Radar Imagery of the Chryse-Xanthe Region, Mars

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Introduction
Earth-based radar imagery of Mars has been used to map regions of enhanced small-scale (sub-meter) surface roughness based on the brightness of the depolarized echo component. Although most bright depolarization features are associated with lava flows in the major volcanic provinces [1,2], some apparent non-volcanic bright features were also seen in early (pre-upgrade) Arecibo imagery of the Chryse-Xanthe region [3]. Here we present updated imaging results for Chryse-Xanthe and environs based on observations made with the upgraded Arecibo radar during the 2005 and 2012 Mars oppositions. We will concentrate on four specific subregions showing bright depolarization features that appear to be signatures of aqueous deposition/modification or other effects peculiar to the unique Chryse-Xanthe region.

Southwest Chryse and VL-1 Lander Site
Northeast of Maja–Lunae Basin (A) is a radar-bright region covering a large area of southwest Chryse Planitia. This feature, which is separated from the Maja–Lunae feature by the radar-dark Xanthe Montes (D), appears to be largely attributable to rocky outwash debris debouched from the various narrow Maja-system drainage channels cutting through the Montes. The brightest part of the southwest-Chryse feature constitutes a large arc that wraps around the north and west sides of the dark-halo crater Santa Fe (E). The southern part of the arc (F) appears to be largely outwash debris from Maja, Vedra, and Maunee Valles, while the northern swath (G) may be dominated by rocky flood deposits from Bahrani Valles. There is support for this scenario from THEMIS imagery, which shows dark daytime IR features and bright nighttime IR features in the Bahram and Maja-Vedra-Maunee outwash zones. The radar image shows the Viking 1 lander site (H) lying on the eastern end of the northern bright band (G). This suggests the possibility that the VL-1 lander site contains surface debris from Bahrani Valles. At the very least, the radar and THEMIS imagery strongly suggest that the Bahrani Valles outwash deposits are more extensive than previously thought.

Central Chryse and Bright Craters
Central and northern Chryse Planitia shows moderate depolarized radar brightness attributable to rocky outwash from the various southern and western channels draining into the basin, although the deposits are probably sparser than those in the brighter Maja outwash region of southwest Chryse. Superimposed on the general background brightness of the region are numerous bright and dark features associated with impact craters. The dark features are identified with “dark-halo craters” such as Calahorra, which are similar to dark-halo craters seen in Mars’ volcanic regions [2], or with other craters (Kipiani, Orabali, Wahoo) whose elevated rims divert surrounding radar-bright outwash. The unusual crater Bonestell is interesting for showing a radar-bright rim and central dome as well as a large surrounding radar-dark halo. The radar-bright crater features are mostly “bright- ejecta craters” of a type we have not found elsewhere on Mars outside of the Chryse-Xanthe channel region. The more prominent of these include a trio of named craters Lusumae (J), Grundakiv (K), and Seftu (L), a fourth crater (M) located in channel floor near the terminus of Tiu Valles, and a cluster of smaller bright craters northwest of the trio. The ejecta blankets of these craters appear very bright in THEMIS nighttime infrared images and dark in daytime IR images (see above), which implies very rocky ejecta surfaces consistent with the radar brightness. The fact that the bright-ejecta craters are located in outwash plains or outflow channel floors suggests that aqueous modification/alteration effects were conducing to the formation of rocky impact ejecta, although it is also possible that Chryse has peculiar crustal properties making for rocky ejecta.

Summary
Arecibo radar imagery of the Chryse-Xanthe region of Mars reveals an interesting variety of radar-bright depolarization features that can be identified with enhanced diffuse backscatter from the following types of surfaces:
1. Rocky floodplain or outwash debris deposited by aqueous flows.
2. Unusually (for Mars) rocky ejecta blankets of impact craters.
3. Rough plateaus surfaces bordering chasma, chaos, and channel features.

Perhaps the two most important questions raised by these findings are:
1. What mechanism is responsible for the surface roughening of the Xanthe plateau border regions?
2. Why does Chryse host bright-ejecta craters not seen elsewhere on Mars?

References: