SIR-A OBSERVATIONS OF A SILICIC SHIELD VOLCANO IN BOLIVIA; P.R. Christensen and R. Greeley, Department of Geology, Arizona State University, Tempe, Arizona, 85287

In the fall of 1981, the Shuttle Imaging Radar (SIR-A) experiment obtained a 50-km-wide image across the Altiplano in Bolivia (1,2). These data provide estimates of surface textures, at scales equal to and larger than the radar wavelength (23.5 cm), that are useful for assessing geologic processes and surface modification (3). The SIR-A groundtrack covered several volcanic structures within the Altiplano and the western cordillera of the Andes. Of particular interest for comparison with remote sensing observations of other planets is Volcan Quemado, located at -18° 37' S, 68° 45' W. This feature is a low, broad "shield" volcano with a series of explosion craters and an extrusive dome at the summit. It has a basal diameter of 8 km and rises 360 m above the surrounding valley floor, with a summit elevation of 4215 m. The flank slopes vary from 4° to 15°, generally increasing towards the summit. The summit region contains a series of pit craters, with evidence for at least four separate explosive events. These craters create a crater chain 4.5 km long and 2.6 km wide along a line oriented nearly N-S. The diameter of each crater is ~1.5 km. Within this crater complex is an extrusive dome, 1.6 km by 1.0 km at its base and elongated parallel to the crater chain which rises approximately 200 m above the floor of the central crater.

The radar data show a very high reflection from the summit dome and from the rims of the explosion pit craters. The region surrounding the summit has a very low radar reflectivity, indicating a very smooth surface at 20 cm and larger scales. This texture is suggestive of a fine ash or pumice deposit formed by, or in association with, the explosion craters at the summit.

To better understand and interpret the radar signature, a program of field investigation was initiated in 1983. The first step was to perform an overflight of Volcan Quemado to provide closer inspection of the crater, dome, and flank morphology and to give a regional view of the volcano. Layered bedrock units, presumably flows, are exposed in the crater walls and pre-date crater formation. Based on its superposition, the summit dome appears to be younger than all explosive events. No surface expression of lava flows on the flanks was observed on this flight. The southern and western portions of the crater complex are covered by bright, unvegetated material that appears to have mega-ripples with wavelengths of 2 to 4 m. This material may be sand-to granule-sized pumice fragments that are being reworked by aeolian processes.

In July, 1984, a field study of Volcan Quemado was conducted to permit a more detailed investigation of this feature and to collect rock samples and study surface textures that relate to the SIR-A observation. This investigation focused on the eastern flank and summit-dome region. The dome is composed of glassy to fine-grained rhyolite; samples collected from within the explosion craters are rhyolitic, as are the pumice and glass fragments that cover much of the surrounding terrain. At the summit of the dome is a series of ridges approximately 8 m high and spaced approximately 100 m apart. The surface rocks are heavily jointed and fractured; joint spacings are approximately 0.5 m, with local slopes up to 60°. Much of the surface is covered by loose blocks that are typically 25-50 cm in diameter but range up to 1.5 m. The surface surrounding the summit craters is covered by pumice particles ranging from 1 mm to 10 centimeters. Layered ash and pumice beds are exposed within small gullies on the flanks of the volcano. No evidence for flows exposed at the surface was found during the surface traverses, although only a small fraction of the flank surface was studied.

Based on these field observations, the interpretation of the radar return is relatively straightforward. The high return from the dome is consistent with the observed abundance of rocks, jointed blocks, and steep slopes. The high return from the crater rims can also be interpreted as being due to the relatively high slopes, the exposed bedrock units, and the large amount of slope talus. Slope appears to be the major contributor to the radar reflectivity because the return is greatest for slopes perpendicular to the radar look direction. The very low radar return from the flank regions can be understood from the fine particle size observed and the lack of particles larger than 10 cm. Using the radar data, the relatively limited region that is accessable on the ground and could be directly sampled can be extrapolated to a much larger region of constant radar reflectivity that extends 20 to 30 km radially from the summit. This extrapolation suggests that this entire region is covered by fine-grained pumice deposited during explosive eruptions at the summit.

Previous studies have described radar observations of basaltic flows (4,5). Volcan Quemado and its environs provides an excellent site to study the radar signature of a silicic volcanic construct. This feature differs from basaltic terrains primarily by the evidence of explosive eruptions associated with silica-rich magmas. These explosions produced a complex of distinctive craters that are visible on radar because of their steep inner walls and exposed bedrock units. Explosive events have also generated surface deposits of fine (1 mm to 10 cm) material that mantles the region around the volcano to a distance of 20 to 30 km from its center. These features are very different from those observed on basaltic flows, which typically lack violent, explosive events. In these terrains, the surface is dominated by radar-rough flows with steep, lobate flow fronts. Craters are less common, although maars are found in some regions (15). These comparisons suggest that spaceborne radar may be able to distinguish surface characteristics that can be used to identify volcanic eruptive styles on Venus, Mars, and other solar-system bodies.

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