What are asteroids made of?

The physical properties of huge space-rocks whirling around the Sun could hold clues to the origins of the Solar System

Protecting Earth is one of the main reasons why scientists keep a close eye on asteroids, which are space rocks of all shapes and sizes that can be found scattered throughout the Solar System.

It's unclear how meteoroids, the rocks that become meteors when they crash into Earth's atmosphere, were generated from asteroids. Still, NASA isn't ruling a link out and is examining asteroids to learn more about how the Solar System was formed.

Since planetary scientists believe planets gradually grew from rocks crashing into each other, the asteroid belt between Mars and Jupiter could be made up of the leftovers of the early Solar System.

Therefore, ferreting out the secrets of asteroids could also give scientists clues as to how the Solar System came to be. Possibly, it could even reveal how the Earth was born.

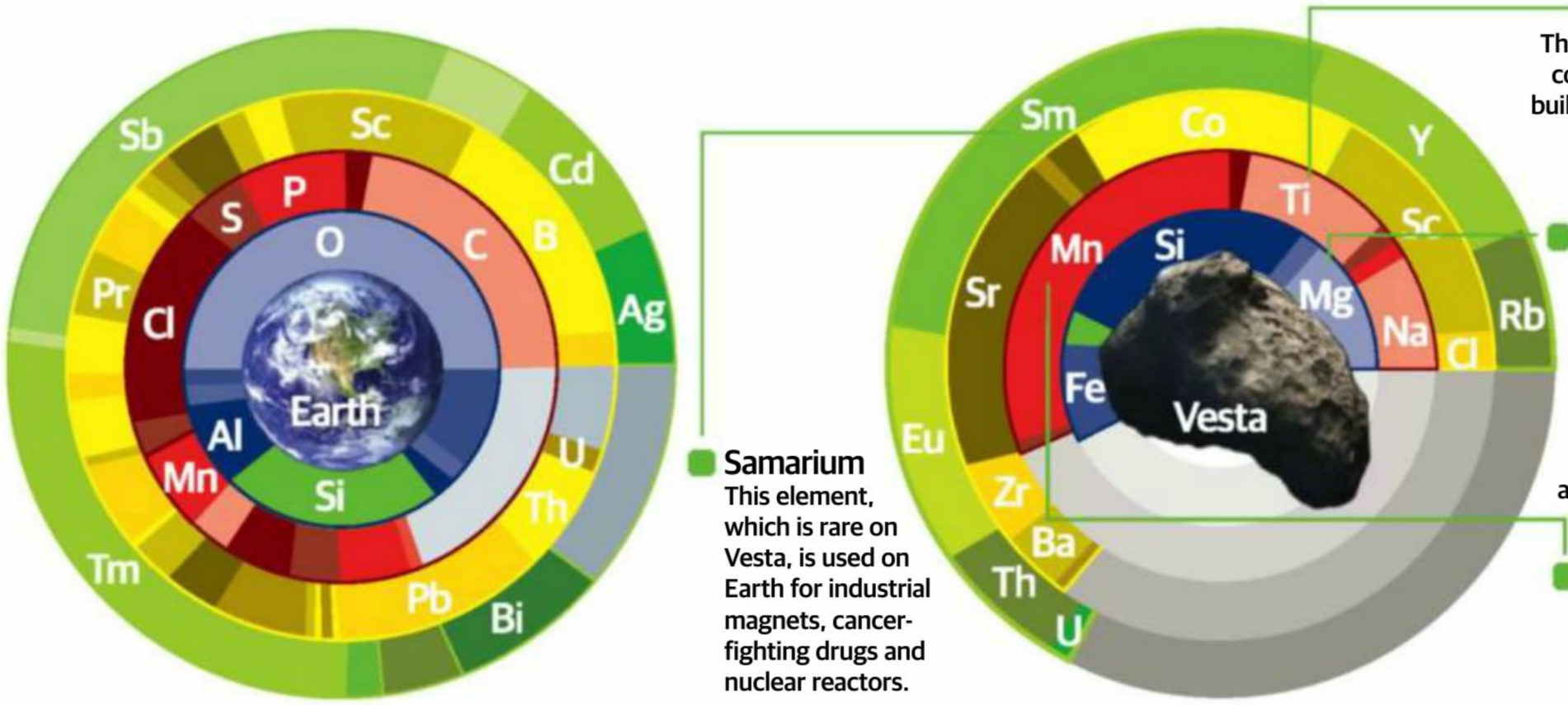
Studying asteroids is a challenge for scientists, however, because they are so small. A typical space rock is perhaps just a few metres across. However, the largest known asteroid in our Solar System, Ceres, is 950 kilometres (590 miles) in diameter and makes up a third of the mass of the known asteroid belt. However, through a telescope sitting on Earth, an asteroid of this size looks incredibly small. This makes asteroids difficult to see and study, but scientists are pretty crafty when it comes to getting information from a distance.

