Lunar Regolith to Oxygen: Advancing Oxygen Production for In-Situ Propellant Production

Importance of beneficiation for higher regolith utilization and process sustainability

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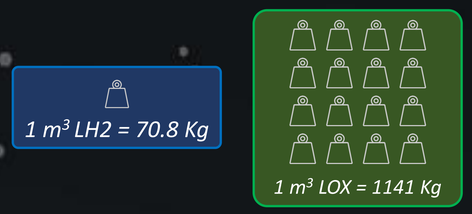
Why in-situ O_2 production?

LOX is 16 times heavier than LH2: In-situ O_2 production reduces the launch mass



Beneficiation testbed: DLR Bremen

The multi-stage beneficiation testbed was developed for producing ilmenite-rich feedstock from lunar mare regolith as a feedstock for O_2 production

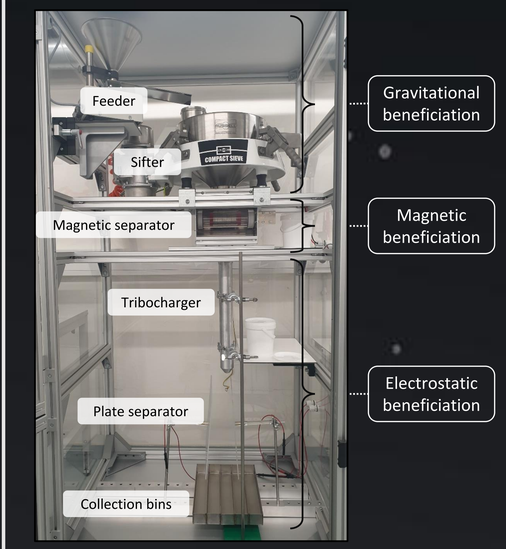
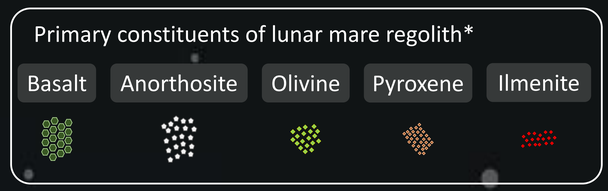


Figure: Multi-stage beneficiation testbed at DLR Bremen[1]

- The beneficiation experiments demonstrated an increase in ilmenite concentrations from 4 wt.% to about 12 wt.%.
- For details on the experimental results see Kulkarni, K. et.al. 2024[1]

Composition of lunar regolith

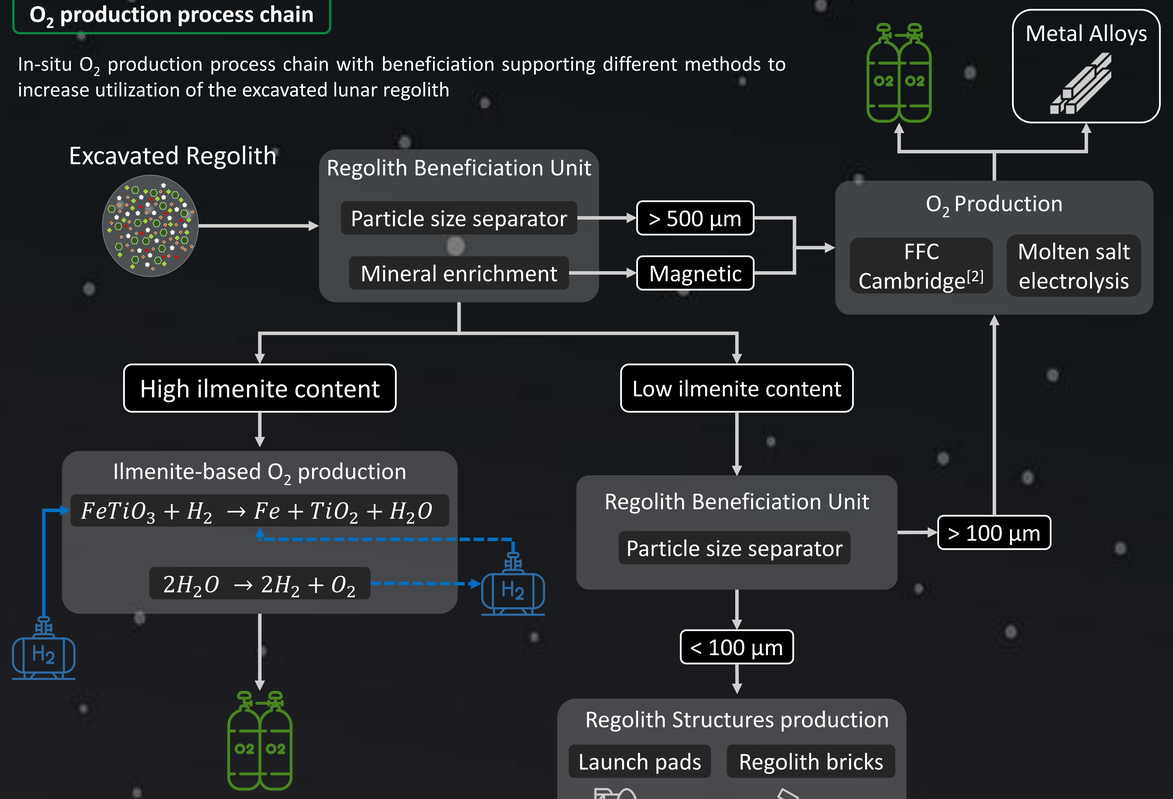
- Lunar regolith is an unconsolidated mixture of various rock-forming minerals.
- The primary constituents of the lunar regolith are illustrated in the diagram to the right →



**Reference composition from LMS-1 lunar regolith simulant procured from Space Resources Technologies*

O_2 production process chain

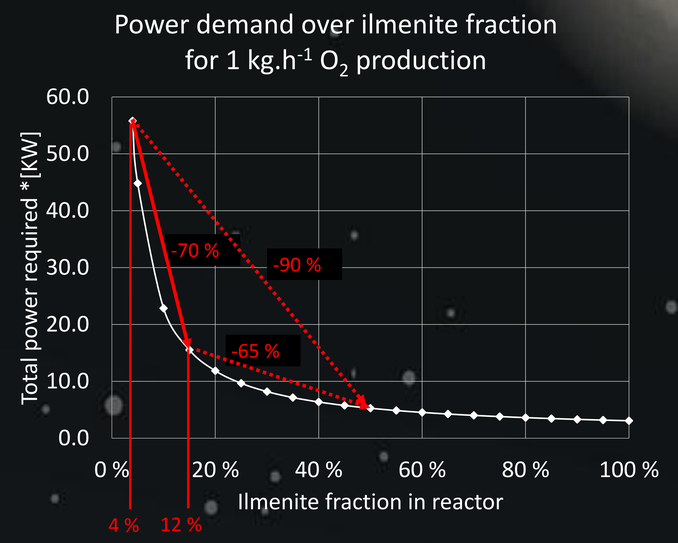
In-situ O_2 production process chain with beneficiation supporting different methods to increase utilization of the excavated lunar regolith



Next Steps

Beneficiation process optimization → Integration with ISRU extraction → Integration with other processes such as excavation and storage → Experimental validation of integrated system

Beneficiation Impact on Ilmenite-based O_2 production



**Total power is limited to power required for heating up the regolith and maintaining the temperature for the appropriate reaction time*

Conclusion and Outlook

- Regolith beneficiation has high impact on ISRU process efficiency and performance
- Beneficiation of lunar regolith increases utilization of the excavated material
- Holistic research is necessary for the integration of beneficiation into ISRU Infrastructure

References

1. Kulkarni, Kunal; Fabien Franke, Michel; Jundullah Hanafi, Muchammad Izzuddin; Gesing, Thorsten M.; Zabel, Paul (2024): Optimizing lunar regolith beneficiation for ilmenite enrichment. In Front. Space Technol. 4, Article 1328341. DOI: 10.3389/frspt.2023.1328341.
2. Mini-ROXY: the next step towards an efficient method for oxygen extraction from regolith