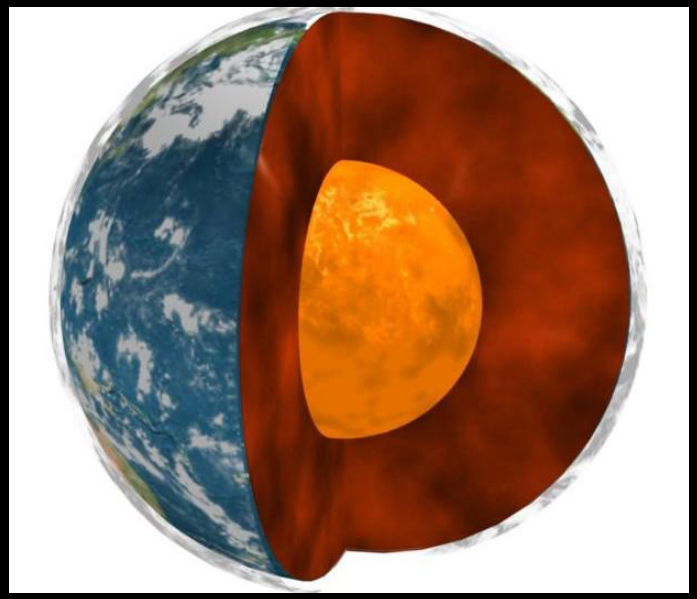
Where are the space resources?

