OSIRIS-REx
ASTEROID SAMPLE RETURN MISSION

OSIRIS-REx Mission Nomenclature Submission, Batch 1

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Submitted: October 2019

Approved: January 2020, 11 of the 12 submissions

Proposed names of features: Boulders aka Saxum

Feature #1 Proposed Name: Benben

Center latitude: -45.86

Center longitude: 127.59

Northernmost latitude:-40.02

Southernmost latitude:-51.70

Westernmost longitude:119.56 E

Easternmost longitude:135.62 E

Feature size: 52 m diameter (largest axis)

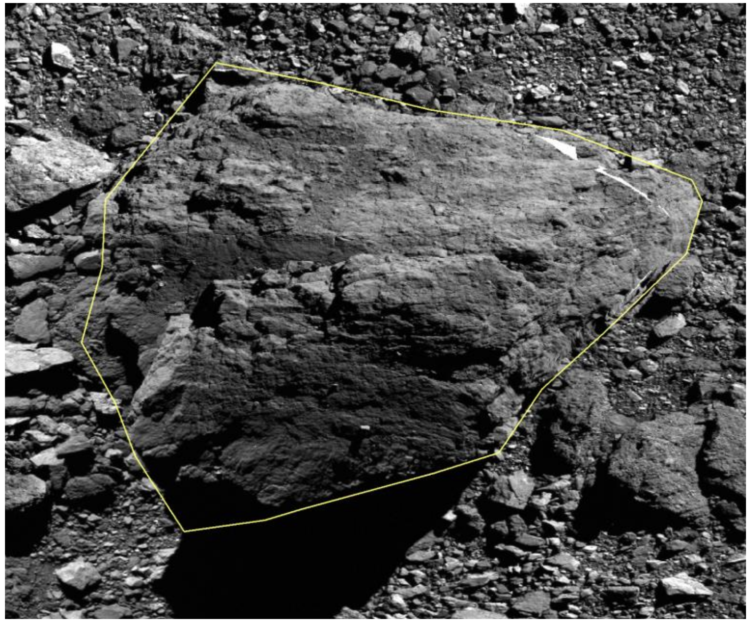
Feature type: Saxum, saxa

CT: AF

ET: EG

Source: [465]

Origin: The god of creation Atum flew over the primordial waters Nu in the form of Bennu, who is a piece of his soul. He landed on a mound called Benben, from which he created the world. The mound was said to have turned into a small pyramid located in Heliopolis. The Benben stone (or Benbenet in ancient Egyptian), named after this primordial mound, was a sacred stone in the temple of Ra at Heliopolis, the location upon which the first rays of the sun fell. The bird diety Bennu was venerated in this city and lived atop the Benben stone. Because of this, pyramids had Benben stones (aka pyramidia), capstones inscribed with titles and religious symbols, and were often gilded to reflect sunlight. They can be seen in museums all over the world.



Justification: The rationale for naming the proposed features comes from their near-term and future inclusion in peer-reviewed papers and geologic maps by the OSIRIS-REx team. This is the tallest localized feature on Bennu and will be a major feature described, discussed, and used to constrain the origin and history of Bennu. Such a large boulder must pre-date the formation of Bennu as will be discussed in several papers (and has been e.g., Walsh et al. 2019 etc.) and numerous published abstracts (please see AGU 2019; LPSC 2019). It was the only feature identified pre-encounter (Nolan et al. 2013) and as thus also has importance in relating Earth-based remote sensing to that of asteroid ops. The OSIRIS-REx team, as well as the broader scientific community, will benefit from using formal names to reference these recognizable and major topographic features.

Proposed names of features: Boulders aka Saxum

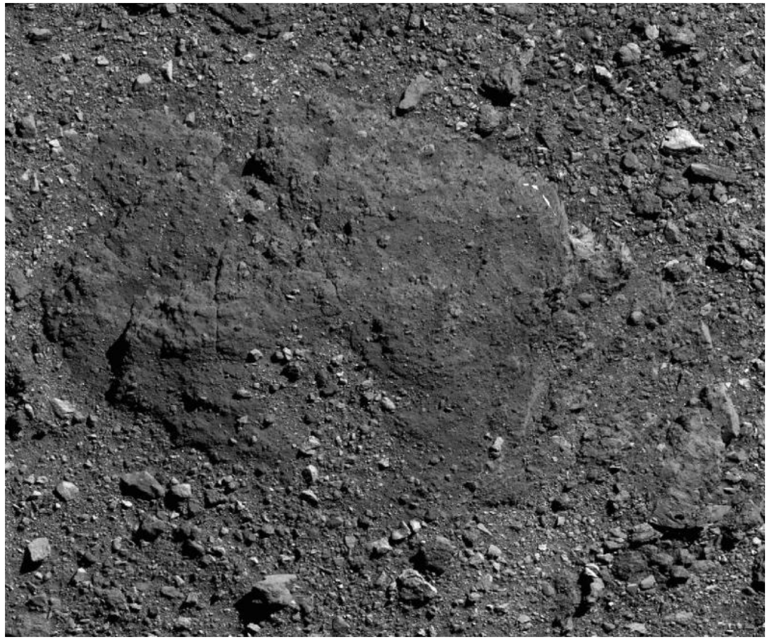
Feature #2 Proposed Name: Roc
Center latitude: -23.46
Center longitude: 25.36 E
Northernmost latitude:-16.61
Southernmost latitude: -30.31
Westernmost longitude:14.49 E
Easternmost longitude: 36.23 E
Feature size: 96 m diameter (largest axis)
Feature type: Saxum, saxa
CT: AS
ET: PE

