

Resource Definition and Delineation of Near Earth Asteroids Using Automated Probes

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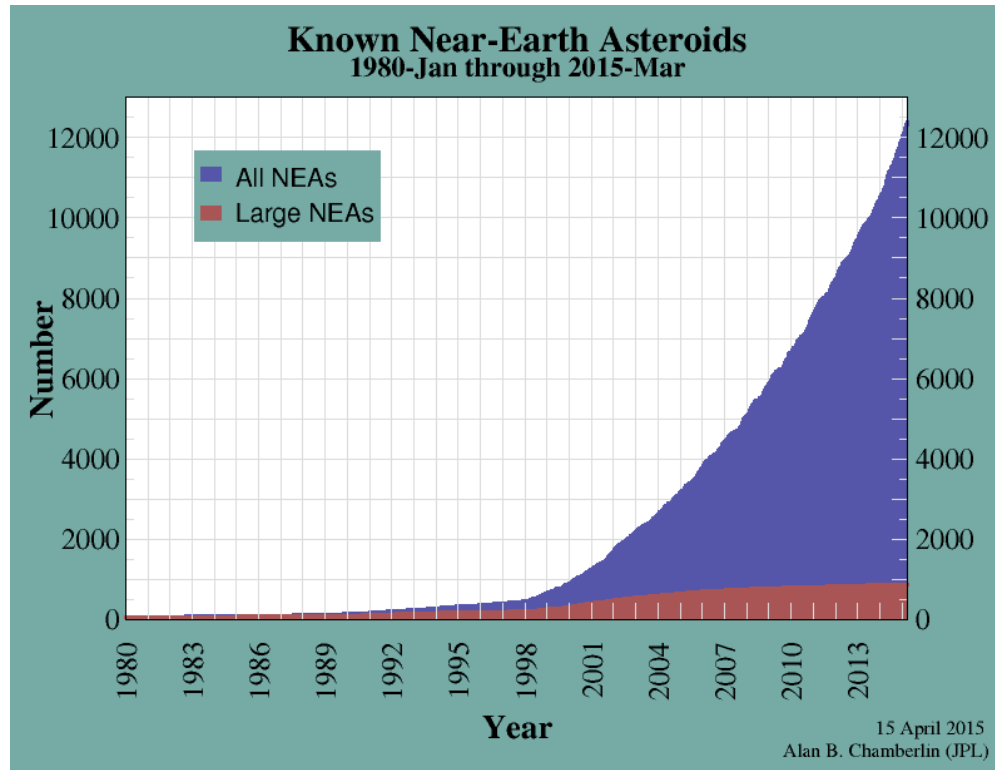


Benefits of Asteroid Mining



- 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:



- 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

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)

- 0.5 m³ 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

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

$$v = v_{req} r - v_{rel} y - \int_{H_0}^H G(r) \cdot dr$$

- 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

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

References

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