Science Leveraged by a Human Lunar Presence. J.W. Ehrlich\(^1\), T. Cichan\(^2\), E. Bierhaus\(^3\) and R. Wall\(^4\)\(^1\)Lockheed Martin (joshua.w.ehrlich@lmco.com), \(^2\)Lockheed Martin (timothy.cichan@lmco.com), \(^3\)Lockheed Martin (edward.b.bierhaus@lmco.com), \(^4\)Lockheed Martin (ryan.e.wall@lmco.com).

Introduction: In the next decade, humans will be traveling back to the Moon and landing at the lunar south pole. This endeavor drives a new era of scientific investigation of deep space, building on the foundation set during the Apollo program and propelling human spaceflight forward towards further discovery. These missions will enable crews to support NASA’s key science goals through direct lunar surface exploration. A human presence is a necessity to better understand the impacts to biology. Likewise, a human presence in conjunction with supporting robotics will have a significant impact in propelling exploratory science and maturation forward.

Lunar Science Investigations: A human presence at the lunar south pole provides planetary scientists and geologists an invaluable opportunity to make on-site observations in ‘real-time’. For example, future excavation locations can be communicated to astronauts for data collection and feedback; the crew can then determine which tools and techniques should be utilized. Implementing efficient surface sortie navigation and tasking with opportunities for in-mission adjustment of surface objectives will optimize the mission’s scientific return, helping to reach a sample return goal requirement of 100 kg.

With the support of lunar rovers, humans can begin to explore an expanded region, \(\geq 10\) km, outside a lunar landing site. Accessing the cold and heavily cratered regions of the lunar south pole will allow astronauts to collect lunar volatiles from within areas capable of housing water ice deposits either directly or through the use of robotics.

Each surface sortie will include the capture of high-resolution imagery, along with on-site characterization of unexplored lunar landscapes to further define the lunar geologic scale through in-situ measurements and analysis in addition to other lunar science data.

Exploration Maturation: To establish a sustainable lunar surface presence, exploratory investigations can be performed that encompass both human-directed and observed implementation of advanced science experiments and coordinate with investigations occurring in orbit. Payload experimentation and demonstrations should include topics in the fields of ISRU, fluid transfer, power systems, and other areas that will support NASA in locating optimal sites and distributing resources for future surface and orbital assets.

One example is the Orion spacecraft, NASA’s human-rated deep space exploration vehicle, which will support lunar sample collection and return. Other deep space systems supported through a human-derived lunar science campaign include Gateway, Commercial Lunar Payload Services (CLPS) landers including the Lockheed Martin McCandless lunar lander, and other lunar surface infrastructure.

Fig. 1: Astronauts on EVA conducting lunar surface science.

Fig. 2: Gateway and Lunar surface infrastructure will evolve and expand over time.

Additionally, with missions on the surface extending beyond those durations experienced during Apollo, humans returning from the Moon will serve a critical role in the future prognosis of the long-term biological impacts while residing on the lunar surface. Environmental effects such as lunar dust intrusion and radiation exposure are of significant concern and will need to be observed. Current technologies for dust mitigation and radiation protection will require increased scrutiny as a human presence on the lunar surface becomes more permanent.