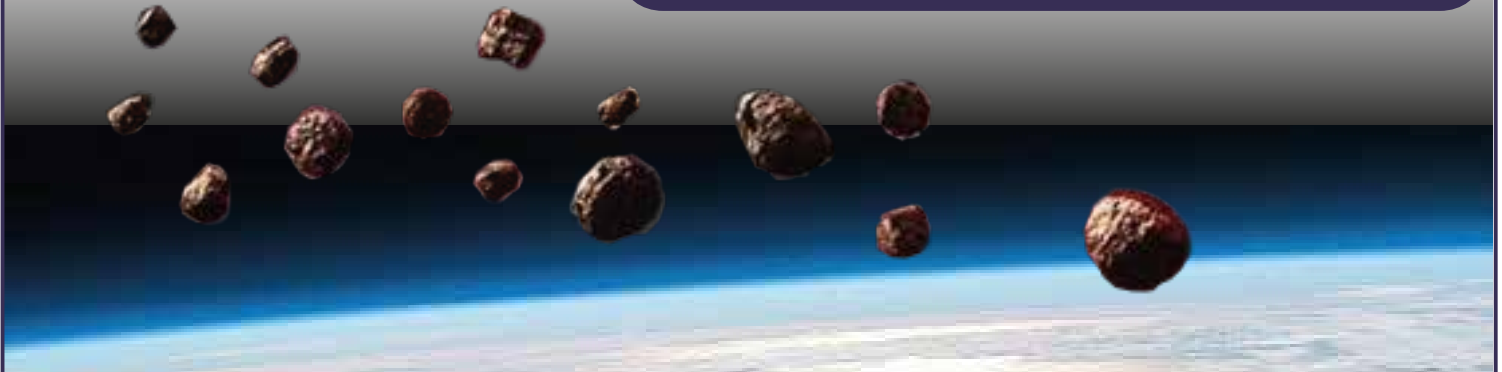


THERE ARE **EXTRATERRESTRIALS** AMONG US!

Did you Know? It's the meteorites!
But...Why do we say they are aliens?
Every day, about 100 tons of material from space fall to Earth;
luckily 99% are particles smaller than half a millimeter.



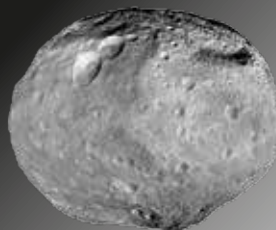
Do you know where they originate?

Almost all meteorites and micrometeorites come from remains of asteroids and comets. A few of them originated in impacts that detached pieces from the crust of the Moon and Mars.

COMET



ASTEROID



MOON



Meteorites were traditionally classified according to their composition into: **stony**, **iron** and **stony - iron**. A mere modern classification considers, in addition to the composition, the origin and degree of differentiation of the body of origin of the meteorite. Stony meteorites are subdivided into **chondrites** and **achondrites**.

