# 78501 and 78530

Soil

1166 and 89 grams

*Figure 1: Photo of raked area where 78500 was collected. AS17-142-21712. Footprints for scale.*

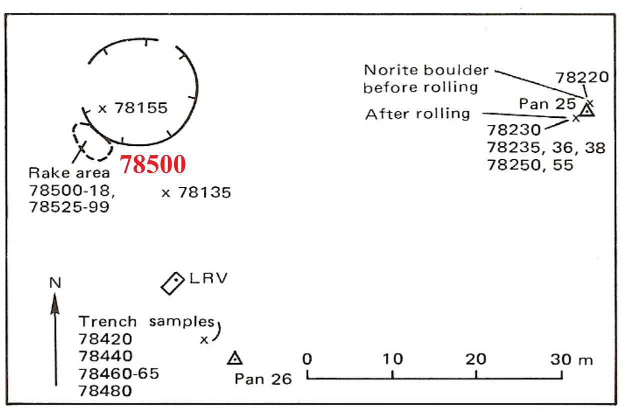



*Figure 2: Map of station 8, Apollo 17.*

## Introduction

Two big bags of soil were returned from the raked area at station 8, Apollo 17 (figure 1). Both bags also contained large samples, both basalts and breccias. In fact, the mode for the particles in the 90 – 150 micron size, the ratio of coarse-fine particles and the ratio of large samples found in the soil all indicate that the soil is about half basalt and half breccia. Only a few fragments of highland rock (impact melt rock) were found. The nature of the "sculptured-hill" remains a mystery.

## Petrography

The maturity index of 78501 is $I_s$/FeO = 36 and the average grain size is 31 microns (Morris 1978; Graf 1993). Note that the low maturity is not consistent with small grain size, nor high C and $N_2$ content. The agglutinate content was only 35 %.

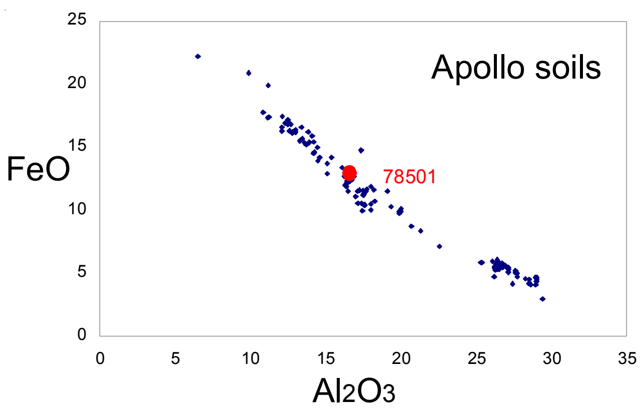



*Figure 3: Composition of 78501 compared with that of other Apollo soil samples.*

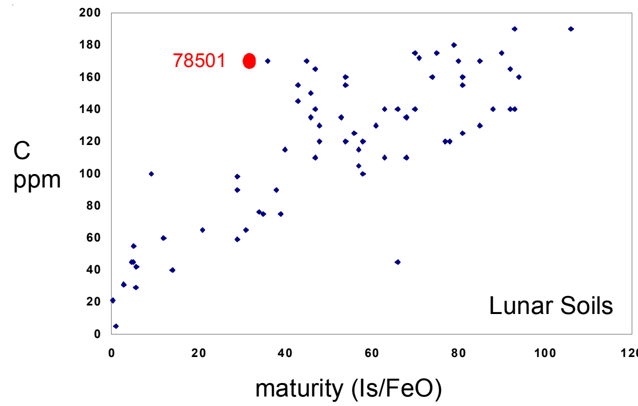



*Figure 4: Carbon content and maturity index of 78501 compared with Apollo soils.*

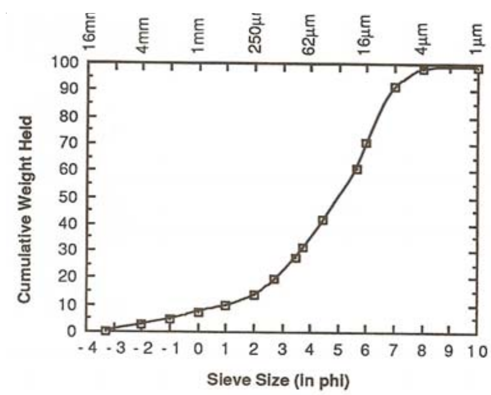
Heiken and McKay (1974) determined the modal mineralogy of the 90 – 150 micron size fraction of 78501, finding about half basalt and half breccia. Meyer (1973) cataloged the 4 – 10 mm size fraction (78504) and Bence et al. (1974) studied the coarse-fines from78503 (figure 6). Irving et al. (1974) studied orthopyroxene-plagioclase grains from 78502.

