CRYPTOMARE AND PYROCLASTIC DEPOSITS IN THE GASSENDI REGION OF THE MOON. T.A. Giguere[1,2] , B.R. Hawke[1], D.T. Blewett[3], B.A. Campbell[4], J.J. Gillis-Davis[1], P.G. Lucey[1], C.A. Peterson[1], C. Runyon[5], and G.J. Taylor[1]. [1]Hawaii Institute of Geophysics and Planetology, University of Hawaii, Honolulu, HI 96822, [2]Intergraph Corporation, P.O. Box 75330, Kapolei, HI 96707, [3]NovaSol, 733 Bishop Street, Honolulu, HI 96813, [4]Center for Earth and Planetary Studies, National Air and Space Museum, Washington, D.C., 20560, [5]College of Charleston, 66 George Street, Charleston, S.C. 29424.

Introduction: Gassendi is a floor-fractured impact crater (diameter=110 km) located just north of Mare Humorum on the lunar nearside. The Gassendi region contains a variety of unusual features which have long provoked controversy. These include smooth plains and possible volcanic constructs on the floor of Gassendi [1,2], a large radar anomaly west of the crater [3], possible pyroclastic deposits in Mersenius crater, and a cryptomare deposit [3]. We have used remote sensing data and a variety of spacecraft imagery to investigate the composition and origin of geologic units in the Gassendi region. The goals of this study include the following: 1) To determine the origin of possible volcanic features on the floor of Gassendi, 2) To identify and map the distribution of exogenic dark-haloed craters (DHCs) in the region, 3) To search for cryptomare deposits and to investigate the processes responsible for their formation, 4) To determine the compositions and ages of any buried mare units, and 5) To investigate the compositions of pyroclastic deposits.

Methods: The U.S.G.S. Astrogeology Program has published on CD-ROM a Clementine five-color UV-VIS digital image model (DIM) for the Moon [e.g., 4]. Images from this DIM were used to produce an image cube centered on the Gassendi area. This calibrated image cube served as the basis for the production of a number of other data products, including optical maturity (OMAT) images and FeO and TiO_2 maps [5,6]. Five-point spectra were extracted from the calibrated and registered Clementine UV-VIS image cube.

Three Lunar Prospector (LP) gamma ray spectrometer (GRS) and neutron spectrometer (NS) elemental abundance data sets were used in this study. The half-degree iron abundance data product contains data from the LP-GRS acquired during the low-altitude portion of the mission. A description of the reduction of this data set is given by Lawrence *et al.* [7]. The half-degree titanium abundance values were derived from LP-NS measurements acquired during the low-altitude portion of the mission. The reduction of this data is described by Elphic *et al.* [8]. The half-degree thorium data were described by Lawrence *et al.* [9].

Results and Discussion:

Gassendi Crater Interior. While mare basalt deposits have been identified in the southern, southeastern, and southwestern portions of the Gassendi interior [e.g., 1,2,10,11,12,13,14], no mare units have been mapped in the west central and northwestern portions of the crater floor. However, Schlutz [1] described several features of possible endogenic origin in the NW portion of the floor. These included an irregular depression partly surrounded by a scarp which may be a lava terrace. Large parts of the west central and NW floor exhibit FeO values (12-14 wt%) that are higher than those of the surrounding floor material (8-12 wt%). A number of small impact craters excavated even more FeO-rich material. These craters range from 1 to 1.4 km in diameter and have very faint dark haloes. The maximum FeO abundances measured for the dark haloes range from 14.4 to 14.8 wt%. These values fall within the range of FeO abundances (14-18 wt%) determined for the mapped mare units in the southern, SE, and SW portions of the crater floor. Five-point spectra were extracted from the Clementine UV-VIS image cube for two of the dark-haloed impact craters (DHCs). These spectra have moderately strong "1µm" bands centered near 0.95 µm. The materials for which these spectra were obtained have mafic assemblages dominated by high-Ca clinopyroxene. Both the chemical and spectral data indicate that mare basalts were exposed by DHCs on the western portions of the Gassendi crater floor. Mare basalt flows were emplaced in parts of the western floor and, later, were obscured by highlands-rich ejecta from Gassendi A and other craters.

