

**VIRTUAL MICROSCOPE VIEWS OF THE APOLLO 11, 12, 14 and 15 LUNAR SAMPLES.** E. K. Gibson<sup>1,2</sup>, A. G. Tindle<sup>1</sup>, S. P. Kelley<sup>1</sup> and J.M. Pillinger<sup>1</sup>. <sup>1</sup>Science, Technology, Engineering & Maths Faculty, The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK., and <sup>2</sup>XI111, ARES, NASA Johnson Space Center, Houston, TX 77058. U.S.A. [everett.k.gibson@nasa.gov]

**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 from the Apollo 11, 12, 14 and 15 missions may be viewed at:

**[www.virtualmicroscope.org/content/apollo](http://www.virtualmicroscope.org/content/apollo)**

**Introduction:** During the six NASA missions to the Moon from 1969-72 a total of 382kg of rocks and soils, often referred to as “the legacy of Apollo”, were collected and returned to Earth. A unique collection of polished thin sections (PTSs) was made from over 500 rocks by the Lunar Sample Curatorial Facility at the Johnson Spacecraft Center (JSC), Houston. These materials have been available for loan to approved Principal Investigators (PIs) but of course they can’t be simultaneously investigated by several researchers unless they are co-located or the sample is passed back and forward between them by mail/hand carrying - which is inefficient and very risky for irreplaceable material.

When The Open University (OU), the world’s largest Distance Learning Higher Education Establishment found itself facing a comparable problem (how to supply thousands of undergraduate students with an interactive petrological microscope and a personal set of thin sections), they decided to develop a software tool called the Virtual Microscope (VM). As a result it is now able to make the unique and precious collection of Apollo specimens universally available as a resource for concurrent study by anybody in the world’s Earth and Planetary Sciences community. Herein, we describe the first steps of a collaborative project between the OU and the JSC Curatorial Facility to record a PTS for every lunar rock, beginning with those collected by the Apollo 11, 12, 14 and 15 missions.

**Method:** Production of a virtual microscope dedicated to a particular theme divides into four main parts - photography, image processing, building and assembly of virtual microscope components, and publication on a website. The method used to produce the VM images has been described earlier [1].

**Earlier investigations:** We have undertaken a number of pilot studies to demonstrate the efficacy of the petrological microscope with lunar samples. The first

was to make available on-line images collected from the Educational Package of Apollo samples provided

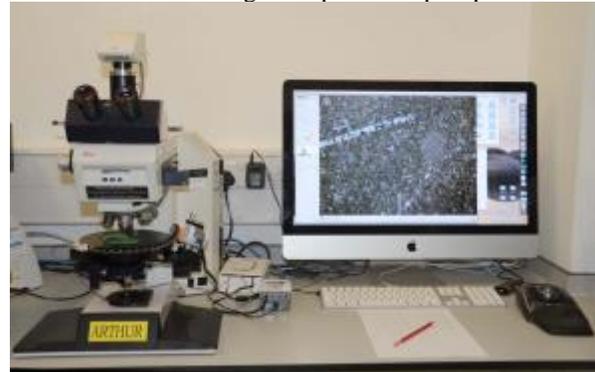


Figure 1: Rotating stage microscope with Lego Mindstorm motor and controller – one of two microscopes used by the virtual microscope team.

by NASA to the UK STFC (Science and Technical Facilities Council) for loan as educational material e.g. for schools. The real PTSs of the samples are no longer sent out to schools removing the risks associated with transport, accidental breakage and eliminating the possibility of loss.

The availability of lunar sample VM-related material was further extended to include twenty-eight specimens from the Apollo missions. Some of these samples were made more generally available through an ibook entitled “Moon Rocks: an introduction to the Geology of the Moon” free from the Apple Bookstore [2].

**Research possibilities:** Although the Virtual Microscope was originally conceived as a teaching aid and was later recognised as a means of public outreach and engagement, we now realize that it also has enormous potential as a high level research tool.