LSPET (1973) and Moore et al. (1974) reported 170 ppm carbon (figure 4). Muller (1974) determined 73 ppm nitrogen with very high nitrogen in the finest fraction (surface correlated). Gibson and Moore (1974) reported 1125 ppm sulfur. Goel et al. (1975) and Becker and Clayton (1975) found 125 and 119 ppm nitrogen, respectively.

## Chemistry

Scoon (1974), Rhodes et al. (1974), Duncan et al. (1974), Laul et al. (1979), Korotev and Kremser (1992) and other reported the chemical composition of 78501, but no one has determined 78530. Brunfelt et al. (1974) also reported the chemical composition of mineral separates from 78501.

The heavy rare-earth elements (Gd to Lu) seem to be depleted compared with soils from other locations at Taurus-Litrow (figure 7).




Average grain size = 31 microns

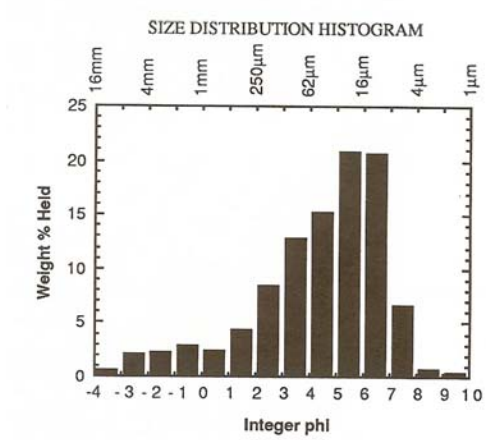



*Figure 5: Grain size distribution for 78500 (Graf 1993, data from McKay).*

**Modal content of soil 78501 (90-150 micron).**
*From Heiken and McKay 1974.*

| | 78501 |
|---|---|
| Agglutinates | 35.3 % |
| Basalt | 11 |
| Breccia | 10.6 |
| Anorthosite | 2 |
| Norite | |
| Gabbro | |
| Plagioclase | 13.3 |
| Pyroxene | 13.3 |
| Olivine | |
| Ilmenite | 3.7 |
| Orange glass | 2 |
| Glass other | 6.9 |

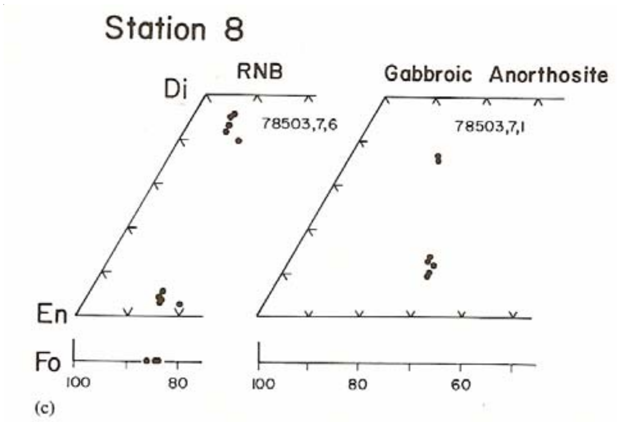



*Figure 6: Olivine and pyroxene composition of two coarse-fine particles from 78503 (Bence et al. 1975).*

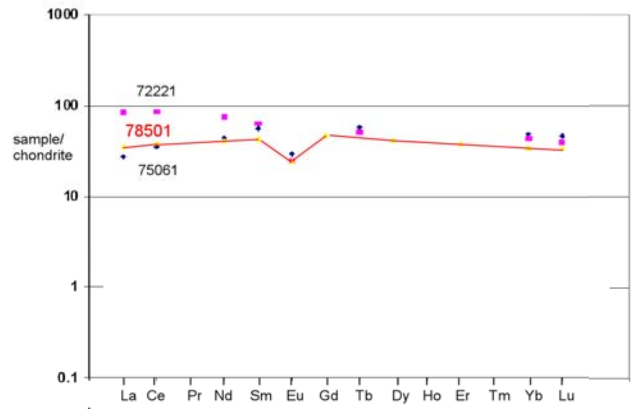



*Figure 7: Normalized rare-earth-element diagram for 78501 compared with mare and highland soils.*

