# 71501 and 71520

Soil

1066 and 48 grams

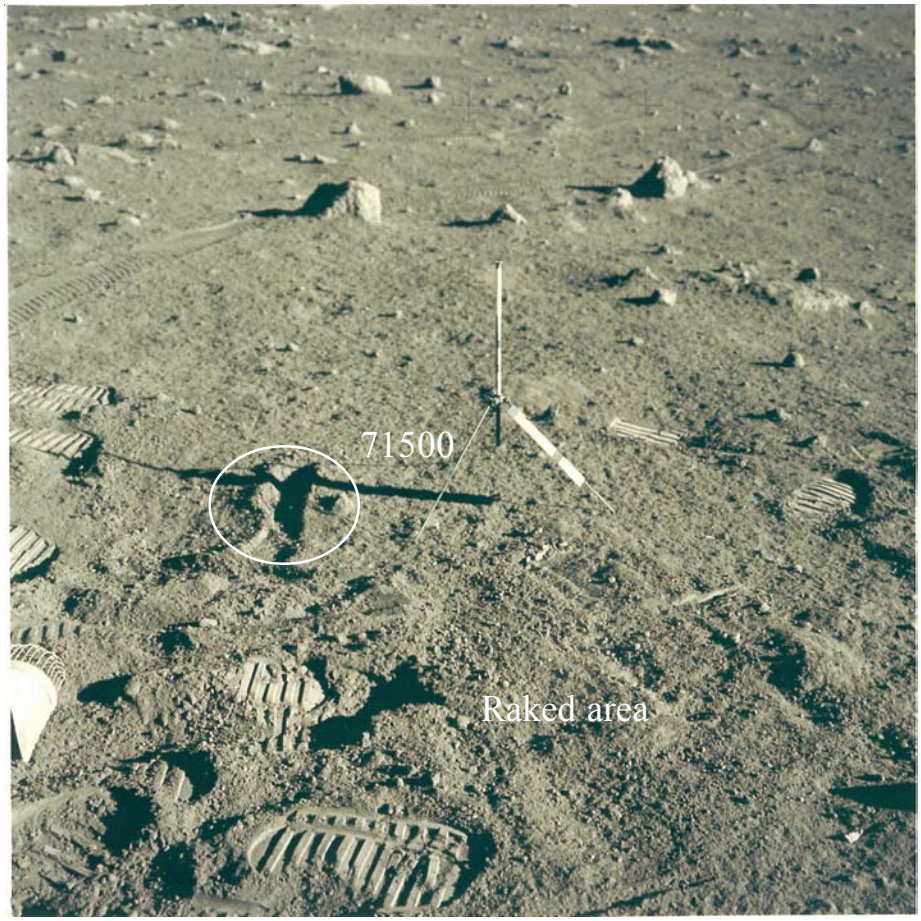



*Figure 1: Photo of area where 71500 was collected - adjacent to rake sample. AS17-134-20432*

## Introduction

71500 is the comprehensive soil sample at station 1, collected to accompany a rake sample (figure 1). It is one of the most studied Apollo 17 soil samples. 71520 is the bag residue for the rake samples, which were all basalts.

Station 1 was located about 150 meters from Steno Crater – which is about 600 meter diameter and thought to have sampled to a depth of 120 meters (Wolfe et al. 1981).

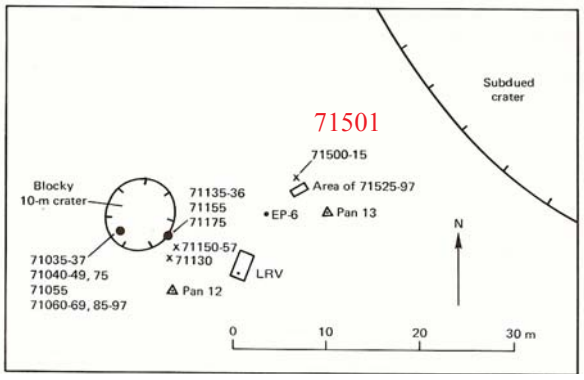



*Figure 2: Map of station 1, Apollo 17.*

## Petrography

The maturity index of 71500 is $I_s$/FeO = 35 and the average grain size is 75 microns (Morris 1978, Graf 1993). Heiken and McKay (1974) found only 35 % agglutinates, so this is not a very mature soil. Taylor et al. (1996) used more modern techniques to perform a more detailed mineral mode analysis of 71501. The mineral mode shows that this soil is composed mostly

