United Nations/Argentina Workshop on Space Law

"Contribution of Space Law to Economic and Social Development"

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Legal Aspects of Mining of Asteroids

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To mine metals from asteroids and bring them back to Earth

This is the plan of the firm Planetary Resources, launched at the Museum of Flight in Seattle, U. S., on last 24th April.

U.S. space entrepreneurs started announcing venture to launch robotic prospectors into outer space in hopes of extracting water and precious metals from asteroids.

The gold race in asteroids

To *The Economist*, "it sounds like the plot of a film by **James Cameron**—and, appropriately, Mr Cameron is indeed one of the company's backers".

Funders of **Planetary Resources**:

1) **Peter Diamandis** – instigator of the X Prize, awarded in 2004 to Paul Allen and Burt Rutan for the first private space flight;

2) **Eric Anderson**, from **Space Adventures**, a company which has already shot seven tourists into orbit;

3) **Larry Page** and **Eric Schmidt**, respectively the chief executive and the chairman of **Google**.

4) **Charles Symonyi**, who oversaw the creation of Microsoft's Office software and has been into space twice thanks to **Space Adventure**.

Asteroid probes launched and planned

1) NEAR Shoemaker photographed 253 Mathilde in 1997, before entering into orbit around 433 Eros, finally landing on its surface in 2001.

Other asteroids briefly visited by spacecraft en route to other destinations include 9969 Braille (by Deep Space 1 in 1999), and 5535 Annefrank (by Stardust in 2002).

2) In September 2005, the Japanese Hayabusa probe started studying 25143 Itokawa in detail and was plagued with difficulties, but returned samples of its surface to Earth on June 13, 2010.

3) The European Rosetta probe (launched in 2004) flew by 2867 Šteins in 2008 and 21 Lutetia, the second-largest asteroid visited to date, in 2010.

4) In September 2007, NASA launched the Dawn Mission, which orbited the protoplanet 4 Vesta from July 2011 to September 2012, and is planned to orbit 1 Ceres in 2015. 4 Vesta is the largest asteroid visited to date.

5) The Japan Aerospace Exploration Agency (JAXA) plans to launch around 2015 the improved Hayabusa 2 space probe and to return asteroid samples by 2020. Current target for the mission is the C-type asteroid (162173) 1999 JU_3.

6) In May 2011, NASA announced the OSIRIS-REx sample return mission to asteroid 1999 RQ36, and is expected to launch in 2016.

7) Asteroids might be used as a source of materials that may be rare or exhausted on earth (asteroid mining), or materials for constructing space habitats. These materials are heavy and expensive to launch from Earth may someday be mined from asteroids and used for space manufacturing and construction. That is the objective of Planetary Resources.

Asteroids look like popcorn

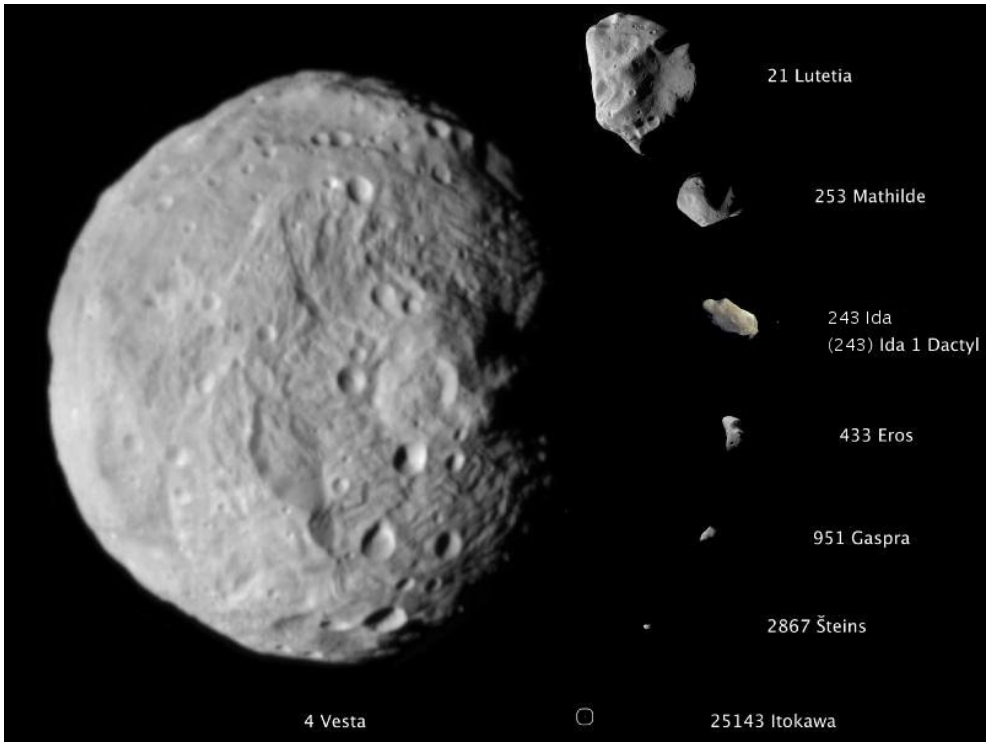
How many near Earth asteroides (NEA) exist, and how many of them can be viable for mining?