MARS



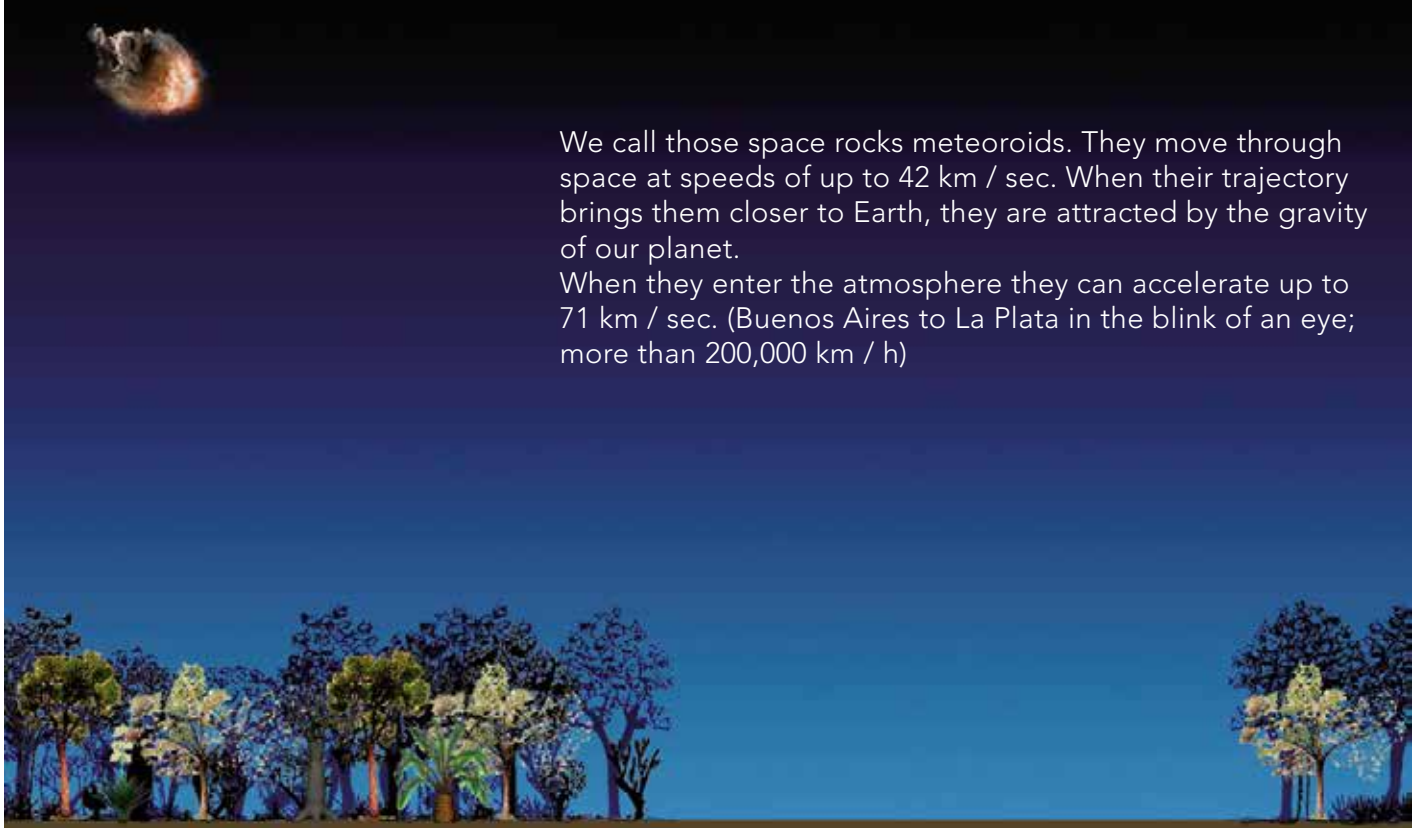
chondrites achondrites

stony meteorites

iron meteorites

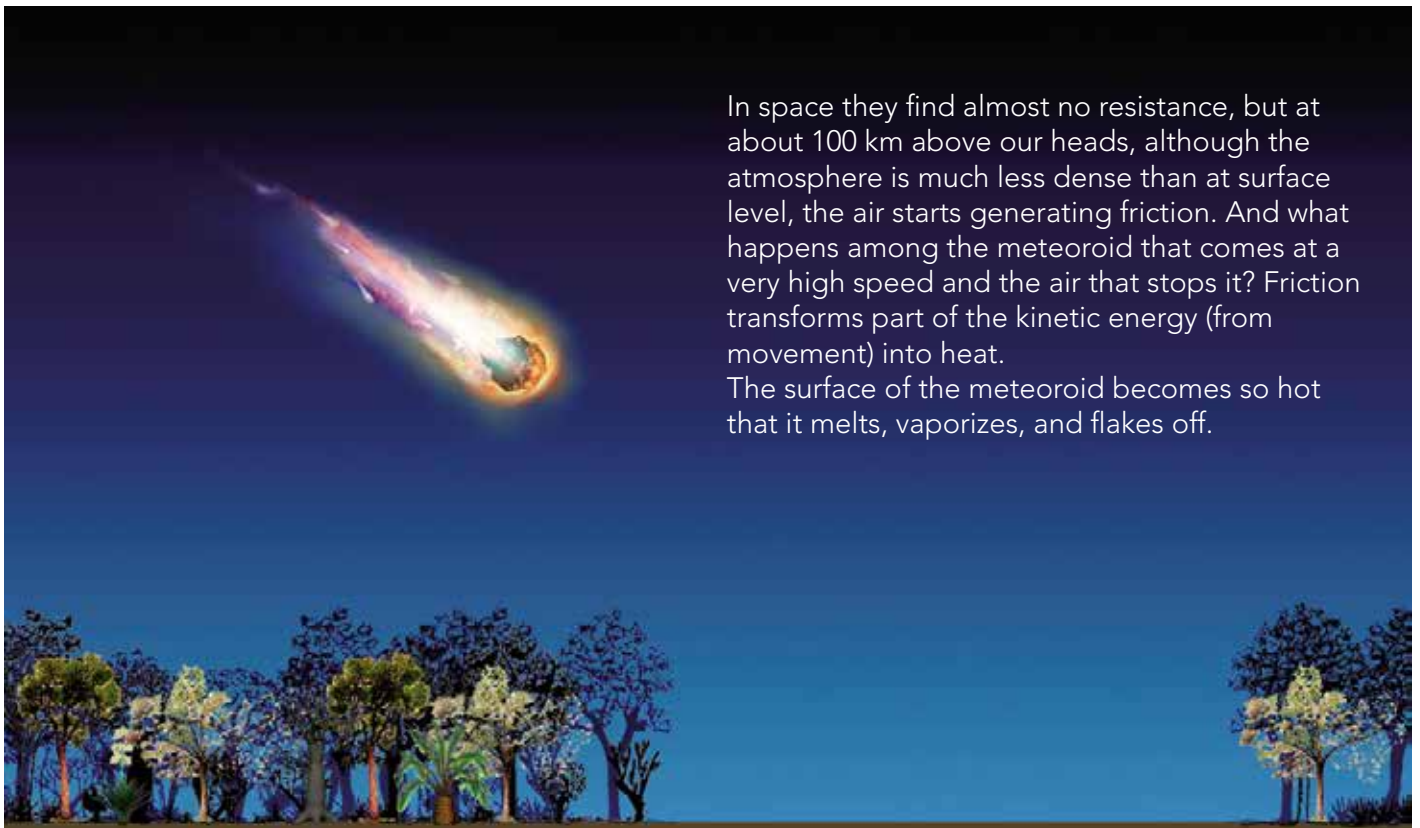
stony-iron meteorites

How do these rocks from space get to Earth?
And what happens to them on the way?



We call those space rocks meteoroids. They move through space at speeds of up to 42 km / sec. When their trajectory brings them closer to Earth, they are attracted by the gravity of our planet.

When they enter the atmosphere they can accelerate up to 71 km / sec. (Buenos Aires to La Plata in the blink of an eye; more than 200,000 km / h)



In space they find almost no resistance, but at about 100 km above our heads, although the atmosphere is much less dense than at surface level, the air starts generating friction. And what happens among the meteoroid that comes at a very high speed and the air that stops it? Friction transforms part of the kinetic energy (from movement) into heat.

The surface of the meteoroid becomes so hot that it melts, vaporizes, and flakes off.

How do these rocks from space get to Earth?
And what happens to them on the way?



The air around is also heated and the atoms are charged with excess energy, released then as light.

That's the flash that is observed and is called a **meteor**.

When the brightness of the meteor exceeds that of the planet Venus (magnitude -4) it is called a **fireball**. Some fireballs can be brighter than the full Moon.

