

SHACKLETON

An expedition to the lunar south pole



Patron: The Hon. Alexandra Shackleton

OUR OBJECTIVE

Water has been detected in shadowed regions near the Moon's south pole. This has both scientific and economic implications, because water can be electrolyzed to create oxygen and hydrogen for use as rocket propellants. However, there is currently no ground truth: the water could be in the form of surface frost, or it could be mostly underground. We propose to send a small rover to locate and make contact with the ice. The information we gather will be important to planetary science and vital to the future use of this resource in space exploration.

THE SHACKLETON TRADITION

We will recall Shackleton's spirit of determination, and we will underline this through our mission objectives and our narrative of polar exploration. We will carry a fragment of the *RRS Discovery* to the moon, just as the *Ingenuity* helicopter carried a fragment of the *Wright Flyer* to Mars. We will work towards lunar co-operation and stewardship, noting that the success of the Antarctic Treaty System depends on the presence of responsible actors on the ground. Overall, we will seek to inspire by showcasing ambition, discovery, and engineering excellence.

ENGINEERING ADVANTAGE

In lunar gravity, smaller rovers struggle to drill into the terrain because they cannot generate sufficient weight-on-bit. Comparable missions, such as Australia's *Roo-ver* and Europe's *Magpie*, focus on near surface exploration as a result. Shackleton will be different: weighing just 20 kg, it will use ultrasonic granular fluidisation to reduce the resistance of the terrain. This will allow it to target depths that would otherwise require larger landers, such as America's upcoming 430 kg *Viper*. However, by combining mobility and depth capability, smaller rovers will be able to prospect more sites, more quickly, and this will increase our chances of success.

ECONOMIC OUTLOOK

Exploration, for exploration's sake, is currently not supported in the UK Space Strategy. Philanthropic support for this scientific endeavour would be most welcome. We also believe that our mission can be a pathfinder for interests which may eventually supply the lunar economy. The projected cumulative value for the launcher propellant market is expected to be worth around \$63 billion by 2040 [PwC, 2021], and there will be other excavation requirements such as concrete-making and buried structures. Access to demonstrated earthmoving technologies is an important first step for any enterprise seeking to enter this market.

DELIVERY MECHANISMS

The USA operates a programme named CLPS: Commercial Lunar Payload Services. Shackleton would seek to purchase a landing slot on an expedition scheduled for late 2030. Separately, we anticipate considerable partnerships with Australian and Canadian interests. These will include operations sharing, such that a 24h mission may be maintained across multiple timezones for several weeks. We currently estimate the total mission cost, including delivery by CLPS at £25m. A detailed costing activity is currently underway.

THE TEAM

The team consists of many senior figures in the UK space exploration community, along with partners from the Canadian and Australian lunar programmes. More details may be found at www.shackletonrover.co.uk; or alternatively contact Prof. Patrick Harkness at patrick.harkness@glasgow.ac.uk