Most asteroids, according to NASA, can be classified in three groups: C-type (carbonaceous), S-type (siliceous) and X-type (various compositions). Around 75 per cent are C-type asteroids that lurk in the outer asteroid belt. They are very dark and probably lack helium, hydrogen and other lighter

"In 1995, there were only 335 known near-Earth asteroids, however, today there are more than 9,700 catalogued"

Asteroid Ida and its moon, Dactyl. The spacecraft Galileo discovered the small moon when it passed by the asteroid in 1994

Explaining the elements



Titanium
This element could come in useful for building lightweight alloys for use in spacecraft.

Magnesium
A very common element in the universe, it is used in fertilisers and to make magnesium-aluminium alloys.

Samarium
This element, which is rare on Vesta, is used on Earth for industrial magnets, cancer-fighting drugs and nuclear reactors.

Manganese
An important element for stainless steel.

Ag - Silver
Al - Aluminium
B - Boron
Bi - Bismuth
C - Carbon
Cd - Cadmium
Cl - Chlorine
Mn - Manganese
O - Oxygen
P - Phosphorus
Pb - Lead
Pr-Praseodymium
S - Sulphur
Sb - Antimony
Sc - Scandium
Si - Silicon
Th - Thorium
Tm - Thulium
U - Uranium
Ba - Barium
Co - Cobalt
Cl - Chlorine
Eu - Europium
Fe - Iron
Mg - Magnesium
Mn - Manganese
Na - Sodium
Rb - Rubidium
Sc - Scandium
Si - Silicon
Sm - Samarium
Sr - Strontium
Th - Thorium
Ti - Titanium
U - Uranium
Y - Yttrium
Zr - Zirconium

What are asteroids made of?

Asteroids can range from just a few metres wide to almost 1,000km in diameter

'volatile' elements. S-type asteroids, about 17 per cent of the population, make up most of the inner belt rocks in the asteroid belt. They're a little more reflective and are usually made of metallic iron mixed with silicates of iron and magnesium. Squeezed in between these asteroids are X-types, which are mostly made up of metallic iron asteroids and the like. These are found in the middle of the asteroid belt.

While most asteroids sit safely between Mars and Jupiter, some approach Earth and sometimes cross its orbit. Scientists think most of these asteroids were 'disturbed' into different orbits due to Jupiter's gravity or collisions with other asteroids.

There are three types of near-Earth asteroids. Amors cross the orbit of Mars, but don't get very close to Earth. Apollos cross Earth's orbit in a period of one year or longer, while Atens also cross the orbit but in a shorter time frame – a year or less.

In the past two decades, space agencies and observatories around the world have discovered thousands of these types of asteroids. In 1995, there were only 335 known near-Earth asteroids, however, today there are more than 9,700 catalogued, according to NASA.

Since scientists believe we have now found more than 90 per cent of threatening asteroids that are more than one kilometre (0.6 miles) in diameter, NASA is now emphasising the search for finding near-Earth objects of 140 metres (460 feet) or greater.

Still, a much smaller object can cause a lot of damage. The dinosaurs were probably wiped out by a small body just ten kilometres (6.2 miles) in diameter that hit the Mexico area about 66 million years ago.

In Russia this year, more than 1,000 people were injured when a house-sized asteroid – 17 metres wide (56 feet) – detonated in the atmosphere. The event caught both the public and astronomers by surprise, demonstrating we still have a lot to learn about predicting meteor strikes on Earth.

