Water production from lunar samples and simulants

Conference or Workshop Item

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1. Introduction

- Water is a critical resource needed to support future crewed space exploration.
- In situ experiments are required to analyse and harvest water on the Moon.
- ProSPA is an analytical module for in situ regolith analysis onboard the Luna-27 mission [1].
- ProSPA will search for volatiles and also perform an ISRU demonstration.
- Reduction of lunar minerals is planned to be performed on the lunar surface using ProSPA.

In this work, lunar simulants and samples are reduced in a ProSPA breadboard model [2,3]. The results will help determine the feasibility of ProSPA producing water on the lunar surface.

2. Method

- Water can be produced from hydrogen reduction of FeO-bearing minerals.
- ProSPA is not optimized for this technique and the reaction must take place in a static (non-flowing) system (Fig. 2).
- Ilmenite is used as an `ideal` lunar mineral for initial testing [2,3].

![Fig. 2 Reduction pressures for 60500.](image)

3. Lunar Simulant

- NU-LHT-2M, a highland simulant with ~1.05 wt.% ilmenite [4]. Later sieved to remove <38 µm fraction.
- Pressure drop suggests reduction has occurred.
- Ilmenite grains show evidence of reduction along with small amounts of pyroxene and plagioclase.
- Yields of 0.29±0.04 wt.% O₂, compared to 3.43±0.14 wt.% O₂ for pure ilmenite.

![Fig. 3 BSE images of grains of NU-LHT-2M before reduction.](image)

4. Lunar Meteorite

- NWA12592, a feldspathic fragmental lunar regolith breccia [5].
- Manually crushed and sieved, with fines <38 µm removed.
- Some samples treated with EATG [6,7] to remove secondary oxides from weathering.
- Some reduction recorded (0.07±0.02 wt.% O₂), no significant difference with EATG.
- Melt material and relatively large grain sizes could be limiting yields.

![Fig. 4 BSE images of grains of NWA12592 before reduction.](image)

5. Apollo Samples

- 10084 mare soil, <1 mm sieved fraction of Apollo 11 bulk soil [8]. Later sieved to remove <38 µm fraction. Relatively rich in FeO (1-3 vol.% ilmenite) [9].
- Significant reaction observed, with yields of 0.94±0.03 wt.% O₂.
- Different mineralogies show reduction.

![Fig. 5 BSE images of grains of 10084 before reduction.](image)

6.0500 highland soil, unsieved fraction of Apollo 16 bulk sample. Later sieved to remove <38 µm fraction. Relatively poor in FeO (trace ilmenite) [10].
- Some reaction observed, with yields of 0.18±0.02 wt.% O₂.
- Mostly pyroxene reducing.

![Fig. 6 BSE images of grains of 60500 before reduction.](image)

1. Conclusions

- Lunar simulants and samples can reduce in a ProSPA-like system.
- Highland samples give lower yields, but still measurable.
- Could this be the 1st ever production of water on the lunar surface?