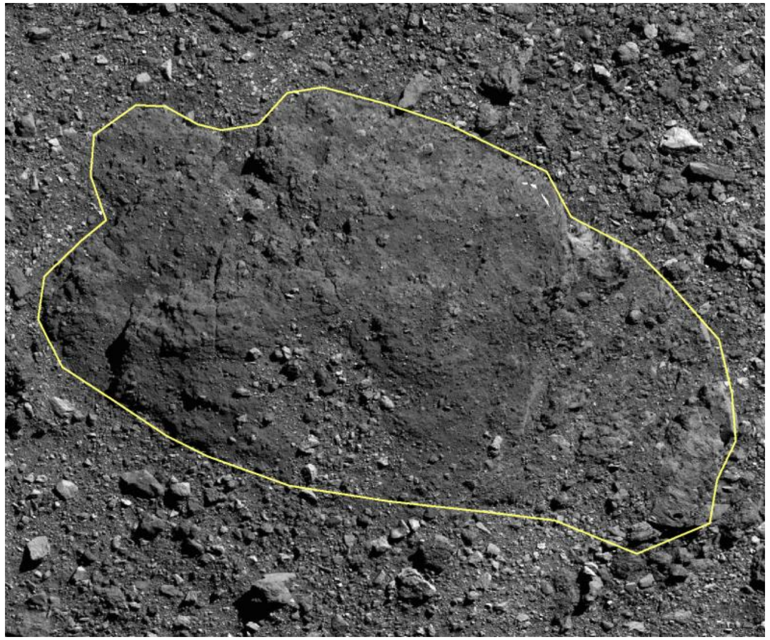
Source: Marco Polo and Rustichello da Pisa, "Il Milione" chapter 186, c. 1298;

ed. Antonio Lanza, 1982

Origin: The roc (from Persian: رخ ruḵ (also rukh or rux)) is an enormous legendary bird of prey in the popular mythology of the Middle East.The roc appears in Arabic geographies and natural history, popularized in Arabian fairy tales and sailors' folklore. Ibn Battuta tells of a mountain hovering in the air over the China Seas, which was the roc.

Justification: The rationale for naming the proposed features comes from their near-term and future inclusion in peer-reviewed papers and geologic maps by the OSIRIS-REx team. This feature is the largest boulder feature on Bennu, it is only partially exposed and as thus is of considerable scientific interest. It is too large to have been formed by impact on the surface of Bennu and the fact that it is partially cover may attest to the fact that it is from the catastrophic distribution phase. It will be the subject of numerous scientific papers, has been that of published abstracts and will help constrain the history of Bennu. Also this feature is a ‘type specimen’ for the morphological classification of boulder and is featured in a paper by Jawin et al. (2020 to be submitted to EPSL shortly). The OSIRIS-REx team, as well as the broader scientific community, will benefit from using formal names to reference these recognizable and major topographic features.





Alternative:

Source: Dictionary of Contemporary Mythology: Third Edition, by William Harwood: World Audience, Inc., 2011
Origin: Mythical bird featured in the Arabian Nights tale of Sinbad the sailor.

Proposed names of features: Boulders aka Saxum

Feature #3 Proposed Name: Simurgh

Center latitude: -25.32

Center longitude: 4.05

Northernmost latitude: -20.79

Southernmost latitude:-29.84

Westernmost longitude: 0 E

Easternmost longitude: 8.09 E

Feature size: 39 m diameter (largest axis)

Feature type: Saxum, saxa

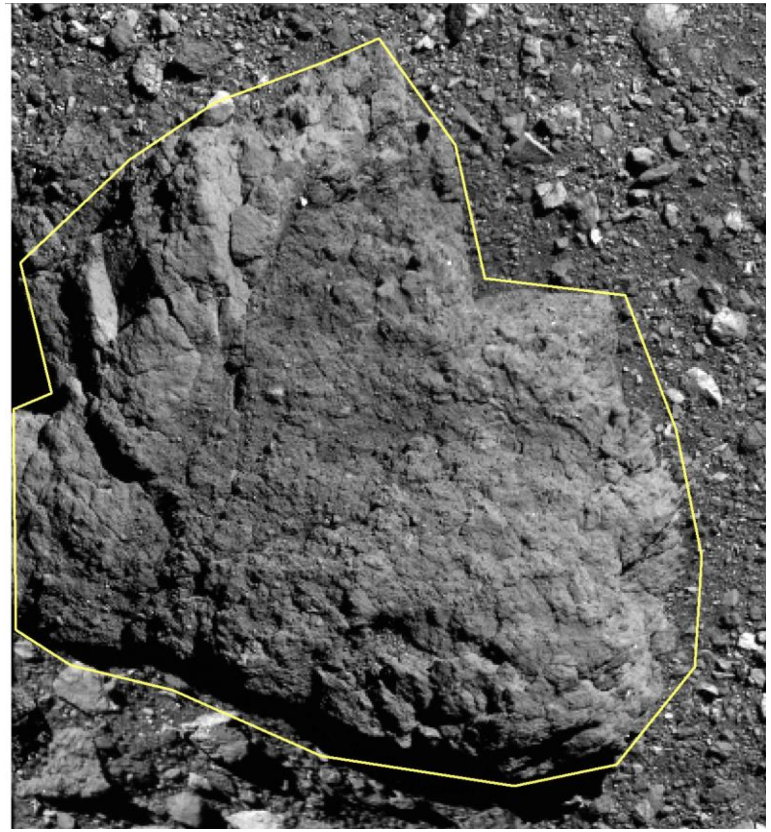
CT: AS

ET: IR

Source: Ferdowsi, Shahnameh, chapter "Zál, the Son of Sám", 11th c.A modern critical edition can be cited as: Ferdowsi, Abu al-Qāsem. Shahnameh. Edited by Djalal Khaleghi-Motlagh. 8 vols. New York: Bibliotheca Persica, 1987–2008.

Origin: A benevolent, mythical bird in Iranian mythology and literature, she possesses the knowledge of all ages and purifies land and water and bestows fertility.

Justification: The rationale for naming the proposed features comes from their near-term and future inclusion in peer-reviewed papers and geologic maps by the OSIRIS-REx team. Simurgh creates a foundation for the coordinate system on Bennu with the location of the designated prime meridian housed within it. It has and will appear as thus in publications and anything to do with the coordinate system used on Bennu. As such, it is of exceptional importance to planetary science for the study of Bennu. It is also a feature investigated by Ishimaru et al (in prep for Icarus and LPSC 2020). The OSIRIS-REx team, as well as the broader scientific community, will benefit from using formal names to reference these recognizable and major topographic features.



Source: The Mythical Creatures Bible: The Definitive Guide to Legendary Beings, by Brenda Rosen: Sterling Publishing, New York: 2009.

Origin: The Simurgh is the mythical bird of Persia, so old it has seen the destruction of the universe three times over.

Additional Information: As discussed above, this feature contains the the prime meridian.

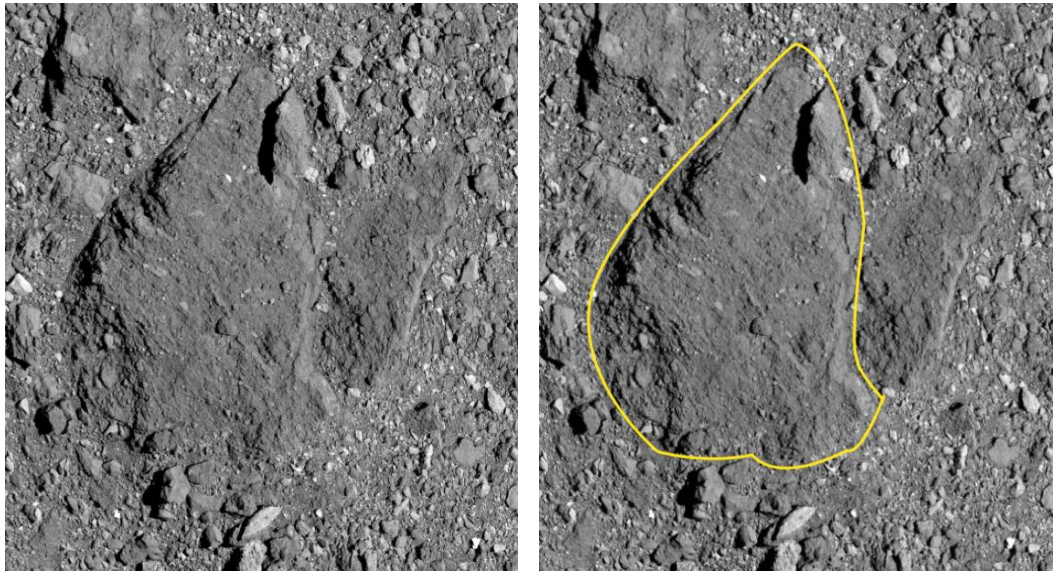
Proposed names of features: Boulders aka Saxum