About 9,000 (nine thousand) NEAs

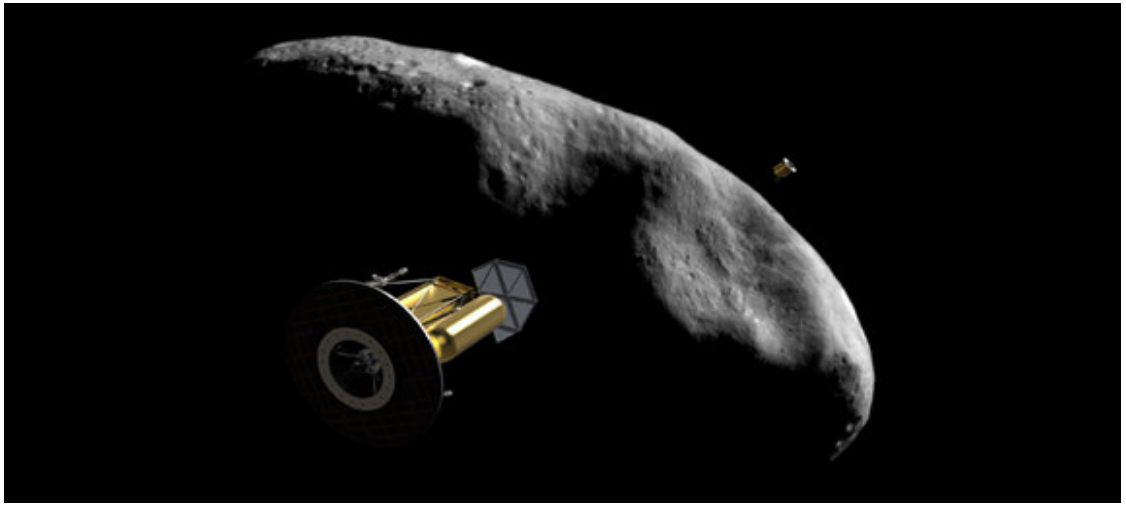
Most of them courtesy of ground-based programs looking for bodies that might one day hit Earth.

Asteroids considered for mining

The Planetary Resources promises to make a catalogue of appropriated NEAs, but plans to go further.

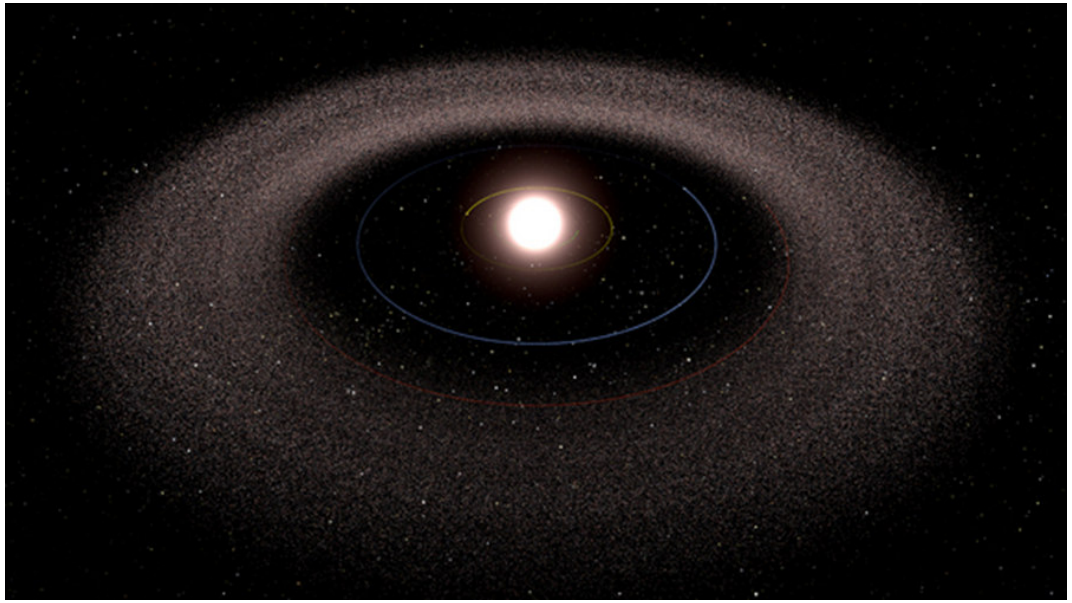


Small space telescopes seeking out appropriated asteroids.



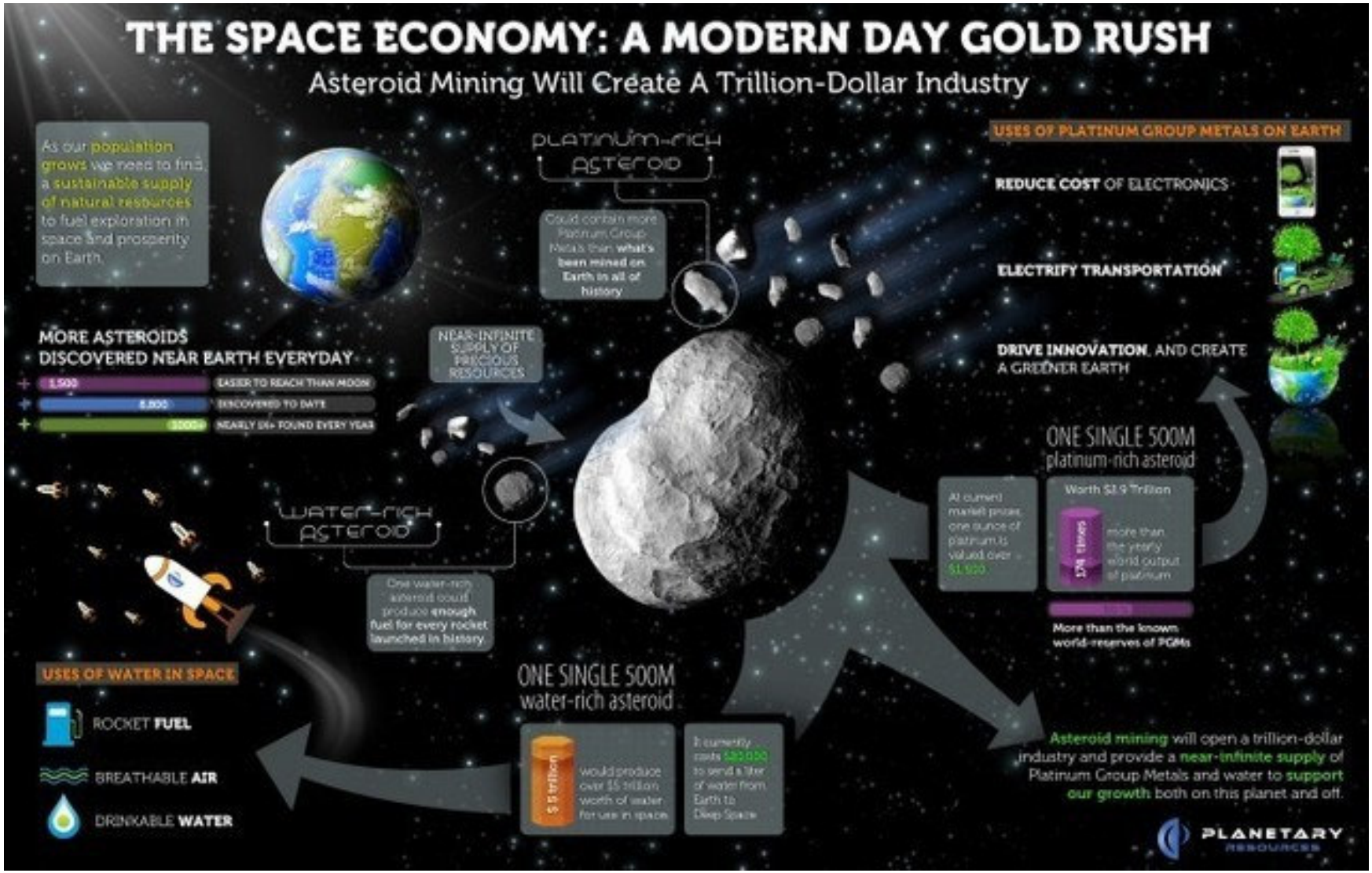
In 2014, the Planetary Resources intends to launch a set of small space telescopes with the purpose to seek out asteroids which are easy to get to.
The orbits of these asteroids return them to the vicinity of Earth often enough for the accumulated spoils of a mining operation to be downloaded at frequent intervals.

