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# Mining Asteroids vs Mining the Moon – Can you Have your Cake and Eat it?

**Alex Ellery**

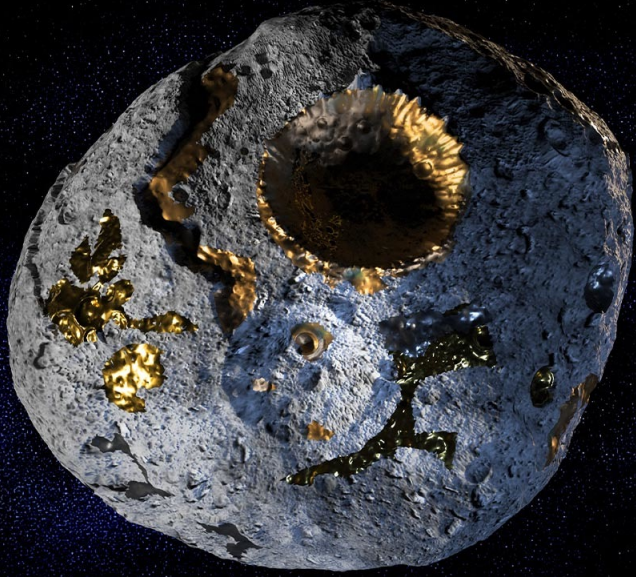
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**SPACE RESOURCES ROUNDTABLE 2025**



Can humanity enjoy the benefits of both asteroid and lunar mining without compromise, or do we have to choose one at the expense of the other?