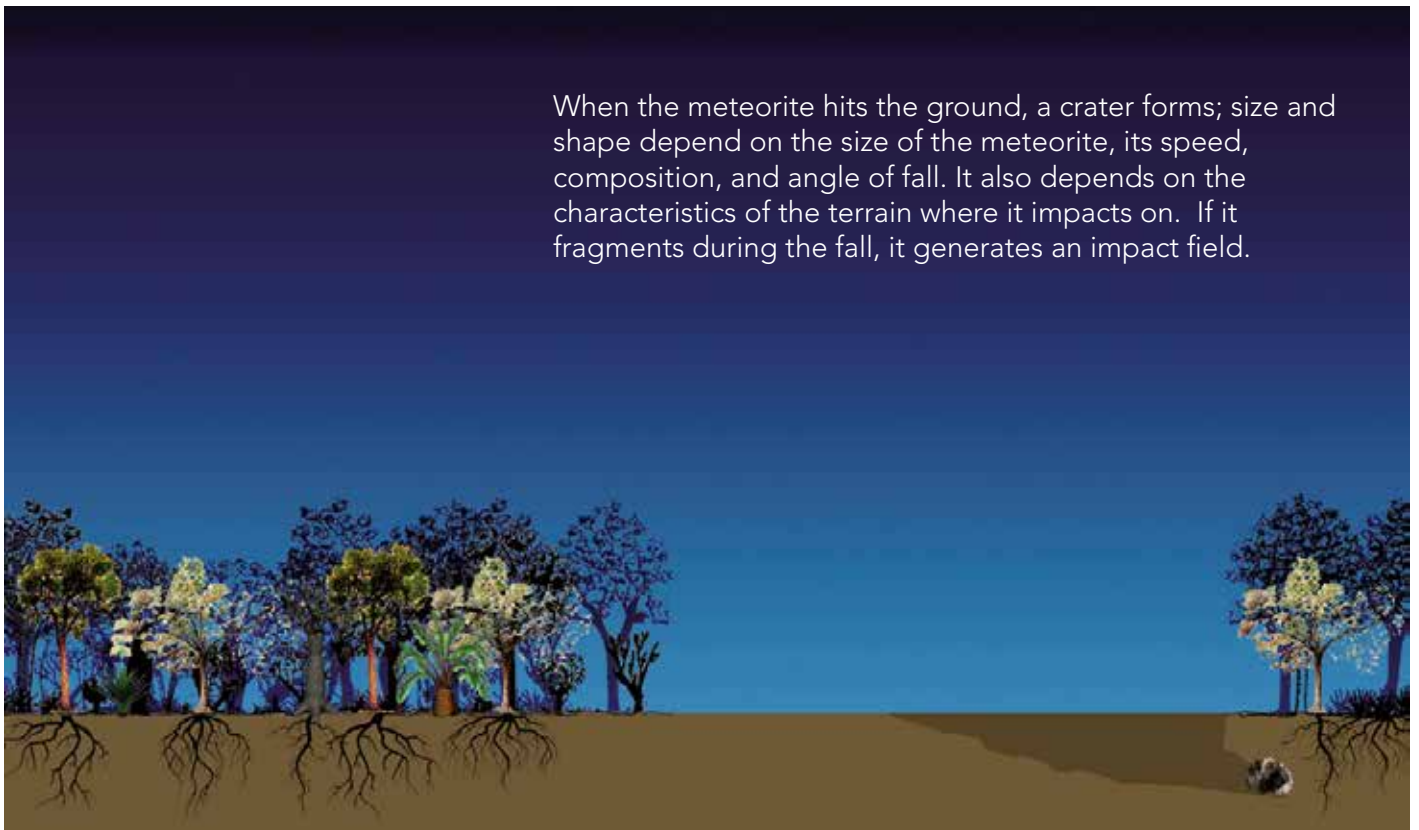
