BINAR PROSPECTOR: AN AUSTRALIAN LUNAR RESOURCE PROSPECTING MISSION. P. A. Bland[1] and the Binar Prospector Team, [1]Space Science and Technology Centre, Curtin University, GPO Box U1987, Perth, WA 6845, Australia (p.a.bland@curtin.edu.au).

Introduction: Binar Prospector is an Australian lunar resource prospecting mission. Australia is partnering with NASA in Artemis. The Australian Space Agency's Moon-to-Mars program is designed to support the NASA effort, with ISRU identified as a critical strategic roadmap element. Binar Prospector will fly payloads that can materially improve our understanding of the resource potential of the Moon, while being low cost and small form-factor. The mission will consist of two 12U orbiters, each carrying two payloads - a multi-aperture thermal IR imaging system and a magnetometer - designed to identify localised accessible ice deposits and mineralization. Binar Prospector will have a novel mission architecture, with a propulsion system and fuel payload dedicated to maintaining extremely low altitude orbits. The mission is led by Curtin University, with partners Sitael Australia and Fugro.

Payloads: Thermal imaging will allow identification and mapping of hypothesised local small-scale cold traps containing ice [1]. The physical model to support the viability of localised ice deposits is well founded, but it requires data to confirm it. The DIVINER radiometer instrument on NASAs Lunar Reconnaissance Orbiter has gathered a stunning thermal imaging dataset, but with best resolution around 300m it is just below what is required to test the localised ice hypothesis [1]. Flying at low altitude, with a high-resolution thermal imaging camera, Binar Prospector could accomplish this goal.

While characterising the location and abundance of volatiles is a key element of lunar ISRU, a sustainable presence at the Moon will require more than just ice. Prospecting for economic resources requires high-resolution geophysical datasets. Magnetometry is a prerequisite. A high-resolution magnetic survey would provide a deeper understanding of the geology of the Moon, and its resource potential, but the current global lunar magnetic survey has insufficient resolution to deliver that.

In magnetometry, because the field decays with the inverse of distance, better resolution means lower altitude observations. Orbits with low periapsis tend to be unstable, requiring regular maintenance manoeuvres and a prohibitive fuel mass burden. Those manoeuvres shorten the mission lifetime. For large missions with multiple payloads this is not optimal: every other payload science team is negatively impacted in order to gather high resolution magnetometry data. The two previous lunar missions that carried magnetometers - Lunar Prospector and SELENE – had nominal missions at an altitude of 100km, but did descend to lower altitudes in an extended mission phase. Those final extended missions made some remarkable discoveries, including the Rainer Gamma feature, but the overall global spatial resolution was 60-100km.

How can a small Australian mission do better? By being the first lunar mission with magnetometers as the primary payload, rather than trying to juggle the needs of multiple mission payloads, Binar Prospector will be focussed on extreme low altitude data collection for its principal magnetometer payload. Our modelling indicates that we can maintain an altitude of 18+/-9km with the propulsion system and fuel budget for a nominal mission lifetime of 3 months. Flying twin small spacecraft allows us to gather higher resolution data, and provides immediate confirmation of any detected surface anomalies. Twinned observations and low altitude mean that Binar Prospector will deliver a x10 improvement on the current average magnetic survey resolution.

Summary: Blending Western Australia's globally recognised geoscience, mineral exploration, and remote operations expertise, Binar Prospector will gather data that can assist with a multi-agency international effort in lunar resource evaluation. Importantly, it will also pave the way for more missions. It will validate an Australian interplanetary-class small spacecraft bus: the R&D effort that goes into Binar Prospector will define a platform that can support multiple future Australian missions. And it will explore the potential of a radically new mission architecture. Low altitude is a requirement for high resolution magnetometry, but the ability to inexpensively acquire high value, high resolution datasets at low altitudes opens up a range of other mission types. Binar Prospector could define a new class of lunar missions, all focusing on low-altitude data acquisition using inexpensive spacecraft.

In 2021 the Binar Prospector team received funding via the Australian Space Agency Demonstrator Feasibility scheme to perform a detailed feasibility study for Prospector. The project is now at PDR. The project is supported by the WA State Government. A proposal to the Australian Space Agency Demonstrator Mission scheme for funding to support the bulk of the mission will be submitted 1st July 2022.

References: [1] Hayne P. O. *et al.* (2021) *Nature Astronomy*, *5*, 169-175.