

High-Grading Lunar Samples

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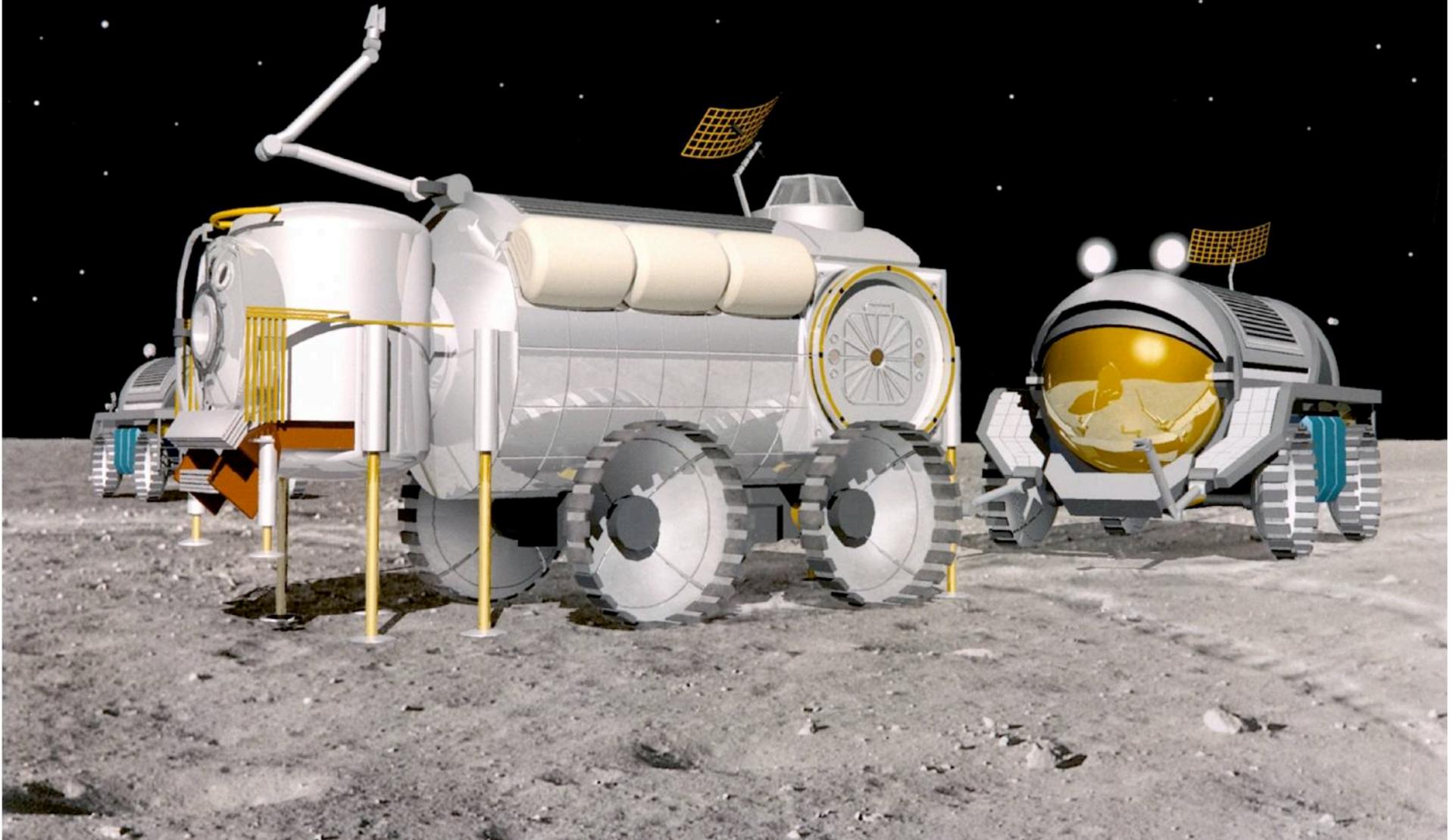
Each Apollo mission transported carefully-collected rock and soil samples to Earth



Apollo 17 3 days 110 kg



Current Constellation architecture baselines a total sample transport mass of 100 kg from missions lasting for many days or weeks



LUNAR SAMPLE ACQUISITION AND CURATION REVIEW (LSACR)

CAPTEM – LEAG (2008 – 2009)

(1) Sortie and outpost activities have the capability to collect more samples than can be returned.

Therefore, high-grading of scientifically important samples will be needed.

(2) High-grading should be made on scientific grounds involving astronaut observations and instruments.

(3) Instruments need to provide rapid analysis that can be easily interpreted.

(4) These data should be available to a science backroom to assist the decision making process.

What is the necessary and sufficient set of instruments and tests that will allow intelligent selection of lunar samples for transport to Earth ?

**The JSC Curation Office is proposing a
Lunar Sample Reference Suite and Testbed**

A new resource for the lunar science community to test instruments and concepts for high-grading samples on the Moon

Reference Suite of returned lunar rock and soil samples – spanning the range of rock types and compositions in the Apollo collection – available for instrument demonstration and testing

Reference Suite Lunar Basalts

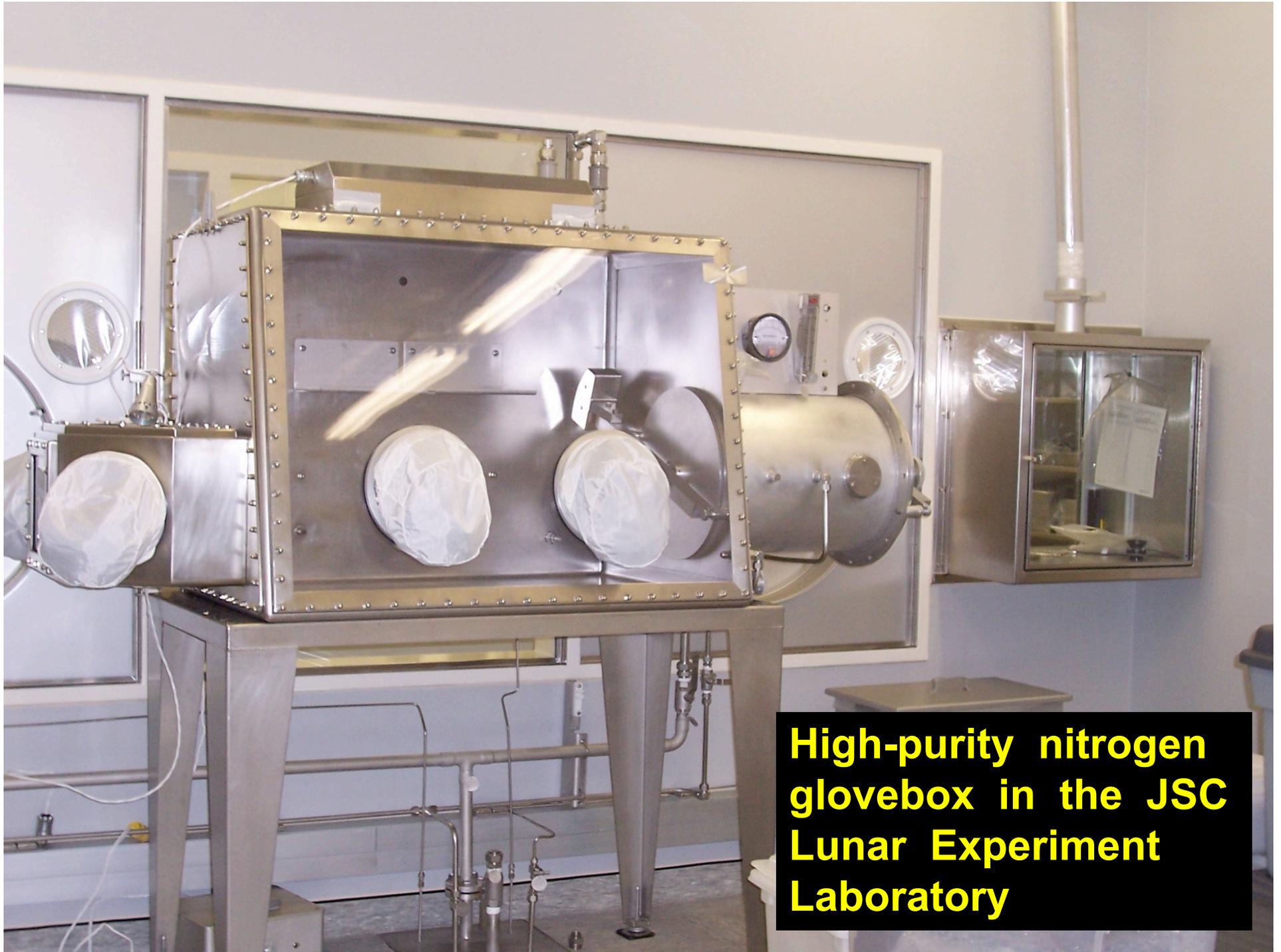
10017	basalt, fine-grained
12002	basalt, medium-grained
12052	basalt, coarse
14310	basalt, Al rich (impact derived)
15555	basalt, coarse-grained
15556	basalt, vesicular
70215	basalt, very fine-grained