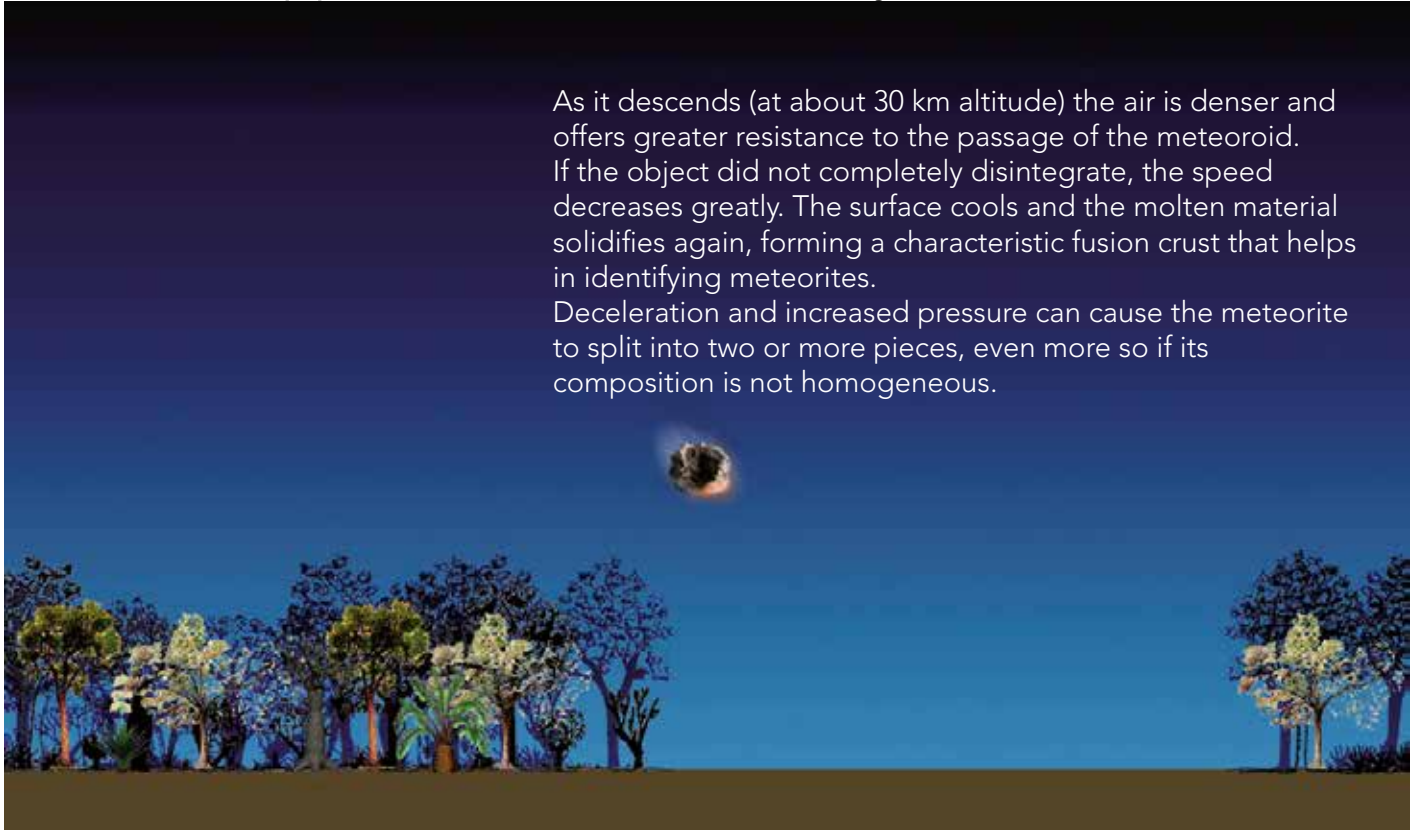


