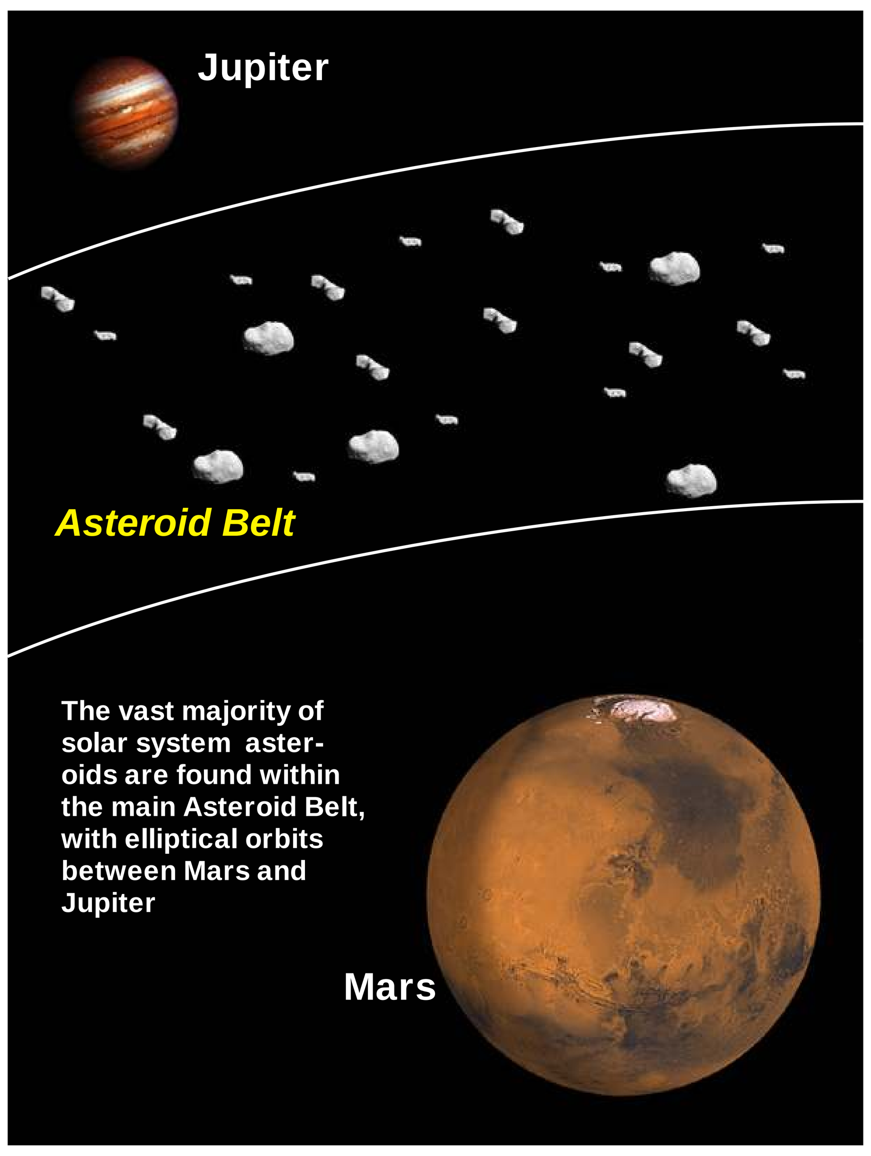


Near-Earth Objects (NEOs) are comets and asteroids that have been nudged by gravitational interaction into orbits that take them into Earth's neighbourhood. They represent relatively unchanged leftovers from the formation of the inner rocky planets of our solar system, including Earth, and have significantly modified Earth´s biosphere over the eons. Of irregular shape, they may reach up to several hundred kilometres in size, but often measure only a hundred metres across or less - which still is as big as a football stadium!

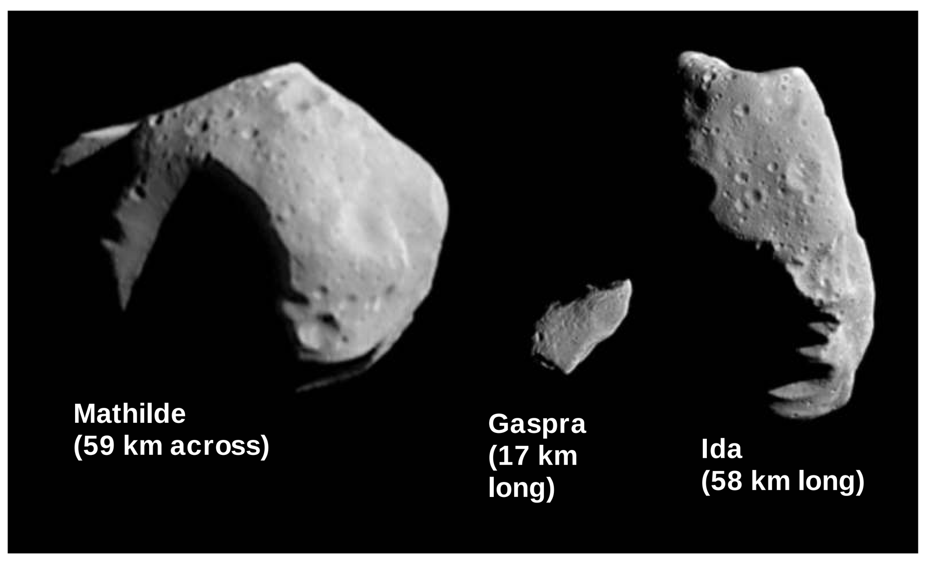
Near-Earth Objects and Life on Earth

As the origin of life - apart from an energy source - requires the presence of carbon-based molecules and liquid water, which were scarce on the young Earth, it is speculated that collisions with comets and asteroids, containing abundant supplies of both, may have initiated life on our planet. This is thought to have happened some 3.8 billion years ago, after the cessation of the first heavy bombardment by meteoroids and other interplanetary debris left over from the formation of the solar system, that kept surface temperatures far too high for life to form. Accordingly such collisions could have been agents of biological as well as geological change on Earth.

Artist's concept of a catastrophic asteroid impact with Earth

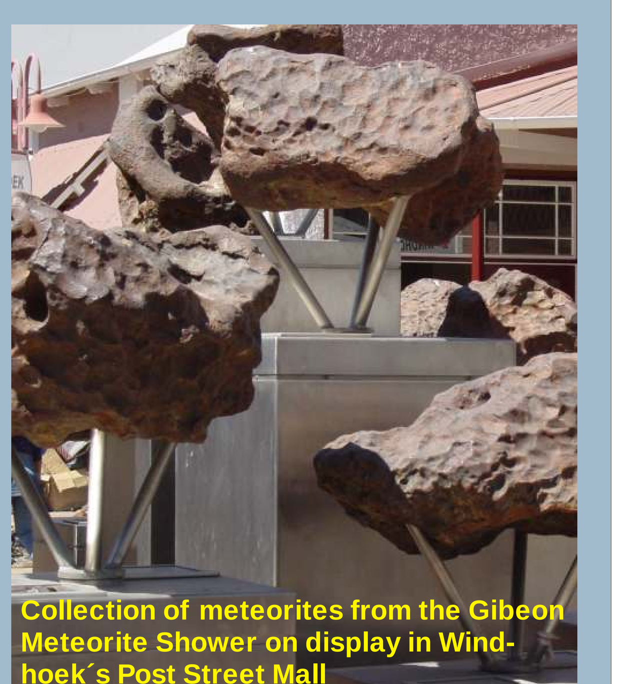
About Asteroids and NEOs

It is believed that the main *Asteroid Belt* owes its existence to gravitational perturbations by massive Jupiter, which - during the formative period of the solar system - prevented the incorporation of proto-planetary remnants into the planets within its sphere of influence. Gravitational disturbance or collisions among main belt asteroids also caused some of these bodies to drop down to lower orbits, bringing them into the vicinity of Earth. Alternatively near-Earth asteroids may have originated as comets, which were captured when passing too closely to a planet in the inner solar system. Current estimates put the total number of asteroids with a diameter of more than 1 km in the solar system between 1.1 and 1.9 million, but still their combined mass is less than 5% of the mass of our moon.