## Radiometric Age

Bence et al. (1974) reported an $^{39}Ar/^{40}Ar$ plateau age of 4.13 ± 0.03 b.y. for a small particle of gabbroic anorthosite from 78503.

Nyquist et al. (1974) reported the Rb and Sr isotopic composition of 78501. Silver (1974) and Church and Tilton (1974) reported the U, Th and Pb isotopic composition of 78501 and 78500.

## Cosmogenic isotopes and exposure ages

O'Kelley et al. (1974) determined the cosmic-ray-induced activity of $^{22}Na$ = 90 dpm/kg, $^{26}Al$ = 105 dpm/kg, $^{46}Sc$ = 30 dpm/kg, $^{48}V$ = 10 dpm/kg, $^{54}Mn$ = 96 dpm/kg, and $^{56}Co$ = 150 dpm/kg.

## Other Studies

Becker and Clayton (1975) found the isotopic composition of nitrogen was variable as a function of thermal release (figure 8). This phenomena is typical of other lunar soils and breccias and has yet to be fully understood.

Rare gases were reported by Hubner et al. (1975).

Merlivat (1974) reported the hydrogen content and isotopic ratio of 78501.

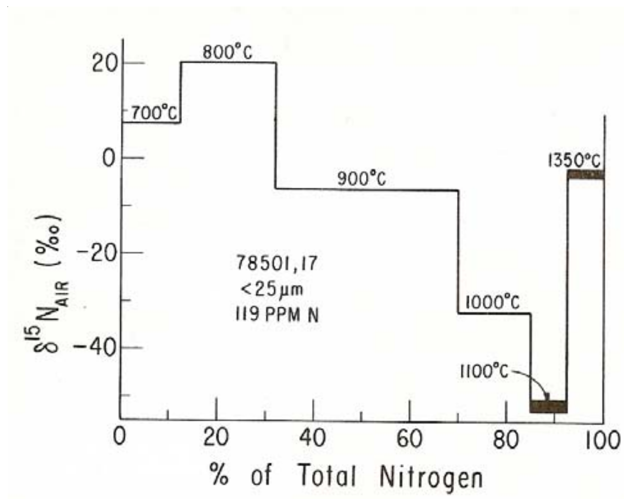
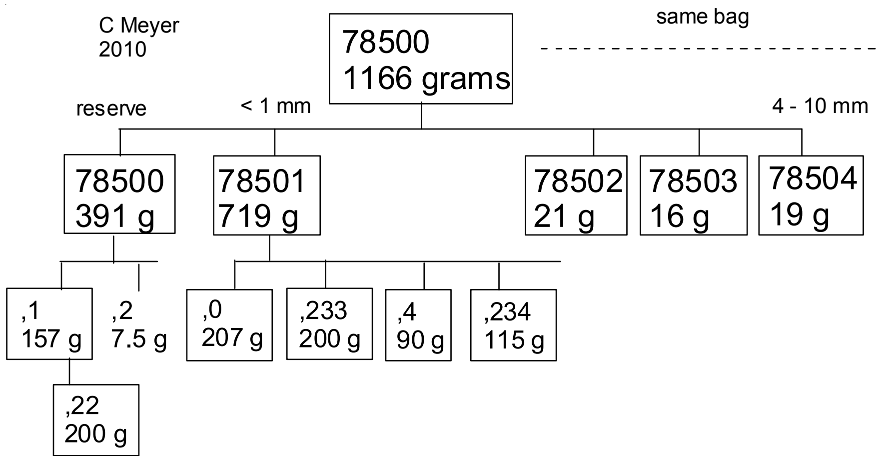



*Figure 8: Nitrogen isotopic composition as function of temperature release (Becker and Clayton 1975)*