Reference Suite Lunar Breccias

10048	soil breccia, glass-rich
14311	coherent breccia, very fine-grained
14321	breccia, crystalline
15015	soil breccia, glass rich
15459	coherent soil breccia with clasts
15565	friable soil breccia with basalt clast
61016	melted anorthosite
60025	chalky white anorthosite
64435	plagioclase rich breccia
66095	plagioclase rich breccia (rusty rock)
73255	aphanitic impact breccia

Reference Suite Lunar Soils

10084	soil, main
14163	soil, main
64501	soil, aluminum-rich
72501	soil, aluminum-rich
75081	soil, iron-rich



High-purity nitrogen glovebox in the JSC Lunar Experiment Laboratory

But wait – there's more !

Compilation of research results on each sample in the Reference Suite



Lunar Sample Compendium

C. Meyer, Mail Code KT, NASA Johnson Space Center, Houston, Tx 77058



WHERE CAN I FIND OUT MORE ABOUT LUNAR SAMPLES?

The LSC!

WHAT KINDS OF SAMPLES ARE IN THIS COLLECTION?

BASALTS, IMPACT MELTS, BRECCIAS, SOILS, AND CORES.

WHAT TYPE OF INFORMATION IS AVAILABLE FROM THE LSC WEBSITE?

THIS COMPENDIUM ALLOWS EASY ACCESS TO THE SCIENTIFIC LITERATURE BY BRIEFLY SUMMARIZING THE SIGNIFICANT FINDINGS OF EACH ROCK ALONG WITH THE DOCUMENTATION OF WHERE THE DETAILED SCIENTIFIC DATA ARE TO BE FOUND.

ARE SAMPLES AVAILABLE FOR DISPLAY?

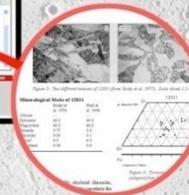
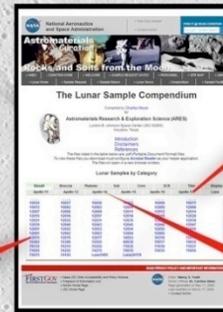
YES. MANY LUNAR SAMPLES ARE ON PUBLIC DISPLAY AT PRESIDENTIAL LIBRARIES, NASA CENTERS, AND PUBLIC MUSEUMS. THE LSC CURATOR ALSO DISTRIBUTES REAL LUNAR SAMPLES FOR EDUCATION AND SMALLER SAMPLES ARE AVAILABLE FOR SCIENTIFIC STUDIES. SEE [HTTP://CURATOR.LSC.NASA.GOV/LUNAR](http://CURATOR.LSC.NASA.GOV/LUNAR)

WHAT IS THE PURPOSE OF THE LSC?

TO INFORM SCIENTISTS, ASTRONAUTS AND THE PUBLIC ABOUT THE VARIOUS LUNAR SAMPLES THAT HAVE BEEN RETURNED FROM THE MOON.

HOW DO I GET TO THE WEBSITE?

JUST GOOGLE "LUNAR SAMPLE COMPENDIUM"



HOW ARE THE SAMPLES CATEGORIZED IN THE CATALOG?

THE INFORMATION IS CATEGORIZED BY TYPE OF ROCK (E.G. BASALT, BRECCIA) AND IS ALSO AVAILABLE BY THE MISSION THAT COLLECTED THE SAMPLE (E.G. APOLLO 11, APOLLO 12).

WHO CAN USE THIS INFORMATION AND WHAT WILL THEY DO WITH IT?

ANYONE! THIS KNOWLEDGE, ALTHOUGH SOMEWHAT TECHNICAL, IS AVAILABLE TO THE PUBLIC. NOT ONLY WILL IT PROVE USEFUL TO SCIENTISTS PROPOSING TO STUDY INDIVIDUAL LUNAR SAMPLES BUT IT SHOULD ALSO HELP PROVIDE BACKUP INFORMATION FOR LUNAR SAMPLE DISPLAYS, SAMPLE REQUESTS, AND OTHER EDUCATION PRODUCTS.

Epoxy Encapsulated Core
This epoxy impregnated drive tube illustrates what the fragmental lunar regolith looks like in the lunar highlands.

27.0 Cm

30.0 Cm

33.0 Cm

36.0 Cm

39.0 Cm

41.5 Cm

44.5 Cm

47.5 Cm

50.5 Cm

53.5 Cm

56.5 Cm

59.5 Cm

61.1 Cm



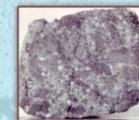
Mare Basalt

This very vesicular mare basalt has vesicles that are 4-6 mm in size. They were created by an unknown volcanic gas.



Impact Melt Rock

This holocrystalline rock has the texture and chemistry of a feldspathic basalt, but since it contains relatively high Ir content, it is interpreted as a recrystallized melt formed by meteorite impact with the lunar crust.



Fra Mauro Breccia

The ancient Fra Mauro formation was formed from the Imbrium impact ejecta. This surface shows clasts of basalt, anorthosite and microbreccia. The matrix of this fragmental breccia is crystalline.



Thin sections of each sample
in the Reference Suite

15556
width 3 mm

JSC Curation will recommend to CAPTEM :

Set aside this reference suite for testing of instruments being developed for geologic analysis on the Moon

Open the reference suite and testbed for proposals from the entire community

Proposals to be recommended by CAPTEM and approved by SMD

**Initial test – Multispectral
Microscopic Imager (MMI)
developed by ASU and JPL**



A Multispectral Micro-Imager for Lunar Field Geology

Jorge Nunez, Jack Farmer (ASU)

Glenn Sellar (JPL)

Carl Allen (JSC)

