IN-SITU PRODUCTION OF OXYGEN THROUGH LUNAR REGOLITH PYROLYSIS. E.H. Cardiff[1], T.R. Maciel[2], I.S. Banks[3]. [1]NASA GSFC, Building 11, Room E135, Greenbelt, MD 20771. Eric.H.Cardiff@nasa.gov, [2]NASA GSFC, Building 11, Room S130, Greenbelt, MD 20771. tmaciel@uoregon.edu, [3]NASA GSFC, Code 552, Greenbelt, MD 20771. Ian.S.Banks@nasa.gov.

Introduction: A variety of techniques have been proposed to extract oxygen from the metal oxide-abundant lunar soil. Taylor reviewed these techniques and suggested regolith pyrolysis as the optimal method of oxygen production [1]. Experimental testing at NASA GSFC is continuing to determine the feasibility of pyrolysis by indirect resistive heating for a number of applications, including oxygen production on the Moon.

Previous Work: The original prototype focused solar radiation through a large Fresnel lens and vaporized a sample of lunar regolith at temperatures upwards of 1500°C. Previous work has demonstrated that in the process, the metal oxide bonds within the soil will be broken [2]. The reduced oxides can then be rapidly condensed out while the oxygen remains gaseous and can be collected for later use. Terrestrial experiments to model this method have involved both solar radiation and resistive heating to vaporize different types of simulant lunar regolith, including MLS-1A and JSC-1A [3].

Current Progress: A new experimental setup is currently being assembled that improves on the prototype resistively-heated crucible. A larger vacuum chamber houses an uncovered, high-grade zirconia crucible wrapped with tungsten wire for heating, as shown in Figure 1. This wire connects to a power input from the bottom, delivering up to 160 DC volts. The crucible and stands are surrounded by several layers of tungsten foil shields, as shown in Figure 1 (Right).

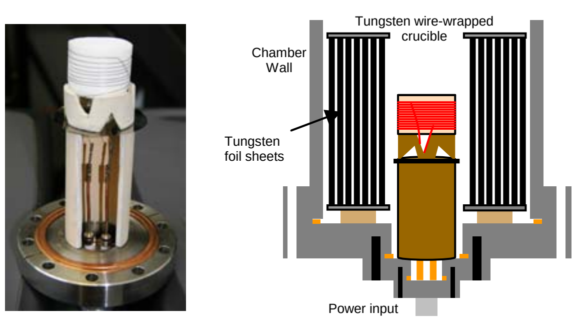

Figure 1. (Left) Wired-wrapped 1.65" diameter crucible connected to power. (Right) Side-view diagram of the chamber interior.

Thermocouples fed through the top of the chamber measure the temperature of the simulant regolith as it is being heated, as well as the temperature of various points around the chamber itself. The turbo pump, pressure gauge, and an RGA mass spectrometer are mounted above the vacuum chamber, as shown in Figure 2. A window and shutter at the top of the chamber allow for IR temperature measurements and visual inspection during testing. This setup is designed to prove the possibility of releasing significant levels of oxygen and other volatiles from simulant regolith. A cryogenic condensation and collection module has also been developed.

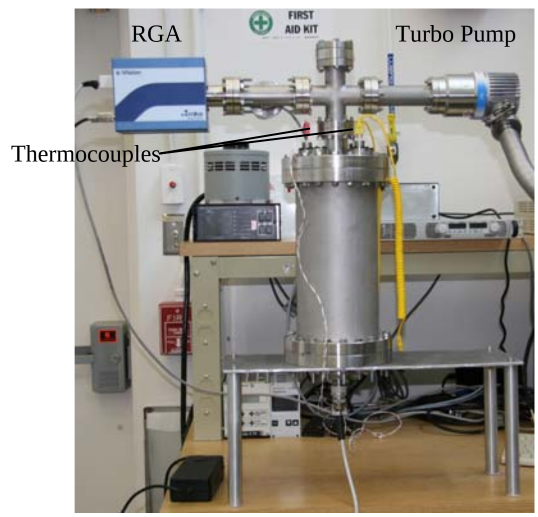

Figure 2. Current setup for regolith pyrolysis without a cryocooler.

In addition, this setup will be used to perform tests for the Volatile Analysis by Pyrolysis of Regolith (VAPoR) project. VAPoR is a triage instrument designed to identify samples with scientifically significant volatiles via mass spectrometry.

Conclusion: The new setup seeks to improve the resistively-heated vacuum pyrolysis setup, and is designed to achieve a higher maximum crucible temperature and improved thermal efficiency. The previous chamber was limited to 1000°C, and the current setup can attain temperatures in excess of 1300°C.

Reference: [1] Taylor L.A. & Carrier W.D. III. (1993). Oxygen Production on the Moon: An Overview and Evaluation, Resources of Near Earth Space. [2] Matchett J.P. (2005). Production of Lunar Oxygen Through Vacuum Pyrolysis. Masters Thesis. The George Washington University. [3] Cardiff E.H., Pomeroy B.R., Banks I.S., Benz A. (1997). Vacuum Pyrolysis and Related ISRU Techniques. STAIF Conference Paper.