GEOLOGY OF THE APOLLO 11 AND 12 LANDING SITES – NEW MAPS AND INSIGHTS. W. Iqbal[1], H. Hiesinger[1], C. H. van der Bogert[1], [1]Institut für Planetologie, Westfälische Wilhelms-Universität, Wilhelm-Klemm-Str. 10, 48149, Münster, Germany, iqbalw@uni-muenster.de

Introduction: Geological mapping combined with crater size-frequency distribution (CSFD) measurements are important tools for understanding geological processes through lunar history [e.g., 1-8]. The Apollo missions played a vital role in deciphering the lunar geological history via the collection of samples that serve as important groundtruth for remote observations [e.g., 5,9]. Using modern Lunar Reconnaissance Orbiter Camera (LROC) data [10] along with Clementine [11] and Moon Mineralogy Mapper (M3) [12] spectral data, we reanalyzed the geology of the Apollo 11 and Apollo 12 landing sites and produced new geological maps to provide an updated context for landing site-related sample and remote sensing studies.

Methods: We calibrated and map-projected LROC Wide Angle (WAC; 100 m/pixel) and Narrow Angle Camera (NAC; 1.2 m/pixel) data with incidence angles of 73-75° in ISIS 3 [10]. The geological units were mapped on the basis of their morphology and their albedo. In addition, we used the LOLA/Kaguya digital elevation model (DEM) [13] to aid in defining the units and related structures. Spectral data, including Clementine [11] and Chandrayaan-1 M3 [12], were used to identify various units in the mare basalts. We mainly used the stratigraphic scheme proposed by Wilhelms (1987) [1]. Thus, the mapped craters were classified as *Cc*-Copernican, *Ec*-Erathosthenian, *Ic*-Imbrian, and *pIc*-Pre-Imbrian craters. The symbology of the mapping units follows the standards of the Federal Geographic Data Committee (2006) [14], and the nomenclature used for the mapped craters and regions is consistent with the Gazetteer of Planetary Nomenclature (1999) [15].

Apollo 11 Landing Site Geology: The landing site lies near the southwestern edge of Mare Tranquillitatis basin [16]. Based on variations in the iron and titanium concentrations observed in spectral data, we mapped five different mare units in the study area (*Im1*, *Im2*, *Im3*, *Im4* and *Im5*; *Fig. 1*). We observed rays (*Ccr*) around the landing site, which likely are from Theophilus crater. However, a few rays probably belong to other young craters (*Cc*) (Fig. 1), such as Moltke, Alfraganus, Dionysius, and Tycho. We also mapped units in the highlands near the landing site on the basis of albedo contrast and topography. These units include three different plains units: *Ifs*-Imbrian Fra Mauro smooth plains, *Ip*-Imbrian plains, and *IpIm*-undivided Imbrian or pre-Imbrian material observed in topographical depressions in the highlands. Other mapped units in the highlands include: *Ifm*-Imbrian Fra Mauro formation representing the ejecta of the Imbrium basin and *IpIt*-undivided Imbrian or pre-Imbrian terrain, which lacks the northwest-southeast striation characteristic for *Ifm*. We observed a concentric pattern of graben (rilles) around the southwestern edge of Mare Tranquillitatis, which are mostly perpendicular to the radial pattern of the wrinkle ridges.

Apollo 12 Landing Site Geology: The landing site is situated in Mare Cognitum on a southwest trending ray (*Ccr*) from Copernicus crater [17]. We observed mare units with Erathosthenian (*Em1*, *Em2*) and Imbrian (*Im1*, *Im2*) ages on the basis of spectral contrast in M3 data and crater density differences. Most rays (*Ccr*) in the mapping area point toward Copernicus crater, while a few may also belong to other Copernican-aged craters (*Cc*), such as Gambert A and Lansberg B. A few north-south and east-west trending graben are mapped to the west of the landing site. Wrinkle ridges show a half concentric orientation in the east and south of the landing site. In the north, east, and west, the highlands are covered with Imbrian ejecta (Fra Mauro formation; *Ifm*), while in the south and southwest of the landing site, a few areas in the highlands are mapped as undivided Imbrian and pre-Imbrian material (*IpIt*).

Implications: In addition to the better understanding of the geological processes at work in the landing regions, detailed geological mapping is necessary for defining homogeneous areas for the accurate measurement of CSFDs and for deriving absolute model ages (AMAs). We used our new maps to check and improve the previously selected count areas [e.g., 3,4] for determination of the *N*(1) values assigned to Apollo 11 and Apollo 12 landing sites [16,17]. Our new values [16,17] compared with radiometric ages determined via modern sample analyses are consistent with those of [3,4,6,8], supporting the calibration of the lunar cratering chronology curve purposed by [3,4] via our updated landing site studies.

