

APOLLO VIRTUAL MICROSCOPE COLLECTION: LUNAR MINERALOGY AND PETROLOGY OF APOLLO ROCKS

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Abstract: The Apollo virtual microscope is a means of viewing, over the Internet, polished thin sections of every rock in the Apollo lunar sample collections. It uses software that duplicates many of the functions of a petrological microscope. Images (575) from the six Apollo and the Luna 16 mission may be viewed at: www.virtualmicroscope.org/content/apollo

Introduction: The Apollo Virtual Microscope Collection [Fig. 1] is an Open Educational Resource which allows users to investigate the mineralogy and petrology of polished thin sections of 556 of the Apollo lunar samples [1]. Including duplicate thin sections, the collection totals 575 virtual microscopes (VMs). A breakdown of VMs according to mission reads Apollo 11 = 45 VMs, Apollo 12 = 47 VMs, Apollo 14 = 61 VMs, Apollo 15 = 132 VMs, Apollo 16 = 127 VMs, Apollo 17 = 162 VMs. One LUNA 16 sample is also included in the collection. Table 1 shows our 40 favorite VMs.

By rock type there are four main divisions - basalts (214 VMs)[Fig. 2], plutonic rocks (33 VMs), breccias (272 VMs) and impact rocks (106 VMs). Note some impact rocks are also breccias. Other VMs total 27 and include an agglutinate, a granulite, a soil, a core sample, and a few samples containing glass beads.

Within these broad divisions are further subdivisions, so for instance the basalts can be broken down in the following mineralogical types: picritic (2 VMs), olivine (52 VMs), ilmenite (88 VMs), pigeonite (33 VMs), high Ti (8 VMs), KREEP (4 VMs), [Fig.2] shocked (7 VMs) and others (23 VMs). The plutonic rocks divide into anorthosite (21 VMs), norite (7 VMs), troctolite (3 VMs), dunite (1 VM), and gabbro (1 VM). Similarly, the breccias can be broadly divided into granulitic (5 VMs), crystalline (17 VMs), polymict (16 VMs), fragmental (4 VMs), vitric matrix (7 VMs), light matrix (5 VMs), glassy (9 VMs), KREEP (3 VMs), regolith (102 VMs) or im-

part melt (80 VMs). There are 24 other breccia VMs. Excluding the impact melt breccias, the other impact rocks are described as impactites (5 VMs) or impact melts (21 VMs). Samples containing green or orange glass often in the form of beads completes the collection (21 VMs).

Nearly all of these VMs consist of a set of three high resolution images of the entire thin section taken in plane polarized light (PPL), between crossed polars (XPL) and in reflected light. Each sample also contains two rotation points - carefully selected locations on the thin section where 144 additional photographs have been taken. At these points the VM simulates the rotation of the stage of a polarising microscope (in PPL and XPL)[2,3] and this allows variations in pleochroism and birefringence to be observed. It has also allowed us to focus attention on specific features that may not be immediately obvious at first glance (i.e. the location of cristobalite in some basaltic rocks).

Research possibilities: The earliest “research” collection using Apollo and meteorite samples, was presented at LPSC in 2010 by Anand et al.[4] These authors used lunar meteorite LAP 04841 to illustrate the new technique of VM creation. In the following years further major collections were added and include UK rocks, British & Irish meteorites, Europlanet meteorites, samples from Darwin’s voyage of the Beagle and Geolab (an Irish Universities collection). Small pilot collections of lunar meteorites and Martian meteorites were also added to the website.

Lunar and Martian meteorites are a priority for future VM work. These pilot collections can be found here:

<https://www.virtualmicroscope.org/content/lunar-meteorites>

<https://www.virtualmicroscope.org/content/martian-meteorites>

Table 1. Our “Favorite Top 40” Virtual Microscope Samples**Apollo 11**

Vesicular basalt 10072
 Ilmenite basalt 10092
 Regolith breccia 10082

Apollo 12

Olivine vitrophyre 12008
 Olivine basalt 12075
 Ilmenite basalt 12062

Apollo 14

Al-rich basalt 14053
 KREEP basalt 14276
 Crystalline breccia 14006
 Vitric-matrix breccia 14267

Apollo 15

Ferroan anorthosite 15415
 Picritic basalt 15385
 Olivine basalt 15643
 KREEP basalt 15282
 Pigeonite basalt 15075
 KREEP breccia 15205
 Mare basalt breccia 15145
 Volcanic glass 15366

Apollo 16

Anorthosite cataclasite 60025
 Micro-gabbro 61224
 Polymict breccia 67605
 Polymict breccia 60115
 Devitrified glass 67629
 Devitrified glass 67696
 Glassy-coated breccia 65035
 Glass-coated impact melt 64455
 Impact melt 64576
 Glass object 65016
 Glass object 67728
 Glass object 67946

Apollo 17

Troctolite 76536
 Norite 78238
 High-Ti basalt 70148
 Ilmenite basalt 78135
 Shocked basalt 79155
 Fragmental breccia 77517
 Impact melt breccia 76055
 Impact melt breccia 76295
 Granulitic impactite 72559
 Orange glass 74220



Figure 1. The Apollo VM home page:

<https://www.virtualmicroscope.org/collections/apollo>

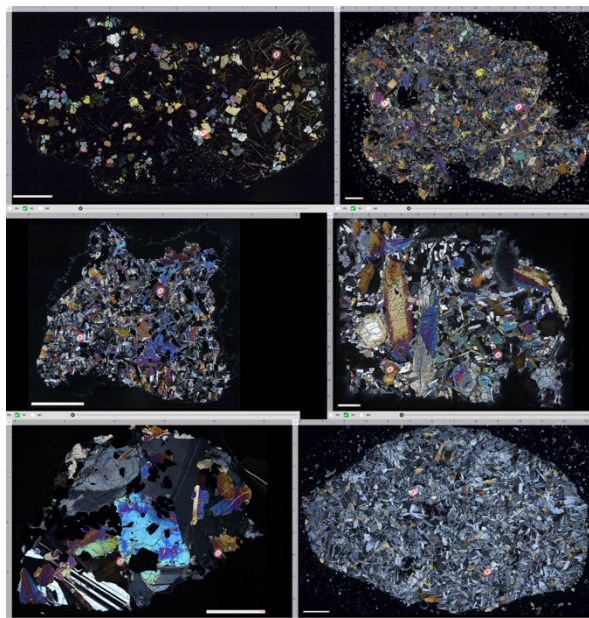


Figure 2. Representative basalt samples viewed between crossed polars. Top left – olivine vitrophyre 12008; top right – olivine basalt 12075; mid left – ilmenite basalt 10092; mid right – pigeonite basalt 15075; bottom left – high-Ti basalt 70148; bottom right – KREEP basalt 14276.

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