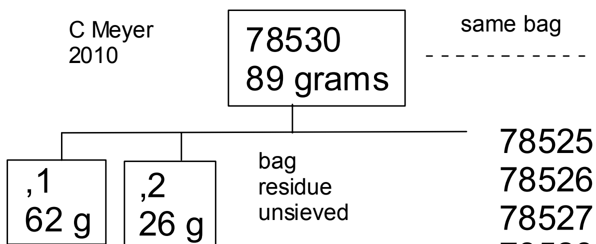
## Table 1. Chemical composition of 78501.

| *reference* | LSPET73 | Rhodes74 | Korotev92 | Duncan74 | Philpotts74 | Eldridge74 | Brunfelt74 | Laul79 | Scoon74 |
|---|---|---|---|---|---|---|---|---|---|
| *weight* | Rhodes74 | Wiesmann76 | | | | | unpublished | | |
| SiO2 % | 42.67 (a) | | | 42.83 (a) | | | | 42.7 (c ) | 43.2 (e) |
| TiO2 | 5.47 (a) | | | 5.28 (a) | | | 4.8 (c ) | 5.4 (c ) | 5.34 (e) |
| Al2O3 | 15.73 (a) | | | 15.65 (a) | | | 16 (c ) | 15.8 (c ) | 15.7 (e) |
| FeO | 13.15 (a) | | 13.4 (c ) | 13.18 (a) | | | 12.75 (c ) | 13.4 (c ) | 13.3 (e) |
| MnO | 0.18 (a) | | | 0.177 (a) | | | 0.18 (c ) | 0.17 (c ) | 0.18 (e) |
| MgO | 9.91 (a) | | | 10.01 (a) | | | 8.6 (c ) | 10.7 (c ) | 9.98 (e) |
| CaO | 11.77 (a) | | | 11.51 (a) | | | 14.7 (c ) | 11.7 (c ) | 11.7 (e) |
| Na2O | 0.35 (a) | | 0.387 (c ) | 0.38 (a) | | | 0.4 (c ) | 0.39 (c ) | 0.42 (e) |
| K2O | 0.09 (a) | 0.095 (b) | | 0.09 (a) | 0.09 (b) | 0.092 (d) | 0.107 (c ) | 0.095 (c ) | 0.11 (e) |
| P2O5 | 0.05 (a) | | | 0.082 (a) | | | | | 0.06 (e) |
| S % | 0.1 (a) | | | 0.109 (a) | | | | | 0.09 (e) |
| *sum* | | | | | | | | | |
| | | | | | | | | | |
| Sc ppm | | | 42.3 (c ) | | | | 39.2 (c ) | 41 (c ) | |
| V | | | | 82 (a) | | | 68 (c ) | 80 (c ) | |
| Cr | 2531 (a) | 2300 (b) | 2480 (c ) | 2429 (a) | | | 2170 (c ) | 2395 (c ) | |
| Co | | | 33.9 (c ) | 32 (a) | | | 31.6 (c ) | 31 (c ) | |
| Ni | 194 (a) | | 210 (c ) | 177 (a) | | | | 200 (c ) | |
| Cu | | | | 10 (a) | | | 8.5 (c ) | | |
| Zn | 40 (a) | | | 32.8 (a) | | | 26 (c ) | 25 (c ) | |
| Ga | | | | | | | 5 (c ) | 8 (c ) | |
| Ge ppb | | | | | | | | | |
| As | | | | | | | | | |
| Se | | | | | | | | | |
| Rb | 2.1 (a) | 1.96 (b) | | 2.4 (a) | 1.87 (b) | | 1.9 (c ) | | |
| Sr | 155 (a) | 154 (b) | 170 (c ) | 150 (a) | 153 (b) | | 142 (c ) | 160 (c ) | |
| Y | 58 (a) | | | 50.4 (a) | | | | | |
| Zr | 189 (a) | 195 (b) | 220 (c ) | 186 (a) | 179 (b) | | | | |
| Nb | 15 (a) | | | 15.2 (a) | | | | | |
| Mo | | | | | | | | | |
| Ru | | | | | | | | | |
| Rh | | | | | | | | | |
| Pd ppb | | | | | | | | | |
| Ag ppb | | | | | | | | | |
| Cd ppb | | | | | | | | | |
| In ppb | | | | | | | | | |
| Sn ppb | | | | | | | | | |
| Sb ppb | | | | | | | | | |
| Te ppb | | | | | | | | | |
| Cs ppm | | | | | | | 0.099 (c ) | | |
| Ba | | 105 (b) | 120 (c ) | 102 (a) | 102 (b) | | 88 (c ) | 100 (c ) | |
| La | | 8.29 (b) | 8.44 (c ) | | | | 6.3 (c ) | 8.3 (c ) | |
| Ce | | 23.3 (b) | 23.7 (c ) | | 24.1 (b) | | | 24 (c ) | |
| Pr | | | | | | | | | |
| Nd | | 18.4 (b) | 16 (c ) | | 18 (b) | | | 20 (c ) | |
| Sm | | 6.36 (b) | 6.67 (c ) | | 6.34 (b) | | 6.1 (c ) | 6.4 (c ) | |
| Eu | | 1.37 (b) | 1.38 (c ) | | 1.42 (b) | | 1.35 (c ) | 1.4 (c ) | |
| Gd | | 9.34 (b) | | | 8.31 (b) | | | | |
| Tb | | | 1.61 (c ) | | | | 1.46 (c ) | 1.5 (c ) | |
| Dy | | 10.2 (b) | | | 9.89 (b) | | 9.5 (c ) | 10 (c ) | |
| Ho | | | | | | | | 2.2 (c ) | |
| Er | | 6.02 (b) | | | 5.47 (b) | | | | |
| Tm | | | | | | | | 0.83 (c ) | |
| Yb | | 5.54 (b) | 5.65 (c ) | | 5.48 (b) | | 6.2 (c ) | 5.4 (c ) | |
| Lu | | 0.83 (b) | 0.976 (c ) | | 0.847 (b) | | 0.86 (c ) | 0.79 (c ) | |
| Hf | | | 5.91 (c ) | | | | 4.2 (c ) | 5.6 (c ) | |
| Ta | | | 0.91 (c ) | | | | | 1 (c ) | |
| W ppb | | | | | | | 190 (c ) | | |
| Re ppb | | | | | | | | | |
| Os ppb | | | | | | | | | |
| Ir ppb | | | < 6 (c ) | | | | | 10 (c ) | |
| Pt ppb | | | | | | | | | |
| Au ppb | | | | | | | | 2 (c ) | |
| Th ppm | | | 1.26 (c ) | | | 1.11 (d) | 0.88 (c ) | 1.1 (c ) | |
| U ppm | | 0.36 (b) | 0.41 (c ) | | | 0.28 (d) | 0.3 (c ) | | |