Feature #4 Proposed Name: Huginn
Center latitude: -29.77
Center longitude: 43.25
Northernmost latitude: -24.46
Southernmost latitude: -35.08
Westernmost longitude: 38.71 E
Easternmost longitude: 47.78 E
Feature size: 46 m diameter (largest axis)
Feature type: Saxum, saxa
CT: EU
ET: NS

Source: Poetic Edda, Grímnismál, stanza 20. Numerous print editions exist e.g. "De Gamle Eddadigte," ed. Finnur Jónsson, G.E.C. Gads Forlag, København, 1932; Old Norse text based on Codex Regius, GKS 2365 4º, 13th c.

Origin: Huginn and Muninn are ravens from Norse mythology who flew around Midgard and gave information to Ogden.

Justification: The rationale for naming the proposed features comes from their near-term and future inclusion in peer-reviewed papers and geologic maps by the OSIRIS-REx team. The proposed feature name, Huginn, and thus the object itself is represented by the large dark boulder on the left side of this image, which appears to be slightly separated from the smaller boulder to the right, (proposed name Muninn, next chart). Like that of the proposed feature name, Roc, it is an apparent outcrop of a boulder, partially covered, and is the second largest such object. It's scientific merit is that it will help to constrain the history of asteroid Bennu through scientific investigation and the subject of a paper by Ishimaru et al (in prep for Icarus and LPSC 2020). It is and will be the focus of many studies and publications. The OSIRIS-REx team, as well as the broader scientific community, will benefit from using formal names to reference these recognizable and major topographic features.



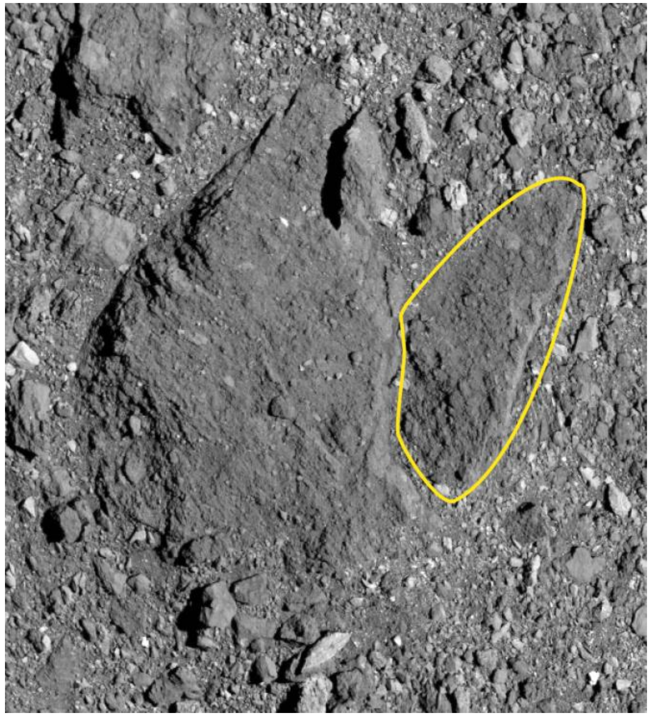
Proposed names of features: Boulders aka Saxum

Feature #5 Proposed Name: Muninn
Center latitude: -29.34
Center longitude: 48.68 E
Northernmost latitude: -26.23
Southernmost latitude: -32.44
Westernmost longitude: 46.56 E
Easternmost longitude: 50.79 E
Feature size: 28 m diameter (largest axis)
Feature type: Saxum, saxa
CT: EU
ET: NS

Source: Poetic Edda, Grímnismál, stanza 20. Numerous print editions exist e.g. "De Gamle Eddadigte," ed. Finnur Jónsson, G.E.C. Gads Forlag, København, 1932; Old Norse text based on Codex Regius, GKS 2365 4º, 13th c.

Origin: Huginn and Muninn are ravens from Norse mythology who flew around Midgard and gave information to Ogden.

Justification: The rationale for naming the proposed features comes from their near-term and future inclusion in peer-reviewed papers and geologic maps by the OSIRIS-REx team. Muninn is represented by the smaller dark boulder on the right of this image, which is slightly separated from the larger boulder on the left side, Huginn. It is possible that these two objects are genetically related, both being still partially sub-surface and as thus provide valuable constraints on the history of Bennu. The investigations of the surface of this feature with that of the proposed feature name Huginn and Roc may provide valuable clues to the effects of space weathering (Ishimaru et al in prep for Icarus and LPSC 2020). The OSIRIS-REx team, as well as the broader scientific community, will benefit from using formal names to reference these recognizable and major topographic features.



