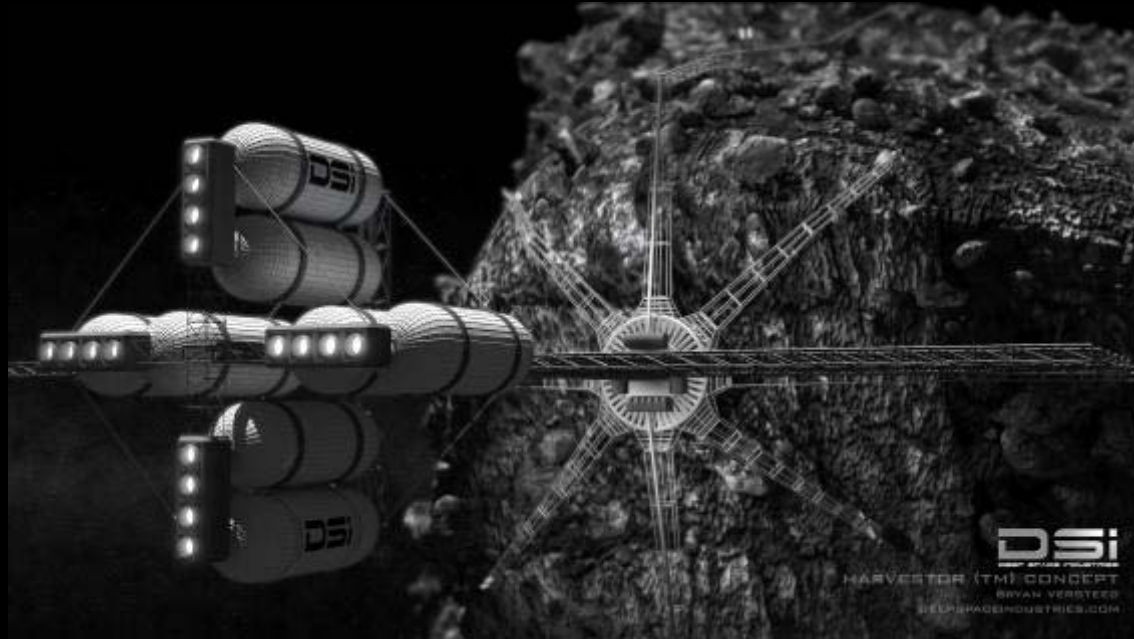


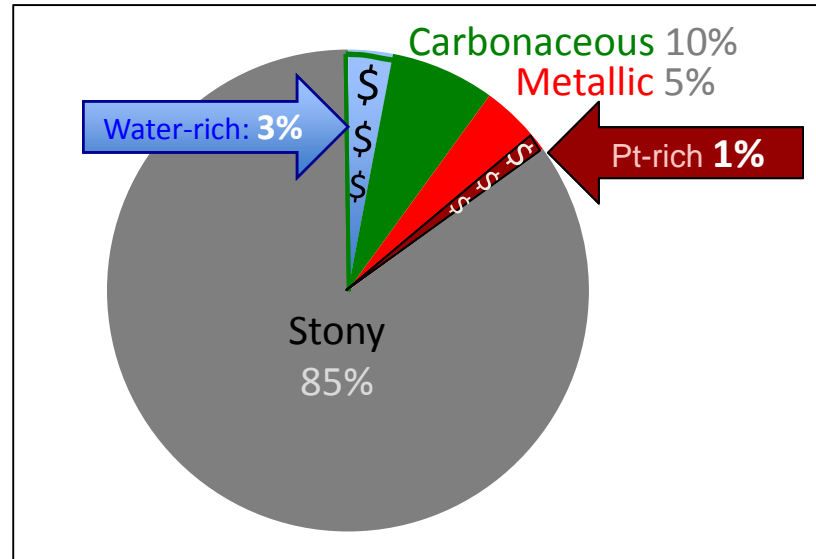
Asteroid Mining



Martin Elvis
Harvard-Smithsonian Center for Astrophysics

What is the Near-Earth Asteroid Population Worth?

Not every mountain is a gold mine.
Only a few percent of asteroids are valuable



Published in Elvis, M., 2014,
"How many ore-bearing asteroids?"
Planetary & Space Science, 90, 20.

