Lunar volatile extraction, separation, and collection consists of all aspects of locating and characterizing lunar volatile resources (especially polar hydrogen/water); excavating regolith in the permanently shadowed craters (≤-233°C and down to 2 meters); mechanical, thermal, chemical, and/or electrical processing of this regolith to release volatiles; identifying/quantifying all volatiles; and separating and collecting volatiles of interest. Metrics of interest include: excavation rate (kg/hr); excavation efficiency (power required/excavation rate); resource extraction efficiency (Watts per mass of volatiles produced per hour); collection efficiency (mass collected vs. total evolved); and collection purity (mass collected of desired product vs. total collected). Specific areas of interest include:

- Excavation techniques for soil-like to rock-like regolith (70MPa), depending on water content, and very cold (40K to 100K) regolith and local environment conditions;

- Gas separation and collection techniques for a product stream containing various concentrations of hydrogen, carbon dioxide, nitrogen, helium, water, ammonia, and methane;

- Demonstration of sealing technology for repetitive (> 50 times) use at a wide range of temperatures (40K - 500K nominal and up to 1500K maximum) in abrasive, electrostatic, high vacuum environment; and

- Regolith thermal processing concepts that maximize heat transfer and minimize processing times for regolith with low thermal conductivity.