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 impact 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/luunar-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

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References: