CORRELATING GRAIN-SCALE PROPERTIES AND SYNTHETIC APERTURE RADAR ON ARID ALLUVIAL FANS FOR INTERPRETING PLANETARY SURFACES. A. D. Maue, D. M. Burr, and M. J. Jarquin; Northern Arizona University, Flagstaff, AZ (maue@nau.edu).

Introduction: Characterizing surface sediments through remote sensing paints a picture of planetary surface processes in the absence of in situ data. By exploring the relationship between radar and granulometric ground truth at accessible terrestrial locales, we aim to advance the quantitative sedimentology possible in planetary data analyses.

As described in [1], radar backscatter is generally a function of geometric properties (e.g., surface roughness), dielectric properties (e.g., chemical composition), and source-target-sensor imaging angles. Surface roughness relative to the radar wavelength is often the dominant influence and for an alluvial surface can be considered in terms of the grain-scale characteristics of near-surface sediment. For cm-scale-wavelength synthetic aperture radar (SAR) images of unconsolidated sedimentary deposits, we are interested in how radar backscatter is influenced by grain properties such as size, shape, and sorting.

Geologic SAR studies typically interpret variations in the magnitude of radar backscatter in terms of qualitative differences in surface properties. Few studies have employed granulometric ground truth to validate sedimentary interpretations made with radar. For example, [2] sampled surface gravel sizes and observed the transition from specular to diffuse reflection but studied only relative power with no absolute calibration of their airborne radar images. More recently, many SAR studies aim to characterize surface roughness to isolate soil moisture for agricultural purposes [3]. Various SAR models for interpreting planetary data infer bulk layer properties [4]. Here we take the approach of considering individual grain properties that constitute an alluvial surface, more akin to [2]. To focus on sediment and avoid the strong dielectric influence of moisture, we study arid alluvial fans in and around Death Valley National Park. We have thus far measured grain properties in the field at 30 study sites to develop an empirical model for comparison to existing theory.

Methods: Study sites were selected to cover a range of SAR backscatter coefficient (σ^0) values at C- and L-band wavelengths and build on pilot study results [5].

Ground truth. Study sites of ~16 by ~36 meters were selected on several alluvial fans. Hand measurements of 192 grains $\gtrsim$2 mm were taken across each site based on a regularly spaced sampling grid. Measurements of three axes allow for quantification of basic shape and size statistics. Each grain was also assessed qualitatively for roundness based on six categories [6]. Sieving at select locations further characterized fines from 63 µm to 2 mm. Ground-based structure-from-motion (SfM) imaging for three 1-m-radius areas of distinct grain sizes within each study site constrain roughness endmembers.

Satellite data. Basic study site characterization is done with 10 m/pixel visible Sentinel-2 images, 30 m/pixel SRTM DEMs, and higher resolution topography where available. Radar backscatter is measured in linearly polarized ~10 m/pixel SAR images from C-band (5.5 cm) 2019–2021 Sentinel-1 and L-band (23.6 cm) 2011 ALOS PALSAR. SAR images are calibrated into σ^0 by the Alaska Satellite Facility and are further co-registered to subpixel precision based on a custom Python script [7]. The σ^0 statistics are derived from GPS points defining polygons for each study site.

Initial Results: Across the 30 study sites, D_{50} of the intermediate-length axes ranges from ~0.5 to ~20 cm (~0.1 to ~3.5 $\lambda_{\text{C-band}}$), i.e., sand- to cobble-scale median grain sizes. Size sorting in terms of the ratio of standard deviation to mean size ranges 0.7 to 1.9. Qualitative roundness ranges from mean values of 1.8 to 3.6, indicating predominately angular to sub-rounded shapes, whereas well-rounded clasts were extremely rare. Minimum and maximum RMS heights thus far derived from SfM models are correlated to hand-measured grain size (R^2 ~ 0.6). Any possible effect of dielectric variations on backscatter will be investigated alongside the measured size and shape data.

Discussion: As σ^0 statistics are extracted from SAR images of varying wavelength, incidence and look angle, the influence of grain properties versus topography on SAR will be compared. Using alluvial deposits in the arid Mojave Desert, we derive correlations between sedimentological properties and SAR backscatter to verify and build on the largely theoretical understanding of sediment interpretations from SAR. Our findings will eventually be extended to remote sensing of other planetary bodies where constraints on distant grain properties would indicate formative geologic conditions and surface processes.

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