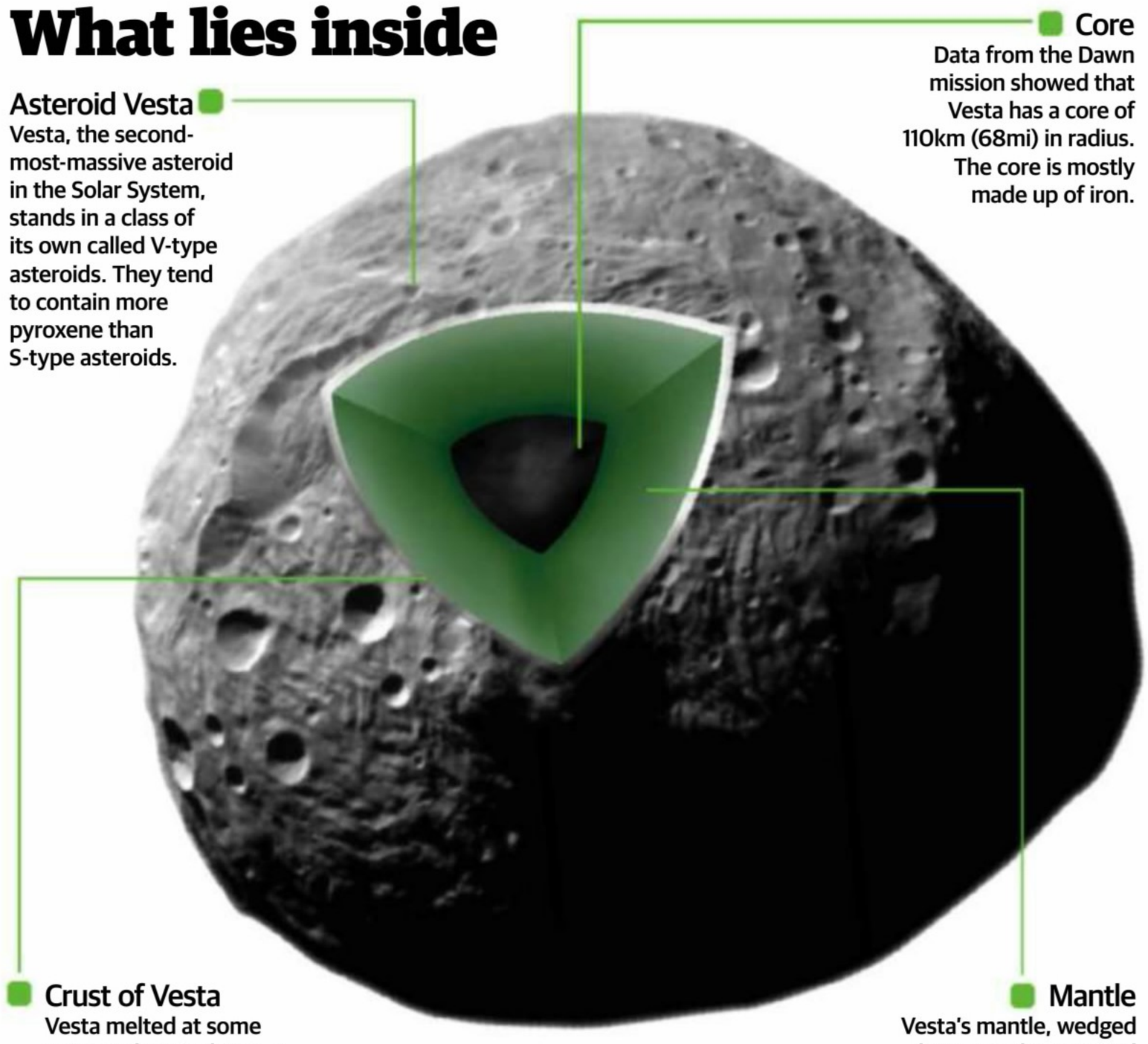
In more recent years, several space missions have ventured out to asteroids to get more information from closeup. NASA's Dawn mission, for example, scooted by the asteroid Vesta in 2011 and is now en route to Ceres.

Its closeup views revealed a battered world that, surprisingly, has some links to how the Moon was formed. Vesta and the Moon were each peppered by a population of space rocks ejected into the inner Solar System early in the Earth's history.

Both Jupiter and Saturn shifted their orbits in less than a million years. Their motions perturbed the asteroid belt and sent the rocks into planet-crashing orbits. This bombardment had been known about for decades – astronauts on the Apollo missions even discovered evidence of it on the Moon – but scientists didn't know until recently that Vesta had also experienced it.

The next step will be obtaining a sample of an asteroid and studying it here on Earth. Origins Spectral Interpretation Resource Identification Security Regolith Explorer (OSIRIS-REx) will journey into space in 2016, scoop up a bit of dirt from the Apollo asteroid (101955) 1999 RQ36, and return it to Earth by 2023 for further investigation.

What lies inside



Asteroid Vesta
Vesta, the second-most-massive asteroid in the Solar System, stands in a class of its own called V-type asteroids. They tend to contain more pyroxene than S-type asteroids.

Core
Data from the Dawn mission showed that Vesta has a core of 110km (68mi) in radius. The core is mostly made up of iron.

Crust of Vesta
Vesta melted at some point early in its history, producing a 'differentiated' core and a basaltic crust.

Mantle
Vesta's mantle, wedged between the core and crust, likely includes olivine and diogenite.

Mining asteroids

Asteroids could be a valuable source of resources and so far two companies have announced plans to mine them

Deep Space Industries

Deep Space Industries plans – at some point – to send robotic probes on a one-way reconnaissance mission to potential asteroid mining sites. Later, larger DragonFly spacecraft would potentially pick up samples or small asteroids for further evaluation on Earth.

Power
The Harvester will be blasted into space on major launch vehicles such as the Falcon Heavy or Ariane 5.

Resources
The machinery will be able to produce water, propellant and building materials for use on Earth or in space.

Production
The missions will be able to generate and return thousands of tons of resources each year.

Deep Space Industries plans to use its Harvester to mine vital resources from asteroids

Planetary Resources

Planetary Resources first plans to scope out potential asteroids using a telescope. They will then capture a suitable asteroid and reposition it in a stable orbit near Earth, before sending a fleet of robotic spacecraft to return samples from the surface. They expect to begin surveying asteroids in the coming years.

Resources
Groups of robots will scour the asteroid to retrieve its resources.

Capture
Once they've found a suitable asteroid Planetary Resources will capture it to begin mining.