A big question: what does it cost to mine an asteroid?



About of US$2.6 billion.

Estimative by the Collaborative Modeling for Parametric Assessment of Space Systems (COMPASS) team at NASA Glenn Research Center in Cleveland.


THE SPACE ECONOMY: A MODERN DAY GOLD RUSH
Asteroid Mining Will Create A Trillion-Dollar Industry
As our population grows we need to find a sustainable supply of natural resources to fuel exploration in space and prosperity on Earth.
PLATINUM-RICH ASTEROID
Could contain more Platinum Group Metals than what's been mined on Earth in all of history
USES OF PLATINUM GROUP METALS ON EARTH
REDUCE COST OF ELECTRONICS
ELECTRIFY TRANSPORTATION
DRIVE INNOVATION, AND CREATE A GREENER EARTH
MORE ASTEROIDS DISCOVERED NEAR EARTH EVERYDAY
1,500
EASIER TO REACH THAN MOON
8,800
DISCOVERED TO DATE
1000+
NEARLY 16+ FOUND EVERY YEAR
NEAR-INFINITE SUPPLY OF PRECIOUS RESOURCES
ONE SINGLE 500M platinum-rich asteroid
At current market prices, one ounce of platinum is valued over $1,920
Worth $1.9 Trillion
more than the yearly world output of platinum
More than the known world-reserves of PGMs
WATER-RICH ASTEROID
One water-rich asteroid could produce enough fuel for every rocket launched in history.
ONE SINGLE 500M water-rich asteroid
$5 trillion
would produce over $5 trillion worth of water for use in space
It currently costs $20,000 to send a liter of water from Earth to Deep Space
USES OF WATER IN SPACE
ROCKET FUEL
BREATHABLE AIR
DRINKABLE WATER
Asteroid mining will open a trillion-dollar industry and provide a near-infinite supply of Platinum Group Metals and water to support our growth both on this planet and off.
PLANETARY RESOURCES

Controversy of arguments

Planetary Resources says: platinum from a 30-meter long asteroid is worth 25-50 billion US$.

A critic remarked: any outside source of precious metals could lower prices sufficiently to possibly doom the venture.

Argument favorable: Development of an asteroid-orbit manipulation infrastructure could offer an irresistible return on investment.

Argument against: altering the trajectories of asteroids in nearby interplanetary space can cause a catastrophic collision with Earth. This was the concern of the astrophysicists Carl Sagan and Steven J. Ostro, who recommended stringent controls on the misuse of orbit-engineering technology.

Another big question: what is the legal base to mine asteroids?

Is the today International Space Law a solid legal base to support the Plans of Planetary Resources and other companies to mine metals in asteroids?

Is it legally permitted?

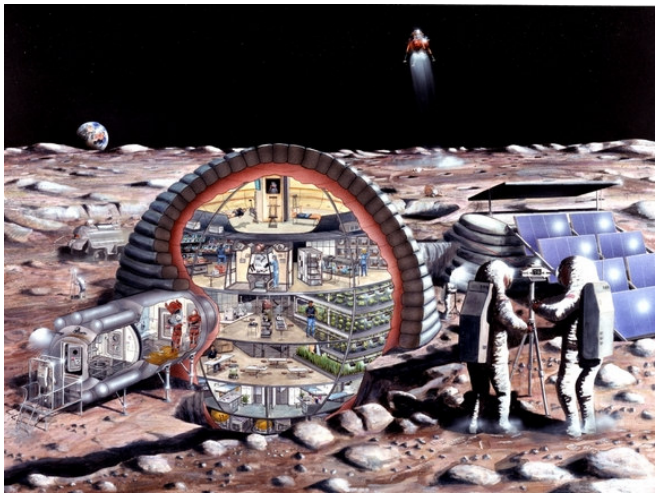
What are the legal sources to regulate the exploration and use of asteroids?

1) Treaty on Principles Governing the Activities of the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (Outer Space Treaty), of 1967.

2) Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Moon Agreement), of 1979.

But are these instruments sufficient?

