

# TEACHER NOTES – ASTRONOMY IN THE NEWS #55

## BENNU SAMPLE RETURNED

This bulletin is slightly different in that there isn't really any science to the article, but both slides will contain background science. The first discusses the Bennu mission, whilst the second contains one of the science goals.

### Slide 2: Asteroid Bennu

The Asteroid Bennu is part of the Apollo asteroid group, a group that is made up of objects which overlap with the orbit of Earth around the Sun. It is about 500 m across, and has a mass of 70 billion kg. The shape of the object resembles a spinning top, with the equatorial diameter (around the middle) about 15% larger than its polar diameter.

The most crucial feature of Bennu, though, is that it is a credible object to collide with Earth in about 150 years time (a 1 in 2,700 chance in 2182 for those interested). As a result, our understanding of it could be crucial to averting disaster at that time (assuming we haven't killed off humanity with climate change before then!).

As a result, the OSIRIS-REx (Origins, Spectral Interpretation, Resource Identification, Security, Regolith Explorer) visited and collected samples from Bennu in 2020. After collecting this sample, it returned the sample to Earth, with a successful re-entry of the sample on September 24<sup>th</sup>, 2023. After returning this sample in a capsule, the satellite is going to go and visit another asteroid.

This capsule and its sample will be analysed to determine the constituent materials and organic compounds of this type of asteroid (carbonaceous), the geochemistry and spectral properties of the regolith, as well determining the texture. By doing so, it will answer questions about the formation of the Solar System and maybe the origin of water on Earth.

The articles discussing the imminent, then successful, return of the sample can be found here:

<https://www.bbc.co.uk/news/science-environment-66844738>

<https://www.bbc.co.uk/news/science-environment-66893661>

<https://www.theguardian.com/science/2023/sep/24/nasa-osiris-rex-mission-bennu-asteroid-sample-earth>

#### IMAGES:

1. (Left) The orbits of Earth and Bennu, along with the other inner planets. As you can see from this plot, the orbits of Earth and Bennu do overlap, although it's not quite as straight forward since Bennu's is much more inclined than Earth's.

2. (Top right) Image of Asteroid Bennu. Bennu is considered a “rubble pile” and a collection of leftover material from the formation of the Solar System.
3. (Bottom right) The Osiris-Rex capsule returned to Earth containing the sample from Bennu.

## Slide 3: Origin of Water on Earth

Water covers about 70% of the surface of the Earth and is essential to life on Earth. However, the origin of the water is not well understood with three prevailing theories.

The first is that carbonaceous chondrites and other icy planetesimals accumulated on Earth about 4.5 billion years ago as the Earth grew from 60%-90% of its current mass to now. These objects would have brought water to Earth, and a significant number of collisions would have eventually built the abundances of water. The strengths of this argument are that the deuterium/hydrogen isotope ratio found on these objects is similar to that found in ocean water, and the fact that rock samples from the Apollo missions show chemical compositions similar to the Earth. The fact that this occurs indicates water must have been present on Earth at the time of the formation of the Moon.

The second is that water was delivered much later in the process, after the formation of the Moon. The reason for the requirement of this is that the noble gas isotope ratios are different in the mantle compared to the atmosphere, indicating that they formed from different sources. However, since the amount of mass accreted after the Theia collision is very low, these objects must have been very water-rich, which could be possible if icy asteroids were impacting the Earth due to Jupiter migrating closer to the Sun.

The final hypothesis is that it was, in fact, the collision with Theia that created the Moon that brought water to the Earth. If this object formed in the outer Solar System rather than in the inner Solar System, it would have been water and carbon rich, and this collision would have provided a lot of water to the Earth.

IMAGES:

1. (Top left) Image of Earth showing the water on the surface that we all know exists!
2. (Bottom left) Image of a carbonaceous chondrite, the meteorite in question in Slide 3, along with the suspected origin of a fraction of the water on Earth.
3. (Right) Cartoon depiction of the collision between the Earth and Theia, the planet the size of Mars that is hypothesised to have collided with Earth to form the Moon 4.5 billion years ago.

## Slide 4 – Activity: How to save Earth?

This week’s activity is a simple one. Discuss ways how to save the Earth from an imminent asteroid collision, especially a collision from such a large object. The only rule is that you can’t blow the asteroid up. There is the deflection method demonstrated by the DART mission but a series of other methods that could be used too!

## GCSE Specifications:

Specification	Knowledge Point
Pearson Edexcel Astronomy	11.1, 11.13, 11.26, 11.27