Proposed names of features: Boulders aka Saxum

Feature #6 Proposed Name: Ocypete
Center latitude: 25.09
Center longitude: 328.25 E
Northernmost latitude: 25.52
Southernmost latitude: 24.66
Westernmost longitude: 327.50 E
Easternmost longitude: 328.99 E
Feature size: 5.6 m diameter (largest axis)
Feature type: Saxum, saxa
CT: EU
ET: GR
Source: [1]

Origin: Ocypete is one of the three named Harpies. Harpies in Greek and Roman mythology were Wind Spirits, personified by hybrid bird-women, that would snatch and carry things away from Earth.

Justification: The rationale for naming the proposed features comes from their near-term and future inclusion in peer-reviewed papers and geologic maps by the OSIRIS-REx team. The boulder feature is one that appears to be a breccia with high and low albedo phases or clasts present. The existence of breccia/brecciated boulders on Bennu's surface are key clues to the formation history of the asteroid or it's parent body. This boulder feature and wand will be part of the focus of investigation on the existence of different albedo material within single boulders and on the number, kind, and formation of breccia. Some preliminary results were published by Walsh et al. (2019), it is a part of a study by DellaGustina et al (submitted Nature Astronomy) and Ishimaru et al in prep for Icarus and LPSC 2020. A study by McCoy et al (to be submitted to Meteoritics and Planetary Sciences in 2020) focuses specifically on the breccias of Bennu and their origin). The OSIRIS-REx team, as well as the broader scientific community, will benefit from using formal names to reference these recognizable and major topographic features.

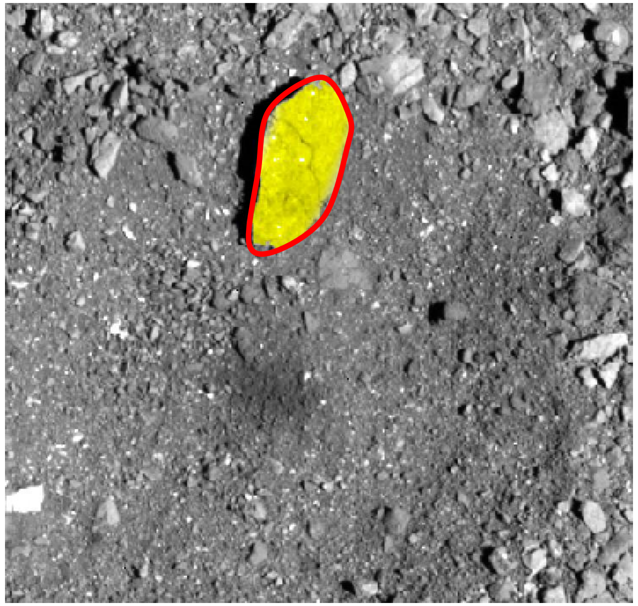
Alternative:
Source: [1]
Origin: Ocypete is one of the three named Harpies, who were personifications of storm winds, 'tempest goddesses', winged creatures swift as birds, monsters with the face of an old hag, ears of a bear, and the body of a bird with long, hooked claws.

Proposed names of features: Boulders aka Saxum

Feature #7 Proposed Name: Strix
Center latitude: 13.40
Center longitude: 88.26 E
Northernmost latitude: 13.94
Southernmost latitude: 12.85
Westernmost longitude: 87.86 E
Easternmost longitude: 88.65 E
Feature size: 5.3 m diameter (largest axis)
Feature type: Saxum, saxa
CT: EU
ET: RM
Source: **P. Ovidius Naso, Fasti VI, 131 ff.**

Origin: The Strix in the mythology of classical antiquity, was a bird of ill omen, the product of metamorphosis, that fed on human flesh and blood.

Justification: The rationale for naming the proposed features comes from their near-term and future inclusion in peer-reviewed papers and geologic maps by the OSIRIS-REx team. The feature is a high-albedo boulder that is a promanate feature on the surface of Bennu. It is a type specimen/boulder for a morphological classification scheme for Bennu boulders in a paper by Jawin et al. (2020 to be submitted shortly to EPSL). It is also within one of the final potential sample sites and will be featured in a paper by Enos et al (2020; in prep for EPSL). The OSIRIS-REx team, as well as the broader scientific community, will benefit from using formal names to reference these recognizable and major topographic features.



