

# Carbonaceous Asteroid Volatile Recovery (CAVoR) system, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)



## ABSTRACT

The Carbonaceous Asteroid Volatile Recovery (CAVoR) system produces water and hydrogen-rich syngas for propellant production, life support consumables, and manufacturing from in-situ resources in support of advanced space exploration. The CAVoR thermally extracts ice and water bound to clay minerals, which is then combined with small amounts of oxygen to gasify organic matter contained in carbonaceous chondrite asteroids. In addition to water, CAVoR produces hydrogen, carbon monoxide, and carbon dioxide that comprise precursors to produce oxygen for propellant and breathing gas and to produce organic compounds including fuels such as methane when integrated with a downstream methanation-electrolysis. Thermochemical production of hydrogen by CAVoR results in substantial reductions in electrolysis mass and power requirements compared to combustion-based volatile recovery methods. A conceptual Phase II continuous flow auger reactor design was based on successful Phase I batch reactor operations. Phase II advancements will include reactor seal designs to accommodate regolith simulant feeding and discharging while collaborations will be developed to aid the infusion of the CAVoR system into a conceptual asteroid resource utilization mission plan.

## ANTICIPATED BENEFITS

### To NASA funded missions:

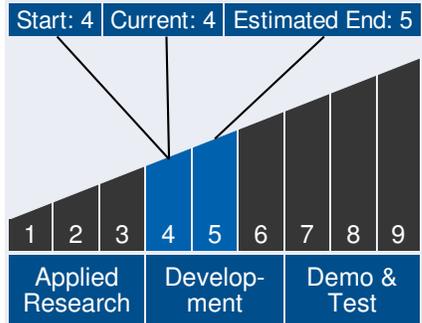
Potential NASA Commercial Applications: The primary application of the Carbonaceous Asteroid Volatile Recovery (CAVoR) system is to provide a compact, high performance apparatus for the extraction and recovery of water and organic matter in support of propellant production, breathing gas, and life support. The in-space production of these mission critical items results in substantial launch cost savings and can help to enable the extension of NASA's mission beyond low earth orbit to include long-duration space habitation, lunar, and Mars



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## Technology Maturity



## Management Team

### Program Executives:

- Joseph Grant
- Laguduva Kubendran

### Program Manager:

- Carlos Torrez

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colonization missions.

## To the commercial space industry:

Potential Non-NASA Commercial Applications: The autothermal steam reforming technology proposed for the CAVoR has applications in the recovery of water and energy values from terrestrial wastes and resources. Steam reforming technology has mostly been applied to feed matter containing only small amounts of inorganic matter. The efficient use and recovery of process heat to be established during the CAVoR program will enable non-catalytic autothermal steam reforming technology to be applied to feeds such as contaminated soils, low-grade hydrocarbon feeds, oil shale, un-sorted municipal waste, and other organic materials, including renewable resources. By so doing, many otherwise refractory, hazardous compounds can potentially be broken into syngas constituents for use as fuels rather than being incinerated with no economic gain. The CAVoR technology will be poised for entry into the growing market demand for waste volume reduction and low-grade fuels resources. The device solves a variety of industrial and municipal waste challenges with minimal environmental impact.

### Management Team *(cont.)*

#### Principal Investigator:

- Mark Berggren

### Technology Areas

#### Primary Technology Area:

Human Exploration Destination Systems (TA 7)

- └ In-Situ Resource Utilization (TA 7.1)
  - └ Processing and Production (TA 7.1.3)

