# 15379 and 15380

Shocked Olivine Basalt

64.3 and 5.2 grams

*Figure 1: Photo of dust-covered walnut sample 15379 (basalt?). Sample is about 4 cm across. NASA S87-44333.*

## Introduction

Lunar samples 15379 and 15380 were collected as part of a rake sample from the rim of Spur Crater (part way up the Apennine Front). They have similar mode, texture and shock features and may be companion pieces.

## Petrography

Papanastassiou and Wasserburg (1973) give a brief description. Ryder (1985) states that: "15379 is a fine-grained mare basalt containing about 20% stubby-angular and partly "hollow" plagioclase, abundant brownish pyroxene, and at least some olivine and ilmenite". Plagioclase is milky, but not maskelynite. Both plagioclase and pyroxene have deformed twinning. Veins of dark glass, containing bubbles, crosscut the sample and show evidence of flow (figure 2).

Ryder (1985) finds that sample 15380 is very similar to 15379. It also has shock features and glass veins (figure 3).

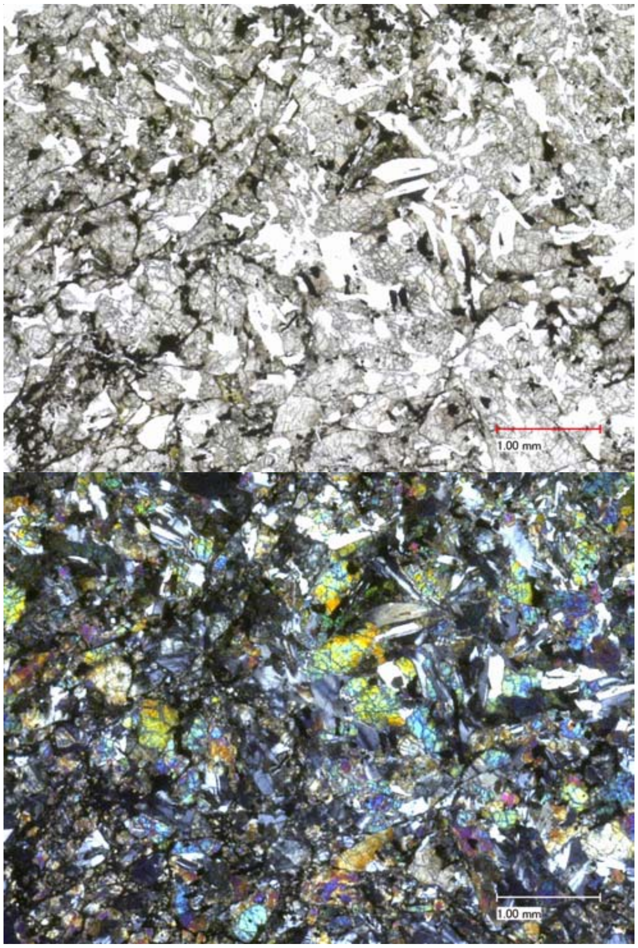



*Figure 2: Photomicrographs of 15380,3 by C Meyer @50x (bottom with crossed-polarizers).*

