# ISPACE'S POLAR ICE EXPLORER: COMMERCIALLY EXPLORING THE POLES OF THE MOON

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**Introduction:** ispace is a company whose vision is to expand and sustain humanity's presence in space by utilizing resources available on the Moon. ispace manages Team Hakuto, a front-running team in the now closed Google Lunar XPRIZE (GLXP). ispace developed and flight qualified Team Hakuto's SORATO rover, which won the $500K mobility milestone award. As Team Hakuto originally only planned to develop a rover, the team needed to partner with another GLXP team developing a lander in order to be transported to the Moon. Team Hakuto signed a partnership in 2017 with Team Indus, which had a validated launch and become a finalist for the $20M Grand Prize. Unfortunately, neither Team Indus nor any other remaining team was not able to raise enough funds to pay a launch contract and Google official declared the end of the contest on January 23, 2018 [1].

ispace has a vision that expands beyond the GLXP. The company intends to build-upon two fundamental transport focused technologies, a rover and a lander, in order to enable the commercial exploration of the lunar surface and prepare for the establishment of in-situ resource utilization (ISRU) on the Moon. ispace plans to partner with space agencies, scientists, and the mining community for sensor and technology development to better detect water ice deposits. In addition, ispace will offer transportation opportunities so the international community can develop and test its own technology to explore the lunar surface.

**Polar Ice Explorer (PIE) Project:** The Polar Ice Explorer mission is an ISRU exploration mission that aims to identify and define the extension of the hydrogen and potential water ice deposits in lunar polar regions. This mission also will obtain valuable information on the geotechnical and trafficability properties of the polar regolith.

Four scientific mission objectives were established to address during this project:

1. To determine the local distribution and abundance of H in the subsurface regolith.
2. To characterize the form in which volatiles species containing hydrogen are present in the subsurface regolith.
3. To assess the volatile-rich contamination produced by lander exhaustion plume.
4. To obtain soil mechanics and trafficability information.

**Payload:** Three criteria are used to identify potential instruments for the PIE: The instrument fulfils at least one of the science objectives, its design is mature and the instrument can be easily procured.

Based on these conditions several instruments have been reviewed and considered as potential payload: (1) A Neutron Spectrometer (NS) to detect areas with enhanced hydrogen signatures, which may indicate the presence of subsurface water ice. (2) A Ground Penetrating Radar (GPR) to can detect, localize and characterize homogeneous stratigraphic units, such as segregated ice. In combination with the NS, the GPR facilitates more accurate mapping of the subsurface water ice deposits. (3) Mass Spectrometer (MS) to characterize the form in which the H-rich species are present in the polar regolith.

**Mission Concepts:** From the combination of several of the previously described payloads, several missions concepts have emerged (Table 1). Each concept fulfills at least two of the science objectives. In addition to the scientific aspects, programmatic, management and business considerations have to be taken into account in order to select the concept that provides the best cost/benefit ratio.

| Concept | Goldcrest | Rose | Melusine | Fox |
|---|---|---|---|---|
| Sensing | 2 NS | 2 NS | 2 NS | 2 NS |
| Mapping | | | | GPR |
| Sample analyses | | Ion Trap MS | Magnetic Sector MS | |
| Objectives fulfilled | 1,4 | 1,3,4 | 1,2,3,4 | 1,2,4 |

*Table 1: Mission concepts for the PIE.*

**Landing Site:** The targeted landing sites for this project are regions characterised by sufficiently low annual temperatures to maintain permafrost layers. These regions would receive some direct solar radiation for short amounts of time, but would still remain cold enough to avoid water loss via sublimation [2,3].

**Mission Funding:** As a private company, ispace must consider new and innovative approaches to cover the costs and even make revenue from its mission. These approaches include selling access to the lunar surface for other scientific and non-scientific payloads, as well as selling the data generated by this mission. ispace intends to market its scientific and engineering data to space agencies, research institutes, and scientists interested in the most up-to-date data on the lunar surface.

**References:** [1] Google Lunar XPRIZE UPDATE, *XPRIZE* (2018). [2] Vasavada A. R. et al. (1999) *Icarus* 141.2:179-193. [3] Paige D. A. et al. (2010) *Science* 330.6003:479-482