Roger R. Fu

The Earth is compositionally different from most asteroids

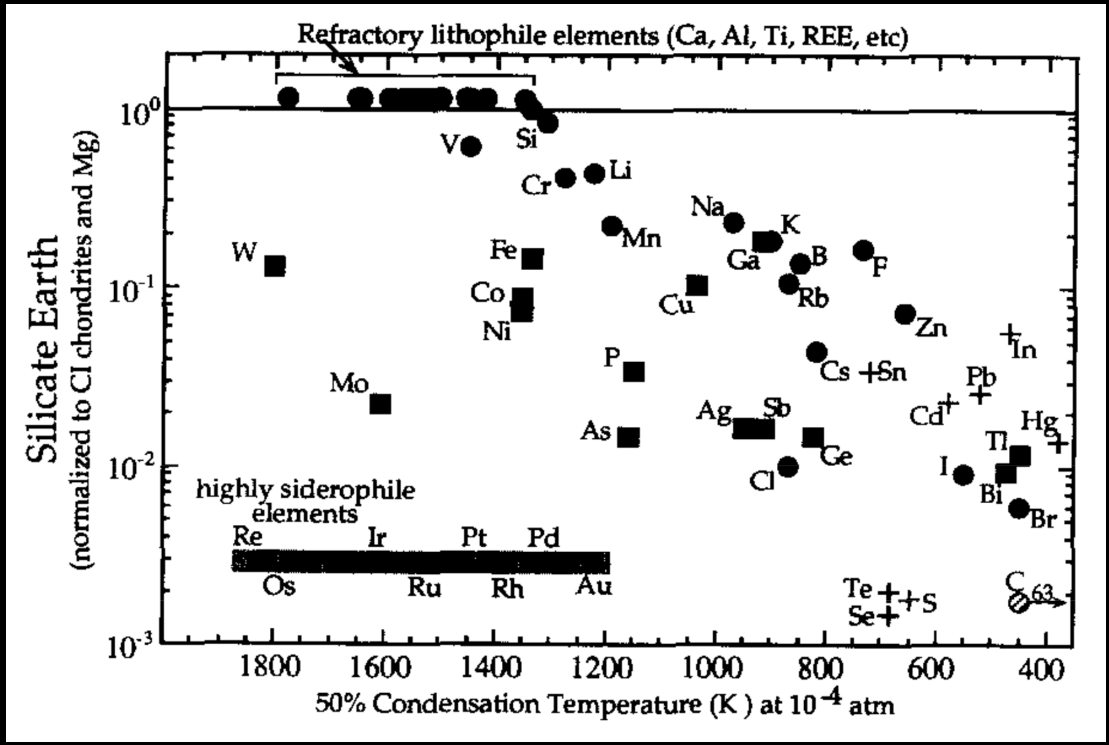


Core formation extracted siderophile (“iron-loving”) elements

Giant impacts removed “volatile” elements

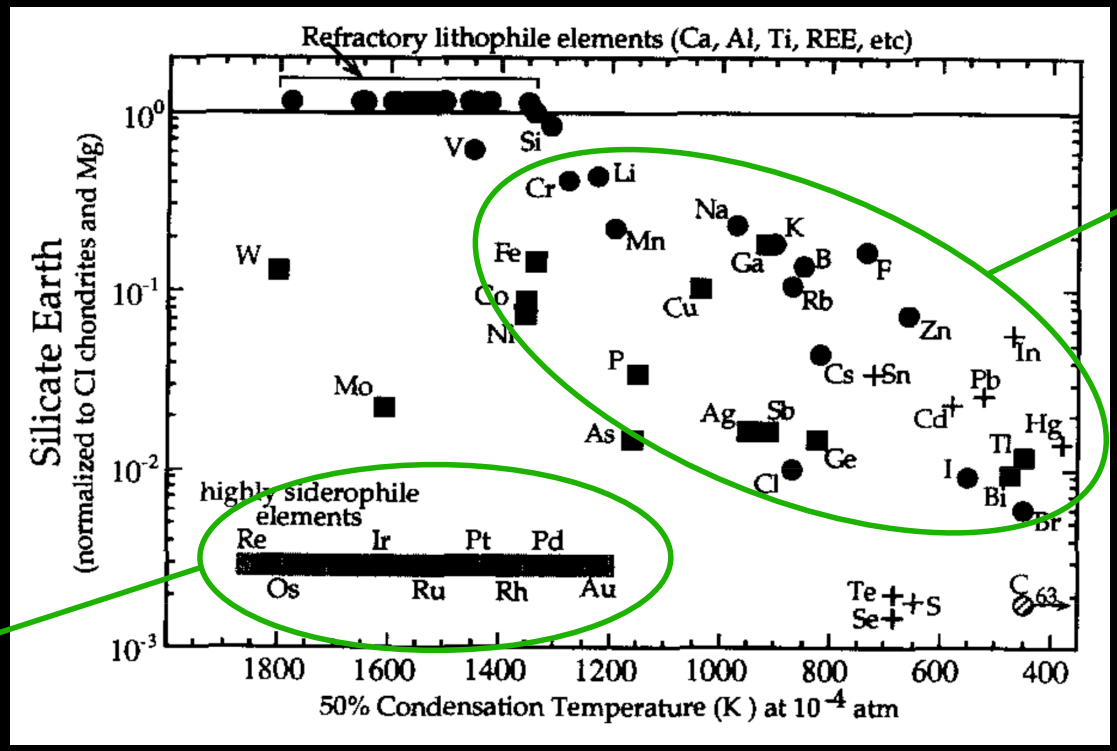
Image credits: IPGP;

Abundances of elements in Earth rocks compared to meteorites



McDonough and Sun (1995)

Abundances of elements in Earth rocks compared to meteorites



Lost due to hot formation process

Lost to the core

McDonough and Sun (1995)