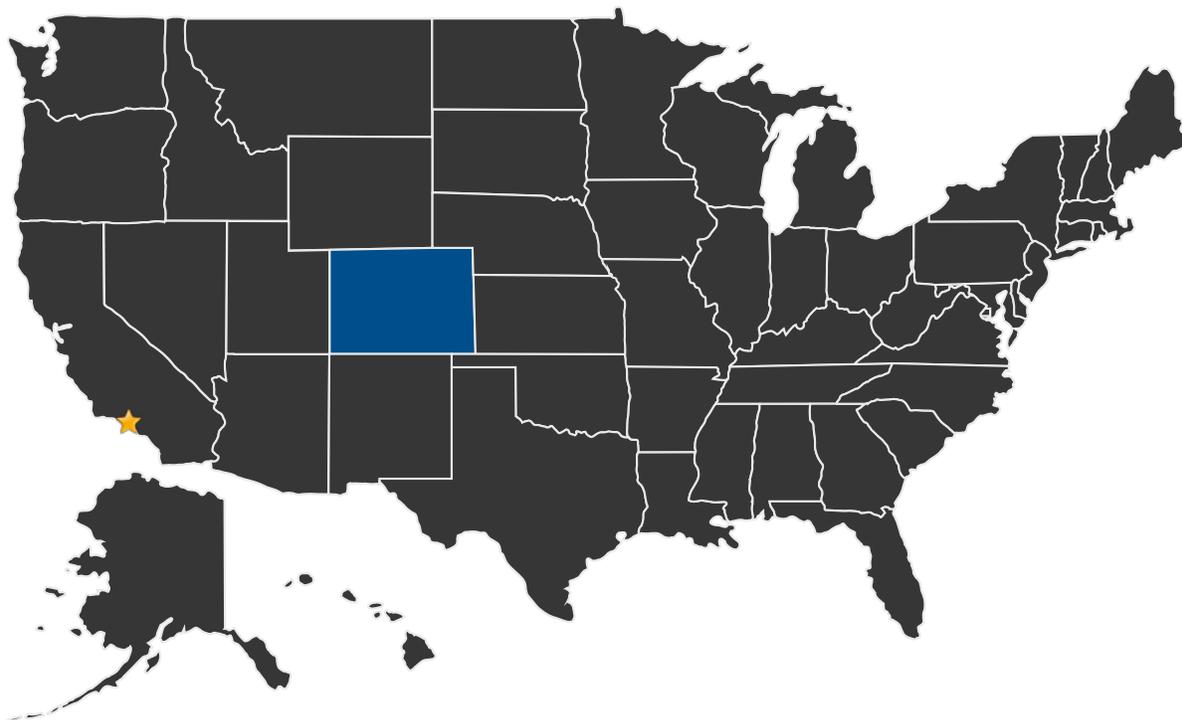
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## U.S. WORK LOCATIONS AND KEY PARTNERS

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- U.S. States With Work      ★ **Lead Center:**  
Jet Propulsion Laboratory

### Other Organizations Performing Work:

- Pioneer Astronautics (Lakewood, CO)

## PROJECT LIBRARY

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### Presentations

- Briefing Chart
  - (<http://techport.nasa.gov:80/file/23261>)

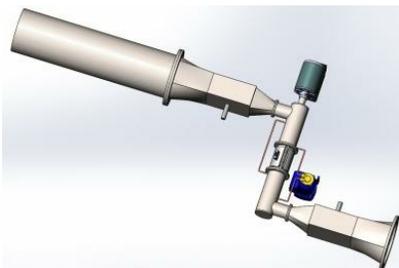
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## IMAGE GALLERY

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*Carbonaceous Asteroid Volatile Recovery (CAVoR) system, Phase II*

## DETAILS FOR TECHNOLOGY 1

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### Technology Title

Carbonaceous Asteroid Volatile Recovery (CAVoR) system, Phase II

### Potential Applications

The primary application of the Carbonaceous Asteroid Volatile Recovery (CAVoR) system is to provide a compact, high performance apparatus for the extraction and recovery of water and organic matter in support of propellant production, breathing gas, and life support. The in-space production of these mission critical items results in substantial launch cost savings and can help to enable the extension of NASA's mission beyond low earth orbit to include long-duration space habitation, lunar, and Mars colonization missions.