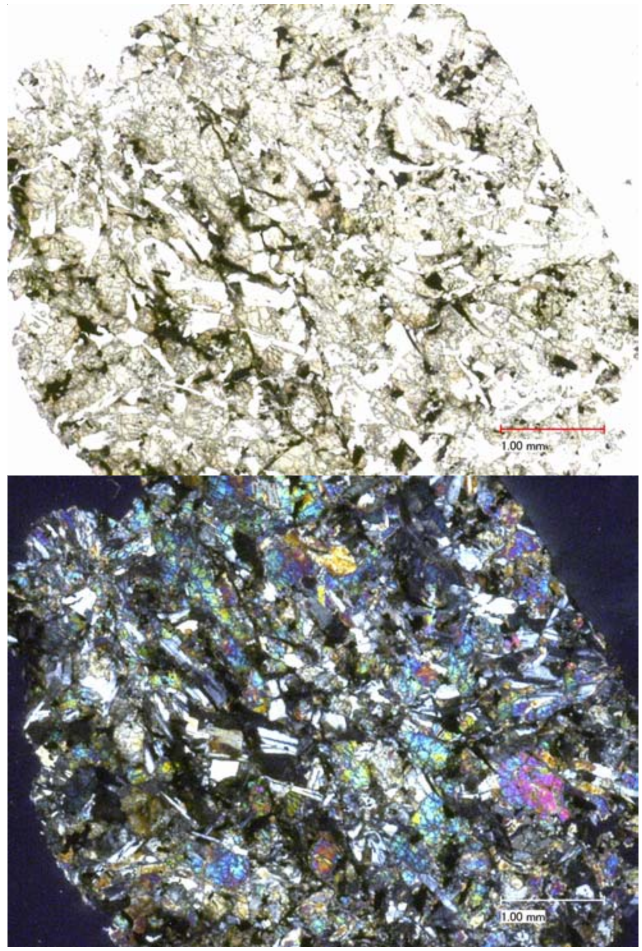



*Figure 3: Photomicrographs of 15379,1 by C Meyer @50x (bottom with crossed-polarizers).*

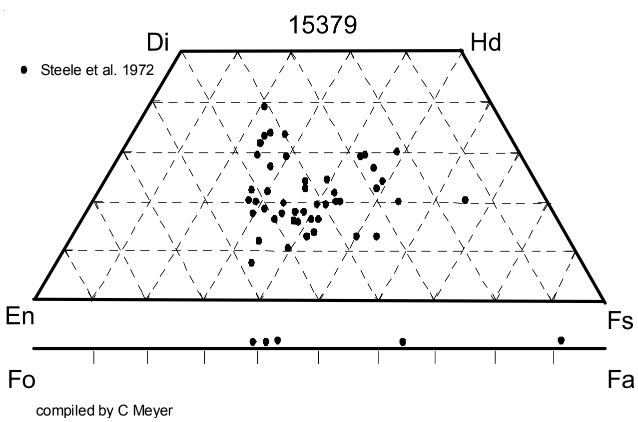



*Figure 4: Chemical compsosition of olivine and pyroxene in 15379 (from Steele et al. 1972).*

## Mineralogy

**Pyroxene:** Steele et al. (1972) determined the pyroxene composition (figure 4).

## Chemistry

The chemical composition of 15379 and 15380 is consistent with that of the olivine-normative clan of Apollo 15 basalts (figures 5 – 7).

## Radiogenic age dating

Nyquist et al. (1973) and Papanastasiou and Wasserburg (1973) determined the isotopic composition of Sr and concluded that 15379 was a typical Apollo 15 basalt.

## Cosmogenic isotopes and exposure ages

Eldridge et al. (1972) reported the cosmic-ray-induced activity of $^{22}Na$ = 31 dpm/kg. $^{26}Al$ = 42 dpm/kg and $^{54}Mn$ = 32 dpm/kg (which make it "undersaturated" and hence recently brought to the surface).

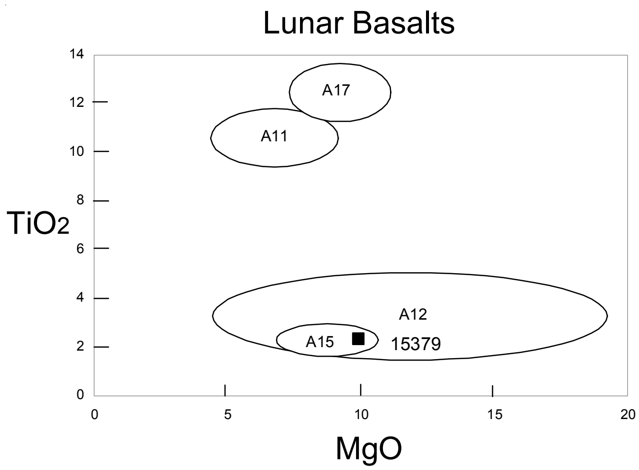



*Figure 5: Chemical composition of 15379 compared with that of other lunar basalts.*

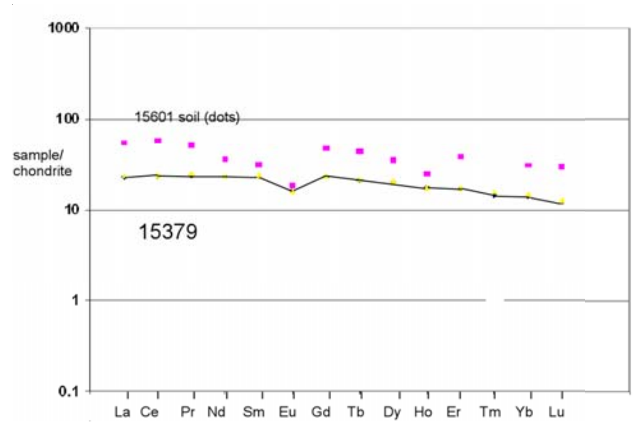



*Figure 6: Normalized rare-earth-element diagram for 15379. 15601 soil is plotted for comparison.*

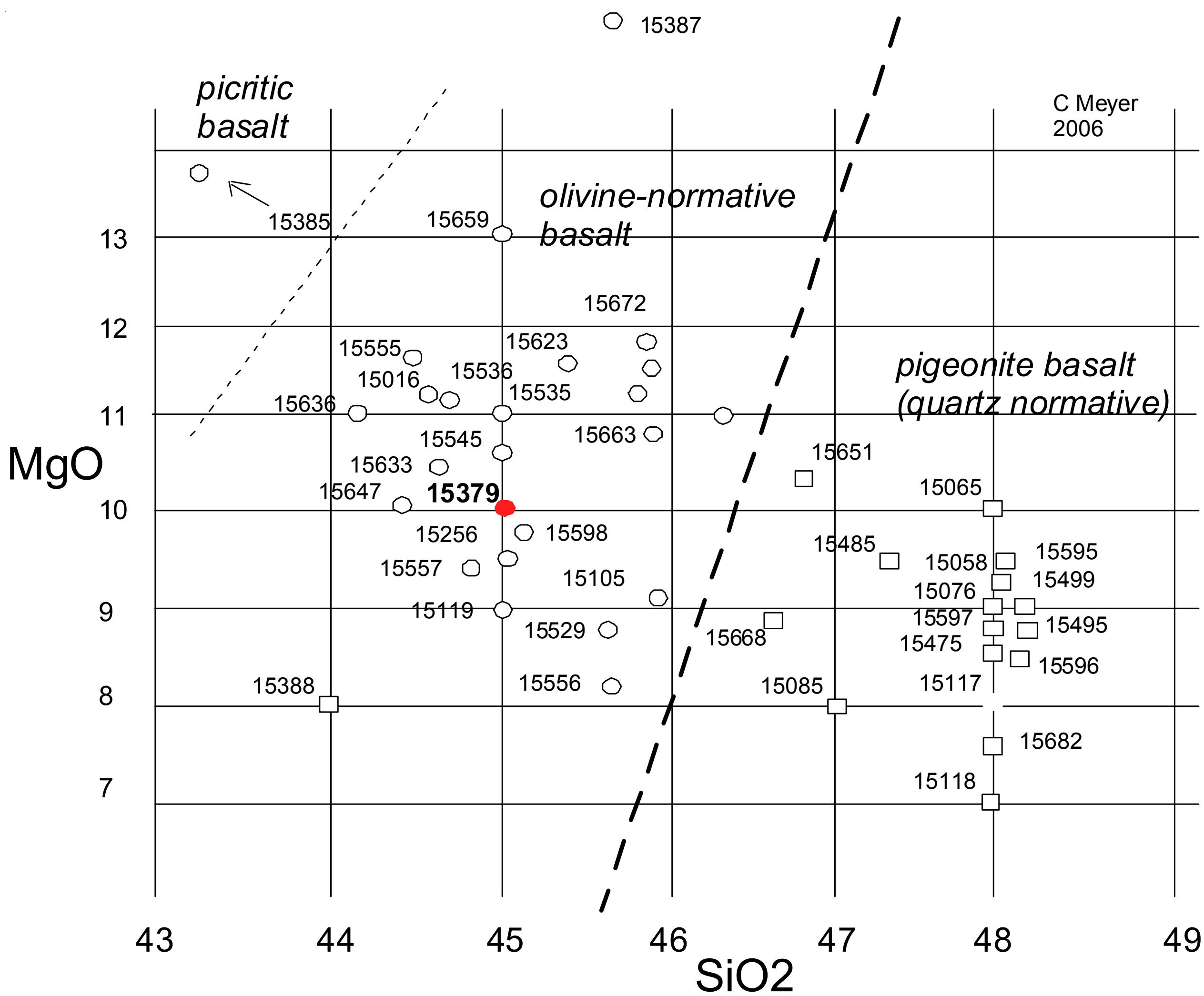
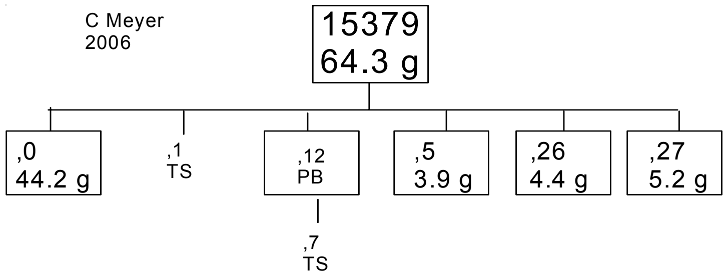