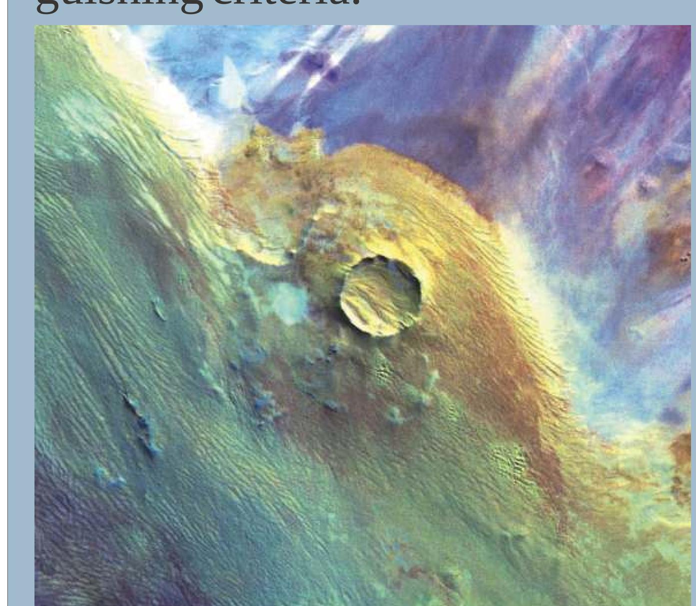


Meteorites - Samples of Asteroids

Meteorites are extraterrestrial bodies (e.g. pieces of asteroids or comets) that survive impact with the Earth's surface. During atmospheric entry, air resistance causes the body to glow, thus the name `shooting star´. Meteorites are not particular to Earth, but have been found on the Moon and on Mars. Traditionally they are divided into stony meteorites (mainly consisting of silicate minerals), iron meteorites (mostly composed of metallic iron-nickel), and stony-iron meteorites (consisting of both metallic and rocky material), but modern classification schemes rather use properties like structure, chemical and isotopic composition, and mineralogy as distinguishing criteria.



Collection of meteorites from the Gibeon Meteorite Shower on display in Windhoek´s Post Street Mall