(poster at this meeting)

substrate-removed InGaAs focal-plane array

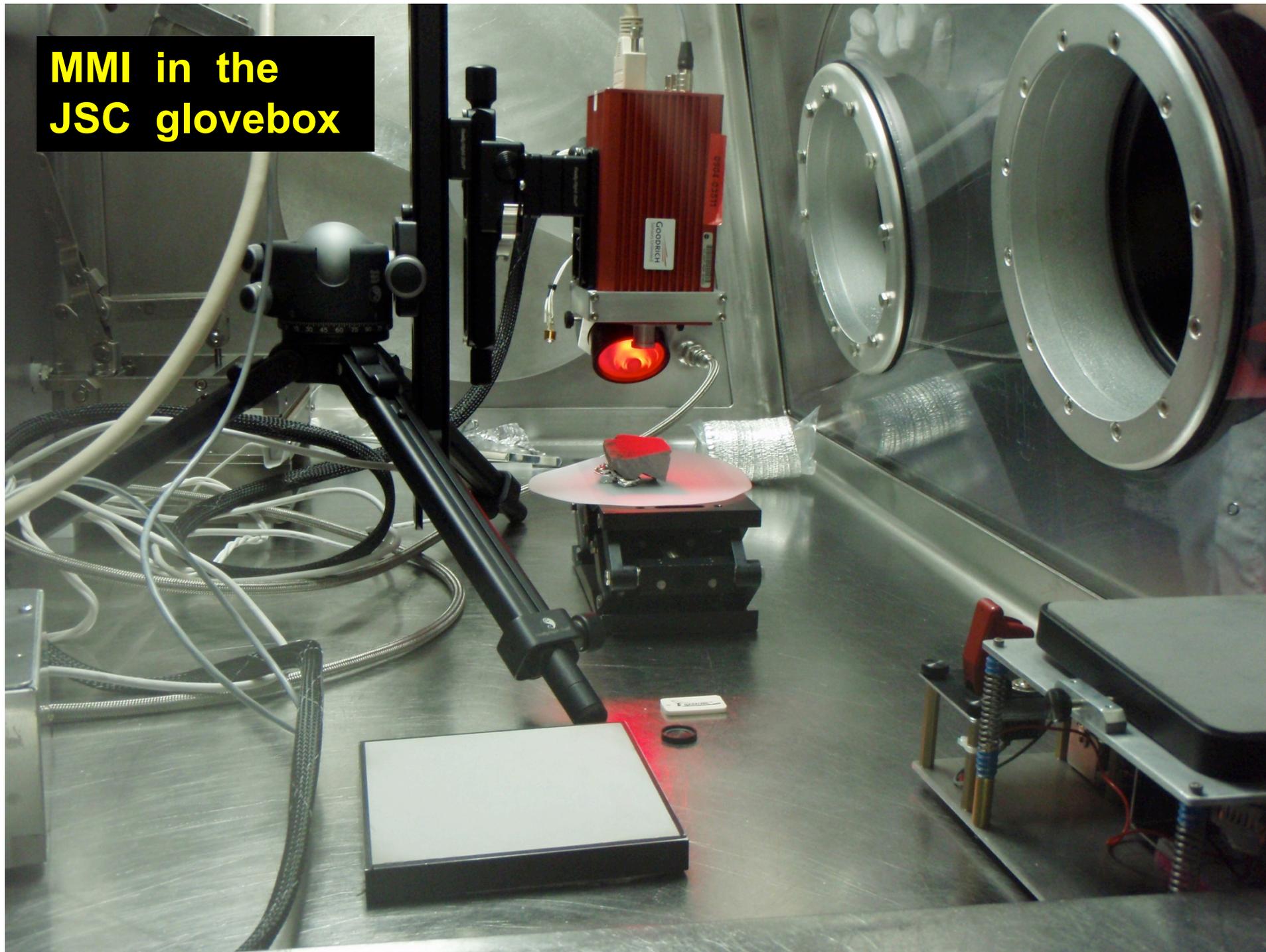
multi-wavelength, light-emitting diodes

FOV 32 X 40 mm pixel 62.5 microns

21 spectral bands 470 to 1750 nm

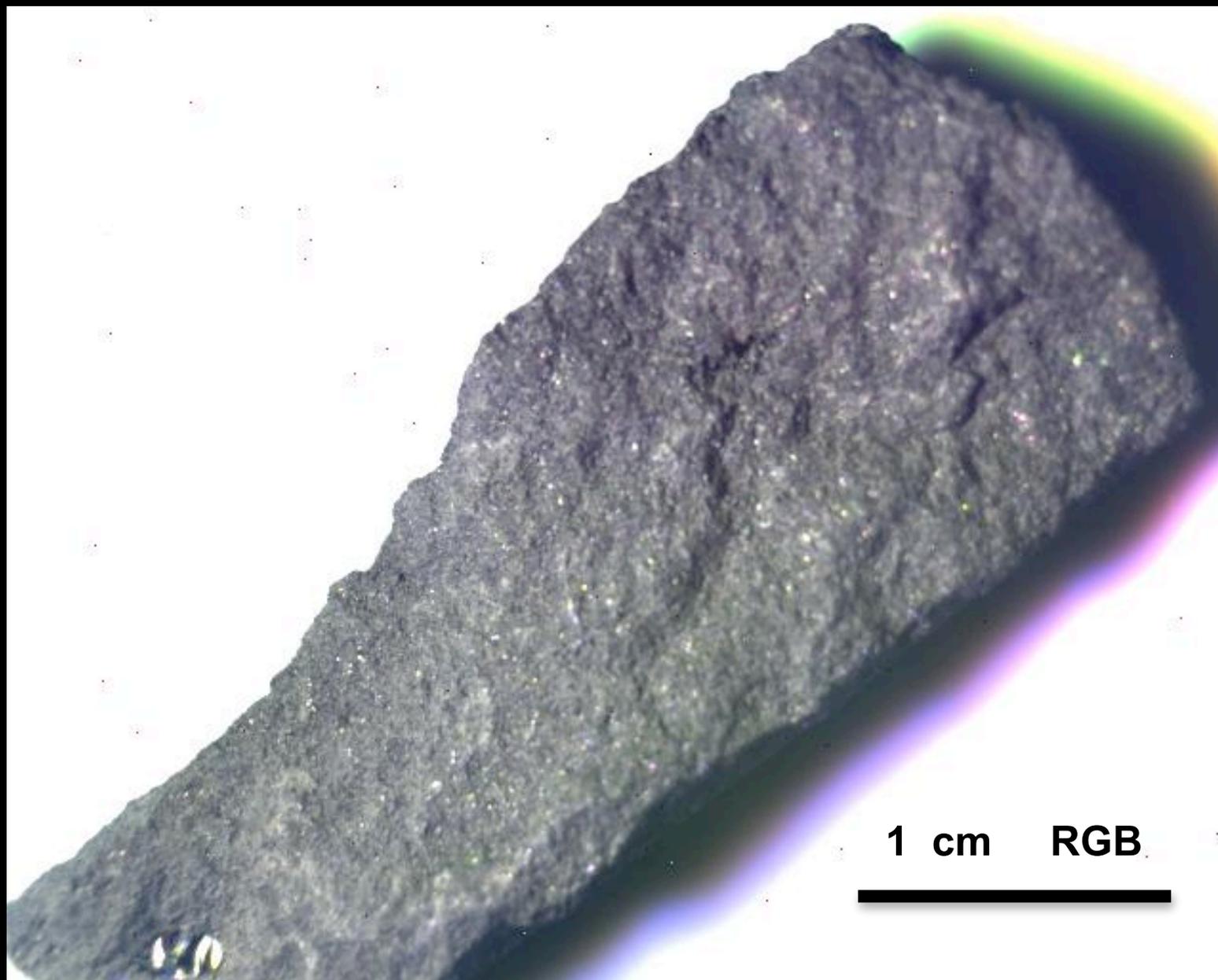
discriminates a wide variety of rock-forming minerals

