of surface gravity, surface stress, and volumetric stress [10].

Collectively the features, their distributions, and their morphologies may reflect processes expected to be common among all asteroids (i.e. cratering, boulder and regolith generation and redistribution), as well as processes that are the result of contact binary formation and evolution. More broadly, contact binaries have been observed in comets and Kuiper Belt objects (in addition to

asteroids), and the novel high-resolution Lucy data will help elucidate the processes for this class of object.

References

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