A SORTIE FOR PRISTINE MOON ROCKS FROM OCEANUS PROCELLARUM:
1. BASALTS AND IMPACT MELTS FROM SOIL 12001 -- Gregory A. Snyder, Lawrence A. Taylor, and Allan Patchen, Planetary Geosciences Institute, Department of Geological Sciences, University of Tennessee, Knoxville, TN 37996.

A group of sixteen fine-grained fragments have been studied from the 2-10mm fraction of lunar soil 12001. Six of these basaltic rocks have textures indicative of quench crystallization and/or have definitive shock features and may be classified as clast-free impact melts. The ten remaining samples appear to be texturally pristine and seven of these are classified as ilmenite basalts. Two others have features typical of pigeonite basalts and a third is difficult to classify (neither olivine or pigeonite was observed). These “new” basalts add to our understanding of the diversity and genesis of volcanism at the Apollo 12 landing site.

INTRODUCTION: Soil 12001 was the contingency sample collected by astronauts Pete Conrad and Alan Bean at the Apollo 12 landing site in the Sea of Storms. It was a soil sample with a mass of approximately 2.2 kg. In 1995, the curatorial staff at JSC-Houston sieved the sample, and we picked several fragments from the coarse-fines (2-10) mm size range for further study. Ten of these fragments we have classified as cumulate gabbros [I] and the remaining sixteen we classify as basalts or impact melts, the petrography and mineralogy of which are described herein.

MARE BASALTS FROM APOLLO 12: -- Whereas the Apollo 12 landing site was in a mare basin, the collection of an important group of mare basalts rocks was expected by the astronauts. Furthermore, it is not as intensely cratered as the Apollo 11 landing site; therefore, mare basalts should be better preserved. These basalts turned out to be the youngest in the Apollo collections with ages from 3.1 to 3.3 Ga (e.g., [2]). Four groups of Apollo 12 mare basalts were delineated by James and Wright [3], and Rhodes et al. [4]: olivine, pigeonite, ilmenite, and feldspathic basalts. Subsequently, Neal et al. [5] have presented evidence that the feldspathic group does not exist and that those samples previously allocated to this group belong in the olivine and pigeonite groups.

PETROGRAPHY AND MINERAL CHEMISTRY: Major minerals in these sixteen rocks include high-Ca pyroxene (augite), low-Ca pyroxene, olivine, plagioclase, ilmenite, chromite-ulvospinel, and minor FeNi metal. Pyroxferroite and fayalite are common mafic phases in the ubiquitous fine-grained mesostasis as are K- and Si-rich glass, silica, and occasionally K-spar. Pyroxferroite is also commonly found as rims on pyroxenes. Four samples are olivine-free (12001,781; 12001,790; 12001,792; 12001,838) and four samples are free of low-Ca pyroxene (12001,781; 12001,792; 12001,791; 12001,794).

Ten of the sixteen fine-grained basaltic rocks appear to be texturally pristine. Seven of these texturally pristine basalts are classified as ilmenite basalts (12001,791; 12001,794; 12001,796; 12001,797; 12001,828; 12001,829; 12001,838) (Fig. 1: photomicrograph of 12001,838), two are classified as pigeonite basalts (12001,826 and 12001,827), and one is unclassified (it contains neither olivine nor pigeonite, and little ilmenite; 12001,792), as per the classification of James and Wright [3] and Neal et al. [5]. The six remaining samples (12001,781; 12001,783; 12001,790; 12001,830; 12001,837; 12001,842), although probably monomict, exhibit textures suggestive of quenched impact melts and/or have grains with definitive shock features. One of these six samples, 12001,837, also has unusually high Ni (22-28 wt%) contents in the metals.

Olivines and pyroxenes occur both as coarse subhedral to euhedral phenocrysts (0.2 to 1.6 mm in longest dimension) and as finer-grained (<0.1 mm), anhedral, matrix material. Plagioclase also occurs as relatively coarse-
grained, prismatic grains (0.1 to 0.7 mm), and finer-grained (0.05 to 0.2 mm), acicular to granular crystals, often with several grains radiating from a common point. Acicular plagioclase also occurs in matrix material in association with parallel, acicular plates of ilmenite (<0.3 mm). Ilmenite also exhibits a blocky to prismatic habit, with prismatic grains usually being largest. Spinels are fine-grained (0.02 to 0.2 mm), anhedral, and blocky. Two samples (783 and 790) have extremely fine-grained, acicular to devitrified matrix material consisting mostly of ilmenite and plagioclase and may be interpreted as “quench” textures.

The chemistry of the major minerals is summarized in Table 1. Most are strongly zoned in chemical composition and only core compositions are given in Table 1. Pyroxene rims are strongly enriched in Fe (often by up to 45 Fs units, all the way to pyroxferroite composition), and rims on low-Ca pyroxene are often Ca-enriched (by 3-7 Wo units). Typically, rims on plagioclase grains are depleted in Ca by 1-3 An units. However, in some cases rims are reversed by 1-2 An units. Rims on olivines are usually 5-20 Fo units less, although in a few rare cases thin rims of nearly pure fayalite (Fo4 to Fo10) are present. Spinel rims range in composition from chromite to iluvospinel with up to 1.2% V2O3. Rims on spinels are extremely enriched in TiO2, MnO, and FeO, and depleted in Al2O3 and Cr2O3. Ilmenites typically contain very little Mg. FeNi metal grains in all samples have relatively high Co contents for given Ni contents, typical of Apollo 12 mare basalts [6].

SUMMARY: Ten texturally pristine mare basalt fragments have been studied from the 2-10 mm coarse-fine fraction of soil 12001. Seven of these samples are classified as ilmenite basalts, raising the total number of ilmenite basalts [5] to twenty-one. Two other samples are classified as pigeonite basalts, bringing the total number of samples in this group of basalts to fourteen. One other sample does not fit into the classification scheme of James & Wright [3] and Rhodes et al. [4]. These new basalts add immeasurably to our understanding of the character of volcanism at the Apollo 12 landing site and especially to that of a high-Ti tenor.