**MMI in the
JSC glovebox**



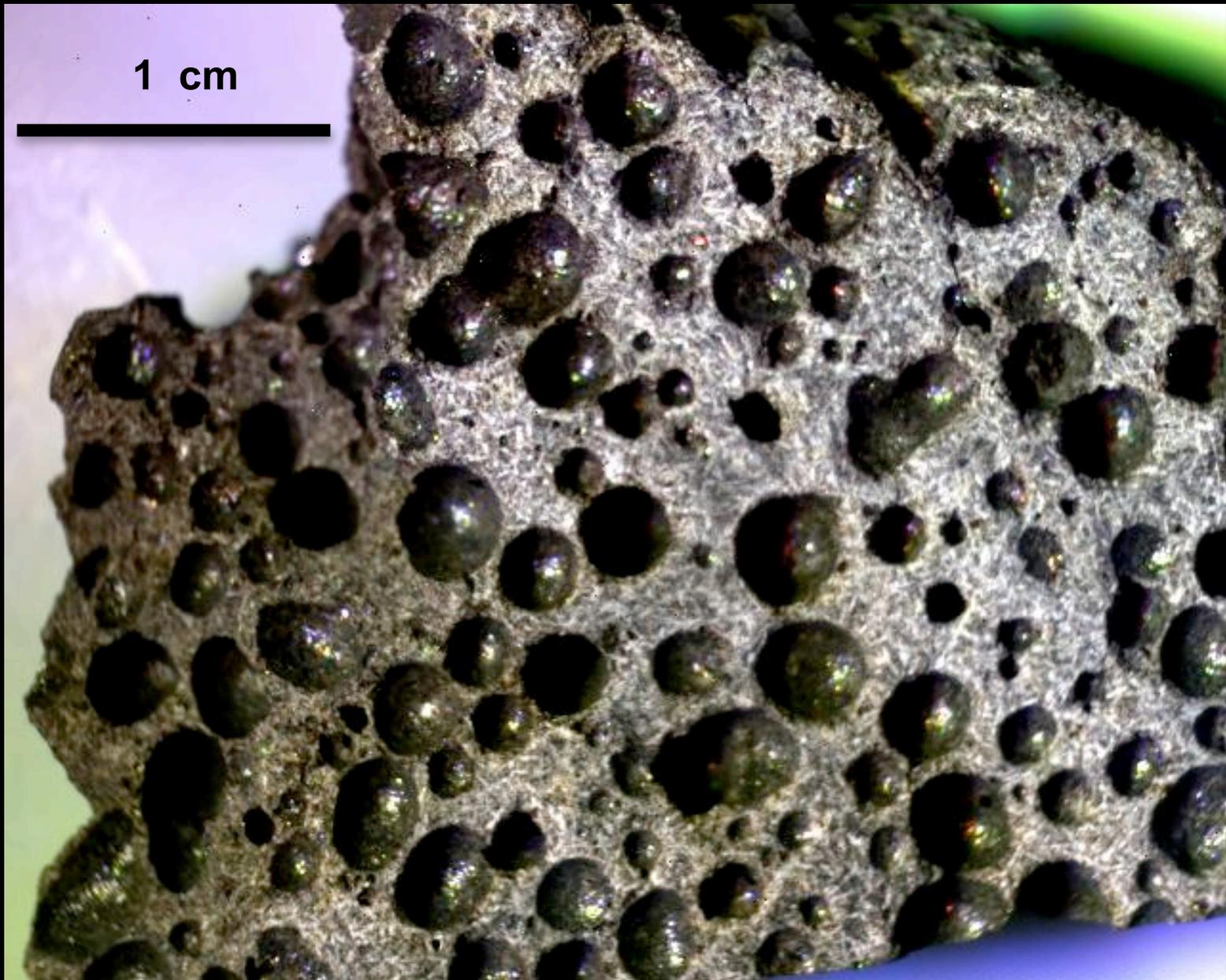
70215

very fine-grained basalt



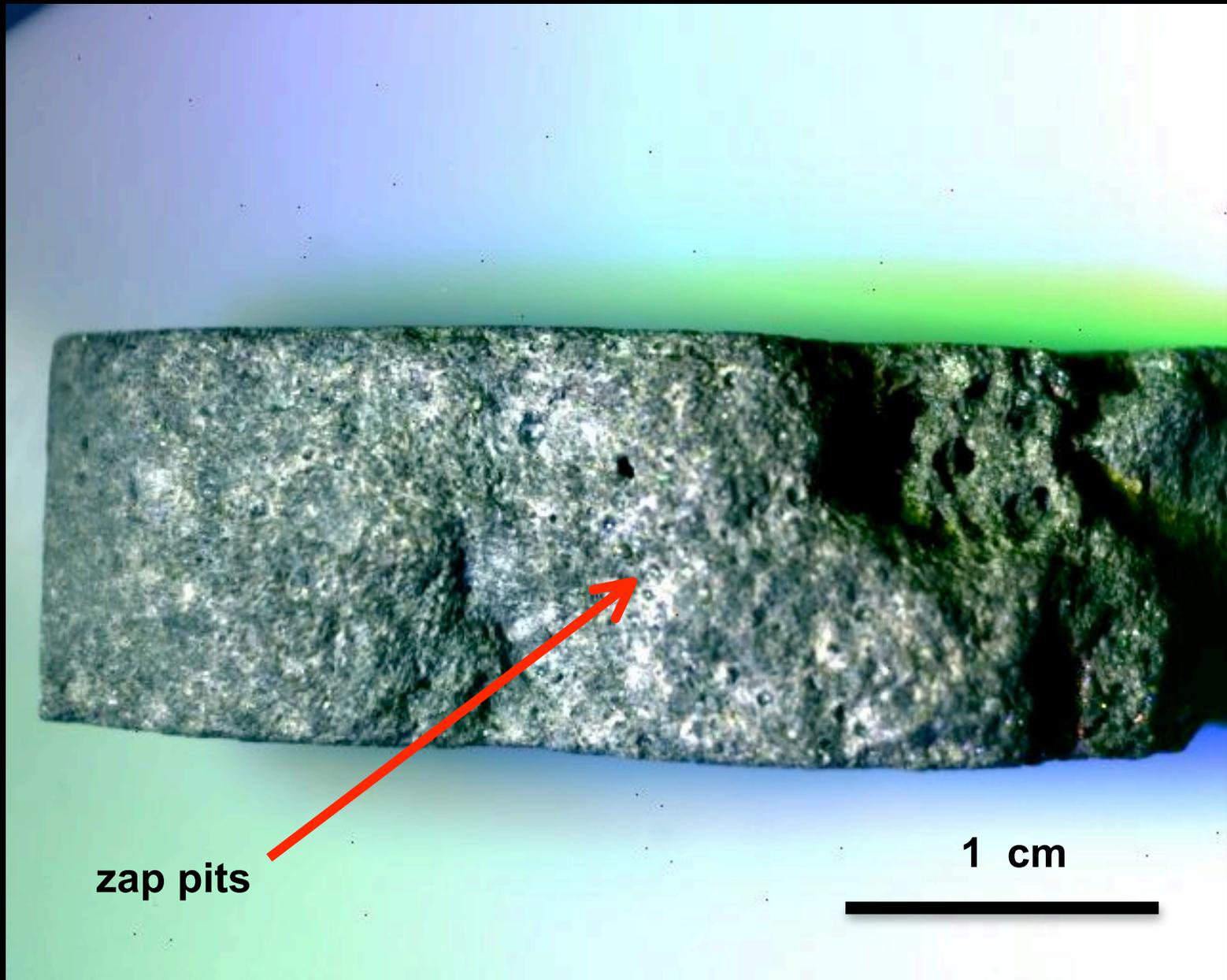
15556

vesicular basalt



12002

medium-grained basalt (top surface)

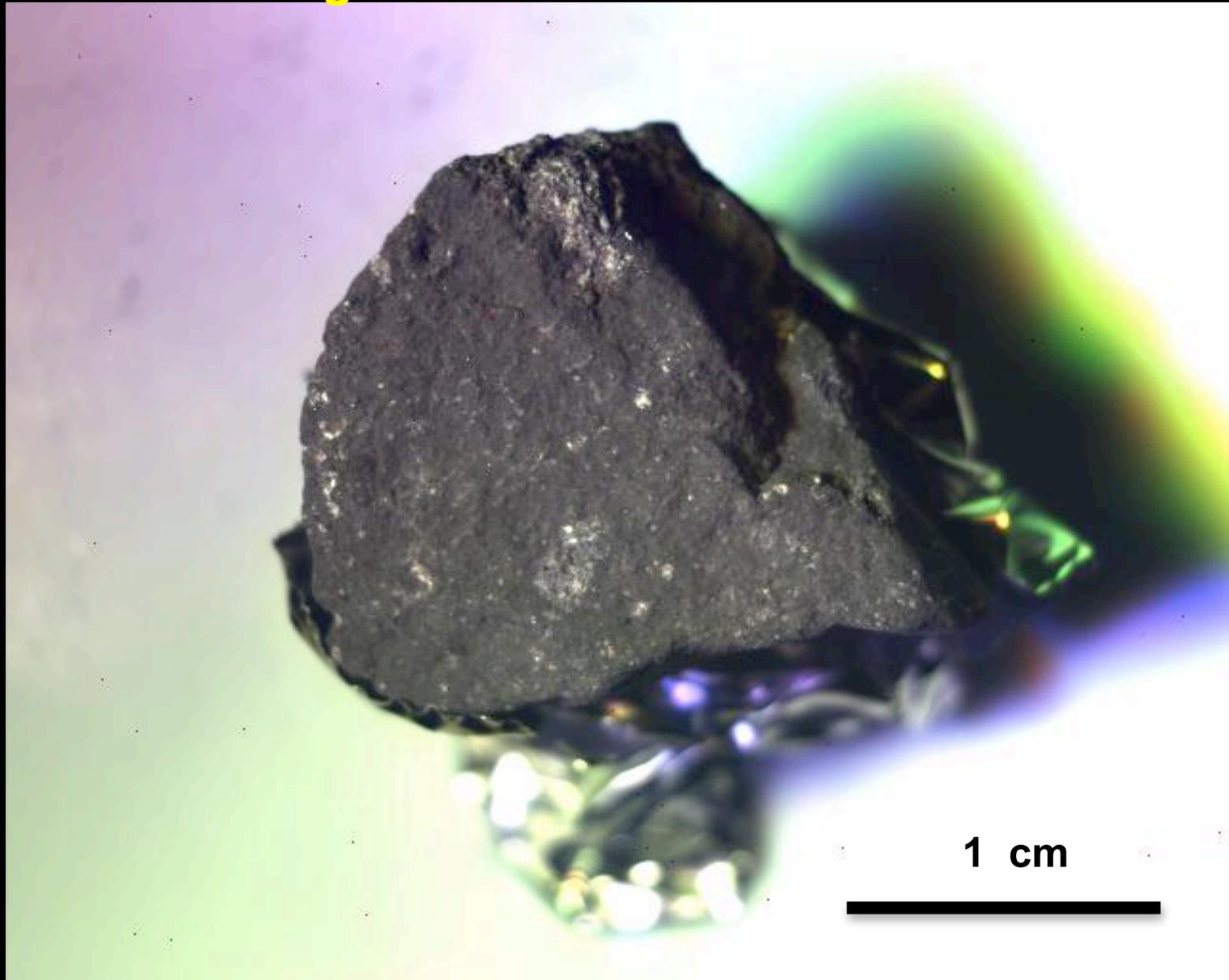


zap pits

1 cm

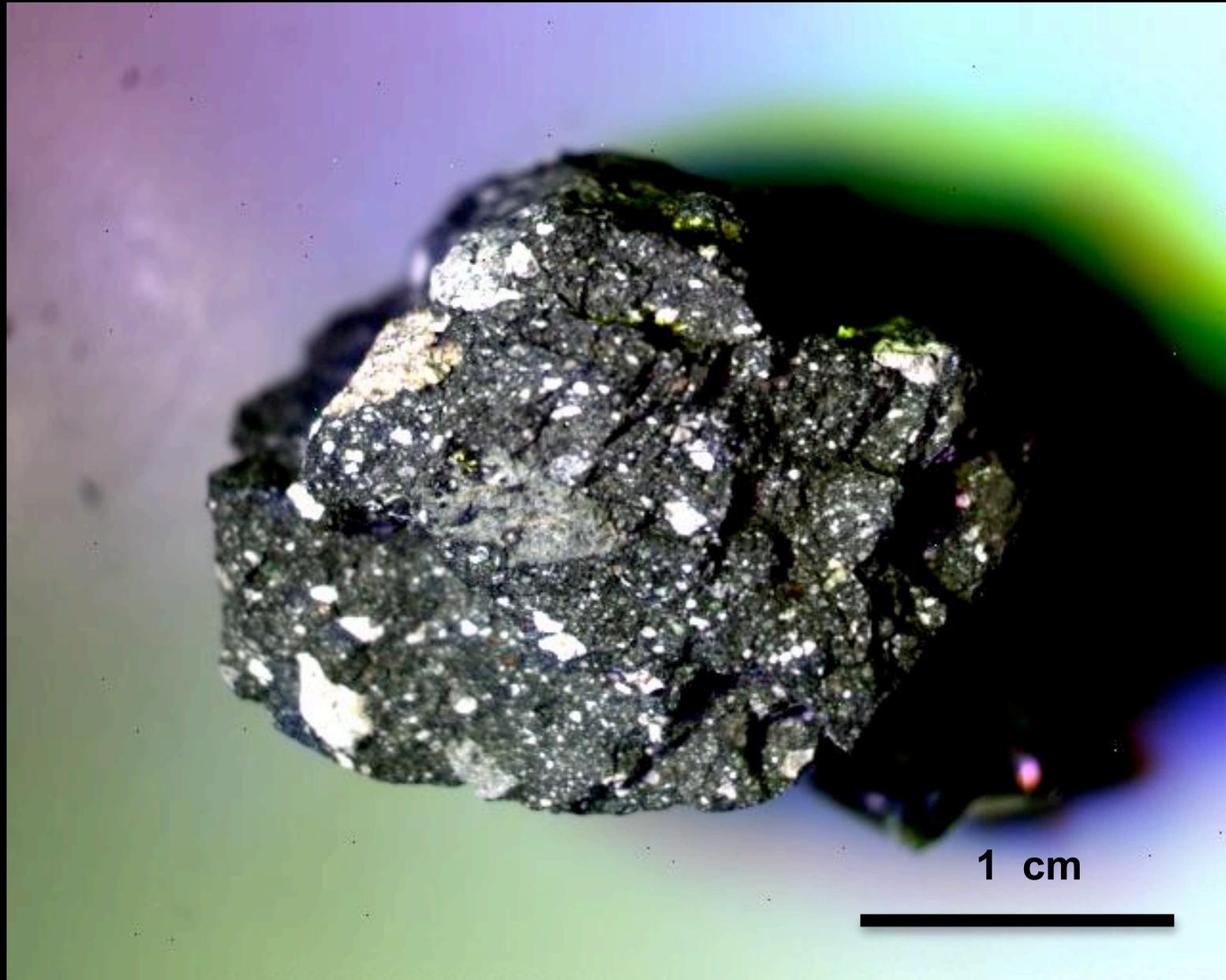
10048

glass-rich soil breccia



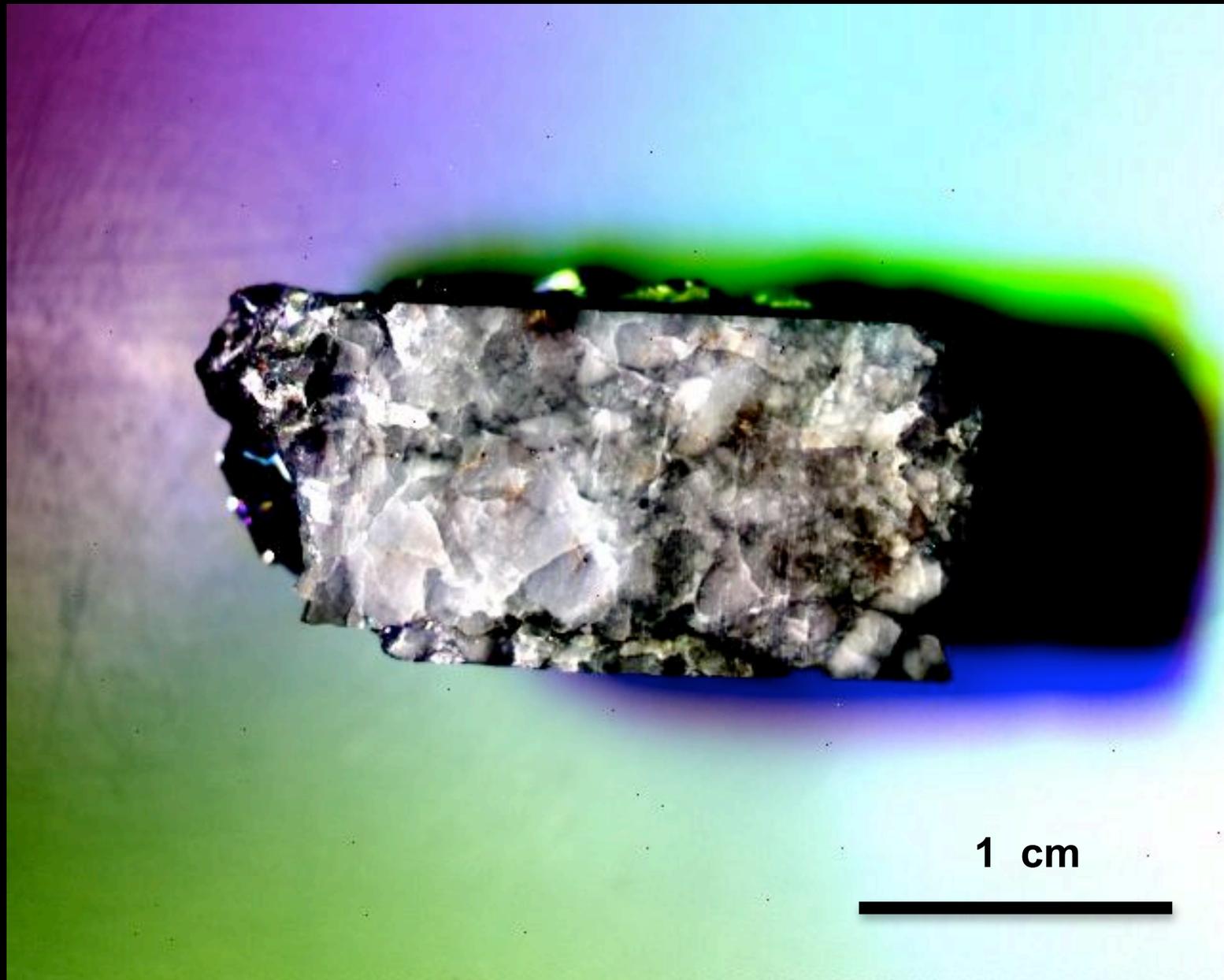
15459

coherent soil breccia with clasts



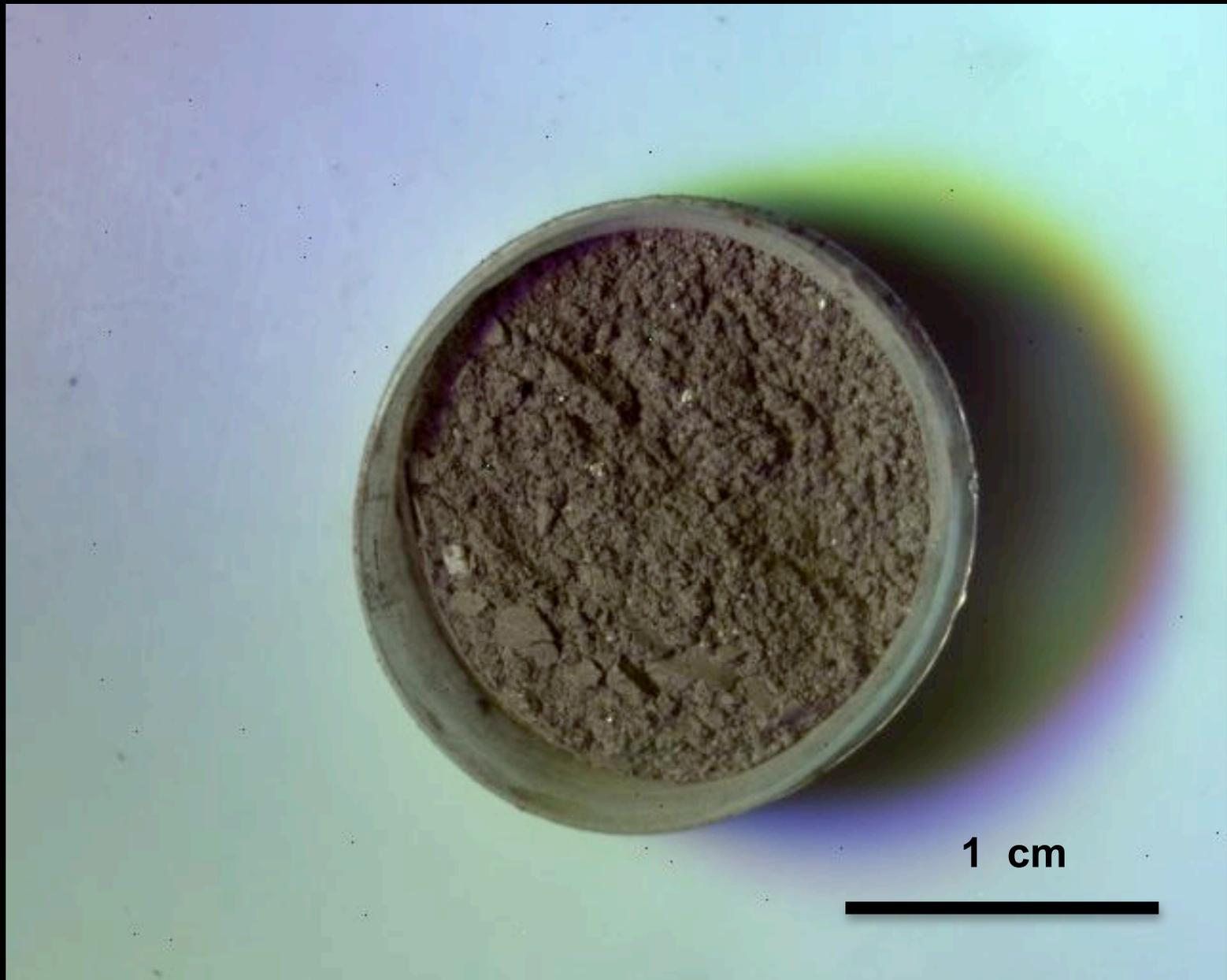
61016

melted anorthosite



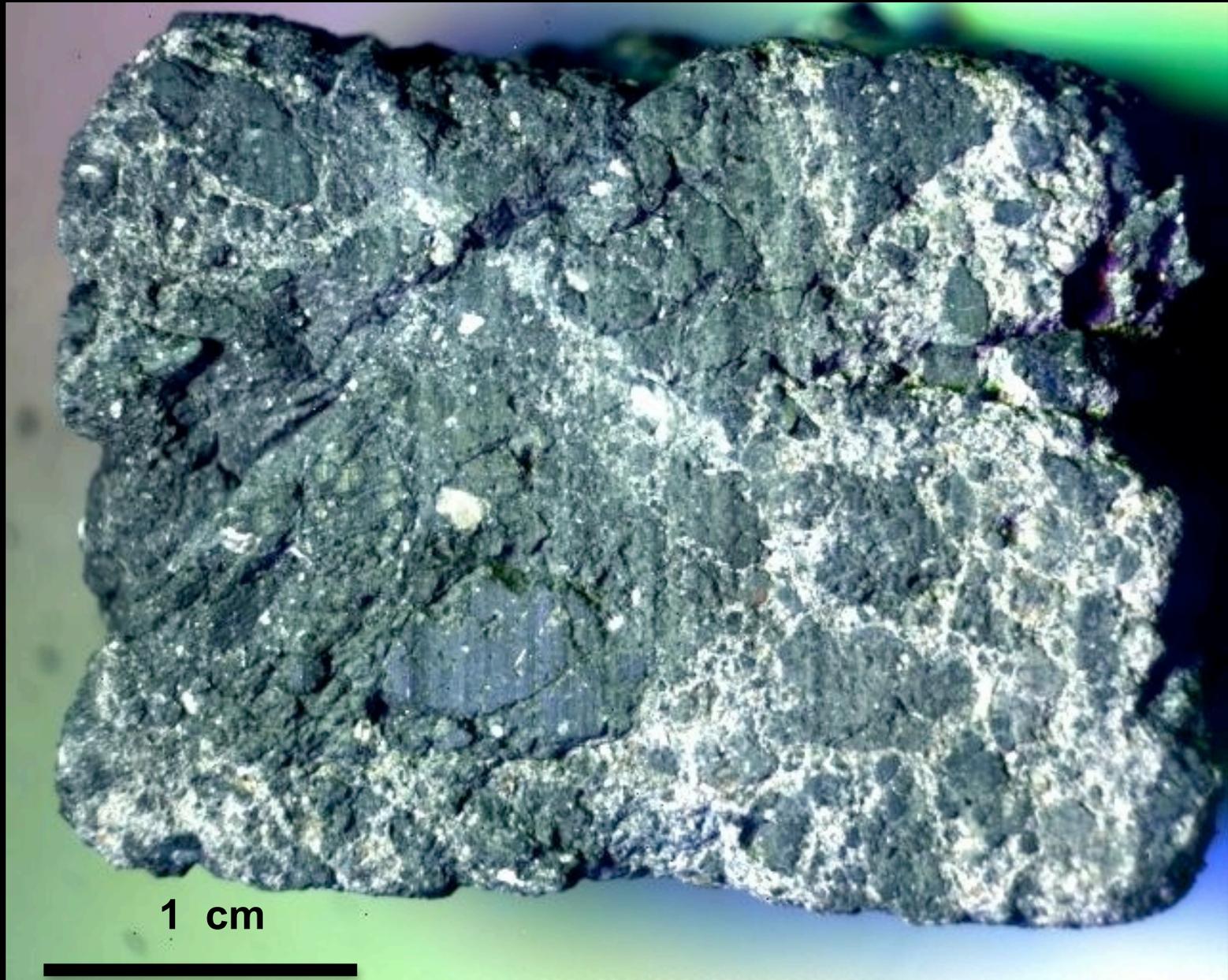
64501

aluminum-rich soil