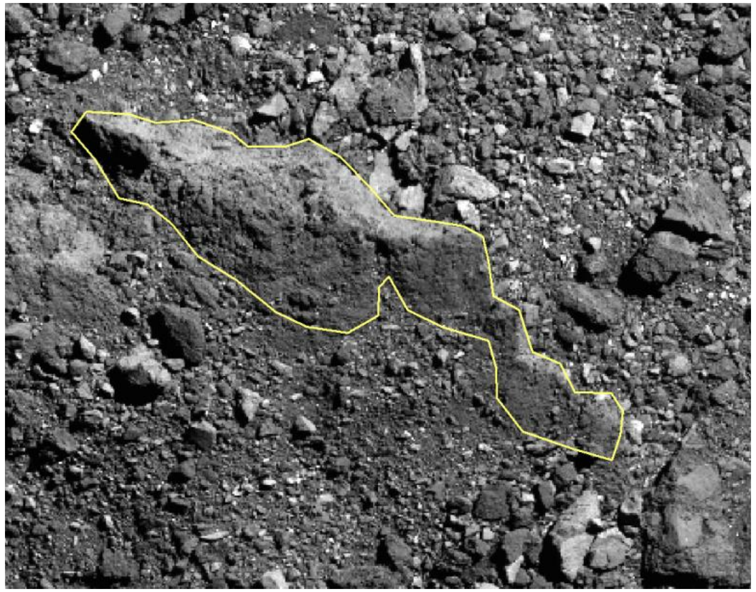
Proposed names of features: Boulders aka Saxum

Feature #8 Proposed Name: Amihan
Center latitude: -17.96
Center longitude: 256.51 E
Northernmost latitude: -15.70
Southernmost latitude: -20.22
Westernmost longitude: 252.93 E
Easternmost longitude: 260.09 E
Feature size: 33 m diameter (largest axis)
Feature type: Saxum, saxa
CT: AS
ET: PH

Source: The Philippine Archipelago, by Yves Boquet, Springer International Publishing: Switzerland, 2017.

Origin: Tagalog (Philippines) deity that is depicted as a bird, the first creature to inhabit the universe.

Justification: The rationale for naming the proposed features comes from their near-term and future inclusion in peer-reviewed papers and geologic maps by the OSIRIS-REx team. This large flat boulder appears to be partly buried and is located in a region that has an anomalously high concentration of large boulders. As with similar such boulders, it provides important constraints on the origin of Bennu and the geologic processes that alter the surface of Bennu. It is part of a study by Jawin et al (in prep 2020 for Icarus) on the effects of mass movement on Bennu's surface (note finer material surrounding it). The OSIRIS-REx team, as well as the broader scientific community, will benefit from using formal names to reference these recognizable and major topographic features.



Proposed names of features: Boulders aka Saxum

Feature #9 Proposed Name: Poua-Kai

Note from MSS: Not approved yet, but expected to be thus without the hyphen.

Center latitude: -40.45

Center longitude: 166.75 E

Northernmost latitude: -39.26

Southernmost latitude: -41.63

Westernmost longitude: 165.35 E

Easternmost longitude: 168.14 E

Feature size: 10.6 m diameter (largest axis)

Feature type: Saxum, saxa

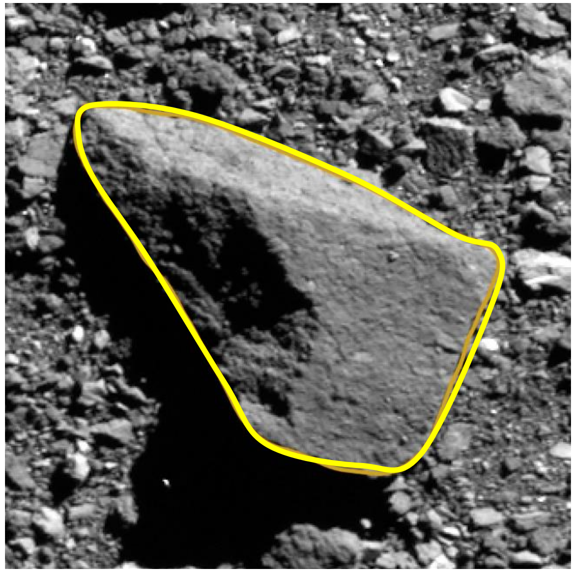
CT: OC

ET: PO

Source: Worthy, Trevor N. The Lost World of the Moa. Bloomington, IN: Indiana University Press, 2002.

R. Paul. Scofield & Ken. W. S. Ashwell (2009) Rapid somatic expansion causes the brain to lag behind: the case of the brain and behavior of New Zealand's Haast's Eagle (Harpagornis moorei), Journal of Vertebrate Paleontology, 29:3, 637-649, DOI: 10.1671/039.029.0325

Origin: In Māori mythology, the Poua-Kai is a monstrous bird. In some of these legends poua-kai kill and eat humans. The myth may refer to the real but now extinct Haast's eagle: the largest known eagle species, which was able to kill adult moa weighing up to 230 kilograms, and which had the capability to kill a small child.



Justification: The rationale for naming the proposed features comes from their near-term and future inclusion in peer-reviewed papers and geologic maps by the OSIRIS-REx team. It is a type specimen/boulder for a morphological classification scheme for Bennu boulders in a paper by Jawin et al. (2020 to be submitted shortly to EPSL). It also contains what are termed candidates impact crater from micro-impacts and is the subject of an investigation by Ballouz et al. to be submitted in 2020 to LPSC and Icarus. The OSIRIS-REx team, as well as the broader scientific community, will benefit from using formal names to reference these recognizable and major topographic features.

