SPIKE

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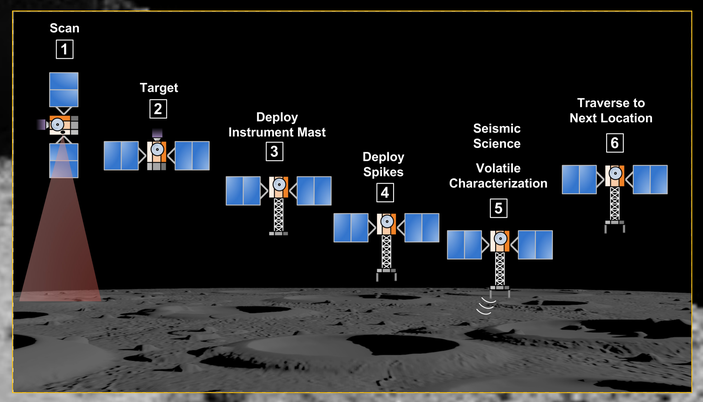
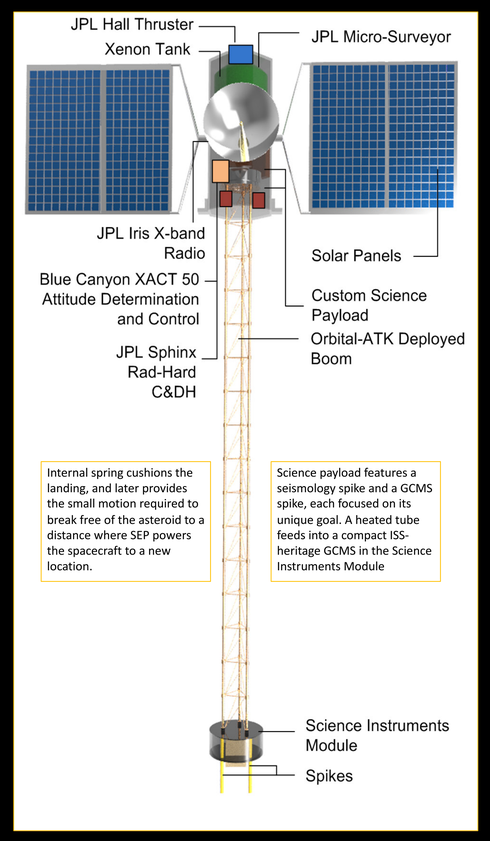
Goals	Measurables	Observables	Payload	Capability
Volatiles & Organics	Bound and free water content in the regolith	Abundance of H_2O ice in the regolith	Gas Chromatograph and Mass Spectrometer (GCMS)	Collector to acquire volatiles and organics from >30 cm below surface
	Spatial and chemical distribution of identified organic species	Abundance and composition of carboxylic acids, PAHs and amino acids		
Seismology	Seismological properties of asteroid and local regolith	Seismic reflections detected for >1 minute	• Geophone • Thumper • Vibrators • Accelerometers • Camera Imaging	Sensors buried to >30 cm depth into seismically competent material Navigation
	Regolith response to tactile forces, compactions, vibrations and jolts	Landing/takeoff forces and accelerations Vibration response Penetration depth		

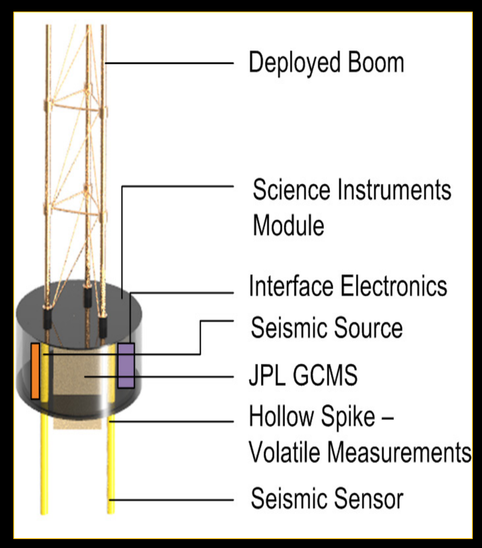
Spacecraft Penetrator for Increasing Knowledge of NEOs (SPIKE) is a subsurface-probing asteroid lander in the form of a deep space solar electric propulsion orbiter. It does science that has never been done at an asteroid: *seismology*, and *detecting subsurface volatiles and organics.* Using penetrators at the end of a three-meter boom, the spacecraft is kept at safe distance while providing ample power. The payload acquires data from 0.3-1 meter depth in a variety of locations, building up a detailed understanding of volatile and organic composition and mechanical structure, essential to planetary science, hazardous asteroid mitigation, and in situ resource assessment. Designed for small NEOs where SEP thrust exceeds gravity, SPIKE detaches mechanically, attains new orbit, and lands again, without requiring a chemical propulsion system, and heads to a second asteroid. SPIKE can be flown as a single low-cost mission, or several can be launched together to conduct in situ science at 5-10 asteroids.





Mission Specifications	
System:	ESPA-class Small Satellite
Mission:	Asteroid Seismology + Volatile Chemical Detection
Trajectory:	Rendezvous with 2 NEOs
Instruments:	GCMS Penetrator Seismology Penetrator
Candidate Bus:	JPL Micro Surveyor
Mass:	<100 kg (wet)
Power:	750 W (BoL)
Comms:	X-band 256 kBps (DSN)
Propulsion:	JPL MaSMi Hall Thruster (Xe)

Target Requirement	Probability
First asteroid target must be primitive (B, C or D)	Certain; many candidates
Regolith bed at least 1 m deep exists somewhere on the asteroid	Almost certain for NEOs >100 m diameter; can be verified by groundbased IR/radar
Clast sizes <30 cm in the target footprint (dust ponds, gravel beds are ideal)	Unknown for the smallest (~50 m) bodies considered; almost certain for 0.3–1 km
Regolith cohesion < 10 kPa in the target footprint	Could be greater if ice-cemented materials (unlikely), or as low as 10–100 Pa
Surface g < 0.3 mm/s^2 for gentle landing and to allow SEP-powered escape	Certain for <1 km diameter



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