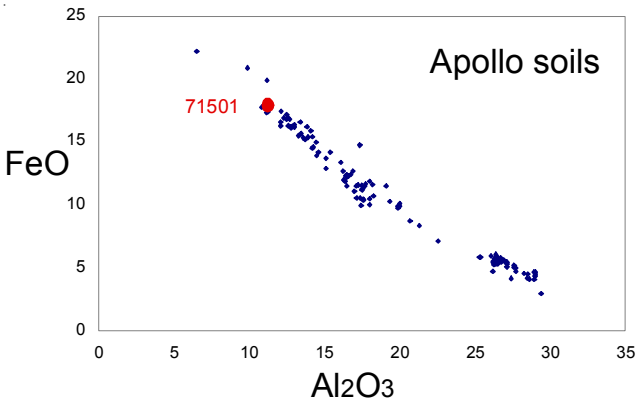



*Figure 3: Composition of 71501 compared with that of other Apollo soil samples.*

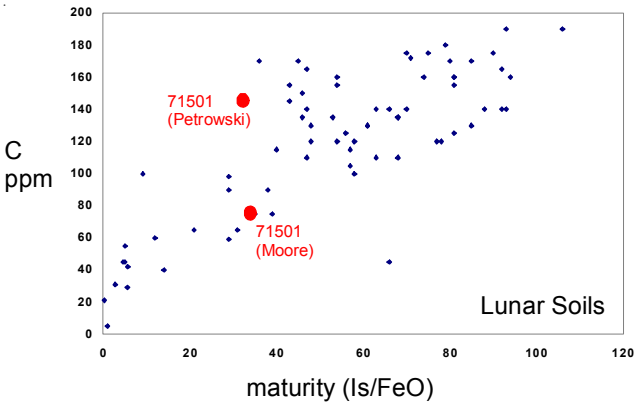



*Figure 4: Carbon content and maturity index of 71501 compared with that of other Apollo soil samples.*

of basalt fragments and composites or minerals derived from them.

Meyer (1973) cataloged the 4 – 10 mm coarse-fines finding 28 mare basalt, 10 soft breccias and 2 anorthositic particles. Blanchard et al. (1975) studied the 1 – 2 mm fraction. In the 1 – 2 mm fraction, Blanchard et al. found 10 "mare basalts", 6 "glassy breccias" and 3 "highland rocks", but gave no details.

Hu and Taylor (1977) conclusively showed that agglutinates are simply fused soil particles (i.e. nothing *mysterious*).

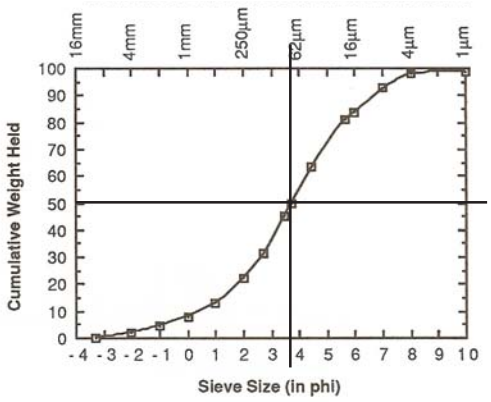
## Chemistry

Rhodes et al. (1974), Laul et al. (1974), Philpotts et al. (1974), Blanchard et al. (1975), Chou and Pearce (1976), Korotev and Kremser (1992) and others reported analyses of 71501 (tables 1 and 2). Figures 3 and 6 show that 71501 is similar to other mare soils at Apollo 17.

