ADVANCED LUNAR DATA ANALYTICS/VISUALIZATIONS : WATER AND VOLATILE DETECTION/TARGETING INSIGHTS VIA MACHINE LEARNING. B. DeWitt[1] and J. Plate[2], Lunar Station Corporation, One Broadway, Cambridge, MA 02142 U.S.A. blair@lunarstation.net [1]. Watts, Griffis, and McOuat Limited ("WGM"), One Yonge Street, Suite 1506, Toronto, Ontario, Canada, M5E 1E5, jplate@wgm.ca [2].

Introduction: Fundamental to prospecting, exploration, and exploitation of in-situ water and volatiles on the lunar poles is de-risking mission planning with better resolution of available orbital data. Lunar Station Corp and WGM have recognized this issue and combined expertise in lunar analytics, mineral exploration and prospecting to create a dynamic, highly efficient machine learning platform. It has dramatically improved the definition and correlation of existing orbital data with the precision utilization of overlayed visualization of advanced predictive algorithms for locations of water and volatiles. The results display resolutions of better than 100 meters, in certain instances.

Limitations of existing data: Existing data sets from the Lunar Reconnaissance Orbiter("LRO") and other missions are of varying quality and resolutions. The primary instrument for analyzing water content is the neutron spectrometer (LEND) which has limited resolution as poor as $10km^2$ per pixel. This resolution is insufficient for mission planning or exploration/prospecting missions. Using a combination of signal reprocessing, analytical insights and scientific first principals, it is possible to rework the existing data sets thorough the fusion of machine learning to gain deep insights.

Process and techniques: WGM has developed a geological depositional model for lunar water and volatiles based on geological first principles, geochemistry, geophysics, ballistics, fluid/gas dynamics and fundamental physics and chemistry. All told, there are sixteen discrete exploration methods developed for identifying water and volatile resources using only orbital data. Using enhanced, uniform data sets developed via Lunar Station's MoonHacker™ Intelligence Platform architected with machine learning algorithms based on WGM's work results in a functional tool for water and volatile prospecting on the Moon.

Output and Insights on Lunar Water and Volatile Resources: The machine learning models have produced a series of discrete, high-value water and volatile prospecting targets with resolutions at the sub-$100m^2$ level. Further, overlain on the targeting is a mine favorability function which allows for optimization of target prospecting based on the ability to exploit the resource. Such favorability includes rover pathing, operating temperature, mine planning, optimized mine transport distances and proximity to resources. In crater targeting, analysis has defined probabilistic areas of maximal deposition of a select species of know volatiles. A major finding is a high correlation with Water Equivalent Hydrogen (WEH) data and a surprising indication that volatile resources that are located on the sides of craters, not the floors. This corresponds to past theoretical work on deposition presented in various scientific forums.

Implications for Future Exploration and Development: As with the terrestrial analog of the colonization of the New World, areas of the lunar surface containing exploitable water and volatile resources will favor future colonies and bases in-turn creating infrastructure and support services. Identifying where these resources are located are paramount for mission planning, future exploration missions, and monitoring. Risk mitigation is key to unlock financial resources to further explore by reducing the probability finding the terrestrial equivalent of a "dry hole". Success begets success and encourages further investment so any tool which assists mission planners is of high practical value..

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