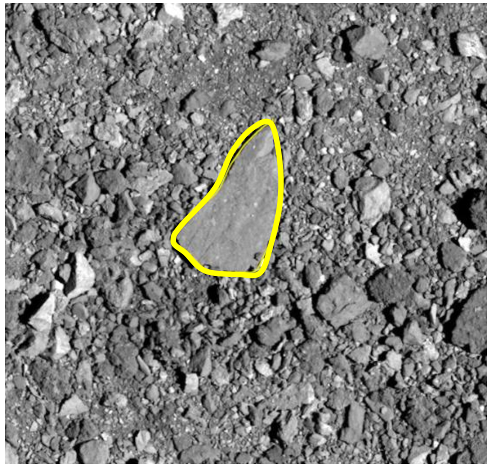
Proposed names of features: Boulders aka Saxum

Feature #10 Proposed Name: Aetos
Center latitude: 3.46
Center longitude: 150.36 E
Northernmost latitude: 4.40
Southernmost latitude: 2.52
Westernmost longitude: 149.69 E
Easternmost longitude: 151.02 E
Feature size: 9.1 m diameter (largest axis)
Feature type: Saxum, saxa
CT: EU
ET: GR

Source: Kerényi, C (1951) The gods of the Greeks. Thames and Hudson: London. p.95.
https://archive.org/details/in.gov.ignca.7346/page/n115

Origin: Aetos was a childhood playmate of Zeus who was turned into an eagle by Hera.

Justification: The rationale for naming the proposed features comes from their near-term and future inclusion in peer-reviewed papers and geologic maps by the OSIRIS-REx team. This is a conspicuously flat boulder with a general wing-like shape. It is a feature being investigated by Jwain et al (2020 in prep for Icarus) in conjunction with mass movement on Bennu's surface and by Ishimaru et al (in prep 2020) and the morphological/textural nature of feature and similar boulder to illuminate their origin and history in relation to Bennu. The OSIRIS-REx team, as well as the broader scientific community, will benefit from using formal names to reference these recognizable and major topographic features.



Proposed names of features: Boulders aka Saxum

Feature #11 Proposed Name: Gargoyle

Center latitude: 4.59

Center longitude: 92.48 E

Northernmost latitude: 6.57

Southernmost latitude: 2.61

Westernmost longitude: 91.13 E

Easternmost longitude: 93.83 E

Feature size: 18 m diameter (largest axis)

