REVISITING THE RETENTION FRAMEWORK OF LUNAR HELIUM-3 THROUGH SPACE WEATHERING PROCESSES AND ITS IMPLICATIONS. S. Shukla[1,2], S. Kumar[1] and V. A. Tolpekin[2], [1]Indian Institute of Remote Sensing, ISRO, India (sshashwat@ieee.org, shashi@iirs.gov.in), [2]Faculty ITC, University of Twente, The Netherlands (v.a.tolpekin@utwente.nl).

Introduction: The Moon may serve as an expedition base through which human space exploration policies could be strengthened. One of the primary steps to the lunar settlement is the utilization of potential feedstock resources for supporting in-situ operations. ^{3}He proves to be an efficient fusion fuel for lunar energy production without any radioactive wastes [1]. The amount of such deposits in the lunar soil is spatially variable, which is highly dependent on the incoming solar wind supply. It is also influenced by the electro-conductive nature of the ilmenite mineral and varying radiation deformities in the crystal lattice [2], [3]. Hence, there is a need to precisely identify such regoliths capable of trapping solar wind ^{3}He prior to in-situ exploration. The present study focusses on developing a new spectral parametric framework for lunar ^{3}He characterization based on space weathering processes, thereby identifying prospective mining candidates.

Methods: Space weathering influences the regolith in three ways: darkening (albedo, *A*), reddening (continuum slope, *C*), and reduced spectral contrast (integrated band depth ratio, *I*). This study models an improved solar wind plasma fluence (*F*) with the variations in topography and Earth's magnetotail shielding. The ilmenite abundance (*T*) is further mapped following the Shkuratov's approach [4]. With increasing maturity, *C* increases whereas *A* and *I* decreases. Such behavior may be attributed to the increase in nanophase iron particles upon reduction of Fe^{2+} during micrometeorite impacts. The solar wind ^{3}He retention enhances with comminuted regolith grains, which avails more surface area for the influx. A statistical relationship is, hence, established between 61 in-situ ^{3}He estimates and developed space weathering based spectral parameter (*FTC*/*IA*). Luna samples are included for minimizing saturation effect. Astronaut traverse maps are used to extract the spectral parameters. The preliminary model testing is performed near the Vallis Schroteri region.

Higher Retentivity of Pyroclasts: According to Fig. 1 (a), there is a higher correlation of the in-situ records with newly developed hybrid parameter. The measurement bias due to the irregular spatial distribution of samples is minimized by including a site-specific averaging operator. This significantly increases the correlation, thereby exhibiting an error of <1 ppb. The Luna samples receive ~47.77% solar wind flux more than that of the Apollo samples, indicative of higher ^{3}He saturation. In Fig. 1 (b), the most abundant region tends to be pyroclasts (in red color) with >7.3 ppb and reduced Fe^{2+} band depths. This attributes to highly crystalline regolith gardened with ilmenite-rich glass beads. Further traces of hydrated spectra incline such regions to be of ISRU potential. The site, thus, offers promising exploratory science in terms of evolved volatiles. In addition, the dominating processes affecting the concentration of ^{3}He are mainly found to be *C* and *I*. The developed framework provides new insights into the prospective mining site identification for initiating the establishment of lunar energy sector.

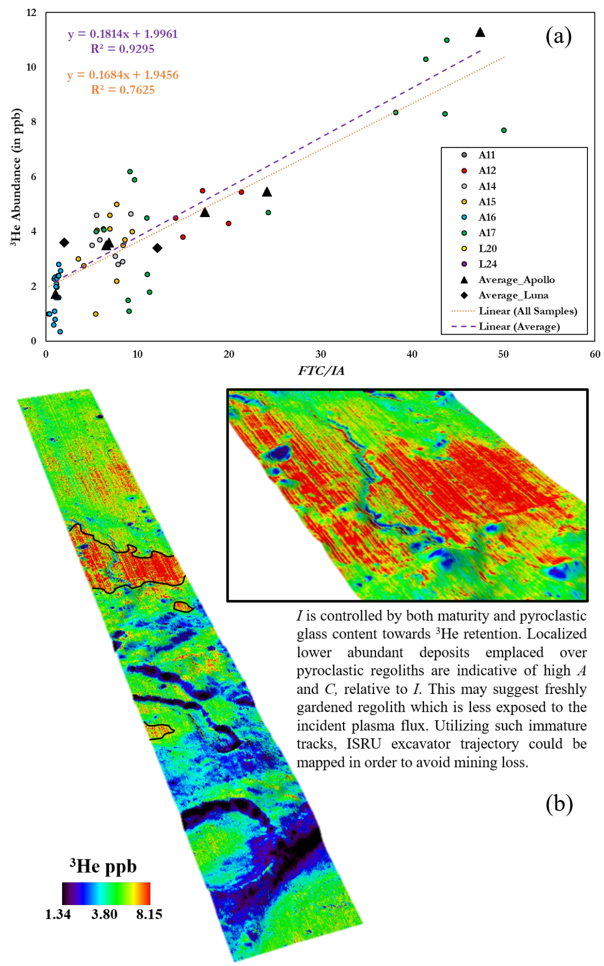

Fig. 1: (a) Comparison of in-situ ^{3}He measures with a spectral hybrid parameter, (b) Lunar ^{3}He abundance of the Vallis Schroteri region. Black lines depict higher abundant zones.

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