Siderophile elements reside in the Earth's core

Ag, Au, Ir, Os, Pd, Pt, Re, Rh, Ru, W

Gold: $1,200 per oz

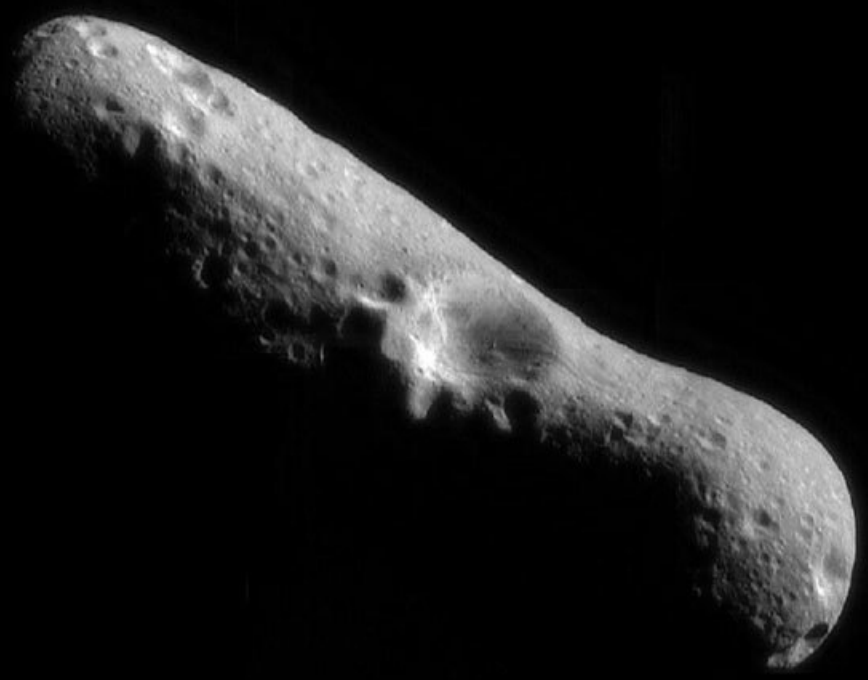
Iridium: $1,500 per oz

Palladium: $1,100 per oz