**Modal content of soil 71501 (90-150 micron).**
*From Heiken and McKay 1974.*

| | 71501 |
|---|---|
| Agglutinates | 35 |
| Basalt | 24.6 |
| Breccia | 5.2 |
| Anorthosite | |
| Norite | |
| Gabbro | |
| Plagioclase | 5 |
| Pyroxene | 17.9 |
| Olivine | |
| Ilmenite | 8 |
| Orange glass | 1.3 |
| Glass other | 2.2 |

LSPET (1973) and Moore et al. (1974) reported 75 ppm carbon (figure 4). Muller (1974) determined 51 ppm nitrogen. Petrowski et al. (1974) determined 145 ppm carbon, 60 ppm nitrogen and 60 ppm hydrogen. Goel et al. (1975) found 68 ppm nitrogen.




average grain size = 75 microns

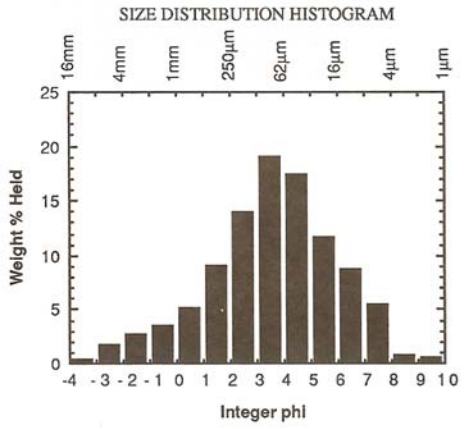



*Figure 5: Grain size distribution of 71500 (Graf 1993).*

## Table 1. Chemical composition of 71501.

| *reference* | Korotev92 | | | LSPET73 | | Wiesmann76 | | Laul74 | | Philpotts74 | | Eldridge74 | | Brunfelt74 | | Korotev76 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *weight* | | | | Rhodes74 | | Rhodes74 | | | | | | | | unpublished | | | |
| SiO2 % | | | | 39.82 | (b) | | | | | | | | | | | | |
| TiO2 | | | | 9.52 | (b) | | | 8.5 | (a) | | | | | 8.4 | (a) | | |
| Al2O3 | | | | 11.13 | (b) | | | 11.3 | (a) | | | | | 11.9 | (a) | | |
| FeO | 17.8 | 17.4 | (a) | 17.41 | (b) | | | 17.6 | (a) | | | | | 17 | (a) | 17.4 | (a) |
| MnO | | | | 0.25 | (b) | | | 0.222 | (a) | | | | | 0.226 | (a) | | |
| MgO | | | | 9.51 | (b) | | | 9 | (a) | | | | | 8.95 | (a) | | |
| CaO | | | | 10.85 | (b) | | | 10.2 | (a) | | | | | 12 | (a) | | |
| Na2O | 0.38 | 0.38 | (a) | 0.32 | (b) | 0.35 | | 0.36 | (a) | | | | | 0.38 | (a) | 0.396 | (a) |
| K2O | | | | 0.07 | (b) | 0.074 | (c ) | 0.076 | (a) | 0.072 | (c ) | 0.07 | (d) | 0.085 | (a) | | |
| P2O5 | | | | 0.06 | (b) | | | | | | | | | | | | |
| S % | | | | 0.12 | (b) | | | | | | | | | | | | |
| *sum* | | | | | | | | | | | | | | | | | |
| Sc ppm | 66.6 | 66.4 | (a) | | | | | 69 | (a) | | | | | 62.5 | (a) | 64 | (a) |
| V | | | | | | | | 100 | (a) | | | | | 116 | (a) | | |
| Cr | 3130 | 3120 | (a) | 3147 | (b) | 2900 | (c ) | 3024 | (a) | | | | | 2770 | (a) | 3256 | (a) |
| Co | 32.1 | 30.3 | (a) | | | | | 38 | (a) | | | | | 27 | (a) | 30.6 | (a) |
| Ni | 140 | 140 | (a) | 131 | (b) | | | | | | | | | | | 125 | (a) |
| Cu | | | | | | | | | | | | | | 8.9 | (a) | | |
| Zn | | | | 33 | (b) | | | | | | | | | 24 | (a) | | |
| Ga | | | | | | | | | | | | | | 4.9 | (a) | | |
| Ge ppb | | | | | | | | | | | | | | | | | |
| As | | | | | | | | | | | | | | | | | |
| Se | | | | | | | | | | | | | | | | | |