*Figure 7: Chemical composition of Apollo 15 basalts, with 15379 squarely within the field of olivine-normative basalts.*

## Table 1. Chemical composition of 15379.

| | | | | | | | Church72 | | | | Cuttitta73 | | Neal2001 | | 15380 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *reference* | Laul 73 | | Ryder2001 | | | | Weismann75 | | O'Kelley72 | | Christian72 | | | | Helmke73 | |
| *weight* | | | 5 g | | | | 34 mg | | | | | | | | | |
| SiO2 % | | | 44.9 | (e) | | | | | | | 44.6 | (b) | | | 46.1 | (f) |
| TiO2 | 2.3 | (a) | 2.42 | (e) | | | 2.25 | (c ) | | | 2.51 | (b) | | | 2.55 | (f) |
| Al2O3 | 9.3 | (a) | 8.76 | (e) | | | | | | | 8.27 | (b) | | | 8.33 | (f) |
| FeO | 22.6 | (a) | 22.34 | (e) | 22.3 | (a) | | | | | 22.92 | (b) | | | 22.8 | (f) |
| MnO | 0.27 | (a) | 0.283 | (e) | | | | | | | 0.29 | (b) | | | 0.258 | (f) |
| MgO | 10 | (a) | 10.07 | (e) | | | 8.62 | (c ) | | | 10.75 | (b) | | | 10.2 | (f) |
| CaO | 9.1 | (a) | 9.72 | (e) | | | | | | | 9.55 | (b) | | | 9.85 | (f) |
| Na2O | 0.28 | (a) | 0.22 | (e) | 0.258 | (a) | 0.26 | (c ) | | | 0.27 | (b) | | | 0.258 | (f) |
| K2O | 0.05 | (a) | 0.045 | (e) | | | 0.05 | (c ) | 0.048 | (d) | 0.06 | (b) | | | 0.057 | (f) |
| P2O5 | | | 0.065 | (e) | | | | | | | 0.12 | (b) | | | | |
| S % | | | | | | | | | | | | | | | | |
| *sum* | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| Sc ppm | 42 | (a) | | | 42.5 | (a) | | | | | 38 | (f) | 41 | (g) | 44 | (a) |
| V | 220 | (a) | | | | | | | | | 250 | (f) | 213 | (g) | | |
| Cr | 4060 | (a) | 4898 | (e) | 4860 | (a) | | | | | 4380 | (b) | 4319 | (g) | 4600 | (a) |
| Co | 49 | (a) | | | 54.6 | (a) | | | | | 67 | (f) | 54 | (g) | 49 | (a) |
| Ni | | | 66 | (e) | 84 | (a) | | | | | 120 | (f) | 68 | (g) | | |
| Cu | | | 8 | (e) | | | | | | | | | 14 | (g) | | |
| Zn | | | | | | | | | | | | | 17 | (g) | 3 | (a) |
| Ga | | | | | | | | | | | 4.7 | (f) | 3.85 | (g) | 3.5 | (a) |
| Ge ppb | | | | | | | | | | | | | | | | |
| As | | | | | | | | | | | | | | | | |
| Se | | | | | | | | | | | | | | | | |
| Rb | | | *3* | (e) | | | 0.84 | (c ) | | | | | 0.97 | (g) | 0.9 | (a) |
| Sr | | | 92 | (e) | 60 | (a) | 98.5 | (c ) | | | 130 | (f) | 100 | (g) | | |
| Y | | | 22 | (e) | | | | | | | 28 | (f) | 28.5 | (g) | | |
