

Exploration of Near-Earth Asteroids (4)  
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MAPPING ASTEROIDS FOR VALUABLE MINERALS AND PLANETARY DEFENSE USING  
COST-EFFECTIVE CUBESATS

**Abstract**

Over the last decade, deep-space exploration has been taking a turn towards the technological development in the NewSpace industry. Earlier, government-backed missions explored inner rocky planets, outer gaseous planets, moons, dwarf planets, asteroids, comets, and the farthest reaches of the solar system, paving the way for private companies seeking to disrupt the industry and expand the global economy. The only drawbacks to early space programs are that they were too risky, time-consuming, and exuberant. Nowadays, space mining startups, securing tens of millions of private funds, are developing novel, cost-effective technologies for the extraction, exploitation, and processing of natural resources on Near Earth Objects (NEO), Main-Belt Asteroids (MBA), as well as those on the Moon and Mars.

These ventures are often challenged by the high risk and high-cost factors of embarking on such endeavors, discouraged for not precisely demonstrating economic potential, quantitative value propositions, and business cases to potential stakeholders. From a technical standpoint, this is mainly due to the limited knowledge about asteroids' composition and the concentration of elements on the asteroids' surface/subsurface. This technical know-how can also be used for planetary defense purposes. Identifying the chemical composition and orbital/physical characteristics can help categorize asteroids and estimate the likelihood and the effects of a potential impact. To deal with these setbacks, Asteroid Mining companies invest a considerable amount of money, effort, and resources in RD, developing, testing, and launching expensive hardware for the sole purpose of studying asteroids (i.e. scouting) instead of developing mining systems to exploit them. They also mainly rely on the support of governmental agencies, which is often erratic due to regular changes in administrations, policies, national priorities, and budgets. In this vein, the research question stated is: How can NewSpace startups create a roadmap, in which the development phases fulfill the needs of the space mining industry in its current state? Accordingly, this paper will analyze the steps that have been taken such as small launchers and small satellites development, and the cooperation stages, systems, and subsystems that need to be addressed to develop small prospector spacecraft (Nanosats equipped with deployable Pico/Femtosaurs), capable of performing in-orbit formation flying for mapping celestial bodies, implementing Artificial Neural Networks and Computer Vision techniques, near Earth's vicinity. Finally, there will be a number of potential policy suggestions based on the current key issues and how space mining using small satellites has developed to date.