SMALL CRATER POPULATIONS ON CALLISTO. E. B. Bierhaus, Aerospace Engineering Dept., University of Colorado at Boulder, Boulder CO 80309; Southwest Research Institute, 1050 Walnut St. Suite 426, Boulder CO 80302 (bierhaus@ucsu.colorado.edu), C. R. Chapman, W. J. Merline, Southwest Research Institute, 1050 Walnut St. Suite 426, Boulder CO 80302, USA, R. Greeley, J. Klemaszewski, Department of Geology, Arizona State University, Tempe AZ 85287, USA, and The Galileo Imaging Team.

Introduction. The Galileo spacecraft acquired a sequence of high resolution (15 m/pix) Callisto images during the 21st orbit (hereafter C21). These images cover a small region at about 1° N latitude and between 106-107° W longitude, a region previously imaged only at low resolutions (km/pix). We find that the small crater density in this region is significantly higher than seen in other high resolution Callisto images.

Background. Voyager observations showed that Callisto's surface is densely cratered, approaching saturation at crater diameters between 10 – 50 km diameter [1], meaning Callisto’s surface is so deeply cratered that the formation of a new crater must destroy pre-existing craters. Typical power law distributions of impactors observed in the solar system imply that the crater densities should increase at smaller diameters; in addition, larger craters produce extensive secondary craters. Both effects should contribute to a high density of small craters. However, our counts from the nominal Galileo mission Callisto data show this is not the case [2]. The crater density, in a variety of regions, actually decreases at diameters < 10 km. The density decrease continues down to about 100 m diameter, the completeness limit of the high resolution images from the 3rd orbit (hereafter C3).

Callisto’s surface has a global dark unit, probably the result of the dark lag that remains after the ice sublimates out of the mixture that comprises Callisto’s surface [3]. There is strong evidence this unit can be quite mobile via mass wasting events [3], but cannot entirely account for the steep depletion of small craters [2]. This led to speculation that the objects making the craters, primarily comets [4], may lack a small diameter population [5].

Description. The high resolution images from C3 all appear within Valhalla’s giant multir-ring structure. (Valhalla is Callisto’s largest impact basin, it’s outer rings measuring about 4000 km diameter [6].) The area targeted in C21 was chosen to sample terrain outside the influence of any of Callisto’s major basins. Figure 1 provides the R-plots for the combined high resolution counts from C3 and for the new C21 data. The differences are striking, and exceed the regional variability seen elsewhere on Callisto [7]. Below 1 km diameter, the crater densities diverge rapidly, with the C3 density decreasing at a slope of about 1, while the C21 density increases at a slope of about -1. Before we claim discovery of the missing small crater population outside the influence of the giant basins, we offer a few observations. First, the spatial density of small craters is non-uniform, ranging from near saturation in some areas to lightly cratered in others. The craters that appear in clusters exhibit similar states of degradation, suggesting these may be secondary craters. Second, there are many cases where the small "craters" demonstrate morphology similar to the possibly endogenic pits seen elsewhere on Callisto; specifically they have oblong shapes, contorted outlines, and appear in clusters or chains, similar to secondary crater clusters. It is possible that the pits may simply be a highly modified population of secondary craters: in some cases two sharp lobes point to one another from opposite sides of a pit; it is possible that the wall shared by adjacent secondary craters eroded, leaving only lobes and creating an oblong pit. Third, small craters also appear immediately adjacent to the bright knobs of remnant large crater rims; usually regions next to topographic highs on Callisto are devoid of small craters, likely due to in-filling by mass wasting. Without mass wasting, this region could maintain a higher population of small craters. And finally, there may also be a lack of 10 km craters in this locale. Craters of this size are nearly saturated in most regions on Callisto. A 10 km crater would occupy roughly a single frame of this sequence, yet the largest crater we see is only about 5 km diameter. A 10 km diameter crater, and its continuous ejecta blanket, would wipe out many of the small craters.

Summary. Unfortunately, Galileo will not target Callisto again, so we have no further opportunities to sample the small crater population elsewhere on Callisto. Similar small crater analysis on the sister moons Ganymede and Europa may provide further insight regarding the influence of secondary craters, and the state of the current small impactor flux. Based on data in hand, however, we offer a few conclusions:
1. The C21 data are the highest resolution Callisto data, by about a factor of three, but this cannot account for the higher crater densities observed at sizes we thought were completely sampled in earlier observations.

2. The similar degradation states of tightly spaced crater clusters strongly suggests a secondary crater origin for many of the craters in this sequence.

3. Lack of mass wasting events may suggest this region has been undisturbed for long enough to accumulate a significant small crater population; however, we cannot rule out the possibility that, in general, erosional effects may be more efficient inside impact basins than outside the impact basins.