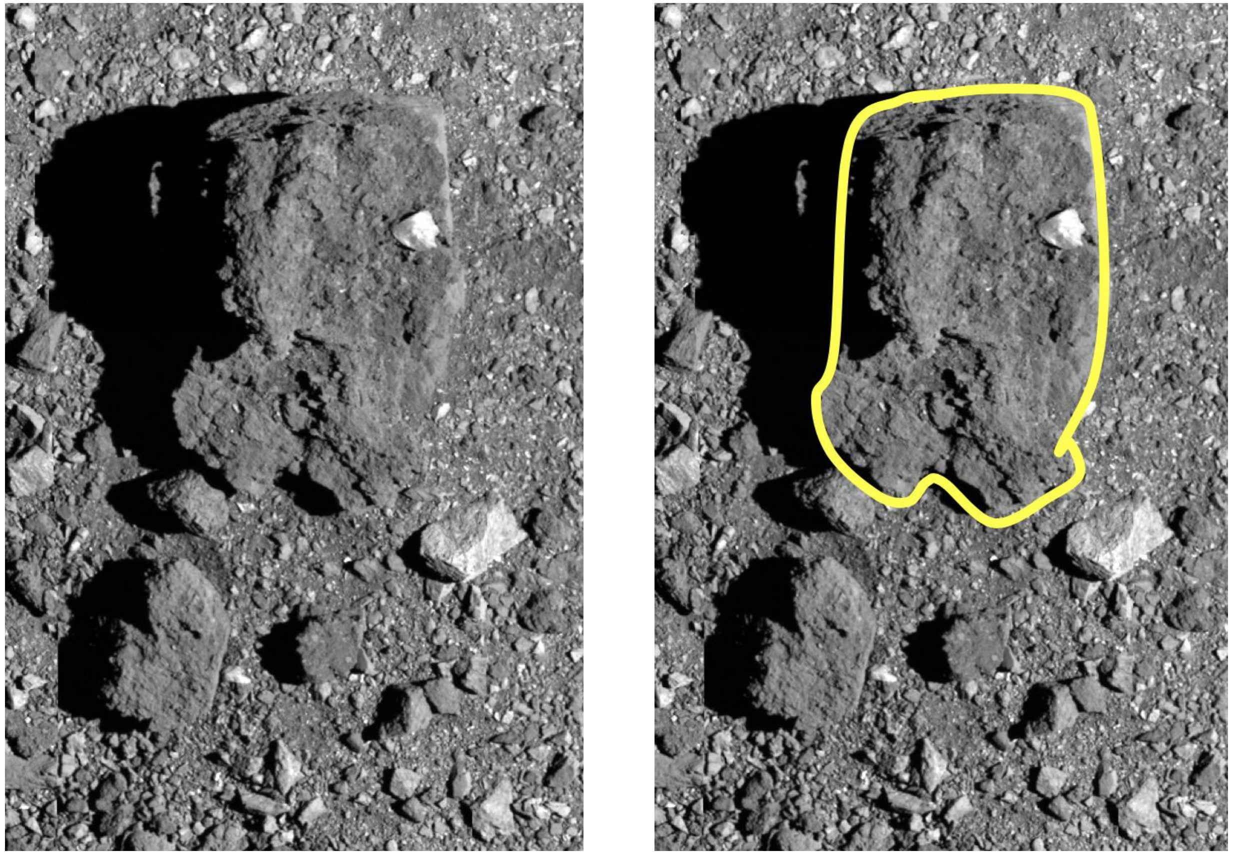
Feature type: Saxum, saxa

CT: EU

ET: FR

Source: Reference: Poetic Edda, Völuspá, stanza 43. Numerous print editions exist e.g. "De Gamle Eddadigte," ed. Finnur Jónsson, G.E.C. Gads Forlag, København, 1932; Old Norse text based on Codex Regius, GKS 2365 4º, 13th c. AND Holy Terrors: Gargoyles on Medieval by Janetta Rebold Benton, Abbeville Press, 143 pgs.

Origin: Gargoyles are by definition an architectural feature that is used as a water spout. The term originates from the French word gargouille, originally "throat" or "gullet. In layman's terms a gargoyle more often refers to the 'animal or creature' being depicted. Gargoyles are often shown as chimera, with bird heads, wings and talons atop the body of lions or wolves. Large eagles, Harpies and Griffins are also common forms of gargoyles and one of the most famous of these is the Strix, or Styrga, a human bird hybrid which is posed with its head in its hands atop the Notre-Dame de Paris. They are seen as guardians of the cathedral or castles. There are many depictions of gargoyles in modern folklore but the first known example is attributed to St. Romanus, a 7th Century Bishop, who was said to have saved the region of Rouen from a monster called the gargouille. The gargouille was similar to a dragon with wings, a long serpent or bird like neck, and the ability to breathe fire.



Justification: The rationale for naming the proposed features comes from their near-term and future inclusion in peer-reviewed papers and geologic maps by the OSIRIS-REx team. This boulder is extremely promanant feature on the surface of Bennu and is another breccia. The origin of breccias is the focus of a study by McCoy et al (to be submitted to Meteoritics and Planetary Sciences in 2020) with this feature as a major component of that investigation. It is also a feature close to one of the final sample sites and will be the highlighted in a paper by Enos et al (in prep for EPSL, 2020). The OSIRIS-REx team, as well as the broader scientific community, will benefit from using formal names to reference these recognizable and major topographic features.

Proposed names of features: Regio

Feature #12 Proposed Name: Tlanuwa
Center latitude: -37.86
Center longitude: 261.70 E
Northernmost latitude: -9.00
Southernmost latitude: -66.72
Westernmost longitude: 223.13 E
Easternmost longitude: 300.26 E
Feature size: 301.0 m diameter (largest axis)
Feature type: Regio, regiones
CT: NA
ET: US
Source: From the Nest of the Tlanuwa

Lankford, George E. Native American Legends of the Southeast : Tales from the Natchez, Caddo, Biloxi, Chickasaw, and Other Nations. 5th ed., University of Alabama Press, 2011.

Origin:

Tlanuwa are very large birds from Cherokee lore. In one particular story the birds steal a baby to eat. That baby's grandmother kills the Tlanuwa's young as revenge. The woman turns the rope she used to climb to the Tlanuwa's nest into a mythical serpent called a Uktena. The Tlanuwa parents attack and tear apart the Uktena. The pieces of the Uktena fall to the Earth and turn into standing pillars of rock.

Justification: The rationale for naming the proposed features comes from their near-term and future inclusion in peer-reviewed papers and geologic maps by the OSIRIS-REx team. The region is one of areas where the effects of mass movement on the surface of Bennu have focused. There is a paper by Jawin et al (in prep 2020 for Icarus) and also several abstracts. It is part of the greater area investigated by Walsh et al (2019). The area will be part of the greater geologic map of Bennu that is being produced by Jawin et al (in prep) with location of publication TBD. The OSIRIS-REx team, as well as the broader scientific community, will benefit from using formal names to reference these recognizable and major topographic features.