Different colors can be observed depending on the atoms present (coming from the meteoroid or present in the atmosphere).

As it continues to descend, the surface of the meteoroid continues to melt and detach. This process (ablation) dissipates excess heat and prevents the interior from heating up, but if the object is very small it is completely disintegrated. There may also be marks like fingerprints called **regmaglypts**.



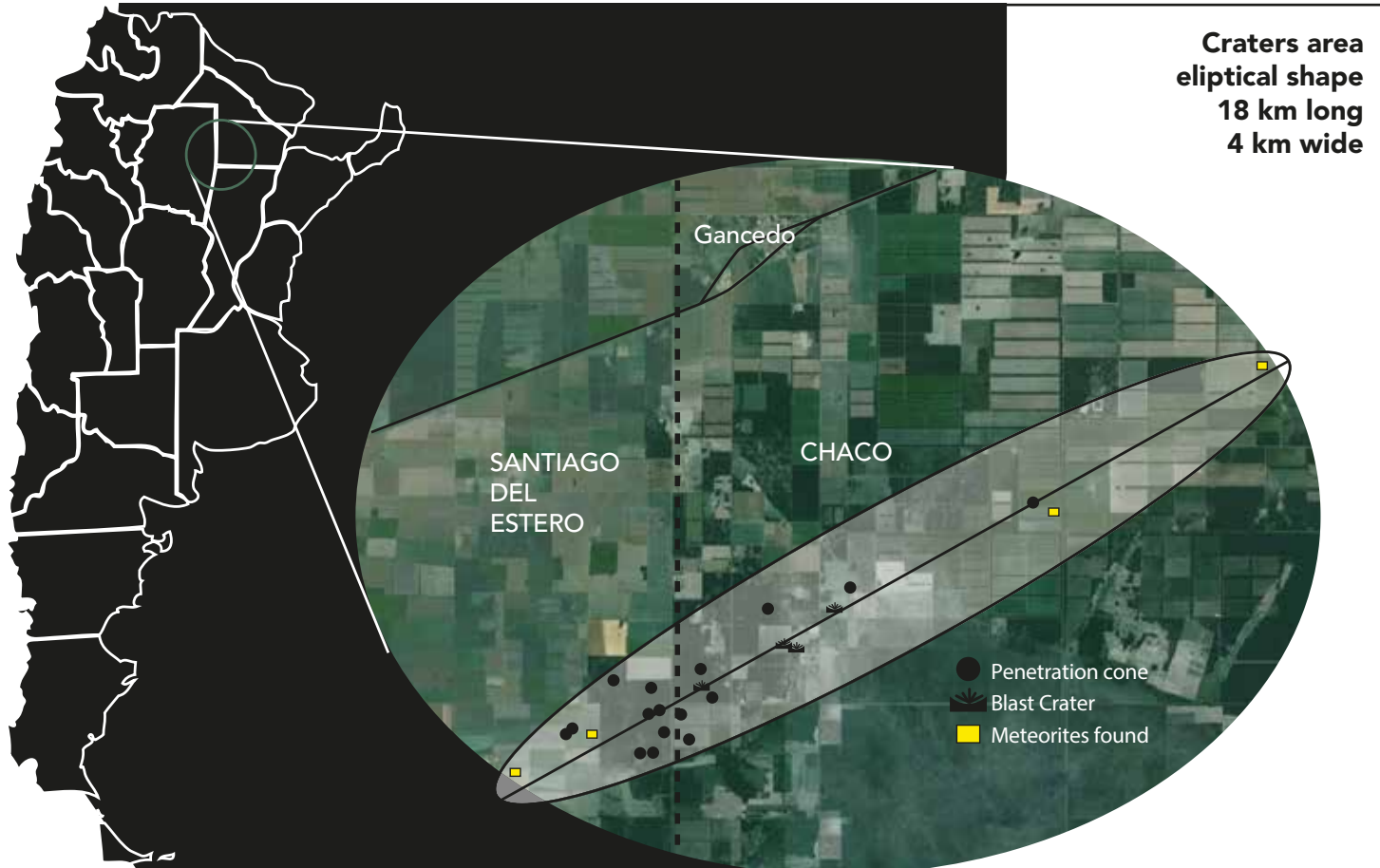
How do these rocks from space get to Earth? And what happens to them on the way?



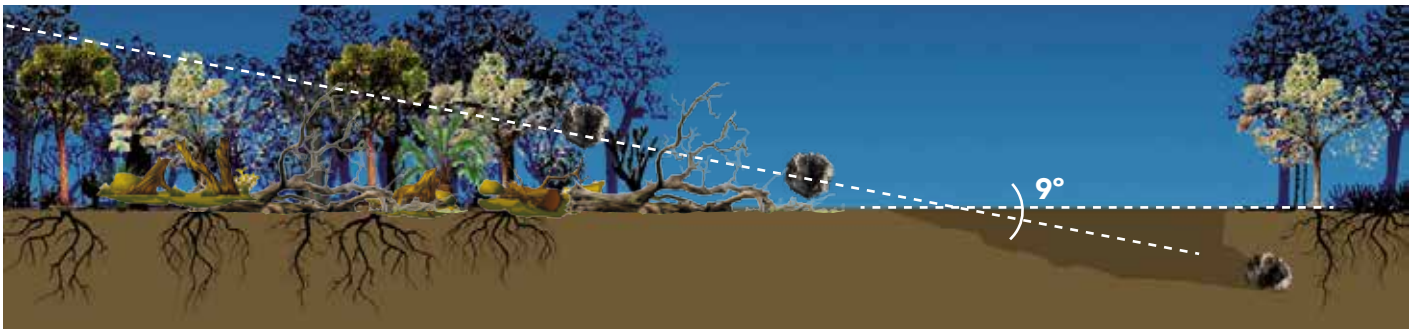
CAMPO DEL CIELO

It was precisely the fragmentation of a large meteoroid with an estimated weight of 800 tons that gave rise to Campo del Cielo, one of the largest known meteorite impact fields.

It is located between the Argentine provinces of Chaco and Santiago del Estero. More than 20 craters were studied there. Each one provides information about how the meteorites hit the ground. The location of the craters and fragments, helps to deduce what the event that gave rise to it was like.



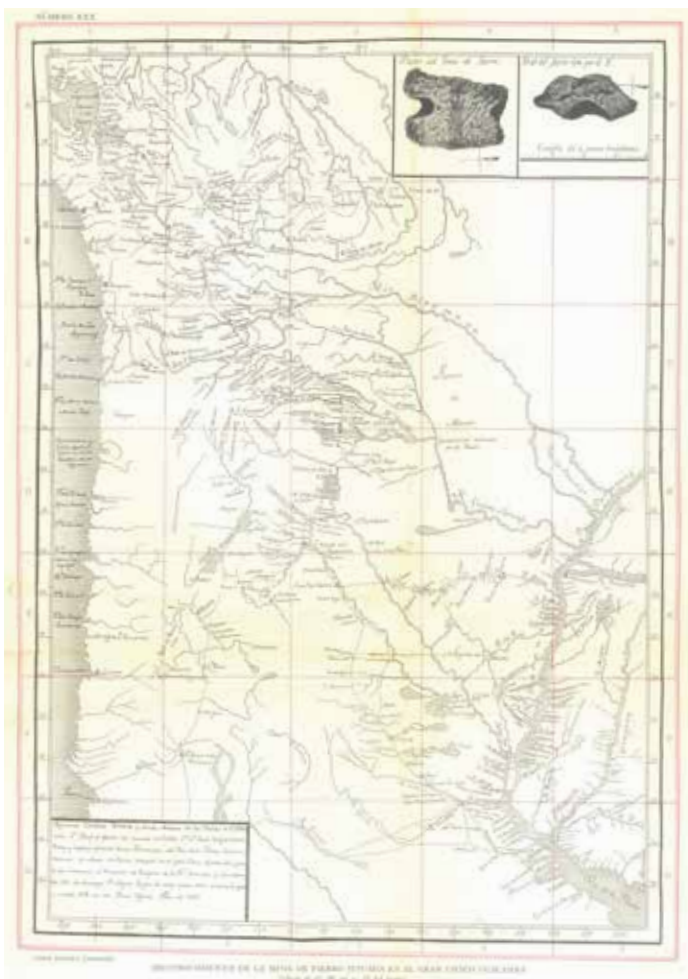
Due to the shape and orientation of the impact field, the trajectory could be precisely calculated: it entered from the southwest and at a very low angle (9°). We also know that the meteoroid broke into many fragments of various sizes.



Based on chemical analysis of the plant material that was under the meteorites, the age of the fall can be known: 4000 years.

THE MYSTERY OF THE CHACO IRON

Surely the large blocks outcropping on the ground (where there are no rocks on the surface) caught the attention of the peoples that inhabited the area. Perhaps they have even witnessed the fall, but there is no reliable data to assure or deny it.



Copy from Rubin de Celis map, General Archive of the Nation, from Buenos Aires, Historic Research Institute Bulletin, T. XV, pp.531 a 554, Buenos Aires, 1932. ...