About 300 water-rich large (>100 m dia.) near-Earth asteroids

Each has ~30,000 mt of water

i.e. ~\$150 billion each at \$5 M/mt

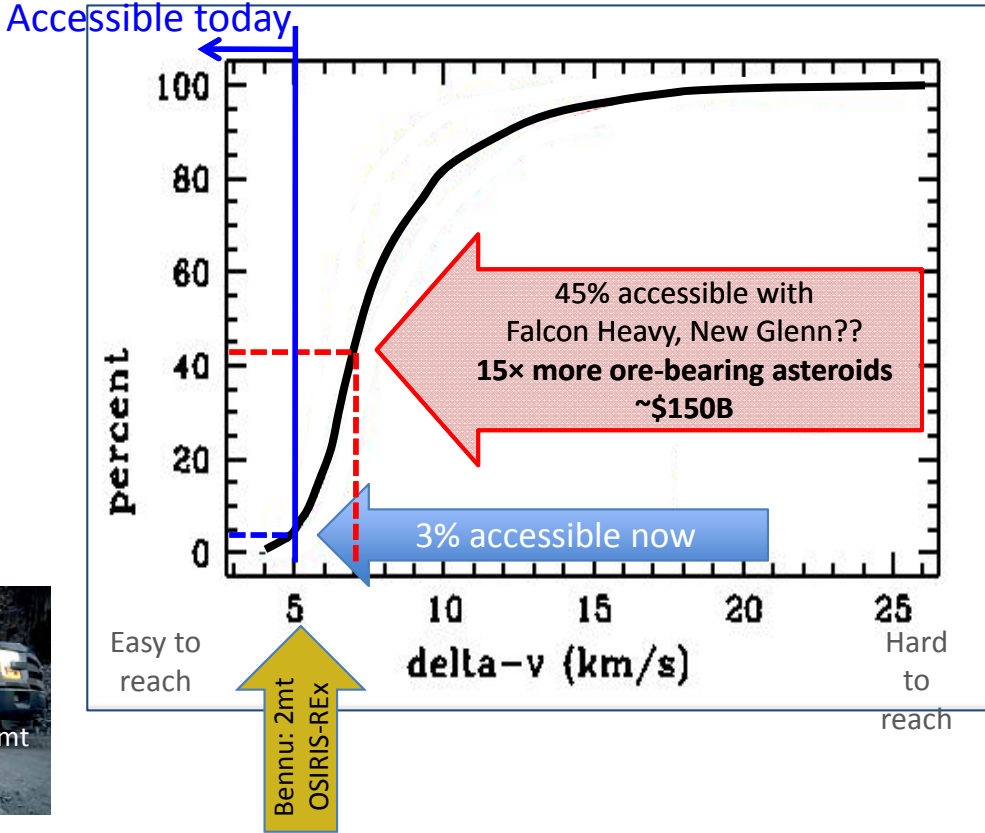
→ nearly **\$50 trillion total**

... *if there is a market*

In space no-one can hear you sell.

And we don't know which 300 are water-rich

Our rockets limit the number of ore-bearing asteroids



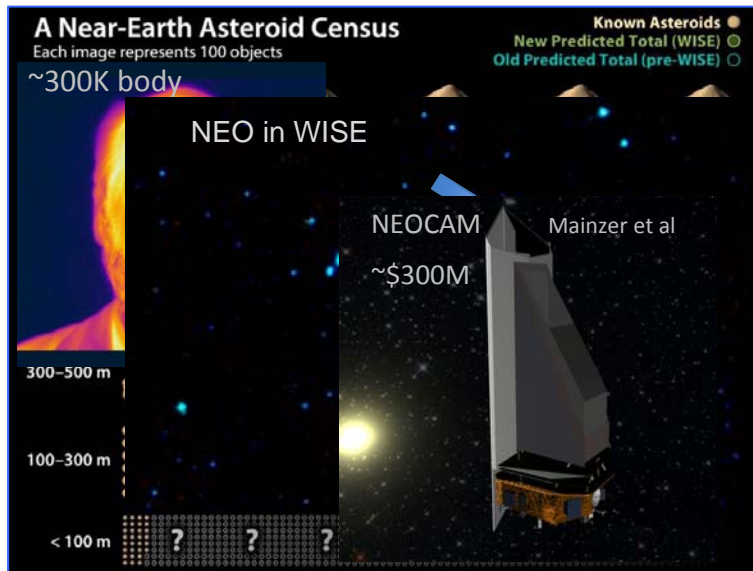
Published in Elvis, M., 2014, "How many ore-bearing asteroids?" Planetary & Space Science, 90, 20.



"Ore-bearing" = profitable to mine
 ~10 known with $\Delta v < 5 \text{ km s}^{-1}$
 Value ~\$10B
 Similar number for Platinum-rich asteroids
 (All these numbers need refining)

My Response #1: Applied Astronomy

Find More Asteroids



Product is Intellectual Property (IP)

Should these be:

- USGS-like activities by government?
- philanthropic activities?
- or private, for-profit, undertakings?
E.g. Aten Engineering

Galache JL., Beeson, C., McLeod, K.K., & Elvis, M., 2015,
The Need for Speed in Near-Earth Asteroid characterization,
Planetary & Space Science, 111,
155

My Response #2: Anticipate Policy, Law Issues

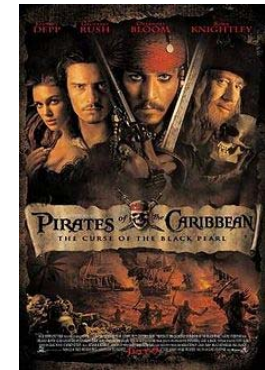
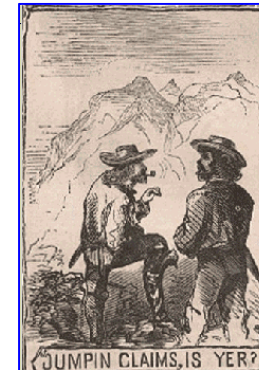
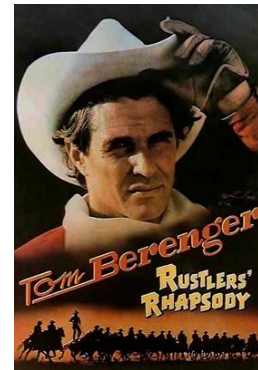
Rare, valuable resources lead to conflicts



Elvis, Milligan & Krolikowski, 2016, *Space Policy*, 38, 30.

Krolikowski & Elvis, 2017, *Research Policy*, submitted

Elvis & Milligan, 2017, in preparation



Missions differ in their main goal:
 Science, Settlement, Security, Sales.
 And so may conflict.
Who arbitrates disputes?

A land grab approach may not work out so well.
 Sets precedent.
 More valuable assets may come to light and be seized by others.



My Theme: Quantitative Skeptical Optimism

“Trillions of dollars in space resources”
“The first trillionaires will be space miners”

NO.

Treat space like any other resource or market
Do your due diligence.
Then jump in!