Platinum: $840 per oz

Rhodium: $2,600 per gram

Asteroids are far more concentrated in many precious metals

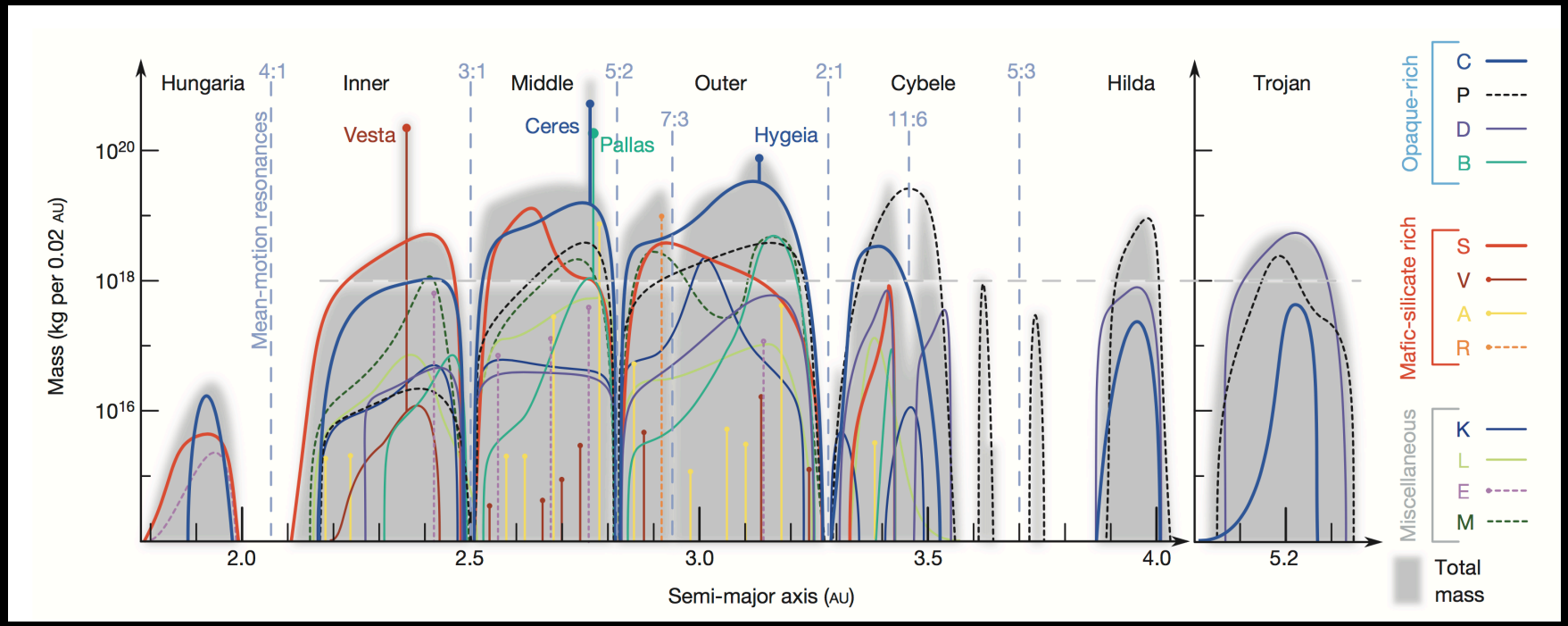


Meteorites show that most asteroids are metal-rich