In 1783, an expedition led by Frigate Lieutenant **Miguel Rubin de Celis**, tried to verify whether it was an outcrop or an isolated mass. They dug and planted explosives to try to remove it from its site. As a result of these maneuvers, the "Mesón de Fierro" was buried and was never found to this day.

Now we have no doubts about the nature of the metallic fragments scattered in Campo del Cielo: we know they are meteorites. But for centuries its presence on the Chaco plain was a true mystery.

We do know that, through them, the Spanish conquerors learned of the presence of these metallic masses. That is why they organized numerous expeditions to analyze and take advantage of them. They even thought that they could find silver mines like those in Alto Peru.



In 1576 an expedition of 8 soldiers commanded by **Hernán Mexia de Miraval** departed from Santiago del Estero (the oldest city in Argentina).

After many difficulties they managed to find a large "iron overhang", from which they took samples. After two centuries of oblivion, rumors about the existence of a silver mine revived interest in Chaco iron. New expeditions set out on its search, taking samples and measurements.



CAN STONES FALL FROM SKY?

Over time, other iron masses were found, which we now identify as meteorites. But at the end of the 18th century nobody could explain their presence in that place.

In those years, although meteorite falls had already been observed in Europe and samples of the material had been collected, scientists did not recognize the possibility that "stones could fall from sky".

They assumed that they could have been thrown by a volcano, condensed in the atmosphere or were the product of a lightning strike.

Only in 1803 it was accepted that they could come from space. In those years the first objects of the Asteroid Belt were also discovered, before that, only the existence of the planets (up to Uranus) and some of their moons were known.

METEORITES FOR INDEPENDENCE

After the May Revolution of 1810, one of the main concerns of the First National Government (called Primera Junta de Gobierno) was that no weapons were available, or factories to manufacture them. The "Buenos Aires Rifle Factory" is created, located where the Palace of Justice (Courts) is currently situated.



Iron was not very abundant in the area. In 1815 they received a large piece of metal (2,500 kg) from Campo del Cielo.

Esteban de Luca, the factory director, decided to make two pistols out of that iron.



Representation of the guns

According to a report he submitted to the government in 1816, he was well aware of the latest theories about the nature of meteorites.

Also **Manuel Moreno**, brother of Mariano Moreno and one of the intellectuals of the May Revolution, recognized that the Chaco iron was "meteoric stones of different magnitudes", as published in 1922 in **La Abeja Argentina**, the communication body of the Society of Physical-Mathematical Sciences of Buenos Aires.



SCIENTIFIC WORK

The first work to scientifically study the Campo del Cielo meteorites was carried out in 1923 by the Argentine geologist **Juan José Nágera**, from the General Directorate of Mines and Hydrology. As the area became more populated, more and more findings began to be recorded.

In the mid-20th century, at the beginning of the space race, meteorites represented the only form of contact with elements of extraterrestrial origin. The study of meteorite craters on Earth made it possible to understand the impacts left on the Moon and other rocky bodies. Campo del Cielo was an ideal natural laboratory for this type of study.

Between 1962 and 1972, a team of Argentine and North American researchers completed Nágera's work.

For the first time, magnetometers, metal detectors, and equipment were used to extract stratigraphic samples.



From 1986, the **Chaco Association of Astronomy** continued the surveys and incorporated new technology, such as satellite remote sensing. New craters were studied and with the support of **NASA**, campaigns were carried out that allowed finding new meteorites, some over 10 tons in weight.

The concentration of material is so big that, despite the predation by clandestine collectors and the alteration of the area due to agricultural activities and excessive clearing, findings continue to be recorded, such as that of **the Gancedo meteorite in 2016, , which turned out to be the largest found to date.**



Many of the discovered pieces were donated to different museums, some were left in private hands and the legislation about the ownership of meteorites began to be discussed. In 2007, the **National Law No. 26,306** was passed, which declares all meteorites fallen in Argentine territory as cultural property and penalizes their commercialization.

In the province of Chaco the **«Pigüem N'Onaxa» Cultural Natural Reserve** was created to preserve the scientific and cultural heritage of Campo del Cielo.