

# Resource Definition and Delineation of Near Earth Asteroids Using Automated Probes

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# Benefits of Asteroid Mining

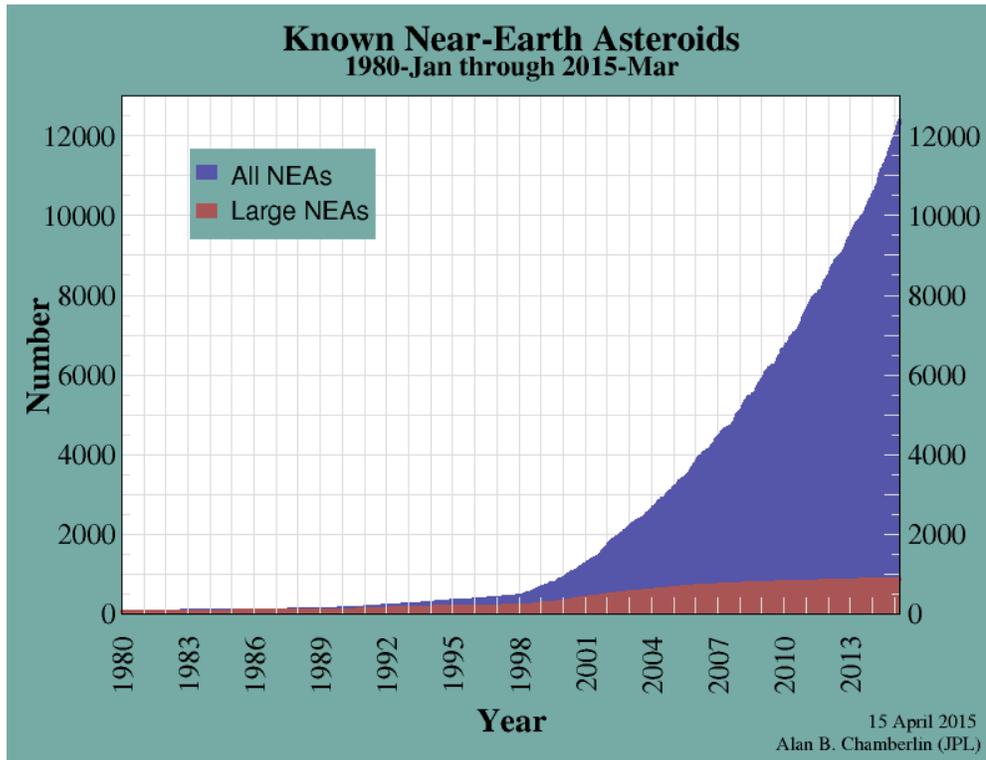
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- Natural resources on Earth are limited and depleting at alarming rates
- Conflicts for limited resources between countries
- Mining on Earth leads to many problems
  - > deforestation
  - > soil erosion
  - > chemical contamination
  - > ground water pollution
- None of above risks associated with space mining (less resource bottlenecks too)
- One asteroid, 16 Psyche, could supply world production of nickel-iron for several million years

# Investment and Profits:

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- Estimated that an asteroid 98 feet long could contain \$50 billion in platinum
- 700 to 800 NEAs are easier to reach and land on than the Moon
- As technology evolves, cost of operations will drop
- Costs of space mining will be high in the short term, but far lower in the long term. This drives competition, leading to innovation and further reduction of costs.
- This has the potential to result in new solar panel technologies to power spacecraft, new mining equipment, and advanced extraction techniques.

# Additional Advantages of Space Mining

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Material	Product
Raw silicate	Ballast or shielding in space
Water and other volatiles	Propellant in space
Nickel-Iron (Ni-Fe) metal	Space structures Construction on earth
Platinum Group Metals (PGMs)	Catalyst for fuel cells and auto catalyzers on earth Jewelry on earth
Semiconductor metals	Space solar arrays Electronics on earth

- Water can be "mined" for **hydrogen** and **oxygen**, while silicon can be used for solar power systems, nickel and iron for potential space manufacturing.
- Water harvested from asteroids can be used as a radiation shield for humans during deep space expeditions, consumption, aid mining processes on asteroids
- Mars exploration can be cheaper and more efficient if capsules could pick up fuel en route to Mars

# ADAR (Asteroid Data Acquisition Robot)

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- 0.5 m<sup>3</sup> in volume
- Exterior mounting to parent spacecraft
- Symmetrically mounted harpoon system
- Carries drilling apparatus, mass spectrometer, or any equipment required to effectively ground truth the asteroid
- Transmits collected data short range to parent craft to then be relayed to mission control

# Implementation

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$$v_{req} = v_{harp} m_{harp} / m_{tot}$$

$$v = v_{req} r - v_{rel} y - \int H \nabla \cdot G(r) \cdot dr$$

- Determines the ideal velocity for the probe to have so the harpoon system effectively arrests the probe's momentum.

- Determines launch velocity from the parent vehicle, taking into account the speed of the parent vehicle, and the gravitational pull of the asteroid.

# Conclusion

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- Increase success rate and efficiency of mining operations
- Cost effective
- Improve viability of space-based mining

# References

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