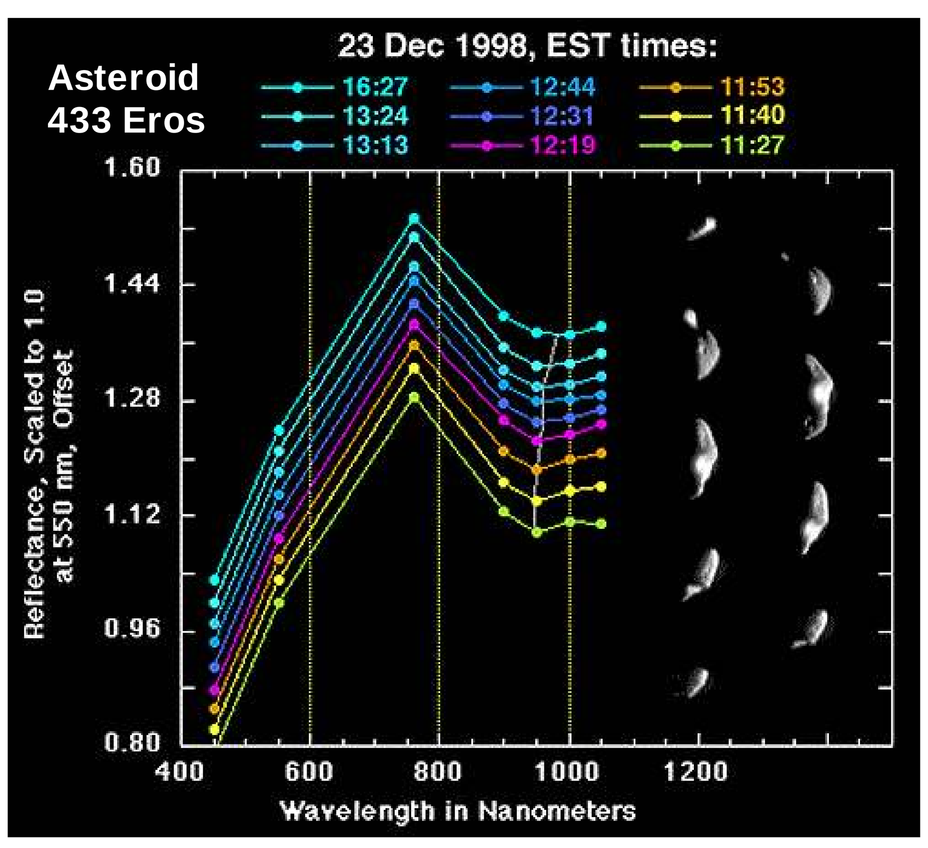


Most meteorites disintegrate, when entering Earth's atmosphere, and only an estimated 500, ranging in size from marbles to basketballs or - rarely - larger, do reach the surface each year; because of their composition iron meteorites are more likely to survive atmospheric entry than other types.

Few meteorites are big enough to create impact craters, the kind of crater depending on the size, composition, degree of fragmentation, and incoming angle of the impactor. After impact meteorites are subject to weathering and decomposition like any other material on Earth. In accordance with a slow rate of chemical weathering, most finds therefore have been made in arid (Sahara, Australian desert, Namibia) or cold climates (Antarctica).

NEO Missions

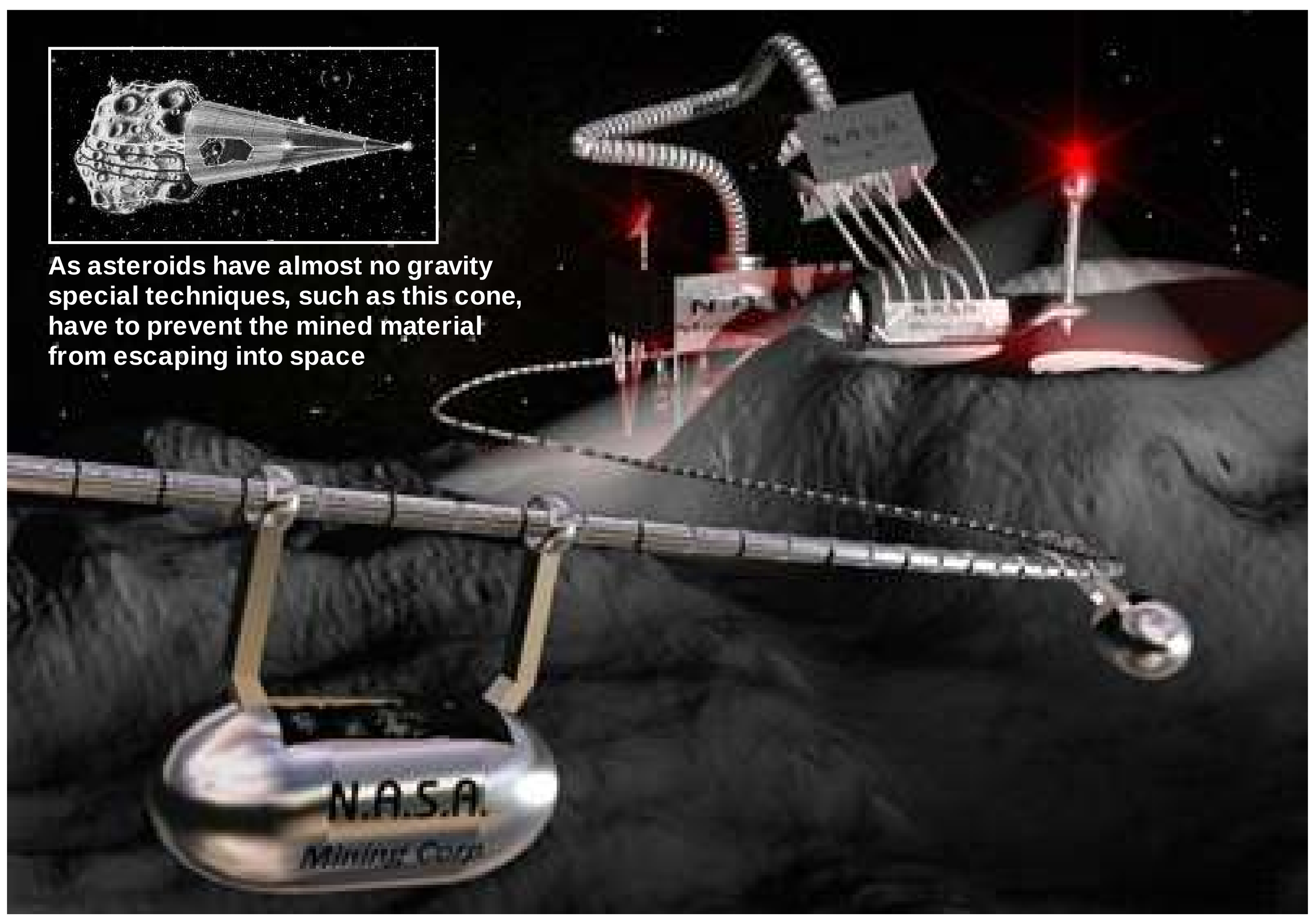
As the primitive leftover building blocks of the solar system formation process, comets and asteroids offer clues to the chemical mixture from which the planets formed some 4.6 billion years ago. Composed mostly of water ice and dust particles, comets formed in the cold outer reaches of the solar system, while most of the rocky asteroids originated in the warmer inner solar system between the orbits of Mars and Jupiter. To study their structures and chemical makeup several spacecraft missions have been undertaken (*Deep Space*, *NEAR Shoemaker, Stardust*, *Hayabusa*, *Rosetta*, *Deep Impact*, *Dawn*), in order to rendezvous with either a comet or an asteroid (both near-Earth and in the main belt) and collect real-time data. In addition, some of them have been designed as sample return missions, and will bring back material for study in laboratories on Earth.