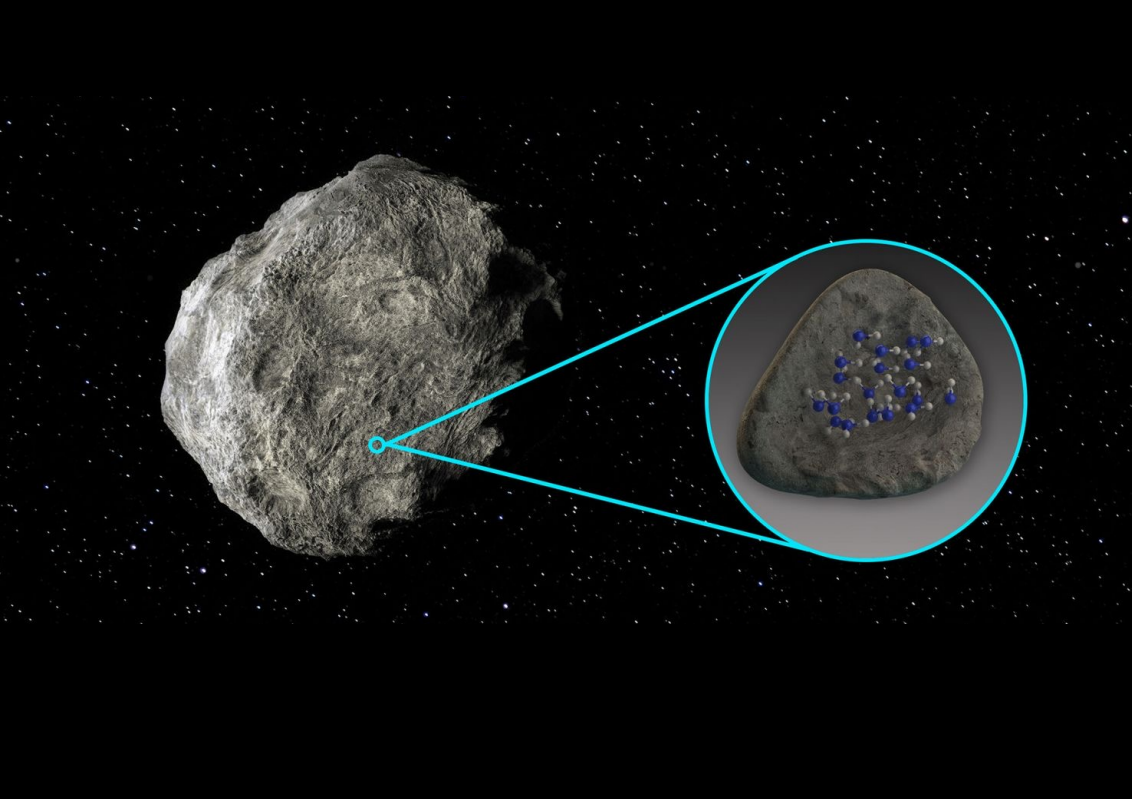


44 <b>Ru</b> Ruthenium	45 <b>Rh</b> Rhodium	46 <b>Pd</b> Palladium	47 <b>Ag</b> Silver
76 <b>Os</b> Osmium	77 <b>Ir</b> Iridium	78 <b>Pt</b> Platinum	79 <b>Au</b> Gold

Traditionally asteroid mining has focused on precious metals like noble metals and PGMs

but

**Only 1 in 2000 NEOs is known to have PGMs in economically mineable concentrations**



Although water has been detected  
in asteroids



**Water in hydrated minerals is  
also rare (~1 in 1000 NEOs)**

**Asteroids are definitely useful for industrial resources**

**All-types: Troilite (Fe)**

M-type



S-type



C-type



# Asteroids are definitely useful for industrial resources

**M-type:** 70 - 95% Fe  
5 - 30% Ni  
0.2 - 2% Co  
0.5 - 2% S  
0.1 - 0.5% P

M-type



S-type



C-type



# Asteroids are definitely useful for industrial resources

**S-type:** Olivine ( $\text{Mg}_2\text{SiO}_4$ ,  $\text{Fe}_2\text{SiO}_4$ )  
Pyroxene ( $\text{MgSiO}_3$ ,  $\text{CaMgSi}_2\text{O}_6$ )

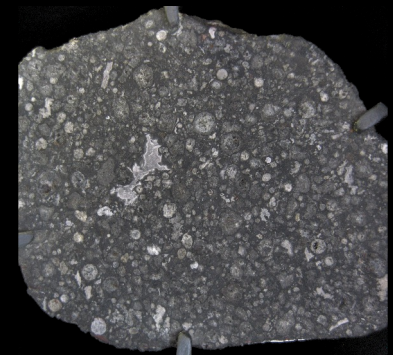
M-type



S-type



C-type



# Asteroids are definitely useful for industrial resources

**C-type:** High Carbon content (carbonates and organics) and clays

CI, CM and CR chondrites are rich in **C**  
~**2-5%** and **N** ~**500-2000 ppm**

