Gruithusien Domes: Insights from Silicate Mineralogy and Surface Textures. D.M. Bower[1], T. L. Livengood[1], M.A. Barker[2], T. Hewagama[2,] C.I. Honniball[3] [1] Department of Astronomy, University of Maryland, College Park, MD, dina.m.bower@nasa.gov, [2]NASA Goddard Space Flight Center, Greenbelt, MD, [3]Universities Space Research Association

Introduction: The upcoming CLPS mission to Gruithuisen Domes (GD) will provide the opportunity to better understand the Earth-Moon system and the magmatic evolution of the Moon. The GD are a trio of ~10 km-size domes located along the western edge of the Imbrium [1]. The distinct lithologies of the ~3.8 Gyr old GD stand out against the mare materials that dominate the lunar surface. Multiple observations of the region from, e.g., Clementine, Diviner on the Lunar Reconnaissance Orbiter, and M^3 on Chand-rayaan-1 indicate highly silicic lithologies including quartz, alkali feldspars, and silica glass with compositional variations among the three domes [2,3]. As in terrestrial rhyolitic volcanism, the high silica and low FeO and TiO_2 compositions that formed GD and their distinct morph-ologies indicate a more viscous magma material than what formed the mare highlands [1, 3]. Variations in composition within the region also suggest more than one volcanic process, and the mechanisms are not yet well-constrained [5].

Landed Approach: The distinct morphologic, morphometric, and spectroscopic characteristics of GD observed in remote sensing data may also exist at scales of individual grains requiring techniques that correlate micro-scale topographic and textural surface features with mineralogy. Suitable spatial scales can be explored with technologies similar to those used for orbital remote sensing maps, while fine scales resolving individual clasts and grains are suitable for in situ technologies. Orbital remote sensing provides an overview of regional variation on the Moon with a resolution element on the order of several 100's of m. A progressively narrower field of view from 10's of m to 10's of cm to 10's of mm to point-target probing enables finely scaled information to be incorporated into the context of regional mapping.

A landed mission to GD should emphasize techniques that clarify variations in silica mineralogy to identify different types of silicic minerals and glasses at the surface. Multiple quartz polymorphs are detected in Apollo rocks, each representative of specific formation conditions [6]. Lunar meteorites from Northwest Africa (NWA) contain clasts containing silica polymorphs quartz, cristobalite, tridymite (NWA 773), moganite, coesite, and stishovite (NWA 2727), indicative of silicic volcanism or high-T/high-P silicic fluids [6,7].

Raman spectroscopy (RS) probes the composition of features at 10's µm. RS facilitates the distinction between polymorphs and is especially sensitive to silicate minerals. The RS characterizations of NWA 2727 and 773 clearly discern silica polymorphs among other silicates , e.g. K-feldspar and plagioclase [4,5]. A landed RS instrument can identify specific polymorphs, determining the properties of the original lava flow.

Coordinated microscopy of regolith is needed to understand top layer structure, its effects on surface photometric properties in reflected and thermally emitted light, and its correlation with mineralogy. Micro-scale imaging of regolith can discern individual grains and grain structures that RS probes, in a larger context. Remote sensing studies of the Moon regularly invoke micro-structural changes to the regolith related to its porosity, surface roughness, and elaborate grain structures ("fairy-castles") to explain data over a range of wavelengths [7-10], but these hypotheses have never been directly tested. Optical microscopy correlates mineralogy to microtextures, uncovers the nature of "fairy castles", and provides ground-truth for surface textures inferred from remote sensing.

Thermal imaging and IR hyperspectral imaging resolve terrain features as a ground-level counterpart to orbital measurements. Near-IR spectroscopy distingu-ishes silicates and space-weathering features related to the deposition age of lava flows or regolith deposits. Landed MWIR studies of the 8 µm silicate Christiansen feature can resolve ambiguities in minerals mapped from orbit. Surface temperature as a function of exp-osure time, either on sunlit regions exposed over hours or days or regions at the edge of retreating shadows with exposure times on the order of minutes yield thermal inertia related to the porosity of the soil.

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