Different minerals reflect sunlight with a different spectrum, providing a "fingerprint" of composition of an asteroid's surface

"Dino Killer"

While NEOs may have promoted life on Earth in its beginnings, they have also been known to destroy it. The now widely accepted theory of the extinction event at the Cretaceous / Tertiary boundary - including the large dinosaurs - being due to an asteroid hit in the Caribbean region, as well as the 1994 impact of comet *Shoemaker-Levy 9* on Jupiter, has caused an increasing public awareness of near-Earth asteroids, and the potential threat they pose. A collision with a 500 km projectile would effectively sterilize our entire planet - no matter where on Earth it hit - by vaporizing the oceans and dispersing the atmosphere. Even though the chance of this happening is extremely small, NEOs are routinely monitored and assessed in respect of their potential risk to Earth, which depends on size, orbital parameters, composition and velocity. Currently there are 821 known near-Earth objects classified as *Potentially Hazardous Asteroids (PHAs)*, with a closest approach distance of less than 0.05 astronomical units (ca. 7.5 million km) and an absolute magnitude (measure of size) of 22.0 or more. None of them, however, are at present considered likely candidates for a collision with Earth.



As asteroids have almost no gravity special techniques, such as this cone, have to prevent the mined material from escaping into space

Asteroid Mining

The comets and asteroids that are potentially the most hazardous, because they closely approach Earth, are also the ones that could be most easily exploited for their raw materials, as Earth´s own resources dwindle. Asteroids fall into three basic types, i.e. carbonaceous (75%), silicaceous (17%) and metallic (8%), although, due to the their diverse origins, the ratios of elements and minerals within each type vary markedly. For instance, a metallic asteroid with a diameter of one kilometre might contain some 30 million tons of nickel, 1.5 million tons of cobalt and 7,500 tons of platinum, with the latter alone having a current market value of more than U$150 billion.

Due to gravitational differentiation and other geological processes, almost all the nickel and much of the iron on Earth reside in the core and mantle, where it is impossible to access; on the surface iron only exists bonded to oxygen, silicon or sulfur. In contrast, asteroids are rich in free iron and nickel, as well as in precious metals (i.e. Au, Pt, Ir, Os, Pd, Rh and Ru), which are extremely rare in Earth's crust. To mine these treasures in the future a variety of methods, such as strip mining or tunneling (above) are being envisaged.