**EXTREMELY VALUABLE** as only  
~120ppm C on Moon

M-type



S-type

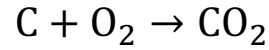


C-type

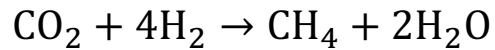


# Unlocking carbon sources would enable carbon valorization:

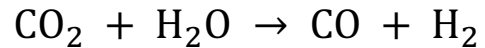
## Pyrolysis



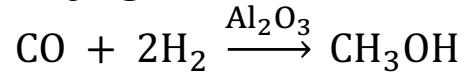
## Sabatier Process



## Sabatier Process



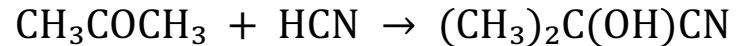
## Syngas to methanol



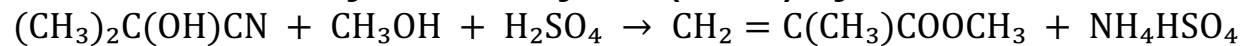
## Acethone synthesis



## Acethone cyanohydrines (ACH) synthesis



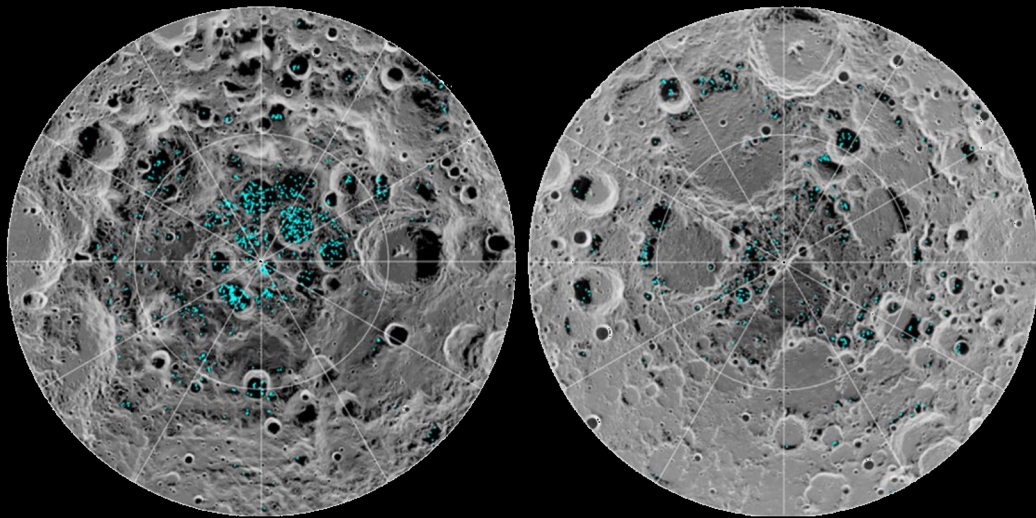
## Methyl Methacrylate (MMA) synthesis





**The Moon lacks many of these,  
however:**

Easier access to water at the lunar poles



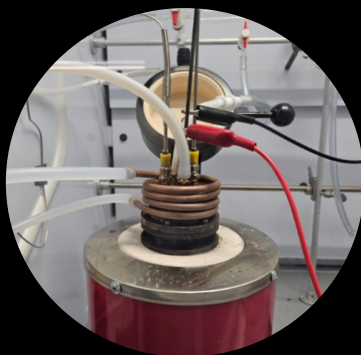
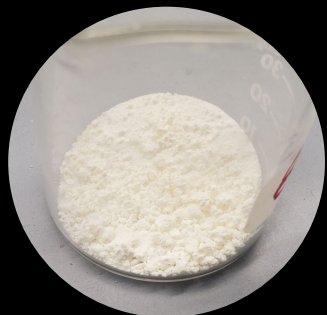
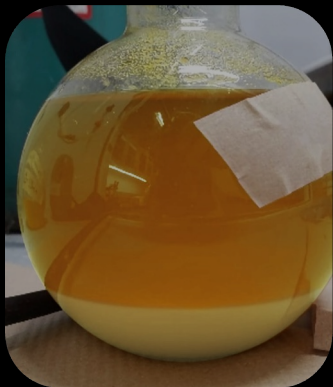


Anorthite  
 $\text{CaAl}_2\text{Si}_2\text{O}_8$



Calcium - aluminate inclusions represent the highest concentration of **Al** <5% in meteorites/asteroids

While **anorthites** are **rare** in meteorites, they are **common** on the **Moon**



**Al and Si can be extracted from anorthite in the same process:**

HCl leaching followed by molten salt electrolysis

**Al is multifunctional material**  
comprising 43% of a spacecraft making it  
a **high priority target**



The Moon has **tungsten** at much higher concentrations

~500  $\mu\text{g/g}$  vs ~1 ppm in asteroids

**Critical for vacuum technology**

We are investigating biomining of ~ ppm W on the Moon with hyperthermophilic archaea using tungstoenzymes



## Takeaways:

Asteroids have **diverse resources**, including some not found on the Moon:

C  
N  
Ni  
Co



## Takeaways:

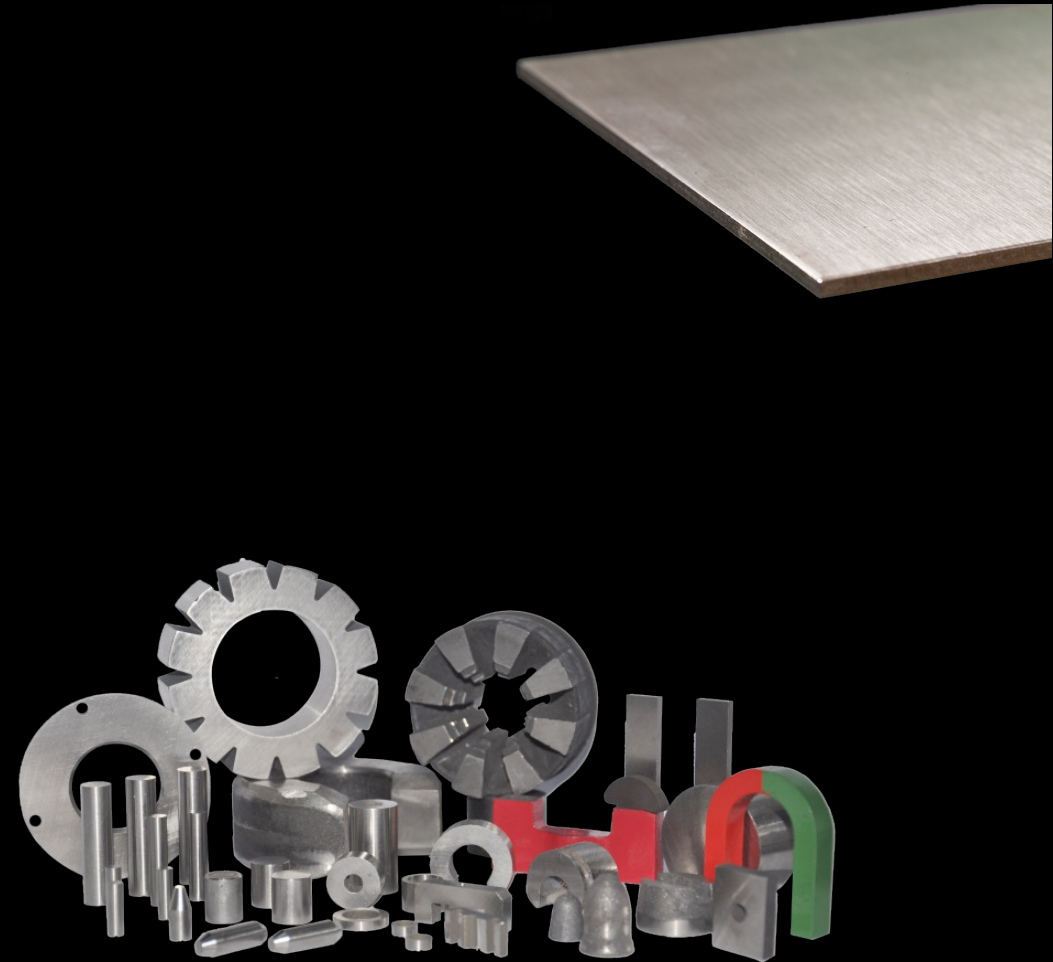
Due to scarcity, dispersion, and technical complexity, **asteroids alone cannot support industrial self-sufficiency**