| Rb | | | | 1.2 | (b) | 1.17 | (c ) | | | 1.14 | (c ) | | | 1.3 | (a) | | |
| Sr | 210 | 180 | (a) | 157 | (b) | 159 | (c ) | | | 156 | (c ) | | | 150 | (a) | | |
| Y | | | | | | | | | | | | | | | | | |
| Zr | 230 | 230 | (a) | 214 | (b) | | | | | 224 | (c ) | | | | | | |
| Nb | | | | 19 | (b) | | | | | | | | | | | | |
| Mo | | | | 74 | (b) | | | | | | | | | | | | |
| Ru | | | | | | | | | | | | | | | | | |
| Rh | | | | | | | | | | | | | | | | | |
| Pd ppb | | | | | | | | | | | | | | | | | |
| Ag ppb | | | | | | | | | | | | | | | | | |
| Cd ppb | | | | | | | | | | | | | | | | | |
| In ppb | | | | | | | | | | | | | | | | | |
| Sn ppb | | | | | | | | | | | | | | | | | |
| Sb ppb | | | | | | | | | | | | | | | | | |
| Te ppb | | | | | | | | | | | | | | | | | |
| Cs ppm | | | | | | | | | | | | | | 0.055 | (a) | | |
| Ba | 110 | 81 | (a) | | | 87 | (c ) | 50 | (a) | 86 | (c ) | | | 70 | (a) | | |
| La | 7.36 | 7.3 | (a) | | | 7.14 | (c ) | 6.7 | (a) | | | | | 5.8 | (a) | 7.49 | (a) |
| Ce | 23.4 | 21.3 | (a) | | | 22.2 | (c ) | 24 | (a) | 21.5 | (c ) | | | | | 24.8 | (a) |
| Pr | | | | | | | | | | | | | | | | | |
| Nd | 23 | 18 | (a) | | | 21 | (c ) | 20 | (a) | 20.7 | (c ) | | | | | | |
| Sm | 8.1 | 7.88 | (a) | | | 8.02 | (c ) | 7 | (a) | 8.02 | (c ) | | | 7.78 | (a) | 8.62 | (a) |
| Eu | 1.69 | 1.66 | (a) | | | 1.66 | (c ) | 1.7 | (a) | 1.67 | (c ) | | | 1.87 | (a) | 1.65 | (a) |
| Gd | | | | | | 12.2 | (c ) | | | 10.7 | (c ) | | | | | | |
| Tb | 1.95 | 1.97 | (a) | | | | | 2.2 | (a) | | | | | 1.95 | (a) | 2.36 | (a) |
| Dy | | | | | | 13.6 | (c ) | 13 | (a) | 13.3 | (c ) | | | 10.6 | (a) | | |
| Ho | | | | | | | | | | | | | | | | | |
| Er | | | | | | 7.95 | (c ) | | | 7.84 | (c ) | | | | | | |
| Tm | | | | | | | | | | | | | | | | | |
| Yb | 7.5 | 7.36 | (a) | | | 7.37 | (c ) | 6.7 | (a) | 7.28 | (c ) | | | 7.5 | (a) | 7.96 | (a) |
| Lu | 1.04 | 1.03 | (a) | | | | | 0.89 | (a) | 1.11 | (c ) | | | 1.02 | (a) | 1.12 | (a) |
| Hf | 7.15 | 7.05 | (a) | | | | | 7.3 | (a) | | | | | | | 7.5 | (a) |
| Ta | 1.27 | 1.28 | (a) | | | | | 1.3 | (a) | | | | | 1.25 | (a) | 1.6 | (a) |
| W ppb | | | | | | | | | | | | | | 140 | (a) | | |
| Re ppb | | | | | | | | | | | | | | | | | |
| Os ppb | | | | | | | | | | | | | | | | | |
| Ir ppb | 7 | 3 | (a) | | | | | | | | | | | | | | |
| Pt ppb | | | | | | | | | | | | | | | | | |
| Au ppb | 4 | 5 | (a) | | | | | | | | | | | | | | |
| Th ppm | 0.74 | 0.68 | (a) | | | | | | | | | 0.75 | (d) | 0.56 | (a) | 0.5 | (a) |
| U ppm | 0.2 | < 1 | (a) | | | 0.23 | (c ) | | | | | 0.23 | (d) | 0.2 | (a) | | |