Ordinary chondrite

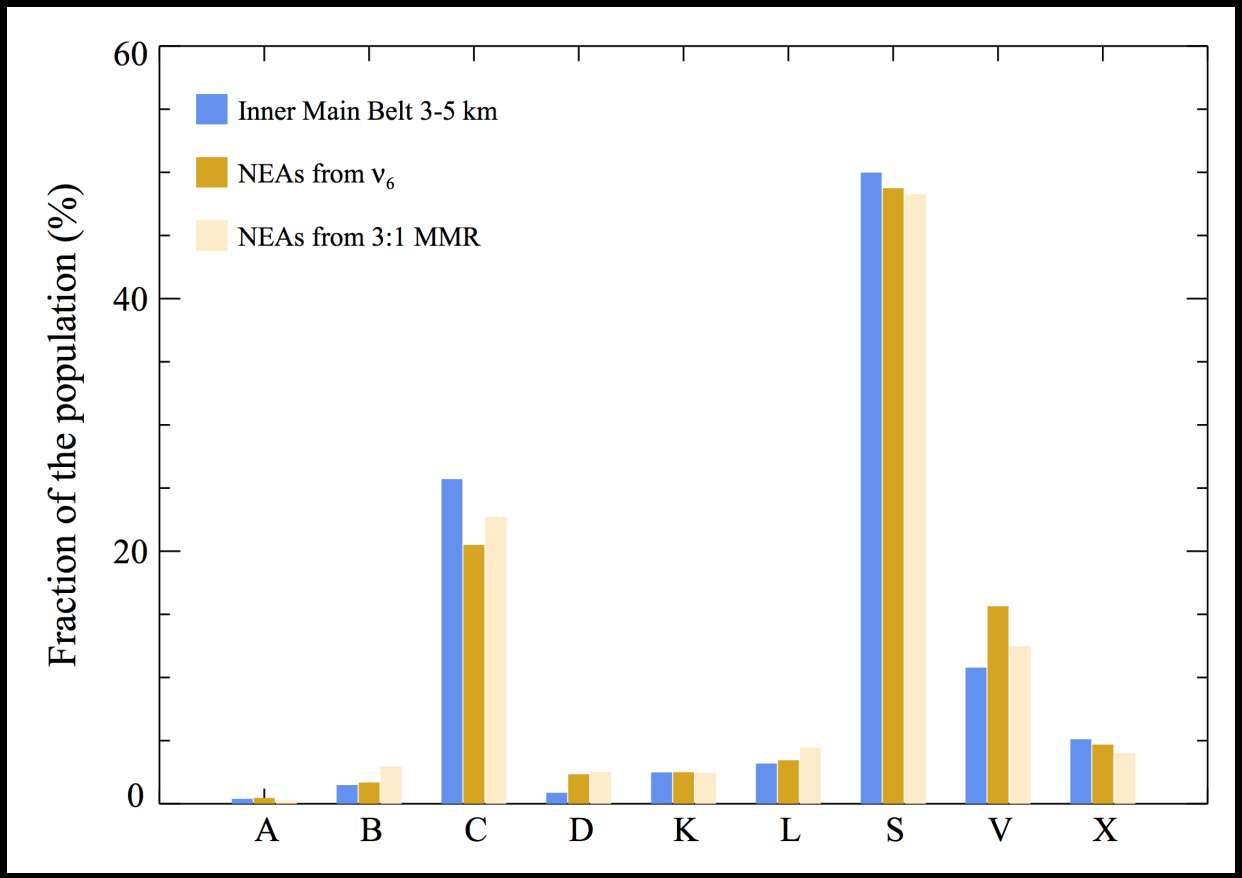
Earth rocks

Most asteroids also belong to metal-rich classes



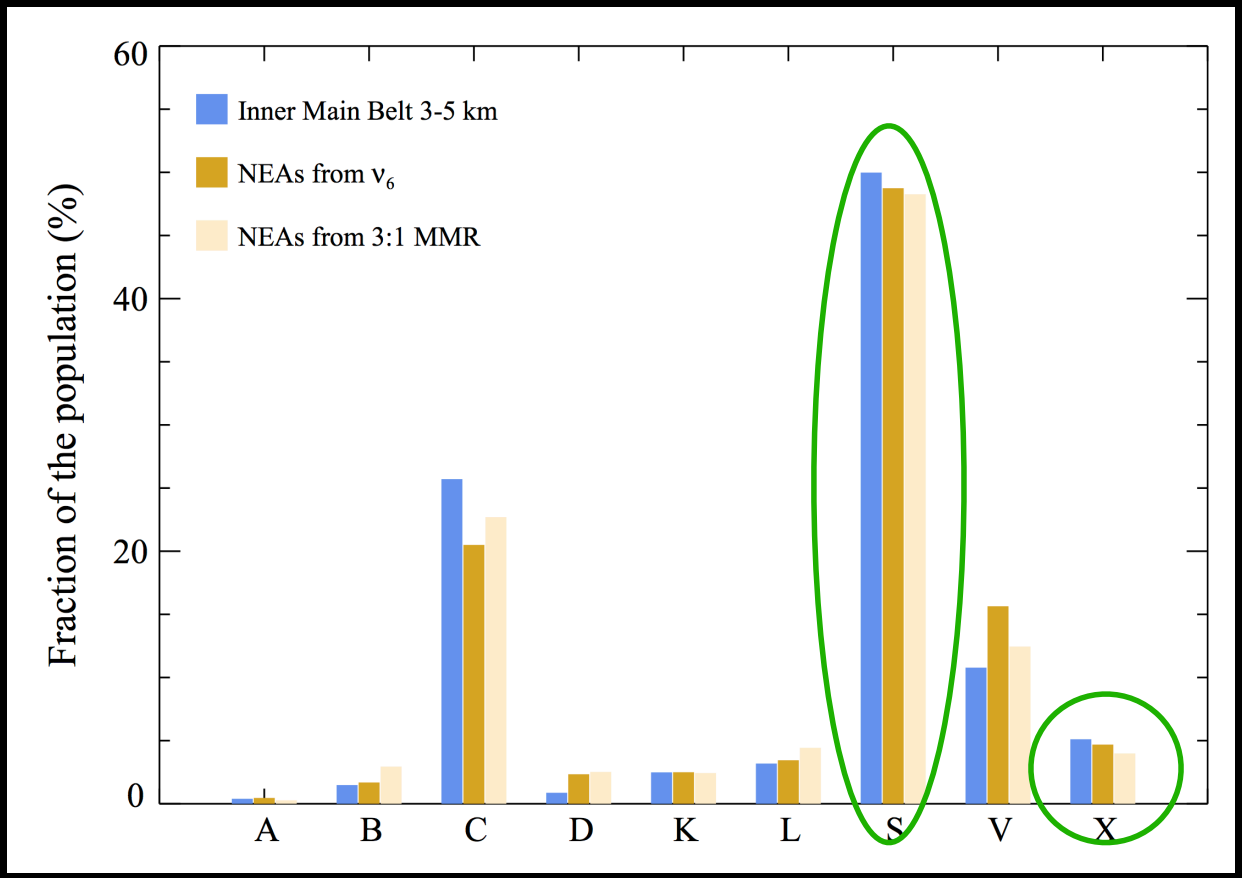
Demeo and Carry (2014)