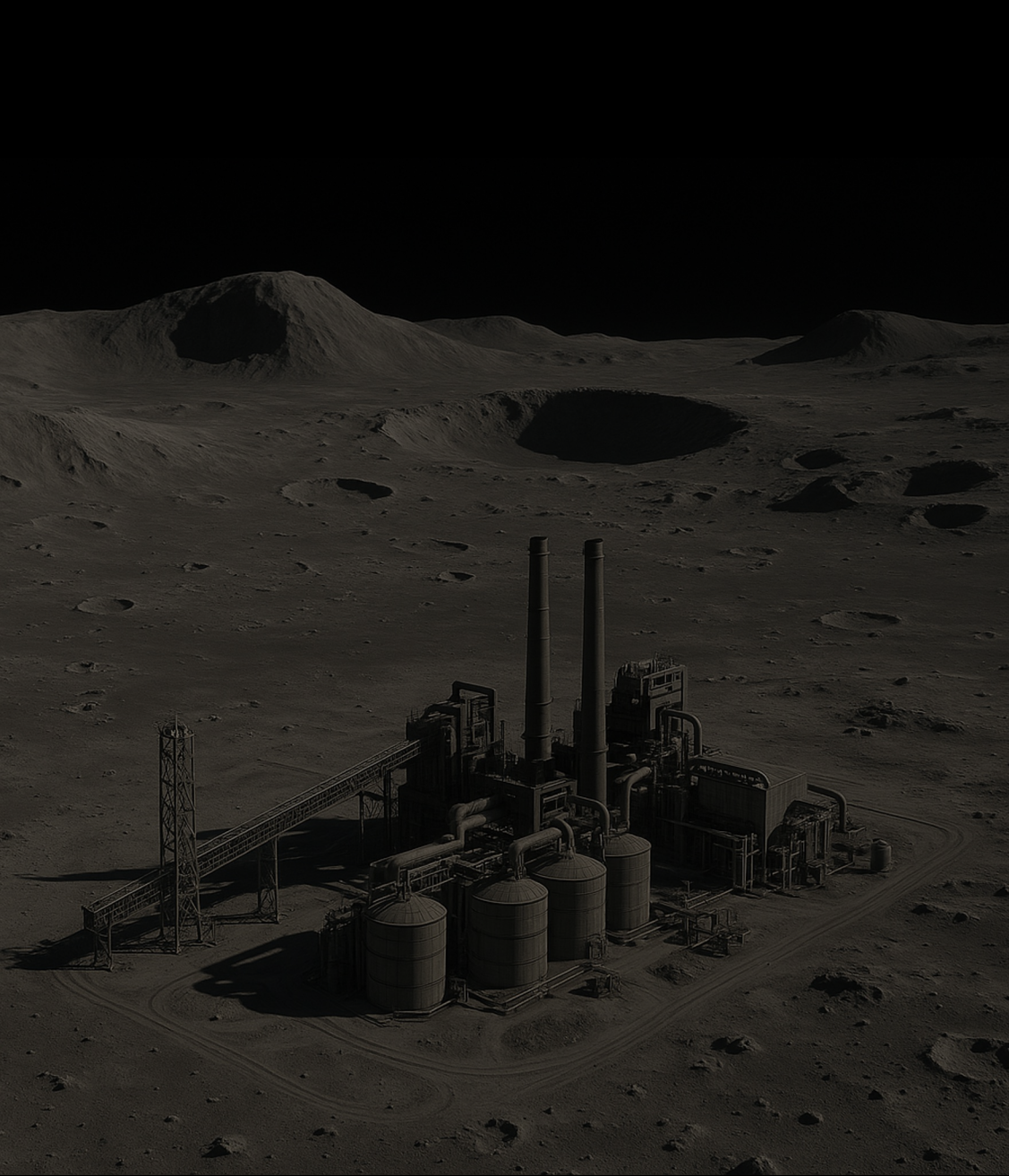
## Takeaways:

Fe and Al from the Moon could benefit  
from C, Ni and Co

Production of stainless steel

Production of AlNiCo magnets





## Takeaways:

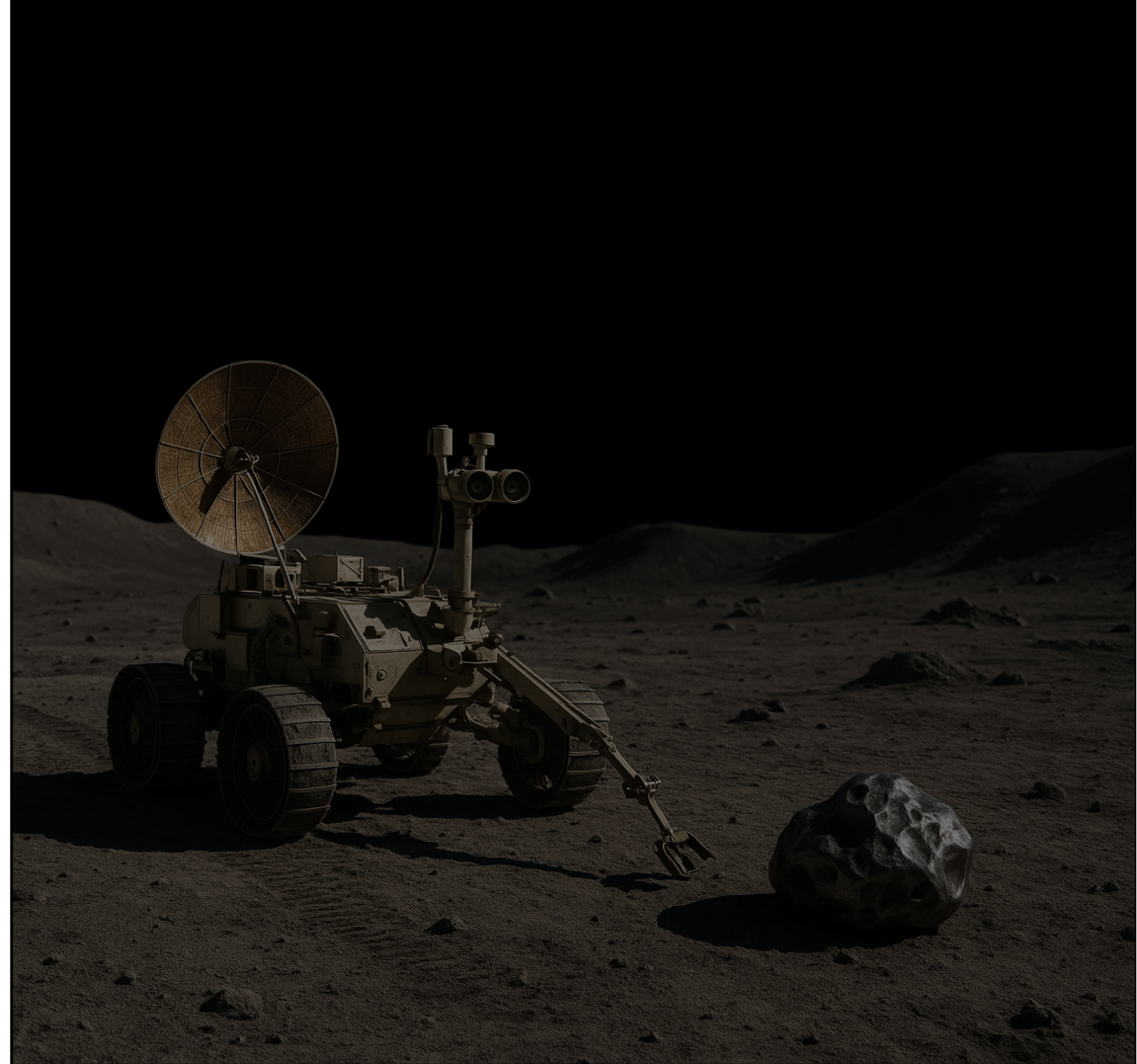
If a **lunar** industry is able to collect deposits of **asteroid-sourced materials**, it would have both bulk and rare resources, that would enable a closed industry in cislunar space.