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

## Table 2. Chemical composition of 71501.

| *reference* | Blanchard75 | | | | Miller74 | Chou76 |
|---|---|---|---|---|---|---|
| *weight* | | 1 -2 mm | | | | |
| SiO2 % | | ave. 20 | | 40.2 | | |
| TiO2 | | | | 9 | | |
| Al2O3 | | | | 10.96 | | |
| FeO | 17.6 | 18.5 | (a) | 18.3 | 17.4 | (a) |
| MnO | 0.24 | 0.26 | (a) | 0.23 | 0.25 | (a) |
| MgO | | | | 9.3 | | |
| CaO | | | | 10.2 | | |
| Na2O | 0.395 | 0.35 | (a) | 0.47 | | |
| K2O | | | | | 0.08 | (a) |
| P2O5 | | | | | | |
| S % | | | | | | |
| *sum* | | | | | | |
| | | | | | | |
| Sc ppm | 62.8 | 76.9 | (a) | | 68 | (a) |
| V | | | | | | |
| Cr | 2980 | 4020 | (a) | | 2900 | (a) |
| Co | 33.5 | 25.7 | (a) | | 31 | (a) |
| Ni | 200 | 270 | (a) | | 118 | (a) |
| Cu | | | | | | |
| Zn | | | | | | |
| Ga | | | | | | |
| Ge ppb | | | | | | |
| As | | | | | | |
| Se | | | | | | |
| Rb | | | | | | |
| Sr | | | | | | |
| Y | | | | | | |
| Zr | | | | | | |
| Nb | | | | | | |
| Mo | | | | | | |
| Ru | | | | | | |
| Rh | | | | | | |
| Pd ppb | | | | | | |
| Ag ppb | | | | | | |
| Cd ppb | | | | | | |
| In ppb | | | | | | |
| Sn ppb | | | | | | |
| Sb ppb | | | | | | |
| Te ppb | | | | | | |
| Cs ppm | | | | | | |
| Ba | | | | | 102 | (a) |
| La | 7.4 | 7.3 | (a) | | 6.5 | (a) |
| Ce | 24.7 | 22.3 | (a) | | 19 | (a) |
| Pr | | | | | | |
| Nd | | | | | 19 | (a) |
| Sm | 8.95 | 8.35 | (a) | | 7.6 | (a) |
| Eu | 1.7 | 1.52 | (a) | | 1.72 | (a) |
| Gd | | | | | | |
| Tb | 2.47 | 2.13 | (a) | | 1.9 | (a) |
| Dy | | | | | 13 | (a) |
| Ho | | | | | | |
| Er | | | | | | |
| Tm | | | | | | |
| Yb | 8.47 | 8.06 | (a) | | 7.7 | (a) |
| Lu | 1.19 | 1.19 | (a) | | 1.05 | (a) |
| Hf | 8 | 8.2 | (a) | | 6.9 | (a) |
| Ta | 1.9 | 1.6 | (a) | | 1.4 | (a) |
| W ppb | | | | | | |
| Re ppb | | | | | | |
| Os ppb | | | | | | |
| Ir ppb | | | | | 14 | (a) |
| Pt ppb | | | | | | |
| Au ppb | | | | | 5 | (a) |
| Th ppm | | | | | 0.69 | (a) |
| U ppm | | | | | | |
| *technique* | *(a) INAA* | | | | | |

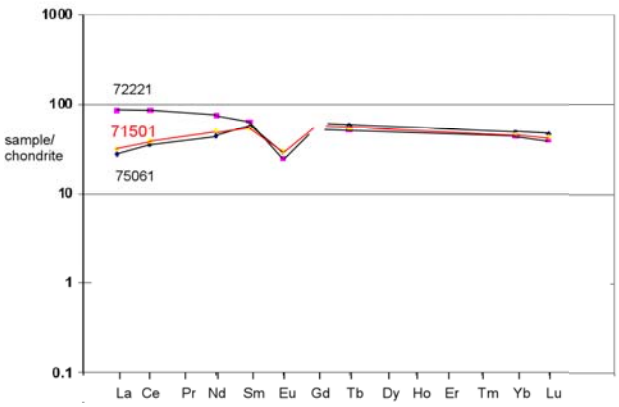



*Figure 6: Normalized rare-earth-element diagram for 71501 - note similarity with mare soil 76051.*

## Cosmogenic isotopes and exposure ages

O'Kelley et al. (1974) determined the cosmic-ray-induced activity of $^{22}$Na = 89 dpm/kg, $^{26}$Al = 73 dpm/kg. and $^{54}$Mn = 135 dpm/kg.