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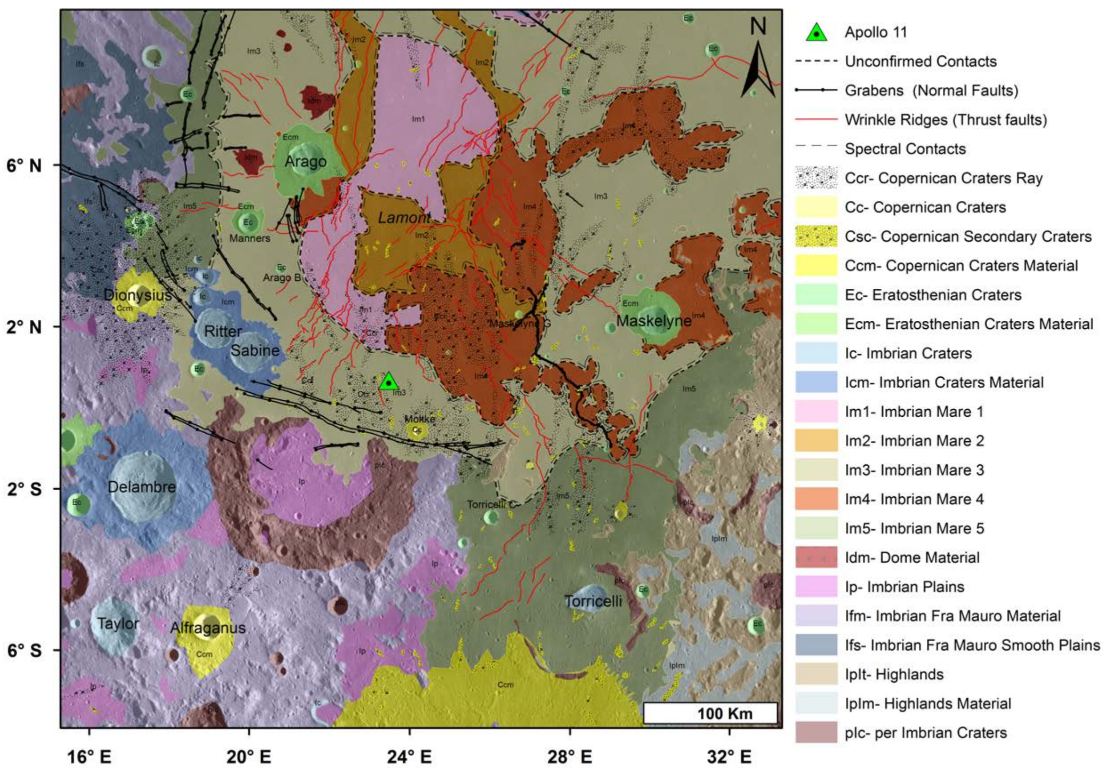

Figure 1: *New geological map of the southwestern part of the Mare Tranquillitatis around the Apollo 11 landing site (green triangle), showing mare units, various highland units (including the Fra Mauro and Cayley Formations), a radial pattern of wrinkle ridges, a concentric pattern of rilles, as well as different generations of craters and rays.*

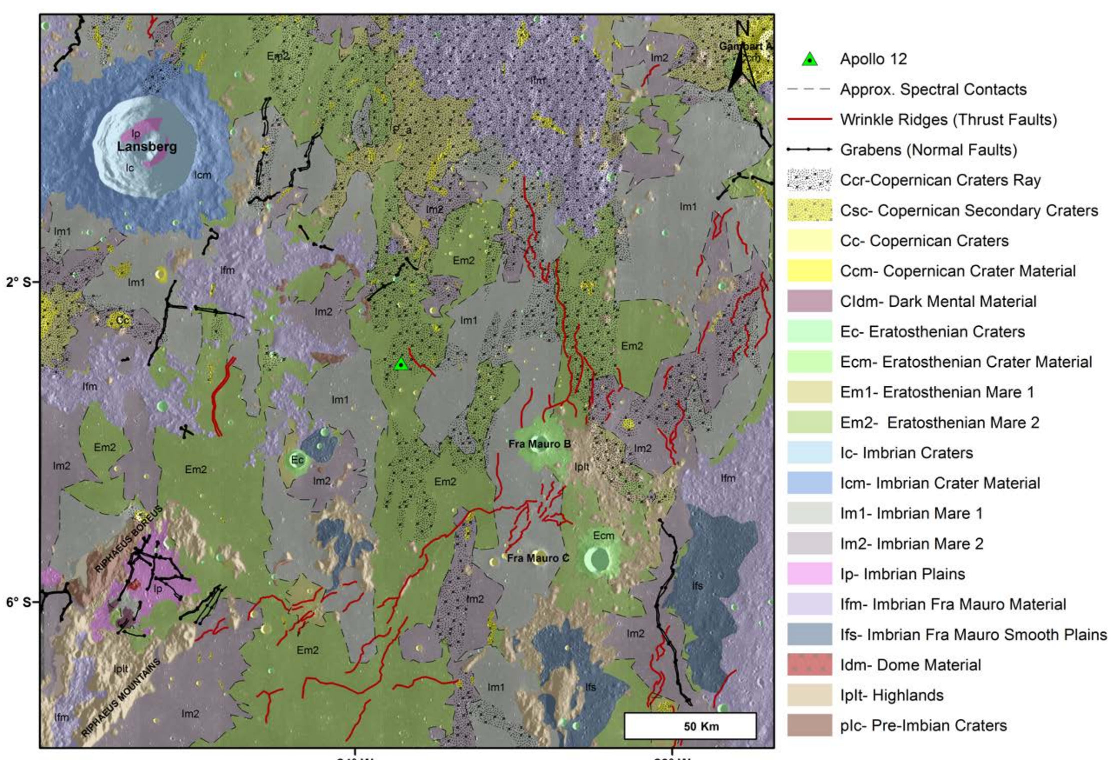

Figure 2: *New geological map of the Apollo 12 landing site (green triangle) in Oceanus Procellarum, which shows mare units, differently aged craters, rays crossing the landing site, highland units (including Fra Mauro Formation and older material), as well as wrinkle ridges and rilles.*