## **Paths to achieve this:**

### **1. Prospecting**

More understanding of asteroid and lunar resources

Find asteroid-delivered materials

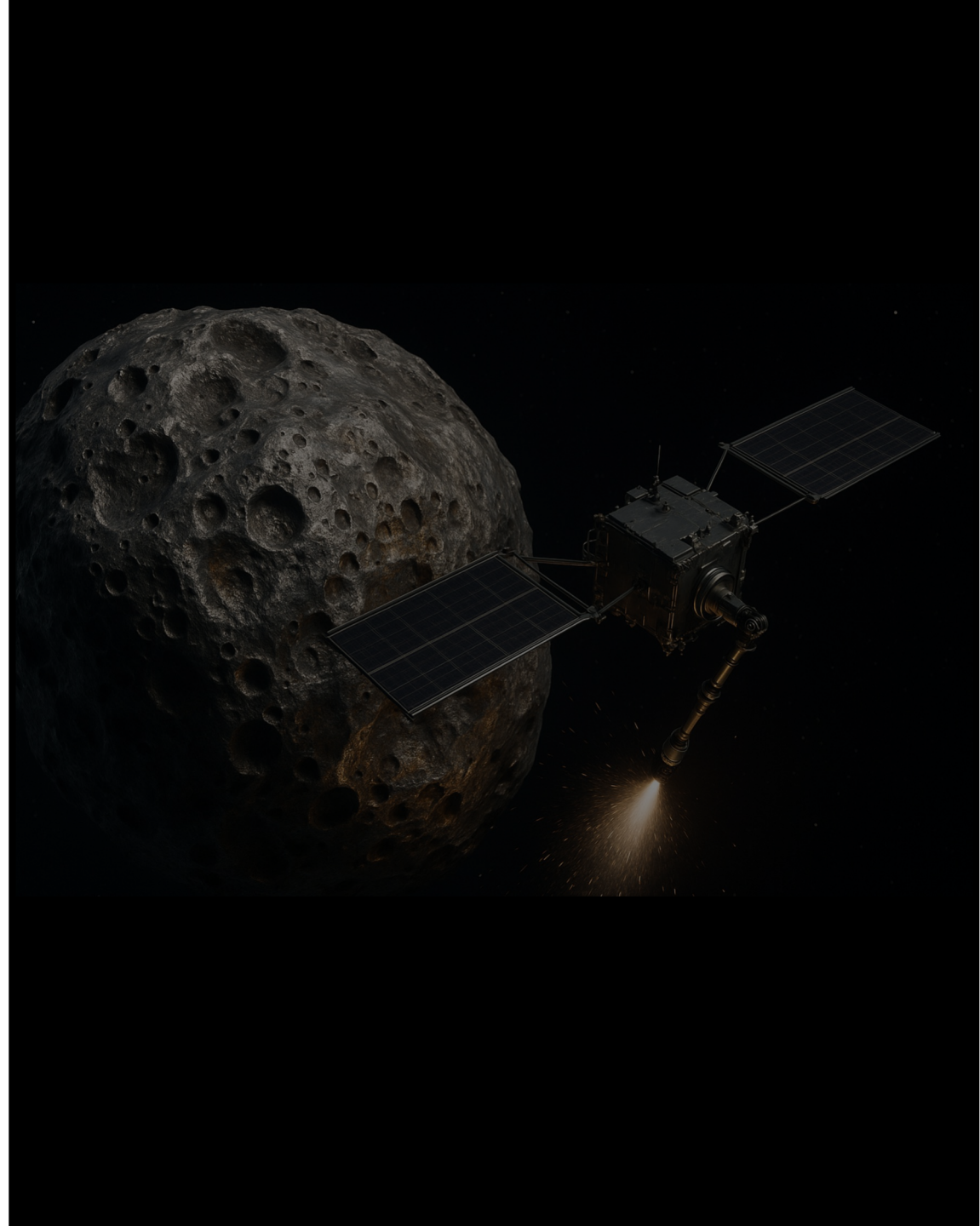


## **Paths to achieve this:**

2. Source directly from asteroids

No issues atmospheric scape from Earth

Possibility of generating propellant in-situ





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# Thank you!

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**Carleton**  
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