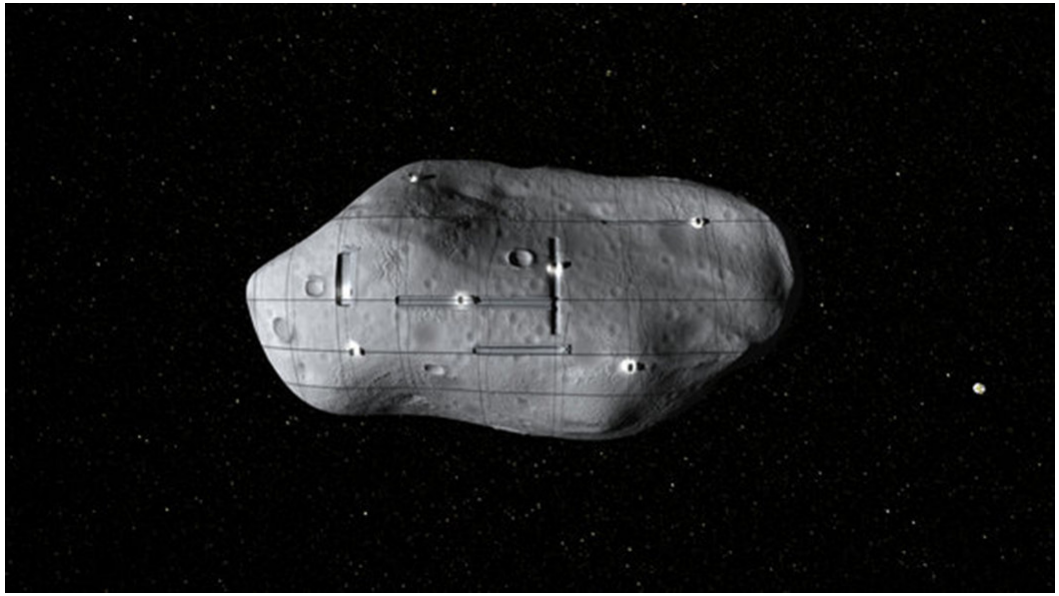
Is it already internationaly regulated the specific issue of mining of the natural resources of Moon or the asteroids?



Not yet, but would not it be time to doing that?

How to legally define an “asteroid”?

Is it a "celestial body“, the term used in the Outer Space Treaty just after the Moon?



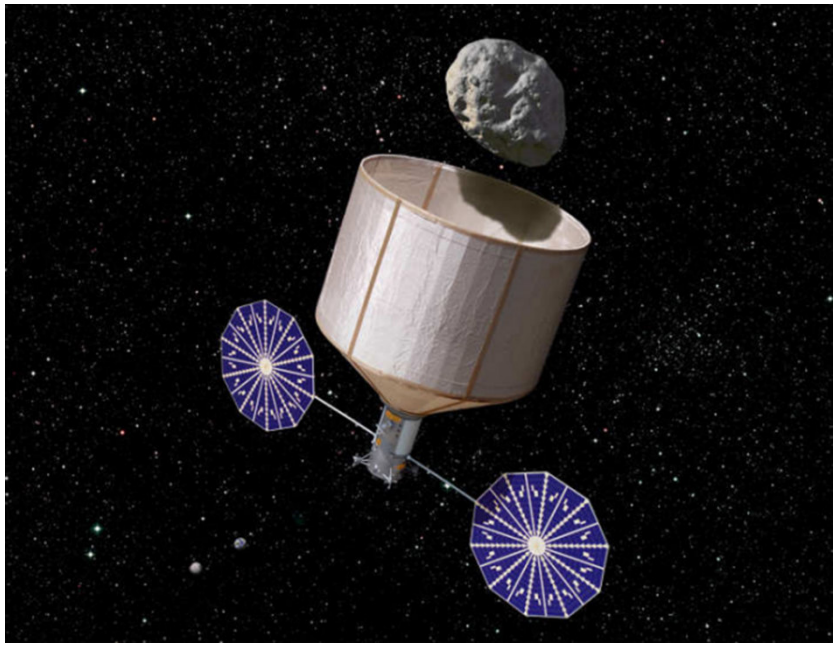
Are asteroids like the Moon from the legal point of view?

Article I of the Moon Agreement:

"§1. The provisions of this Agreement (...) shall also apply to other celestial bodies within the solar system, other than the earth, except in so far as specific legal norms enter into force with respect to any of these celestial bodies."

Can the asteroids have specific norms?

Yes, as says the Article 1 of Moon Agreement, any celestial body can be an exception and, therefore, be governed by a specific norm.