| Zr | | | 84 | (e) | | | 86.3 | (c ) | | | 74 | (f) | 96 | (g) | | |
| Nb | | | 10 | (e) | | | | | | | 12 | (f) | 6.5 | (g) | | |
| Mo | | | | | | | | | | | | | 0.06 | (g) | | |
| Ru | | | | | | | | | | | | | | | | |
| Rh | | | | | | | | | | | | | | | | |
| Pd ppb | | | | | | | | | | | | | | | | |
| Ag ppb | | | | | | | | | | | | | | | | |
| Cd ppb | | | | | | | | | | | | | | | | |
| In ppb | | | | | | | | | | | | | | | | |
| Sn ppb | | | | | | | | | | | | | | | | |
| Sb ppb | | | | | | | | | | | | | 10 | (g) | | |
| Te ppb | | | | | | | | | | | | | | | | |
| Cs ppm | | | | | | | | | | | | | 0.04 | (g) | 0.043 | (a) |
| Ba | 60 | (a) | | | 43 | (a) | 51.5 | (c ) | | | 70 | (f) | 55 | (g) | | |
| La | 4.9 | (a) | | | 4.92 | (a) | 5.64 | (c ) | | | | | 5.4 | (g) | 4.21 | (a) |
| Ce | 14 | (a) | | | 14.7 | (a) | 14.6 | (c ) | | | | | 14.2 | (g) | 11.2 | (a) |
| Pr | | | | | | | | | | | | | 2.14 | (g) | | |
| Nd | | | | | 9 | (a) | 10.3 | (c ) | | | | | 10.5 | (g) | 9.1 | (a) |
| Sm | 3.6 | (a) | | | 3.51 | (a) | 3.18 | (c ) | | | | | 3.4 | (g) | 3.14 | (a) |
| Eu | 0.93 | (a) | | | 0.89 | (a) | 0.98 | (c ) | | | | | 0.89 | (g) | 0.81 | (a) |
| Gd | | | | | | | 3.67 | (c ) | | | | | 4.55 | (g) | 4.1 | (a) |
| Tb | 0.7 | (a) | | | 0.76 | (a) | | | | | | | 0.77 | (g) | 0.69 | (a) |
| Dy | 4.7 | (a) | | | | | 4.42 | (c ) | | | | | 4.96 | (g) | 4.65 | (a) |
| Ho | | | | | | | | | | | | | 0.98 | (g) | 0.93 | (a) |
| Er | | | | | | | 2.92 | (c ) | | | | | 2.7 | (g) | 2.6 | (a) |
| Tm | | | | | | | | | | | | | 0.35 | (g) | | |
| Yb | 2.3 | (a) | | | 2.17 | (a) | 2.11 | (c ) | | | 4.3 | (f) | 2.3 | (g) | 2.05 | (a) |
| Lu | 0.33 | (a) | | | 0.29 | (a) | 0.304 | (c ) | | | | | 0.29 | (g) | 0.279 | (a) |
| Hf | 3.1 | (a) | | | 2.56 | (a) | 2.2 | (c ) | | | | | 2.54 | (g) | 2.1 | (a) |
| Ta | 0.4 | (a) | | | 0.37 | (a) | | | | | | | 0.38 | (g) | | |
| W ppb | | | | | | | | | | | | | | | | |
| Re ppb | | | | | | | | | | | | | | | | |
| Os ppb | | | | | | | | | | | | | | | | |
| Ir ppb | | | | | | | | | | | | | | | | |
| Pt ppb | | | | | | | | | | | | | | | | |
| Au ppb | | | | | | | | | | | | | | | | |
| Th ppm | | | | | 0.43 | (a) | | | 0.49 | (d) | | | 0.53 | (g) | | |
| U ppm | | | | | | | 0.133 | (c ) | 0.15 | (d) | | | 0.14 | (g) | | |

*technique: (a) INAA, (b) wet chem, (c ) IDMS, (d) radiation counting, (e) XRF, (f) other, (g) ICP-MS*



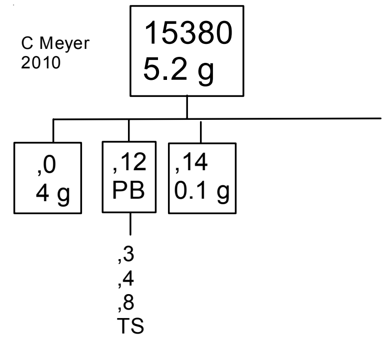





*Figure 7: Processing photo of 15380 after breaking. Scale in mm. S87-34935.*

## References for 15379


Butler P. (1971) Lunar Sample Catalog, Apollo 15. Curators' Office, MSC 03209

Carron M.K., Annell C.S., Christian R.P., Cuttitta F., Dwornik E.J., Ligon D.T. and Rose H.J. (1972) Elemental analysis of lunar soil samples from Apollo 15 mission. *In* **The Apollo 15 Samples,** 198-201.

Church S.E., Bansal B.M. and Wiesmann H. (1972) The distribution of K, Ti, Zr, U, and Hf in Apollo 14 and 15 materials. *In* **The Apollo 15 Lunar Samples**, 210-213.

Cuttita R., Rose H.J., Annell C.S., Carron M.K., Christian R.P., Ligon D.T., Dwornik E.J., Wright T.L. and Greenland L.P. (1973) Chemistry of twenty-one igneous rocks and soils returned by the Apollo 15 mission. *Proc. 4th Lunar Sci. Conf.* 1081-1096.

Eldridge J.S., O'Kelley G.D. and Northcutt K.J. (1972) Concentrations of cosmogenic radionuclides in Apollo 15 rocks and soils. *In* **The Apollo 15 Lunar Samples** 357-359.

Helmke P.A., Blanchard D.P., Haskin L.A., Telander K., Weiss C. and Jacobs J.W. (1973) Major and trace elements in igneous rocks from Apollo 15. *The Moon* **8**, 129-148.

Laul J.C. and Schmitt R.A. (1973b) Chemical composition of Apollo 15, 16, and 17 samples. *Proc. 4th Lunar Sci. Conf.* 1349-1367.

Lofgren G.E., Donaldson C.H. and Usselman T.M. (1975) Geology, petrology and crystallization of Apollo 15 quartz-normative basalts. *Proc. 6th Lunar Sci. Conf.* 79-99.

LSPET (1972a) The Apollo 15 lunar samples: A preliminary description. *Science* **175**, 363-375.

LSPET (1972b) Preliminary examination of lunar samples. Apollo 15 Preliminary Science Report. NASA SP-289, 6-1—6-28.

Neal C.R. (2001) Interior of the moon: The presence of garnet in the primitive deep lunar mantle. *J. Geophys. Res.* **106**, 27865-27885.

Nyquist L.E., Hubbard N.J., Gast P.W., Bansal B.M., Wiesmann H. and Jahn B-M. (1973) Rb-Sr systematics for chemically defined Apollo 15 and 16 materials. *Proc. 4th Lunar Sci. Conf.* 1823-1846.

O'Kelley G.D., Eldridge J.S. and Northcutt K.J. (1972a) Abundances of primordial radioelements K, Th, and U in Apollo 15 samples, as determined by non-destructive gamma-ray spectrometry. *In* **The Apollo 15 Lunar Samples**, 244-246.

O'Kelley G.D., Eldridge J.S., Schonfeld E. and Northcutt K.J. (1972b) Primordial radionuclides and cosmogenic radionuclides in lunar samples from Apollo 15. *Science* **175**, 440-443.

O'Kelley G.D., Eldridge J.S., Northcutt K.J. and Schonfeld E. (1972c) Primordial radionuclides and cosmogenic radionuclides in lunar samples from Apollo 15. *Proc. 3rd Lunar Sci. Conf.* 1659-1670.

Papanastassiou D.A. and Wasserburg G.J. (1973) Rb-Sr ages and initial strontium in basalts from Apollo 15. *Earth Planet. Sci. Lett.* **17**, 324-337.

Rhodes J.M. and Hubbard N.J. (1973) Chemistry. classification, and petrogenesis of Apollo 15 mare basalts. *Proc. 4th Lunar Sci. Conf.* 1127-1148.

Ryder G. (1985) Catalog of Apollo 15 Rocks (three volumes). Curatoial Branch Pub. # 72, JSC#20787

Ryder G. (1989) Mare basalts on the Apennine Front and the mare stratigraphy of the Apollo 15 landing site. *Proc. 19th Lunar Planet. Sci. Conf.* 43-50.

Ryder G. and Schuraytz B.C. (2001) Chemical variations of the large Apollo 15 olivine-normative mare basalt rock samples. *J. Geophys. Res.* **106**, E1, 1435-1451.

Steele I.M., Smith J.V. and Grossman L. (1972a) Mineralogy and petrology of Apollo 15 rake samples: I. Basalts. *In* **The Apollo 15 Lunar Samples** 158-160.

Swann G.A., Hait M.H., Schaber G.C., Freeman V.L., Ulrich G.E., Wolfe E.W., Reed V.S. and Sutton R.L. (1971b) Preliminary description of Apollo 15 sample environments. U.S.G.S. Interagency report: 36. pp219 with maps

Swann G.A., Bailey N.G., Batson R.M., Freeman V.L., Hait M.H., Head J.W., Holt H.E., Howard K.A., Irwin J.B., Larson K.B., Muehlberger W.R., Reed V.S., Rennilson J.J., Schaber G.G., Scott D.R., Silver L.T., Sutton R.L., Ulrich G.E., Wilshire H.G. and Wolfe E.W. (1972) 5. Preliminary Geologic Investigation of the Apollo 15 landing site. In Apollo 15 Preliminary Science Rpt. NASA SP-289. pages 5-1-112.

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