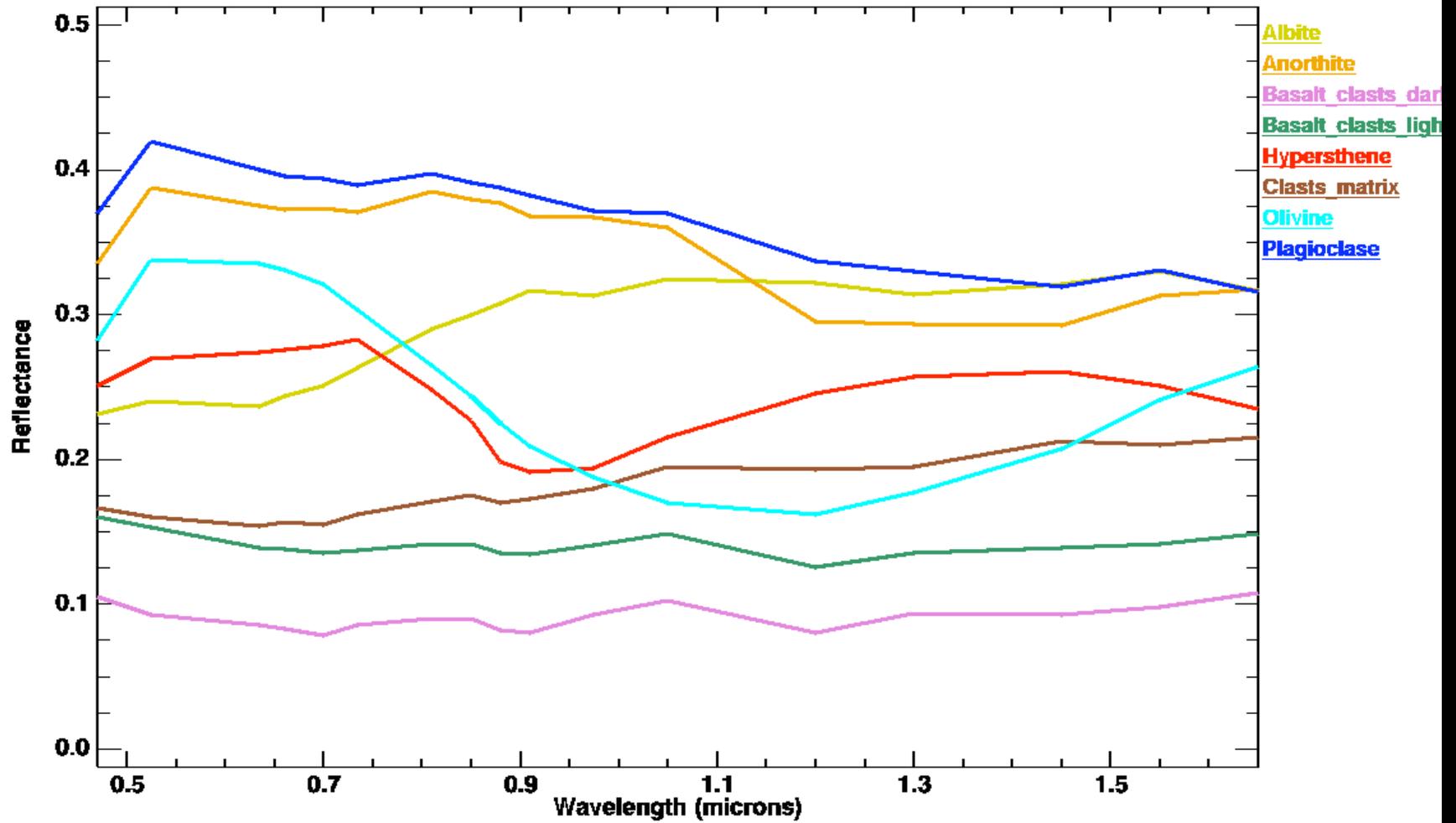
14321

crystalline breccia



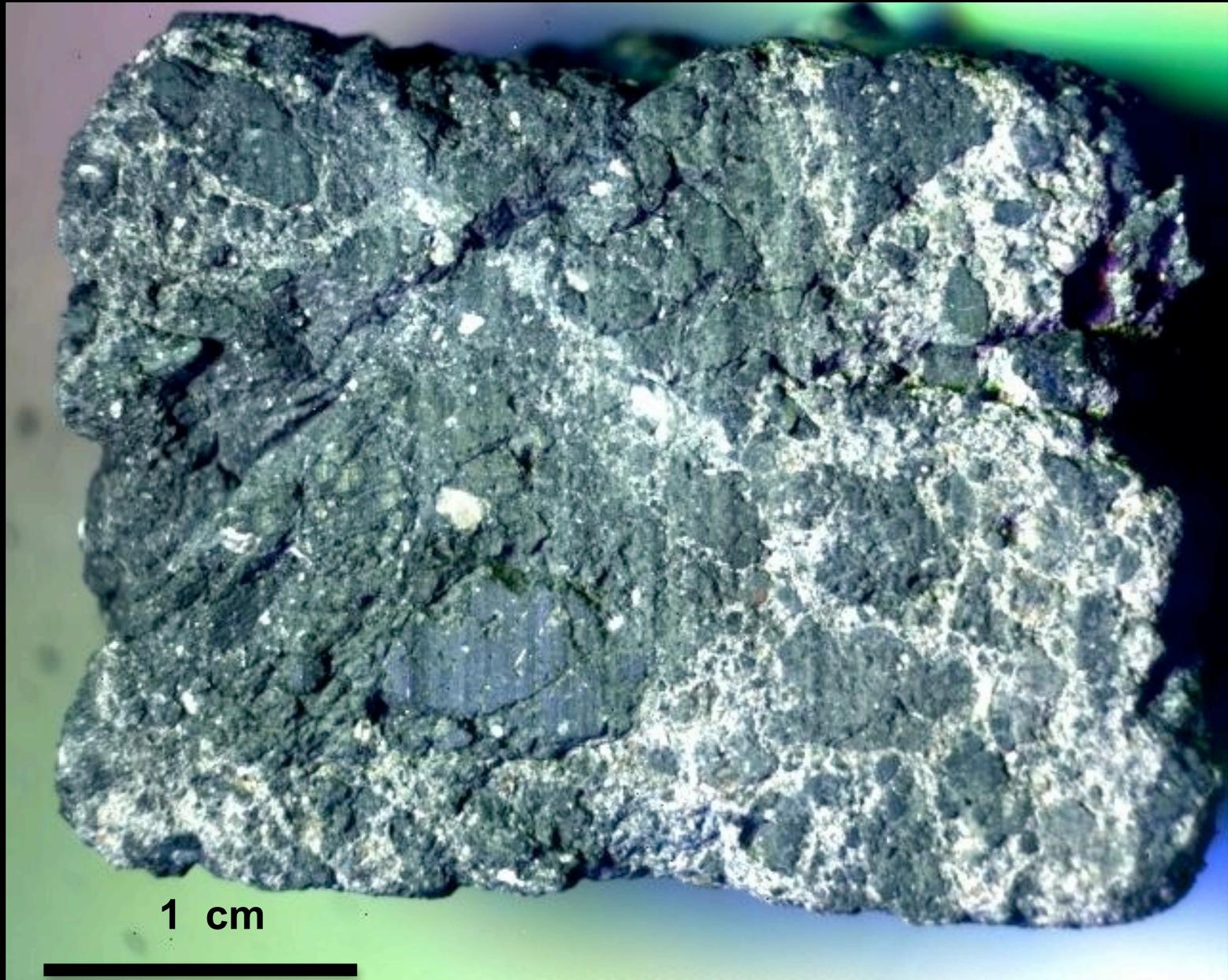
14321

crystalline breccia



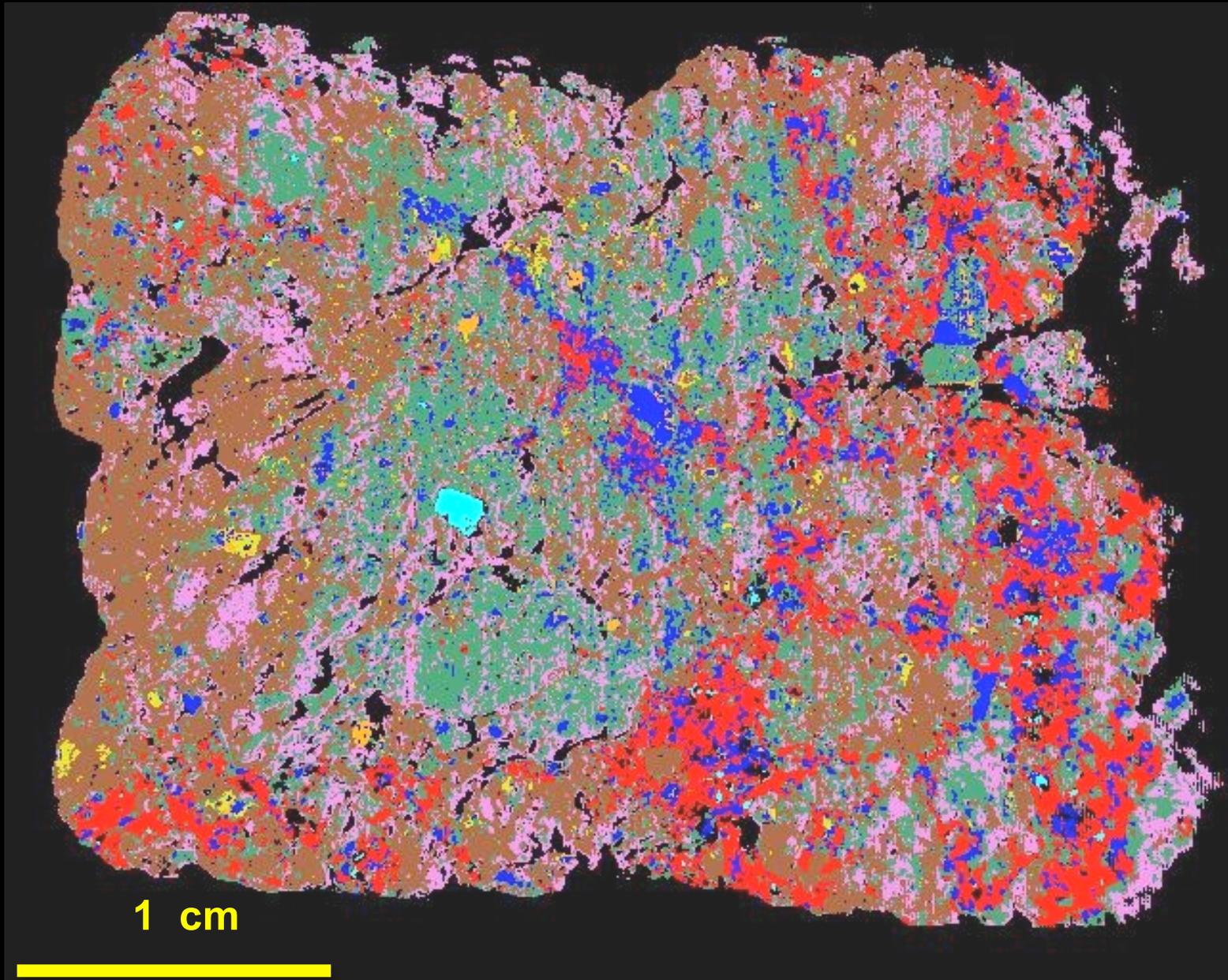
14321

crystalline breccia



14321

crystalline breccia



Do you have an instrument that would be useful for high-grading samples on the Moon ?

This could be your chance to prove it . . .