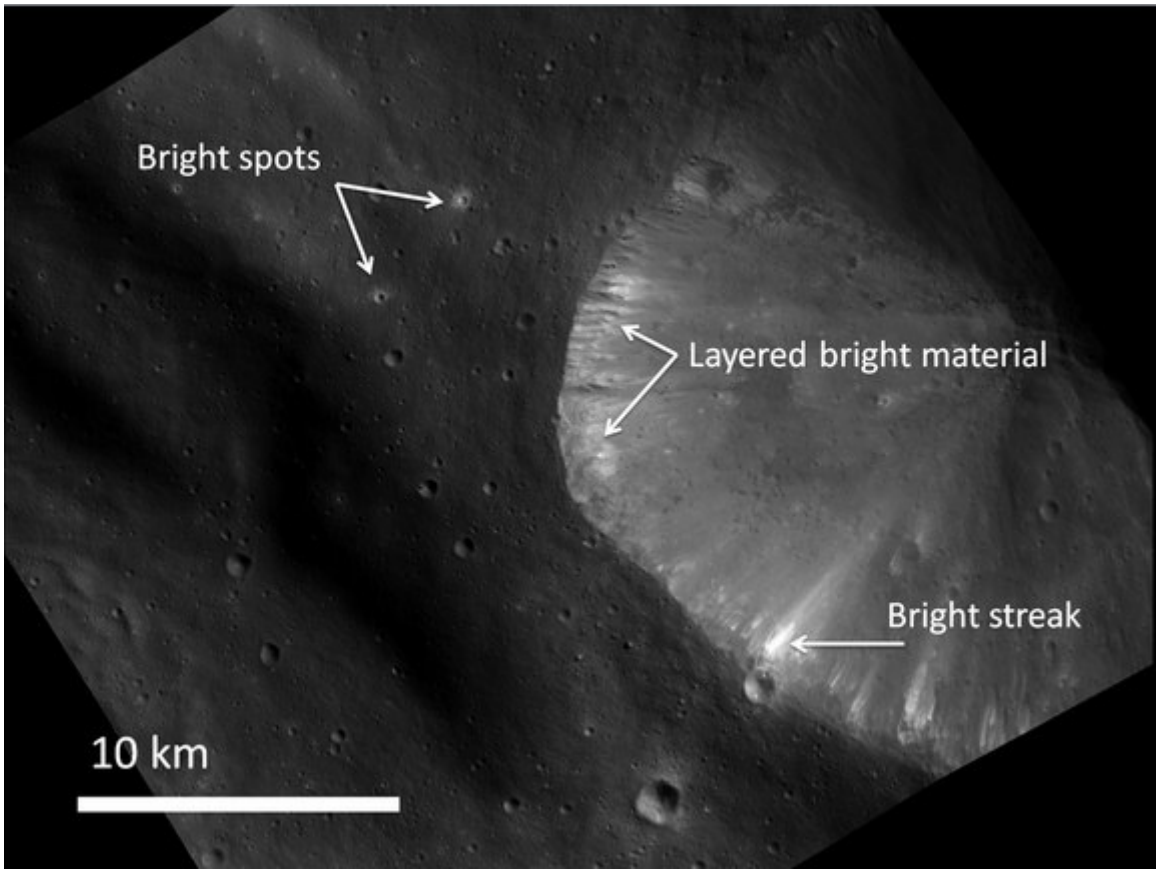
Everything depends on the decision of the States.

What is the first legal obligation in the exploration and use of the asteroids?

Article I of Outer Space Treaty:

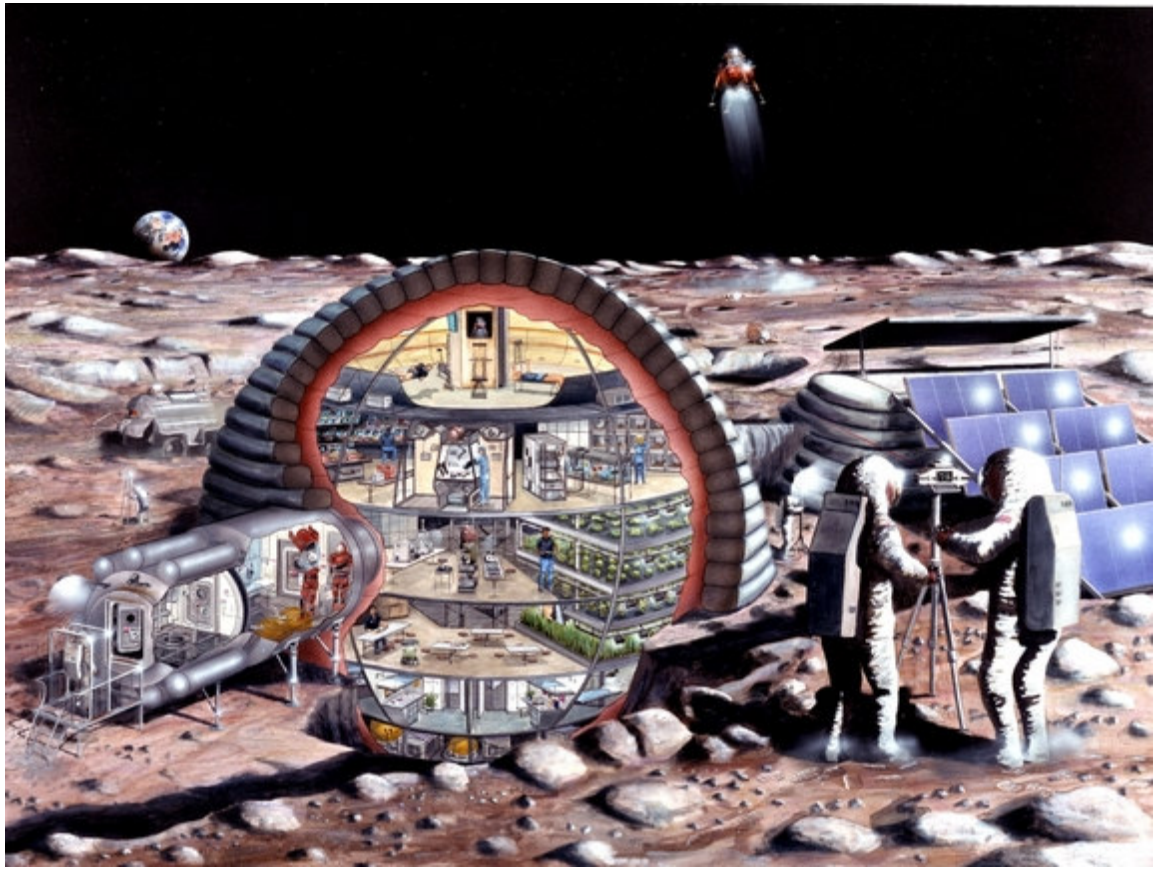
"The exploration and use of outer space, including the moon and other celestial bodies [asteroids], shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind."

So, mining of asteroids shall be carried out for the common benefit.



Asteroid Vespa researched by NASA

How to mine asteroids for the common benefit?



Can a State or a private company be owner of an asteroid or part of it?

Article II of the Outer Space Treaty:

"Outer space, including the moon and other celestial bodies [asteroids], is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means."

But today there is another view defending the ownership over the resources of the asteroids. It is based on the principle of the ancient Roman law, named Pedis possessio.

Pedis means foot.

"Regarding claiming ownership over asteroidal resources, it appears that the ancient Roman law will apply. *Pedis possessio* is the basis for Western law on ownership, and analogies have long existed in other parts of the world as well.

It means that the first entity to set foot (*pedis*) upon and occupy a space can claim possession. The current interation of *pedis possessio* in modern mining law will probably apply."

But the asteroids are not free for the exploration and use by all States?

Article I (§ 2) of the Outer Space Treaty:

"Outer space, including the Moon and other celestial bodies [asteroids], shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies."

What is owning, exploring, using, and exploiting?

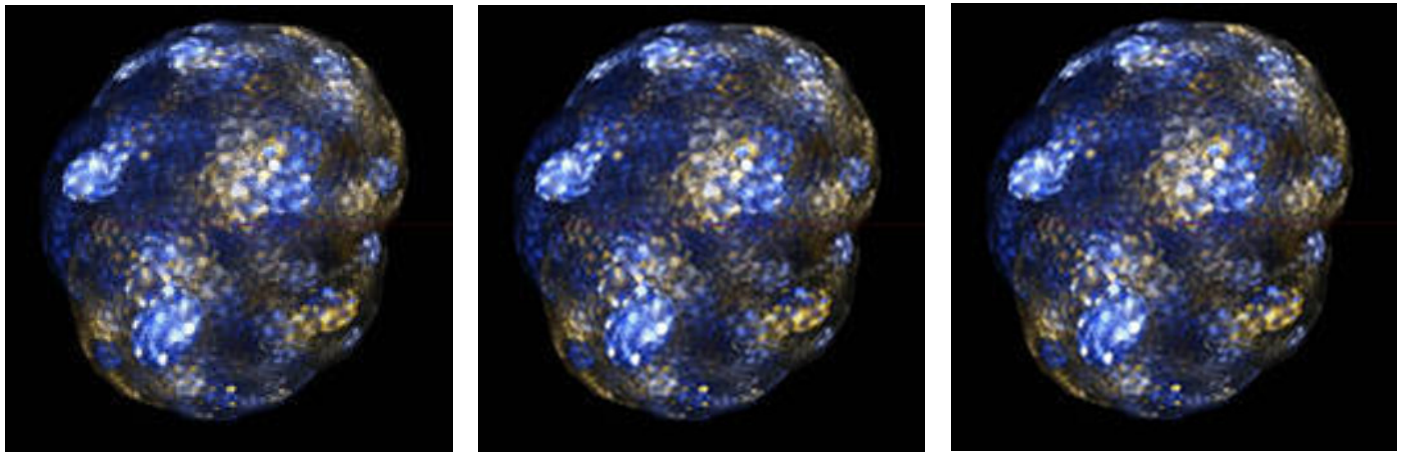
Owning a thing is to possess it, exercise exclusive domain on it, and freely to exploite it in the limit of the law, if any.
Exploring a thing is to study it, research it, inquire into it, examine it minutely.
Using a thing is to apply, employ, consume, harness, being or not its owner.
Exploiting a thing is to manipulate it to one's advantage, make business/profit of it.