*technique: (a) XRF, (b) IDMS, (c ) INAA, (d) radiation count. (e) wet*




78505 - 506 g
78506 - 56 g
78507 - 23 g
78508 - 11 g
78509 - 9 g
78515 - 5 g
78516 - 3 g
78517 - 2 g
78518 - 1 g
walnuts




78525 - 5 g
78526 - 8.8 g
78527 - 5 g
78528 - 7 g

78535 - 103 g
78536
78537
78538
78539
78545
78546 - 43 g
78547 - 30 g
78548
78549
78555
78556
78557
78558
78559
78565
78566
78567
78568
78569
dark matrix breccia

78575 - 140 g
78576
78577
78578
78579
78585 - 44 g
78586
78587
78588
78589
78595
78596 - 7.55 g
78597 - 319 g
78598 - 224 g
78599 - 198 g
basalts

**References for 78501**


Becker R.H. and Clayton R.N. (1975) Nitrogen abundances and isotopic compositions in lunar samples. *Proc. 6th Lunar Sci. Conf.* 2131-2149.

Bence A.E., Delano J.W., Papike J.J. and Cameron K.L. (1974) Petrology of the highlands massifs at Taurus-Littrow: An analysis of the 2-4 mm soil fraction. *Proc. 5th Lunar Sci. Conf.* 785-827.

Butler P. (1973) Lunar Sample Information Catalog Apollo 17. Lunar Receiving Laboratory. MSC 03211 Curator's Catalog. pp. 447.

Butler J.C. and King E.A. (1974) Analysis of the grain size-frequency distributions of lunar fines. *Proc. 5th Lunar Sci. Conf.* 829-841.