Schultz [1,2] also described features of possible volcanic origin in the northeastern floor of Gassendi. These included a terraced depression which may represent a drained lava lake, high-level lava marks within fractures, and perched plains units. The region with these possible volcanic features exhibits enhanced FeO and TiO_2 values. The FeO abundances range from 12 to 16 wt%. The highest FeO concentrations (14-16 wt%) are associated with perched plains deposits NE and SW of Rima Gassendi II. These perched plains have a relatively low albedo and enhanced TiO_2 abundances (2-3 wt%). This area corresponds to the ST spectral unit defined by Chevrel and Pinet [10,11] on the basis of Earth-based telescopic multispectral images. They determined that clinopyroxene was a major component in the ST material.

We collected five-point spectra from the Clementine image cube for four fresh surfaces associated with fracture walls and lava terrace scarps in the FeO-rich portion of the NE floor. These spectra exhibit strong "1μm" bands centered at or longward of 0.95μm. The lithologies for which these spectra were collected clearly contain large amounts of pyroxene and have mafic assemblages dominated by high-Ca clinopyroxene. These fracture walls and terrace scarps are dominated by mare basalt fragments. The results of previous studies [1,2,10,11] as well as the chemical and spectral data presented in this study indicate that mare volcanism occurred in the NE portion of the floor of Gassendi crater. These mare surfaces were contaminated and obscured by non-mare debris from Gassendi A and other craters in the surrounding highlands, and cryptomare deposits were formed.

Cryptomare Deposits West of Gassendi. A portion of the highlands terrain west of Gassendi and northwest of Humorum basin exhibits anomalous characteristics in several remote sensing data sets. Gaddis *et al.* [15] and Hawke *et al.* [3] pointed out that an area of ~45,000 km^2 west of Gassendi exhibited relatively low returns in both the depolarized 3.8-cm and depolarized 70-cm radar data sets. Previous spectral studies [3,16] concluded that both Gassendi G and F craters excavated mare material from beneath a highlands-rich surface unit that was emplaced as a result of the Gassendi, Mersenius, Mersenius P, Letronne, and other impact events. This ancient buried basalt unit (i.e., cryptomare) was emplaced after the formation of Humorum basin but prior to the Orientale impact.

The results of this study are consistent with those of previous investigations [3,16]. Our chemical and spectral data clearly indicate that Gassendi G and F excavated FeO-rich, basaltic material with an average TiO_2 value of 2.5 wt%. Both Gassendi G and F are 8 km in diameter and excavated mare material from depths up to 800 m. We have identified several smaller DHCs in this region. The five DHCs selected for detailed study range in diameter from 1 km to 3.4 km and exposed dark material from much shallower depths than Gassendi G and F. The range of FeO values (12.2-15.5 wt%) determined for these five craters as well as their five-point spectra indicate that the dark material is dominated by mare basalt. The covered mare basalts are Balmer-type cryptomare deposits [17,18]. Imbrian-aged mare flows were obscured by the compound effect of discontinuous, distal ejecta deposits of such nearby craters as Mersenius C and S and Gassendi E. It is interesting to note that, with one exception, the Imbrian-age, Balmer-type cryptomare exhibit lower TiO_2 abundances (1.3-1.7 wt%) than the values (~2.5 wt%) determined for the older cryptomare deposits exposed by Gassendi G and F. The exception has an average TiO_2 concentration of 4.7 wt%.

The cryptomare deposits west of Gassendi exhibit enhanced FeO values (9-13 wt%) on the LP-GRS map. These deposits also show slightly enhanced TiO_2 abundances on the LP-NS TiO_2 image. Relatively high Th values (6-7 ppm) are associated with Letronne ejecta south of the crater.

Pyroclastic Deposits. A previously unmapped dark mantle deposit of probable pyroclastic origin was identified in the highlands northeast of Gassendi. Dark material mantles and subdues underlying highland terrain. In places, it is draped over rugged mountain ridges. The deposit covers ~250 km^2 and is centered at 14.8°S, 37.7°W. No source vents can be seen in the available images. Two five-point spectra extracted for the dark material indicate that the deposit is dominated by mare basalt fragments and contains minor amounts of highland debris.

Several localized pyroclastic deposits have been identified along fractures on the floor of Mersenius crater [3,19]. Five-point spectra collected for two pyroclastic deposits on the northwestern portion of the crater floor indicate a basaltic composition.

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