Near-Earth asteroids are also mostly metal-rich



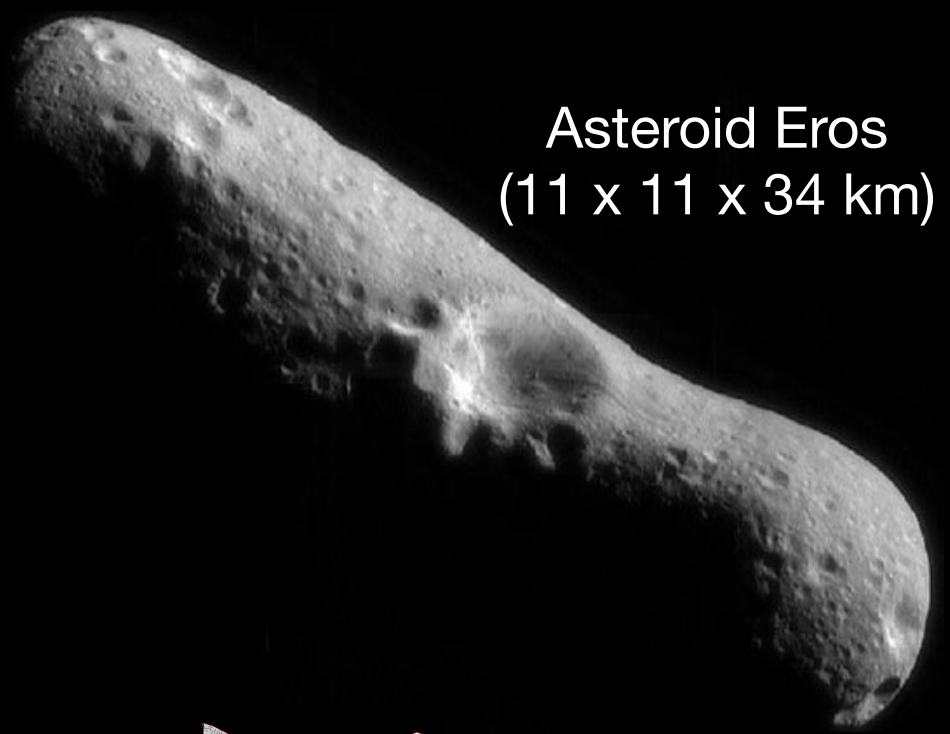
Carry et al. (2016)

Near-Earth asteroids are also mostly metal-rich

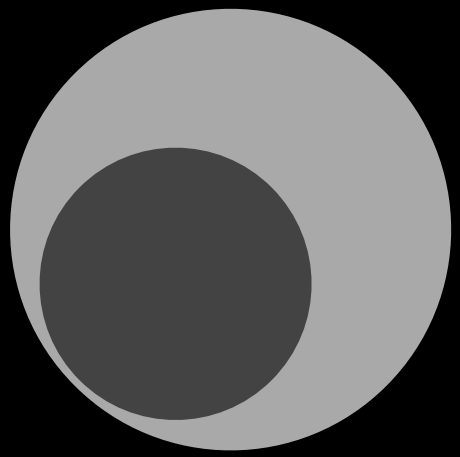


Carry et al. (2016)

How much asteroid do we need?

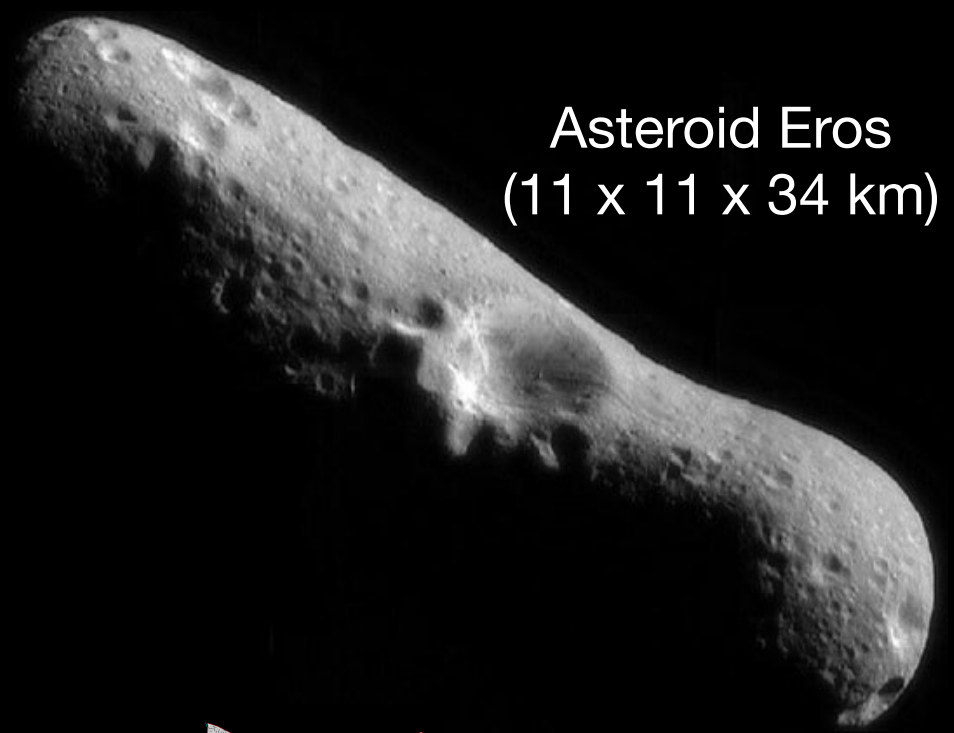


Asteroid Eros
(11 x 11 x 34 km)



All gold in
human history
(~7-12 km)

How much asteroid do we need?



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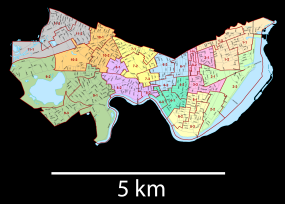

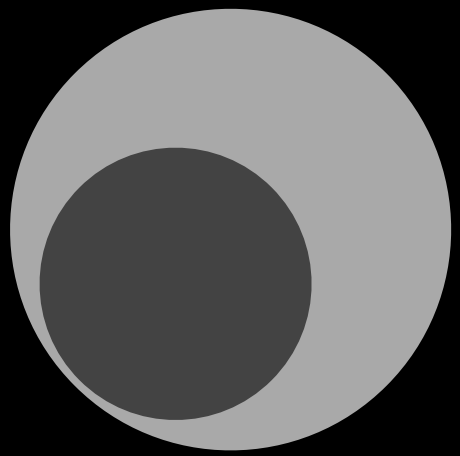

All gold in
human history
(~7-12 km)

Match annual
production of gold
(~2-3 km)

Match annual
production of
platinum
(~0.5-0.6 km)

Summary

Asteroids represent a very large reservoir of precious metals that, in total, far exceeds human consumption

The near-Earth asteroid population alone contains abundant precious metals

Further characterization of asteroid density and composition, possibly by spacecraft, is necessary to identify the most viable targets