Chou C.-L. and Pearce G.W. (1976) Relationship between nickel and metallic iron contents of Apollo 16 and 17 soils. *Proc. 7th Lunar Sci. Conf.* 779-789.

Church S.E. and Tilton G.R. (1974) Lead isotope systematics of some Apollo 17 soils and some separated components from 76501. *Proc. 5th Lunar Sci. Conf.* 1389-1400.

Curtis D.B. and Wasserburg G.J. (1977) Transport and erosional processes in the Taurus-Littrow Valley – Inferences from neutron fluences in lunar soils. *Proc. 8th Lunar Sci. Conf.* 3045-3057.

Duncan A.R., Erlank A.J., Willis J.P., Sher M.K. and Ahrens L.H. (1974) Trace element evidence for a two-stage origin of some Titaniferous mare basalts. *Proc. 5th Lunar Sci. Conf.* 1147-1158.

Eldridge J.S., O'Kelley G.D. and Northcutt K.J. (1974a) Primordial radioelement concentrations in rocks and soils from Taurus-Littrow. *Proc. 5th Lunar Sci. Conf.* 1025-1033.

Gibson E.K. and Moore G.W. (1974a) Sulfur abundances and distributions in the valley of Taurus-Littrow. *Proc. 5th Lunar Sci. Conf.* 1823-1837.

Gibson E.K. and Andrawes F.F. (1978a) Nature of the gases released from lunar rocks and soils upon crushing. *Proc. 9th Lunar Planet. Sci. Conf.* 2433-2450.

Goel P.S., Shukla P.N., Kothari B.K. and Garg A.N. (1975) Total nitrogen in lunar soils, breccias, and rocks. *Geochim. Cosmochim. Acta* **39**, 1347-1352.

Goldstein J.I., Hewins R.H.and Axon H.J. (1974) Metal silicate relationships in Apollo 17 soils. *Proc. 5th Lunar Sci. Conf.* 653-671.

Goldstein J.I., Hewins R.H. and Romig A.D. (1976a) Carbides in lunar soils and rocks. *Proc. 7th Lunar Sci. Conf.* 807-818.

Graf J.C. (1993) Lunar Soils Grain Size Catalog. NASA Reference Pub. 1265, March 1993

Heiken G.H. (1974) A catalog of lunar soils. JSC Curator

Heiken G.H. (1975) Petrology of lunar soils. *Rev. Geophys. Space Phys.* **13**, 567-587.

Heiken G.H. and McKay D.S. (1974) Petrology of Apollo 17 soils. *Proc. 5th Lunar Sci. Conf.* 843-860.

Hubner W., Kirsten T and Kiko J. (1975) Rare gases in Apollo 17 soils with emphasis on analysis of size and mineral fractions of soil 74241. *Proc. 6th Lunar sci. Conf.* 2009-2026.

Irving A.J., Steele I.M. and Smith J.V. (1974) Lunar noritic fragments and associated diopside veins. *Am. Mineral.* **59**, 1062-1068.

Jovanovic S. and Reed G.W. (1974a) Labile and nonlabile element relationships among Apollo 17 samples. *Proc. 5th Lunar Sci. Conf.* 1685-1701.

Korotev R.L. and Kremser D. (1992) Compositional variations in Apollo 17 soils and their relationships to the geology of the Taurus-Littrow site. *Proc. 22nd Lunar Planet. Sci. Conf.* 275-301.

Laul J.C., Lepel E.A., Vaniman D.T. and Papike J.J. (1979) The Apollo 17 drill core: Chemical systematics of the grain size fractions. *Proc. 10th Lunar Planet. Sci. Conf.* 1269-1298.

LSPET (1973a) Apollo 17 lunar samples : Chemical and petrographic description. *Science* **182**, 659-690.

LSPET (1973c) Preliminary examination of lunar samples. Apollo 17 Preliminary Science Report. NASA SP-330, 7-1—7-46.

McKay D.S., Fruland R.M. and Heiken G.H. (1974) Grain size and the evolution of lunar soils. *Proc. 5th Lunar Sci. Conf.* 887-906.

Merlivat L., Lelu M., Nief G. and Roth E. (1974a) Deuterium, hydrogen, and water content of lunar material. *Proc. 5th Lunar Sci. Conf.* 1885-1895.