What is prohibited and what is permitted in outer space?

To own is prohibited.

To explore, use, and exploit are permitted.

What is the difference between to use and to exploit outer space?



To use a celestial body is to utilize it for scientific research and survival at the local, being not its owner.

To exploit a celestial body is to manipulate it to one's advantage, making profit of it.

What is the legal framework proposal of the Moon Agreement for the exploitation of the asteroidal resources?

It is in its famous article 11:

1. The asteroids and its natural resources are the common heritage of mankind.

2. The asteroids is not subject to national appropriation by any claim of sovereignty, by means of use or occupation, or by any other means.

Article 11 of the Moon Agreement (II)

3. Neither the surface nor the subsurface of the asteroids, nor any part thereof or natural resources in place, shall become property of any State, international intergovernmental or non-governmental organization, national organization or non-governmental entity or of any natural person.

The placement of personnel, space vehicles, equipment, facilities, stations and installations on or below the surface of the asteroids, including structures connected with its surface or subsurface, shall not create a right of ownership over the surface or the subsurface of the asteroids or any areas thereof.

The proposal to establish an International Regime to govern the exploitation of the natural resources of the asteroids, proposed by the Moon Agreement.

Article 11 of the Moon Agreement (III)

4. States Parties have the right to exploration and use of the asteroids without discrimination of any kind, on the basis of equality and in accordance with international law and the terms of this Agreement.

5. States Parties to this Agreement hereby undertake to establish an international regime, including appropriate procedures, to govern the exploitation of the natural resources of the asteroids as such exploitation is about to become feasible.

6. In order to facilitate the establishment of the international regime (...), States Parties shall inform the Secretary-General of the United Nations as well as the public and the international scientific community, to the greatest extent feasible and practicable, of any natural resources they may discover on the asteroids.

The proposal to establish the Principle of Equitable Sharing Benefits in the exploitation of the natural resources of the asteroids, according to the Moon Agreement.

Article 11 of the Moon Agreement (IV)

7. The main purposes of the international regime to be established shall include:

(a) The orderly and safe development of the natural resources of the asteroids;

(b) The rational management of those resources;

(c) The expansion of opportunities in the use of those resources;

(d) An equitable sharing by all States Parties in the benefits derived from those resources, whereby the interests and needs of the developing countries, as well as the efforts of those countries which have contributed either directly or indirectly to the exploration of the asteroids, shall be given special consideration.

Principle of Preventing the disruption of existing balance of the asteroid's environment, proposed by the Moon Agreement

Article 7 of the Moon Agreement:

1. In exploring and using the asteroids, States Parties shall take measures to prevent the disruption of the existing balance of its environment, whether by introducing adverse changes in that environment, by its harmful contamination through the introduction of extra-environmental matter or otherwise.

States Parties shall also take measures to avoid harmfully affecting the environment of the Earth through the introduction of extraterrestrial matter or otherwise.

Some ideas as conclusions.

1) The Moon Agreement was discussed and elaborated during more than 10 years. It is a rich experience, we cannot ignore.

2) But so far only 13 States rafifyed it.

3) So, it does not solve the question of ordering the exploitation of natural resources of the Moon and asteroids.

4) We need to create a new agreement on this matter, in order to assure the Rule of Law in so crucial outer space activity.

Thank you for the
kind attention!