Following discussions with the JSC Curators we have received CAPTAM permission to embark on the programme of digitizing the entire lunar sample PTS collection. By the time of the 2017 LPSC meeting we will have completed 268 rocks collected during the Apollo 11, 12, 14 and 15 missions and the data, with cross-links to the Lunar Sample Compendium [3]. These go live on the Web in January 2017. 287 VM images of the A-11 (41 VM images), A-12 (47 VM images), A-14 (56 VM images), and Apollo 15 (124 VM images) along with 19 additional samples from

A-16 and A-17 missions can be viewed at:  
[www.virtualmicroscope.org/content/apollo](http://www.virtualmicroscope.org/content/apollo)

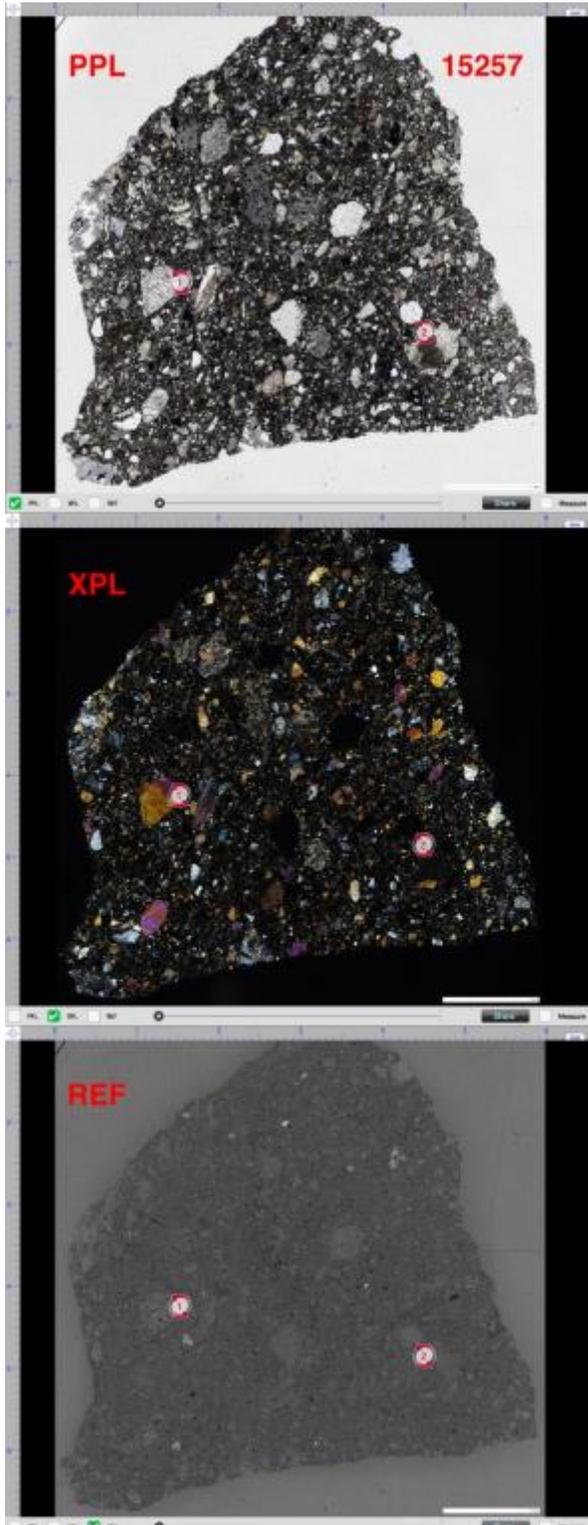


Figure 2: Screen shots from one of the Apollo15 virtual microscopes showing regolith breccia sample 15257.

The lunar sample VM will enable large numbers of skilled/unskilled microscopists (professional and amateur researchers, educators and students, enthusiasts and the simply curious non-scientists) to share the information from a single sample. It means that all the PTSs already cut, even historical ones, could be available for new joint investigations or private study. The scientific return from the collection will increase exponentially as a result of further debate and discussion.

Simultaneously the VM will remove the need for making unnecessary multiple samplings, avoid consignment of delicate/breakable specimens (all of which are priceless) to insecure mail/courier services and reduce direct labour and indirect costs, travel budgets and unproductive travelling time necessary for co-location of collaborating researchers.

For the future we have already recognized further potential for virtual technology. There is nothing that a petrologist likes more than to see the original rock as a hand specimen. It is entirely possible to recreate virtual hand specimens with 3-D hard and software, already developed for viewing fossils, located within the Curatorial Facility. Preparation of VM images for A-16 is currently underway.

The Team has also created a Mars Virtual Microscope that includes numerous Martian meteorites. The Martian meteorite site can be viewed at: <http://www.virtualmicroscope.org/content/martian-meteorites>

#### References:

- [1] GIBSON, E.K., TINDLE, A.G, KELLEY S.P. AND PILLINGER J.M. (2016), , In LPSC XLVII, Abstract #1199.
- [2] TINDLE, A.G. AND KELLEY, S.P. (2012). *MOON ROCKS: AN INTRODUCTION TO THE GEOLOGY OF THE MOON*. OPEN UNIVERSITY.
- [3] <http://curator.jsc.nasa.gov/lunar/lsc/index.cfm>

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