Meyer C. (1973) Apollo 17 Coarse Fines (4-10 mm) Sample Location, Classification and Photo Index. Curator Report. pp. 182.

Mitchell J.K., Carrier W.D., Costes N.C., Houston W.N., Scott R.F. and Hovland H.J. (1973) 8. Soil-Mechanics. *In* Apollo 17 Preliminary Science Rpt. NASA SP-330. pages 8-1-22.

Moore C.B., Lewis C.F. and Cripe J.D. (1974a) Total carbon and sulfur contents of Apollo 17 lunar samples. *Proc. 5th Lunar Sci. Conf.* 1897-1906.

Moore C.B., Lewis C.F., Cripe J.D. and Volk M. (1974b) Total carbon and sulfur contents of Apollo 17 lunar samples (abs). *Lunar Sci.* **V**, 520-522. Lunar Planetary Institute, Houston.

Morris R.V. (1976) Surface exposure indicies of lunar soils: A comparative FMR study. *Proc. 7th Lunar Sci. Conf.* 315-335.

Morris R.V., Score R., Dardano C. and Heiken G. (1983) Handbook of Lunar Soils. Two Parts. JSC 19069. Curator's Office, Houston

Morris R.V. (1978) The surface exposure (maturity) of lunar soils: Some concepts and Is/FeO compilation. *Proc. 9th Lunar Sci. Conf.* 2287-2297.

Müller O. (1974a) Solar wind nitrogen and indigenous nitrogen in Apollo 17 lunar samples. *Proc. 5th Lunar Sci. Conf.* 1907-1918.

Müller O. (1974b) Solar wind and indigenous nitrogen in Apollo 17 lunar samples (abs). *Lunar Sci.* **V**, 534-536. Lunar Planetary Institute, Houston.

Müller O. (1975) Lithophile trace and major elements in Apollo 16 and 17 lunar samples. *Proc. 6th Lunar Sci. Conf. 1303*-1312.

Nyquist L.E., Bansal B.M., Wiesmann H. and Jahn B.M. (1974) Taurus-Littrow chronology: Some constraints on the Early Lunar crustal development. *Proc. 5th Lunar Sci. Conf.* 1515-1540.

O'Kelley G.D., Eldridge J.S. and Northcutt K.J. (1974a) Cosmogenic radionuclides in samples from

Taurus-Littrow: Effects of the solar flare of August 1972. *Proc. 5th Lunar Sci. Conf.* 2139-2147.

Papike J.J., Simon S.B. and Laul J.C. (1982) The lunar regolith: Chemistry, Mineralogy and Petrology. *Rev. Geophys. Space Phys*. **20**, 761-826.

Philpotts J.A., Schuhmann S., Kouns C.W., Lum R.K.L. and Winzer S. (1974) Origin of Apollo 17 rocks and soils. *Proc. 5th Lunar Sci. Conf.* 1255-1267.

Rhodes J.M., Rodgers K.V., Shih C., Bansal B.M., Nyquist L.E., Wiesmann H. and Hubbard N.J. (1974) The relationships between geology and soil chemistry at the Apollo 17 landing site. *Proc. 5th Lunar Sci. Conf.* 1097-1117.

Schonfeld E. (1974) The contamination of lunar highland rocks by KREEP: Interpretations by mixing models. *Proc. 5th Lunar Sci. Conf*. 1269-1286.

Scoon J.H. (1974) Chemical analysis of lunar samples from the Apollo 16 and 17 collections (abs). *Lunar Sci.* **V**, 690-692. Lunar Planetary Institute, Houston.

Silver L.T. (1974) Patterns for U, Th, Pb distributions and isotopic relationships in Apollo 17 soils (abs). *Lunar Sci.* **V**, 706-708.

Wiesmann H. and Hubbard N.J. (1975) A compilation of the Lunar Sample Data Generated by the Gast, Nyquist and Hubbard Lunar Sample PI-Ships. Unpublished. JSC

Wolfe E.W., Bailey N.G., Lucchitta B.K., Muehlberger W.R., Scott D.H., Sutton R.L and Wilshire H.G. (1981) The geologic investigation of the Taurus-Littrow Valley: Apollo 17 Landing Site. US Geol. Survey Prof. Paper, 1080, pp. 280.