Curtis and Wasserburg (1977) determined the total flux of neutrons by measuring the Gd isotopes.

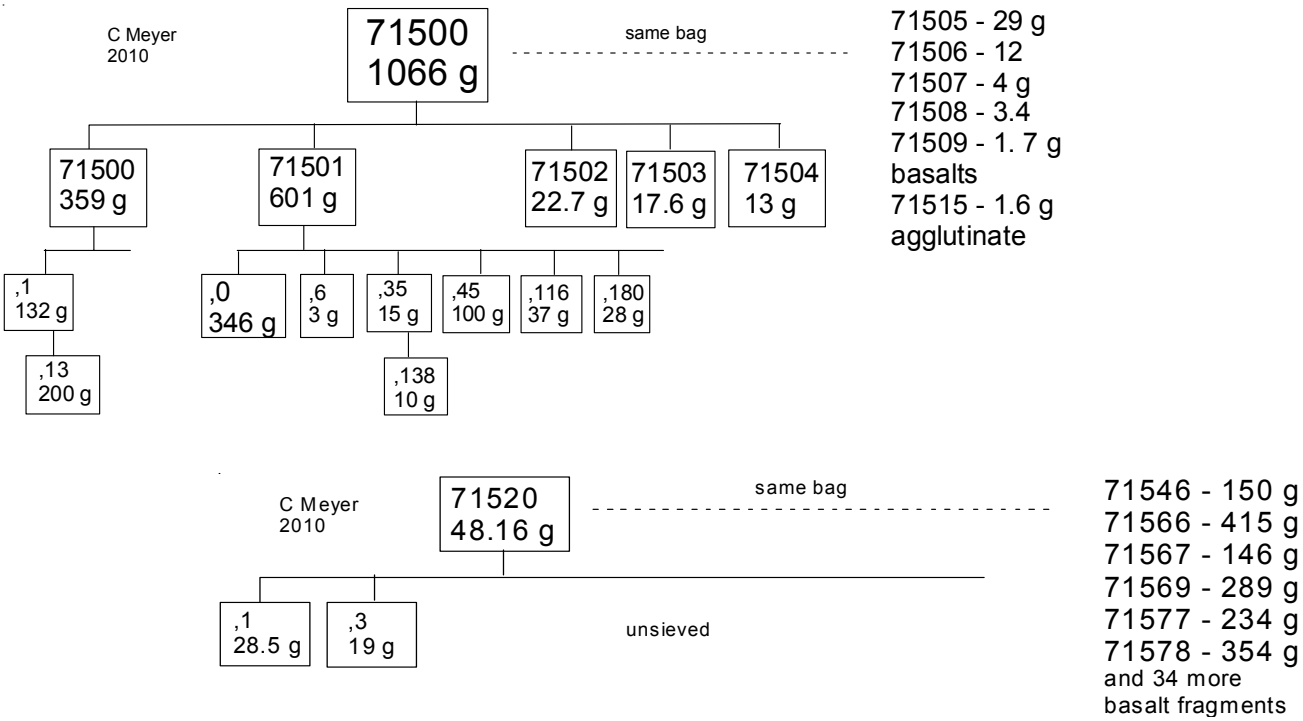
## Other Studies

Lunar soil 71501 has been extensively studied with respect to implanted solar wind gases. Alexander et al. (1977), Becker and Pepin (1989), Signer et al. (1977), Frick et al. (1987), Benkert et al. (1993), Hubner et al. (1975), Kiko et al. (1978), Heber et al. (2001, 2003) and Wieler et al. (1980, 1983) reported rare gas abundance and isotopic ratios for bulk 71501 as well as for mineral separates - in particular - ilmenite. *(my apologies for NOT trying to summarize this extensive and exhaustive work !)*

Goswami and Lal (1974) measured the abundance of fossil nuclear tracks in many feldspar grains.

Housley et al. (1974), Taylor et al. (2001a,b) and Noble et al. (2001) used samples of 71501 to study space weathering.

Evensen et al. (1974), Nyquist et al. (1974) and Church and Tilton (1974) determined the isotopic systems for Rb/Sr and U/Th/ Pb. Rees and Thode (1974) determined the isotopic composition of sulfur.

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